Aotearoa New Zealand's biogenic methane target:

1.5°C demands the highest possible ambition



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Report prepared by:

Kristen Green, Director – Kapiti Climate Insights

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Contact:

Queries related to the report should be directed to:

- **Kapiti Climate Insights**: Kristen Green, kristen@kapiticlimate.com
- **Lawyers for Climate Action NZ**: Jessica Palairet, jessica@lawyersforclimateaction.nz

Declaration:

The author of this report declares no active conflicts of interest. Kristen was previously employed by the New Zealand Government in roles related to the design of policies to mitigate greenhouse gas emissions from agriculture, forestry, and land-use (2019-2023), and New Zealand's climate change targets (2013-2016).

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Summary

Reducing methane emissions is crucial for meeting the Paris Agreement's temperature goal of limiting warming to well below 2°C and pursuing efforts to limit warming to 1.5°C. The powerful warming effect of methane coupled with its relatively short lifetime in the atmosphere means that it plays a crucial role in limiting peak temperatures over the coming decades. Reducing methane emissions is particularly important for Aotearoa New Zealand, as biogenic methane emissions have contributed around two-thirds of New Zealand's warming to date.

The Climate Change Response Act 2002 (the Act or CCRA) is the framework guiding New Zealand's contribution to global efforts limiting warming to 1.5°C and sets out its current biogenic methane target of 24-47% below 2017 emissions by 2050. Recently, agricultural industry groups have lobbied to lower this target range to one consistent with achieving 'no additional warming' from biogenic methane (Beef+Lamb NZ, DairyNZ, and Federated Farmers, 2023; DairyNZ, 2023; Federated Farmers, 2024).

In response, the Government appointed an "*independent panel*" in June 2024 to review the current target "*for consistency with no additional warming*" (McClay and Watts, 2024; McClay *et al.*, 2024), seeking recommendations for targets that achieve 'no additional warming' from biogenic methane above levels contributed in 2017. While the Terms of Reference for the panel acknowledges critical considerations of equity and fairness, it explicitly excludes such considerations from the panel's work.

The risk from this process is that the independent panel's recommendations may be perceived as being consistent with climate science and global efforts but without these considerations of equity, fairness and ambition needed for 1.5°C being squarely addressed.

To fill this gap, this report thus examines:

- What constitutes ‘no additional warming,’ and how this relates to concepts such as ‘climate neutral’ and ‘temperature neutrality’, and the metric GWP*.
- The implications of pursuing a 'no additional warming' target relative to 2017.
- How ‘no additional warming’ targets compare to global efforts needed to limit warming to 1.5°C, and progress on warming by other developed countries.
- Equity considerations between countries and sectors.
- The feasibility of New Zealand’s current target range.
- Trade and reputational implications.

Key findings:

1 No additional warming is not a scientific principle, but a political choice that allows targets that necessitate only gradual reductions in methane emissions. It is inappropriate and dangerous to imply that it aligns with global scientific understanding of reductions in emissions necessary for 1.5°C, or that it is ethically defensible.

2 Global pathways for limiting warming to 1.5°C require reductions of all GHGs as rapidly as possible. Whether a country’s efforts on a particular gas result in some additional warming, no additional warming or reduced warming is a function of the properties of that gas, and the circumstances of that country. For methane, its short lifetime means that even small reductions can achieve ‘no additional warming,’ yet this outcome bears no correlation to efforts reflecting the highest possible ambition demanded by the Paris Agreement.

3 Using the principle of ‘no additional warming’ as a cap on our level of ambition for methane reductions is an arbitrary constraint on the principle embedded in scientific literature that emissions of all greenhouse gas emissions must fall

as rapidly as possible. As such, it runs counter to the Paris Agreement's core temperature goals, as well as its requirements for targets which progressively increase ambition over time, and pursuit of the highest possible ambition in domestic mitigation measures. Adopting a self-serving and arbitrary limit on our level of ambition also risks weakening international norms and encouraging other counties to similarly shirk their responsibilities, in which case the goals of the Paris Agreement will fail.

4 As New Zealand's domestic budgets and NDCs are set based on all gases combined, a reduction in ambition for biogenic methane will likely necessitate greater reductions for other gases. No analysis has been undertaken on the impacts of this burden placed elsewhere within the economy. A reduction of the current target to 'no additional warming' would also necessitate taking a negative emissions target for other gases by 2050 to avoid backsliding on current committed efforts in warming terms.

5 Adopting a 'no additional warming' target would allow New Zealand to maintain its current share of warming from methane into the future. As such, it is self-serving for New Zealand and unfair for others – particularly in the Global South. Given global temperatures have already risen by 1.06°C from pre-industrial levels (Gulev *et al.*, 2021), this approach shifts the burden of reductions in GHG emissions to other sectors and countries. It privileges countries with developed agricultural sectors and penalises low-income nations who are still developing their food systems in the face of increasing food security challenges.

6 It is entirely possible for New Zealand to make meaningful reductions in biogenic methane emissions - several developed countries have already achieved reductions in biogenic methane sufficient to decrease their warming since 2000. The choice to limit ambition to maintaining warming at 2017 levels is arbitrary and misaligned with what peer countries with advanced agricultural

sectors have achieved. Evidence suggests emissions reductions greater than that needed for ‘no additional warming’ are also feasible under plausible technology scenarios for New Zealand out to 2050.

7 Reducing ambition risks disrupting trade arrangements, breaching trade agreements (including the NZ/EU FTA), and damaging New Zealand's reputation for sustainable agricultural exports. It may ultimately backfire as a measure to protect current production, as it will harm New Zealand’s brand and risks placing exporters at a disadvantage compared to housed farming systems overseas competing for FMCG contracts where climate requirements are part of terms of supply.

Methods

1 This report draws on a comprehensive literature review of research focused on the warming effects of methane, the concept of 'no additional warming', equity considerations for climate targets, and GHG metrics.

2 The Finite Amplitude Impulse Response (FaIR) model is used to examine warming implications of choices for New Zealand's 2050 target. Specifically, the model is used to help evaluate:

   a. Warming contributed from New Zealand's past and future emissions.
   b. How New Zealand's warming contribution compares to other countries.
   c. Warming outcomes under different global pathways consistent with 1.5°C (reflecting methane's nature as a reactive GHG).

3 Background global emissions scenarios run through FaIR (Table 1) draw on reference scenarios from Working Group 3 of the IPCC's Sixth Assessment Report (AR6) (Byers *et al.*, 2022; IPCC, 2023). Further details on methods and datasets used can be found in the accompanying technical appendix.

Table 1: Background global emissions scenarios used in FaIR

Scenario name	Model & scenario in AR6 database	Warming to 2100	Purpose in report
C7_Current_Policies	**GCAM 5.3:** NGFS2_Current Policies	C7: Warming of <4°C	Reflect current international policy efforts through to today.
C1_1.5_REN	**REMIND-MAgPIE 2.1-4.3:** DeepElec_SSP2_ HighRE_Budg900	C1: 1.5°C (limited or no overshoot)	Consistent with CCRA purpose, with global emphasis on early energy transition.
C1_1.5_SP	**REMIND-MAgPIE 2.1-4.2:** SusDev_SDP-PkBudg1000	C1: 1.5°C (limited or no overshoot)	Consistent with CCRA purpose, with emphasis on emissions from land-use.

1) Why methane matters

1.1 Methane's warming effect as a short-lived GHG

Key takeaways

- Temperatures have risen by 1.06°C since pre-industrial levels.
- Methane is the second largest contributor to this warming at 0.5°C, with biogenic methane responsible for 0.29°C warming.
- Changes in the rate of methane emissions can have a substantial impact on sustained warming given its short-lived nature and powerful effect.
- Recent global agricultural methane trends are off-track from both 1.5°C and below 2°C pathways.

4 Globally, GHG emissions from human activities have caused average surface temperatures to rise an estimated 1.06°C during 2010-2019 relative to pre-industrial levels (0.88-1.21°C, 5-95 percent confidence interval) (Gulev *et al.*, 2021). More recent observations indicate further warming, with the World Meteorological Organization reporting temperatures approximately 1.45°C above pre-industrial levels in 2023 (WMO, 2024), with a likely (80%) chance that at least one year between 2024-2028 will exceed 1.5°C.

5 Methane (CH_4) emissions have provided the second largest contribution to this warming after carbon dioxide (CO_2), contributing around 0.5°C to present-day warming (IPCC, 2021b; Reisinger, 2024; Shindell *et al.*, 2024). Sources of anthropogenic methane can be broadly classified into two categories: biogenic (e.g., from ruminant animals and decaying organic waste) and fossil methane (e.g., from gas infrastructure leaks). In New Zealand, biogenic sources account

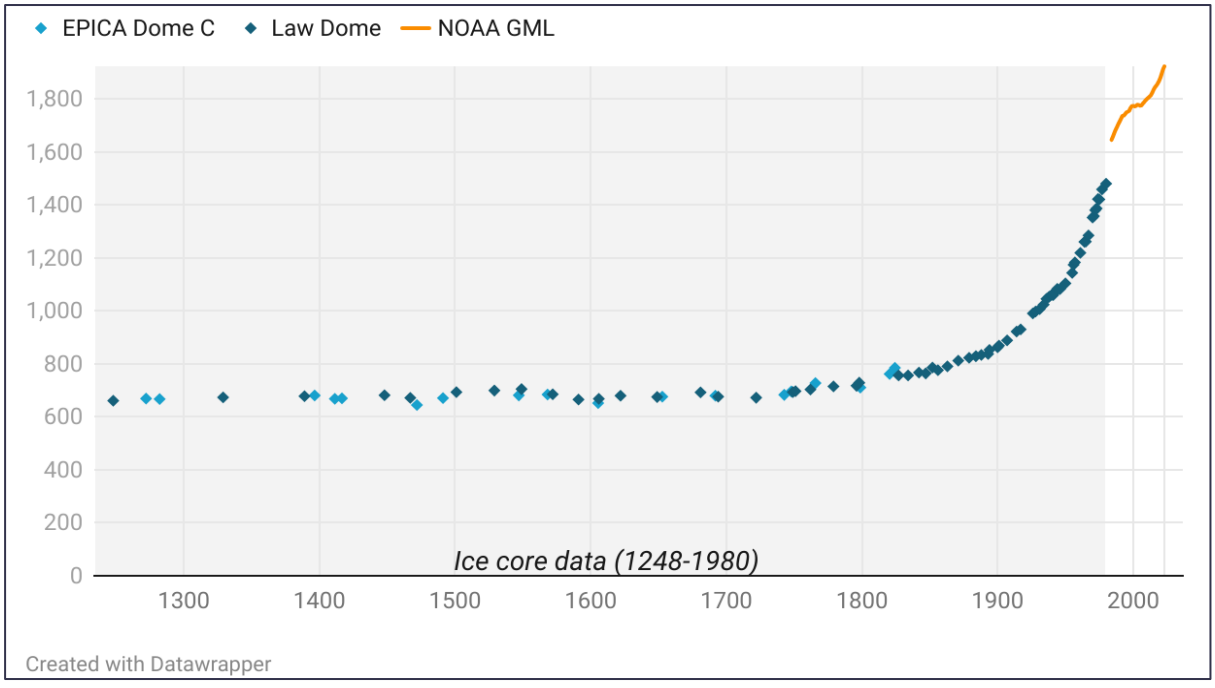
for 98% of methane emissions, while globally these sources are responsible for an estimated 0.29°C of present-day warming (Reisinger, 2024).

6 Methane possesses a relatively short lifetime in the atmosphere, largely disappearing from the atmosphere within the 50 years after it is emitted, though with some warming remaining for more than a century (Reisinger, 2018, 2024).

7 This means that methane behaves like a flow-pollutant (Allen *et al.*, 2018; Lynch *et al.*, 2021; Prudhomme *et al.*, 2021), where warming results from the sustained rate of emissions each year (Rogelj and Schleussner, 2019; Lynch *et al.*, 2021; Tanaka *et al.*, 2021). This contrasts with long-lived GHGs such as CO_2 that function as stock-pollutants, where each new tonne emitted accumulates in the atmosphere (Allen *et al.*, 2018; Meinshausen and Nicholls, 2022).

8 Despite its short lifetime, increasing emissions since pre-industrial times have contributed to a significant increase in concentrations of methane in the atmosphere (**Figure 1**).

Figure 1: Estimates of global atmospheric methane concentrations (parts per billion, ppb CH_4) 1248-2023 from ice core data (EPICA Dome C & Law Dome) and air sampling (NOAA GML)

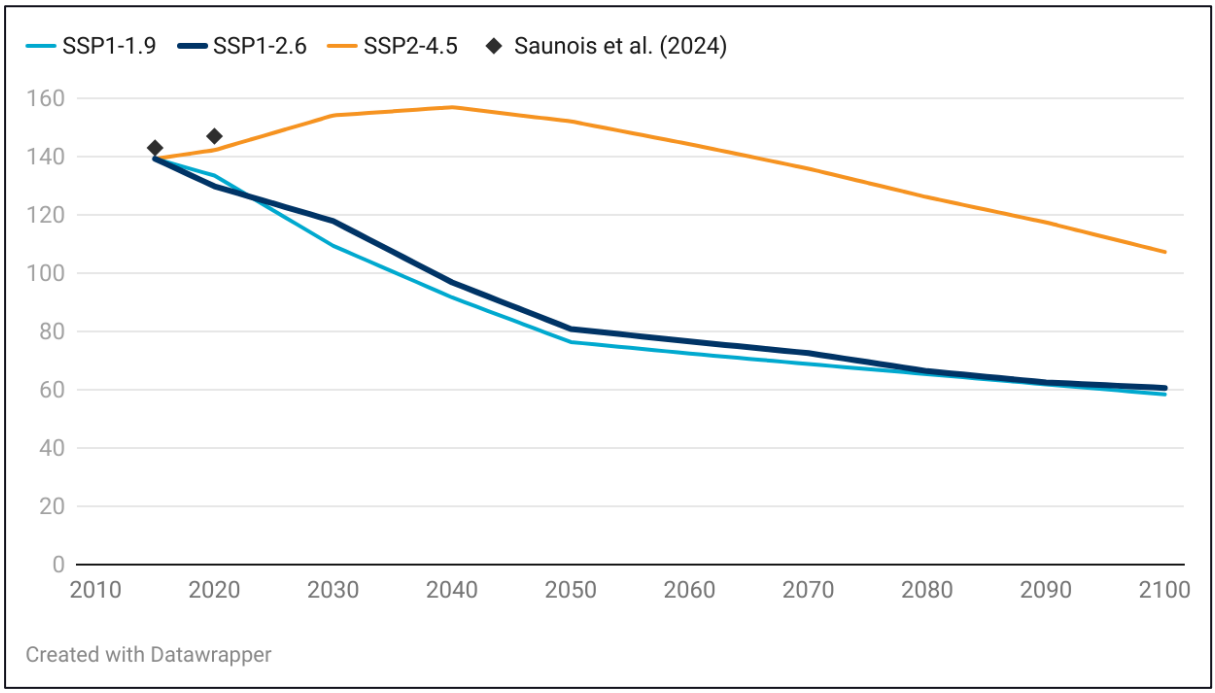


Source: Etheridge *et al.*, 2002; Bereiter *et al.*, 2015; Lan, Thoning and Dlugokencky, 2024

9 Methane's sizeable role in warming to date stems from its powerful forcing effect - over 80 times that of carbon dioxide during the first 20 years after emission (Institute for Governance & Sustainable Development, 2023). This warming effect of methane is why the IPCC has recommended strong, rapid, and sustained reductions in methane emissions (IPCC, 2021, 2023b).

10 Methane's nature as a flow-pollutant coupled with its large warming impact mean that changes in the rate of emissions can have a large and immediate impact on observed warming, with decreases in the rate of methane leading to a reduction in sustained warming. However, recent trends in agricultural methane emissions have diverged from pathways consistent with limiting warming to 1.5°C or 2°C (**Figure 2**).

Figure 2: Estimates of recent global agricultural emissions (million tonnes CH_4) (Saunois *et al.*, 2024) compared to CMIP6 pathways consistent with 1.5°C (SSP1-1.9), <2°C (SSP1-2.6) and above 2°C (SSP2-4.5)



Source: Gidden *et al.*, 2019; Saunois *et al.*, 2024

1.2 Methane emissions in New Zealand

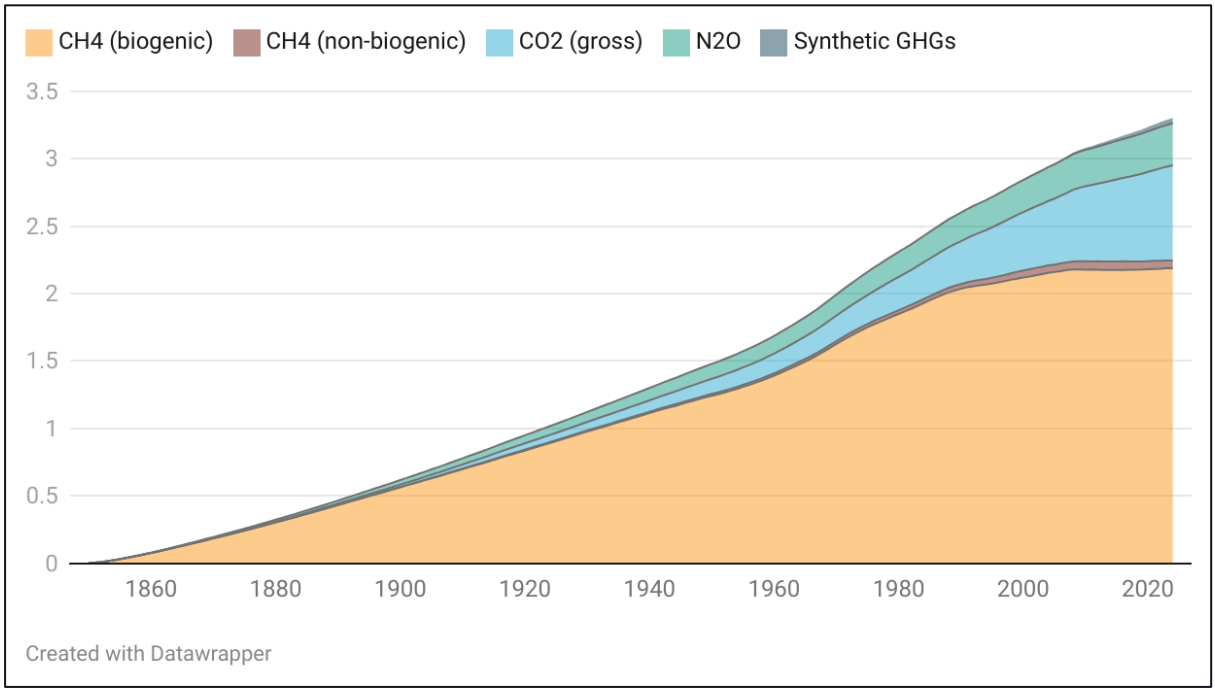
Key takeaways

- New Zealand's methane emissions made up 48% of its gross emissions in 2022, and two-thirds of contributed warming to date.

11 Using the predominant GHG metric used globally, GWP_{100}, biogenic methane emissions made up 48% of New Zealand's gross emissions in 2022 (MfE, 2024a). Historically however, biogenic methane has made up an even greater share of this profile, contributing upwards of 80% of New Zealand's gross emissions in the 19th century (Commission, 2024b).

12 This significance is also reflected in warming terms, with biogenic methane emissions responsible for 66% of New Zealand's present-day contribution to warming from gross emissions (3.2m°C). Additional year-on-year warming from biogenic methane has slowed more recently thanks to agricultural emissions peaking and waste CH_4 reducing in the 2010s, as illustrated in **Figure 3.**

Figure 3: Warming (m°C) from New Zealand's gross GHG emissions (1850-2024)



Background scenario: C7_Current_Policies

1.3 Reflecting the warming effects of methane through metrics or separate communication

Key takeaways

- GWP_{100} remains the predominant GHG metric used globally, though its use presents ambiguous warming outcomes for economy-wide targets.
- Differences in warming effect for short-lived GHGs can be addressed through separate communication of efforts or alternative metrics. New Zealand's split-gas domestic targets are an example of the first approach.
- GWP* does not imply that countries should aim for 'no additional warming' from methane.

13 New Zealand's targets and emissions budgets under the CCRA are set using a metric called GWP_{100} - the agreed metric for reporting emissions under the Paris Agreement and inventories under the UNFCCC (Rogelj and Schleussner, 2021).

14 GWP_{100} compares emissions of different GHGs to CO_2 based on their forcing effect over 100-years; and enables evaluation of different mitigation actions at a global, national, and local level (Cain *et al.*, 2021; Meinshausen and Nicholls, 2022). GWP_{100} is also used for life-cycle assessments of products, consumption patterns, and emissions from organisations (Barnsley *et al.*, 2021; Edwards and Trancik, 2022; Hörtenhuber *et al.*, 2022).

15 However, some researchers have highlighted that using GWP_{100} within multi-gas targets can present ambiguous warming outcomes for short-lived GHGs like methane (Tanaka and O'Neill, 2018; Sun *et al.*, 2021; Allen *et al.*, 2022), and risks distracting from pursuit of net-zero CO_2 needed to limit further warming (Lynch *et al.*, 2021). This has led to two main suggestions in climate literature for addressing these limitations:

a. Using alternative metrics in targets and policies, with GWP* being a prominent example (see breakout box – page 15-16).
b. Using the conventional GWP_{100} metric for policies and targets but communicating efforts on short- and long-lived GHGs separately.

16 The latter approach of communicating how efforts on short- and long-lived GHGs contribute to overall emissions reductions *within* comprehensive all-gases NDCs has seen broad support among researchers (Denison, Forster and Smith, 2019; Allen *et al.*, 2022; Becken *et al.*, 2024), as it enables proper assessment of warming outcomes in global stocktakes under the Paris Agreement. New Zealand's framework of split-gas domestic targets, operating within its all-gases NDC, aligns with this approach of transparent communication while maintaining comprehensive coverage.

17 This framework also highlights the important distinct contributions that New Zealand can make on both short- and long-lived GHGs under its all-gases NDCs. For example, under this approach it is possible to evaluate outcomes from New Zealand's largest source of short-lived GHGs (critical to limiting overshoot of 1.5°C, and slowing year-on-year warming), and the timing of net-zero long-lived GHGs (critical to ceasing further warming and assessment of the world's remaining carbon budget).[1]

18 However, neither GWP* nor split-gas approaches imply specific policy objectives at a national or subnational level for short-lived GHGs. Just as GWP* within policy architecture does not imply that countries or sectors should pursue net-zero warming-equivalent emissions (Cain *et al.*, 2021), neither should separate

[1] Such transparency could be furthered improved upon with communication of the breakdown of New Zealand's five-yearly emissions budgets between short- and long-lived GHGs as part of its next NDC, and communication of efforts broken down by gross emissions and removals.

targets for short-lived GHGs treat the equivalent aim of ‘no additional warming’ as if it were a logical objective rooted in science.

19 Instead, with temperatures already approaching 1.5°C (WMO, 2024), mitigation efforts on short-lived GHGs must be maximised if the world is to remain below 2°C and minimise overshoot of 1.5°C. In this context, principles like ‘no additional warming’ that arbitrarily limit ambition will only increase this overshoot and hamper efforts to bring warming back to 1.5°C.

Breakout box: What is GWP*?

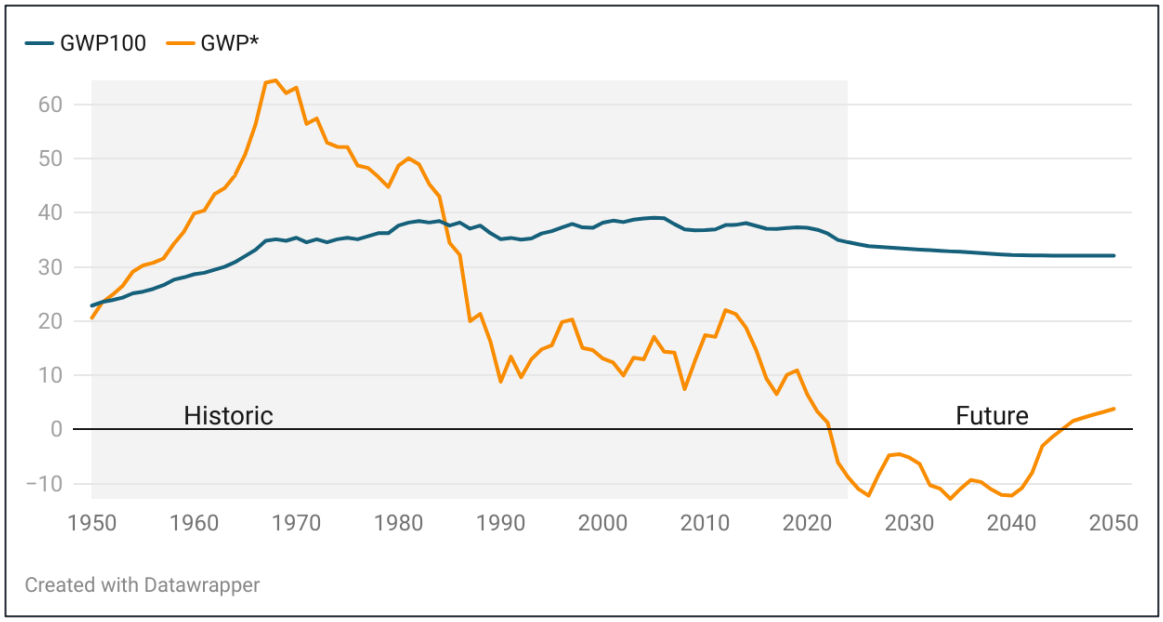
Another metric commonly used in debates on methane is GWP* - an approach closely related to the concept of ‘no additional warming.’ GWP* equates the warming effect of short-lived GHGs to CO_2 based on changes in emission rates for short-lived GHGs over time (Cain *et al.*, 2019). As it compares an entity’s current emissions to historical levels (20-years prior), an entity's GWP* emissions ($CO_{2\text{-we}}$) depend on their past emissions.

Countries that have high historical methane emissions can achieve near net-zero GWP* emissions by maintaining constant methane emissions, or net-zero by slightly reducing these relative to 20-years ago. This has led to criticism that GWP* can inadvertently grandparent existing warming shares (Rogelj and Schleussner, 2019, 2021), particularly where it is inferred that net-zero $CO_{2\text{-we}}$ (reflecting ‘no additional warming’) is a logical goal for countries or companies.

For example, New Zealand’s high historical CH_4 emissions mean that negative $CO_{2\text{-we}}$ emissions will be achieved ahead of 2030 under current policies, whereas when

accounted for with GWP_{100}, these represent a 9.9% reduction by 2030, and 13.2% by 2050 (MfE, 2024b). This is shown in **Figure 4** below.

Figure 4: New Zealand's biogenic methane emissions (1950-2050) for current ERP2 projections under GWP_{100} (Mt $CO_{2\text{-}e}$) and GWP* (Mt $CO_{2\text{-}we}$)[2]



1.4 What does 'no additional warming' mean?

Key takeaways

- No additional warming targets and related concepts of 'climate neutral' and 'temperature neutrality' imply that emissions year-on-year do not add further warming than has already been contributed by an entity.
- A country's choice on how far it limits warming (such as to its warming contributed in 1990 or 2017) requires ethical consideration of fair-share and cannot be answered by climate science.
- The extent that a country grandparents its share of contributed warming from historical emissions also requires ethical consideration of fair-share.

[2] GWP* calculation method adapted from Smith *et al.* (2021). AR6 100-year period GWP for biogenic methane of 27.2 is used for calculation of GWP_{100} and GWP*.

20 Following research on new metrics for valuing short-lived GHGs, some researchers and agricultural industry groups have promoted concepts of 'no additional warming', 'temperature neutrality' (Wheatley, 2023), and ‘climate neutrality’ (Prudhomme *et al.*, 2021; Ridoutt, 2024). These terms have been explored for both national targets (Barth *et al.*, 2023; Wheatley, 2023; McClay and Watts, 2024; McClay *et al.*, 2024), and industry claims in countries such as the USA, Australia, and New Zealand (Elgin, 2021; Donnison and Murphy-Bokern, 2023; Brown, 2024; Ridoutt, 2024).

21 These concepts aim to reflect methane's short-lived nature by halting year-on-year increases in warming from continued emissions. These concepts are often also closely related to GWP*, which has been used to support such claims (Donnison and Murphy-Bokern, 2023; Wheatley, 2023; Brown, 2024).

22 However, methane's nature as a flow gas means that a ‘no additional warming’ approach risks unfairness among countries. Countries with developed agricultural sectors may find it easy to cease further warming while maintaining current production levels. In contrast, an equally efficient producer in a developing country with a rising domestic population may find such claims out of reach. Hence, as Prudhomme *et al.* (2021, p. 12) suggests:

> *“territorial climate neutrality may not be an appropriate target for many countries – for some it is too ambitious, for others it is insufficiently ambitious.”*

23 While recent research funded by Beef+Lamb NZ, DairyNZ and Federated Farmers (Barth *et al.*, 2023) proposed limiting warming at ‘current’ levels, this holds no special status when considered against climate science or equity perspectives. New Zealand could just as plausibly pursue stabilisation at earlier historical

levels, such as those contributed in 1990 (Green, 2024) or aim to reduce its warming amount by a certain percent below current levels.

24 Likewise, evaluating warming from both historical and future emissions together tends to benefit countries that have already increased their emissions, leading to suggestions that it can be fairer to evaluate ambition based on warming outcomes from future emissions alone (Rogelj and Schleussner, 2019).

25 Promotion of ‘no additional warming’ targets as ambitious efforts by developed countries also risks missed reduction potential. Key mitigation measures like methane inhibitors (Dijkstra *et al.*, 2018; Kebreab *et al.*, 2023), and dietary changes (Bryngelsson *et al.*, 2016; Pérez-Domínguez *et al.*, 2021) can present potential mitigation greater than that needed for ‘no additional warming’.

26 Thus, countries or sub-national entities seeking to frame targets around warming outcomes must necessarily respond to three core questions:

a. What level will warming be limited at or reduced to?
b. Will warming be considered for past and historical emissions together, or future emissions alone?
c. Why do these choices together reflect an ambitious, fair, and reasonable contribution to global efforts towards 1.5°C?

27 These fundamental choices—whether to evaluate warming from historical and future emissions together or future emissions alone, and which reference point to target—require careful reflection on New Zealand's specific circumstances and broader equity considerations. This goes beyond what physical science alone can resolve (Allen *et al.*, 2022; Lecocq and Winkler, 2024) and requires grappling with New Zealand's responsibilities as a developed nation with a unique emissions profile.

2) Warming outcomes from varying action on biogenic methane

2.1 What does the current target range mean for warming?

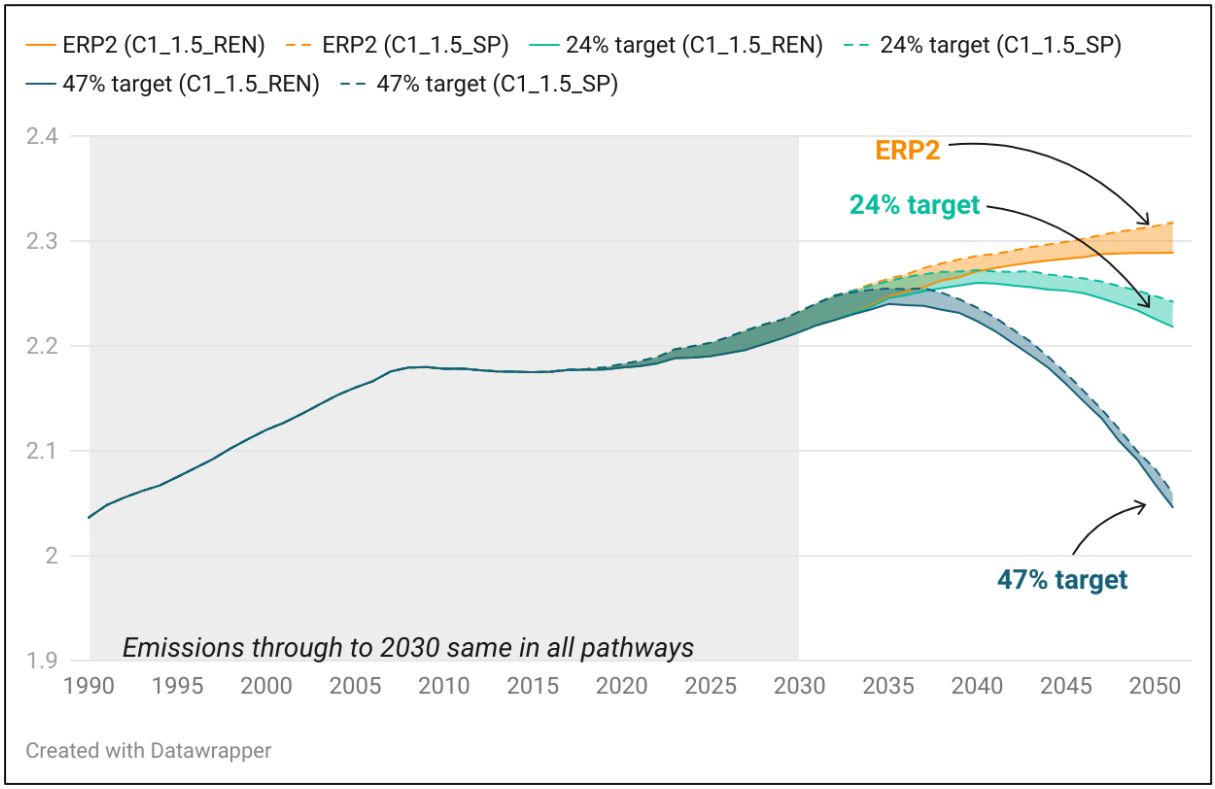
Key takeaways

- Limiting warming to 2017 levels represents lower ambition than using older reference years (e.g., 1990) given New Zealand's sustained warming increased by 7.4% over this period.
- Current policy efforts under the draft ERP2 will see increased warming through to 2050 from biogenic methane.

28 Understanding the warming implications of differing levels of methane ambition is crucial for evaluating New Zealand's target choices. This section examines what current policy efforts set out in the Government's draft second emissions reduction plan (ERP2) will mean for warming outcomes, and highlights the important contribution to warming outcomes that can be made by pursuing higher ambition within or above New Zealand's current target range (24-47% below 2017 emissions by 2050).

29 **Figure 5** below illustrates New Zealand's contributed warming from emissions since 1850 under two 1.5°C background scenarios, comparing warming outcomes under the draft ERP2 against both ends of the current target range.

Figure 5: New Zealand's contribution to warming (m°C) from biogenic methane emissions (1850-2050) for ERP2 policies compared to current target range



Background scenarios: C1_1.5_SP & C1_1.5_REN

30 The upper end of the current target (47%) is sufficient to limit warming to levels in the early 1990s (**Figure 5**). The lower end of the target (24%) ceases further warming increases by the late 2030s, though with outcomes at 2050 varying based on the background scenario assumed, reflecting methane's reactive nature to global concentrations of a range of gases and aerosols (Thornhill, Collins, Kramer, *et al.*, 2021; Thornhill, Collins, Olivié, *et al.*, 2021).

31 In contrast, the Government's current draft ERP2 measures that see a 13.2% reduction in emissions by 2050 (with no carbon price applied to agriculture) see warming continue to rise, and a broader span in possible warming outcomes.

2.2 Focusing on warming from future emissions

Key takeaways

- New Zealand's contribution to warming from biogenic methane is largely determined by choices for its future emissions.
- The upper-end of New Zealand's target (47%) averts additional year-on-year warming from *future* methane emissions by mid-century.
- Reducing methane emissions represents New Zealand's greatest opportunity to limit warming - future methane warming far exceeds that from future CO_2 emissions.

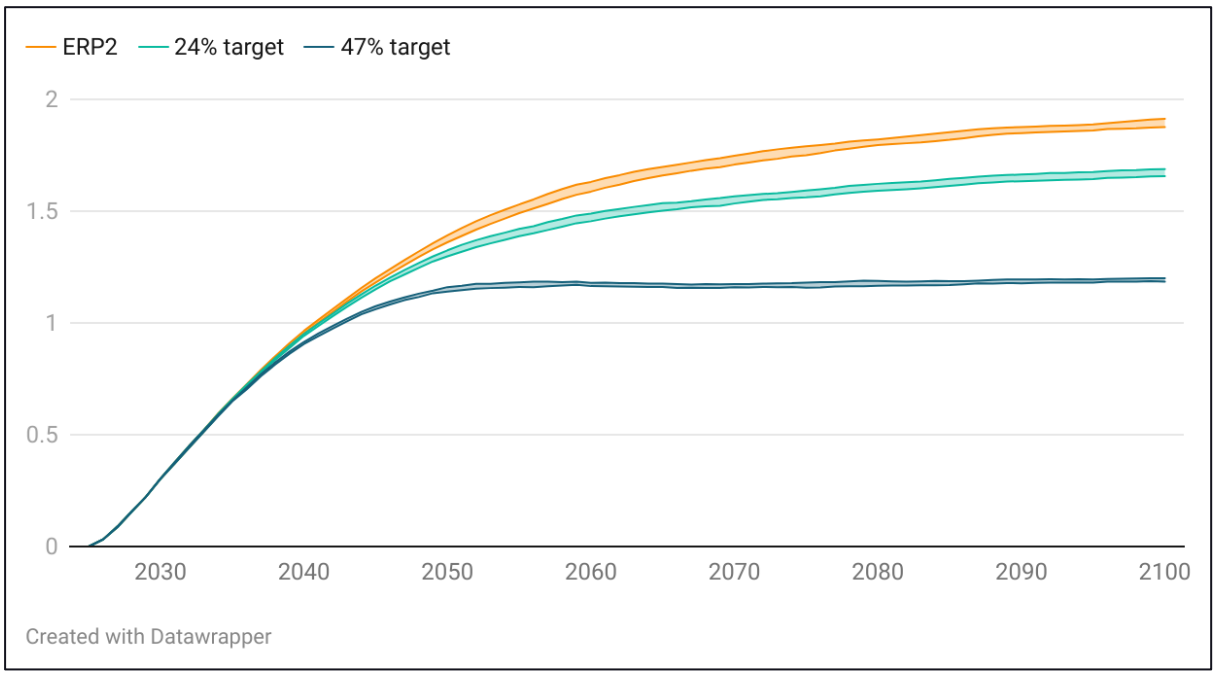
32 New Zealand's contribution to warming from biogenic methane is largely determined by its future emissions due to methane's short lifetime (Reisinger and Leahy, 2019). While New Zealand cannot change its historical emissions, its future emissions pathway remains firmly within its control through policy choices. This makes it critical to consider warming outcomes from future emissions when evaluating target ambition.

33 The significance of future choices is clear: halting emissions from 2025 would see warming from methane decline to 41% of present levels by 2050, and to 18% by 2100. Every tonne of methane emitted from now thus results in more warming than would occur in the absence of these emissions.

34 When examining warming effects of future emissions alone, the differences between policy choices become stark. The upper end of New Zealand's current target (47%) sees warming peak and level off shortly after mid-century. In contrast, both the lower end of the target (24%) and projected emissions under

the draft ERP2 result in continued warming through the century, as illustrated in **Figure 6**.

Figure 6: Warming (m°C) attributable to New Zealand's future biogenic methane emissions from 2025-2100 with constant emissions assumed post-2050

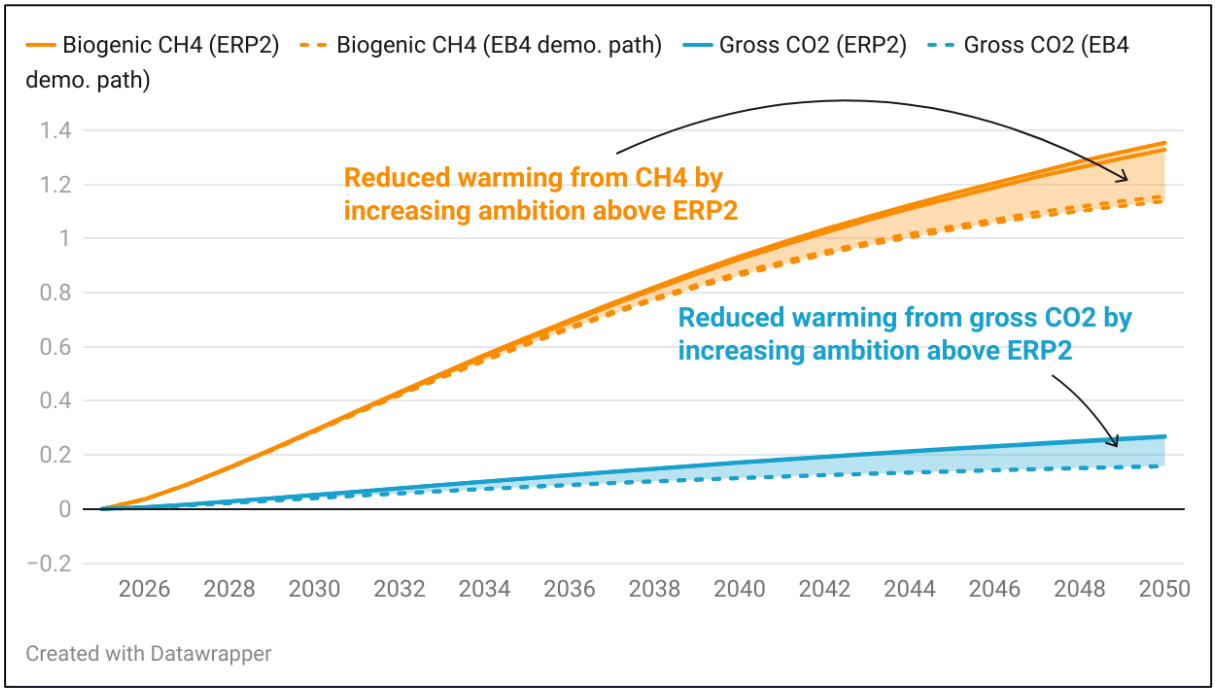


Background scenarios: C1_1.5_SP & C1_1.5_REN

35 The significance of New Zealand's choice for methane ambition is further highlighted when comparing warming to that from CO_2. The warming contribution from future methane emissions significantly exceeds that from future gross CO_2 emissions (**Figure 7** below).

36 While both gases under ERP2 fall short of the Commission's demonstration pathway, closing the methane ambition gap offers the greatest potential to reduce warming through to mid-century (**Figure 7)**. Hence, as noted by the PCE (Upton, 2023), action on biogenic methane represents arguably New Zealand's greatest opportunity to limit and reduce its contribution to warming.

Figure 7: Warming (m°C) from future emissions (2025-2050) of biogenic CH4 and gross CO2 in Government's ERP2 and Commission EB4 demonstration pathway



Background scenarios: C1_1.5_SP & C1_1.5_REN

2.3 How does New Zealand compare to other countries?

Key takeaways

- Several developed countries have already seen warming from biogenic methane peak, and in some cases decline since 2000.
- Some countries with export-orientated agricultural sectors like New Zealand and Ireland have seen their warming increase, coinciding with expansion of their dairy sectors.

37 New Zealand's resistance to stronger agricultural emissions targets has rested on two key claims: that reducing emissions would cause unacceptable economic damage, and that New Zealand's farmers are already among the world's most emissions-efficient producers. However, evidence from other developed nations reflects that reduced warming from biogenic methane is possible while sustaining an internationally competitive agricultural sector.

38 Several countries have achieved significant reductions in emissions from key sources of biogenic methane. In the European Union, for example, agricultural methane emissions have decreased by more than 20% since 1990 (European Environment Agency, 2024).[3]

39 To consider what this looks like in warming terms, **Figure 8** overleaf below provides a comparative overview of warming from biogenic methane emissions in eleven developed countries since 1961. Warming is indexed to each country's warming contribution in 2000 (warming in 2000 = 100 denoted by orange dashed line in each subplot).[4] This analysis reveals two distinct patterns:

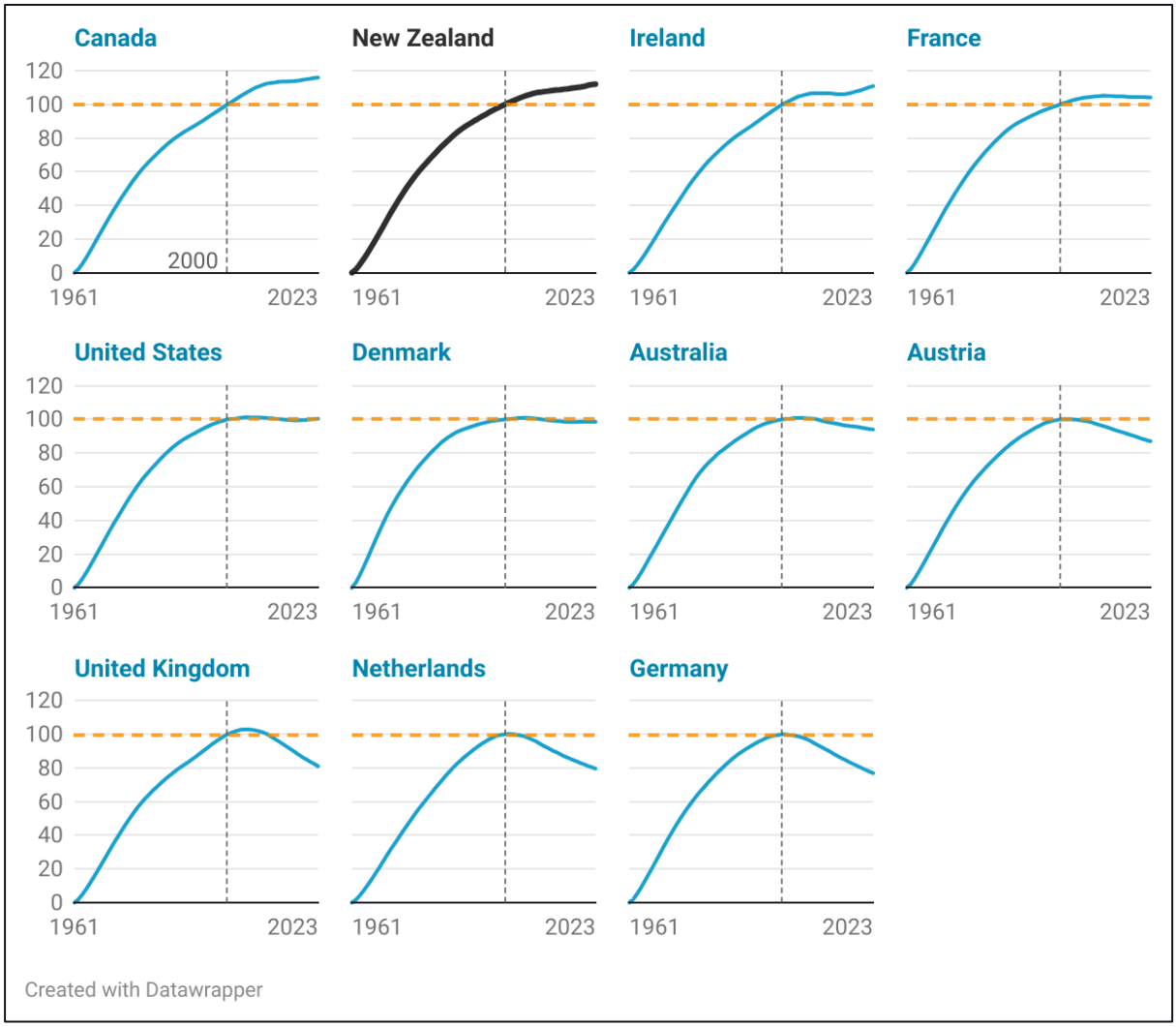
a. Several developed countries have already achieved 'no additional warming' from biogenic methane, with some reducing their warming contributions over time (e.g., the Netherlands, Germany, and the UK).
b. Smaller, export-oriented countries like New Zealand and Ireland that expanded dairy production in recent decades have seen increased warming from biogenic methane.

40 This comparison highlights the arbitrary nature of 'no additional warming' targets. Had such targets been set in 2000 for these countries, they would have been easily achieved by some countries, and permitted higher emissions than would have otherwise occurred. For others, they could have conflicted with the agricultural growth observed over this period.

[3] While several European countries show declining warming contributions from biogenic methane, this should be considered alongside increases in agricultural imports during this period, suggesting some emissions may have been effectively exported to other regions.

[4] The choice of a 2000 reference year for warming holds no special status but enables clear examination of how emissions and warming have evolved over recent decades covered by the Kyoto Protocol and Paris Agreement.

Figure 8: Warming from biogenic methane emissions (1961-2022) in 11 developed countries (2000 warming = 100)



Background scenario: C7_Current_Policies

41 Looking ahead, the fairness and ambition of targets premised on 'no additional warming' will continue to vary widely across countries, underscoring that they should not be seen as universally logical for countries, companies, or sectors.

42 The challenge then is to evaluate a country's biogenic methane target considering its specific economic, social, environmental, and historical context. As section 3 explores, these assessments must also account for issues of equity and fair share within the framework of the global 1.5°C goal.

3) Considerations for setting climate targets

43 This section sets out considerations the Minister should weigh-up when deciding whether to amend New Zealand's methane target. This section responds in part to the unduly narrow Terms of Reference for the Methane Science and Target Review (New Zealand Government, 2024), which explicitly:

a. operates from a premise of limiting warming to 2017 levels;
b. bars consideration of implications for New Zealand's broader climate strategy;
c. prevents assessment of burden-sharing between sectors or nations; and
d. excludes review of other aspects of the 2050 target as set out in s5Q of the CCRA.

3.1 What is needed globally to achieve the aims of the Paris Agreement?

Key takeaways

- The Paris Agreement's temperature goal requires net-zero carbon dioxide by about mid-century, coupled with deep reductions in non-CO_2 gases.
- An overshoot of 1.5°C is increasingly likely, and reductions in methane play a crucial role in limiting this overshoot and slowing warming.
- Where emissions of non-CO_2 gases do not reduce in line with pathways compiled by the IPCC, the world's remaining carbon budget will be reduced.
- Recent calculations imply reductions in agricultural methane of 32% below 2020 emissions by 2050 (16-43% for 25-75th percentile range).

44 The Paris Agreement's core goal is to hold global average temperatures *"to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C."* (Article 2). To achieve this goal, Parties agreed to aim to peak global emissions as soon as possible, and "*achieve a balance between anthropogenic emissions by sources and removals of greenhouse gases in the second half of this century."* (Article 4(1)).

45 The purpose of the CCRA reinforces this goal, seeking to:

a. "*contribute to the global effort under the Paris Agreement to limit the global average temperature increase to 1.5°C above pre-industrial levels*"; and

b. "*enable New Zealand to meet its international obligations…under the Paris Agreement*."

46 This means that any 2050 target that *is not* consistent with these purposes presents fundamental challenges for the wider integrity and functioning of the CCRA, particularly given the key role that New Zealand's 2050 targets play within the Act (e.g., guiding New Zealand's five-yearly emissions budgets).

47 When considering CO_2 and other GHGs separately, scientific literature provides clear guidance on requirements for each. For CO_2:

a. Ceasing further warming requires human-induced CO_2 emissions to be reduced to approximate net-zero (Jenkins et al., 2022).

b. Pathways limiting warming to 1.5°C (with limited or no overshoot) further demand that net-zero CO_2 is achieved by around mid-century (Huppmann *et al.*, 2018; Reisinger *et al.*, 2024).

48 For non-CO_2 gases like methane, it is clear that deep reductions are needed alongside pursuit of net-zero CO_2 (Huppmann *et al.*, 2018; Reisinger *et al.*, 2024). However, it is also accepted that some biological constraints can limit the

complete elimination of some sources, such as nitrous oxide from agricultural sources (Smith, Vaughan and Forster, 2024), and that for shorter-lived GHGs, achieving net-zero emissions of these gases is not strictly needed.

49 Failure to act appropriately on non-CO_2 emissions, however, may prevent the world from achieving the 1.5°C temperature goal, irrespective of whether CO_2 reaches net-zero (Institute for Governance & Sustainable Development, 2023).

50 Ambitious cuts in non-CO_2 emissions over the next 20-40 years also provide several advantages:

a. Slowing the rate of warming (Cael and Goodwin, 2023; Miller *et al.*, 2024; Shindell *et al.*, 2024).
b. Reducing reliance on speculative carbon removal technologies to counteract overshoot of 1.5°C (Johansson *et al.*, 2020; Pérez-Domínguez *et al.*, 2021; Sun *et al.*, 2021).
c. Lowing peak warming and overshoot of 1.5°C (Sun *et al.*, 2021; Shindell *et al.*, 2024).
d. Keeping carbon budgets within reach (Shindell *et al.*, 2024).
e. Minimising climate risks associated with peak and decline pathways (Schleussner *et al.*, 2024).

51 Recent evidence that wetland methane emissions are increasing with climate change also further emphasise the importance of prompt action by developed countries to reduce emissions where feasible (Shindell *et al.*, 2024).

52 Agriculture is crucial in these efforts. Without substantial reductions in agricultural emissions, limiting warming to 1.5°C may prove impossible (Clark *et al.*, 2020; Leahy, Clark and Reisinger, 2020). For agricultural methane, pathways

within the IPCC's special 1.5°C report (Rogelj, Popp, *et al.*, 2018; Rogelj, Shindell, *et al.*, 2018) saw methane 24-47% below 2010 by 2050 in 1.5°C pathways.

53 Recent research (Rogelj and Lamboll, 2024) building on estimates of the world's remaining carbon budget (IPCC, 2021; Forster *et al.,* 2023) has also found that a 32% reduction in agricultural CH_4 below 2020 levels is required by 2050 in 1.5°C scenarios (16-43% for the 25-75th percentile range; 6-52% for the 10-90th range).

54 Crucially, the centre of this range (32%) represents a *reduction* in warming at a global level, equivalent to avoidance of 25 Gt CO_2 when calculated using GWP* (Smith *et al.*, 2021; Rogelj and Lamboll, 2024).

55 However, the IPCC and Rogelj and Lamboll (2024) ranges are not prescriptive for individual countries and do not reflect diverse national circumstances. Low-income countries with growing populations, where farming of livestock is essential to livelihoods (Zhang *et al.*, 2022), may find it difficult to limit methane to these ranges while ensuring food security as an example.

3.2 Principles raised in literature for sharing effort

56 A wide range of effort-sharing approaches has emerged in international literature for allocating emissions reduction responsibilities among countries (Höhne, den Elzen and Escalante, 2014; Lecocq and Winkler, 2024). The IPCC (2015) has categorised these under four key perspectives:

a. **Responsibility:** Obligation to address climate change is proportional to contribution to the problem.
b. **Capacity (or ability to pay):** Those who can afford to contribute should do so.
c. **Right to development:** Meeting basic needs of poor people and countries is a global priority (Andreassen and Marks, 2007).

d. **Equality:** Every person has equal moral worth, and therefore equal rights.

57 While detailed application of effort-sharing indicators is beyond the scope of this report, the Commission's draft advice (2024d) found the current target range (24-47%) is not sufficiently aligned with any of these approaches.

58 Yet applying effort-sharing indicators universally remains challenging. For example, per-capita emissions approaches (reflecting the equality perspective) can place greater burden on countries with export-oriented agricultural sectors than for those producing for domestic consumption (Prudhomme *et al.*, 2021).

59 This report instead reflects more broadly in the next section on the Paris Agreement's requirements and how perspectives like the right to development and responsibility should factor into New Zealand's 2050 target decisions.

3.3 'No additional warming' considered against effort-sharing perspectives

Key takeaways

- Transformative change is needed to limit warming below 1.5°C, with every country maximising its efforts.
- A choice to limit ambition to 'no additional warming' risks placing reduction burdens on low-income countries where food security risks are most acute.

60 The Paris Agreement requires that each country's NDC represents its "*highest possible ambition*" (Article 4.3). With biogenic methane comprising 48% of New Zealand's emissions profile, this principle ought to logically extend to its 2050 methane target.

61 Long-term strategies submitted under the Agreement further emphasise that achieving its temperature goals requires transformative rather than incremental

change as part of longer-term commitments out to 2050 (UNFCCC Secretariat, 2023). Likewise, the IPCC and broader scientific literature similarly stress that all countries must maximize their mitigation efforts to address climate change (Reisinger *et al.*, 2024).

62 For agricultural methane, responsibility for climate change and right to development are particularly relevant effort-sharing perspectives. However, metrics like GWP* and 'no additional warming' targets create tensions with these perspectives by internalising past and future warming.

63 For example, pursuing ‘no additional warming’ above 2017 levels effectively means retaining New Zealand’s existing share of contributed warming. With temperatures already 1.06°C above pre-industrial levels (Gulev *et al.*, 2021), this shifts responsibility for reducing warming from agricultural methane on a global scale onto farmers in other countries, other non-CO_2 emitters, or through a reduced global carbon budget.

64 Even if New Zealand does not face financial repercussions for this choice, the moral and ethical implications will undoubtedly be understood by countries that are considered friends or allies to New Zealand.

65 Mitigation challenges for agricultural methane warrant recognition (Leahy, Clark and Reisinger, 2020) and may justify greater emphasis on reducing long-lived GHGs earlier and faster (Leahy, Clark and Reisinger, 2020; Lynch *et al.*, 2021). However, any reduction in New Zealand’s biogenic methane ambition without corresponding increases in ambition for other GHGs is inconsistent with this logic and would contradict the Paris Agreement’s principles that countries do not backslide on commitments and increase ambition over time.

66 From a development rights perspective, with only 0.44°C of warming remaining before 1.5°C, 'no additional warming' targets by developed countries effectively constrain room available for low-income countries to develop their agricultural sectors when compared to targets set on a principle of maximising one's efforts. This is particularly problematic given that severe food security challenges from climate mitigation and climate impacts are often most acute in low-income countries (Ferranti, 2023; Smith, Vaughan and Forster, 2024).

67 Some New Zealand stakeholders cite Paris Agreement food security clauses when cautioning against aggressive methane reductions. However, while estimates suggest New Zealand feeds upwards of 40 million people globally (Proudfoot, 2017), much of this food does not reach those most in need in low-income countries where food security challenges are most acute. These arguments also warrant scrutiny given recent aims for New Zealand to be *"the world's most sustainable provider of **high-value** food and fibre products*" (MPI, 2022, p. 7) (emphasis added).

68 Focusing solely on emissions reductions within specific production systems also overlooks the broader context of consumption patterns and trade flows (Davis and Caldeira, 2010; Han *et al.*, 2019), where shifts in dietary patterns - particularly in high-income countries - remain a critical mitigation lever towards 1.5°C (Bryngelsson *et al.*, 2016; Pérez-Domínguez *et al.*, 2021; Arndt *et al.*, 2022).

69 New Zealand's choice to restrict ambition to 'no additional warming' could thus limit development opportunities in low-income countries (Rogelj and Schleussner, 2019; Prudhomme *et al.*, 2021), while setting a concerning precedent for other developed countries to similarly reduce their agricultural methane ambition.

3.4 Balancing ambition and feasibility

Key takeaways

- Evidence shows targets more ambitious than 'no additional warming' are feasible under various scenarios for technology availability and efficacy.
- Reducing the target range's upper end has little practical benefit and risks discouraging investment in mitigation technologies.
- Current environmental constraints and prior sector commentary already suggest New Zealand has reached peak livestock numbers.
- Trade and brand risks arise from reducing ambition below current range

70 Determining appropriate ambition involves balancing economic, social, equity and political considerations (Allen *et al.*, 2022). While physical science informs this process, it cannot resolve these complex trade-offs.

71 International research shows significant low-cost abatement potential exists for waste methane, while agricultural emissions reductions require both targeted technological solutions and broader system changes (Shindell *et al.*, 2024), with much of this research focused on reducing agricultural emissions for the same amount of production. However, even where cost-effective options exist, effective policy frameworks and targets remain crucial to drive uptake.

72 Two recent comprehensive studies provide insights into mitigation potential in a New Zealand context. Manaaki Whenua modelling (Greenhalgh and Djanibekov, 2022) found reductions of up to 19% below 2017 levels were achievable by 2030 through carbon pricing. The Commission's analysis (2024b, 2024c) found the current target range achievable under various scenarios for technology

availability and efficacy, with four of five core scenarios achieving reductions of 36-47% by 2050, above that needed for ‘no additional warming’.

73 These modelling studies often show significant changes to livestock numbers and land-use are needed to achieve deeper emissions reductions and have raised concerns about impacts on rural communities (Carbon News, 2024). However, such modelling represents plausible rather than prescribed pathways. The diversity of responses already seen from New Zealand's farmers—from adopting new technology, to diversifying land use, and pursuing leaner and more efficient farming systems—suggests that those adapting can continue to thrive.

74 Shifts toward efficient, mixed-use farming systems are often viewed positively by both farmers and companies supporting such actions (Silver Fern Farms, 2023; AgMatters, 2024), contrasting with political narratives that methane targets threaten farming. And while New Zealand's agricultural efficiency is often emphasised by political leaders, opportunities remain to support less efficient producers to evolve their farming systems with climate outcomes in mind.

75 Further optimism comes from the current market availability of methane inhibitors that can reduce emissions from ruminants by around 30% in housed systems (Dijkstra *et al.*, 2018; Kebreab *et al.*, 2023; Commission, 2024c), suggesting similar technology suitable for New Zealand’s farming systems should be available well before 2050 (Commission, 2024c).

76 Any reduction in methane ambition would also have implications across the wider economy. Given New Zealand’s domestic budgets and NDCs cover all gases together, reducing the methane target would require steeper reductions from other sectors through New Zealand’s third emissions budget already set in law for 2031-2035, and its forthcoming fourth emissions budget (2036-2040)

due for decisions next year. Notably absent from current discussions is any analysis of these implications, despite the Government's apparent decision to reduce ambition to 'no additional warming' above 2017 for biogenic methane.

77 New Zealand also faces significant intersecting environmental constraints beyond its climate targets. Many freshwater systems are already degraded by excess nutrients (Ministry for the Environment (MfE) and StatsNZ, 2023), and achieving limits for nitrogen toxicity and periphyton will require significant land-use change away from agriculture in some regions (MfE, 2020; MPI, 2020). Agricultural leaders have also acknowledged that New Zealand has reached its peak dairy herd size (Hancock, 2021) and livestock production more generally (Beef+Lamb NZ and MIA, 2022), reflecting these environmental pressures.

78 While achieving a 47% reduction may seem challenging today, lowering the target to minimum 'no additional warming' levels risks discouraging critical investment in low-emissions technologies, particularly given New Zealand's unique pastoral farming systems require specific adaptation of emerging solutions. For the waste sector, it may similarly discourage necessary capital investment in emissions reductions.

79 Internationally, reduced ambition would damage New Zealand's reputation in climate negotiations, attract negative media attention, and create risks for exporters. Supermarket chains and FMCG firms for example are increasingly pursuing comprehensive emissions reporting systems (Quinn, 2023), and setting mitigation obligations on suppliers (e.g., SBTi targets) as part of terms of supply.

80 A weakening of New Zealand's targets is also significant from a market access perspective, given New Zealand's commitments to the Paris Agreement are explicitly referenced in its recent EU free trade agreement (2024, 19-12), requiring

that both parties "*refrain from any action or omission that materially defeats the object and purpose of the Paris Agreement."* Failure to comply with this provision thus explicitly opens the possibility of New Zealand facing trade sanctions. While it is difficult to quantify this risk, it remains significant given the importance of the EU as a trading partner to New Zealand.

81 While some agri-food exporters have developed their own climate targets and brand identities linked to sustainability, the tension between reduced government ambition and expectations of international FMCG firms and supermarket chains will remain challenging for these companies to navigate on behalf of their farm suppliers.

82 Though emissions leakage risks are often cited against proactive agricultural emissions policies, many international competitors active in the same markets as New Zealand exporters already have comparable emissions intensities. Competitors with housed grain-fed systems will also be better positioned to adopt technologies like 3-NOP (Dijkstra *et al.*, 2018; Kebreab *et al.*, 2023). Weakening the current target would thus move counter to competitors' increasing sustainability efforts, and risk placing New Zealand behind others on its sustainability footing in future.

83 These factors require careful ministerial consideration through open consultation that surfaces trade-offs with all stakeholders. While both technological evolution and New Zealand's progress against linked environmental outcomes remain uncertain, the evidence presented in this report suggests that limiting warming to 2017 levels falls short of New Zealand's highest possible ambition. Such a target would neither reflect the transformative change needed globally to limit warming to 1.5°C and run counter to increasing sustainability expectations in high value export markets.

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