Major Electricity Users' Group

26 March 2021

Dr Rod Carr
Chair
Climate Change Commission
Downloaded to web site https://haveyoursay.climatecommission.govt.nz/comms-and-engagement/future-climate-action-for-aotearoa/consultation/

Dear Rod

Climate Change Commission 2021 Draft Advice for Consultation

1. This is a submission from the Major Electricity Users' Group (MEUG) on the Climate Change Commission consultation papers "2021 Draft Advice for Consultation" (the "Draft Advice" report) and the accompanying "Evidence report" published 31st January 2021.[1] MEUG also considered additional material published after the date consultation opened, the proceedings of webinars, and ad hoc discussions with Commission staff. MEUG benefited from discussions with the Chair, Chief Executive and staff of the Commission who attended the MEUG monthly meeting on 24th February.
2. MEUG members have been consulted in the preparation of this submission. This submission is not confidential. Some members will also make separate submissions.
3. Attached and to be read as part of this submission is a report by Mike Hensen, Senior Economist, NZIER titled "Climate change model review – Climate Change Commission ENZ and C-Plan models" dated 25th March 2021 prepared for MEUG, Major Gas Users' Group and Energy Resources Aotearoa.
4. The Commission's draft emission budgets and draft supporting advice to government has been developed using sector specific analysis (the ENZ model) with output aggregated into the C-PLAN economy wide top-down model and outputs from the latter used in the DIM-E model. This submission follows the same path starting with feedback on the electricity and other relevant sectors, and then considering the economy wide package proposed.
5. This submission does not consider the advice on Nationally Determined Contribution.
6. The submission concludes with comments on the consultation process.
7. Appendix 1 has a glossary of terms used in this submission. Appendix 2 cross-references questions in the Draft Advice paper with relevant paragraphs in this submission. Appendix 3 is the Commission's response of 5th March to MEUG questions of 5th February.

[1] Refer https://www.climatecommission.govt.nz/get-involved/our-advice-and-evidence/.

8. The two over-arching themes of this submission are:

- **An initial cautious not accelerated strategy might be better.**

  The Commission stresses the need for urgent action over the four years of the inaugural emission budget period #1, 2022 to 2025, with an aggressive emission path and proposes 7-time critical necessary actions. That approach is continued in the following 2 budget periods. We query if there has been sufficient and robust analysis to support the claimed need for urgency. However, the bigger problem is a lack of access to the models leaves MEUG unable to validate that the models support an accelerated level of action compared to alternative strategies.

  MEUG cannot say for sure that taking a more cautious approach in emission budget period #1 and the following 2 emission budget periods is better either because we do not have access to the models to test that proposition. Hence our theme is not that we absolutely recommend a cautious approach. Instead MEUG recommends the prudent course of action is to compare the accelerated and cautious approaches over emission budget period #1 and the following 2 emission budget periods subject to an appropriate level of external scrutiny given the significant consequences of taking the wrong strategy.

  An initial cautious approach is not an excuse to do nothing. Rather, taking an initial cautious approach ensures there are no unexpected harmful distributional effects in the next 1 to 3 years that could undermine future consensus by consumers with proposed emission budgets. Such an approach allows decision makers to retain more degrees of freedom and optionality to achieve budgets at least cost.

- **Open models and improved consultation are needed for future steps**.

  The quality of consultation processes matter. In this instance lack of transparency to the models used has undermined the credibility of the consultation process to allow rigorous testing of the evidence that supports the draft advice. The past cannot be undone. What matters is future consultation processes are improved. First in the consideration by Ministers of the final recommendations being submitted by the Commission by 31st May. Second, in future monitoring of progress and proposing further emission budgets by the Commission.

9. The titles of the sections that follow are:

- The risk of assuming cheap electricity this decade to facilitate electrification.
- Impact on affordability of proposed electricity line investment needs more work.
- Risk in assuming biomass can complement electrification in shift from thermal fuels.
- Agree thermal generation is needed longer term to support new renewable.
- Options to increase daily use flexibility and accessing emergency hydro reserves.
- Problems with the ETS price paths underpinning the proposed budgets and advice.
- Some proposed non-ETS interventions are not supported with cost-benefit-analysis.
- Risks in assuming the modelling is sufficiently robust to support the budgets.
- Keeping options open in the near-term is worth re-considering.
- Theme 1: An initial cautious not accelerated strategy might be better.
- Theme 2: Open models and improved processes are needed for future steps.

The risk of assuming cheap electricity this decade to facilitate electrification.

10. A key driver for the strategy of electrifying the process heat and transport sectors is an assumption electricity later this decade will be much cheaper. MEUG had doubts that will be true and set out in a question to the Commission on 5th February and evidence that electricity prices in the forward market were much higher than assumed in the Draft Advice report.[2] We asked NZIER to consider the Commission's Draft Advice report, Evidence report, response by the Commission to our questions on electricity prices and zoom presentations. The Key points section of the NZIER report (pi) on electricity modelling concludes:

> "The ENZ model (a bottom-up model of feasible reductions in greenhouse gas emissions by selected sectors) forecasts annual average wholesale electricity prices in a range of $63 per MWh to $74 per MWh - well below current and forward market prices and lower than the Energy Link forecast used by the Climate Change Commission (CCC) as a cross-check on the ENZ model. (The Energy Link model forecasts average wholesale electricity[3] prices of $94 per MWh in 2021 falling to below $53 to $62 per MWh by 2036 and then rising to $120 to $140 per MWh by 2050. The initial fall is driven by the combination of an increase in geothermal generation capacity (150 MW in 2024) and a phased reduction in aluminium smelter demand[4] partially offset by a reduction in gas capacity (380 MW in 2025).
>
> The ENZ model does not explain what will drive the transition from current wholesale electricity market pricing to the levels forecast. The ENZ model assumes that the levelized cost of energy (LCOE) of wind generation will set the average wholesale prices. The CCC advice should explicitly consider the sensitivity of ENZ transport and

[2] Refer MEUG Qu. 2.2 and CCC answer in appendix 3.
[3] Haywards node price.
[4] The forecast phase-down in aluminium smelter electricity demand is 730 MWh in 2024, 1,752 MWh in 2025, 1653 MWh in 2026 and 869 MWh in 2027.

process heat electrification to wholesale prices as the assumption of the ENZ model do not reflect the current reality of the wholesale electricity market. A similar comment was made in the peer review by Dr. Marc Hafstead[5].

The ENZ model outputs do not explicitly state how dry year risk and security of supply have been included in the modelling and what level of increased generation capacity will be necessary to manage the additional dry year risk arising from the increased share of wind in the generation stack and reduced role of thermal generation plant. The Energy Link presentation includes comment on dry year risk, but it is not clear how this is incorporated into its 'headwinds' and 'tailwinds' scenarios.

ENZ modelling assumes that gas supply will continue to be available for process heat and peak period electricity generation after the closure of Methanex and baseload gas-fired electricity generators. However, these changes reduce gas demand by more than 60 percent by 2030 and change the structure of the gas market by removing counterparties that would be willing to enter long term contracts that would fund ongoing development of gas supply. At the same time, the forecast increase in the carbon price will add about $7.50 per GJ to the cost of gas by 2030 and $10.05 by 2040.

The CCC in its draft advice states that Government will need to manage energy affordability and security of supply issues as part of a national energy strategy, but its model outputs do not provide an indication of the potential size and timing of changes in affordability and security of supply that are attributable to CCC's recommendations for reducing greenhouse gas emissions. The CCC advice should include sensitivity analysis of both electricity wholesale prices and gas supply and price risks."

11. Until there is a reconciliation between the electricity price paths for the first emission budget period estimated by the Commission and market evidence from the electricity wholesale price forward market, MEUG believes it is risky to rely on the Commission's analysis.

12. For example, the Commission estimates wholesale prices may be as low as 6.5 c/kWh mid this decade whereas for 2020 the wholesale and retail (retail being a small add-on to the wholesale component) costs in an average household electricity bill was around 17 c/kWh.[6] If the Commission is correct on average households will have a decrease in their electricity costs of up to 10.5 c/kWh. For an average household (year ended March 2020) that used 7,099 kWh pa this would have a value of around $745 pa. Across all households (around 13 TWh pa), 10.5 c/kWh has a value of around $1.3 billion pa. It is unclear if this assumption has flowed into the C-PLAN model.

13. MEUG is sceptical a decrease of this size will occur. If we are correct, then households and businesses will not have a material windfall gain from significantly lower power prices and therefore be less able to invest in electrification options in emission budget period 1.

[5] NZ Climate Change Commission Model Review, Part 1, Dr. Marc Hafstead, pages 1 to 2.
[6] MBIE Residential Sales-based Electricity Costs, Report for December 2020, results for year ended March 2020, refer https://www.mbie.govt.nz/building-and-energy/energy-and-natural-resources/energy-statistics-and-modelling/energy-statistics/energy-prices/electricity-cost-and-price-monitoring/ and URL https://www.mbie.govt.nz/assets/Data-Files/Energy/nz-energy-quarterly-and-energy-in-nz/QRSS-December-2020.xlsx

14. The uncertainty of affordability for households and businesses is one reason why MEUG cannot support the recommended actions for Time-critical necessary action 2, Accelerate light electricity vehicle uptake.[7] Before considering Time-critical necessary action 2 the government needs to be sure and convince consumers that electricity prices will track at the lower levels predicted by the Commission over emission budget period #1.

Impact on affordability of proposed electricity line investment needs more work.

15. Electricity prices for households and businesses are a combination of wholesale prices, plus a retail margin, and regulated monopoly line charges. For households, the latter averages around 42% of a total delivered electricity bill.[8] There is a large spread around this average between households and SMEs with low and high demand for electricity and variability in how each EDB constructs tariff proportions between fixed and variable charges. Large commercial and industrial (C&I) consumers tend to be on time-of-use (TOU) meters where it is easier to predominantly use economically more efficient fixed charges for line services. This detail matters when considering the distributional effects of alternative electrification strategies for the transport sector in different regions.

16. For example, with little generation in the Upper North Island major electricity transmission capital upgrade capex will be needed for a rapidly growing EV fleet. An important policy question is whether C&I consumers that do not have large EV fleets or lower decile income households unable to afford investing in EV should pay a share of line upgrades to meet growing EV demand? The ENZ and C-Plan models do not have the granularity to assist answer this and similar distributional effect policy questions.[9] More tightly scoped standard partial equilibrium cost-benefit-analysis to test the impact of alternative line prices due to different rates of EV uptake on different classes of consumers in different regions are needed to assist policy decisions.

17. One last aspect of distributional effects that need to be considered is the effect on government cashflows if electricity prices in emission period #1 are higher than the Commission expects. As majority owner of 3 of the 4-largest vertically integrated suppliers and 100% owner of Transpower, we would end up with the perverse situation of the government having significant windfall gains from dividends if prices are high while households and businesses will struggle to pay the cost of switching their transport and heat and process loads to electricity. This aspect is similar to the question of if and how the government might recycle ETS receipts back into the economy in so far as the government is a net beneficiary and how it spends that windfall is important. The possibility of recycling ETS proceeds back into climate change projects is discussed on p101 and p132/134 of the Draft Advice report.

[7] MEUG has other conceptual concerns with the detailed recommendations of Time-critical necessary action 2 over and above the problem of electricity affordability. Those are not detailed in this part of the submission as they extend beyond MEUG's primary interest of the electricity and gas markets.
[8] See footnote 6 above.
[9] Refer appendix 3, response to Questions 3.1a, 3.1b and 3.1c. Line costs also discussed in paragraph 42 to 44 of this submission.

Risk in assuming biomass can complement electrification in shift from thermal fuels.

18. Along with electrification of existing process heat the Commission also expect switching process heat load to biomass to be an important opportunity.[10] The Draft Advice paper (p68) notes,

> "Overall, there appears to be a large potential biomass supply from collecting and using waste from forestry and wood processing. However, the availability is likely to vary across the country due to regional mismatches in supply and demand of biomass, and the cost of transporting biomass. While the supply of biomass residues may appear to be abundant in some regions, trade-offs may also need to be made when deciding what parts of the economy to decarbonise using biomass first."

19. We asked for more details and were provided model outputs of biomass potential that were at a broad regional level (refer appendix 3, response to Question 3.3). We could not validate the detailed assumptions and calculations because we had no access to the models. Therefore, we continue to have concerns with the Commission's expectations that the future supply of biomass will first be sourced from currently unused slash wood. Only after unused slash is consumed will new biomass supply be sourced from the pulp log and chip markets. The Commission assume the price of biomass will not rise above current pulp log prices. The experience of some MEUG members using biomass to meet process heat requirements or value add through fibre board and paper manufacturing etc. (which adds to the countries prosperity through further processing & export receipts while at the same time denying or restricting further carbon leakage), is that new large increments of demand are only currently achievable by competing with existing committed pulp log and chip supply. Competing current and future demand for pulp log and chip is likely to drive prices above current biomass prices. In an environment where biomass prices have been and are expected to increase the business case for existing process heat load to switch to biomass is weakened. More analysis is needed to test if the view of owners of large process heat loads is more likely or not compared to the Commission's view of future biomass pricing. Regional Biomass market analysis could be undertaken to uncover barriers not considered by the Commission to realize opportunities to switch process heat load to biomass. Those analysis would consider the dynamics of regional demand and supply for biomass, any information asymmetry barriers, and how expectations of the range of future ETS prices will affect biomass supply and demand.

[10] Draft Advice p114.

Agree thermal generation is needed longer term to support new renewable.

20. MEUG agrees with the Commission that having gas available as a fuel for electricity generation is likely to be the lowest cost option, refer Draft Advice p63:

> "Natural gas currently plays a significant role in the electricity system by backing up renewable generation, particularly in dry years when hydro lake levels are low. Using gas in this way supports the reliability and affordability of the country's electricity system.
>
> There are options to eliminate the use of natural gas for electricity generation. However, these are likely to be expensive for the size of the emissions reductions they deliver. In addition, the transition away from gas across the economy would need to occur without compromising the affordability and security of the electricity supply or increasing total emissions."

21. MEUG agrees with the Commission's recommendation the Government's 100% renewable electricity target should be treated as aspirational as set out in the preface text of Time-Critical necessary action 3, Target 60% renewable energy no later than 2035.[11]

Options to increase daily use flexibility and accessing emergency hydro reserves.

22. Two options not considered in the Advice report or Evidence report are:

- Increasing flexibility in resource consents to use existing hydro generation to assist manage the expected increased daily variability of more wind and solar generation in the generation fleet; and
- Increasing the ability to access emergency hydro reserves to assist manage dry-year and unexpected long-duration outages. A good example of this is the large increase in emergency reserves accessible to Meridian at Lake Pukaki announced in November 2019 if an Official Conservation Campaign is declared.[12] If an Official Conservation Campaign is declared then there is a very high risk of unplanned outages. That can be due to prolonged seasonal dry-year risk or some other long duration unexpected supply failure.

23. Both rely on positive outcomes from RMA consenting processes. The Commission should consider what advice it could give Ministers on the current review of the RMA to assist how trade-offs are weighed in the consenting processes relevant to improving the use of our existing largest renewable energy stock of hydro-generation. MEUG therefore recommends a third new recommendation be added to Enabling recommendation 4, Central and local government working in partnership.[13] MEUG's proposal is new recommendation c. "Agree that additional flexibility and reservation of emergency reserves for existing hydro-generation in RMA processes is an important option to meet a net zero carbon goal."

[11] Draft Advice p112.
[12] Refer Transpower, prepared by System Operator, Contingent Storage, February 2020, p2, URL https://www.transpower.co.nz/system-operator/security-supply/hydro-information#Contingent%20Storage at https://www.transpower.co.nz/system-operator/security-supply/hydro-information.
[13] Draft Advice p42.

Problems with the ETS price paths underpinning the proposed budgets and advice.

24. This section considers if the Commission's analysis has adequately considered the feasible range of ETS price paths and the effect they may have on emissions in future the scenarios?

25. The short answer is MEUG is not convinced the Commissions analysis has adequately canvassed alternative ETS price paths. In our view the assumed flat $35/t ETS price to 2050 in the Reference case undermines the credibility of that scenario as the appropriate counterfactual.

26. The NZIER report Key points (pii-piii) section concludes:

> "The CCC advice on the options for emission reductions pathways and their impact on GDP:
>
> - Compares the options to a current policy reference (CPR) path which already has substantial opportunity for reductions in emissions baked in (the closure of the Methanex and the aluminium smelter, energy efficiency gains in industry and electrification of transport). This means it is unsurprising that the difference in GDP at the end of the modelling period between the CPR and other options is small.
> - Considers a set of options in the C-Plan model that are based on but not explicitly linked to the options in the ENZ model. In particular, the C-Plan model which forecasts the economic impacts of the CCC advice:
>   - assumes a slower emissions reduction pathway than the pathways that the ENZ model estimates are technically feasible - see Table 1
>   - generates carbon prices that start below the ENZ model path but rise above the ENZ model path later in the modelling period – see Table 2

Table 1 C-Plan (exogenous) and ENZ (endogenous) other long lived gas emissions

Gross emissions (Mt CO_2e) of gases other than CH_4

Year	ENZ Model				CPR	C-Plan			
	Head-winds	Behaviour Change	Tech. Change	Tail-winds		TP1	TP2	TP3	TP4
2025	42.5	41.8	42.0	41.3	**44.3**	43.9	43.9	43.2	39.4
2030	38.0	36.7	34.3	33.2	**43.9**	40.0	40.0	38.4	29.9
2035	34.2	32.2	27.1	25.6	**41.5**	36.1	36.1	33.6	27.2
2040	28.3	25.8	18.7	17.0	**39.0**	32.1	32.1	28.8	24.5
2045	22.1	19.4	13.9	11.9	**36.8**	28.2	28.2	24.0	21.9
2050	17.6	15.0	11.8	9.6	**34.8**	24.3	24.3	19.2	19.2

Source: ENZ and C-Plan model outputs

Table 2 C-Plan (endogenous) and ENZ (exogenous) emissions carbon prices

Long lived gases (other than CH_4) ($ per t CO_2e)

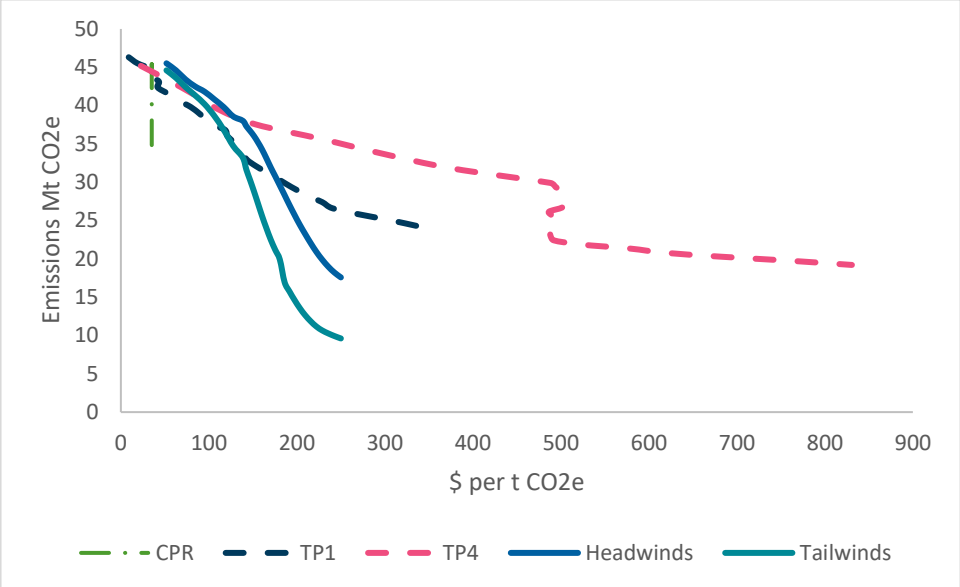
Year	ENZ Model	CPR	C-Plan			
			TP1	TP2	TP3	TP4
2025	84.21	**35.00**	32.26	32.14	44.12	111.54
2030	138.42	**35.00**	76.57	76.37	112.19	488.02
2035	160.47	**35.00**	120.81	120.47	182.84	502.97
2040	186.02	**35.00**	153.06	152.68	275.37	481.86
2045	215.65	**35.00**	213.32	212.81	394.21	521.94
2050	250.00	**35.00**	337.79	336.86	860.91	830.57

Source: ENZ and C-Plan model outputs

High carbon prices generated later in the C-Plan model period (compared to the ENZ model) suggests that energy efficiency, fuel-switching and technology changes included in the C-Plan are not sufficient alone to deliver the emissions reduction for the model.

The difference between ENZ and C-Plan modelled trade-offs between emission reductions and carbon prices are illustrated more clearly in Figure 1.

Figure 1 Reduction and price paths for gross emissions of other (non CH_4) GHGs



Source: Drawn from C-Plan and ENZ modelling outputs

The CCC advice does not explain why:

- A different set of emissions reduction pathways were assumed for the C-Plan model to those estimated as achievable by the ENZ model
- ENZ and C-Plan trade-offs between carbon prices and emissions reductions diverge

Which scenarios are used to support which aspects of the CCC recommendations."

27. The inconsistency of the ETS price modelled with the narrative in the Advice Paper:

- Undermines the rationale for the time-critical necessary action 7 to ramp up ETS prices. MEUG therefore does not support time-critical necessary action 7, Driving low emissions choices through the NZ ETS until the inconsistencies between ENZ and C-Plan models, and the narrative in the Advice Paper can be clarified. This will require all models to be published and adequate opportunity for interested parties to test those models, questions to be lodged and the Commission to respond.
- Also weakens the rationale for the suite of proposed non-ETS interventions and the proposed emission budgets. We discuss the proposed non-ETS interventions in the next section.

28. We also asked NZIER to consider risks in assuming an initial ETS price path out of step with trading partners. The NZIER report Key points (piii) conclude:

> "The C-Plan model assumes a uniform rest of the world (RoW) carbon price starting at zero at the beginning of the model period and increases in a straight line to USD250 in 2050. This assumption means that NZ carbon prices are above the carbon prices assumed for trading partners for a large part of the modelling period.
>
> This difference will affect the competitiveness of emissions intensive trade exposed (EITE) industries. The ENZ model assumes these industries either exit or their output remains constant over the modelling period. While a uniform carbon price is a useful simplification, it does not reflect the experience to date and will understate risks of rising domestic carbon prices to both the viability of EITE industries and the risk of carbon leakage."

29. MEUG suggests it is important we understand the following effects of NZ ETS prices differing from our trading partners:

- The relative cost or benefit effects on households and SMEs.
- The effect on the EITE sector which includes hard to abate industries. This is discussed later in paragraphs 37 to 41 of this submission.
- Differences between firms that can and cannot pass on higher ETS costs and may or may not benefit from high C-prices than their least cost of abatement.

Some proposed non-ETS interventions are not supported with cost-benefit-analysis.

30. This section considers if the suite of proposed non-ETS interventions affecting the electricity and gas sectors is reasonable? The short answer is given the conclusion from the preceding section that the role of the ETS price has been under-estimated in modelling the Reference case, then that casts doubt on some of the proposed non-ETS interventions. Setting that aside there are also other concerns we have with some of the proposed non-ETS interventions related to the electricity and gas sectors. It is not all bad news. MEUG also agrees with some of the proposed non-ETS interventions. The following sub-sections discuss the main non-ETS interventions of interest to MEUG.

➢ Problems with a renewable energy target but support an energy strategy forum.

31. Time-critical necessary action 3, Target 60% renewable energy no later than 2035, has two recommendations[14]:

- (MEUG proposed changes underlined) Recommendation a. "Develop a long-term national energy strategy <u>de-politicised forum of departmental, regulator and industry representatives</u> that provides clear objectives and a predictable pathway away from fossil fuels and towards low emissions fuels, and the infrastructure to support delivery."
- Recommendation b. "Under the framework of the national energy strategy, set a renewable energy target to increase renewable energy to at least 60% by 31 December 2035."

32. On the one hand MEUG is not convinced that a national energy strategy is needed unless a full review of existing strategies that must be published is undertaken to identify any gaps or overlaps that would warrant considering the pros and cons of a new central government strategy document being published as opposed to modifying existing publications that are published. For example, MBIE used to publish an excellent annual energy forecast and plan. Resurrection of that report as an independent departmental annual publication updated to ensure aspects of the emissions budgets that government will first set by 31st December 2021 would be very helpful. On the other hand MEUG believes there is a gap in the governance of the energy sector (this includes all fuels and energy sources and primary energy uses) as there is no forum where energy sector participants and policy makers and regulators can have an ongoing de-politicised discussion about improvements to the energy sector and a clear understanding of what the private sector will be doing, what the government sector will be doing and opportunities for collaboration between the private sector and government. We therefore recommend a modified Time-critical necessary action 3, recommendation a. as marked up above for a national energy strategy de-politicised forum of departmental, regulator and industry representatives.

33. MEUG does not support Time-critical necessary action 3, recommendation b. There are three reasons we object to setting a renewable energy target. The first is conceptually in that setting targets that are not clearly caveated as "aspirational" are prone to unintended consequences. The second reason is the overall goal of lower emissions is not the same as a high renewables target because the latter is not technology and fuels agnostic. It may be that over time using gas as a transition fuel is a better overall strategy in terms of meeting an end goal of zero emissions at least cost to the economy than harming the economy by having an expensive to attain renewable energy target. The third reason is, in our view, the Commission has provided insufficient analysis to support why 60% is the optimal target. That issue is a subset of our wider concern with the lack of rigour of the modelling set out in paragraphs 52 to 58 of this submission.

[14] Draft Advice, p112.

➢ Making accountability of recommended necessary actions clear.

34. Necessary action 5, Maximise the use of electricity as a low emissions fuel, has two recommendations we have clarified in the consultation process are relevant to the existing responsibility of the Commerce Commission and Electricity Authority. [15] Accordingly, MEUG recommends the recommendations make accountability of the necessary actions clear as follows (proposed new text underline and deleted text struck out):

- Recommendation d. "The Commerce Commission and Electricity Authority assess whether electricity distributors are equipped, resourced and incentivised to innovate and support the adoption on their networks of new technologies, platforms and business models, including the successful integration of EVs."
- Recommendation f. "The Electricity Authority monitor, and ~~review~~ takes action to ensure electricity remains affordable and accessible, and measures are in place to keep system costs down, such as demand response management."

➢ Cost-benefit-analysis needed before banning coal.

35. MEUG asked about Necessary action 7, Reduce emissions from process heat, Recommendation a. "Urgently introducing regulation to ensure no new coal boilers are installed.[16] The Commission's answer is primarily based on a principles-lead perspective to support this proposed necessary action. MEUG does not support this recommendation unless a quantitative cost-benefit analysis can demonstrate there is a real risk that new coal boilers will be built and there is no viable alternative option. MEUG would therefore rephrase this recommendation (proposed new text underline and deleted text struck out): "Urgently consider if there is a risk of new coal boilers being built, and what options are available if there is a risk including the option of introducing regulation to ensure no new coal boilers are installed."

➢ Alleged barriers to capital may be normal business not economic market failures.

36. The Commission replied in detail to MEUG's questions on alleged barriers to capital, refer Appendix 3, Question 2.3b. MEUG is still not convinced the alleged barriers to capital are economic market failures as opposed to normal business uncertainties dependent on the characteristics of individual business strategies and economic cycles. Accordingly, MEUG opposes the following three recommendations relating to alleged barriers to capital:

- Necessary action 7, Reduce emissions from process heat, Recommendation d. "Helping people to access capital to reduce barriers to the uptake of technology or infrastructure upgrades such as boiler conversions, energy efficiency technologies, and electricity network upgrades."[17]
- Necessary action 5, Maximise the use of electricity as a low emissions fuel, recommendation e. "Enable more independent generation and distributed

[15] Refer MEUG Qu. 2.2 and CCC answer in appendix 3.
[16] Refer MEUG Qu. 2.3 and CCC answer in appendix 3.
[17] Draft Advice p115.

generation, especially for remote rural and Māori communities, and ensure access to capital for this purpose."[18]

- Necessary action 3, Accelerate light electric vehicle uptake, recommendation b. "As part of an equitable transition, evaluate and support interventions such as leasing, hire and sharing schemes to remove barriers and address some of the upfront capital costs of EVs"[19]

➢ Support for sector strategies for hard to abate businesses.

37. MEUG supports in large-part Necessary Action 8, Support innovation to reduce emissions from industrial processes, Recommendation a, "Developing a long-term strategy for the future of hard-to-abate industries, including iron, steel making, cement and lime production and petrochemical production. This strategy should be developed alongside the forum for a national energy strategy, future Economic Plans and strategies for an equitable transition."[20]

38. The underlined text reflects MEUG's suggestion there is a forum of government and industry to allow ongoing discussions on long-term national energy strategy as discussed in paragraphs 31 and 32 of this submission.

39. MEUG notes that the Commission has identified some hard to abate industries and is also making assumptions on closure of others. The Commission is also recommending a first principles review of industrial allocation settings (also discussed in paragraph 45 of this submission). MEUG supports those proposals and notes for the latter that MfE is and plans to have affected businesses involved.

40. Decisions by business on investment to stay in business, expand the business or cessation are inherently tied to climate change policy and the impact on domestic emissions and energy demand from single firm decisions are likely to be material. This introduces considerable uncertainty from emission budgets and wider stakeholder perspectives.

41. The Commission is advocating sector specific strategic plans. MEUG supports establishing dialogue to ensure all aspects of business decision making are understood at specific hard to abate industry levels and the wider the EITE sector industrial allocation review.

➢ Forced closure of reticulated natural gas is heavy-handed.

42. In considering efficient energy use in buildings the Commission proposed as part of measures government should consider under Necessary action 9, Increase energy efficiency in buildings, recommendation c. "Setting a date by when no new natural gas connections are permitted, and where feasible, all new or replacement heating systems installed are electric or bioenergy. This should be no later than 2025 and earlier if possible." MEUG has no concern with the Commission suggesting the government consider the costs and benefits of retrofitting existing natural gas appliances used by households and SME's and the pros and cons of setting a date banning new connections.

[18] Draft Advice p113.
[19] Draft Advice p109.
[20] Draft Advice p116

43. MEUG does object to the last sentence of the Commission's recommendation, underlined in the preceding paragraph, "This should be no later than 2025 and earlier if possible." There is a precision in the Commissions recommended date of no later than 2025 that is not supported by any analysis we are aware of. Forced closure of reticulated natural gas is heavy-handed and should not be taken lightly. A significant amount of due diligence and cost-benefit-analysis should be taken to decide if and how best, including timing, to make such a major intervention on a sector that is and will already be factoring in future ETS prices.

44. One of the details in considering this recommendation is the impact on the owners of and parties that pay for stranded gas infrastructure assets and for additional electricity infrastructure that will be required.[21] The Commission's response to MEUG's questions on assumed infrastructure costs and treatment of stranded costs is set out in appendix 3, response to Question 3.1a, 3.1b and 3.1c. MEUG's interpretation of the response is that by necessity the modelling in ENZ was relatively coarse (MEUG accepts that), and gas infrastructure costs remain constant and paid for by a decreasing base of gas users (MEUG thinks that is unlikely to be feasible). This reinforces our view if government decides to further consider Necessary action 9, recommendation c., then that process should be subject to rigorous cost-benefit-analysis.

➢ First principles review of industrial allocation policy is underway.

45. MEUG notes that Necessary action 19, Continued ETS improvements, recommendation b "… the Government make progress on … Undertaking a first principles review of industrial allocation policy" is already underway by MfE. MEUG is aware of and supports the work programme and process planned by MfE.[22]

Risks in assuming the modelling is sufficiently robust to support the budgets.

46. The modelling work completed in such a short timeframe is praiseworthy. However, in the view of MEUG, it is insufficient to support the accelerated step change in emissions proposed in the first emission budget period. MEUG's view that the modelling is insufficient is founded on two parts:

- First, in our view best practice for major, complex and or contentious policy decisions is to have all models publicly available. This is the practice adopted by other Crown entities such as the Electricity Authority and the Commerce Commission. The Commission has published expert peer reviews of the models though those experts did not have access to the models.[23] That is a second-best

[21] This question is also considered in the example of who should pay for new EV driven line infrastructure discussed in paragraph 16 of this submission in the section titled "Impact on affordability of proposed electricity line investment needs more work."
[22] Draft Advice p134.
[23] For example, see expert peer reviews:
- Weitzel and Vandyck (paragraph 1) "*We received model descriptions and/or presentations about the models, including (preliminary) results, as well as key (draft) chapters of the report that rely on modelling output. In addition, we had the chance to interact with the modelling team and other reviewers on two occasions.*"
- Daigneault "*The initial estimates and model documentation were provided to 5 climate policy modeling experts for review in November 2020.*"

.

approach to making models fully public and commissioning expert peer reviews to parties that had full access to the models.

- Second, the report by NZIER sets out modelling issues including the selection of scenarios tested (and those not tested) that, given more time and involvement of interested parties with access to the models, could have been worked through to arrive at a better consensus on the best mix of modelling advice the Commission should have exercised its judgement to recommend budgets and advice.

47. MEUG acknowledges that models have limitations and ultimately decision makers and policy advisors must have the option of exercising their judgement. Best practice is to have at least modelling advice that is robust to rely on to weigh quantitative and qualitative factors.

48. To be clear, MEUG does not believe the Commission can use the modelling as sufficiently robust to support the draft emission budgets and advice. Government may buy-into an argument that robust modelling is not critical as no matter what the cost in the first emission budget period it will have much higher positive benefits in the long-term. That is a risky stance as illustrated in paragraph 8 above on whether the emission budgets and advice assume or not that households will be up to a $745 pa richer in the middle of this decade to facilitate accelerated electrification.

49. The prudent approach is for the Commission to first recognise the models and scenarios tested and output measures considered may not be robust or as relevant as other measures of success. Second to publish all models and collaborate with experts outside of government with the aim of reaching a consensus before final recommendations are lodged with the government by 31st May.

Keeping options open in the near-term is worth re-considering.

50. MEUG is not convinced the scenario of taking a cautious approach in the emission budget period #1, 2022 to 2026 and keeping our options open to take advantage of possible new technologies and robust international carbon markets has been adequately explored.

51. We asked NZIER how optionality (refer principle 3 Create options, Draft Advice p29) and uncertainty should be considered in the Commission's models. The Key points section of the NZIER report (piv) concludes under the subsection header "Limitations of CCC modelling":

> "The problem of how to reduce emissions at least cost is complex with multiple risks, interdependencies and uncertainties. The models available to the CCC require key variables such as land use change, technology adoption etc. to be set outside the values based on assumptions, effectively ignoring any feedback loops to between the assumptions and what is modelled just to make the modelling tractable.
>
> This means the CCC estimates of the cost and composition of recommended emissions reductions path should be:
>
> - Stated as ranges with caveats about the factors that could affect the estimates rather than as point estimates

- Accompanied by sensitivity analysis of the range of possible outcomes that allow for:
  - Delays in the closure of Methanex or the aluminium smelter or delays in the construction of new generation and transmission capacity.
  - Variation in the rate of energy efficiency improvement, fuel switching, transport electrification and the rate of take-up and effectiveness of methane reduction measures.

The desirability of further sensitivity analysis to clarify how policies could be used to achieve emission reductions efficiently was raised in three of the four independent peer reviews of the CCC modelling.

Policy recommendations based on the modelling should include suggestions on how to make the policies simple and flexible enough to adjust quickly to impacts that diverge from the modelling."

Theme 1: An initial cautious not accelerated strategy might be better.

52. The Commission stresses the need for urgent action over the four years of the inaugural emission budget period #1, 2022 to 2026, with an aggressive emission path and proposes 7-time critical necessary actions. That approach is continued in the following 2 budget periods.

53. We query if there has been sufficient and robust analysis to support the claimed need for urgency.

54. However, the bigger problem is a lack of access to the models leaves MEUG unable to validate that the models support the proposed accelerated level of action compared to alternative strategies. We discuss this major flaw in the consultation process in the next section under the header "Theme 2: Open models and improved consultation processes are needed in the future."

55. MEUG believes it would be foolhardy to proceed with many of the recommended strategies to accelerate action without that work having been undertaken and adequate time for interested parties to test and comment on the modelling.

56. MEUG cannot say for sure that taking a more cautious approach in emission budget period #1 and the following 2 emission budget periods is better either because we do not have access to the models to test that proposition. Hence our theme is not that we absolutely recommend a cautious approach. Instead MEUG recommends the prudent course of action is to compare the accelerated and cautious approaches over emission budget period #1 and the following 2 emission budget periods subject to an appropriate level of external scrutiny given the significant consequences of taking the wrong strategy.

57. An initial cautious approach is not an excuse to do nothing. Rather, taking an initial cautious approach ensures there are no unexpected harmful distributional effects in the next 1 to 3 years that could undermine future consensus by consumers with proposed emission budgets. Such an approach allows decision makers to retain more degrees of freedom and optionality to achieve budgets at least cost.

58. The Evidence Report refers to a Westpac Report as evidence of lower costs from early action.[24] However, the Commissions reliance on the Westpac model is misplaced and misleading. Westpac modelled two cases, with the early action case introducing the agriculture sector into the ETS (i.e., agriculture sector in ETS from 2020 over a 10-year period versus 2030 in two 3-year periods) and international units accessible earlier (international units allowed for 20% from 2022 versus no international units). Overall, the impact on GDP from the Westpac study was $30m which is small relative to total GDP. Note the Commission assumed there is no access to international units and the agriculture sector is kept separate; hence our conclusion the claimed relevance by the Commission of the Westpac analysis is weak and the comparison false.

Theme 2: Open models and improved consultation processes are needed in the future.

59. MEUG submits that the Commission models should have been public. Access to the models has been the subject of an Official Information Act request for official information (OIA) by MEUG. We have not decided whether to appeal the Commission's decision to decline our request. Whatever the outcome, MEUG recommends the Commission for all future consultations that rely on models to publish those at the same time consultation papers are published.

60. A lot of work by the Commission has gone into consultation processes including multiple webinars and meeting interested parties. MEUG was one of the latter and we appreciated the time by the Commission Chair, Chief Executive and staff attending our monthly meeting on 24th February. A lot of time and work has been expended by those being consulted. Improvements to the consulting process we think could have assisted the Commission and parties making submissions. We suggested some of those on 5th February and would welcome an opportunity to discuss other suggestions with staff after the close of submissions[25].

61. We appreciate the Commission has a very compressed timeframe to consider submissions and prepare a final recommendations paper to the government by end of May. Nevertheless, it is important that as far as possible as much consensus is achieved across all stakeholders. MEUG encourages the Commission to release the final advice for limited review prior to it being issued as final advice and/or need for clear identification in final advice of changes made from draft advice with underlying reasoning (assumption changes, new information, etc).

Yours sincerely

Ralph Matthes
Executive Director

[24] Evidence report, Chapter 12, p11.
[25] Part of those discussions are covered in MEUG Qu. in section 1. Process questions and CCC answer in appendix 3.

Appendix 1 Glossary

$m	millions of dollars
$/t	dollars per tonne of CO_2 equivalent
CCC	Climate Change Commission
C&I	commercial and industrial
EITE	energy intensive trade exposed
ETS	Emission Trading Scheme
EV	electric vehicle
GDP	Gross Domestic Product
kWh	kilowatt hour
MBIE	Ministry of Business Innovation & Employment
MEUG	Major Electricity Users' Group
MfE	Ministry for the Environment
OIA	Official Information Act 1982
pa	per annum
RMA	Resource Management Act
SMEs	small and medium-sized enterprises
TOU	time of use (metering)
TWh	Terawatt hour

Appendix 2: Cross-reference of Draft Advice paper questions referenced in this submission.

The column on the right-hand-side titled "view" refers to a summary of MEUG's view on the Commission's recommendations. The colour code key follows:

MEUG supports the Commission's recommendation.

MEUG either proposes a modified recommendation or notes the recommendation is being actioned.

MEUG opposes the Commission's recommendation or has insufficient information to support.

CC question theme		Submission paragraph	view
Qu1	Principles to guide our advice, re optionality	[50] and [51]	
Qu2	Emissions budget levels	[8], and [52] to [58]	
Qu3	Break down of emissions budget	See Qu2 above.	
Qu4	Limit on offshore mitigation for emissions budgets and circumstances justifying its use	-	
Qu5	Cross-party support for emissions budget	-	
Qu6	Coordinate efforts to address climate change across Government	-	
Qu7	Genuine, active and enduring partnership with iwi/Māori	-	
Qu8	Central and local government working in partnership	-	
	Enabling recommendation 4, MEUG proposal re RMA & hydro use	[22] and [23]	
Qu9	Establish processes for incorporating the views of all NZers	-	
Qu10	Locking in net zero	-	
Qu11	Locking in net zero	-	
Qu12	Our path to meeting the budgets	See Qu2 above.	
Qu13	An equitable, inclusive and well-planned climate transition	-	
Qu14	Transport	-	
	Time critical necessary action 2, re Accelerate light EV uptake	[14]	
	Necessary action 3 (b), re access to capital for EV's.	[36]	
Qu15	Heat, industry and power sectors:		
	Time critical necessary action 3, re 60% renewables by 2035.		
	~ Preface re "aspirational" 100% renewable electricity target.	[21]	
	~ (a) national energy strategy (MEUG suggests a forum)	[32]	
	~ (b) renewable energy target.	[33]	
	Necessary action 5 (d), re EDBs prepared?	[34]	
	Necessary action 5 (e), re access to capital for Maori generation/DG	[36]	
	Necessary action 5 (f), re monitor electricity for affordability etc.	[34]	
	Necessary action 7 (a), re no new coal boilers.	[35]	
	Necessary action 7 (d), re access to capital for HIP sector.	[36]	
	Necessary action 8 (a), re strategy for hard-to-abate businesses	[37]	
	Necessary action 9 (c), re no new gas connections	[42] - [44]	

Table continued next page.

Table continued from prior page.

CC question theme		Submission paragraphs	
Qu16	Agriculture	-	
Qu17	Forestry	-	
Qu18	Waste	-	
Qu19	Multisector strategy:		
	Time critical necessary action 7, re ETS price path recommendations	[27]	
	Necessary action 19 (b), re industrial allocation policy review	[45]	
Qu20	Rules for measuring progress	-	
Qu21	Nationally Determined Contribution (NDC)	-	
Qu22	Form of the NDC	-	
Qu23	Reporting on and meeting the NDC	-	
Qu24	Biogenic methane	-	
Other matters raised by MEUG			
	Consultation process	[8], and [59] to [61]	

Appendix 3: Attachment 1 – Answers to 5 February 2021 Questions from the Major Electricity Users Group (MEUG)

The attachment is from the CCC is set out in the following 14-pages.
The attachment was emailed by the CCC to MEUG on 5th March 2021 in response to MEUG questions of 5th February. The email also attached a covering letter formally responding to information MEUG requested under the OIA.

Attachment 1 - Answers to 5 February 2021 Questions from the Major Electricity Users Group (MEUG)

Please note, many of your questions refer to decisions and recommendations. The Commission is still in the process of making decisions on the final advice. Following feedback over consultation on the draft advice, we will be reassessing the draft recommendations. The Commission will only provide advice on the direction of the emissions reduction plan policy development and decisions sit with government.

1. Process questions

Question 1.1 - *Provide a list of all models used and the status as to if, and if so when, the Commission propose to publish them.*

Answer - Please refer to the answer provided in the response letter.

Question 1.2 - *Please provide in spreadsheets, or easy to use tables, all datapoints for the text tables, graphs, charts, and other material metrics and reported results in the draft advice and evidence published for consultation and subsequent zoom and other public presentations*. We acknowledge that the Commission announced yesterday a suite of material will be published that may in part of whole meet this request. *Could you please advise all interested parties when this material will be published so parties can effectively manage our time and resources?*

Answer - This request/question was addressed in conversations between MEUG (Ralph Matthes) and the Climate Change Commission (the Commission - Team Lead, Heat, Industry and Power) on Friday 19 February 2021 and in subsequent emails.

In summary, the following was discussed and agreed to:

- data that underpins the charts created by the Commission in the advice report has been released and can be accessed here: https://www.climatecommission.govt.nz/get-involved/sharing-our-thinking/data-and-modelling/
- Ralph would ask (MEUG) members to identify any Commission-created charts in the Evidence report that they would like the data for, and the Commission will provide the information as soon as possible.
- The datasets published by the Commission should provide the underlying data for every figure and number in Evidence report chapters 7-9 and 12-13 (i.e. all the scenarios and impacts content).
- Numbers have been provided for each figure in chapters 12 and 13 in the C-PLAN and DIM-E results datasets. This was not done for chapters 7-9 because of the great number figures contained in these chapters, but everything there should be replicable from the ENZ scenarios dataset provided.
- The Commission is happy to provide help if members need assistance finding the information they want in the datasets.
- Finally, it was agreed that Ralph would ask members to identify any Commission created charts members have seen in any public zooms, presentations or any other forum and they wanted data for - the commission is committed to provide this data.

Question 1.3 - *Can the Commission provide transcripts of all public zoom presentations including Q&A?*

Answer - This question/request was addressed in conversations on Friday 19 February 2021 and subsequent email correspondence between Ralph Matthes and Antonia Burbidge. It was agreed that the Commission currently does not have capacity to do this (i.e. provide transcripts) but that further thought will be given to the desirability of this for future consultation events.

Question 1.4 - *Can the Commission establish a webpage with questions from interested parties and the written response from the Commission?*

Answer - The Commission has a Frequently Asked Questions (FAQ) page https://www.climatecommission.govt.nz/get-involved/faq/ and is happy to receive any feedback from MEUG on any missing questions.

2. Electricity and gas sector questions

Question 2.1 - Refer Figure 5.1 "In our modelling path, wholesale electricity prices in Aotearoa decrease and then return to close to 2021 levels by 2035. The shaded area shows the range between the maximum and minimum price for different regions." Note:

- The Commission's modelled price range in 2021 to 2023 is more than 30% less than current observed futures prices. Put another way, observed market expectations from futures prices are more than 40% higher than the Commission's estimates.
- The Commission assume for the Current Policy Reference that the Tiwai Point Aluminium Smelter closes in 2023. Figure 5.1 shows wholesale prices falling before that date. Unless there is an assumed retirement of large generation plant and or significant new generation entering the market before that date, we would expect prices based on the current offer behaviour and market structure to remain at materially higher levels than in Figure 5.1. MEUG's view aligns with the above bullet point on observed futures market prices.

To understand the outputs in Figure 5.1 we need access to the models including demand forecasts and assumptions about the construction of generation capacity.

MEUG's questions are:

Question 2.1a - *Has the Commission a tolerance on the accuracy of Figure 5.1 e.g., +/- 50% or +/- 100% etc that they are comfortable with and so consider that they have modelled the electricity price adequately provided they are within this unpublished tolerance?*

Answer – Please refer to the cover letter in relation to the models.

The wholesale electricity price path shown in the referenced figure is from the complementary electricity market modelling that we undertook using Energy Link's E-market and I-Gen models. The purpose of this modelling was to gain insight into the market pricing and generation build that our electrification scenarios would entail and to validate the more simplified electricity market modelling approach undertaken in ENZ. The electricity demand paths for the Headwinds and Tailwinds scenarios (as of November 2020) from ENZ were used as inputs for the Energy Link modelling piece. These inputs are available on our website (see link below). This tailwinds scenario model result was used for the price commentary provided for the Central Pathway as the growth in demand was judged sufficiently similar so as to not warrant a unique model run.

The price modelling is not intended to be a short-term price forecast, but rather a projection of what could occur in a particular electrification scenario based on explicit assumptions around emissions, generation and fuel costs. If the assumptions around these costs are incorrect, or the market

operates in a manner not consistent with what has been modelled, then these costs will differ from those actually observed in the market. We undertook this modelling in November 2020. It is fair to say that the recent or current market conditions, which combine a tight gas situation and low hydro storage, have not been reflected in the model and therefore the modelled market prices are not accurate while this condition persists.

We have undertaken a sensitivity analysis around future gas prices for the projected electricity system in 2029, but for a scenario with a lower level of electrification than that shown in figure 5.1. We explored what we considered to be an upper bound on wholesale gas prices. The results of this sensitivity analysis are available in the Electricity Market Modelling Presentation available on our website. Data and modelling » Climate Change Commission (climatecommission.govt.nz)

Question 2.1b - *If the Current Policy Reference case and scenarios tested were adjusted so that the near-term price path reflected futures market prices, then how would that change the Commission's emissions budgets and recommendations?*

Answer - This has not been modelled.

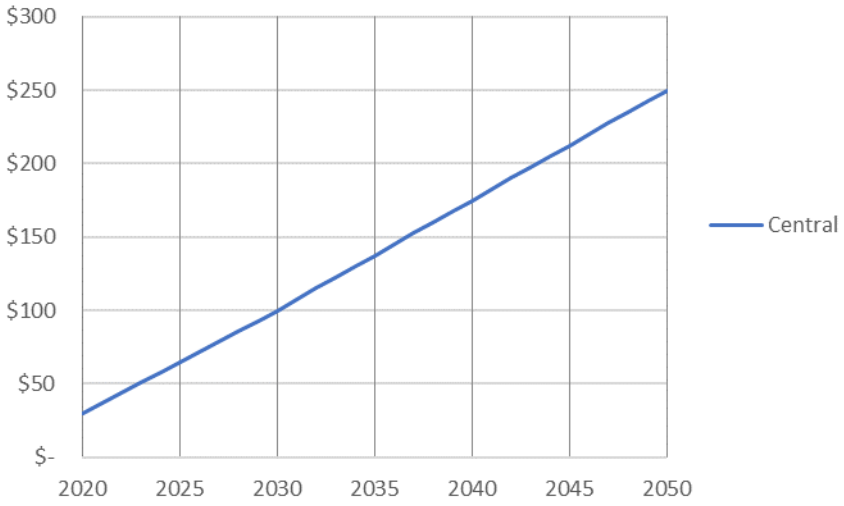
We note that the transition to a low carbon Aotearoa depends on the uptake of long-lived capital assets and expect that investment decisions will be made with an outlook beyond short-term price expectations. We have noted in the Advice to that is it critical there is affordable, abundant, low emissions and secure electricity to ensure that the transition to a low emissions economy takes place. Specifically 'Necessary Action 5' makes draft recommendations pertinent to this.

Question 2.1c - *What carbon prices have been included in the electricity price modelling and specifically has the price trend from Figure 8.2 in Evidence Chapter 8 been applied?*

Answer - The price path shown in figure 8.2 on page 8 of chapter 8 in the evidence report corresponds to an 'emissions value' - this is a modelling construct used in ENZ and is not intended to correspond directly to an ETS setting. The 'emissions value' does not equate to a forecast of the NZU price. The emission value rises within the ENZ model to trigger the uptake of abatement measures. These actions could however be encouraged through a mix of emissions pricing and other policies.

The emissions price path used as an input for the Energy Link electricity modelling is not exactly equivalent to the emissions value path in figure 8.2, although the starting and finishing points are the same. The path is shown in the figure below. This emissions price is the cost of emissions applied to gas, coal, diesel and geothermal generators within the model – i.e it is modelled as if it was an ETS within the Energy Link setting. However, it is likely that that the actual NZU price would be lower than this in the future, depending on the extent to which the Government adopts complementary policies as we have recommended. The more that complementary polices are driving actions to reduce emissions, the more likely it is that the NZU price will be lower. We do anticipate the NZU price would follow an overall upwards trajectory however we have not provided a forecast.

Model emissions value ($/TCO2)



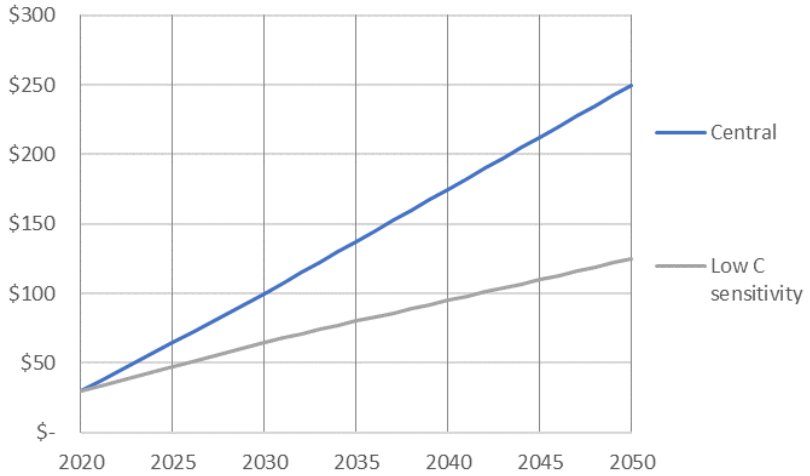
As part of the electricity market modelling done using the Energy Link modelling tools, a lower emissions pricing path was also tested as a sensitivity. This is included alongside the model inputs and summary result files on the Commission's website.

Question 2.1d - *What is the effective C-price impact as a percentage of the wholesale costs illustrated in Figure 5.1? Alternatively, please provide the Carbon $/MWh impact across the 2021-2035 period.*

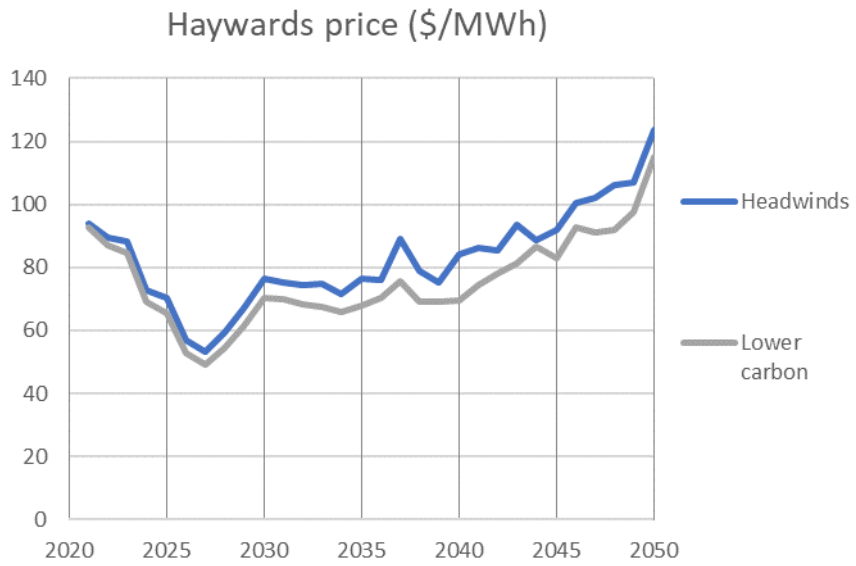
Answer - Please see previous answer on emissions price.

The emissions value impact was tested through sensitivity analysis of the modelled headwinds scenario using the Energy Market modelling tools. In this sensitivity the emissions value rises to 50% of the level of that used in the central model run. The paths are compared in the figure below.

Model emissions value ($/TCO2)



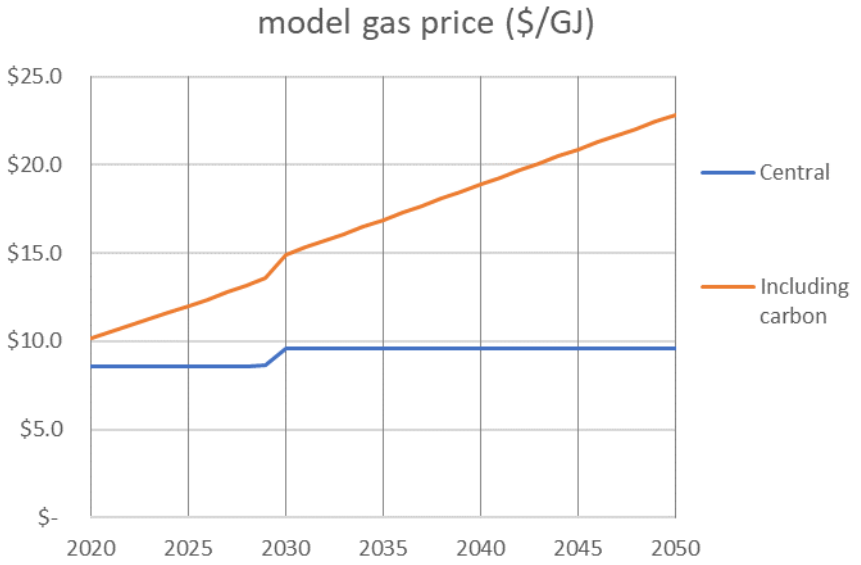
The results of the sensitivity test are shown on the plot below. The result shows that for a scenario with a similar amount of electrification a lower emissions price translates to a $7/MWh lower electricity price (averaged across record).



This data is available in the results file published on the CCC's website here: https://www.climatecommission.govt.nz/get-involved/sharing-our-thinking/data-and-modelling/

Question 2.1e. - *What is the assumed gas price with and without carbon costs across the time-period?*

Answer - See the figure below which shows the modelled gas price for electricity generators with and without an emissions price incorporated in the total cost of gas. The price step at 2029 corresponds to the assumed departure of Methanex. This data is available in the results file published on the CCC's website: https://www.climatecommission.govt.nz/get-involved/sharing-our-thinking/data-and-modelling/



Question 2.2a - Refer necessary action 5, Maximise the use of electricity as a low emissions fuel: Recommendation d. "Assess whether electricity distributors are equipped, resourced and incentivised to innovate and support the adoption on their networks of new technologies, platforms and business models, including the successful integration of EVs." The remits of the Commerce Commission and Electricity Authority cover this.

Is the CCC suggesting another government agency become involved or are there gaps in the regulatory governance of electricity distributors by the Commerce Commission or Electricity Authority?

Modified request - *What Board papers did the Commissioners receive from staff on the question whether there are gaps in the regulatory governance of electricity distributors by the Commerce Commission or Electricity Authority? and Can the staff please explain what the thought process was for arriving at the recommendation?*

Answer - A number of considerations informed recommendation *Necessary Action 5.* The pathway set out in the report is not prescriptive, it illustrates one way of meeting the emissions budgets. However, common to all of the sensitivities is a significant uptake of electric vehicles. This means an accompanying change in the load in homes as people charge and charging infrastructure nationally. Other changes which may affect EBDs include but are not limited to more distributed generation, localised storage, changing tariffs, more and different technology interacting with their networks and entities asking to use it differently. The Commission is aware that the Commerce Commission and EA have programmes of work in place to identify the necessary regulatory and price barriers and incentives. The Climate Commission sought to reinforce the importance of successful adoption of new technologies and business practices critical to enabling the transition. We welcome feedback through the submissions process.

A number of Board Papers were relevant to the discussions the Board had around the draft recommendation. Specifically, the draft versions of the Evidence report chapters (sent in November 2020), papers on draft recommendations for 2 Board meetings in early December, revised Evidence Report chapters sent to the Board in December, draft Advice report sent in mid-December, draft reports sent in January.

A complete set of Board minutes are due to be released soon.

Question 2.2b - Refer necessary action 5, Maximise the use of electricity as a low emissions fuel: Recommendation f. "Monitor and review to ensure electricity remains affordable and accessible, and measures are in place to keep system costs down, such as demand response management." This has been comprehensively considered in the Electricity Price Review (EPR) and subsequent decisions by government.

Has the CCC identified any gaps or additional aspects not covered by decisions from the EPR?

Modified request - *What Board papers did the Commissioners receive from staff referencing the Electricity Pricing Review or noting affordability of electricity issues?* and *Can the staff please explain what the thought process was for arriving at the recs?*

Answer - The Commission was conscious of the work done by the EPR and this (and previous reviews) was discussed in the context of arriving at the wording of this recommendation. Ensuring that electricity is affordable and accessible is critical to ensuring that the switch to electric vehicles takes place, that process heat users have viable alternatives fuels and that electricity remains a low emissions option that households and businesses can rely on. We appreciated the free and frank

discussion we had with MEUG members on 24 February 2021 regarding current market conditions and options to ensure that electricity remains affordable was informative. We would welcome continued engagement as we refine our modelling and revise our recommendations.

A number of Board Papers were relevant to the discussions the Board had around the draft recommendation. Specifically, the draft versions of the Evidence report chapters (sent in November 2020), papers on draft recommendations for 2 Board meetings in early December, revised Evidence Report chapters sent to the Board in December, draft Advice report sent in mid-December, draft reports sent in January.

A complete set of Board minutes are due to be released soon which will outline the Board's decision-making process.

Question 2.3a - Refer necessary action 7, Reduce emissions from process heat:

Recommendation a. "Urgently introducing regulation to ensure no new coal boilers are installed."

This is not discussed in the draft advice or evidence chapters. It simply appears in the list of necessary actions.

We want to understand the CCC rationale for making this recommendation. For example, has the CCC identified a risk that parties may build new coal boilers and that there are no other policy levers that can be considered other than recommending a ban. If so, can we see that analysis. If there is no analysis, then is this recommendation virtue signalling?

Modified request - *What Board paper did the Commissioners receive (from staff) around the recommendation to "Urgently introducing regulation to ensure no new coal boilers are installed."?* and *Can staff please explain what the thought process was for arriving at the recs?*

Answer - from a principles-led perspective, in section 2.2 of the Advice report, principles 1 (align with the 2050 target), 2 (decarbonise the economy) and 4 (avoid unnecessary cost) taken together inform this recommendation. It is worth reading the detail under each of these, which I won't repeat here. Installing a coal boiler today could commit to emissions for up to 40 years given the lifespan of the average boiler. That takes it beyond the 2050 target and commits to gross emissions that are incompatible with the objective to decarbonise the economy. Principal 2 focuses on reducing gross emissions within our borders rather than sequestering in forests. There are viable alternative lower emissions technologies to coal boilers today. The rising emissions price may make a coal boiler an asset that needs replacing ahead of its natural replacement cycle due to it becoming an uneconomic proposition. Avoiding scrapping assets will reduce overall costs to the economy.

A number of Board Papers were relevant to the discussions the Board had around the draft recommendation. Specifically, the draft versions of the Evidence report chapters (sent in November 2020), papers on draft recommendations for 2 Board meetings in early December, revised Evidence Report chapters sent to the Board in December, draft Advice report sent in mid-December, draft reports sent in January.

A complete set of board minutes are about to be released.

Question 2.3b - Refer necessary action 7, Reduce emissions from process heat:

Recommendation d. "Helping people to access capital to reduce barriers to the uptake of technology or infrastructure upgrades such as boiler conversions, energy efficiency technologies, and electricity network upgrades."

Alleged barriers to access to capital is a theme not just for companies considering process heat conversions. The Commission makes two other recommendations about access to capital:

- "Enable more independent generation and distributed generation, especially for remote rural and Māori communities, and ensure access to capital for this purpose" (Necessary action 5, Maximise the use of electricity as a low emissions fuel, recommendation 4).
- "As part of an equitable transition, evaluate and support interventions such as leasing, hire and sharing schemes to remove barriers and address some of the upfront capital costs of EVs" (Necessary action 3, Accelerate light electric vehicle uptake).

MEUG is unsure if the alleged barriers are:

- circumstances that some parties find themselves in from time to time as part of fluctuating economic cycles; or
- true economic barriers reflecting some fundamental and material economic market failure.

If the latter, then we agree solutions need to be considered though relying on capital from taxpayers would have to a policy of last resort. If the former, then is the Commission in effect recommending a preference for cross-subsidisation between classes of households and corporate-welfare?

(in either case) Can we have all the analysis the Commission has considered before making these recommendations?

Modified request - *What Board papers did the Commissioners receive from staff mentioning access to capital as a barrier?*

Answer - For remote, rural and Māori communities, please refer to evidence report, chapter 6, pg. 24-26. This has been informed by interviews with Māori-collectives. Draft versions of the evidence report were seen by the board.

For HIP, it was discussed in 12-13 May 2020. Access to capital has been cited as a barrier in stakeholder engagement that took place throughout 2020 and through the heat, industry and power technical reference group meetings. Our analysis also drew on submissions from stakeholders to MBIE's Accelerating Energy Efficiency and Renewable Energy consultation, Productivity Commission's Low emissions economy inquiry, and the Process Heat in New Zealand work programme.

For transport, no Board paper specifically discussed access to capital as a barrier to the uptake of EVs or participation in car sharing schemes. Recommendation was informed by stakeholder engagement and mitigation options analysis.

Part of modified request - *Can the staff please explain what the thought process was for arriving at the recs?*

Staff can follow up with a conversation after materials have been sent.

Question 2.4 - Refer necessary action 9, Increase energy efficiency in buildings, recommendation c6:

"Setting a date by when no new natural gas connections are permitted, and where feasible, all new or replacement heating systems installed are electric or bioenergy. This should be no later than 2025 and earlier if possible."

This would be a large intervention in the gas sector with wide-spread ramifications for gas demand and supply side affecting households and businesses. There is little analysis of the pros and cons of

this recommendation apart from a statement that "Electricity is a more efficient and lower emissions source of energy for heating homes and businesses than gas."7 It's unclear if this refers to thermal or whole-of-asset-life economic efficiency. Please provide the analysis or reference supporting this statement.

There is no supporting economic analysis as to why the date of 2025 is recommended.

Please provide the analysis the Commission considered relating to this recommendation.

Modified request- *Please restrict the scope of this request to the modelling information and supporting analysis.*

Answer - The costs of heating appliances variabilised over the asset's entire lifetime in units of $/kWh are given in the table below. These values are based on the inputs of the Marginal Abatement Costs Curve analysis by MFE. These costs are also available in the detailed assumptions sheet which has been published in the 'Technical assumptions in ENZ' workbook on the Commission's website.

	Space heating		Water heating	
	Heat pump	Gas	Electric cylinder	Gas
Commercial and public	0.08	0.07	0.03	0.04
Residential	0.17	0.14	0.07	0.09

The heating cost is the sum of this capital cost and the delivered energy costs. The delivered energy costs are calculated endogenously in the ENZ model and are based on wholesale costs weighted by consumer use profiles (DWA/TWA), network costs and retail costs. The assumptions which build up these prices are outlined in the 'Technical assumptions in ENZ' workbook, as are the modelled output consumer energy costs.

As modelled, the cost of heating is generally similar for gas vs electric technologies, although rising emissions prices and gas network costs lead to the model favouring electricity. The 2025 ban and 2050 phase out are imposed in the model. They are not cost driven.

3. Cross-sector questions relevant to the electricity and gas sectors.

Question 3.1a - *Please provide the new and replacement capital investment and early retirement (i.e., earlier than the end of the economic life of existing assets) for each year to 2050 assumed for the Current Policy Reference scenario and every other scenario considered by the Commission for:*

• Electricity transmission.

• Electricity distribution.

• Gas transmission.

• Gas distribution.

Question 3.1b - *For each of the above infrastructure sectors for year and each scenario, please provide:*

• The assumed operating and maintenance costs.

• The assumed volumes transported, and relevant units used (flow and or peak).

Modified/clarified request - *please ask Simon for the numbers or the formulae used to calculate the incremental transmission and distribution costs or both. We will provide part 2 (assumed O&M and volumes) of this query too. Part 3 (regulated monopoly assets) – please narrow the scope from "any material or consideration" to "any reports to the Board".*

Answer - We have not modelled infrastructure or infrastructure costs at this level of detail. Infrastructure is not a constraint within the ENZ model.

We have made estimates of total infrastructure costs for electricity transmission and distribution which are intended to reflect capital and operating costs. For electricity the cost is driven by growth in generation and growth in demand with various assumptions around proportionalities for different user groups.

It is difficult to explain succinctly in text and we would prefer follow-up conversation to explain.

The total system network costs are allocated to different user groups in the model. Within the model logic, the only sectors which make fuel switching decisions based on these network costs are residential and commercial consumers in selection of heating system (although this is overruled by ban and phaseout settings). The variabilised and fixed network costs for consumers are reported in the published datasets.

Pipeline infrastructure costs are assumed to be constant at $260 million per year. These costs become allocated amongst a smaller base of gas users. Total gas use is reported in the published data outputs.

Question 3.1c - *Provide any material or consideration made to the treatment of regulated monopoly assets stranded by the Commission's recommendations.*

A presentation was provided to the chair of the Board in October 2020 to, in part, outlining how regulated monopoly assets operate under current electricity market regulatory settings. The material does not assume these assets are stranded by the Commission's recommendations.

Question 3.2 - Refer necessary action 19, Continued ETS improvements, recommendation b:

"… the Government make progress on … Undertaking a first principles review of industrial allocation policy."

We note that industrial allocation phase-out through the currently legislated reduced level of assistance has not been considered despite this being a material change by 2035 (high emissions intensity firms will reduce allocation from 90% to 70% and moderate intensity firms from 60% to 40%).

Evidence Chapter 7 p21 states," Changes in rates of industrial allocation in the NZ ETS are assumed to have no effect on industrial output, nor on uptake of mitigation options, where decisions are assumed to be made based on marginal costs."

Has there been any consideration of the impacts on profitability of EITE firms, emission budgets or wider economic impacts in the modelling?

Modified request - *Please substitute "any consideration" for "any material that went to the Board"*

Answer - To clarify, the quoted text (Evidence Chapter 7 p21) refers to the modelling approach in the ENZ model. This model does not assess the profitability of EITE firms. Firm profitability depends not only on domestic emission and energy prices, but also their ability to pass changes in operating costs on (through price increases in finished goods) and their competitiveness in an international market (which depends on many things beyond domestic climate policy). Although these are important considerations, we have not tried to address the impact of profitability within the ENZ model.

A document titled 'Summary of key HIP assumptions' was discussed in a workshop attended by members of the board on the 22nd of September 2020. The document which pertains only to the ENZ model assumptions summarised the production activity assumptions of industrial sectors and made that note that 'The model does not explore the viability of industries in response to a rising carbon price.'

In terms of other board papers with reference to the profitability of EITE firms, the board saw the draft versions of the advice and evidence reports which make reference to the free allocations for EITE firms.

Question 3.3 - A large increase in the use of biomass is an important part of the draft pathways, e.g.:

"In our path, fuel switching to biomass also occurs in some other energy-intensive industries such as pulp and paper production.

Overall, our path takes advantage of the country's currently under-used biomass resource, moving towards a more circular economy. Achieving this uptake will require the development of supply chains for gathering and processing biomass along with the establishment of local markets."

MEUG members agree with the Commission that use of biomass is constrained locally due to transport costs. That does leave energy-intensive businesses where conversion to biomass is not economic in a bind.

Is there a report, or chapter in the Commissions reports, or model that tabulates the biomass pathway to 2035 by regional locality?

Modified request – Following clarification conversations, it was agreed that *instead of the final sentence in this section, the CCC would provide a written explanation of how the model works out biomass availability and the regional figures for biomass availability for future years.*

Answer - In the ENZ model forestry residue and pulp logs are utilised as a fuel for process heat and as a feedstock for liquid biofuel production. The available supply of biomass is based on the forestry module of ENZ.

The National Exotic Forest Description and other data from MPI are used to estimate standing forest areas by region. Forest harvesting is modelled based on an average rotation length of 28 years. Total recoverable volume (TRV) and the proportion of pulp logs are calculated based on a reference yield table and regional multipliers provided by Scion. The volume of recoverable harvest residues is assumed to be 5% of the TRV.

Note that the wood yield tables and other forestry assumptions are available on our website in the worksheet titled 'Technical-assumptions-in-ENZ-land-and-waste.xlsx'

An adjustment to the available supply of pulp logs is made to remove the consumption of existing domestic users.

Regional matching of supply and demand occurs for biomass use as a boiler fuel in food processing. Scaling factors are also applied to restrict the available regional supply – the purpose of this is to prevent the food processing sector from consuming all the available supply within the region at the expense of other users and to ensure a balance between fuel switching to bioenergy and electrification. The latter is thought to reflect the practicalities of using biomass as a boiler fuel on a massive industrial scale which might limit the uptake. The scaling settings are varied between scenarios with settings of 25% of regional availability for CPR, Headwinds and Further Behaviour and 50% for other scenarios and pathways.

Wood, pulp and paper processors also utilise biomass to displace fossil fuels. We have not regionally matched supply and demand for these sectors as they are located in forestry regions.

A workbook (Attachment 2) is provided which details the biomass supply, regional consumption (for food processing) and other consumption.

Question 3.4 - *Has the Commission undertaken a probability analysis of sector pathways being met taking into account the uncertainty of human reactions or economic hardship decisions driving behaviour?*

Modified request - *The CCC to provide a written explanation of the question in the first sentence rather than conduct a search of Board papers etc.*

Answer - We have looked at alternative combinations of measures which would achieve the same overall budget levels to assure ourselves that the budgets could be met in a range of circumstances. We have not attempted to assign probabilities to the delivery of specific abatement measures. We intend to explore the sensitivity of our path to uncertainty through conducting sensitivity analysis prior to providing our final advice.

Question 4.1 - The modelled impact on GDP in 2035 is reported in the draft advice (pe87) as:

"Looking out to 2035, our modelling suggests that reducing emissions to meet our proposed emissions budgets would cost Aotearoa no more than $190 million each year over emissions budget 1, $2.3 billion each year over emissions budget 2, and $4.3 billion each year over emissions budget 3."

Taking the Commission's estimates of GDP in 2020 of $321b and the Current Policy Reference estimate of GDP in 2035 of $396b, and the using the above estimates of annual decreases for each emission budget period to 2035, we calculate GDP in 2035 of the proposed emission budgets as $362b. $362b is 8% less than $396b.

In contrast the lowest estimate of GDP in table 12.2 of any scenario in the Evidence Chapter 12 is $392b (Transition Pathway 4 (TP4): Faster reductions).10 $392b is 1% less than $396b. These estimates support the draft advice:

"The overall costs of meeting the country's targets and our proposed emissions budgets are likely to be less than 1% of projected GDP."

Please provide a reconciliation of the estimates of the effect on GDP in 2035 compared to the Current Policy Reference between the text in the draft advice (pe87) with table 12.2 of the Evidence Chapter 12.

Answer - The figures in the Advice Report for the reduction in GDP under Transition Pathway 4 (as modelled by CPLAN) compared to the CPR represent the average difference in GDP in each year

across each of the budget periods, not the annual difference in each of the periods. The figures are not the additional difference in GDP in each year.

The level of GDP projected under each scenario for each year are now published on our website. See https://ccc-production-media.s3.ap-southeast-2.amazonaws.com/public/C-PLAN-results-dataset-for-2021-draft-advice.xlsx

Question 4.2 - The Commission's CGE model is described in the evidence report (Chapter 12 p 4) as having important differences from other CGE models used to analyse the effects of climate change policy:

"C-PLAN models emissions reducing in response to climate policy with little or no reduction in output, and so shows a smaller impact on gross domestic product (GDP) and abatement costs than other CGE models in Aotearoa.3 This occurs because C-PLAN explicitly includes key emissions-reducing technologies that allow emissions to be reduced without reducing output (e.g. a methane vaccine), and also allows industries to switch the energy sources they are using."

Please provide a description by industry as modelled in C-Plan of the new technologies adopted and the switch in energy use preferably at 5-year intervals starting from 2020. If this cannot be supplied quickly, then at 2017, 2025, 2030, 2035 and 2050 – the years reported in "Table 12.2: GDP projections from the Commission's C-PLAN modelling ($ billion)" (Chapter 12 p7).

Answer - We have not provided the switch in energy use by sector as this will require significant additional analysis, and only providing it for the specified years would not reduce the size of the task.

The modelled technologies in C-PLAN can be found in the spreadsheet we have published with C-PLAN outputs. This sets out the output in dollar terms for each year and scenarios is given in the OutputDetails sheet. See https://ccc-production-media.s3.ap-southeast-2.amazonaws.com/public/C-PLAN-results-dataset-for-2021-draft-advice.xlsx
(found on our website at https://ccc-production-media.s3.ap-southeast-2.amazonaws.com/public/C-PLAN-results-dataset-for-2021-draft-advice.xlsx).

The sheet EmissionsDetails in the same spreadsheet has the emissions quantities for both the new technology sectors and their existing counterparts, and so the change in emissions due to the new technologies can be determined from this data.

Explicit new technologies:

- Electric vehicles for household transportation - see sector hht1, and compare with sector hht which is the equivalent for internal combustion household transport
- Electric vehicles for commercial land transportation (including rail) - see sector rtp1, and compare with sector rtp which is the equivalent for internal combustion commercial land transport
- Methane-reducing technology for dairy farming - see sector rmk1, and compare with sector rmk which is the equivalent for dairy farming without this technology
- Methane-reducing technology for beef and sheep farming - see sector b_s1, and compare with sector b_s which is the equivalent for dairy farming without this technology
- Carbon capture and storage for geothermal electricity - see sector eoth_ccs, and compare with sector eoth which is the equivalent for geothermal electricity without CCS.
- Biomass for process heat is produced by the sectors bh_hor, bh_mil, bh_mtp, bh_ofd, bh_omf, bh_w_p, and used in the sectors hor, mil, mtp, ofd, omf, w_p respectively

(horticulture, dairy processing, meat processing, other food products, other manufacturing, wood & paper). This will be substituting for coal, gas, and other non-electricity energy sources in these sectors.

- Energy for electrification of process heat is in the sectors eh_hor, eh_mil, eh_mtp, eh_ofd, eh_omf, eh_w_p, and used in the sectors hor, mil, mtp, ofd, omf, w_p respectively (horticulture, dairy processing, meat processing, other food products, other manufacturing, wood & paper). This will be substituting for coal, gas, and other non-electricity energy sources in these sectors (as with biomass), and use electricity in their production.

Question 4.3 - *Could you please explain what modelling approach led to the different assumptions for the scenarios "Table 12.1: The key assumptions used in each of the scenarios run in C-PLAN." (Chapter 12 p5-6) delivering almost identical GDP growth paths in "Table 12.2: GDP projections from the Commission's C-PLAN modelling ($ billion)" and provide data on the share of GDP by industry as modelled in C-Plan.*

Answer – These assumptions came from staff assessment of the key material changes that could affect the economy. They deliver similar but not identical growth paths because the economy has many ways to decarbonise in the model including the new technologies in the model, as well as the low proportion of the economy that is emissions-intensive. The uptake of new technologies that are explicitly specified in the model, price-driven fuel switching, and price-driven energy efficiency (where the price is determined by an ETS-type scheme for each of the two net emissions caps) means that emissions can be reduced to meet the emissions caps without substantially reducing output from most sectors. It is also the case that large parts of the economy (such as the services sector) are not emissions-intensive and so are not heavily affected directly by the emissions caps.

The output of each sector is given in the OutputDetails sheet of our recently published spreadsheet https://ccc-production-media.s3.ap-southeast-2.amazonaws.com/public/C-PLAN-results-dataset-for-2021-draft-advice.xlsx (found on our website at https://ccc-production-media.s3.ap-southeast-2.amazonaws.com/public/C-PLAN-results-dataset-for-2021-draft-advice.xlsx). Note that the total output of all sectors does not add to GDP as it includes both intermediate and final production, whereas GDP is defined as solely final production.

NZIER
NEW ZEALAND INSTITUTE OF ECONOMIC RESEARCH

Climate change model review

Climate Change Commission ENZ and C-Plan models

NZIER report to Major Electricity Users Group (MEUG), Major Gas Users Group (MGUG) and Energy Resources Aotearoa

25 March 2021

About NZIER

NZIER is a specialist consulting firm that uses applied economic research and analysis to provide a wide range of strategic advice.

We undertake and make freely available economic research aimed at promoting a better understanding of New Zealand's important economic challenges.

Our long-established Quarterly Survey of Business Opinion (QSBO) and Quarterly Predictions are available to members of NZIER.

We pride ourselves on our reputation for independence and delivering quality analysis in the right form and at the right time. We ensure quality through teamwork on individual projects, critical review at internal seminars, and by peer review.

NZIER was established in 1958.

Authorship

This paper was prepared at NZIER by Mike Hensen.

It was quality approved by John Yeabsley.

Registered office: Level 13, Willeston House, 22–28 Willeston St | PO Box 3479, Wellington 6140
Auckland office: Ground Floor, 70 Shortland St, Auckland
Tel 0800 220 090 or +64 4 472 1880 | econ@nzier.org.nz | www.nzier.org.nz

Key points

Electricity modelling

The ENZ model (a bottom-up model of feasible reductions in greenhouse gas emissions by selected sectors) forecasts annual average wholesale electricity prices in a range of $63 per MWh to $74 per MWh - well below current and forward market prices and lower than the Energy Link forecast used by the Climate Change Commission (CCC) as a cross-check on the ENZ model. (The Energy Link model forecasts average wholesale electricity[1] prices of $94 per MWh in 2021 falling to below $53 to $62 per MWh by 2036 and then rising to $120 to $140 per MWh by 2050. The initial fall is driven by the combination of an increase in geothermal generation capacity (150 MW in 2024) and a phased reduction in aluminium smelter demand[2] partially offset by a reduction in gas capacity (380 MW in 2025).

The ENZ model does not explain what will drive the transition from current wholesale electricity market pricing to the levels forecast. The ENZ model assumes that the levelized cost of energy (LCOE) of wind generation will set the average wholesale prices. The CCC advice should explicitly consider the sensitivity of ENZ transport and process heat electrification to wholesale prices as the assumption of the ENZ model do not reflect the current reality of the wholesale electricity market. A similar comment was made in the peer review by Dr. Marc Hafstead[3].

The ENZ model outputs do not explicitly state how dry year risk and security of supply have been included in the modelling and what level of increased generation capacity will be necessary to manage the additional dry year risk arising from the increased share of wind in the generation stack and reduced role of thermal generation plant. The Energy Link presentation includes comment on dry year risk, but it is not clear how this is incorporated into its 'headwinds' and 'tailwinds' scenarios.

ENZ modelling assumes that gas supply will continue to be available for process heat and peak period electricity generation after the closure of Methanex and baseload gas-fired electricity generators. However, these changes reduce gas demand by more than 60 percent by 2030 and change the structure of the gas market by removing counterparties that would be willing to enter long term contracts that would fund ongoing development of gas supply. At the same time, the forecast increase in the carbon price will add about $7.50 per GJ to the cost of gas by 2030 and $10.05 by 2040.

The CCC in its draft advice states that Government will need to manage energy affordability and security of supply issues as part of a national energy strategy, but its model outputs do not provide an indication of the potential size and timing of changes in affordability and security of supply that are attributable to CCC's recommendations for reducing greenhouse gas emissions. The CCC advice should include sensitivity analysis of both electricity wholesale prices and gas supply and price risks.

1 Haywards node price

2 The forecast phase-down in aluminium smelter electricity demand is 730 MWh in 2024, 1,752 MWh in 2025, 1653 MWh in 2026 and 869 MWh in 2027

3 NZ Climate Change Commission Model Review, Part 1, Dr. Marc Hafstead, pages 1 to 2

Comparison emission reduction pathways and impact on GDP

The CCC advice on the options for emission reductions pathways and their impact on GDP:

- Compares the options to a current policy reference (CPR) path which already has substantial opportunity for reductions in emissions baked in (the closure of the Methanex and the aluminium smelter, energy efficiency gains in industry and electrification of transport). This means it is unsurprising that the difference in GDP at the end of the modelling period between the CPR and other options is small.
- Considers a set of options in the C-Plan model that are based on but not explicitly linked to the options in the ENZ model. In particular, the C-Plan model which forecasts the economic impacts of the CCC advice:
  - assumes a slower emissions reduction pathway than the pathways that the ENZ model estimates are technically feasible - see Table 1
  - generates carbon prices that start below the ENZ model path but rise above the ENZ model path later in the modelling period – see Table 2

Table 1 C-Plan (exogenous) and ENZ (endogenous) other long lived gas emissions

Gross emissions (Mt CO_2e) of gases other than CH_4

Year	ENZ Model				CPR	C-Plan			
	Head-winds	Behaviour Change	Tech. Change	Tail-winds		TP1	TP2	TP3	TP4
2025	42.5	41.8	42.0	41.3	**44.3**	43.9	43.9	43.2	39.4
2030	38.0	36.7	34.3	33.2	**43.9**	40.0	40.0	38.4	29.9
2035	34.2	32.2	27.1	25.6	**41.5**	36.1	36.1	33.6	27.2
2040	28.3	25.8	18.7	17.0	**39.0**	32.1	32.1	28.8	24.5
2045	22.1	19.4	13.9	11.9	**36.8**	28.2	28.2	24.0	21.9
2050	17.6	15.0	11.8	9.6	**34.8**	24.3	24.3	19.2	19.2

Source: ENZ and C-Plan model outputs

Table 2 C-Plan (endogenous) and ENZ (exogenous) emissions carbon prices

Long lived gases (other than CH_4) ($ per t CO_2e)

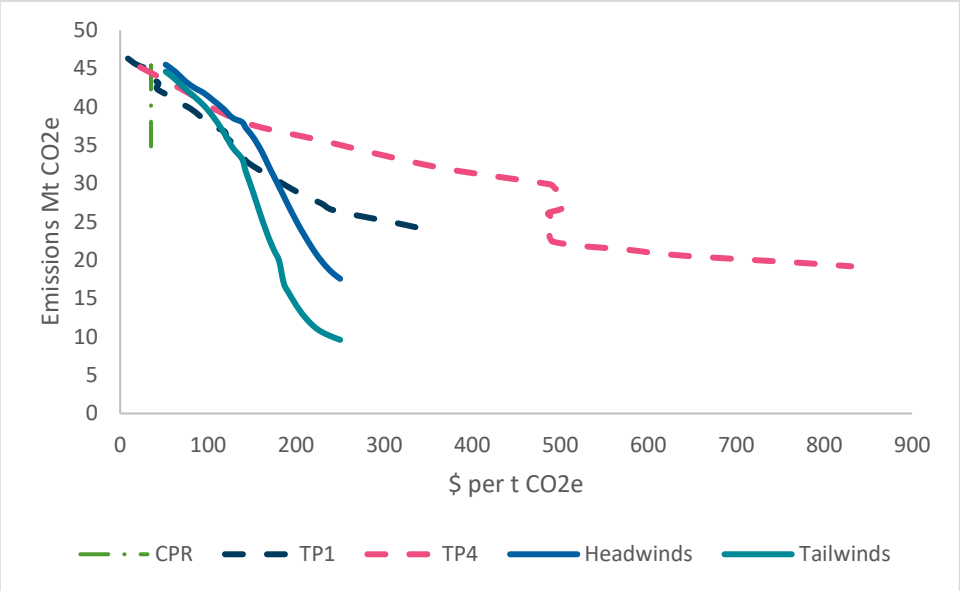
Year	ENZ Model	CPR	C-Plan			
			TP1	TP2	TP3	TP4
2025	84.21	**35.00**	32.26	32.14	44.12	111.54
2030	138.42	**35.00**	76.57	76.37	112.19	488.02
2035	160.47	**35.00**	120.81	120.47	182.84	502.97
2040	186.02	**35.00**	153.06	152.68	275.37	481.86
2045	215.65	**35.00**	213.32	212.81	394.21	521.94
2050	250.00	**35.00**	337.79	336.86	860.91	830.57

Source: ENZ and C-Plan model outputs

High carbon prices generated later in the C-Plan model period (compared to the ENZ model) suggests that energy efficiency, fuel-switching and technology changes included in the C-Plan are not sufficient alone to deliver the emissions reduction for the model.

The difference between ENZ and C-Plan modelled trade-offs between emission reductions and carbon prices are illustrated more clearly in Figure 1.

Figure 1 Reduction and price paths for gross emissions of other (non CH_4) GHGs



Source: Drawn from C-Plan and ENZ modelling outputs

The CCC advice does not explain why:

- A different set of emissions reduction pathways were assumed for the C-Plan model to those estimated as achievable by the ENZ model
- ENZ and C-Plan trade-offs between carbon prices and emissions reductions diverge
- Which scenarios are used to support which aspects of the CCC recommendations.

Rest of world carbon prices

The C-Plan model assumes a uniform rest of the world (RoW) carbon price starting at zero at the beginning of the model period and increases in a straight line to USD250 in 2050. This assumption means that NZ carbon prices are above the carbon prices assumed for trading partners for a large part of the modelling period.

This difference will affect the competitiveness of emissions intensive trade exposed (EITE) industries. The ENZ model assumes these industries either exit or their output remains constant over the modelling period. While a uniform carbon price is a useful simplification, it does not reflect the experience to date and will understate risks of rising domestic carbon prices to both the viability of EITE industries and the risk of carbon leakage.

Limitations of CCC modelling

The problem of how to reduce emissions at least cost is complex with multiple risks, interdependencies and uncertainties. The models available to the CCC require key variables such as land use change, technology adoption etc. to be set outside the values based on assumptions, effectively ignoring any feedback loops to between the assumptions and what is modelled just to make the modelling tractable.

This means the CCC estimates of the cost and composition of recommended emissions reductions path should be:

- Stated as ranges with caveats about the factors that could affect the estimates rather than as point estimates
- Accompanied by sensitivity analysis of the range of possible outcomes that allow for:
  - Delays in the closure of Methanex or the aluminium smelter or delays in the construction of new generation and transmission capacity.
  - Variation in the rate of energy efficiency improvement, fuel switching, transport electrification and the rate of take-up and effectiveness of methane reduction measures.

The desirability of further sensitivity analysis to clarify how policies could be used to achieve emission reductions efficiently was raised in three of the four independent peer reviews of the CCC modelling.

Policy recommendations based on the modelling should include suggestions on how to make the policies simple and flexible enough to adjust quickly to impacts that diverge from the modelling.

Contents

Appendices

Figures

Tables

1 Overview

1.1 Scope

The terms of reference for this report are:

Critique of the CCC modelling inputs, assumptions, linkages between models and potential uncertainty in the model results due to the 'loose coupling' of the ENZ, C-Plan and DIM-E models. The analysis will include:

- Recommendations that have a material impact on electricity and gas security of supply and total delivered (sum of energy and line charges plus potential change in dry year/unexpected unplanned outage costs) to households, businesses and EITE businesses.
- Comparison of the CCC proposed pathways and key assumptions such as carbon prices and rates of technological change with the marginal cost of emission reductions in the CCC proposed pathways that cannot be delivered by technology change.

1.2 Model structure

The Climate Change Commission (CCC) has supported its advice with three streams of modelling:

- ENZ model of emission reductions by industry which is designed to show the impact of changes in energy and land use on greenhouse gas (GHG) emissions given assumptions about carbon price, rates of technology change and closure of some industries (aluminium and methanol production). The models include a 'current policy reference', 'our path to 2035' and four scenarios: 'headwinds', 'further behaviour change', 'further technology change' and 'tailwinds'. CCC has released a copy of the:
  - ENZ model results and the ENZ model technical assumptions for rates of change in technology and input use in energy, transport, agriculture, forestry and waste
  - Energy Link electricity market model results which were used as a cross-check on the ENZ models of the electricity demand and assumptions about electricity prices. The Energy Link models include 'tailwinds' and 'headwinds' scenarios but these have **different assumptions and outputs** from the two ENZ scenarios with the same names.
- C-Plan a computable general equilibrium (CGE) model of the economy which is designed to show the effects of (GHG) emission reduction pathways on activity in selected sectors of the economy, trade and gross domestic product (GDP) and the carbon prices 'required'[4] to deliver the GGH emissions pathway. The model includes:
  - Target Pathway 1 (TP1): based on the central assumptions for energy and land use and three scenarios other scenarios with alternatives to the central assumptions:

[4] The CCC modelers have emphasised that the carbon prices calculated the by the C-Plan model are not forecast of ETS prices because the C-Plan model separates the emissions reduction pathway into CH_4 and other long lived gases (which are in turn separated into CO_2 and N_2O)

- Target Pathway 2 (TP2): Methane technology which combines quicker uptake of methane reduction technologies with tighter methane targets.
- Target Pathway 3 (TP3): Lower forestry removals to identify costs of relying more heavily on emissions reductions.
- Target pathway 4 (TP4): Faster reductions which tests the impacts of adopting more ambitious near-term emissions reduction targets for non-biogenic methane.

The CCC has released a spreadsheet of the C-Plan outputs including exports, imports, GHG emissions by type, output by selected industry, electricity, land use and employment.

- Distributional Impacts Microsimulation -Employment (DIM - E) which is used to assess the regional impacts of climate change pathways by disaggregating the national output and employment from the C-Plan model into regional changes in jobs by type which is used to estimate regional changes in the distribution of personal incomes and jobs. This report does not discuss this model as it is not directly covered by main focus of the terms of reference. However due to its dependence on the C-Plan model outputs the concerns raised about the C-Plan model outputs will flow through to DIM-E.

1.3 Model linkages and drivers

1.3.1 Loose coupling of ENZ and C-Plan models

The ENZ and C-Plan models were described as 'loosely coupled'[5]:

- The ENZ model assumptions about the effects of technology change on fuel switching and changes in energy use and emissions inform the scenarios used in the C-Plan model but are not used as direct inputs to the C-Plan model
- The scenarios in the ENZ model and the C-Plan model are different with different emissions profiles and energy use assumptions,

This means the industry output levels and GDP impacts forecast in the C-Plan for different emissions paths cannot be directly linked to the bottom-up estimates of changes in energy and land use forecast in the ENZ model. (The ENZ Model is the primary tool for the setting of "Our Path to 2035" and the associated budgets and carbon price pathway.)

> *Our modelling indicates that the pathways for meeting the 2050 target might require actions to reduce emissions in some sectors with cost of about $140 in 2030, and $250 by 2050. These modelled costs are not a forecast of the NZ ETS market price. Rather, they reflect the marginal cost of the measures that would need to be implemented to meet the relevant emission budget and get on the pathway for meeting the 2050 target[6].*

Having tried to "disconnect" the carbon price pathway from the ETS market prices, the CCC do recommend ETS price settings to allow this price path (and much higher) to be realised.

[5] This phrase was used at a CCC model workshop and is also used in one of the peer reviews: 'Review of Models and Modelling, 18 December 2020', Adolf Stroombergen, page 1, available at https://www.climatecommission.govt.nz/get-involved/our-advice-and-evidence/ see 'Stroombergen-Model-Review-Part-2.pdf'. The comparison of the ENZ and C-Plan emission reduction scenarios in section 3 of this report is an example of the difference between the models.

[6] CCC Evidence Chapter 17, p5.

1.3.2 Model drivers

Two of the key drivers of the model are the setting of the carbon price outside the model and the CCC decision to focus on a rapid early reduction in gross emissions while limiting the role of exotic forest planting[7].

The CCC has set the carbon price path for its modelling based[8] on estimated marginal abatement costs of $140 per tonne in 2030 and $250 per tonne in 2050. The carbon price path for the years from 2021 is then modelled as an increase of:

- $10.84 per year from the 2020 price of $30 per tonne of CO2 until 2030 when the price reaches $138.42 per tonne of CO2.
- 3 percent per year from 2031 to 2050 when the carbon price reaches $250 per tonne of CO2 – an annual increase that is initially less than half the $10.84 increase per year over 2021 to 2030 and in 2050 Is $7.26.

The CCC does not provide any indication of the modelling used to estimate the marginal abatement costs forecast for 2030 and 2050. The price path chosen by the CCC shifts the costs for GHG emission reduction toward the beginning of the adjustment period with little explanation of how this is related to the shape of marginal abatement cost curves or traded-off against the potential for technology to reduce the costs of reductions in the future.

The CCC also notes that the zero net emissions could be reached by 2050 with a carbon price of $50 per tonne of CO2 but discounts this option because it would pass the problem of decarbonising to the next generation.

> *This approach would fail to drive meaningful decarbonisation and instead use up land resources for the purpose of offsetting avoidable emissions.*[9]

The CCC does not consider the potential for a middle ground between the reduction in gross emissions path that it has chosen and the reduction of net emissions. Approximately 83 percent of gross emissions target is met at $35. The difference between this price and the ENZ carbon price path is rough indicator of the additional cost of the faster emission reduction.

The CCC model outputs do not include an assumption for the carbon price faced by New Zealand's trading partners. At a presentation[10] on the C-Plan model, CCC staff indicated that the assumed price path starts at zero at the beginning of the model period and increases in a straight line to USD250 in 2050. Figure 1 compares the:

[7] A review of the cost of tree planting 'PWC (2020) Native Forests: Resetting the Balance' estimated that the cost of planting pine forests for production (including the cost of thinning, landings and harvest roading) was $3,925 per hectare and the cost of planting indigenous trees at low density (625 stems/hectare) was $3,438 per hectare while medium density planting (2500 stems/ha) costs $13,750 per hectare. Estimates based on material from 'Trees that count' a tree planting charity indicate the following costs: low density planting (400 stems/hectare) $3,600 per hectare, medium density (1600 stems/hectare) $13,600 per hectare and high density (5000 stems/hectare) $40,400 per Hecate.

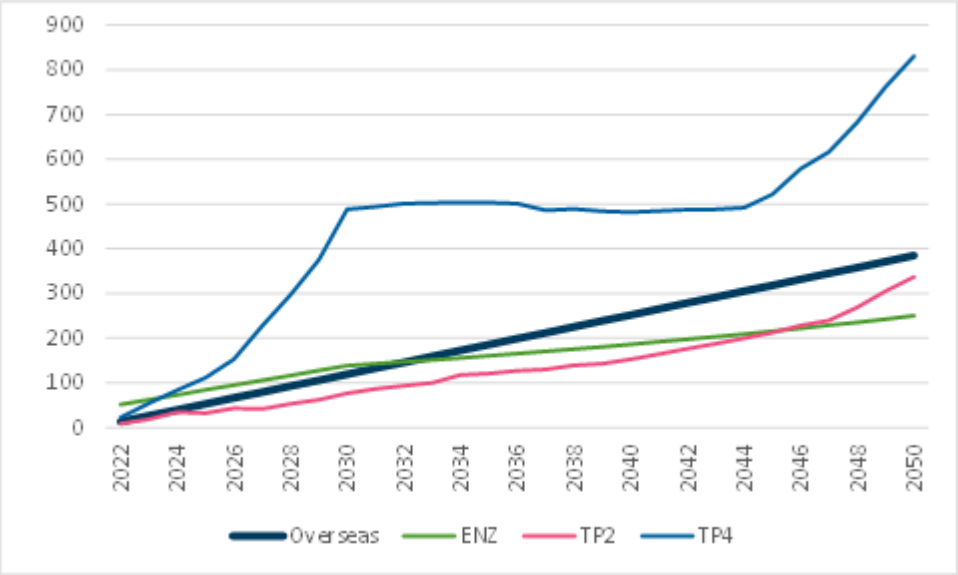
[8] '31 January 2021 Draft Advice for Consultation', page 50. Low and medium temperature heat in industry and buildings could be decarbonised by 2050 through a switch away from coal, diesel and gas to electricity and biomass. Our analysis indicates that these costs could range up to $250 per tonne CO2e reduced but would be less than this where heat pumps or biomass can be used.

[9] 31 January 2021 Draft Advice for Consultation', page 46. We have tested a variation to the current policy reference case assuming a slightly higher NZ ETS unit price of $50. In this variation, new forest planting increases to around 1.3 million hectares by 2050, allowing net zero emissions to be reached with minimal further reductions in gross emissions. The results suggest that Aotearoa could meet the net zero target for long-lived gases with relatively little additional change.

[10] Climate Change Commission open Zoom series - How our models work: C-Plan and DIM-E, 23 February 2021, time 46:54 to 47:35 available at https://www.climatecommission.govt.nz/get-involved/events/

- RoW carbon price based on a linear progression between the assumed prices of USD 0 in 2021 to USD 250 in 2050 converted to NZD at an exchange rate of USD 0.65 per NZD (the exchange rate assumed in the ENZ model)
- ENZ carbon price path
- C-Plan 'Emissions Values Long-Lived Gases ($NZ/t CO2e)' [11] for TP2 (the lowest of the four paths) and TP4 (the highest of the four paths).

Figure 2 Overseas and New Zealand carbon price estimates (NZD per tonne CO_2e)



Source: Drawn from C-Plan and ENZ modelling outputs

1.4 Approach

The analysis of the CCC modelling in this report focuses on two aspects:

- Consistency between the modelling of electricity prices and generation mix in the ENZ and Energy Link models and the demand for electricity in the ENZ and C-Plan models
- Comparison of the cost of emissions reduction in the C-Plan model scenarios.

[11] C-PLAN-results-dataset-for-2021-draft-advice.xlsm, EmissionsValues, E10:E38 and G10:G38. The model includes the following note: *Emissions values are generated for hypothetical ETS schemes that start in 2022 and include some free allocation. These are NOT a forecast of prices in the existing NZ ETS scheme*

2 Electricity modelling

2.1 Introduction

The electricity price forecasts presented in the CCC advice report are based on Energy Link modelling of the wholesale price at the Benmore and Otahuhu nodes rather than the ENZ model assumptions. The electricity and gas prices presented in the ENZ assumptions are lower than those used in the Energy Link modelling (except for 2026 to 2028).

The ENZ modelling reports the mix of generation over the forecast period but does not report the forecast generation stack over the full forecast period. The Energy Link modelling does provide a forecast of the generation stack.

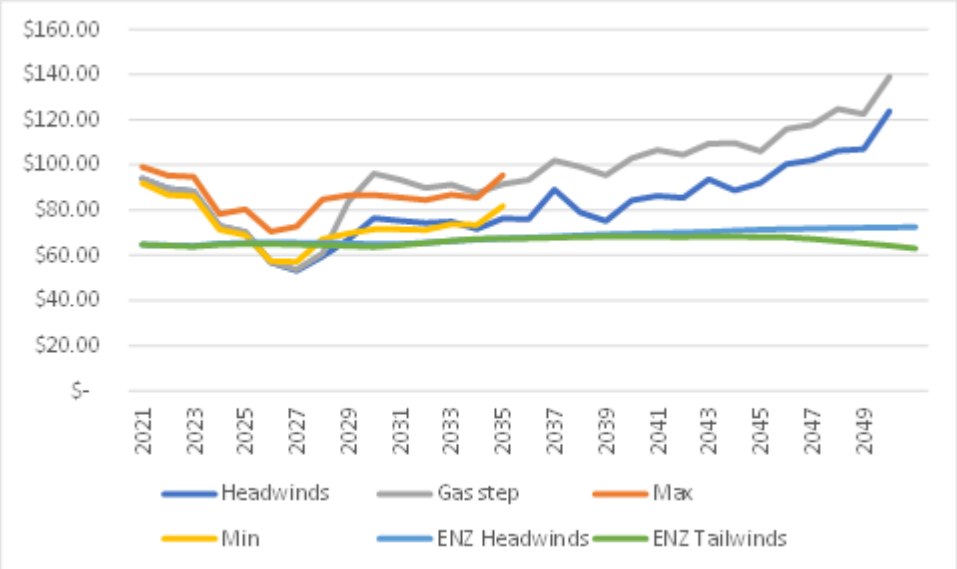
The ENZ and Energy Link modelling were both completed before November 2020 and the forecast wholesale prices are substantially below current wholesale electricity prices. The ENZ modelling specifically assumes away the issue of shortages of generation capacity.

> *This calculation of marginal economic new source of generation is based on a market in equilibrium. It does not take account of situations of under-capacity as is the current case for the market due to unexpected interruption to gas supply (from Pohokura) and under-investment in new renewables due to uncertainty as to whether the Tiwai aluminium smelter will exit.* [12]

2.2 Wholesale price comparison

High and low Energy Link wholesale electricity price forecasts are shown in Figure 2.

Figure 3 Wholesale electricity price forecasts ($/MWh)



Source: Drawn from Energy Link and ENZ modelling scenarios

[12] 'Technical-assumptions-in-ENZ-energy-and-transport-2021-02-18.xlsx, Modelled energy costs >', A3. The ENZ model assumes the Tiwai smelter will close-down in stages over August 2024 to August 2027 – see Technical-assumptions-in-ENZ-energy-and-transport-2021-02-18.xlsx, Industry, F3

The lines labelled 'Min' and 'Max' are the electricity price forecast used in Figure 5.1 of the CCC '31 January 2021 Draft Advice for Consultation'. The lines labelled 'Headwinds' and 'Gas Step' are from the Energy Link modelling. The Energy Link model assumes that the wholesale prices will fall over the period 2021 to 2026 initially in response to an increase of 150 MW in geothermal capacity followed by the phased shutdown of the aluminium smelter. Energy Link is less confident about its forecast electricity prices after 2035 because the model 'runs out' of low-cost wind and solar generation projects.

Differences between ENZ and forecast wholesale electricity prices affect the reliability of ENZ modelling of electrification of industrial process heat and commercial heating (as well as transport electrification). In 2021 Energy Link modelled wholesale electricity prices are 40 percent above the ENZ modelled prices. This difference does not fall to around zero until 2026 and increases to around 10 to 20 percent by 2028. This difference suggests that the ENZ modelling over-estimates the electrification of process heat in the first budget period and the budget periods after 2030.

2.3 Gas costs

Wholesale gas prices assumed in the ENZ model are 30 percent lower than those in the Energy Link model over the period 2021 to 2028 but after that are 20 percent lower than the Energy Link 'central' scenario and 80 percent below the Energy Link 'gas step' scenario which is based on an increase in gas prices after Methanex closes.

The cost of using gas either for heating or generation of electricity will also increase as the carbon price increases – see Table 3.

Table 3 Increase in gas cost due ENZ modelled increase in carbon prices

Year	Emissions price ($ /tCO$_2$e)	Additional gas cost[1] ($/GJ)	Additional generation costs ($/MWh)
2021	40.84	2.21	19.86
2025	84.21	4.55	40.94
2030	138.42	7.48	67.30
2035	160.47	8.67	78.02
2040	186.02	10.05	90.44
2045	215.65	11.65	104.85
2050	250.00	13.51	121.55

Notes:

1 Calculated as 'National Weighted Average t CO2/GJ[13]' for 2018 multiplied by the ENZ emission price

2 Based on heat rate[14] of 9.0 GJ/MWh for McKee peaker

Source: NZIER

2.4 Generation source and security of supply

The CCC advice refers to security of electricity supply[15] and:

- Notes that gas and coal generation currently provide this security of supply.
- States: *The Government needs to plan to manage the risk around affordability and security of supply as a result of moving to a low emissions energy system. …All of this will need to be considered by the Government when it is developing a long-term national energy strategy.*

It is unclear how the CCC has considered the impact of the change in generation fuel mix on either security of supply or wholesale electricity price volatility. At best, the modelling provides hints about how the issue is considered.

The ENZ model assumptions include the following description[16]:

> *Time-weighted average wholesale electricity costs are based on LCOE of marginal economic new source of generation to meet demand and displace fossil generation, limited by economic constraints on renewable energy to meet the physical constraints of the demand for flexible energy (for dry-year firming) and factored by the extent to which the 'peaking penalty' (i.e. generation-weighted average price / time-weighted average price) increases with higher proportions of variable renewable electricity. Higher carbon or fossil fuel costs, or lower*

13 'emission_factors_combustion_c02.csv' available at https://www.mbie.govt.nz/building-and-energy/energy-and-natural-resources/energy-statistics-and-modelling/energy-statistics/new-zealand-energy-sector-greenhouse-gas-emissions/

14 'Electricity Allocation Factor Review Background Information, Prepared by Energy Link for Ministry for the Environment, June 2019', p28 available at https://www.mfe.govt.nz/publications/climate-change/electricity-allocation-factor-review-background-information

15 31 January 2021 Draft Advice for Consultation', page 90

16 'Technical-assumptions-in-ENZ-energy-and-transport-2021-02-18.xlsx, Modelled energy costs >', A2

renewable technology costs, will increase the extent to which it is economic to build renewables to displace thermal generation.

It is unclear from the ENZ model outputs how the *'economic constraints on renewable energy to meet the physical constraints of the demand for flexible energy'* were addressed. The ENZ modelling spreadsheets do not provide information on the installed generation capacity but do provide information on the generation by fuel. Our estimate of ENZ forecast increase in geothermal, wind and solar generation capacity based on the ENZ model capacity factors is reported in Table 4. The estimated increase in capacity for the ENZ model is about 85 percent of the increase projected in the Energy Link model 'headwinds' scenario – mainly due to a lower increase in wind generation.

Table 4 Increase in ENZ renewable generation capacity ('headwinds')

Increase capacity (MW) over five years ending the year shown

Year	Geotherma[1]	Wind[2]	Solar[3]	Total
2025	365	650	85	**1,100**
2030	0	0	95	**95**
2035	65	413	98	**576**
2040	116	653	135	**904**
2045	99	919	556	**1,574**
2050	0	1,029	865	**1,894**
Total	**644**	**3,664**	**1,834**	**6,143**

Notes:

1 Average capacity factor of 92.5 percent

2 Average capacity factor of 42.0 percent - not adjusted for ENZ peak penalty

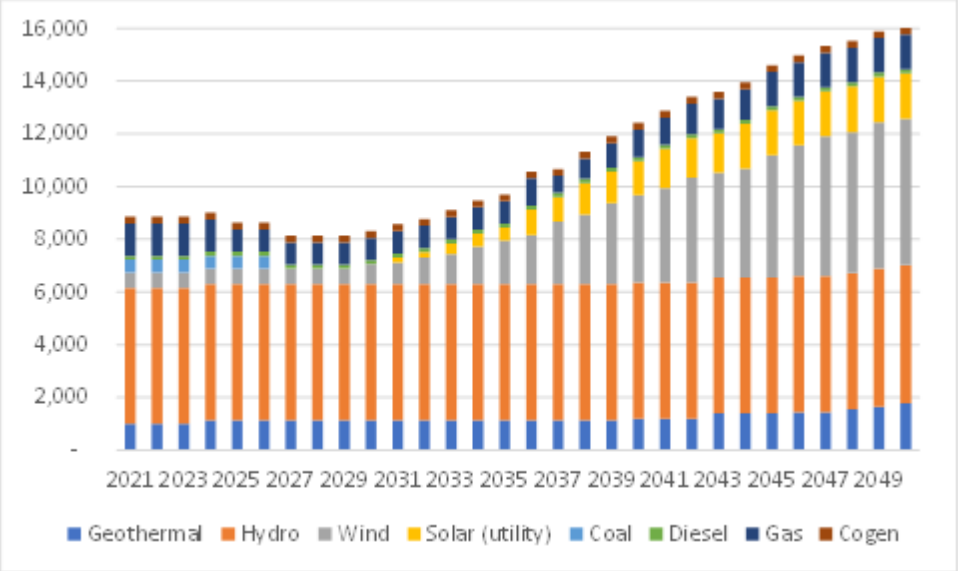
3 Average capacity factor of 23.0 percent

Source: Estimated from ENZ

The Energy Link modelling did consider wet and dry hydro years and for 2035 and 2050 was run in 3- hour time blocks as opposed to the day/night mode used for the other years. However, the model outputs did not include comment on security of supply or the variation in average wholesale prices and wholesale price volatility in dry years compared to wet years.

The Energy Link model outputs do include information on both amount generation capacity (see Figure 3) and the amount of electricity generated by fuel.

Figure 4 'Headwinds' installed generation capacity (MW) by fuel type



Source: Drawn from Energy Link data

Energy Link forecasts gas-fired:

- generating capacity will fall from 1,223 MW in 2021 to 843 MW in 2025 and remain at this level until 2036.
- generation will from 4,660 MWh in 2021 to 1,750 MWh in 2025 and then fluctuate between 1,000 MWh and 1,400 MWh until 2036.

The increase in carbon prices forecast in the ENZ model will more than triple the carbon cost of gas for wholesale electricity generation and materially increase the cost of fuel for electricity generation in peak periods. The Energy Link model outputs do not indicate how this risk is analysed.

The ENZ model outputs do not include a forecast of installed generation capacity. The forecast volume of electricity generated is about 5 to 9 percent above the Energy Link forecast. Most of this additional supply is generated by wind in the ENZ model.

2.5 Peer review comment

The ENZ approach to modelling wholesale electricity prices drew the following comment in the peer review of the CCC modelling by Dr. Marc Hafstead

> *Power Sector Modeling in ENZ*[17]
>
> *I found the statement in Chapter 8 in the "modelling electricity generation" textbox to be revealing, "This is not a market model with offers and bidders. The wholesale electricity price for the year is set by the long run marginal cost of the next renewable project to be built." I've gone through slide decks from model update meetings and this is the first time I've seen this mentioned. And while I do not recommend an update to the ENZ power sector at this time, I believe this*

[17] 'NZ Climate Change Commission Model Review, Part 1, Resources for the Future, Washington, DC' pages 1 to 2 Dr. Marc Hafstead, Fellow and Director, Carbon Pricing Initiative,

assumption needs to be further evaluated and improvements to the ENZ power sector could be applied for future analysis. ….

At a minimum, a discussion of the key wholesale electricity price assumption is warranted and a comparison of ENZ power sector model results to a dispatch model of power supply in NZ would be very useful, especially because electricity prices are drivers of other key emissions reduction opportunities in the model (such as EV uptake). I'd also like to see a discussion on the use of battery storage in the power sector model. My reading is that it is not included but it is also possible I missed something.

2.6 Conclusion

The CCC modelling does not consider either the fact that current wholesale prices are well above forecast wholesale prices or the risk that the delivery of new renewable generation capacity could lag rather than coincide with increased demand.

Also, the CCC modelling does not assess the increased risk to security of supply from reduced thermal generation.

These factors both reduce the likelihood that the forecasts for the cost reduction and adoption rates of electrification of commercial and process heat in the first two carbon budget periods will be achieved.

3 Comparison of CCC reduction pathways

3.1 Introduction

The four ENZ scenarios assume the same path for the carbon price but provide different GHG emission reduction pathways based on different assumptions about the rates of fuel switching (driven by the carbon price path) and energy efficiency improvement for industrial processes and the rate of electrification of transport,

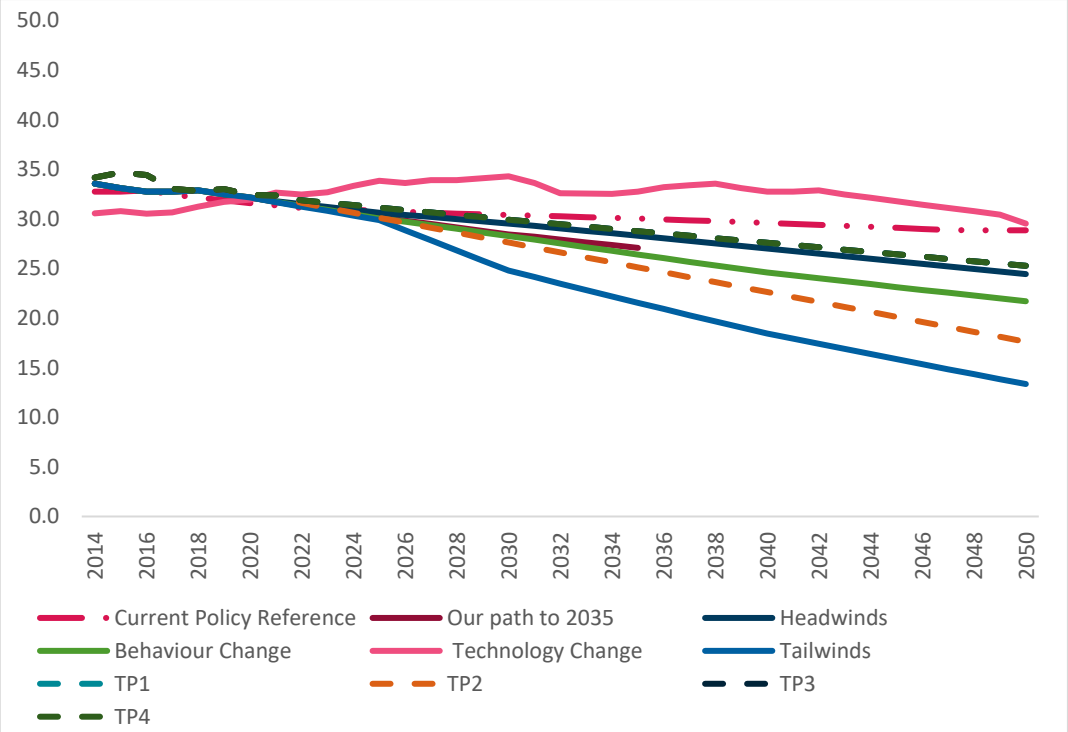
The C-Plan models impose emissions budgets (and land use) on a model of the economy with the capacity of businesses to switch fuels and adopt new technologies embedded in the production functions in the model. (The production functions use an aggregated version of the changes used in the ENZ model and are not published.) The C-Plan model calculates the level of output for individual industries and a price for methane (CH_4) and the other long-lived gases.

The differences between ENZ and C-Plan between what is modelled, the classification of industries, and the reporting of outputs mean that only a small number of the assumptions can be compared directly.

3.2 C-Plan and ENZ scenarios for GHG reduction pathways

The scenarios used in the C-Plan model are informed by but not directly driven by the ENZ scenarios. This is illustrated by the following comparison of the pathways for the reduction of CH_4, gross emissions of other long-lived gases (primarily CO2 and measured in tonnes of CO2 equivalent) and the removal of CO2 (through afforestation).

Figure 5 C-Plan and ENZ CH_4 emissions reduction pathways

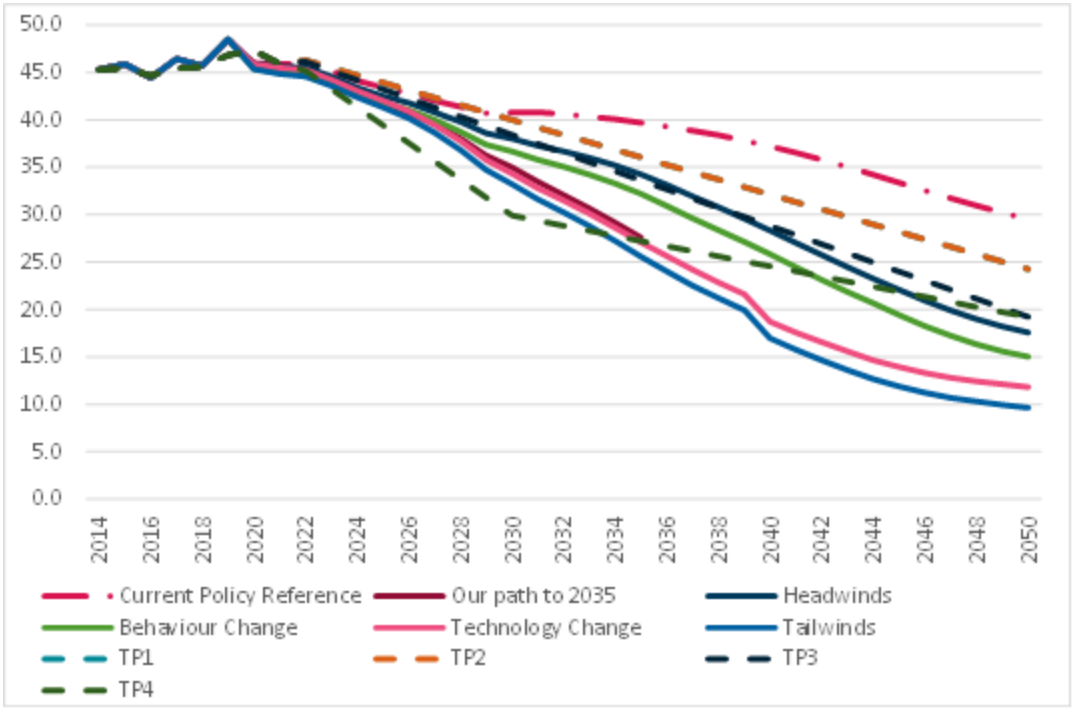


Source: Drawn from ENZ and C-Plan model outputs

Nearly all the modelled CH_4 emissions are generated by agriculture with the remainder coming from waste, The ENZ model scenarios are 'headwinds' 'further technology change', 'further behaviour change', and 'tailwinds'. The C-Plan model scenarios are TP1 (the central path) and TP2, TP3 and TP4. For CH_4 emissions TP1, TP2 and TP4 are identical.

The C-Plan CH_4 paths are much more tightly grouped than the ENZ pathways.

Figure 6 C-Plan and ENZ long-lived gas (CO_2e) emissions removal pathways

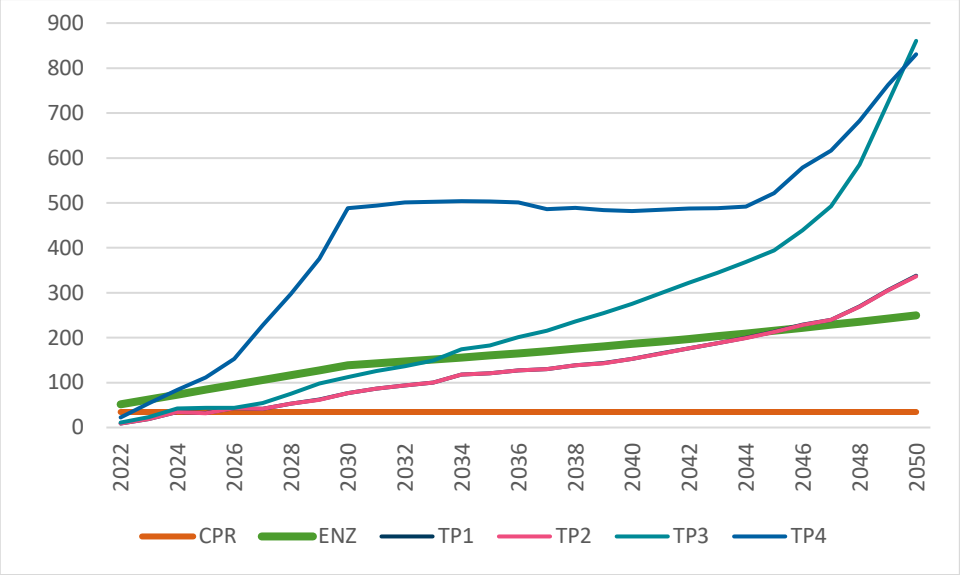


Source: Drawn from ENZ and C-Plan model outputs

C-Plan scenarios TP1 and TP2 are identical for the reduction of long-lived gases and are slower than the what the ENZ indicates as technically feasible emission reductions. The 'carbon' price for long-lived gases in TP1 and TP2 (calculated by the C-Plan) model is similar to the price path assumed in the ENZ model. The 'carbon' price for long-lived gases in TP3 rises above the path in the ENZ model after about 2033 and increases steadily. The carbon price calculated for TP4 is substantially higher than the ENZ model over the entire forecast period,

High carbon prices in the C-Plan model are an indication that fuel-switching and technology gains alone are not sufficient to deliver the emission reduction budget that was set for the model and output needs to be reduced in some industries to meet the imposed emissions budget. This suggests that TP4 and the last 5 years of TP3 are not realistic scenarios of emissions reduction paths.

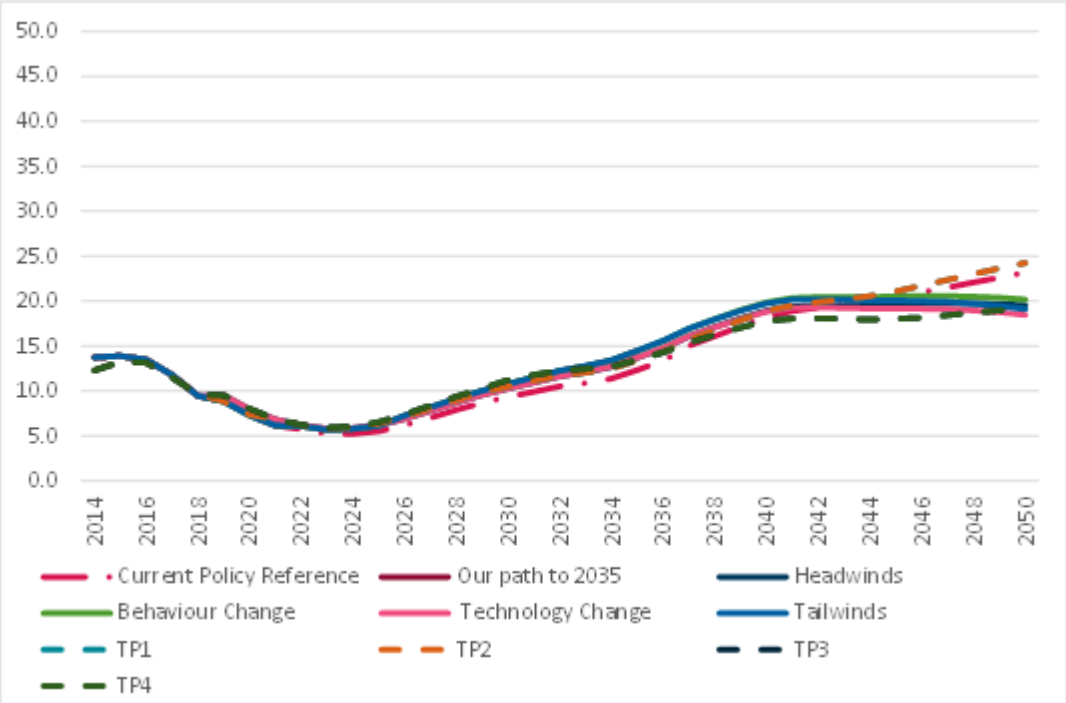
Figure Carbon price path for C-Plan scenarios and ENZ



Source: NZIER

Emission removals are almost identical for the ENZ and C-Plan models over all their scenarios until 2040.

Figure 7 C-Plan and ENZ long-lived gas (CO2e) emissions removal pathways



Source: Drawn from ENZ and C-Plan model outputs

3.3 GDP impact of reduction pathways

The CCC advice comments on the impact of the modelled emissions reduction pathways on GDP are confusing. The CCC advice states[18]:

> *Looking out to 2035, our modelling suggests that reducing emissions to meet our proposed emissions budgets would cost Aotearoa no more than $190 million each year over emissions budget 1, $2.3 billion each year over emissions budget 2, and $4.3 billion each year over emissions budget 3. It is difficult to estimate the benefits of action with any accuracy as there is significant uncertainty in how the benefits will actually be realised.*

If these costs represent a reduction in GDP, then forecast GDP in 2030 and 2035 would be about 3.5 percent and 8.5 percent respectively below the reference path. However, the C-Plan forecasts show GDP paths that are almost identical for each of the four scenarios.

However, the C-Plan model results show a difference between GDP at 2050 of less than 0.5 percent between the CPR and the other scenarios while the CCC advice states:

> *The overall costs of meeting the country's targets and our proposed emissions budgets are likely to be less than 1% of projected GDP. This is significantly lower than what was estimated when the 2050 targets were set.* [19]

The CCC attributes the modest impact on GDP to the characteristics of the C-Plan model[20]:

> *C-PLAN has some important differences from other CGE models that have been used in Aotearoa to inform climate mitigation policy. In particular, C-PLAN models emissions reducing in response to climate policy with little or no reduction in output, and so shows a smaller impact on gross domestic product (GDP) and abatement costs than other CGE models in Aotearoa. This occurs because C-PLAN explicitly includes key emissions-reducing technologies that allow emissions to be reduced without reducing output (e.g. a methane vaccine), and also allows industries to switch the energy sources they are using.*

The CCC comparison the C-Plan model and the earlier CGE modelling of the impact on GDP of emission reductions does not accurately describe the structural differences between the C-Plan model and the earlier CGE models. For example, in 2018 NZIER CGE modelling of climate change scenarios estimated that emissions reductions could reduce GDP in 2050 by between 12.7% and 1.9% below status quo GDP[21]. These forecasts indicated both a substantial cost of emissions reductions forecasts and a wide range in potential impact on GDP. The NZIER modelling scenarios completed in 2018 specifically included the following:

- Methane vaccine that reduces dairy emissions by 15%; S&B by 10%; 70% adoption; spread over 20 years (2030-2050).
- Electrification of transport (80 to 95 percent of the light vehicle fleet and 25 to 50 percent of the heavy vehicle fleet by 2050).

18 '31 January 2021 Draft Advice for Consultation' page 87

19 '31 January 2021 Draft Advice for Consultation, p18

20 '1 February 2021 Draft Supporting Evidence for Consultation, Chapter 12:How we earn our way in the world' page 4

21 'Economic impact of meeting 2050 emissions targets, Stage 2 modelling, NZIER final report to Ministry for the Environment, 9 November 2018', page iv, Figure 2 available at https://www.mfe.govt.nz/publications/climate-change/economic-impact-of-meeting-2050-emissions-targets-stage-2-modelling

- Energy efficiency improvements.

The NZIER model did not refer to fuel switching explicitly. However as can be seen from Appendix A the main fuel switching assumptions covered in the ENZ model not addressed in the NZIER model are the increased use of biomass for process heat and blending of biofuels with transport.

Two key differences between the CCC modelling and the NZIER modelling are that the CCC CPR assumes the closure of Methanex which reduces emissions by 1.5 Mt CO_2e by 2029 and the closure of the aluminium smelter which releases generation capacity to transport and process heat electrification.

3.4 Conclusion

The impression created by the CCC advice that emissions reductions will have a small (1 percent) impact on GDP that is not materially affected by the choice of scenario is not reassuring. It is mainly attributable to a change in the definition of the starting point for the modelling and a narrowing of the variation allowed in the scenarios.

Appendix A ENZ assumptions by sector

A.1 ENZ approach

The ENZ modelling assumptions are organised under the following headings: industries, boilers, buildings, power, gas, road transport and non-road transport. The headings reflect sectors of technologies where the modellers could identify emission mitigation options. In this report we summarise the assumptions for industries, boilers and power. The key observations on the ENZ modelling are:

- Industry emissions reductions rely heavily on the closure of Methanex improved energy efficiency in the food processing industry. (For most other industries emission reductions are achieved through electrification of transport and use of biofuels)
- The regional constraints for the supply and use of biomass ('boilers') are not stated and it is not clear how the model treats the potential for increases in the price of biomass as the cost of fossil fuels rise.
- Electricity modelling ('power') is based on a continuous decline in the cost of solar and wind generation plant cost. The assumptions about the 'peak penalty' for wind generation – the model's response to security of supply risk from wind intermittency are not clearly stated.

A.2 ENZ industry assumptions

The ENZ model assumptions for fuel switching and energy efficiency gains for industry are shown in Table 1. The core opportunities for emissions reductions in industry are:

- Energy efficiency gains
- Fuel switching, driven by the rise in carbon prices, from coal and gas to biomass (constrained to a percentage of local availability) or electricity
- 'Motive power' electrification based on uptake of electrically powered heavy trucks
- Blending of biofuels with petrol and diesel for transport.

The ENZ model also assumes:

- Aluminium production; staged closure from August 2024 to Aug 2027, closing one potline at a time
- Cement, lime and glass: fuel switching from coal to biomass (endogenous) and tire derived fuel (exogenous)
- Food processing for dairy and meat is scaled to the output of agriculture production form the dairy module and other food processing is held constant
- Petrochemical production: Methanex is closed[22] in stages over 2026 to 2029 but other petrochemical producers continue to operate.

The ENZ model does not include any emission mitigations for: 'Coal, oil and natural gas production' and 'Oil refining'.

[22] For the 'Pathway' scenario Methanex is closed in stages over 2027 to 2029

Table 5 ENZ Model assumptions – 'iron and steel', 'food processing' and 'wood, pulp and paper processing'

[insert caption subheading]

Sector	Current policy reference	Headwinds	Further behaviour change	Further technology change	Tailwinds	Pathway
Iron and steel	Emissions reduce by 10% from 2020 due to assumed production reduction	[text]		Green-hydrogen steel conversion in 2040	Green-hydrogen steel conversion in 2040	
Food processing	Energy efficiency improvement 0.7 percent per year	Energy efficiency gain of 0.9% per year Fuel switching. Regional biomass constrained to 25% of availability. Motive power electrification	Energy efficiency gain of 1.1% per year Fuel switching. Regional biomass constrained to 25% of availability. Motive power electrification	Energy efficiency gain of 1.1% per year Fuel switching. Regional biomass constrained to 50% of availability. Motive power electrification Biofuels for motive power (6% of fuel by 2035).	Energy efficiency gain of 1.1% per year Fuel switching. Regional biomass constrained to 50% of availability. Motive power electrification Biofuels for motive power (6% of fuel by 2035)	Energy efficiency gain of 1.3% per year. Fuel switching. Regional biomass constrained to 50% of availability. Motive power electrification Biofuels for motive power (6% of fuel by 2035)
Wood, pulp and paper			Kinleith plant converts to HERB[1] in 2025 Further fuel switching driven by carbon price Motive power electrification Biofuels for motive power (6% of fuel by 2035)	Kinleith plant converts to HERB[1] in 2025 Further fuel switching driven by carbon price Motive power electrification Biofuels for motive power (6% of fuel by 2035)	Kinleith plant converts to HERB[1] in 2025 Further fuel switching driven by carbon price. Motive power electrification Biofuels for motive power (6% of fuel by 2035)	Kinleith plant converts to HERB[1] in 2025 Further fuel switching driven by carbon price Motive power electrification Biofuels for motive power (6% of fuel by 2035)

Notes:

1 HERB stands for high energy recovery boiler. The fuel switching includes biomass for residual process heat.

Source: Technical-assumptions-in-ENZ-energy-and-transport-2021-02-18.xlsx, Industry

ENZ Model assumptions

[insert caption subheading]

[insert heading]	Current policy reference	Headwinds	Further behaviour change	Further technology change	Tailwinds	Pathway
Mining and construction	Motive power electrification	Motive power electrification	Motive power electrification	Motive power electrification Biofuels for motive power (6% of fuel by 2035).	Motive power electrification Biofuels for motive power (6% of fuel by 2035).	Motive power electrification Biofuels for motive power (6% of fuel by 2035).
Other manufacturing	Motive power electrification	Motive power electrification	Motive power electrification	Motive power electrification Biofuels for motive power (6% of fuel by 2035).	Motive power electrification Biofuels for motive power (6% of fuel by 2035).	Motive power electrification Biofuels for motive power (6% of fuel by 2035).
Agriculture, forestry and fishing	Motive power electrification	Motive power electrification	Motive power electrification	Motive power electrification Biofuels for motive power (6% of fuel by 2035).	Motive power electrification Biofuels for motive power (6% of fuel by 2035).	Motive power electrification Biofuels for motive power (6% of fuel by 2035).

Source: Technical-assumptions-in-ENZ-energy-and-transport-2021-02-18.xlsx, Industry,

A.3 Boilers

The ENZ assumptions consider switching the energy source for boilers using:

- coal or gas to either biomass or electricity
- diesel to electricity.

Table 6 Boiler energy cost and supply

Assumptions used to determine boiler fuel switching for food processing

Fuel	Delivered energy cost ($/GJ)	Supply (PJ)	Comments
Forestry residue	10.0	14.3 to 20.7	Residue supply is an additional 5% of total harvested volume. Harvest varies in time - Refer forestry yield and harvesting assumptions. Assumes net calorific value of 8.0 MJ/kg. Portion available for food processing is 25-50% of regional supply (varied between scenarios)
Chipped pulp logs	12.8	27.5 to 51.9	Delivered energy cost assumes $87 pulp log price (including chipping) Assumes net calorific value of 8.0 MJ/kg. Pulp supply is 23% of total harvested volume. Harvest varies in time - Refer forestry yield and harvesting assumptions. Portion available for food processing is 25-50% of regional supply (varied between scenarios)
Coal/lignite	3.0 to 7.5	No restriction	
Gas	6.8 to 9.6	North Island	Gas prices are modelled
Diesel	19.6	No restriction	Assumes oil price of USD 60 per barrel
Electricity	28.0 to 27.8	No restriction	Delivered energy cost assumes wholesale electricity price of $60 to $70 per MWh plus transmission cost of $30 per MWh

Source: Technical-assumptions-in-ENZ-energy-and-transport-2021-02-18.xlsx, Boilers

A.4 Power[23]

The ENZ assumptions include:

- Build schedule for 1,016 MW of new generation capacity over 2020 to 2025 comprising 651 MW of wind and 365 of geothermal generation. (The Energy Link modelling assumes net reduction in generation capacity of 250 MW over this period - 150 MW of geothermal generation is added and 400 MW of gas-fired generation is closed.)
- Levelised cost of energy (LCOE) assumptions for geothermal, wind (onshore), utility solar, and wind offshore with estimates of potential and costs

[23] Technical-assumptions-in-ENZ-energy-and-transport-2021-02-18.xlsx, Power,

- Potential generation in TWh by fuel (40 TWh of onshore wind and 50 TWh for utility solar)
- Capital and fixed and variable operating costs[24] -
- Annual reduction in the LCOE due to efficiency gains partially offset by an increase in LCOE as the most efficient projects are developed first and replaced by less efficient projects.

Table 7 LCOE starting assumptions

Generation plant capacity, costs

Type	Capacity factor	Potential (TWh)	Capital ($/kW)	Operations and maintenance		Capital recovery factor
				Fixed ($/kW/yr)	Variable ($/MWh)	
Geothermal	92.5%	5.0	$4,700	$50	$18	8.0%
Wind - Onshore	42.0%	40.0	$2,100	$24	$10	8.1%
Utility solar	23.0%	50.0	$1,800	$25	$3	8.3%
Hydro	55.0%	3.0			$0	
Wind - Offshore	44.0%	40.0	$5,200	$140	$0	8.1%

Source: Technical-assumptions-in-ENZ-energy-and-transport-2021-02-18.xlsx, Power

Table 8 LCOE change assumptions

Reduction in LCOE due

Type	Price increase[1]	Annual rate of cost reduction				
	($/MWh per TWh)	Headwinds	Further Behaviour	Further Technology	Tailwinds	Central Pathway
Geothermal	4.2	0.07%	0.07%	0.10%	0.10%	0.10%
Wind - Onshore	0.6	0.53%	0.53%	0.80%	0.80%	0.80%
Utility solar	$0.4	2.00%	2.00%	3.00%	3.00%	3.00%
Hydro	10.0	0.07%	0.07%	0.10%	0.10%	0.10%
Wind - Offshore	0.7	2.33%	2.33%	3.50%	3.50%	3.50%

Note:

1 The price increase simulates the increase in LCOE as generation investment moves up the supply curve from 'best' to 'worst' projects

Source: Technical-assumptions-in-ENZ-energy-and-transport-2021-02-18.xlsx, Power

[24] Based on Ministry of Business, Innovation and Employment (MBIE) generation stack updates in 2020