

Discussion paper: Interim results for NDC2 offshore mitigation price scenarios

24 October 2024; Contact Nik Black, Markets

Purpose

This document describes the process, assumptions, and initial results of the NDC2 offshore mitigation cost modelling exercise for consultation with internal stakeholders and Treasury. It draws on prior work papers and the 2023 Climate Economic and Fiscal Assessment (CEFA).

Related documents

[241016 Discussion note Offshore cost assumptions and scope.docx](#) – Scoping and assumptions initial discussion note

[240930 Offshore cost data sources.docx](#) – Analysis of potential data sources (see Appendix)

[241018 Modified for NDC2 CEFA - International NDC fiscal cost - calculator.xlsx](#) – Calculations workbook (modified from CEFA 2023)

Introduction

Offshore mitigation through Article 6 of the Paris Agreement is an option to support the ambition of New Zealand's second Nationally Determined Contribution (NDC2) for 2031-2035. The domestic emissions budget (EB3) for the NDC2 period is equivalent to an emissions budget of 240Mt CO₂-e and corresponds to an NDC2 target of ~51%. The Climate Change Commission's draft advice on feasible levels of domestic mitigation for the NDC2 period suggests that further domestic action is possible. Therefore, to achieve an NDC2 target greater than ~51%, offshore mitigation, domestic action beyond EB3, or a combination of both would be necessary.

This workstream aims to estimate the potential cost of offshore mitigation for the NDC2 period to inform Cabinet decisions on New Zealand's highest possible ambition and resultant NDC2 target. There is limited price information available in the Article 6 market as it matures. Greater visibility of price is available to countries actively engaged in Article 6.2 to source Internationally Transferred Mitigation Outcomes (ITMOs). This creates a high level of uncertainty for the Article 6 price pathway. The 2023 CEFA considered three potential price scenarios for offshore mitigation towards NDC1. A similar approach is adopted in this analysis, noting that the CEFA was for a public audience and its ability to draw on confidential information was limited.

Assumptions

Basic assumptions were discussed internally on 17 October.¹ Policy decisions on how offshore mitigation might be procured for New Zealand's NDCs is not in scope of this workstream.

Market conditions

- a. The prices increase at a constant annual rate between known data points. This allows for the model to use current prices, interim prices (i.e. 2030 values), and to extrapolate values for 2035.
 - a. Based on the available data, prices are expected to increase from now to 2035.

¹ [241016 Discussion note Offshore cost assumptions and scope.docx](#)

6(b)(ii)

- c. No significant price shocks before the end of 2035 (prices are smooth).
- d. The market price for ITMOs from carbon projects is similar across all countries in each scenario (or at least the average of purchased ITMOs equals the scenario prices).
- e. Inflation and nominal discount rates reflect published Treasury parameters for 30 September 2024.

9(2)(f)(iv)

Assumptions made by the International Energy Agency (IEA) World Economic Outlook 2024

- n. Advanced economies with net zero emissions pledges includes OECD countries except Mexico. These values are not used due to assumption (f).
- o. Selected emerging market and developing economies (EMDE) with net zero emissions pledges includes China, India, Indonesia, Brazil, and South Africa.
- p. Selected EMDE without net zero pledges means regions excluding OECD countries, selected emerging market and developing economies with net zero emissions pledges, developing Asia and sub-Saharan Africa.
- q. MfE assumes that resultant prices from either EMDE groups in the IEA 2024 analysis are representative of ITMO prices in the associated scenario (following CEFA 2023). This includes that the CO₂ price for electricity, industry, and energy prices is equivalent to the ITMO price.
- r. In the Net Zero Emissions by 2050 Scenario (used in this analysis), CO₂ prices cover all regions and rise rapidly across all advanced economies as well as in prominent emerging market economies with net zero emissions pledges, including China, India, Indonesia, Brazil and South Africa. CO₂ prices are lower, but nevertheless rising in other emerging market and developing economies such as North Africa, Middle East, Russia and Southeast Asia (excluding Indonesia). CO₂ prices are lower in the remaining emerging market and developing economies, as it is assumed they pursue more direct policies to adapt and transform their energy systems.
- s. All scenarios consider the effects of other policy measures alongside CO₂ pricing, such as coal phase out plans, efficiency standards and renewable targets. These policies interact with carbon pricing; therefore, CO₂ pricing is not the marginal cost of abatement as is often the case in other modelling approaches (but is assumed to be the ITMO price).

Method

Data

Several data sources were analysed in Appendix 1. MfE holds limited confidential information on offshore mitigation trends in 2031-2035 that might inform a price trajectory in the NDC2 period. CEFA 2023 used the IEA World Economic Outlook and 2017 Report of the High-Level Commission on Carbon Prices (HLCCP). The test applied to select a data source was whether any other data source is likely to be more accurate than the HLCCP 2017 and IEA WEO 2024 reports, and whether the figures reflect convergence between different data sources to buoy confidence in the data.

The IEA World Economic Outlook 2024 was selected because:

1. There was no clear rationale to prefer another data source based on the assessment in Appendix 1.
2. The IEA data was the most recent available (despite the price assumptions remaining unchanged since the 2022 report used for CEFA 2023).
3. The values presented were judged to be reasonable, considering the current market price and the other sources considered in Appendix 1.

The HLCCP report was not selected because the IEA data already infers a price trajectory, is more recent, and a single source maintains consistent assumptions.

The IEA World Economic Outlook 2024 includes several scenarios in table B.2 below. The CEFA 2023 report used the prices for advanced countries and selected EMDE with net zero emissions pledges under the 'Net Zero Emissions by 2050 Scenario.'

Table B.2 ▶ **CO₂ prices for electricity, industry and energy production in selected regions by scenario**

USD (2023, MER) per tonne of CO ₂	2030	2035	2040	2050
Stated Policies Scenario				
Canada	126	126	126	126
Chile and Colombia	21	24	28	28
China	39	43	46	52
European Union	140	145	149	158
Korea	56	65	73	89
Announced Pledges Scenario				
Advanced economies with net zero emissions pledges*	135	160	175	200
Selected emerging market and developing economies with net zero emissions pledges**	40	65	110	160
Other emerging market and developing economies	-	6	17	47
Net Zero Emissions by 2050 Scenario				
Advanced economies with net zero emissions pledges*	140	180	205	250
Selected emerging market and developing economies with net zero emissions pledges**	90	125	160	200
Selected emerging market and developing economies without net zero emissions pledges	25	50	85	180
Other emerging market and developing economies	15	25	35	55

* Includes all OECD countries except Mexico. ** Includes China, India, Indonesia, Brazil and South Africa. *** Regions excluding OECD countries, selected emerging market and developing economies with net zero emissions pledges, developing Asia and sub-Saharan Africa.

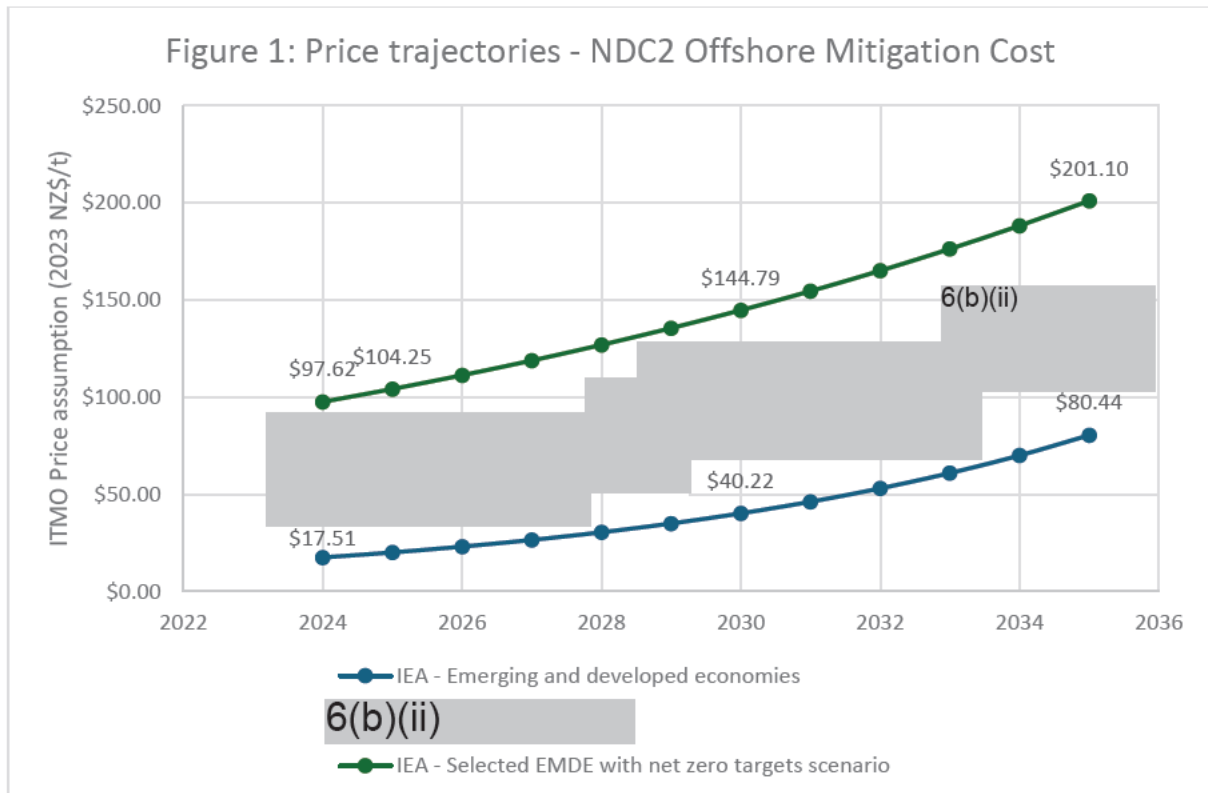
For NDC2 modelling, we selected under the 'Net Zero Emissions by 2050 Scenario:'

- Selected EMDE with net zero emissions pledges as a high-end estimate, because it roughly aligned with low-end estimates by EY and the high-end of estimates by the HLCCP (see appendix 1)
- Selected EMDE without net zero emissions pledges as a low-end estimate consistent with CEFA 2023, because it aligned with estimates by the HLCCP and IETA Capstone Report 2023 (see appendix 1).
- A mid-range scenario based on indicative current prices **6(b)(ii)** at the average rate of annual increase for the selected IEA scenarios. This draws on confidential prices disclosed to MfE.

Advanced economies scenarios were not used **9(2)(f)(iv)**

'Other EMDE' was not used because the CO2 prices are less than the assumed current price until 2035. The 'announced pledges scenario' was not used to reflect an ambitious global scenario compatible with the Paris Agreement objective to limit the global average temperature rise to 2 degrees and pursue efforts to limit the temperature increase to 1.5 degrees above pre-industrial levels and for consistency with CEFA 2023.

Domestic emissions are based on the third domestic Emission Budget (240Mt). Baseline emissions are gross 2005 levels from the 2024 Greenhouse Gas Inventory (86.62Mt). Projected emissions for 2030 are based on the ENZ model run for the First Biennial Transparency Report and projections for Tokelau.



Calculations

The Excel model² was modified from CEFA 2023 for efficiency. Full technical documentation for the original model is available in CEFA 2023 Technical Appendix two.³

The model computes the following steps:

1. **Determine the assumed volume of offshore mitigation purchases** – Currently computed by subtracting EB3 from the emissions budget corresponding to each NDC2 scenario. Purchases in the baseline results are assumed to be evenly distributed.
2. **Calculate price scenarios with associated trajectories from 2024-2035** – Assumes that prices increase at a constant rate, based on the difference between the 2030 and 2035 IEA price scenarios. For the indicative price scenario, the rate of price change is based on the average change between the selected IEA scenarios.
3. **Calculate annual purchase costs** by multiplying the assumed purchase volume by the per-tonne purchase price in each year.
4. **Discount the purchase costs to present value** – Convert the assumed purchase costs in each year based on Treasury’s real risk-free discount rates and sum the annual costs for a total cost. These are assumed as 2% for non-commercial proposals.

Sensitivity checks are performed to test the impact of a 1% increase to the real discount rate, a mandatory test of an 8% discount rate, and different purchase timing (currently a ‘back-loaded’ scenario of purchases late in the NDC2 period and a ‘front-loaded’ scenario of purchases in the late 2020s).

Differences to CEFA 2023

CEFA 2023 and this modelling are in different contexts. The CEFA report is a public-facing document that could not rely on confidential Government information. These NDC2 calculations are intended to inform Ministerial decisions on an NDC2 target level and may draw on confidential information.

Prices are treated differently to CEFA 2023. The annual rate of price increase based on IEA World Economic Outlook data (14.9% / 6.8%) is significantly higher than rate inferred from the HLCCP 2017 report (2.26%). The higher annual rate of change means that the total costs are much more sensitive to purchase timing than in CEFA 2023, where the price escalation rate is close to the applied real discount rate. Price escalation checks are also not performed, because different annual rates of change are now endogenous to the model. A potential extension could be to model various price escalation rates for each 2030 / 2024 price estimate.

Advanced economies and current ETS prices are not considered due to updated assumptions about how New Zealand might engage with the Article 6 market as it matures for NDC2. Current prices are inferred from current offers provided to MfE for ITMOs from developing countries instead of current trading prices for units in established ETSs.

Other adjustments include to extend the modelled range to 2035 and to assume domestic emissions are at EB3 levels for 2031-2035, although this can be adjusted.

² [241018 Modified for NDC2 CEFA - International NDC fiscal cost - calculator.xlsx](#)

³ [CEFA 2023 - Technical Appendix 2: Methodology for scenario analysis of fiscal risk from offshore mitigation](#)

Conclusions of initial analysis

Initial results are presented in Table 2 below. They are shown in present value 2023 billion New Zealand dollars to one decimal place to reflect the inherent uncertainty in the modelling.

Like in CEFA 2023, these results are **price scenarios** and reflect potential futures. They should not be interpreted as forecasts, estimates, or similar.

Offshore mitigation cost - NDC2 target level (%)					
	51	55	60	65	70
NDC2 Emissions Budget (Mt CO2e)	240	230.34	217.35	204.35	191.36
Additional mitigation above EB3 (Mt CO2e, assumed offshore)	0	9.66	22.65	35.65	48.64
Average price per tonne 2031-2035 (2023\$)	NZ\$60, ^{6(b)(ii)} , 173 (EMDE without net zero pledges, escalated current prices, EDME with net zero pledges)				
Cost range between scenarios (PV, 2023\$ billion)	0	0.5-1.4	1.1-3.2	1.8-5.1	2.4-6.9

6(b)(ii)

Table 2: Initial results - Offshore mitigation cost scenarios by NDC2 target

The results are highly sensitive to the timing of purchases and discount rate assumptions. Table 3 below shows the results of sensitivity checks on the initial results. The back-loaded scenario assumes that purchases are concentrated at the end of the NDC2 period. The front-loaded scenario assumes purchases are concentrated in the late 2020s (i.e. contracted for both NDC1 and 2). The baseline timing scenario assumes purchases are evenly distributed from 2031-2035. The discount rate scenarios are 8% and 3% (+1%) real risk-free discount rates to calculate costs in present values.

Sensitivity: Difference to total cost to the initial results by scenario (%)				
	Back-loaded	Front-loaded	Discount rate +1%	Discount rate 8%
IEA – EMDE without net-zero	11%	-41%	-10%	-47%
Indicative current prices	8%	-31%		
IEA – selected EMDE with net-zero	4%	-18%		

Table 3: Sensitivity check results – initial results

Outstanding points and next steps

Next steps are to check with Treasury whether there are rules of thumb and/or multipliers available to apply the cost of offshore mitigation as an economic cost and consult internally and with Treasury on this paper.⁴ The model has been peer reviewed internally.

The model was constructed to allow estimates of offshore mitigation costs across both the NDC1 and NDC2 period, including three potential emissions projections that are not currently in use. Minor changes would be required to enable this functionality (see below). Several checks have also been added to support the model's use in different contexts.

Current limitations are:

1. The model is only compatible with input price data from 2024, 2030, and 2035 due to calculations on sheet 'Calcs – Price Scenarios' and only in USD.
2. For NDC1 calculations, emissions projections and actual emissions for 2021-2030 will need to be updated in sheet 'Inputs' and calculations in sheet 'Calcs – Volume Scenarios' to compare cumulative domestic emissions from 2021-2035 against assumed NDC emissions budgets for both periods.
3. Inputs are current as of 30 October 2024.
4. The model can compute up to five NDC2 target scenarios.

⁴ MfE, Treasury, and MPI met on 6 November to discuss the economic and fiscal estimates of NDC2 target levels. We agreed to present offshore mitigation costs as fiscal, clearly noting the difference between the economic figures for domestic abatement. CEFA 2023 references were also to be caveated since the report served a different purpose.

Appendix 1: Offshore cost data sources

Source	Description	Pros	Cons	Value in 2035 (CAGR)
<p>IEA World Energy Outlook 2024</p> <p>Note: 2024 report released on 16 October.</p>	<p>Used in the 2023 CEFA report for point estimates in 2030.</p> <p>What: Cost per tonne of carbon dioxide in selected domestic compliance emissions markets. Includes aggregated values for OECD economies excluding Mexico, a subset of emerging economies (China, India, Indonesia, Brazil, and South Africa), and other developing countries. Years available are 2030, 2040, and 2050.</p> <p>Key assumptions: Not equal to the marginal cost of abatement. Pricing schemes cover energy-related sectors. No emissions pricing assumed in Sub-Saharan Africa (excluding SA) and Other Asia regions.</p>	<ul style="list-style-type: none"> Provides values for advanced and emerging economies. Precedent for use in CEFA Recent modelling. Includes both 2030 and 2040 values. 	<ul style="list-style-type: none"> Represents the price in compliance emissions trading schemes which may not map to ITMOs. Emerging economies are a limited subset and may not be New Zealand's ITMO partners. Modelling covers energy-related sectors, which are a sub-set of potential ITMO sources. No 2035 value. 	<ul style="list-style-type: none"> TBC Based on 2023: Advanced economies = \$170 (4%) Developing economies = \$46 (13%) 2022 USD
<p>Report of the High-Level Commission on Carbon Prices. (2017)</p> <p>https://www.carbonpricingleadership.org/report-of-the-highlevel-commission-on-carbon-prices</p>	<p>Used in the 2023 CEFA to calculate the expected annual growth rate of carbon prices. A compound annual growth rate of 2.26% was inferred from the difference in price per tonne from 2020 (US\$40-80) to 2030 (US\$50-100).</p> <p>Based on compliance emissions pricing through cap and trade or a carbon tax. Linked to IEA analysis on energy prices. Explicitly based on professional judgement.</p>	<ul style="list-style-type: none"> Precedent for use in CEFA Reputable source 	<ul style="list-style-type: none"> Price estimates highly structured and not clearly analytical (\$40-80 to \$50-100 with a 20% total change) Not recent No values past 2030 means difficult to imply price trajectory will continue uniformly 	<ul style="list-style-type: none"> US\$55-110 (2.26%) Nominal?
<p>Intergovernmental Panel on Climate Change</p>	<p>The IPCC uses global socioeconomic trajectories to describe potential pathways that influence</p>	<ul style="list-style-type: none"> Based on IPCC modelling 	<ul style="list-style-type: none"> Global and economy-wide average 	<ul style="list-style-type: none"> SSP1-1.9 = \$637 (6%)

Source	Description	Pros	Cons	Value in 2035 (CAGR)
Scenarios Data Explorer Shared Socioeconomic Pathways	<p>climate change. These pathways may achieve different or the same temperature outcomes in 2100.</p> <p>The models use a global, economy-wide carbon price as a proxy for climate policy.</p> <p>A recent Treasury report used prices from SSP1-1.9, SSP1-2.6, and SSP2-4.5 to provide indicative carbon price ranges under different global temperature and trajectory scenarios.</p>	<ul style="list-style-type: none"> Considers different global trajectories. 	<ul style="list-style-type: none"> Used as a proxy for climate policy and may not translate to ITMO prices. Not recent 	<ul style="list-style-type: none"> SSP1-2.6 = \$78 (8%) SSP2-4.5 = \$15 (-5%) 2022 USD
<p>Price history of selected compliance emissions pricing markets</p> <p>OR price projections of selected compliance markets</p> <p>6(b)(ii)</p> <p>IEA World Energy Outlook 2024 likely to include EU estimate</p>	<p>The 2023 CEFA based one price scenario on the average of 2022 prices of the UK, EU, WCI, and South Korean ETS' inflated by the assumed annual growth rate. These were selected on the basis of capturing different parts of the world.</p> <p>The indicative 2030 range was from ~\$25 per tonne (South Korea) to ~\$140 per tonne (EU).</p> <p>Officials are aware of some price estimates for the EU and WCI ETS prices for 2030, based on analysis of these individual markets.</p>	<ul style="list-style-type: none"> 6(a) The selected markets are more mature than other Article 6 markets and their price signals may be more reliable. Secondary price estimates for 2030 are recent 	<ul style="list-style-type: none"> The average of a ~\$25-140 range may be misleading. The global average annual growth rate may not be accurate applied to a limited, selected sample. May be uncorrelated with ITMOs sourced from developing countries. Price estimates from some sources are for 2030 with no clear inference to 2035. 	<p>6(b)(ii)</p> <ul style="list-style-type: none"> Nominal USD? EU (WEO 23) = \$124.5 (0.7%) 2022 USD
<p>IETA Capstone Report 2023 6(b)(ii)</p> <p>IETAA6 CapstoneReport 2023.pdf</p>	<p>IETA considered the global Article 6 carbon price in 2030 and 2050 based on full cooperation or the impact of key buyers / sellers exiting the market.</p>	<ul style="list-style-type: none"> Article 6 specific estimates Recent estimates Allows for some judgement on whether 	<ul style="list-style-type: none"> No ability to consider multiple scenarios concurring simultaneously 	<p>6(a)</p>

Source	Description	Pros	Cons	Value in 2035 (CAGR)
	<p>The scenarios include prices for full cooperation and those involving the individual exit of China, India, Brazil, Russia, US, EU, or US + Canada.</p> <p>Assumptions not listed.</p>	<p>key countries would participate</p>	<ul style="list-style-type: none"> • Global price without regional variation • Only values for 2030 and 2050 • Assumptions not listed 	<p>6(a)</p>
<p>EY report: Essential, expensive and evolving: The outlook for carbon credits and offsets</p> <p>ey-net-zero-centre-carbon-offset-publication-20220530.pdf (hubspotusercontent-na1.net)</p>	<p>Considered a central price estimate of four scenarios: nature-enabled net zero, tech-enabled net zero, below 2C, and announced plans.</p> <p>Some assumptions are detailed but not the full methodologies. Assumes current price of US\$25/t.</p>	<ul style="list-style-type: none"> • Includes a 2035 estimate • Current price consistent with quoted prices 	<ul style="list-style-type: none"> • High variation between scenarios • No clear view of the methodology • Single global economy-wide 	<ul style="list-style-type: none"> • US\$90-170 (12.5%) • 2022 USD