He Pou a Rangi Climate Change Commission

Report on the potential domestic contribution to Aotearoa New Zealand's second nationally determined contribution

October 2024

Disclosure statement

As anticipated by the appointment criteria, our board members come from varying fields such as adaptation, agriculture, economics, te ao Māori and the Māori—Crown relationship. While a number of board members continue to hold roles within these fields, our advice is independent and evidence-based. The Commission operates under its Interests Policy, which is derived from the Crown Entities Act 2004. You can read more about our board members on the Climate Change Commission website. The Commission regularly updates and publishes on its website a register of relevant board interests.

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Part A: Context and results

Scope

In June 2024, the Minister of Climate Change (the Minister) requested a report from the Commission on how much reduction in domestic emissions Aotearoa New Zealand could feasibly achieve as part of its second nationally determined contribution (NDC2), and, where possible, the impacts associated with those emissions outcomes. This request supersedes the 2023 request from the previous Government.

The Minister's request was made under section 5K of the Climate Change Response Act (the Act). As with all the statutory deliverables on the Commission's work programme, the Act places strict requirements on the scope and considerations for our advice.

Due to the timing of this request, we have altered our usual approach to producing a report for the Minister and have opted for a technical, focussed briefing that re-uses analysis from our *Draft advice on the fourth emissions budget*. Additional background and context for the draft scenarios for future emissions provided in that draft advice can be found on our website.[1]

Any use of international cooperation as part of NDC2 is outside the scope of the Minister's request to the Commission and not covered by this report. This should be considered when using our advice.

The Commission was not asked for advice on what NDC2 should be. This report provides independent advice on one aspect of the Government's consideration of an appropriate NDC2 commitment. In addition to the achievability and impacts of net domestic emissions reductions as covered by this report, the Government's NDC2 decision is likely to also need to consider:

- policies in the final second Emissions Reduction Plan (ERP2) and the contribution they make to the third emissions budget (and NDC2 period), being 2031–2035
- international obligations under the Paris Agreement, including Article 4, paragraphs 2[2] and 3[3]
- Aotearoa New Zealand's national circumstances
- the need for stronger collective global action to be consistent with the Paris Agreement's long term temperature goal (per the first global stocktake under the Paris Agreement)
- available information about plans for strengthened targets among other countries
- opportunities and risks of any international cooperation for the NDC2 target
- latest emissions projections.

The Government will also need to consider how it will present the NDC2 target and how it will measure progression between its first nationally determined contribution (NDC1) and NDC2, including any contribution from international cooperation. The numerical analysis in this report can help inform the

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[1] He Pou a Rangi Climate Change Commission. (2024). *Draft advice Aotearoa New Zealand's fourth emissions budget*. https://www.climatecommission.govt.nz/our-work/advice-to-government-topic/preparing-advice-on-emissions-budgets/advice-on-the-fourth-emissions-budget/draft-advice-emissions-budget-4/

[2] "Each Party shall prepare, communicate and maintain successive nationally determined contributions that it intends to achieve. Parties shall pursue domestic mitigation measures, with the aim of achieving the objectives of such contributions."

[3] "Each Party's successive nationally determined contribution will represent a progression beyond the Party's then current nationally determined contribution and reflect its highest possible ambition, reflecting its common but differentiated responsibilities and respective capabilities, in the light of different national circumstances."

Government's decision but is not advice about how to present the target, how to measure progression or whether a given emission level represents progression.

Due to the timing of the Minister's request, this report relies on draft scenarios for future emissions out to 2050 that were developed for our *Draft advice on the fourth emissions budget*. The Commission consulted on this draft advice between 8 April and 31 May 2024 and supporting documents can be found on the Commission's website. These scenarios take into account government policies as at July 2023 and the 2023 New Zealand Greenhouse Gas Inventory (GHG Inventory). New information, including updated GHG Inventory data, government policy, government emissions projections, and the feedback received through engagement on our *Draft advice on the fourth emissions budget* will change the scenarios. When considering NDC2, the Government should consider the most recent information available, including the Commission's updated emission scenarios to be published by the end of the 2024 in the final advice on the fourth emissions budget.

Our scenarios are not predictions or forecasts, and they are not prescriptive. Rather they illustrate what multiple credible outcomes across the economy could mean in total if the underpinning actions and assumptions play out. Uncertainty in the assumptions behind the draft scenarios is likely to affect the feasibility of emissions reductions and removal levels, as well as the associated impacts and their distribution. The mix of actions across sectors, managing impacts and handling risk and uncertainty, are things for the Government to consider as part of emissions reduction plans, in setting NDC2 and any potential approach to international cooperation.

The report includes comparison of draft scenarios and domestic emissions budgets for information only. It is indicative and not advice about the budgets or the adequacy of the draft scenarios to meet them.

In line with the scope of Minister's request, we have not considered the impact of any future changes to Aotearoa New Zealand's emissions accounting approaches. These scenarios are contingent on the accounting methodologies in place at a given time. If the Government makes changes to its emissions accounting approach for NDC1 and NDC2, such as updating the NDC1 budget or accounting for land use, land use change and forestry[4], the analysis in this report should be re-considered in light of the new circumstances, to remain a useful input into NDC2 decision making.

Compliance with the terms of reference and the Climate Change Response Act 2002

The terms of reference provided by the Minister for this section 5K request under the Act are published on the Commission's website.[5]

This report complies with the terms of reference by:

- presenting three scenarios of domestic emissions for 2022–2050, based on feasible assumptions for emissions reductions and removals and plausible rates of change in technology, systems, and the cost of mitigation options (Part B and Table A5)

[4] including publishing details of a Forest Reference Level or plans to make use of additional natural sinks and sources

[5] He Pou A Rangi Climate Change Commission (n.d.). *Report on the domestic contribution to the second nationally determined contribution.* https://www.climatecommission.govt.nz/public/Advice-to-govt-docs/NDC2/NDC2-s5k-CCRA-TOR.pdf

- describing the underpinning actions and assumptions within these scenarios that reduce and remove emissions by sector (Part B)
- describing, where possible based on available evidence and modelling, associated positive and negative impacts (Part B)
- including a variety of approaches for target presentation and emissions accounting (Table 3) and including a presentation of domestic emissions for the NDC2 period that facilitates straightforward comparison with NDC1 (Table 3 and Table 4) and domestic emissions budgets (Table 5).

This report has been prepared consistently with the purpose provision of the Act (section 3) and of the Commission (section 5). By supporting Government decisions on NDC2, the report helps "enable New Zealand to meet its international obligations under […] the Paris Agreement" (section 3(1)(a), in particular article 4, paragraphs 2[6] and 3[7] of the Paris Agreement.

We also considered all section 5M matters under the Act.

Our work draws on engagement with iwi/Māori and stakeholders, including through our call for evidence[8] in 2023, to understand a broader context around some of the actions that we are assessing, gain insights into latest trends, and test our assumptions.

Through engagement, previous consultations, and Maui.Tech case studies we have heard about iwi/Māori climate leadership, expressed through intergenerational taiao strategies and grounded in tikanga and mātauranga Māori. A key element for Aotearoa New Zealand to reduce emissions is engagement with iwi/Māori to continue climate leadership. Our analysis and engagement with communities shows this will support faster emissions reduction and help achieve an equitable transition for the benefit of all New Zealanders – as set out in our December 2023 advice to the Government on its next emissions reduction plan.[9]

Results

Detailed results are presented in Part B of this report, with additional technical material in appendices and published on our website.

It is our understanding that Aotearoa New Zealand intends to meet the NDC1 commitment (2021–2030) through both domestic action and international cooperation to reduce net emissions.[10] Our analysis

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[6] "Each Party shall prepare, communicate and maintain successive nationally determined contributions that it intends to achieve. Parties shall pursue domestic mitigation measures, with the aim of achieving the objectives of such contributions."

[7] "Each Party's successive nationally determined contribution will represent a progression beyond the Party's then current nationally determined contribution and reflect its highest possible ambition, reflecting its common but differentiated responsibilities and respective capabilities, in the light of different national circumstances."

[8] He Pou A Rangi Climate Change Commission. (2024). *Call for evidence: Emissions reduction targets and emissions budgets.* https://haveyoursay.climatecommission.govt.nz/comms-and-engagement/p2050/

[9] He Pou a Rangi Climate Change Commission. (2023). *2023 Advice on the direction of policy for the Government's second emissions reduction plan*. https://climatecommission.govt.nz/public/Advice-togovt-docs/ERP2/final-erp2/ERP2-Final-Advice-forweb.pdf

[10] International cooperation refers to activities under Article 6 of the Paris Agreement, which might include, for example, purchasing emissions reductions generated overseas.

shows that it would be feasible to achieve greater net emissions reductions in the NDC2 period (2031–2035) than the NDC1 commitment, through domestic action alone.

Actions would be needed before 2031 to achieve the emission reduction and removal actions for the NDC2 period within these draft scenarios. Beyond 2035 emissions levels continue to fall in the draft scenarios, which could impact future NDCs. Delays in taking action, or policies that promote higher emissions activities and behaviours, risk the indicated emissions reductions and removals becoming unachievable over the NDC2 period, and beyond.

As noted above, the feasible level of emissions reductions and removals for the NDC2 period and associated impacts under these draft scenarios may change based on feedback we received during consultation on the *Draft advice on the fourth emissions budget*, changes in government policy since July 2023, the updated GHG Inventory, and updated emissions projections released by Government. Any Government changes to emissions accounting could also change the results.

Our analysis does not constitute advice on an appropriate level for NDC2, an appropriate target presentation, whether a given emissions level represents progression on NDC1, or how to measure progression. The Government will need to make its own decision about an appropriate NDC2 commitment, including any international cooperation, considering Aotearoa New Zealand's international obligations.

Part B: Technical analysis

Analytical approach

Scenario structure

Our analysis draws on the scenario structure and modelling from our *Draft advice on the fourth emissions budget*. In this advice we present three draft scenarios: a scenario with a higher level of change called High Technology and High Systems Change (draft HTHS), a scenario with a lower level of change called Low Technology and Low Systems Change (draft LTLS), and a central pathway (draft EB4 demonstration path)[11], as well as a reference scenario reflecting government policies at 1 July 2023. Focusing on these potential futures allows demonstration of a range of scenarios the Government can consider in determining Aotearoa New Zealand's domestic contribution to NDC2.

We found the three draft scenarios all result in lower net emissions than the reference scenario, but differ in the speed and adoption rates of technology and systems change, with the draft HTHS achieving more emissions reductions sooner. Systems change achieves reductions in emissions by changes in behaviours or practices, often with co-benefits such as health or environmental savings. Examples of high systems change include converting more marginal and erosion prone land to native forests or shifting more trips from light vehicle travel to walking, cycling and public transport.

While this advice focuses on the NDC2 period (2031–2035), it draws on our draft scenarios covering the period 2022–2050. It is important to consider the full scenario period, as a significant amount of the emissions reductions in the NDC2 period result from actions taken prior to 2031. Likewise, emissions reductions that occur after 2035 are linked to actions taken in the years prior.

All draft scenarios are designed to be technically and economically achievable, assuming plausible rates of change in technology, systems, and the price of mitigation options. The draft HTHS assumes a relatively ambitious pace and scale of change and more optimistic assumptions over technology readiness.

All draft scenarios are at or below zero net accounting emissions of greenhouse gases, other than biogenic methane, in 2050 and subsequent years, with a contribution from carbon dioxide removals through ongoing afforestation.

Assessing impacts

The Act requires us to consider a broad range of matters when developing our advice, including matters under section 5M, where relevant.

Our approach to section 5M matters in the report includes:

- considering current scientific knowledge, technological developments, and economic and broader impacts and their distribution when developing the draft scenarios

[11] Estimates for total net emissions, and emissions by sector, are taken from our draft EB4 modelling results in ENZ. Estimates for the overall impact to the economy are taken from C-PLAN. ENZ and CPLAN are both Commission models and were quality assured, internally and externally, prior to releasing our EB4 consultation draft. Details of the assumptions in each scenario, model outputs, and supporting material about the models can be found on our website.

- assessing specific effects on iwi/Māori informed by feedback from previous engagement
- considering the actions of other countries, as part of impact and sensitivity analysis when developing the draft scenarios (e.g. international emissions pricing and trade competitiveness).

For this report, we estimate impacts in relation to the NDC2 period. As in our *Draft advice on the fourth emissions budget*, we have included selected (co-)benefits and negative impacts where evidence or modelling is available.

For each sector we detail the key emissions reduction and removal actions for each draft scenario and their likely effect on emissions. For brevity we generally don't describe an action more than once if it does not differ between scenarios, and we focus our description on the incremental (ie. 'additional') actions that reduce emission further in the draft EB4 demonstration path and HTHS scenarios relative to the draft LTLS.

As in our *Draft advice on the fourth emissions budget*, the analysis focuses on the following emitting sectors:

- energy
- industrial processes and product use (IPPU)
- transport
- agriculture
- forestry
- waste.

Sectoral actions and impacts

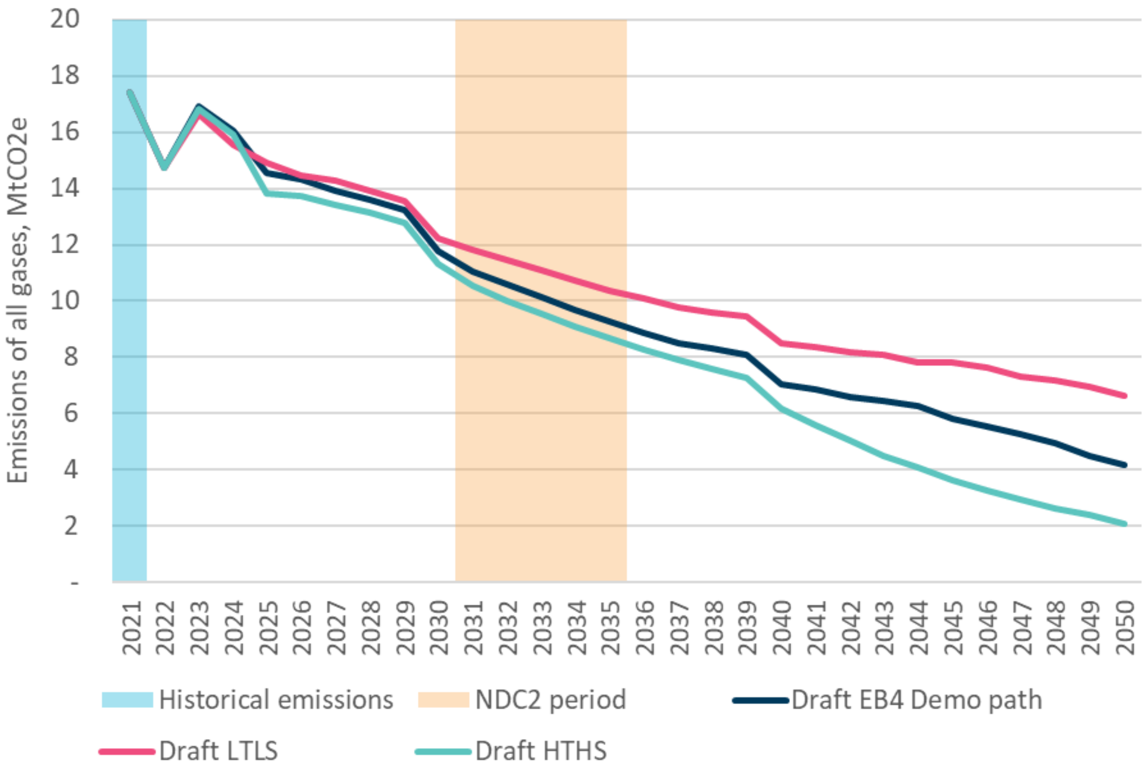
Energy

Figure 1 shows energy sector emissions under the draft scenarios. Energy emissions come from burning fuels to produce useful energy (for example industrial heat to produce milk powder), as well as emissions from electricity generation. In 2021 energy sector emissions accounted for 22% of Aotearoa New Zealand's gross emissions.[12] Note that transport emissions are covered separately in a later section. This differs to the GHG Inventory, which reports transport as part of energy sector emissions.

The energy sector plays a crucial role in decarbonising other sectors' emissions. For example, increasing our capacity to generate, transmit, and distribute renewable electricity is necessary to facilitate the electrification of transport, homes, and buildings. Energy users can also play an important role in efficient energy use and in managing electricity demand during periods of tight supply, such as short-term peaks during winter mornings and evenings, as well as for longer durations when inflows to the hydro lakes are low.

[12] Commission analysis: *ENZ results for draft EB4 advice* available on our website.

Figure 1: Energy sector emissions



Source: Commission analysis

Energy actions in our draft scenarios to 2030

To enable emissions reductions in the NDC2 period at levels implied from our three draft scenarios, we assume the following actions have occurred by 2030:

- 45–50 TWh of renewable electricity generation in 2030 (up from 35 TWh in 2021, a 27–42%[13] increase)
- ongoing efforts to transition to low carbon energy sources in process heat (leading to phasing out coal for low-medium temperature process heat by 2037)
- geothermal carbon capture and reinjection at 100% efficacy for Ngāwhā, expanded to Ōhaaki at 80% efficacy (by 2026).

Note all draft scenarios assume one methanol train[14] closure by the end of 2029.

Key actions in the NDC2 period for energy

Key opportunities to reduce emissions in this sector including transitioning away from fossil fuels in electricity generation and industry, increasing supply of renewable electricity, energy efficiency and

[13] Percentage changes do not precisely match TWh changes shown here due to calculating with precise numbers then rounding results.

[14] This refers to methanol manufacturing by Methanex NZ.

demand management for electricity, and deploying further carbon capture and reinjection technology to reduce fugitive emissions from geothermal electricity generation.[15]

None of our draft scenarios include abatement opportunities for preventing fugitive emissions from fossil fuel extraction and distribution due to uncertainty about whether mitigation technology will be deployed in New Zealand. The emissions impact from the combustion of oil and gas also far outweighs the emissions associated with its production. Our draft scenarios assume fugitive emissions from oil and gas production decrease in line with the shift away from fossil fuel consumption.

Energy emissions in the draft Low Technology Low Systems Change scenario

Low carbon energy transition

In this draft scenario, there is a transition from fossil fuels to low carbon energy sources over longer timelines relative to the draft EB4 demonstration path and draft HTHS scenarios for process heat, space and water heating, and off-road mobile machinery (for example, commercial fishing vessels, and farm, forestry, and mining machinery). This includes a gradual and then complete shift away from:

- coal in commercial buildings by 2037
- coal in low-medium temperature process heat applications (such as food processing) by 2037
- fossil gas in low-medium temperature process heat applications (such as food processing) by 2050
- fossil gas in space and water heating for commercial/residential buildings by 2060
- electrification of mobile machinery and offroad vehicles.

Increasing supply of renewable electricity

This draft scenario also requires increasing supply of renewable electricity, with generation increasing from 45 TWh in 2030 to 52 TWh in 2035.[16]

Improved demand management for renewable electricity

Improved demand management for renewable electricity, including energy efficiency, plays a role in this draft scenario. The draft LTLS scenario assumes low levels of electricity system demand side response[17] (compared to very low levels in the reference scenario). Improved energy efficiency also means electricity demand for space and water heating reduces by 12% for households by 2050 versus 2020, and 33% in commercial settings.

Geothermal carbon capture and reinjection

Geothermal carbon capture and reinjection reduces total emissions from new fields by 50% compared to a counterfactual of no deployment of this technology to new fields.

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[15] Geothermal electricity generation results in fugitive emissions of CO_2. This technology enables these emissions to be captured and reinjected into the field. While this reinjection is not permanent, the technology can continue to capture and reinject these emissions over time.

[16] Not including co-generation of heat and electricity.

[17] These are measures that enable electricity consumers, in particular high users, to reduce their electricity consumption during periods of constrained supply, and/or high prices.

Energy emissions in the draft EB4 demonstration path

The draft EB4 demonstration path assumes further measures to shift away from coal in cement production by 2035, a faster shift away from fossil gas in space and water heating for commercial/residential settings (by 2050, 10 years sooner than the draft LTLS) and faster electrification of mobile machinery and offroad vehicles.

In this draft scenario, renewable electricity generation increases a further 5 TWh to 57 TWH in 2035.

In terms of demand management for renewable electricity, the draft EB4 demonstration path assumes medium levels of electricity system demand side response, and higher reductions in household and commercial space/water heating demand (-19% and -43% by 2050 versus 2020 respectively).

For geothermal carbon capture and reinjection, we assume an increase in efficiency for Ōhaaki (90%), other existing fields (83%) and new fields (90%).

Energy emissions in the draft High Technology High Systems Change scenario

In this draft scenario, the low carbon energy transition is accelerated by:

- faster shift away from fossil fuels in low-medium temperature industrial process heat (by 2045, five years sooner than the draft EB4 demonstration path)
- faster shift away from coal in cement production (by 2030, five years sooner than the draft EB4 demonstration path)
- fastest electrification of mobile machinery and offroad vehicles.

In this draft scenario, renewable electricity generation increases a further 2 TWh to 59 TWh in 2035. We assume greater capital cost reductions for renewable electricity generation, and a faster cost reduction for grid scale batteries (-4% per annum). We also assume high levels of electricity system demand side response. Geothermal carbon capture and reinjection increases in efficacy for Ōhaaki (100%) and new fields (100%).

Summary of impacts

Emissions levels

In the draft LTLS scenario, we estimate gross emissions of all greenhouse gases from energy in the NDC2 period to be 55.4 $MtCO_2e$. Additional effort in the draft EB4 demonstration path would reduce emissions in this period by 9% (-4.7 $MtCO_2e$). In the draft HTHS scenario emissions reduce a further 2.8 $MtCO_2e$ to 47.9 $MtCO_2e$.

Economic and sectoral impacts

Our analysis finds that short-term investment to switch to electric space and water heating, and to low emissions energy sources for process heat, will deliver long term cost savings. The faster the switching to low-emission energy sources for homes, buildings and industry occurs, the quicker the tipping point from costs to benefits is reached. Therefore, with pipeline gas phasing out more slowly in the draft LTLS, there is a risk of energy users missing out on benefits that could have been realised had switching occurred sooner.

In all cases however, switching must be managed to not be so fast as to exceed the overall adaptive capacity of the energy system – for instance where new electricity supply cannot be commissioned quickly enough to meet new demand.

In general, we expect that making greater use of demand-side response and energy storage will result in more efficient utilisation of electricity infrastructure and hence lower costs for electricity consumers. As the draft EB4 demonstration path and draft HTHS scenario assume more demand response, these scenarios could expect greater benefits in this respect.

Low demand response will require further investment in flexible electricity supply and/or energy storage to meet higher periods of peak demand, and further investment in transmission and distribution networks. High demand response will require investments in systems and infrastructure that enable greater data collection, access to data, data sharing and uptake of smart systems. This could also require regulatory amendments. We expect the costs of investment in systems and infrastructure that enable demand response to be significantly less than investing in new flexible supply and associated network infrastructure.

Distributional impacts

The higher ambition draft scenarios are expected to result in more energy efficiency savings for households.[18] However, the upfront costs of electric appliances such as heat pumps, and removing and replacing fossil fuelled appliances, will be a barrier for lower income households, including in the lead up to the NDC2 period. This could mean that these households could face higher energy costs than households who are able to pay the upfront cost of these technologies.

Regions with a greater reliance on employment in extractive fossil fuels industries will be the most impacted by the reduced consumption of these fuels in the higher ambition scenarios. However, the higher ambition scenarios should result in more revenue opportunities and jobs in the electricity sector, energy efficiency, bioenergy and the bioeconomy. For example, Boston Consulting Group estimated $42 billion of investment is needed in electricity generation, transmission, and distribution in the 2020s to meet the needs for rapid electrification of the New Zealand economy.[19]

Māori account for a higher share of employment in emissions-intensive industries than in low emissions intensity industries and Māori employees have historically fared poorly in transitions, being more likely to be made redundant during recessions and finding it more difficult to find re-employment.[20] Māori are over-represented compared to non-Māori in lower-skilled jobs, providing lower employment stability and less resilience to automation[21]. This creates risk of employment disruption for Māori in the transition to a low emissions economy. It is important to note however that Māori employment in

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[18] Noting these assume appropriate policies and measures are put in place to achieve these efficiencies.

[19] Boston Consulting Group. (2022). *The Future is Electric: A Decarbonisation Roadmap for New Zealand's Electricity Sector.* https://www.bcg.com/publications/2022/climate-change-in-new-zealand

[20] Ministry of Business Innovation and Employment. (2021). *The emissions exposure of workers, firms and regions*. https://www.mbie.govt.nz/dmsdocument/13781-the-emissions-exposure-of-workers-firms-and-regions.

[21] BERL. (2021). *Māori economy emissions profile.* https://www.mbie.govt.nz/dmsdocument/17448-maori-economy-emissions-profile

higher-skilled jobs has been growing in recent years, increasing from 47,500 to nearly 87,200 between 2006 and 2018.[22]

Co-benefits

Reduced reliance on fossil fuels in commercial and residential buildings will improve indoor and outdoor air quality. This occurs in all three draft scenarios, but at different paces according to scenario ambition. Hence air quality benefits will be achieved faster in the draft EB4 demonstration path compared to the draft LTLS scenario, and faster again in the draft HTHS. Improving energy efficiency will mean warmer/dryer buildings in all draft scenarios, noting this improvement will be greater in both the draft EB4 demonstration path and HTHS scenarios.

Principal risks and uncertainties

Energy security and affordability is a notable risk to our economy. The transition away from fossil gas will need to be carefully managed to ensure security of supply while limiting impact on consumers, noting gas also plays an important role in providing flexible electricity generation to help manage peak periods currently.

For example, recent data from Ministry of Business, Innovation and Employment (MBIE) suggests that potential gas supply from existing fields may be less than previously expected and likely insufficient to meet demand in the short to medium term.[23] We have already seen the impact of this, with gas prices increasing rapidly in 2024, and Methanex pausing production to on-sell gas to electricity generators.[24,25] Tight gas supply, together with a dry hydrological year, has resulted in electricity price spikes too, with gas unable to provide the seasonal 'firming' it has historically, resulting in greater use of coal and diesel-fired generation at a higher cost.[26, 27] This all has implications for firms and households, with a potential loss of jobs if firms are unable to economically operate, and higher energy prices eventually flowing through to higher household bills.

At the time of writing, the future operation of Methanex is uncertain. The timing of any future reopening or closure of Methanex trains is likely to have significant flow on impacts on fossil gas and electricity markets, including gas producers' incentive to invest in development to bring gas to market, as well as overall emissions levels for the NDC2 period.

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[22] BERL. (2021). *Māori economy emissions profile.* https://www.mbie.govt.nz/dmsdocument/17448-maori-economy-emissions-profile

[23] Ministry of Business, Innovation and Employment. (2024). *Gas production forecast to fall below demand.* https://www.mbie.govt.nz/about/news/gas-production-forecast-to-fall-below-demand

[24] Natural gas spot market price data available at https://www.emstradepoint.co.nz/

[25] Methanex. (2024). *Methanex Corporation to temporarily idle New Zealand operations to assist in approving energy balances*.https://www.methanex.com/news/release/methanex-corporation-to-temporarily-idle-new-zealand-operations-to-assist-in-improving-energy-balances/

[26] Energy News. (2024). *Genesis has been operating all three Rankine units at Huntly recently, almost entirely on coal.* https://www.energynews.co.nz/news/coal/163640/coal-imported-huntly-amidst-gas-hydro-shortages

[27] Average daily electricity prices reached over $800 / MWh in early August, up from around $250 / MWh at the beginning of winter, according to Electricity Authority data. Electricity Authority Te Mana Hiko. (2024). *What was behind high wholesale electricity prices.* https://www.ea.govt.nz/news/eye-on-electricity/what-was-behind-high-wholesale-electricity-prices/

Energy affordability is a risk that will need to be carefully managed to avoid significant hardship on households and firms.

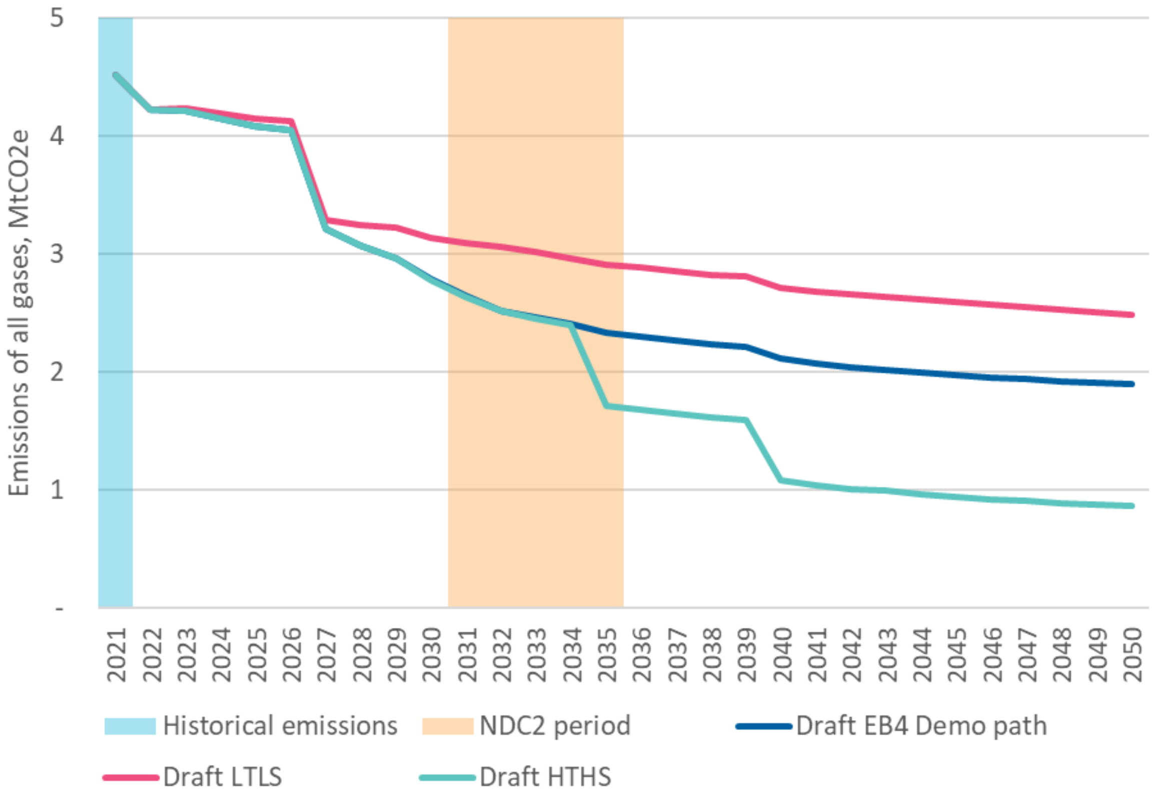
There are uncertainties for costs of low emissions technologies, noting Aotearoa New Zealand has little direct influence on supply and market prices for these. The uncertainty here is the highest for the draft HTHS scenario as it draws more heavily and sooner on technology.

The effect of these issues on emissions projections and associated impacts will be explored further in our final advice on the fourth emissions budget delivered in December 2024.

Industrial processes and product use

Figure 2 shows emissions from industrial process and product use under the draft scenarios. Emissions from industrial activities that are the result of energy consumption, such as combustion of fossil fuels for process heat and electricity usage to power machinery, are part of the energy sector. However, emissions that are by-products of industrial processes, or from the use of products such as refrigerants, are considered industrial processes and product use (IPPU). Examples of these are emissions of carbon dioxide and perfluorocarbon gases (PFCs, a type of f-gas) resulting from the industrial process/chemical reactions required in aluminium smelting.[28] In 2021 IPPU emissions made up 6% of Aotearoa New Zealand's gross emissions.[29]

Figure 2: Emissions from industrial processes and product use



Source: Commission analysis

[28] Note, emissions from fuel combustion for process heat in aluminium production, as well as indirect emissions from consumption of electricity, are included as emissions in the energy sector.

[29] 2023 GHG Inventory.

Actions in our draft scenarios to 2030 for IPPU

Achieving emissions reductions in the NDC2 period at the level implied by our three draft scenarios is enabled by deploying electric arc furnace technology, which will reduce coal use in steel production by 50% (by 2027).

Key actions in NDC2 period for IPPU

Key opportunities to reduce IPPU emissions include transitioning to low emissions production processes (for production of aluminium, steel) and avoiding emissions of f-gases.[30]

Our draft scenarios do not include abatement opportunities for IPPU emissions from lime production such as carbon capture and storage[31] as there is uncertainty that they could be deployed in cost-effective ways in time for NDC2.

Draft Low Technology Low Systems Change scenario

This scenario follows the same assumptions as the reference scenario. These are:

- 50% reduction in coal use for steel production with deployment of electric arc furnace technology by 2027 (transitioning to low emissions productions processes)
- following action required from the Kigali Amendment to the Montreal Protocol – hydrofluorocarbons (HFCs) reduce by 49% by 2040 relative to 2022 (avoiding emissions of f-gases).

Draft EB4 demonstration path

In addition to the draft LTLS, this scenario:

- assumes coal use in steel production can be further reduced by 76% in 2032 rather than 50% in 2027) through use of electric arc furnace technology
- goes further to reduce HFCs 62% by 2040.

Draft High Technology High Systems Change scenario

In addition to the draft EB4 demonstration path, this draft scenario includes:

- deploying zero carbon anodes in aluminium production by 2035
- deploying green hydrogen to decarbonise the remaining 25% of steel production (by 2040).

Summary of impacts

Emissions levels

In the draft LTLS scenario, we estimate gross emissions from IPPU to be 15.0 $MtCO_2e$ in the NDC2 period. In this same period, we estimate emissions would be 18% lower in the draft EB4 demonstration path (12.4 $MtCO_2e$). In the draft HTHS scenario, emissions could reduce a further 0.7 $MtCO_2e$ (to 11.7 $MtCO_2e$).

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[30] Primarily from refrigerants.

[31] Locally, lime is primarily used to produce cement, an input for concrete and mortar. It is also used as an input for other processes such as steelmaking, pulp and paper manufacturing, food processing and water treatment. About two thirds of emissions from lime production are the result of the calcination reaction, the chemical process used to produce lime and clinker (lime for cement production). The remaining emissions from lime are from process heat which is included as part of the energy sector.

Distribution of impacts across sector

The inclusion of electric arc furnace technology will mean economic opportunities for firms involved in scrap steel recycling. Higher levels of scrap steel utilisation or switching to a hydrogen-based production process will mean less revenue opportunities from mining of iron sands and from mining and importation of coal.

Zero carbon anodes are likely to increase the cost of producing aluminium (in the draft HTHS scenario). Cost data on these anodes is commercially sensitive, as such we are not able to estimate what the change in costs might be. As we assume these would be deployed in 2035, they will have a relatively small impact on emissions and costs in the NDC2 period.

There will be higher costs of avoiding HFCs emissions in the draft EB4 demonstration path and draft HTHS scenario. Impacts of this will depend on policy settings.

Co-benefits

Conversion of steelmaking to use scrap steel in electric arc furnace systems will mean fewer environmental impacts from iron sand mining, and better outdoor air quality due to less coal used in the production process. It also aligns with circular economy objectives as scrap steel is recycled for use in steelmaking. These benefits will be highest in the draft EB4 demonstration path and draft HTHS scenario.

Principal risks and uncertainties

There are uncertainties over how a scrap steel recycling scheme will be managed to ensure sufficient supply, including for the step up to 75% conversion to electric arc furnace technology.

For the draft HTHS, there is uncertainty over supply and price of electricity to enable cost-efficient production of hydrogen on site. In particular, it is uncertain whether a sufficient quantity of 'firmed' (i.e. non-intermittent) electricity can be supplied to the site at a price that would enable cost efficient hydrogen production at the scale needed. There is additional uncertainty around the use of green anodes in aluminium production as the technology is still under development.

There are uncertainties over a rising price of carbon and its impacts on cement production. A relatively high domestic price may make it more economic to import clinker from overseas.

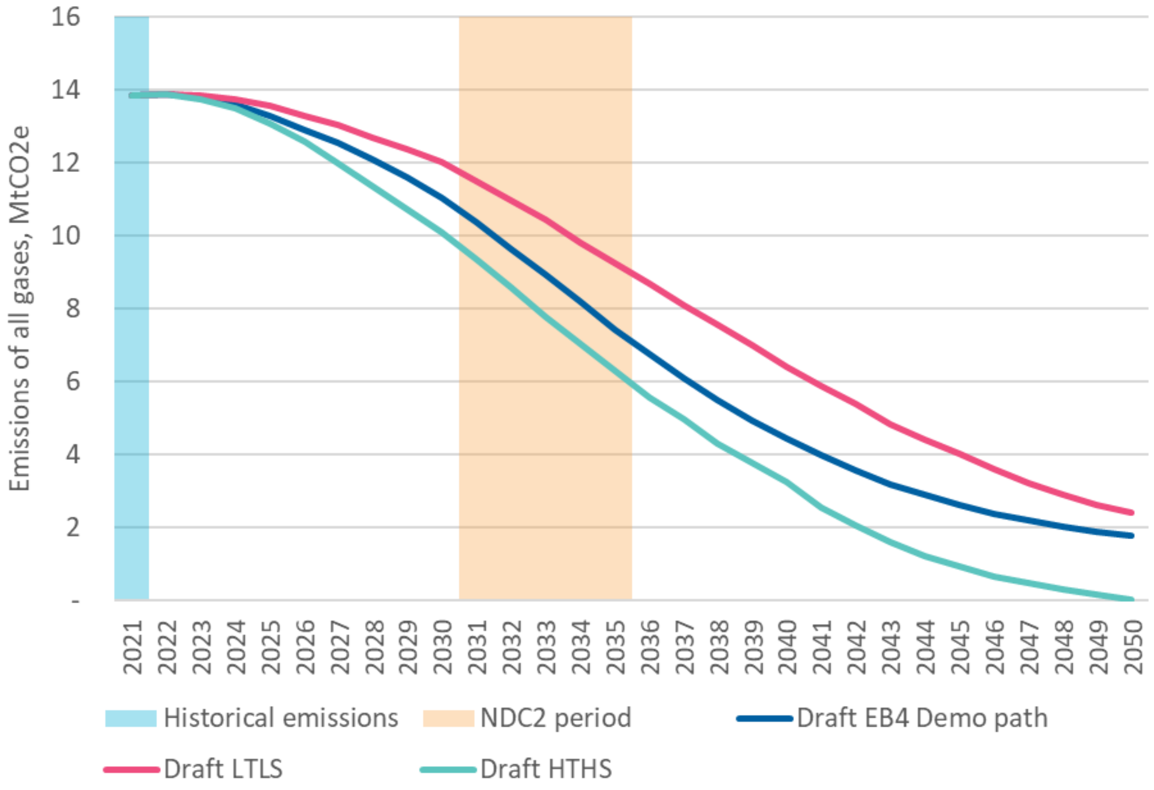
Transport

Figure 3 shows transport sector emissions under the draft scenarios. In Aotearoa New Zealand, transport emissions come from these modes: road, rail, aviation and marine. There are passenger and freight components for each of these modes, and these can occur through either domestic or international travel. Our analysis focuses on emissions from domestic travel as target accounting does not currently include emissions from international shipping and aviation.[32] In 2021 emissions from transport made up 17% of our domestic gross emissions.[33]

[32] Note the Commission is providing advice to Government by 31 December 2024 on whether these emissions should be included in our 2050 target.

[33] Commission analysis: *ENZ results for draft EB4 advice* available on our website

Figure 3: Transport sector emissions



Source: Commission analysis

Transport actions in our draft scenarios to 2030

Decarbonising road transport will be the biggest factor to enable emissions reductions in the NDC2 period to the levels implied in our three draft scenarios. For the draft LTLS this includes growing the electric vehicle (EV) share for:

- light passenger vehicles (LPV) to 16% of fleet (1% in 2021)
- light commercial vehicles (LCV) to 4% of fleet (0% in 2021)
- buses to 24% of fleet (1% in 2021).

In this timeline all draft scenarios have a small but growing share of medium and heavy electric trucks entering the fleet. The draft EB4 demonstration path and draft HTHS have higher EV uptake in this timeline across all vehicle classes. For the draft EB4 demonstration path we assume lower growth in road vehicle kilometres travelled (VKT) in 2030 (+4% versus +18% for the draft LTLS scenario, compared to 2021 levels). For the draft HTHS we assume no change in VKT from 2021 levels.

Key actions in NDC2 period for transport

Key opportunities to reduce Aotearoa New Zealand's domestic transport emissions include decarbonising road transport and freight, modal shift to public and active transport, and decarbonising aviation. Decarbonising road transport provides the greatest potential for emissions reductions at low costs relative to other abatement opportunities. This is even true for medium and heavy freight transport, where battery electric vehicles are on track to reach price parity with internal combustion engine (ICE) vehicles in total cost of ownership by 2031 and 2033 respectively.[34] Walking and cycling are zero emissions modes of travel (excluding any emissions from infrastructure investment, manufacturing and shipping). A shift towards these active travel modes offers further emissions reduction opportunities. While domestic aviation remains a hard to abate sector, opportunities such as battery electric airplanes and low carbon liquid fuels are assumed to emerge in time for NDC2.

Draft Low Technology Low Systems change scenario

As the data table (Table 1) at the end of this section shows, there is a significant step up in the number of EVs in this draft scenario relative to the reference scenario. The share of electric light passenger vehicles by 2035 is nearly 18 percentage points higher in the draft LTLS compared to the reference scenario, reaching a total share of 38.1%. The LTLS share of electric light commercial vehicles increases from 7.8% to 11.2%. There are more than three times as many electric buses for the draft LTLS scenario than the reference scenario (39.1% versus 12.4%). This draft scenario assumes phaseout of new LPV/LCV/bus ICE vehicles by 2040, and used by 2042. The cost of batteries for electric vehicles are assumed to decrease 66% by 2035 from 2023 prices.

In terms of decarbonising freight, the share of medium sized electric trucks reaches 4.9% in 2035, while heavy electric trucks reach 1.5% (compared to 3.6% and 0.7% in the reference scenario). We assume measures are taken to phaseout new heavy ICE vehicles by 2045, and medium ICE trucks by 2035 through a mixture of electrification and hydrogen technology.

For rail and coastal shipping the share of tonne kilometres is assumed to be the same in the draft LTLS scenario as the reference scenario, falling to 12.8% and 11.6% respectively by 2035 (compared to 13.7% and 12.4% in 2019). Rail electrification is assumed to reach a 23% share (tonne kilometres) by 2026, compared to no change in the reference scenario. Rail efficiency improvements increase by 0.5% per annum, compared to 0.25% in the reference scenario.

Total VKT increase by 18.2% in 2035 from 2021 levels, the same as the reference scenario. Modal share by 2035 of public transport (5.3% versus 3.5% in 2019), walking (1.5% versus 1.6% in 2019) and cycling (0.6% - unchanged from 2019) are at the same level as the reference scenario.

For domestic aviation, air passenger kilometres travelled grow by 41% from 7.4 billion in 2019 to 10.4 billion in 2035 (the same as the reference scenario). By 2035, 8% of passenger kilometres travelled are in small battery electric aircraft (0% in reference scenario). By 2035, low carbon liquid fuels are 5% of all fuels used (0% in reference scenario).

Draft EB4 demonstration path

In the draft EB4 demonstration path scenario in 2035, the EV share of LPVs rises to 48.1% (an increase of 10.0 percentage points from the draft LTLS). For LCVs, the EV share is 12.5 percentage points higher than the draft LTLS (23.7% vs. 11.2%). Electric buses represent just over half of the bus fleet (51.4%). In this draft scenario, the phaseout of new LPV/LCV/bus ICE vehicles is brought forward to 2032, and 2035 for used vehicles.

In 2035 the EV share for medium trucks increases from 4.9% in the draft LTLS to 9.1%. In the draft EB4 demonstration path 2.0% of the heavy vehicle truck fleet are EVs, compared to 1.5% in LTLS, noting these reflect a small share of the overall fleet. There are no hydrogen trucks in this draft scenario.

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[34] These are estimates from our reference scenario. For the draft HTHS scenario this happens earlier.

Modal share of rail shipping increases to 15.9% in 2035 (from 13.7% in 2019). Modal share of coastal shipping also increases to 14.4%, two percentage points higher than 2019. Rail electrification is assumed to reach a 23% share in 2026 and then an 80% share by 2050 (tonnes per kilometre).

These is slower growth in VKT in this draft scenario, limited to 3.6% growth in 2035 (compared to 2021 levels). Modal shift in 2033[35] increases to 8.9% for public transport, to 1.9% for walking and to 1.9% for cycling.

Assumptions for decarbonising aviation are the same as in the draft LTLS.

Draft High Technology High Systems change scenario

By 2035 EVs reach a 54.7% share of the LPV fleet, 26.8% of the LCV fleet, and 58.5% of the bus fleet. This scenario assumes a phaseout of new LPV/LCV/bus ICE vehicles by 2030, and used by 2035. The cost of EV batteries is assumed to reduce by 79% by 2035 (from 2023 levels), 13 percentage points higher than the other scenarios.

By 2035 the EV share of fleet reaches 11.8% for medium trucks, more than three times the number in the reference scenario and more than double the draft LTLS. The EV share of heavy trucks reaches 1.7% in 2035. This draft scenario assumes measures are in place to phase out new heavy ICE trucks by 2030, and used by 2035. As in the draft EB4 demonstration path there are no hydrogen trucks.

Modal share of rail freight reaches 18.5% in 2035, and 17.3% for coastal shipping. We assume rail efficiency improvements of 0.75% per annum, with rail electrification share reaching 23% in 2035 and 100% by 2040 (tonnes per kilometre).

VKTs in 2035 are 1.9% lower than 2021 levels. Modal shift in 2033 increases further to 11% for public transport, to 2.1% for walking and to 2.6% for cycling.

In the draft HTHS scenario, we also assume domestic air passenger kilometres travelled reduces over time, 20% by 2050 (relative to 2019 levels). By 2035, 28% of small aircraft domestic kilometres travelled are by electric aircraft. Low carbon liquid fuels represent 20% of total fuel used for domestic air passenger travel.

Table 1 Road transport EV share of fleet in 2035 by mode and draft scenario

Road transport EV share of fleet in 2035 by mode and scenario	Reference scenario	Draft LTLS	Draft EB4 demonstration path	Draft HTHS
Light passenger vehicles (LPV)	20.4%	38.1%	48.1%	54.7%
Light commercial vehicles (LCV)	7.8%	11.2%	23.7%	26.8%
Buses	12.4%	39.1%	51.4%	58.5%
Medium trucks	3.6%	4.9%	9.1%	11.8%
Heavy trucks	0.7%	1.5%	2.0%	1.7%

Source: Commission analysis

[35] Note 2035 figure is not directly available from modelling outputs.