Scientific analysis of compatibility of the NDC with 1.5 degrees

Date Submitted:	5/02/2020	Tracking #: 2020-B-06407	
Security Level	RESTRICTED	MfE Priority:	Non-Urgent

	Action sought:	Response by:
To Hon James Shaw, Minister for Climate Change	"note this Briefing, and agree to the recommendations	**10 February 2020**

Actions for Minister's Office Staff	**Return** the signed report to MfE.
Number of appendices and attachments # Nil	

Ministry for the Environment contacts

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Key Messages

1. As a measure of consistency with global temperature goals, MfE officials' advice adopts a comparison with the global emissions pathways as assessed by the IPCC.
2. New Zealand's NDC is a budget of roughly 601 Mt CO_2-equivalent over the 2021-2030 period.
3. We can adopt a multi-year budget or a point year target to assess consistency with global temperature goals. Both methods require simplifying assumptions and neither is perfect. To assess the compatibility of the NDC with a temperature goal, we suggest budgets are more appropriate for long-lived gases, whereas point years are more appropriate for methane. This reflects the fact that the climate impact of long-lived gases is determined by their cumulative emissions, while the impact of methane depends on the emission rate.
4. Considering all gases together as CO_2-equivalent, New Zealand's NDC is not consistent with pathways limiting warming to 1.5°C with no or limited overshoot, but is consistent with pathways limiting warming to 1.5 with no, limited or high overshoot, or 2 °C.
5. Considering all gases together as CO_2-equivalent misrepresents the warming effects of short-lived gases.
6. By splitting the gases up by their lifetimes, we get a more accurate representation of warming
7. Multi-year budgets and point year targets are two ways of communicating emissions reductions efforts. In and of themselves they do not reflect scale of ambition.

Recommendations

8. We recommend that you:

a. **Agree** that the findings presented be included in the Cabinet Paper *Updating New Zealand's Nationally Determined Contribution under the Paris Agreement*, and the accompanying S6(a)

Yes/No

b. **Agree** that this briefing and appendices will be released proactively on the Ministry for the Environment's website together with the Cabinet paper on Updating the NDC.

Yes/No

Signature

Roger Lincoln
Director, Climate

Hon James Shaw
Minister for Climate Change **Date**

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Supporting material

Purpose and context

1. S6(a) . The split-gas approach used in the Zero Carbon Act is backed by the internationally recognised science and New Zealand is the first country to legislate targets in this way.
2. You requested advice on science-based assessment of compatibility of the NDC with temperature goals, particularly the relation between an emissions budget approach and a point-year target approach.

Analysis and Advice

As a measure of consistency, we adopt comparison with the global emissions pathways as assessed by the IPCC

3. There is no internationally accepted way to compare emissions targets in the NDCs. It is valid to use global aggregate CO_2-equivalent emissions to assess overall progress (as in the UNEP Emissions Gap Report), but as discussed below, this measure is too simplistic to compare individual NDCs.
4. There is no unique emissions pathway to meet any chosen temperature goal. As a measure of consistency with a temperature goal, we adopt comparison with the set of global emissions pathways assessed in the 2018 IPCC Special Report on Global Warming of 1.5 °C (SR15). These pathways include the constraints of technical possibility, cost-effectiveness, and global development, and are assessed according to the temperature goals. Because of the range of scenarios and assumptions that must be made, we don't make definitive statements of consistency. The consistency statements in this briefing are made in the context of the type of comparison and the assumptions involved in that assessment.
5. Following the assessment in the SR15, the pathways are compared with the NDC in three groups that:
    a. Limit warming to 1.5 °C with no or limited[1] overshoot
    b. Limit warming to 1.5 °C with no, limited, or high overshoot[2]
    c. Limit warming to 2 °C.

    Overshoot implies a peak followed by a decline in global warming, achieved through net negative CO_2 emissions globally by anthropogenic removal of CO_2 from the atmosphere.
6. This assessment does not include any evaluation of New Zealand's "fair share" of global mitigation. Burden-sharing approaches can be studied using the models that produce the emission pathways, but conclusions are value-laden and out of scope of this analysis.

[1] Less than 0.1 °C

[2] In scenarios with high overshoot, warming exceeds 1.5°C by at least 0.1°C temporarily but returns to or below 1.5°C by 2100

7. Evaluating the temperature impacts of our NDC using a climate model[3] provides insight into the warming effects of the different gases, but does not significantly add to the assessment of consistency. Such an analysis highlights the strong but short-lived effects of New Zealand's high methane emissions. MfE does not currently have the capability to perform such modelling.

8. The all-gases budget approach doesn't allow consideration of the different warming effects of methane. Unlike long-lived gases, the warming effect of methane is determined by the *rate* of methane emissions, rather than the cumulative amount. For this reason, we suggest budgets are more appropriate for long-lived gas emissions targets, whereas point years are more appropriate for methane.

9. Table 1 summarises the consistency tests used to inform this note.

Considering all gases together as CO_2-equivalent, New Zealand's NDC is consistent with pathways limiting warming to 1.5 with no, limited or high overshoot, or 2 °C.

10. Using the IPCC emissions pathways consistent with the 1.5 and 2 °C warming goals, we calculated a global CO_2-equivalent 'budget' for the 2021-2030 period, and scaled this by New Zealand's fraction of net global emissions between 1990 and 2014[4]. This provides a representation of New Zealand-specific budgets over the 2021-2030 period in each scenario. We do not necessarily endorse the implied burden-sharing approach. We also emphasise that the all-gases approach does not accurately represent New Zealand's expected contribution to climate change.

11. For these emissions budget estimates, we present the median value for each scenario group, the full range, and the central (interquartile) range in square brackets. The interquartile ranges were widely used in the IPCC SR15, and we assess the NDC to be consistent with a scenario group if it falls within this range.

12. The 36 pathways consistent with the 1.5 °C goal with no or limited overshoot imply a median 2021-2030 budget for New Zealand of 516 Mt CO_2-e, with a range of 406 – 612 [490-529] Mt CO_2-e. The NDC budget for this period is 601 Mt CO_2-e. By this measure, New Zealand's NDC is not consistent with the global pathways limiting warming to 1.5 °C with no or limited overshoot, because it lies well outside the central range of pathways.

13. The 68 pathways consistent with the 1.5 °C goal with no, low or high overshoot imply a median 2021-2030 budget for New Zealand of 553 Mt CO_2-e, with a range of 406 – 802 [509-647] Mt CO_2-e. The NDC budget for this period is 601 Mt CO_2-e. By this measure, New Zealand's NDC is consistent with the global pathways limiting warming to 1.5 °C with a temporary overshoot.

14. The 101 pathways consistent with the 2 °C goal imply a median 2021-2030 budget for New Zealand of 631 Mt CO_2-e, with a range of 465 – 821 [571-686] Mt CO_2-e. By this measure, New Zealand's NDC is consistent with the global pathways limiting warming to 2 °C.

[3] For example, as was presented for the ZCB targets in the NZAGRC submission from to the Select Committee process (https://www.parliament.nz/en/pb/sc/submissions-and-advice/document/52SCEN_EVI_87861_EN6883/andy-reisinger)

[4] Estimated using the World Resources Institute CAIT data set

All-gases accounting misrepresents the warming effects of short-lived gases

15. Methane is a short-lived greenhouse gas, so the relationship between emissions and warming is fundamentally different to that for long-lived gases (LLGs) like carbon dioxide and nitrous oxide. The metrics used to combine different gases into CO_2-equivalent always represent this relationship imperfectly in some way.

16. The internationally agreed metric for converting missions to CO_2-equivalent is the 100-year Global Warming Potential (GWP100). GWP100 represents both the heating effect of a gas and its persistence in the atmosphere, over 100 years.

17. The GWP100 metric does not accurately reflect the warming contribution of short-lived gases[5]. This is particularly true for the expected pathway of reducing methane emissions: the all-gases CO_2-equivalent comparison represents this as an ongoing increase in cumulative emissions that would contribute to further warming, whereas in fact it contributes a cooling effect to global climate.

18. Due to New Zealand's high proportion of methane in our emissions profile, an all-gases approach does not adequately reflect the contribution of our NDC to global warming and can lead to invalid assessments of our ambition.

By splitting the gases up by their lifetimes, we get a more accurate representation of warming

19. The ZCA has separate 2050 targets for biogenic methane (bCH4) and all other gases (in this note, we will use "all other gases" and LLGs interchangeably). It also legislates a target for bCH4 of 10% below 2017 levels by 2030. This constrains the way in which New Zealand will meet its NDC.

20. In meeting our emissions targets, New Zealand will reduce bCH4 emissions by at least 10% by 2030 and reduce LLGs by (at least) the amount necessary to remain within the remaining NDC budget over the 2021-2030 period.

21. The total estimated 2021-2030 emissions budget implied by the NDC is 601 Mt CO_2-e. If bCH4 emissions fall from the currently projected level in 2021 to the target level of 10% below 2017 levels in 2030, the total bCH4 emissions will be about 311 Mt CO_2-e. The remaining budget for LLGs is therefore about 290 Mt CO_2-e. We compared these reductions in bCH4 and LLGs to analogous emissions in the IPCC SR15 pathways.

22. The 2030 methane target of 10% below 2017 levels is just outside the 2030 central range in the IPCC 1.5 °C pathways of -11 to -30%. Considering the uncertainty in estimating these emissions, it is reasonable to say that this target is consistent with the 1.5°C pathways with no or limited overshoot.

23. The 33 pathways consistent with the 1.5 °C goal with no or limited overshoot imply a median 2021-2030 LLG budget for New Zealand of 252 Mt CO_2-e, with a range of 189 – 302 [235-261] Mt CO_2-e. The implied NDC budget for LLGs for this period is 290 Mt CO_2-e. By this measure, New Zealand's NDC is not consistent with the global pathways limiting warming to 1.5 °C with no or limited overshoot.

24. The 68 pathways consistent with the 1.5 °C goal with no, limited or high overshoot imply a median 2021-2030 budget for long-lived gases New Zealand of 272 Mt CO_2-e, with a range of 189-397 [250-323] Mt CO_2-e. By this measure, New Zealand's NDC is consistent with the global pathways limiting warming to 1.5 °C with a temporary overshoot.

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[5] See the IPCC Special Report on Global warming of 1.5 °C, cross-chapter box 2 *Measuring Progress to Net Zero Emissions Combining Long-Lived and Short-Lived Climate Forcers*

25. The 101 pathways consistent with the 2 °C goal imply a median 2021-2030 budget for New Zealand of 316 Mt CO_2-e, with a range of 234-410 [286-345] Mt CO_2-e. By this measure, New Zealand's NDC is consistent with the global pathways limiting warming to 2 °C.

26. Assessed using a 2021-2030 budget approach, as in the all-gases analysis above, New Zealand's LLG emissions trajectory to meet the NDC target is consistent with the 1.5 °C pathways with higher overshoot. As the point-year bCH_4 target is also consistent, the NDC is consistent with these pathways.

Multi-year budgets and point year targets are two ways of communicating emissions reductions efforts. In and of themselves they do not reflect scale of ambition

27. The ambition of an emissions reduction target is independent of the methodology used to describe the target. Both emissions budgets and point year targets can be used to communicate ambitious or unambitious climate action. Although a budget approach puts a limit on emission across multiple years, putting a tighter constraint on an emissions reduction target than a point year target, of a budget approach doesn't necessarily imply ambition.

28. Point year percentage reductions are only representative of reductions in one given year (i.e. the endpoint) and actual reductions involved in meeting them are sensitive to the reference year, whereas emissions budgets represent cumulative emissions across a period of time.

29. The choice of reference year can dramatically change the reductions necessary to meet a point year target. For example, if the chosen base year is a year with high forestry removals (e.g. 2010), emissions reductions in 2030 are likely to be smaller relative to the base year than if a base year with low forestry removals is used (e.g. 2015). For this reason emissions budgets are more revealing of the climate impacts of a target, but conclusions of ambition cannot be based purely on the choice of target framing.

30. New Zealand's NDC is consistent with global temperature goals when split-gas point year targets are compared to those in the IPCC pathways limiting warming to 1.5°C with no or limited overshoot, while it is not consistent when compared as an emissions budget. However, the NDC is consistent with pathways limiting warming to 1.5°C with no, limited or high overshoot regardless of the method of comparison used here.

Table 1. Summary of all consistency tests used to inform this note. New Zealand's NDC is consistent with 1.5°C pathways using a split-gases, point year approach.

Approach	Scenarios	Conclusion
2021-2030 budget - all gases NDC budget 601 Mt CO_2-e		
1.5°C no or limited overshoot	36 scenarios	Global range 406-612 [490-529] Mt CO2-e Not consistent
1.5°C no, limited and high overshoot	68 scenarios	Global range 406-802 [509-647] Mt CO2-e Consistent
2°C	101 scenarios	Global range 465-821 [571-686] Mt CO2-e Consistent

2021-2030 budget - split gases All other gases: 2021-2030 budget 290 Mt CO_2-e		
1.5°C no or limited overshoot	33 scenarios	Global range 189-302 [235-261] Mt CO2-e Not consistent
1.5°C no, limited and high overshoot	68 scenarios	Global range 189-397 [250-323] Mt CO2-e Consistent
2°C	101 scenarios	Global range 234-410 [286-345] Mt CO2-e Consistent
2030 below 2010 point year – all gases All gases: -23%		
1.5°C no or limited overshoot	36 scenarios	Central range -39% to -50% Not consistent
1.5°C no, limited and high overshoot	68 scenarios	Central Range -20% to -46% Consistent
2°C	101 scenarios	Central range-5% to -33% Consistent
2030 below 2010 point year – split gases bCH4: -10% All other gases: -35%		
1.5°C no or limited overshoot	33 scenarios	bCH4: -11% to -30% other: -39% to -54% Not consistent
1.5°C no, limited and high overshoot	68 scenarios	bCH4: +4% to -20% other: -18% to -46% Consistent
2°C	101 scenarios	bCH4: +8% to -16% other: -3% to -32% Consistent

Assumptions

- For the all-gases tests, we used an NDC 2021-2030 budget of 601 Mt CO2-e
- For split-gas tests, we assumed biogenic methane decreases linearly from 2020 to the 2030 ZCA target of 10% below 2017 levels.
- We subtracted cumulative biogenic methane emissions from 2021-2030 from the total NDC budget to get an 'other gases' budget of 290 Mt CO2-e.
- For the budgets, entire ranges are given with central (interquartile) ranges in square brackets. For the point years, only central (interquartile) ranges are given