energyresources.org.nz
energymix.co.nz
PO Box 25259, Wellington 6140

POWERING A BETTER NEW ZEALAND TOGETHER

28 March 2021

Submission on the Climate Change Commission's Draft Advice for Consultation

Climate Change Commission
Submitted online at https://haveyoursay.climatecommission.govt.nz/

Submission on the Climate Change Commission's 2021 Draft Advice for Consultation

Introduction

1. Energy Resources Aotearoa[1] ("Energy Resources") represents people and firms in the energy resources sector, from explorers and producers to distributors and users of natural resources like oil, LPG, natural gas and hydrogen.

2. This document constitutes Energy Resources' submission to the Climate Change Commission ("the Commission") on *its 2021 Draft Advice for Consultation* ("Draft Advice"). The Commission's specific questions are briefly addressed in **Appendix One** with reference to the relevant parts of our main submission.

3. Energy Resources supports the objective of transitioning New Zealand and the globe to a net-zero emissions future. We are grateful to the Commission for the opportunity to contribute our sector's expertise and experience to helping Aotearoa make this crucial transition.

4. We thank the Commission for granting submitters an extension to the consultation period of ten business days.

Executive Summary

Energy Resources supports the net-zero carbon objective

5. Our sector is fully prepared to support the transition. The transition cannot happen without a broad consensus approach that minimises the costs (in the broadest sense, including environmental costs) and is fair

---

1. Earlier in March this year we changed our name from the Petroleum Exploration and Production Association of New Zealand (PEPANZ) to Energy Resources Aotearoa. This reflects our new strategic approach and move into being the voice of a successful and resilient energy resources sector.

to all people in Aotearoa. Given we support the statutory goal of net-zero emissions (the "what"), our submission is focussed on the best way for Aotearoa to transition (the "how").

The energy trilemma should be used as a supporting analytical construct

6. The Commission's advice would benefit from using energy trilemma framework throughout. The energy trilemma focusses thinking on the three key components of a successful energy system - affordability, reliability and sustainability. Each component is important, but trade-offs are inevitable.

The focus should be on net emissions, not gross emissions

7. We note the Commission's focus on reducing gross (rather than net) emissions, which effectively looks to limit offsets (such as through land use change, forestry or offshore mitigation). We prefer the international and domestic goals of net zero as these are set out in the Paris Agreement and Climate Change Response Act 2002. The net emissions goal also reflects the bipartisan political consensus that in some cases emissions cannot be eliminated without incurring excessive costs.

8. A focus on gross emissions implies an economic narrative of simply decarbonising or eliminating emitting sectors. However, the advice should consider whether a compelling and plausible economic story aligns with the energy mix and emissions profile that the Commission proposes. Such a narrative is implied but should be explicit.

The ETS is the best available tool and the Commission should support it

9. The Emissions Trading Scheme ("ETS") is an excellent and proven tool for addressing the social cost of carbon emissions. It will efficiently (that is, at lowest social cost) ensure that the beneficiaries of emitting goods and services also incur the costs. The Commission's own modelling shows that an ETS price of $50 is likely sufficient to reach net-zero emissions by 2050.

10. However, the Commission's draft recommendations of further regulatory policies undermine the ETS. Singling out specific sectors and technologies for special treatment, while maintaining the ETS with a fixed emissions cap as a policy mechanism, simply shifts emissions within the capped system (the 'waterbed effect').

Proposed direct interventions have a high risk of increasing global emissions and imposing unnecessary costs

11. The Commission has embarked on an approach to reducing emissions which have a high probability of error. Specific and detailed policy paths for an uncertain future world are inherently risky. It is well documented that most attempts by governments to engineer outcomes with prescriptive policies for highly complex systems result in failure.

12. The Commission should take note of the well-intentioned, but failed attempts by governments to prescribe direct policy interventions for environmental outcomes:

    a. prescriptive measures led Germany in its *Energiewende ('energy turning point')* to extend the life of polluting brown coal power plants and to importing nuclear-generated power from its neighbours. Germany now has the highest consumer electricity prices in the developed world;

b. prescriptive mandates in Europe and the United States for biofuels caused immense environmental destruction, harmed global poor with high food prices and actually increased fossil fuel consumption; and

c. prescriptive choices about technologies for electricity smart meters in Victoria imposed excessive costs and provided almost no benefits compared to the market-led approach for smart meters in New Zealand.

Some of the Commission's key judgements deserve robust evidence-based analysis

13. We are concerned about a range of specific judgements reached by the Commission. There are objectives and regulatory measures which will result in unintended consequences and risk undermining the goal of reduced emissions. These include the renewable energy target and the ban on new gas connections which are recommended without supporting cost-benefit analysis.

14. The Commission's key judgements on the ETS are also misplaced. International integration of the ETS has been inadequately addressed. The problem of carbon leakage, where other countries increase production processes involving emissions due to Aotearoa's policies, is overlooked to the detriment of New Zealanders.

15. We are also concerned about the Commission's specific expectation that electricity prices will not increase, as this expectation leads to a positive view about electrification rates. This requires much more robust analysis in light of points raised by NZIER and others.

The final advice will be defining moment and a watershed for the Commission

16. Ultimately, the Commission's final advice will be a defining and watershed moment in terms of its credibility. The Commission has an opportunity to restore confidence that has been eroded by its proposed interventionist approach. Stakeholders, especially ETS participants, will be carefully watching to see whether the policy measures will be stable for long-term investment decisions or *ad-hoc* and at risk of short-term political changes.

Energy Resources Aotearoa calls on the Commission and government to support an industry accord

17. We propose that the Government work with the energy sector to build on successful policies that will ensure we reach the net zero emissions goal. An accord, properly developed, would create a framework and platform – built around support for the ETS - for government and industry to collaboratively work together to consider and address key challenges in the sector. These could include security of supply, affordability, environmental sustainability including emissions, regulatory environment, and skills and training.

Part 1. Energy Resources Aotearoa Supports a Net Zero Carbon Objective

The energy trilemma should be used as a supporting analytical construct

18. We were surprised to not see the energy trilemma referenced in the discussion document, as it is a recognised framework employed by the World Energy Council. The trilemma focusses thinking on the three key components of a successful energy system - affordability, reliability and sustainability. Each component is important, but trade-offs within and across them are inevitable.

19. The focus should be on achieving sound and balanced energy policy and not *overemphasising* sustainability, especially to the extent that general energy policy gets used to achieve specific climate change objectives.

The Commission has misapplied its legislative mandate: the goal should be net zero emissions

20. We unequivocally support the objective of transitioning to a low emissions economy. However, we think the Commission has misapplied its legislative mandate which will have negative consequences.

21. The Commission has not focussed its analysis on the **net** zero emissions goal. Instead, the Commission has focussed on gross emissions, effectively seeking to overlook offsets. The use of the term "net" in law and policy is important: it reflects the bipartisan political consensus that in some cases emissions cannot be eliminated without incurring excessive costs. It is better for society to offset these emissions with the net result for the climate being the same.

22. The Commission's role and the government's 2050 target are defined in legislation. The target is very clear and specified as **net zero** domestic emissions by 2050. The net zero emissions goal is also reflected in Article 4 of the Paris Agreement which states that:

> "Parties aim to… … achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century.

23. The Commission's choice to focus on gross emissions translates into the need for highly risky policy choices. It assumes that the transition from relatively high emissions to low emissions requires fundamental economic and social transformation.

24. More importantly, by focusing on gross emissions, the Commission is effectively asking New Zealanders to pay more than they should to achieve our net-zero policy goal. The Commission's own modelling shows that modestly increasing the ETS unit price to $50 would result in Aotearoa meeting the net-zero target by 2050, with planting trees an important part of this. However, the Commission's draft advice is that this least-cost path is not appropriate. Instead, the Commission considers that New Zealanders should pay more for direct regulatory measures (and risk a myriad of unintended consequences), to make sure that the ETS price does not rise high enough to incentivise more tree planting.

25. The whole premise of the ETS was that Government is better at setting the broad emission goal, rather than being able to correctly pick the exact paths that our complex economy must take to achieve those

goals. The Commission's recommendations basically reverse that logic, without providing adequate justification for doing so.

26. Focusing on a gross emissions objective necessarily comes at the expense of other worthwhile objectives for reducing emissions. The gross emissions focus undermines lowest cost abatement pathways. This will have welfare and wellbeing implications for New Zealanders as it imposes higher costs for the same emissions outcome. On the Commission's own numbers, focussing on gross emissions multiplies the cost of attaining net zero several times.

27. The Commission's focus on gross emissions means that effectively (even if unintentionally) the goal becomes one of eliminating fossil fuels (as opposed to promoting various kinds of offsets), because offsets are not deemed proper or desirable regardless of costs especially in the short to medium term. A focus on net emissions, by contrast, allows and promotes investment in various offsetting methods and technology.

28. A focus on gross emissions is an implicit economic narrative as it requires the rapid phase out of emitting sectors of the economy. But what the draft advice lacks is a compelling, plausible and explicit economic story that aligns with the energy mix, transport fleet and generally proposed emissions profile. A strong economic narrative should consider what New Zealand firms will plausibly produce domestically and what they will sell to the world that requires the energy mix proposed by the Commission. An Energy Accord, as covered later, could bridge the two elements of the emissions and economy stories.

29. We agree that planting trees is a temporary solution, but afforestation will get the country across a hump that will otherwise be very costly to cross. Foregoing afforestation will mean expensive abatement must be pursued now, even though it is almost certain that in the future lower there will be lower cost abatement opportunities (such as through technological developments).

Part 2. ETS is the Best Policy tool to Solve the Problem of Reducing Emissions

30. We fear that the Commission lacks confidence in the simplicity and effectiveness of the ETS in reducing emissions. We urge the Commission to protect and endorse the use of the ETS as the most effective all-encompassing tool to address the policy problem of emissions.

ETS incorporates emissions costs using a method endorsed with a Nobel prize

31. Emissions are a public policy problem because the beneficiaries of goods and services that involve emissions do not directly face the social cost of excessive emissions. Emissions are therefore a negative externality, and the goal of policy should be to internalise the costs (climate change) of emissions.

32. An ETS is a proven way to solve an environmental externality problem. Emitters are made liable for their emissions and face a price incentive to either abate their emissions or obtain more carbon credits. Consumers of goods and services that involve emissions in turn face price increases where the emitter has to meet emissions costs.

33. Economist William Nordhaus won the Nobel Memorial Prize in Economic Sciences in 2018 for his work demonstrating that carbon pricing is the

most efficient tool for reducing emissions. Nordhaus found that carbon pricing:

a. sends signals to consumers about which goods and services are more carbon-intensive;

b. sends signals to producers about which activities are most carbon-intensive (such as coal burning) and which are less carbon-intensive (like solar or wind);

c. sends signals to propel innovation to find new, affordable alternatives and;

d. … is the best means to convey these signals within well-functioning markets.[2]

ETS sends price signals regardless of the complexity of economic activity

34. The most effective way that policies are translated into behavioural change is through prices. To efficiently shift the emissions in our economy, price signals distil and convey complex, dispersed and dynamic information. Prices that include the cost of emissions will ensure that, at any point in time, the most efficient abatement opportunities are realised by firms and people. The ETS can serve the function of including the costs of emissions into all prices in the economy, not just the goods and services that the Commission may currently think need to reflect emissions costs.[3]

35. The economy and various markets for energy use are becoming increasingly complex and increasingly interwoven. Traditionally, transport fuel, electricity and process heat were quite clearly delineated but this is no longer the case and this complexity must be front of mind for policy makers.

36. An example of the greater interconnection is that with increasing electrification, the electricity market is now relevant to both process heat and transport; and similarly, natural gas becomes more important for affordable electricity in terms of peaking. Another example of interconnectedness is that using gas or electricity for hydrogen production would put upward pressure on the prices of the fuel used for feedstock.

37. This increasing complexity means that simple signals are in fact preferrable, and the ETS aligns with this much better than centrally-planned interventions. Price signals through the ETS are most likely to promote dynamic efficiency (efficiency over time) and this should be enabled wherever possible.

---

2 https://www.iisd.org/articles/nordhaus-nobel

3 We briefly address the claim, occasionally made, that consumers are not switching transport choices in response to carbon pricing. Firstly, decisions are typically made at the margin so are not always particularly 'visible'. Secondly, if there is low price elasticity of demand, then that may mean lower cost abatement opportunities are being pursued elsewhere in the economy. Thirdly, if seriously demonstrated that consumers are not making optimal choices (to the extent that optimal choices really exist at all when viewed in aggregate) then there may be information failures to investigate and to correct, and this should be done before restrictive regulations are made.

The Commission's own analysis confirms the ETS can achieve the net emissions targets

38. The Commission's own modelling clearly shows that the ETS can achieve net-zero emissions. It shows that a modest increase to the ETS unit price to $50 will outright *achieve* the net emission goals by 2050.[4] The Commission also states that even an ETS price of just $35 with no further policy changes will achieve approximately 80% of the target (net emissions down from 36.3Mt p/a to 6.3Mt p/a by the year 2050).

39. In the Commission's own words:

> "The results suggest that Aotearoa could meet the net zero target for long-lived gases with relatively little additional change."[5]

40. This means the Commission has concluded that none of the complementary measures proposed are necessary *per se*.

41. Having reached this conclusion on the effectiveness of the ETS on the statutory net emissions goal, before recommending any measures outside the ETS, the Commission must demonstrate that its recommended measures will in fact be just as (or preferably more) effective for the same or lower economic cost.

42. Otherwise, the Commission is asking New Zealanders to pay more to achieve the net-zero objective, and providing no compelling reasons for this cost increase. The Commission's report provides no evidence that its plan to reach the same emission targets should be preferred to current policies of using the ETS.

The ETS currently has broad support and is durable, but the Commission's recommendations threaten its long-term stability

43. The ETS has broad bipartisan political consensus support in Aotearoa as the policy tool to internalise the cost of emissions and thus reduce them. Since its inception in 2008, it has become an integral part of the country's economic architecture. Carbon prices have materially increased since the inception of the ETS, without significant pushback or public backlash.

44. This alone is a significant achievement and should not be under played. If the Commission seriously considers that political economy issues pose a threat to the effectiveness of the ETS, then we would expect the Commission to have first identified ways to increase the political feasibility of the ETS, before concluding that additional non-ETS policies are needed.

45. As an example of an alternative measure to promote durability of the ETS and public acceptance, a first-best policy recommendation could be to provide tax relief to households using auction revenues. This would help to ensure that households are not directly worse off simply because of the carbon prices they must pay as a necessary part of the

---

4 Climate Change Commission. 2021 Draft Advice for Consultation. https://ccc-production-media.s3.ap-southeast-2.amazonaws.com/public/evidence/advice-report-DRAFT-1ST-FEB/ADVICE/CCC-ADVICE-TO-GOVT-31-JAN-2021-pdf.pdf page 46.

5 Ibid, page 46.

transition. We note that at the recent inaugural auction of New Zealand Units, revenue of approximately $171 million was raised.[6]

46. It is important that the ETS continues to enjoy wide support. Durable climate change policy is essential for ensuring stability and predictability of policy settings for consumers and firms. Without political stability behind climate policy, economic actors will likely delay making important actions to reduce emissions, or they will raise prices as risk is factored in.

47. If the Commission undermines the ETS with direct measures without providing any robust evidence, the Commission will send a strong signal that the ETS can be diluted again in future. This would severely undermine confidence in the ETS by the public and investors who we need to make the capital investments in the technology we require for the transition. Indeed, it might lead to calls for abandoning the ETS in favour of a carbon tax.

48. Ultimately, the Commission's final advice will be a defining and watershed moment in terms of its credibility. The Commission has an opportunity to restore confidence that has been eroded by its proposed interventionist approach. Stakeholders, especially ETS participants, will be carefully watching to see whether the policy measures will be stable for long-term investment decisions (i.e. the ETS even with a rising carbon price) or *ad hoc* and at risk of short-term political changes (like prescriptive regulatory interventions).

Risks to consider when contemplating further policies

49. Care must be exercised when considering regulation beyond the relatively simple policy of an emissions trading scheme. Specifically, the weaknesses of political and bureaucratic institutions must be recognised and carefully considered. Too often the costs of government regulations are assessed simply in terms of direct administrative and compliance costs, but this is far too narrow.

50. Interventions throughout the various sectors and aspects of the economy begin to interact in ways that government cannot realistically envisage. This can lead to an intertwined set of interventions that produce unintended outcomes, and which may be too difficult to reform or repeal should they subsequently prove to be misguided.

51. It can be tempting to focus on a particular policy goal (such as increasing the share of renewables) through regulations, but this will almost inevitably have a ripple effect into other parts of the economy or energy system. Any ripple effects considered inconsistent with future government aspirations may compel these governments to intervene in the affected sectors, to "fix" the incentives and behaviours. Before long, we may end up with a nested web of interventions that are impossible to predict the effects of, and from which we may not be able to extract ourselves.

---

6 Based on 4.75 million units on offer with a clearing price of $36 per unit.

52. Indeed, the pathway the Commission's approach sets us on as a country has been reasonably well foretold in the UK's Helm Report. In his key findings, Professor Helm notes that:

> "The scale of the multiple interventions in the electricity market is now so great that few if any could even list them all, and their interactions are poorly understood. Complexity is itself a major cause of rising costs, and tinkering with policies and regulations is unlikely to reduce costs. Indeed, each successive intervention layers on new costs and unintended consequences. It should be a central aim of government to radically simplify the interventions, and to get government back out of many of its current detailed roles."[7]

53. Interventionism is also more likely to have a chilling effect on commercial investment, as there becomes greater risk of other interventions impairing assets or interfering with commercial plans. Stability and predictability is important given New Zealand's reliance on foreign capital and the lengthy capital-intensive developments involved in the energy sector.

54. Regulated interventions are always likely to be more unpredictable and unforeseeable than changes to the ETS. This increased uncertainty increase sovereign risk and the cost of capital (which is often of overseas origin given lack of depth in local market and therefore particularly attuned to headline impressions of country risk), which can affect all developments, even in renewables.

Part 3. The Commission's proposals are not "complementary measures" - They Fundamentally Undermine the ETS

55. The specific measures recommended by the Commission in its Draft Advice sit outside of the ETS framework and undermine the ETS. The Commission has not provided any analysis to show that the individual measures it identifies will create greater or cheaper emission reductions, compared to a robust ETS-based regime.

Direct emission regulations have a long history of failure and should be treated with extreme caution

56. The Commission's Draft Advice does not consider the risks that policymakers get the particular bets on technologies and emissions-reducing policies wrong. Specific pre-determined policy settings like bans/restrictions (on new gas connections, new coal boilers and internal combustion vehicles for example) risk closing off future options, including for example bio-gases which could use the existing gas infrastructure.

57. These measures prevent new information being acted upon as the options will have already been closed by regulation. This seems inconsistent with the Commission's Principle 3 to Create Options which also is intended to "keep options open for as long as possible".

---

7 Sir Dieter Helm, The Cost of Energy Review, 25 October 2017, page 8, paragraph 3.

58. The Commission should take lessons from other countries that have taken direct measures to reduce emissions. The case of Germany is highly instructive and should be well-known to the Commission.[8]

59. Germany embarked on the *Energiewende* ('energy turning point') in an attempt to internalise all of the costs of energy production. This involved a series of highly selective policy choices that endorsed particular types of technology (renewables and phasing out of nuclear) and policies, driven by shifts in the political mood, rather than the long-term interests of the people and planet.

60. Germany now has the highest electricity prices in the developed world, imports electricity from its neighbours (including nuclear-generated power) and has extended the lives of brown coal fuelled power plants to firm up the larger share of variable renewable (wind and solar) generation. The costs of this experiment in selective measures have been enormous.

61. There are also two further examples that the Commission may or may not be familiar with, but which highlight the perils of selective policy choices:

    a. biofuel mandates in Europe and the United States had a laudable emissions reduction objective but led to disastrous environmental and social outcomes, and increased emissions; and

    b. smart meter choices in Victoria imposed excessive costs on consumers for benefits that could not be unlocked. In contrast Aotearoa's choice to support a market-led smart meter roll out ensured an efficient roll out with no incremental cost increases for consumers.

62. Relevant case studies, prepared by Castalia[9], are presented in Box 1 and Box 2 below.

---

8 We note that the Commission's staff at the public presentations cited Germany's experience to have been positive for the development of solar generation technology. This overlooks the significant cost of the policies, and ultimately the lifespan extension of brown coal mines and associated electricity generation plants.

9 https://castalia-advisors.com

Box 1: Biofuel mandates in Europe and United States

Biofuel mandates were a costly experiment in well-intentioned "complementary measures" policies which had extremely poor social and environmental outcomes. During the 2000s, European countries and the United States (US) implemented biofuel mandates. These specific mandates were intended to reduce the greenhouse gas (GHG) emissions associated with transport fuel consumption. The mandates resulted in significant unintended consequences including environmental degradation and high food prices worldwide, with rises in staple food prices particularly impacting people in developing countries. There is also evidence that the mandates increased overall emissions, compared to no mandate.

First world governments mandated the blending of biofuels in transport fuels in the mid-2000s

The European Union (EU) issued a directive in May 2003 stipulating that member states had to enact measures that would replace 5.75 percent of all transport fossil fuels (petrol and diesel) with biofuels by 2010. A later directive of April 2009 updated the requirement to 10 percent by 2020. Many EU member states implemented biofuels targets, mandating blending of biofuels in transport fuels.[10]

Around the same time, the Federal Government and some State governments in the US introduced biofuels mandates. Rather than setting a percentage, the US set volumetric domestic production targets. Similar to the EU, these mandates were aimed at promoting alternative and renewable energy sources and reducing greenhouse gas emissions and to improve energy security. However, in the United States, a complex mix of subsidies for the production of corn ethanol are also aimed at supporting demand for biofuel input crops such as corn.

The mandates had the direct effect of rapidly increasing the production and use of biofuels. Between 2005 and 2012, global biofuel production tripled.

Biofuel mandates increased food prices

Food prices increased with the rapid increase in biofuel production. The food price crisis in 2008 saw prices for food in developing countries increase by 48 percent in real terms[11] and nearly double for wheat and rice.[12] This direct impact of biofuel mandates on food prices[13] has been confirmed in over 100 studies.[14]

So-called "first generation" biofuels (which are still the dominant type) are mostly produced from cultivated food crops (including residues). Ethanol is distilled from sugars from foods such as corn, wheat, sugar cane, sugar beets and molasses. Biodiesel is mostly derived from vegetable oils such as palm oil and rapeseed oil.

---

10 European Commission (2006), Biofuels Progress Report, available at: https://www.ebb-eu.org/legis/biofuels%20progress%20report%20100107%20provisional%20version.pdf

11 Food and Agriculture Organization (FOA) of the United Nations (2009), ESA Working Paper No. 09-09.

12 European Commission (2011), Causes of the 2007-2008 global food crisis identified.

13 Naylor, R. and Falcon, W. (2010) "Food security in an era of economic volatility", Population and Development Review, vol. 36, pp. 693–723, cited in United Nations Human Rights Council (2014) Report of the Special Rapporteur on the right to food: Final report: The transformative potential of the right to food; European Commission (2011), Causes of the 2007-2008 global food crisis identified.

Biofuel mandates encouraged ecosystem loss and environmental degradation

The European countries' mandates spurred a massive increase in land conversions to biofuel crops. This increased biodiversity loss in sensitive ecosystems. Since agriculture contributes to deforestation and habitat and ecosystem loss, the increased use of agricultural land for palm oil production, and other biofuel feedstock increased the rate of deforestation. Furthermore, in some jurisdictions, biofuel mandates increased the value of certain crops leading to the conversion of land in conservancy back to monocultural agriculture use.[15] Increased biofuel crop production also contributed to increased fertiliser use and environmental harm.

Biofuel mandates may have increased GHG emissions and encouraged greater fossil fuel use

Finally, research suggests that the increased production of biofuel crops actually increased overall GHGs when taking the full life-cycle impact of land conversion and fertiliser production and use into account. The mandates also had the marginal impact of reducing oil prices, which actually increased oil consumption—the so-called rebound effect.[16]

---

14 Transport & Environment (2017), Biofuels policies drive up food prices, say over 100 studies, available at: https://www.transportenvironment.org/news/biofuels-policies-drive-food-prices-say-over-100-studies

15 United States Environmental Protection Agency, available at: https://www.epa.gov/environmental-economics/economics-biofuels

16 Hochman et at (2011), The Effect of Biofuels on the International Oil Market, Applied Economic Perspectives and Policy, OUP.

Box 2: Smart meters in New Zealand and Victoria (Australia)

Over the past two decades, New Zealand has achieved a cost and time effective roll out of smart electricity meters, compared to Victoria where its roll out has increased consumers' electricity costs for unclear benefits. Differences in regulatory approach drive these two contrasting outcomes: New Zealand adopted a light regulatory approach enabling a low-cost roll out of meters meeting the needs of consumers, while Victoria mandated a roll out of over-specified meters which came at high cost to Victorian electricity consumers, while failing to unlock many of the Government's planned benefits.

Widespread adoption of smart meters is a good policy objective

Smart meters unlock benefits in the energy system by enabling:[17]

- Remote electricity reading, energisations, and de-energisations. This removes the need to send personnel to physical locations, thereby, reducing costs.
- Innovative business models (for example, Flick Electric Co is only able to offer retail customers spot prices due to smart meters); and
- Easier integration of new energy technologies behind the meter, such as home battery storage, distributed solar PV, and electric vehicles which require interval metering and remote access to maximise benefits.

Accordingly, increasing the uptake of smart meters is a good policy objective. However, as demonstrated by the Victorian and New Zealand experiences, the means of achieving this objective can have material impacts on the overall outcomes for consumers.

Victoria mandated the roll out of smart meters, which placed a considerable cost on consumers

In 2006, the Victorian Government committed to the Advanced Metering Infrastructure (AMI) programme which mandated that all residential and small business metering infrastructure in Victoria would have to be replaced with smart meters by 2012 (this deadline was extended to 2014 mid-way through the programme). By June 2014, 2.8 million smart meters were installed covering over 98.62 percent of households.

Despite near universal coverage of smart meters, the Victorian Auditor General concluded in 2009 that the AMI programme may result in "an inequitable, albeit unintended, transfer of economic benefits from consumers to industry."[18] In a follow up report in 2015, the Auditor General found that only 40% of the expected benefits of the roll out had been achieved to date.[19] The Victorian government made regulations to allow distributors to pass through the costs of the rollout to consumers, resulting in a $AU130-190 increase in annual residential metering charges by 2015.[20] This dynamic was worsened by the policy decision to mandate highly specified meters and enabling communications networks, which were more costly to roll out than lower specified smart meters, with simpler communications solutions. The Victorian Auditor General estimates that the programme cost consumers $2.239 billion, with a net cost to consumers estimated at $319 million.[21]

---

17 For further information about the benefits of smart meters, see https://www.ea.govt.nz/about-us/media-and-publications/market-commentary/outlook/smart-meters-enhancing-competition-and-enabling-new-consumer-technologies/

18 Victorian Auditor-General (2009) Towards a 'smart grid' – the roll-out of Advanced Metering Infrastructure, page ix.

The AMI programme also failed to realise forecast benefits that were promised at the programme's outset. Many of the benefits depended on changes in consumer behaviour, which did not occur. For example, only 0.27 percent of customers (compared to the initially forecast 4 per cent) had adopted flexible price offers enabled by smart meters by 2014. Updated analysis indicates that only 80 percent of the initially expected benefits are expected to occur by 2028, when the rolled-out meters are expected to reach the end of their useful life.[22]

By adopting a mandatory roll out strategy with smart meters that were over specified for actual use in the market, Victoria placed costs on consumers that did not exceed benefits. The costly and ultimately value-destroying roll out strategy was driven by the Victorian Government, despite strong industry preference for a market-lead roll out over a longer timeframe. The Victorian experience played an important role in ensuring that no other Australian state followed a mandated roll out model.

New Zealand achieved a fast and low-cost smart meter roll out with minimal regulatory intervention

Unlike Victoria, New Zealand adopted a market-led approach to rolling out smart meters. New Zealand set no smart meter roll out deadline, or milestones. Its only regulatory intervention was to set minimum standards for meters which have slowly improved over time. This was coupled with market changes to create a contestable market for meter installation. Compared to the minimum specification in Victoria, New Zealand's specification was a genuine minimum, giving flexibility for the meter owner to decide how sophisticated (and expensive) the meter should be, given the expected benefits that could be unlocked and monetised. Importantly, unlike Victoria, there was no guaranteed cost recovery for the investment through increases in regulated network charges.

This minimalist approach has resulted in New Zealand having one of the highest uptakes of smart meters of any country in the world. Nearly 83% of 2.2 million ICP in NZ have certified smart meters (at 2020).[23] While this is less than Victoria's 98.92 percent coverage, New Zealand achieved its coverage without any notable increase to consumer bills over the past decade. Between 2006 and 2020, the average increase in real household spending on electricity was only $13 per year (an average growth rate of 0.92 percent).

A key difference in specifications was that Victoria mandated all meters to have Home Network Area (HAN) capability, whereas New Zealand did not. HAN capability increases the cost of each meter, but enables meters to communicate digitally with smart appliances. The Victorian government's expectation in 2008 was that HAN capability would be crucial over the coming decade. In reality, even in 2021, with the Victorian meters beginning to reach the end of their useful life, Victorian consumers do not widely utilise the HAN capability that they were forced to pay for. Yet the absence of HAN as a minimum requirement has not hindered New Zealand consumers. HAN-enabled meters are available for sophisticated consumers that want to use that capability. Having HAN capability as option, rather than a requirement, helped keep the costs of the New Zealand roll out significantly lower.

---

19 Victorian Auditor-General (2015) Realising the Benefits of Smart Meters, page xii.

20 Australian Energy Regulator, Draft Determination: Victorian advanced metering infrastructure review, 2009-11 AMI budget and charges applications. https://www.aer.gov.au/system/files/Draft%20determination%20-%20Initial%20AMI%20budgets%20and%20charges%20-%20July%202009_2.pdf
Actual 2009 charges in Tables 4.1, 4.5, 4.9, 4.13. Approved charges 2011-2015 https://www.aer.gov.au/news-release/aer-makes-final-decision-on-smart-meter-charges

21 Victorian Auditor-General (2015) Realising the Benefits of Smart Meters, page xi.

22 Victorian Auditor-General (2015) Realising the Benefits of Smart Meters, pages vii and xiii.

23 https://www.mbie.govt.nz/dmsdocument/12025-eranz-accelerating-renewable-energy-and-energy-efficiency-submission-pdf

The Commissions advice misses the implications of the Waterbed Effect on "complementary measures"

63. The "Waterbed Effect" means that specific abatement efforts do not change total emissions because the overall emissions cap is fixed. That is to say (using the analogy) the 'volume of the waterbed' is fixed and pushing down on one part simply allows it to pop up somewhere else.

64. The Commission essentially acknowledges that complementary policies cannot reduces emissions further than the ETS cap:

> "The prices observed in the NZ ETS will depend on the mix of policies implemented to meet emissions budgets. The more that the Government chooses to complement the NZ ETS with other policies, the more likely it is that the NZU price in the NZ ETS can be lower while still achieving the same overall emissions reductions."[24]
>
> [emphasis added]

65. Although acknowledging that total emissions cannot be reduced by other measures, the Commission maintains the case for them by saying they suppress the ETS unit price thereby making costs less visible:

> "The more that non-ETS policies are used, the more likely it is that the NZU price in the NZ ETS can be lower while still achieving the same overall amount of emission reductions. This might not reduce the overall cost of reducing emissions – it would just mean that the cost of achieving some reductions was less visible in the emissions price..."[25]

66. This statement acknowledges that the ETS negates the ability of non-ETS measures to actually reduce emissions. This reveals that the Commission's core strategy of interventions and regulations by necessity leads to the ETS being undermined as the primary policy tool.

67. Even *if* the Commission thinks it can design complementary measures in a way that circumvents the waterbed effect (by linking emission reductions from complementary measures to reductions in the cap), a fundamental issue still remains – the same abatement could simply be achieved (and more efficiently) through tightening the ETS cap over time rather than through complementary measures which cannot reduce capped emissions and which come with the risk of higher marginal abatement costs and government failure. The Commission does not appear to have engaged with this.

Part 4. If Direct Interventions Are Chosen These Need to be Justified and Durable

68. If the Commission thinks that direct interventions and regulations are justified, it needs to show how the costs of its chosen path to net zero will be met. The ETS provides a transparent and universal cost mechanism for the cost of emissions throughout the economy. The proposals have not been assessed in a cost-benefit framework or exposed to proper analysis of risks.

---

[24] Op. cit., Draft Advice, page 131.

[25] Climate Change Commission, Evidence Report, Chapter 17, page 5.

69. In choosing the mechanism to reduce emissions, the choices are necessarily between imperfect instruments. What instrument is better is an empirical question that can be guided but not resolved from first principles. In considering additional policies, the following questions must be asked:

   a. what is the *specific* and residual problem to be addressed?

   b. what are the feasible options (government and/or non-government) for achieving the desired objective?

   c. are the benefits of government intervention likely to outweigh the costs (including risk of government failure)?

70. Despite an ETS nominally suppressed through complementary measures, the real cost of emissions reductions to New Zealanders are likely to be much higher when achieved through direct regulation. This is because complementary measures can only achieve lower abatement costs if the Commission manages to correctly pick superior measures now relative to the measures that the ETS-driven market will pick in real-time over the coming decades. That prospect relies on the Commission knowing which policies and technologies to pick now for a future that is decades away. It also assumes that the Commission's modelling (which has not been released in full) reflects a precise vision of the future.

Costs and benefits of complementary measures need to be evaluated using established New Zealand government techniques

71. The costs of the policies for the transition should be fairly distributed and not loaded onto certain sectors of the economy without considering the welfare impacts. Consumers and firms in Aotearoa have a right to know the costs of transition in a transparent way.

72. The broad consensus approval of the ETS will also be threatened if the costs of transition are unfair or impose excessive costs. Policy interventions need to justified using regulatory impact analysis, as required by the Cabinet Manual and following Treasury regulatory impact guidance.[26]

Complementary measures bear a high risk of government failure

73. In addition to the direct costs, transaction costs and opportunity costs of resources spent on compliance, it is crucial to consider the risks of *government failure*, which can occur because of:

   a. *political failure*: legislation responds to interest groups at the expense of the general public;

   b. *bureaucratic failure:* government agencies tend to advance their own interests (e.g. expanding budgets and influence) rather than addressing the original problem that warranted intervention in the first place;

   c. *judicial failure*: slow, costly and uncertain legal processes can arise from new regulations;

---

26 https://www.treasury.govt.nz/information-and-services/regulation/impact-analysis-requirements-regulatory-proposals

d. *regulatory capture*: regulatory agencies can end up captured by stakeholders in the regulated industry; and

e. *regulatory creep*: where additional costly regulations are needed to manage unintended consequences of the original policy).

74. The Commission assumes that additional policies are needed without recognising and engaging with the risks of government failure which could compromise its own preferred path of regulation.

75. If there are other market failures in relation to emissions (most plausibly these would be related to imperfect information), it must be demonstrated that these are residual and material following the primary intervention (the ETS). The problem definition must be clearly articulated and then the marginal costs and benefits of intervention must be clearly demonstrated.

Taking care to differentiate general commercial challenges from genuine market failures

76. In terms of identifying residual 'problems' remaining after the ETS has been established we share a few words of caution. Alleged 'capital barriers'[27] may just be a normal part of the commercial sector and not evidence of any market failure. Emission reduction projects certainly compete for internal capital, but this does not represent an actual barrier *per se*. The observation about competition for capital is axiomatic as everything faces competition, as all decisions involve an opportunity cost.

77. We accept that it is important that firms have information to ensure they can make informed decisions about energy but consider that firms already have the right incentives to pursue and use this information. General information can be obtained online, tailored advice can be sought from consultants, advisors and sometimes government agencies where policy has deemed that appropriate.

78. In terms of other commercial challenges that the Commission wishes to manage, we note its concern to avoid 'stranded assets' (whereby investments are made in new coal boilers or gas connections that become redundant). We believe that consideration of long-term risk is a core function of the board of directors and that they are well-placed and incentivised to assess and manage these issues. Any emissions are captured by the ETS and if a firm or consumer *does* end up with stranded assets it should be of no concern of the Commission.

Part 5. Key Judgements Deserve Robust Evidence-Based Analysis

79. A number of the Commission's judgements (when making assumptions, presenting arguments and reaching conclusions) do not seem to stand up to robust scrutiny. Given the extensive implications for New Zealand's workers, consumers and businesses, we would expect more extensive and considered analysis. This is especially

[27] This is covered in *Necessary Action 7 on page 115. It says:* "We recommend that, in the first budget period the Government take steps to reduce carbon emissions from fossil fuelled boilers by: …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".

important given the *high* certainty of the job losses in the regions and the distributional impacts of direct measures, when compared to the relative *uncertainty* of the Commission's modelled emission impacts.

80. The Commission simply assumes that the various interventions proposed will achieve the desired objective, with no apparent consideration of government failure, as discussed earlier. Where any proposal is made, a robust cost-benefit analysis should be applied.[28] Putting aside the significant negative impact on the ETS, the Commission's proposed measures, even when assessed on a standalone basis, are not a good set of measures in our view, and unlikely to pass a net public benefit test.

Renewable energy target could have unintended consequences

81. The Commission has proposed a target of "60% renewable energy by 2035". The Interim Climate Change Committee showed that fuel-specific targets are unlikely to be useful and will lead to perverse consequences.[29] The Commission's focus should be on emissions rather than fuel types or technologies. If the Commission were to recommend *any* quantitative target (something we are generally sceptical of), the target must surely be about *low emissions* (the desired result) and not *renewables* (<u>one</u> of the inputs to achieving the desired result).

82. This is because:

    a. not all *renewable* generation is low emissions (for example, high-emitting geothermal fields which can produce a similar emissions footprint to gas-fired generation);

    b. all generation, *including* renewables, contains embedded emissions created throughout the asset lifecycle, and those embedded emissions should be taken into account; and

    c. hydrocarbons can be used with carbon capture and storage or other offsets.

83. We understand that the Commission recommends the 60% renewable energy goal because its modelling suggests that this will happen by 2035 anyway, but the proposition of a hard target is an unnecessary one-way bet. Targets constrain optimisation and can force second best outcomes. Targets can also be a recipe for rent-seeking, whereby firms lobby government for inefficient policies or subsidies to help achieve an arbitrary goal.

84. A myopic focus on *renewables* could lead to costly decisions to push out fossil fuels simply to meet the 60% target even at the expense of efficiently reducing net emissions. Similar to the German *Energiewende* example, the premature removal of natural gas in Australia increased

---

28 The Treasury provides sound guidance on cost-benefit analysis.https://www.treasury.govt.nz/information-and-services/state-sector-leadership/investment-management/plan-investment-choices/cost-benefit-analysis-including-public-sector-discount-rates

29 "Under the accelerated electrification future, electricity prices remain affordable. This is vital because consumers will not switch to electricity if it is too expensive compared to fossil fuels, and so potential emissions savings would be less."

Page 7, Accelerated Electrification https://www.iccc.mfe.govt.nz/assets/PDF_Library/daed426432/FINAL-ICCC-Electricity-report.pdf electricity prices and price volatility, which has in turn made electrification of production processes less attractive. The impact was so severe, that in 2017 the Australian Government attempted to negotiate with coal generators to keep their remaining plants operating longer than planned.[30]

85. Again, the challenge posed by the Paris Agreement and the Climate Change Response Act 2002 is not to phase out oil and gas (although the industry recognises and accepts that a significant reduction is almost certainly required). Instead, the task and challenge should be to reduce their impact on the environment by lowering net emissions through achieving the right mix of reduced use, improved management of fugitive emissions, offsets, and bio and geo sequestration.

86. We support the Commission in saying that "the 100% renewable electricity target should be treated as aspirational",[31] i.e. it should not be used as a policy target.

A ban on new gas connections will have negligible effect on emissions, but drastic impact on the gas market

87. We strongly oppose the Commission's recommendation that new gas or LPG connections should be banned by 2025 and "earlier if possible". The Commission has not established the intervention logic for such a change, and appears to have ignored basic public policy analysis. It also contradicts Principle 3 which is to "keep options open for as long as possible".

88. A basic calculation shows that this ban could reduce emissions by a mere 2,000 tonnes of CO_2 per year. Around four hectares of exotic forest would need to be planted in each year to offset these emissions. The offsets would be a tiny addition to the exotic forest stock compared to the obvious benefits derived from gas connections.

89. It is concerning to see a substantial recommendation that forces significant change on an entire industry without any assessment of the costs and distributional impacts. Moreover, there are significant economy wide market structure and competition implications for any new business that requires a new natural gas connection. The Commission's ban will force new businesses to use more expensive and/or less effective fuels putting new entrants at a commercial disadvantage relative to incumbents.

90. As a general principle, we do not support bans as they are blunt instruments which reduce optionality and hide the true cost of abatement. Bans may also have significant unintended consequences which cannot be easily unwound, and even if such consequences are identified, it is very difficult to reverse them in a manner that restores investor confidence if the policy is subject to party politics.

91. What may be a good choice for one firm may not be good for another, and because information is dispersed only the firm in question can best make decisions on what technology to use.

---

30 https://www.afr.com/politics/pm-negotiates-with-agl-sale-of-power-station-to-avoid-closure-20170905-gyatjj

31 *Op. cit.,* Draft Advice, page 112.

92. The ban also threatens to destroy the value of long-lived assets that can continue to provide significant value in Aotearoa through and beyond the transition. Biogas and hydrogen can be used in natural gas pipeline infrastructure, but preventing new connections will undermine the ongoing operation and maintenance of that infrastructure closing off the option of cleaner fuels. Gas network operator First Gas is actively looking at how the network can be used for low emission fuels. LNG, which could be imported could also use existing infrastructure.

93. It is interesting to juxtapose this proposal with the carefully considered remarks about Methanex. The Commission rightly identifies that the gas market becomes more precarious if Methanex departs, which may put a real strain on gas generation for peaking. Yet the Commission quickly shifts from that nuanced perspective to proposing a connection ban which would undermine confidence in a sensitive market that they just recognised as being important.

94. Needless to say, ban on new gas connections from 2025 would be unpopular with the 400,000 homes and businesses (such as restaurants and cafes) that currently use natural gas or LPG.

95. These people choose natural gas or LPG because of a range of positive attributes:

    a. it is affordable;

    b. it is reliable; and

    c. it also provides instantaneous heat.

96. A ban would simply force them into using more expensive energy sources they prefer not to use when their current gas equipment reaches the end of its lifespan. It is incorrect to compare electricity to natural gas without considering the different characteristics, infrastructure and cost drivers. Evidence shows this would be an unpopular move with the wider public. For example:

    a. our recent UMR survey[32] of the public found five out of six respondents have a favourable or neutral view towards the oil and gas industry; and

    b. a recent survey by the Restaurant Association of their members found strong resistance to the idea of banning new gas connections. They say it would be extremely expensive to switch away from gas (when their existing ovens need replacement) and very difficult to operate in busy kitchens.

97. This kind of policy (like the confusion around backyard barbeques) is likely to generate criticism and media coverage, and in doing so undermine wider public support for climate policies. This matters because we need broad public buy-in for climate policies to be effective and sustainable.

32 https://www.energyresources.org.nz/oil-and-gas-new-zealand/public-opinion-on- oil-and-gas/

Part 6. International Issues to Consider

International Integration of the ETS deserves a proper assessment

98. A sound ETS should be internationally connected to enable lowest global marginal cost abatement and to help ensure that carbon prices are in line with trade partners and competitors. International units, if allowed in the New Zealand regime, would promote economic efficiency, price discovery, and ultimately increase market depth and liquidity.[33]

99. If emissions budgets must be met as far as possible through domestic action, then more policy work should be done on devising what "as far as possible" really means, so that tests or criteria are in place and known to emitters.

100. We note that there are active ongoing negotiations to achieve the Paris Agreement's Article 6 objective of international carbon markets. Indeed, given domestic experience of having an ETS, New Zealand is a strong contributor to these discussions. We recognise the sovereign right of the New Zealand Government to choose domestic policies, but it seems unusual to actively contribute to advancing Article 6 while at the same time all but rule out the domestic use of offshore units.

Carbon leakage remains an important issue inadequately addressed by the Commission

101. The Commission has overlooked a key issue for global emissions, and Aotearoa's role in contributing to reducing those emissions.

102. As described by the Commission:

> "Emissions leakage is a risk created by the uneven implementation of climate policies around the world. Emissions pricing or other policies aimed at reducing emissions may increase costs for emissions intensive businesses and cause them to lose market share to international competitors who do not face similar costs. If this causes production and investment to shift in a way that increases global emissions, it would be counter to the intended effect of the policy as Aotearoa would be exporting emissions rather than reducing them."[34]

103. Some commentators argue that emissions leakage is no longer an issue in the post-Paris Agreement world. This ignores the reality of how different parties to the Paris Agreement interpret and implement their climate policies relative to other countries.

104. Not all countries have fixed nationally determined contributions and corresponding enforced domestic emission caps. Many large emitting countries do not meet these standards – for example, China merely intends to peak its emissions by 2030 and then to make reductions after that point. That currently incentivises China to obtain as high a

---

[33] There seems to be some concern that international units mean no domestic reductions will be made, but we do not consider that anticipation to be accurate. Firms will look for domestic abatement opportunities in their business and then to domestic credits, so international units will only be used when cheaper domestic opportunities are not available. They therefore serve as important pressure release valve – a concept the Government championed through the introduction of a framework for a Cost Containment Reserve.

[34] *Op. cit.,* Draft Advice, page 92.

peak as possible, and provides plenty of emissions capacity for it to welcome new industries that can shift there from countries that close down emissions-intensive industry.

105. In the scenario of New Zealand methanol no longer being produced here by Methanex due to emission pricing imposts, it is most likely that production will simply shift to China. This is because in the Asian market, Chinese production of methanol from coal is the next cheapest on the cost curve after New Zealand's methanol production.[35]

106. The Commission should also carefully consider its assumption that free allocation of NZUs will ensure domestic firms remain competitive. It states:

> In Aotearoa, emissions leakage risk is mitigated by providing potentially affected industrial activities with free allocation of NZUs. This substantially reduces the cost of the Emissions Trading Scheme (NZ ETS) for these businesses.[36]

107. In itself this statement is reasonable. However, it does not engage with how this will be compromised by the direct interventions and policies that the Commission promotes. Free allocation is only granted under the ETS. If there is an increased reliance on complementary measures, then the associated costs of those measures cannot be compensated as only the ETS delivers free units. The complementary measures can (and are more likely to) simply become an impost. This point should be carefully considered by the Commission, which has dismissively said that "competitiveness at risk" is covered off by free allocation of New Zealand units in the ETS, but that will be compromised by an increased reliance on other policies.

Free allocation of units are still required to manage carbon leakage and ensure a just transition

108. Free allocation of units should only be removed with great caution. Free units help to:

   a. prevent carbon leakage;

   b. protect the property rights of incumbent firms at the time of the ETS's inception; and

   c. reduce the risk of economic activity and jobs being lost prematurely.

109. We occasionally see the claim made that free allocation of units leads to inaction, but even with the free allocation of units, emitters face the price at the margin and therefore receive the signal to lower emissions, as units have a market value so emitting beyond free allocation limits means purchasing more units and abating emissions means the units can be kept or sold. In addition, free units were never guaranteed for the long-term, so no firm would prudently rely on them as a reason to do nothing by way of emissions abatement.

110. Indeed, we see numerous positive examples of emitting firms investing in domestic abatement such as Ballance Agri-Nutrients investment in

---

35 China's emissions trading scheme would not prevent new methanol production shifting there from New Zealand. The Chinese emissions trading scheme only applies to electricity generation and does not apply to petrochemical production.

36 *Ibid,* page 92.

renewably generated hydrogen, Golden Bay Cement's investment to replace coal with chipped tyres, and Methanex's consideration of recycling carbon.

First principles review of free allocation

111. Lastly, the Commission proposes undertaking a first principles review of industrial allocation policy.[37] We note that a review of free allocation is already being undertaken by the Ministry for the Environment. We suggest a need to stop tinkering with this and to let it settle so as to avoid creating a disincentive to act based on outstanding change coming.

Importing gas that could be produced domestically undermines the NZ economy and increases global emissions

112. The Commission acknowledges that natural gas will continue to be needed for peaking electricity generation. The Commission, however, also contemplates the departure of Methanex as the largest user of natural gas. Together with regulatory settings under the Crown Minerals Act preventing new permits outside onshore Taranaki, there are now very real questions about whether the gas necessary for electricity generation will be domestically produced or imported.

113. The Commission even acknowledges that a foreseeable outcome could be importing Australian LNG despite a domestic industry with production and distribution assets and a highly skilled workforce able to provide the resources needed. Again, the Commission has not adequately considered the wellbeing impacts and costs of ending the domestic industry in favour of overseas imports. It is particularly unfortunate that such a policy would mean Aotearoa's electricity consumers support Australia's so-called "gas-led economic recovery" at the expense of the domestic industry.

Part 7. Electricity and Gas Modelling

Electricity firming

114. Natural gas plays an important part in the electricity system, by providing affordable and reliable peaking supply (to cover shortfalls in generation from hydro, wind, and solar). Indeed, the peaking offered from New Zealand fossil fuels is a direct enabler of the high level of renewable electricity the country generates. The role of gas should be recognised and provided for going forward.

115. We also note that high electricity prices compromise the competitiveness of the entire trade sector, so reiterate the importance to New Zealand's economic fundamentals of not artificially or prematurely forcing gas out of the system.

Transition to renewables has risks which natural gas supply can mitigate

116. The Commission should take into account the risk mitigation function that natural gas can provide in the electricity system. The transition to a greater share of variable renewable generation in the electricity network will occur over an uncertain timeframe. The natural gas

[37] *Op cit.* Draft Advice, page 132.

generation assets in the Aotearoa electricity system have the following value:

a. existing assets requiring no additional investment;

b. provide flexibility to ensure resilience of the electricity system;

c. manage price volatility as the transition to variable renewable generation occurs;

d. provide certainty of prices over an extended period as variable renewable generation assets are built and added to the network; and

e. mitigate resilience risks to the extent that weather-related issues affect variable renewable generation.

The Commission's expectation that future electricity prices will not increase requires more robust analysis

117. Expectations that electricity prices will not increase would seem to be a key ingredient for increased renewable-based electrification. The Commission's conclusions in this regard are based on undisclosed modelling, significant assumptions and major contingencies which are not at all certain.

118. The Commission's forecast of electricity prices relies on a number of assumptions about what will happen in the future. We consider key assumptions to be:

a. the closure of Tiwai Point Aluminium Smelter, deferring the need for investment in new generation;

b. the cost of renewable generation continuing to fall;

c. geothermal and wind immediately and rapidly displacing gas powered electricity generation, with gas having a minor role only from 2027;

d. peak demand not increasing with electricity demand growth; and

e. alternative tools to gas are established for dry-year management after 2035 e.g. the "NZ Battery" project being considered for Lake Onslow.[38]

119. We make the following observations about these assumptions:

a. there is a lack of transparency with the Commission's modelling. The full modelling (including sensitivity analysis) and data has not been provided which limits the extent to which its assumptions and forecast outcomes can be scrutinised;

b. the Commission assumes an immediate reversal of the upward trend in wholesale electricity prices over the last decade (last 4 years, in particular). The Commission's

[38] Incidentally, we support the subtle criticism of the Lake Onslow pumped hydro concept, where the Commission says "affordable and reliable. The NZ Battery project will deliver advice on potential solutions to the challenge of dry year energy security. While a solution to this challenge could enable Aotearoa to reach 100% renewable electricity, it could cost taxpayers billions of dollars."

wholesale electricity price starting point (a maximum price for 2021 under $99.10/MWH) is also out of line with (lower than) actual wholesale electricity prices which averaged $97.99 in November, $117.97MWh in December, $140.67 in January and $250.66 in February;[39]

c. consistent with the Commission expectations about the impact of Tiwai exit, various MBIE reports have modelled that there would be significant short-to-medium term wholesale electricity price reductions.[40] While it is reasonable to assume Tiwai exit would result in lower wholesale electricity prices, the Commission provides no obvious explanation why it expects wholesale electricity prices to fall *immediately* from the beginning of 2021 (see commentary below on reduction in gas-plant electricity generation);

d. it is unclear how the Commission has factored in increases in carbon prices on wholesale electricity prices. Genesis Energy has commented that the Commission does not appear to understand the impact of raising the cap on carbon prices in the emissions trading scheme to $70 a tonne as soon as possible — from $50 now — and then to $140 by 2030 would have on wholesale electricity prices in the near term;[41]

e. increase in network infrastructure investment does not appear to be factored into the Commission price modelling**.**

   The Commission has stated:

   > *"Our path shows that annual electricity generation would need to increase by around 20% over 2018 levels by 2035 to meet industry and electric vehicles needs"*[42] and
   >
   > *"Increased demand [due to electrification] will need to be accompanied by expanding transmission and distribution infrastructure"*[43]

   However it isn't clear how, or the extent to which, the investment in network infrastructure has been factored into the Commission price modelling.

f. the Commission's electricity price modelling is for an optimistic/ 'fine sailing' scenario. It is unclear what happens if Tiwai does not exit, if the cost of renewable electricity doesn't fall by as much as Commission assumes, if peak demand isn't restrained while electricity demand grows, and if Transpower

---

39 The daily maximum average price in 2021 is $393.58. Source https://www.emi.ea.govt.nz/Wholesale/Reports/W_P_C?DateFrom=20090721&DateTo=20210223&TimeScale=MONTH&_rsdr=ALL&RegionType=NZ&_si=v

40 e.g. https://www.mbie.govt.nz/dmsdocument/2809-electricity-demand-and-generation-scenarios-2016-pdf and https://www.treasury.govt.nz/sites/default/files/2013-09/nzas-2394495.pdf

41 https://businessdesk.co.nz/article/infrastructure/climate-commission-overly-optimistic-on-power-prices-genesis

42 *Op. cit.,* Draft Advice, page 63.

43 *Op. cit.,* Draft Advice, page 61.

removing peak-usage charges from the transmission pricing methodology results in increase in peak-demand; and

g. the Commission has used the six limited scenarios including 'BAU' (only one scenario has *"relatively high barriers"* to changes in future behaviour and technology, but hasn't detailed what these translate to for pricing purposes).

120. The Commission's assumptions on near-term electricity prices therefore appear overly optimistic, and risk creating the false impression that decarbonising the economy is going to be easy.

121. Alongside the Major Electricity Users Group and Major Gas Users Group we commissioned NZIER to consider the Commission's Draft Advice report and Evidence chapters. NZIER's report (attached as **Appendix Two**) makes the below concluding comments which warrant serious consideration by the Commission:

> "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."[44]

122. 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, we believe it is risky to rely on the Commission's analysis.

Gas production forecasts may be unrealistic given practicalities of production

123. The Commission has not explicitly outlined its assumptions about future gas supplies. It has, however, published its forecasts on gas and other fuel use under both BAU and its suggested pathway. The Commission would have gas use trending down to approximately 25PJ a year by 2050 (down from the BAU scenario of 90PJ being used at that time and down from approximately 200PJ today).

124. There is a risk that this figure of 25PJ is used simply because the Commission determines that is the level of demand, but without adequate consideration of whether those production numbers are plausible in terms of technical field management and economic viability.

125. It is unlikely that 25PJ of gas is enough to viably sustain more than one or two gas producers, and even then, there is a question about whether settings will be conducive to firms remaining to deliver essential fuel products. Security of supply and affordability may not be manageable with only one or two assets left producing, and the Commission should consider this in line with our point about the

---

[44] NZIER. Climate change model review - Climate Change Commission ENZ and C-Plan models. Report to Major Electricity Users Group (MEUG), Major Gas Users Group (MGUG) and Energy Resources Aotearoa. Page 10.

trilemma. If that gas production profile is commercially or technically unsustainable then the energy supply and price situation could become a lot more volatile more quickly than the Commission anticipates.

Part 8. The Commission Appears to Have Overlooked a Key Technological Development That Could Support the Transition

126. Carbon capture and storage ("CCS") has the potential to reduce emissions at a large scale. CCS is the process of capturing carbon emissions from large sources such as power plants and large industrial users and storing them where they cannot escape into the atmosphere. Often this is deep underground in geological formations where natural gas originally came from.

127. Large scale CCS is a reality today and can remove as much as 90% of carbon dioxide from major projects. There are currently 37 projects around the world actively capturing and/or injecting carbon dioxide.[45]

128. Here in New Zealand, the 8 Rivers company proposes a zero emissions power generation plant in Taranaki. As part of its "Project Pouakai", 8 Rivers is proposing to produce electricity, urea and hydrogen fuel with zero-emissions using proprietary Allam-Fetvedt cycle technology that captures all CO2 inherently in the production process enabling sequestration of pure CO2.

129. However, the lack of an enabling regulatory framework for the use of this technology in New Zealand will dissuade investors. New Zealand academics and the Productivity Commission have already shown that the regulatory regime is a major barrier, and identified where the gaps lie.[46] Energy Resources Aotearoa therefore recommends the Commission support changes to relevant legislation to allow this technology to be deployed.

130. We note correspondence to us from Climate Change Minister Hon James Shaw advising that MBIE has the mandate to start developing a regulatory regime for CCS this coming year, in response to the Productivity Commission recommendation that such a regime is needed.

131. We also note that government-funded research body Ara Ake is looking at CCS and this should be looked at by the Commission. This will be vital work to unlocking domestic use of CCS.

132. Ultimately the cost and efficiency of new energy solutions such as CCS are dictated by global, not domestic action although of course domestic regulatory and commercial factors will be important. In looking at emerging technologies, a neutral view should be applied meaning that CCS should be judged no more harshly than say hydrogen or biofuels.

---

45 National Energy Technology Laboratory, US Department of Energy, available at: https://www.netl.doe.gov/coal/carbon-storage/worldwide-ccs-database

46 Barton (et al) (2013), Carbon Capture and Storage: Designing the Legal and Regulatory Framework for New Zealand: Report for the Ministry of Business, Innovation and Employment and the New Zealand Carbon Capture and Storage; Productivity Commission (2018), Low Emissions Economy: Final Report, page 449.

Part 9. Significant skills in a complex energy sector could be lost

133. In terms of skills retention, it will be important that there will be enough jobs in new areas to sustain the workforce. To help inform thinking about necessary skills development, greater consideration is needed in relation to what the new jobs and skill requirements could be and whether the education system or immigration settings are conducive to providing those skills.

134. In terms of skills transfer, it is important that existing skills in the energy resources sector are not prematurely ended through the effects of government regulations before new jobs are available in alternate firms and sectors. If a 'gap' emerges, this is negative not only for workers out of between employment but also for firms in low emissions sectors.

135. The skills in the petroleum sector will have a critical role in supporting other industries such as geothermal, hydrogen or biogas. The skills can also support increased importation of refined petroleum products if the remaining refineries in Australia and at Marsden Point close in the near term. A vibrant ecosystem of service providers is vital both to the current sector but also to the transference of skills and capabilities to adjacent sectors. If such firms cannot access skills then they will struggle to profitably operate.

Part 10. Energy Accord

136. The Commission has proposed a national energy strategy, but rather than adopting a top-down approach we propose that the Government work with the energy resources sector to develop an accord representing a joint commitment to work together to enable and promote a vibrant and well performing energy resources sector.

137. An accord, properly developed, would create a framework and platform for government and industry to collaboratively work together to consider and address key challenges in the sector. These could include security of supply, affordability, environmental sustainability including emissions, regulatory environment, and skills and training. If an accord is reached, a subsequent work plan could be developed to deliver the outcomes agreed upon.

Part 11. Conclusion

138. We thank the Commission for the opportunity to submit and would be happy to discuss any aspect of this with officials.

Appendix One: Energy Resources Aotearoa Response to Certain Consultation Questions

Responses	**Responses**
Question 1 Do you support the principles we have used to guide our analysis? Is there anything we should change, and why?	We suggest an additional and key principle to focus on least cost abatement. Principle 2 should be amended to focus on net emissions, not gross.
Question 2 Do you support budget recommendation 1? Is there anything we should change, and why?	No. We are not convinced of the need for aggressive action and the associated interventions.
Question 3 Do you support our proposed break down of emissions budgets between gross long-lived gases, biogenic methane and carbon removals from forestry? Is there anything we should change, and why?	We do not have a view on the specific breakdown but there appears to be an expectation that there are more emission reduction opportunities for long-lived gases over the three budgets than there are for biogenic methane, meaning that this is the focus area. We prefer a more neutral approach between emissions.
Question 4 Do you support budget recommendation 4? Is there anything we should change, and why?	No. Even though the statute requires a focus on domestic emission reductions, greater focus should be put on determining the policy under which offshore mitigation could be allowed.
Question5 Do you support enabling recommendation 1? Is there anything we should change, and why?	Yes. Durable, stable and predictable policy is important.
Question 6 Do you support enabling recommendation 2? Is there anything we should change, and why?	We do not support the Government devising emission reduction plans right now for second and third emission budgets by 31 December 2021 as there is too much uncertainty so far ahead.
Question 8 Do you support enabling recommendation 4? Is there anything we should change, and why?	We are comfortable with some coordination approach led by central Government. However, emission mitigation policies should be driven by the ETS and not through local councils.

Question 9 Do you support enabling recommendation 5? Is there anything we should change, and why?	This seems unnecessary under an ETS.
Question 10 Do you support our approach to focus on decarbonising sources of long-lived gas emissions where possible? Is there anything we should change?	As set out in our main submission in Part 1, we prefer a focus on net-zero emissions across the economy and not looking to compel particular sectors to nearly completely decarbonise when there are lower cost abatement pathways open.
Question 11 Do you support our approach to focus on growing new native forests to create a long-lived source of carbon removals? Is there anything we should change, and why?	As set out in our main submission in Part 1, no we do not. We prefer neutrality and a "net emissions" approach as required by law. We also note that no cost-benefit analysis has been disclosed to underpin the native vs exotic approach.
Question 12 Do you support the overall path that we have proposed to meet the first three budgets? Is there anything we should change, and why?	No. As set out in our main submission, we highlight a range of fundamental errors and problems with the Commission's proposed approach.
Question 13 Do you support the package of recommendations and actions we have proposed to increase the likelihood of an equitable, inclusive and well-planned climate transition? Is there anything we should change, and why?	Partially. As set out in Part 1 of our main submission, the ETS should be the main tool and as set out in Part 2 we consider that tax relief commensurate with carbon pricing could help to relieve the pressure on households. Free allocation of units is also important as covered in Part 6.
Question 14 Do you support the package of recommendations and actions for the transport sector? Is there anything we should change, and why?	No. As set out in Parts 1 and 2 of our main submission, we prefer the ETS to govern decisions and to find least cost abatement.
Question 15 Do you support the package of recommendations and actions for the heat, industry and power sectors? Is there anything we should change, and why?	No, as set out in our main submission including in Parts 2, 3 and 8. We do however support electrification where it is economically efficient. We also support making the 100% renewable electricity target aspirational only.
Question 16 Do you support the package of recommendations and actions for the	No. We prefer an all-sector all-gases ETS.

agriculture sector? Is there anything we should change, and why?	
Question 17 Do you support the package of recommendations and actions for the forestry sector? Is there anything we should change, and why?	No. We oppose policies to regulate the levels and type of forestry.
Question 18 Do you support the package of recommendations and actions for the waste sector? Is there anything we should change, and why?	No. This seems unnecessary under an ETS.
Question 19 Do you support the package of recommendations and actions to create a multisector strategy? Is there anything we should change, and why?	Rather than creating a top down strategy a collaborative Energy Accord would be better, as set out in Part 10 of our main submission.
Question 20 Do you agree with Budget recommendation 5? Is there anything we should change, and why?	n/a
Question 21 Do you support our assessment of the country's NDC? Do you support our NDC recommendation?	n/a
Question 22 Do you support our recommendations on the form of the NDC?	n/a
Question 23 Do you support our recommendations on reporting on and meeting the NDC? Is there anything we should change, and why?	n/a
Question 24 Do you support our assessment of the possible required reductions in biogenic methane emissions?	Unsure

Appendix Two: NZIER report

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)

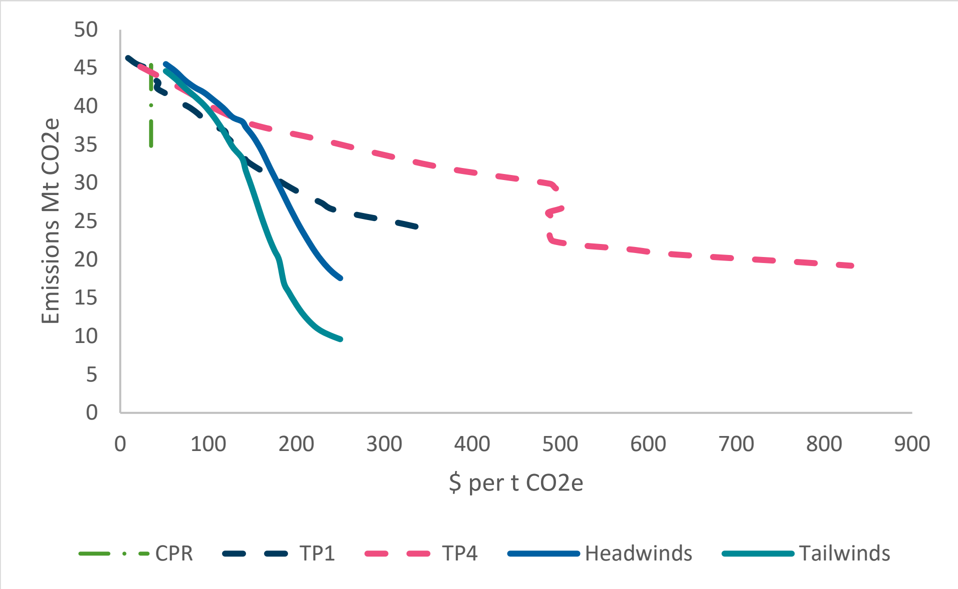
Year	ENZ Model	CPR	C-Plan			
			TP1	TP2	TP3	TP4
2025	84.21	**35.00**	32.26	32.14	44.12	111.54
2030	138.42	**35.00**	76.57	76.37	112.19	488.02
2035	160.47	**35.00**	120.81	120.47	182.84	502.97
2040	186.02	**35.00**	153.06	152.68	275.37	481.86
2045	215.65	**35.00**	213.32	212.81	394.21	521.94
2050	250.00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

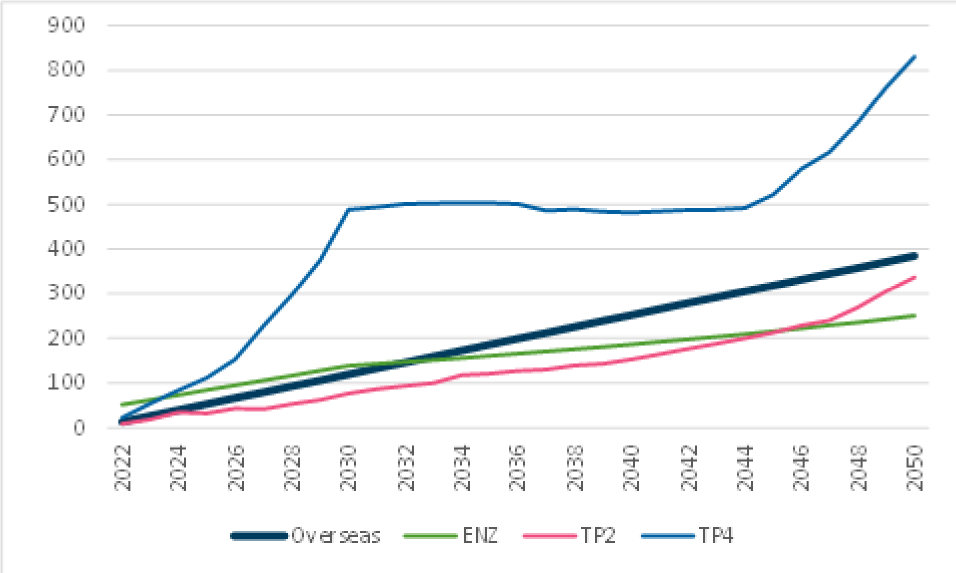
8 '31 January 2021 Draft Advice for Consultation', page 50. Low and medium temperature heat in industry and buildings could be decarbonised by 2050 through a switch away from coal, diesel and gas to electricity and biomass. Our analysis indicates that these costs could range up to $250 per tonne CO2e 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.

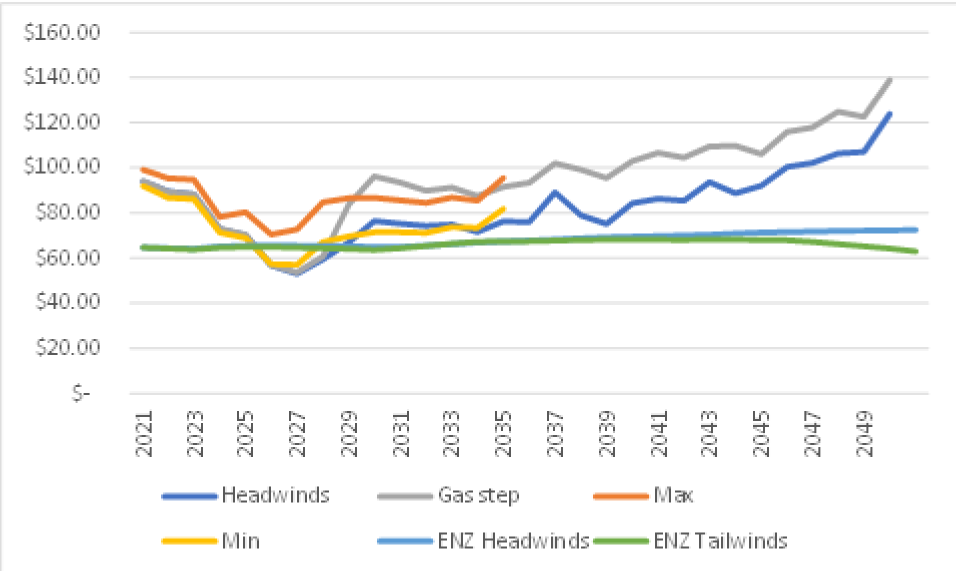
The ENZ and Energy Link modelling were both completed before November 2020 and the forecast wholesale prices are substantially below current wholesale electricity prices. The ENZ modelling specifically assumes away the issue of shortages of generation capacity.

> *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_2e)	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

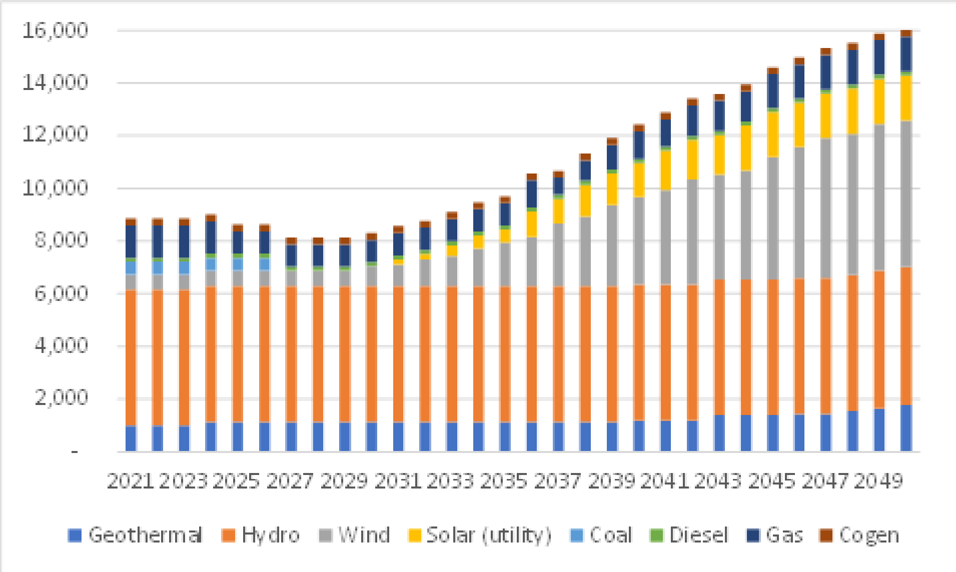
3 Average capacity factor of 23.0 percent

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, Dr. Marc Hafstead, Fellow and Director, Carbon Pricing Initiative, Resources for the Future, Washington, DC' pages 1 to 2

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,

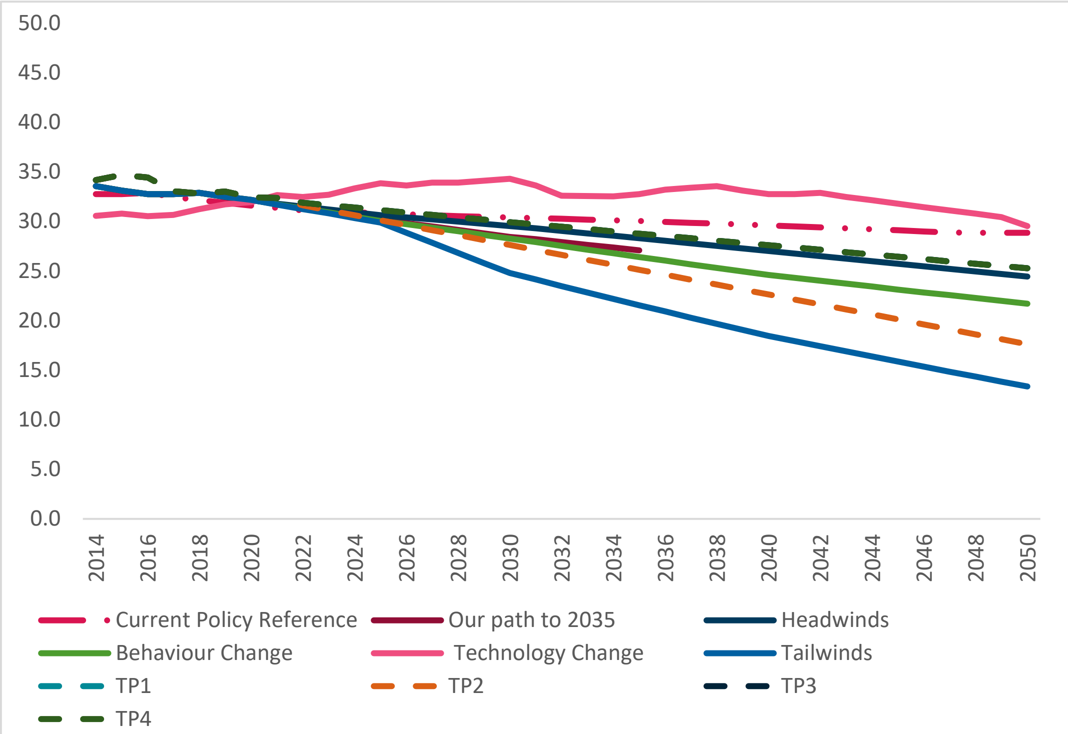
The C-Plan models impose emissions budgets (and land use) on a model of the economy with the capacity of businesses to switch fuels and adopt new technologies embedded in the production functions in the model. (The production functions use an aggregated version of the changes used in the ENZ model and 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

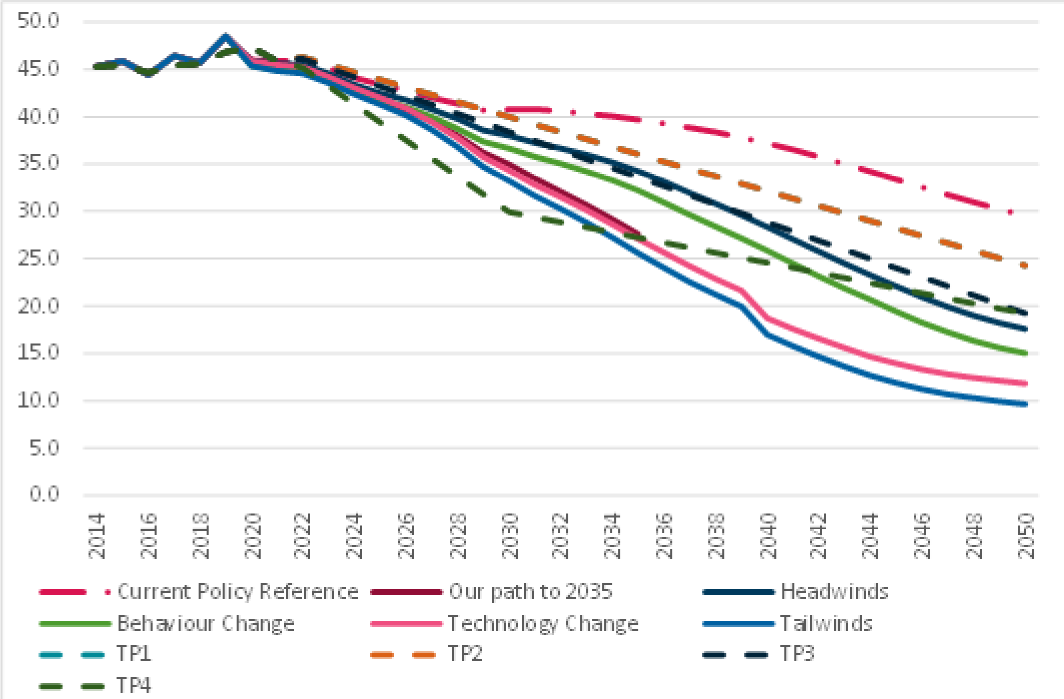


Source: Drawn from ENZ and C-Plan model outputs

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

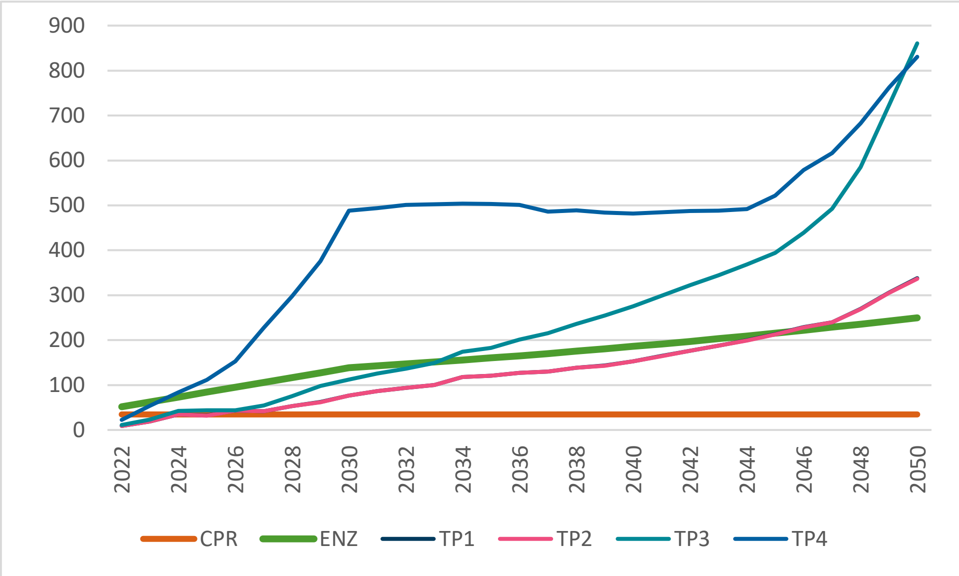


Source: Drawn from ENZ and C-Plan model outputs

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.

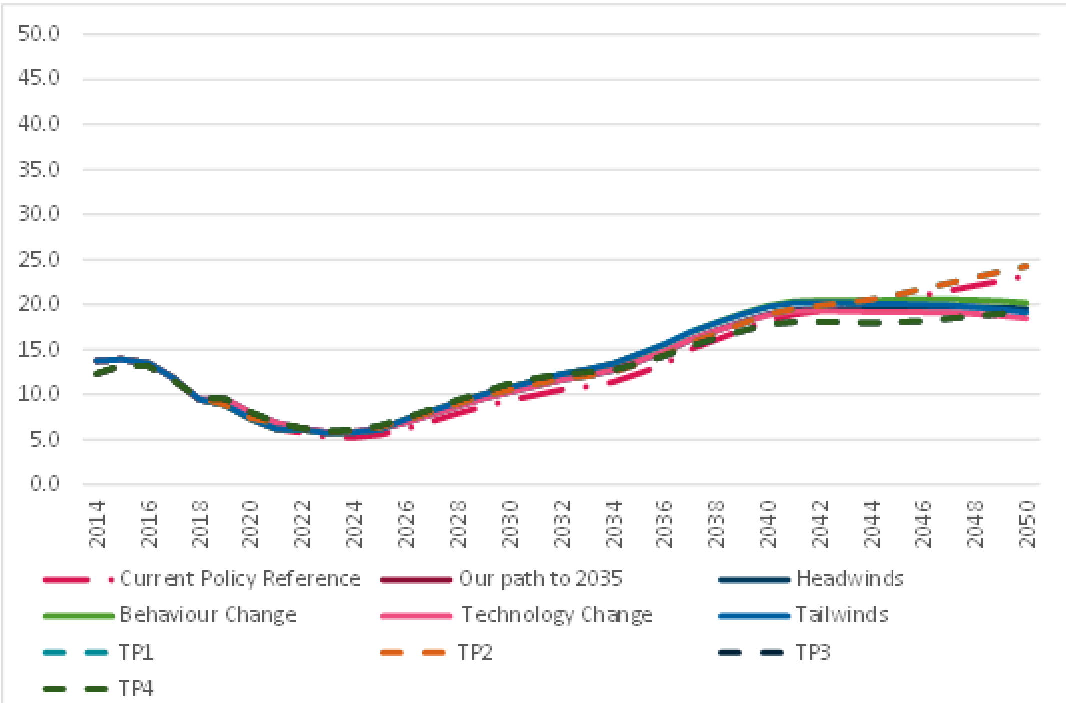
Figure Carbon price path for C-Plan scenarios and ENZ



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