From: Nicola Shadbolt
To: Methane Panel Secretariat
Subject: FW: Submission
Date: Wednesday, 9 October 2024 10:07:25 am

From: 9(2)(a)
Sent: Monday, October 7, 2024 7:31 PM
To: Nicola Shadbolt <N.M.Shadbolt@massey.ac.nz>
Subject: Fwd: Submission

You don't often get email from 9(2)(a) . Learn why this is important

Hi 9(2)(a)
Here is my submission to the Methane Review Commission. Good luck with finding a new path forward for New Zealand.
Warm regards
9(2)(a)
Sent from my iPhone

Begin forwarded message:

From: 9(2)(a)
Date: 1 October 2024 at 2:33:23 PM NZDT
To: 9(2)(a)
Subject: Fwd: Submission

Submission to the Methane Review Commission

* Why was the sequestration of CO2 by pasture not included in the 2015 Paris Accord? The sequestration may be short term, but sequestration forever, the other end of the spectrum, would eventually cause all life on Earth to die. We need CO2 to cycle. It is the gas of life. Where's the double entry accounting?
* Ruminants evolved forty million years ago. The number of ruminants has ebbed and flowed as Earth has gone through warm climatic periods and Ice Ages. What effect, if any, have ruminants had on the climate?

* In 2017 a scientific paper by Dr Kay Steinkamp and six other scientists

measured the sequestration of CO2 by mature native bush in the southern South Island as five times greater than what had been assumed for the Paris Accord in 2015. When I contacted Steinkamp, she said that she wasn't allowed to talk about that paper. In recent years Dr Mikaloff-Fletcher of NIWA has led a research team which has demonstrated that the CO2 absorption across the whole land mass of New Zealand is 60% higher than guesstimated in 2015. Conclusion: New Zealand is carbon positive.

* In June 2023 Dr Tom Sheahen gave a number of presentations in New Zealand about a recent paper by Drs Happer and Wijngaarden. The paper described the measurement of the five GHGs from satellite stations around the world. The conclusion from the paper is that methane and nitrous oxide are in such minute quantities in the atmosphere that their influence on climate is infinitesimal. And that the CO2 heat absorption bands are saturated, so even a doubling of CO2 in the atmosphere will have only a small influence on average global temperature.
I hosted Tom for two nights, and spent a day with him and Mike Butterick(now MP for Wairarapa) in Wellington, meeting with National MP Stuart Smith, Federated Farmers' policy advisor Paul Melville, and Sam McIvor and Dave Harrison of Beef and Lamb. There were no doubts expressed about the scientific legitimacy of the paper.
* The Blame Game against ruminants gained momentum in New Zealand in the 1990s when global timber prices spiked, which encouraged planting of 100,000ha per year for six years. The voluntary substitution of trees for ruminants was a convenient way for New Zealand to meet international treaty obligations at no cost to the taxpayer. It was an obvious "solution" at the time, but timber prices then tanked, and planting stopped.

* Ruminant numbers in New Zealand peaked some years ago. The sheep population peaked at 70 million in 1982, and is now 23 million. The beef cattle population peaked at 6.3 million in the 1970s, and is now 3.9 million. Dairy cow and heifer numbers peaked at 6.7 million in 2014, and have since dropped to 6.1 million. Farmed deer numbers peaked at 1.9 million, and now number 800,000.
* Contrast that decline in ruminant numbers to the rapid increase in New Zealand's human population, from 3.4 million in 1990 to 5.4 million now, a 58% increase. This increase is greater than other developed economies, apart from Australia. But we wouldn't want to blame more people for GHG emissions, would we?
* Urban and lifestyle blocks now cover the same area in New Zealand as dairy farming. Which land use pollutes more?
* Farmed area is shrinking fast. Despite pastoral farming earning around half of New Zealand's merchandise export income, politicians and media pay more attention to fringe lobby groups than to the people who enable New Zealanders to enjoy a high standard of living. Environmental lobby groups are concerned first and foremost about their own sustainability. Their funding relies upon creating fear of the future, talking up "causes"

that people will donate to.

* New Zealand politicians kowtow to the United Nations agenda that methane levels in the atmosphere need to be reduced. Policies have evolved to keep the peasants busy, or under threat of regulations requiring the measurement of each farm's GHG emissions. Government spends hundreds of millions of dollars on science projects to reduce the methane emissions from individual animals, with disregard to whether those animals are simply smaller, and selection lines will become less productive over successive generations.

* As a small player, New Zealand gets bullied in international negotiations. New Zealand farmers are continually lectured about the threat of missing out on premium markets around the globe. Yet Australian produce is not discounted relative to New Zealand's, despite Australia having a huge mining industry, with coal, iron ore, and natural gas exports making Australia a much richer country than New Zealand. Despite New Zealand's virtuous green stance, many thousands of Kiwis emigrate to Australia, following the money trail.

* By contrast, New Zealand has the 13th largest accessible coal reserve in the world, but hardly touches it. New Zealand Steel, which should be called Australian Steel, has recently had a $140 million gift from NZ taxpayers to electrify two of four furnaces!

* Companies in which the NZ government has a shareholding, such as Air New Zealand, the main power companies, and Placemakers, get special protection from competition.

* The subsidy for carbon from trees has distorted land prices and hollowed out

communities. Where will New Zealand sell logs in 2055? Around 90% of export logs have been going to China, used mainly for boxing around concrete, then burnt, with CO2 released to the atmosphere. Is growing trees just virtue signalling, showing up a silo mentality at a global level?

* The world's use of fossil fuels continues to increase. Oil usage is now a record 102 million barrels per day, and predicted to increase over the next ten years. Natural gas volume consumption is almost twice as high as in 1998. Coal usage is also at record levels. Perhaps a significant part of the increase in temperature over the past forty years is caused by direct heating, billions of engines running day and night?

* Natural gas is at least 70% methane. Why not use ruminant methane instead of trying to suppress it? A New Zealand invented prebiotic, brand name Knewe, improves the efficiency of the rumen and simultaneously reduces the belching of methane into the atmosphere. Dairy cows produce more milksolids(15-16% on average), enjoy a higher conception rate, better health, and exhibit calmer behaviour. Stags grow more velvet. Fawns grow faster, and wean earlier. Beef weaners grow faster. Horses are calmer and perform better. But this local product has been ignored by AgriZero.

* Taxpayer money is being spent on killing

wilding pines on barren scree slopes while subsidies for tree planting on farm land make a mockery of financial returns to farming. The gold rush of planting trees, then selling that land to foreigners, is short term political expediency, with no thought given to the long term consequences of this subsidised change in land use.

* I had farms in Australia for twenty years. In the late 1990s there were massive tax breaks to encourage widespread planting of trees. In 2012 two forestry companies went broke, purchased cheaply by a Canadian pension fund. Plantations more than an hour from a port have been reconverted to pasture. It is calculated that taxpayers lost $A20 billion. This story is an echo of New Zealand's Land Development Encouragement Loan Scheme from the late 1970s, when government subsidies paid for the conversion of a large area of marginal land into pasture, the last time that the NZ government interfered in the rural land market. Much of that developed area has reverted to woody weeds, "rewilded". No one apologised to taxpayers.

* Will common sense ever prevail? Reduce the global human population from eight billion to three billion and there will be a big drop in the number of farmed ruminants.

* Have you ever been hungry? Reducing agricultural production with anti-nature policies is easy to do when you enjoy three meals per day.

* Agriculture is New Zealand's main money earner. Undermining farming is a strange policy in a country so dependent upon it. When will New Zealand politicians and trade negotiators be courageous enough to stand up for a reality check on the Paris Accord and farmed ruminants?

In twenty years time there will be comedy shows written about animals being blamed for manmade global warming.

Conclusion. Does the Committee have the courage to

challenge the narrative of political convenience about methane?

The Methane Review Commission should:

1. Renegotiate the Paris Accord's science about methane, using the evidence of GHG models developed recently from satellite climate observations over the past fifty years.

2. Change from single entry to double entry accounting around farmed ruminants and pastures. Otherwise New Zealand will continue to damage its key export industries, while the rest of the world sails on with increasing fossil fuel consumption, untaxed rice paddies, termite mounds undisturbed, and subsidised wetlands all putting extra methane into the atmosphere.

3. Accept that New Zealand is a positive carbon sink already. The planting of pine trees on productive pasture land must be halted immediately. There is no need to tax farmers and all New Zealanders for GHG emissions if the country is already carbon positive.
4. Why doesn't New Zealand stand up for itself? instead of kowtowing to strange concepts masquerading as "saving the planet"?

Greenpeace Submission to the Methane Review Panel on the Review of methane science and target

Submitter Information

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Introduction

Thank you for the opportunity to input into the review of methane science and target.

Given that nearly half of New Zealand's greenhouse gas emissions come from agriculture, the main source of which is methane from the livestock sector, it is imperative for methane emission reduction to occur in this sector in order for New Zealand to achieve its climate commitments under the Paris Agreement.

The Paris Agreement is our roadmap for a livable future for our children and grandchildren. Because climate change is truly an existential crisis, it requires all nations to do their part. Honouring our commitments to the Paris Agreement is essential if we are to avoid catastrophic impacts on our homes, health, livelihoods, critical infrastructure and ability to grow food. It is an obligation we have to future generations both here in Aotearoa New Zealand, in our neighbouring Pacific and across the Earth. The advice you provide in your report to the Government will inform our targets under the Paris Agreement. It will make or break our commitments. Our children's future is in your hands.

We are therefore very concerned that the Panel's terms of reference explicitly require that our methane targets be reviewed in line with "no additional warming" as this would seriously undermine the Paris Agreement and climate action more generally.

The concept of "no additional warming" is related to the model known as Global Warming Potential* (or GWP* for short). While GWP* can be a useful tool to track methane emissions variations over shorter timescales and to differentiate its impacts with longer-lived emissions, climate **scientists have warned against its use as a metric to inform policies and**

mitigation actions corresponding to specific emission reduction targets for a number of reasons. Drawing from this scientific advice, we summarise our key concerns in this short submission under the following headings:

1. Lowering climate ambition at the expense of the Paris Agreement
2. Potential associated breaches of trade agreements

We also provide a bibliography of references to scientific articles raising concerns about GWP*, which we encourage the Panel to go through in detail to inform your advice.

We would appreciate the chance to meet with you to discuss these concerns further.

1. Lowering climate ambition at the expense of the Paris Agreement

Instead of reducing emissions, a methane target consistent with **"*no additional warming*" redefines the goal of climate action as simply stabilising emissions at current levels**. This essentially "builds in" an expectation of continued high levels of anthropogenic methane emissions. But concentrations of methane in the atmosphere are currently around 2.5 times greater than pre-industrial levels and rising, and we urgently need to ***cut*** methane emissions: the Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment report unambiguously advises that we need to make swift reductions in methane pollution as a critical step to slow temperature rise and avoid potentially catastrophic tipping points. The correct "baseline" for metrics, therefore, should be a baseline of not emitting.

As pointed out by the Climate Change Commission, adopting the "no additional warming" concept would lead to a weakening of the methane components of the target, although there is "*no evidence to support weakening the current 2050 target, and enough to consider strengthening it*".

Lowering Aotearoa New Zealand's climate ambitions would in itself seriously compromise commitments made under the Paris Agreement to reduce our climate footprint as an individual country. It also raises serious concerns about duty to others. Using GWP* can lead to inequitable conclusions, putting most developing countries at a disadvantage compared to developed countries, because when using *GWP** countries with high historical emissions of short-lived GHGs are exempted from accounting for avoidable future warming that is caused by sustaining these emissions. Equity is at the heart of Article 4 of the Paris Agreement. GWP* essentially ignores these differences between countries. Setting policy and targets using these calculations would be unfair, unequal, and unethical.

Furthermore, reinterpreting New Zealand's methane target from GWP100 to GWP* would undermine the integrity of the Paris Agreement as a whole. GWP100 is commonly adopted by all Parties to the Paris Agreement. At best, adopting GWP* in New Zealand would make comparison with other countries' Nationally Determined Contributions virtually impossible and

undermine our ability to track global progress towards emission reduction. At worst, it would open up the floodgates for other high emitting countries to adopt GWP*. Scientists have found that interpreting the Paris Agreement goals in a metric like GWP* can lead to profound inconsistencies in the mitigation architecture of the Agreement and could even undermine the integrity of the Agreement's mitigation target altogether by failing to deliver net-zero emissions and therefore failing to ensure warming is halted.

2. Potential associated breaches of trade agreements

As demonstrated above, adopting the concept of "no additional warming" and weakening existing national methane reduction targets could undermine commitments under the Paris Agreement. **This is likely a breach of the EU-NZ FTA Article 19.6(2)-(3) which commits Parties to effectively implement the United Nations Framework Convention on Climate Change and the Paris Agreement** including commitments with regard to nationally determined contributions, which includes the obligation to refrain from any action or omission that materially defeats the object and purpose of the Paris Agreement.

In general, several of our free trade agreements require no weakening of climate and environmental protections. ENGOs have already produced one analysis of how environmental rollbacks will affect the NZ-UK trade agreement and another analysis, which specifically looks at how the *Fast-Track Approvals Bill* would affect trade agreements, including the NZ-EU FTA, NZ-UK FTA and the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP). These detailed analyses contain relevant concerns in the context of reviewing Aotearoa New Zealand's methane target.

New Zealand's environmental rollbacks have already been raised in the UK Parliament due to concern that they would impact New Zealand's commitments under the UK-NZ FTA. MFAT has also recently advised the Government that its decision to repeal the ban on offshore oil and gas exploration has opened New Zealand up to reputational and legal risks with its trading partners. We encourage the Panel to review New Zealand's commitments in these trade agreements and the implications of changing our methane target in line with "no additional warming" in order to inform your recommendations to the Government.

Key References and quotes from the scientific literature

Rogelj, J. and Schleussner, C. F. (2019) Unintentional unfairness when applying new greenhouse gas emissions metrics at country level. Environmental Research Letters, 14(11): 114039. https://iopscience.iop.org/article/10.1088/1748-9326/ab4928

"Comparison factors for non-CO_2 GHGs under the GWP metric depend on past emissions, and hence raise questions of equity and fairness when applied at any but the global level. The use of GWP* would put most developing countries at a disadvantage compared to developed countries, because when using GWP* countries with high historical emissions of short-lived GHGs are exempted from accounting for avoidable future warming that is caused by sustaining*

these emissions. We show that when various established equity or fairness criteria are applied to GWP (defined here as eGWP*), perceived national non-CO_2 emissions vary by more than an order of magnitude, particularly in countries with high methane emissions like New Zealand."*

Hayek, M. N., Samuel, J. and McClelland, S. C. (2023) Methane metrics: the political stakes. Nature, 620(7972): 37. https://www.nature.com/articles/d41586-023-02435-6

Schleussner, C. F., Nauels, A., Schaeffer, M., Hare, W. and Rogelj, J. (2019) Inconsistencies when applying novel metrics for emissions accounting to the Paris agreement. Environmental Research Letters, 14(12): 124055. https://iopscience.iop.org/article/10.1088/1748-9326/ab56e7/meta

"*We show that interpreting the Paris Agreement goals in a metric like GWP* that is significantly different from the standard metric used in the IPCC Fifth Assessment Report can lead to profound inconsistencies in the mitigation architecture of the Agreement. It could even undermine the integrity of the Agreement's mitigation target altogether by failing to deliver net-zero CO_2 emissions and therewith failing to ensure warming is halted. Our results indicate that great care needs to be taken when applying new concepts that appear scientifically favourable to a pre-existing climate policy context.*"

Climate Analytics (2019) Greenhouse gas accounting metrics under the Paris Agreement: A cautionary tale of the implications of applying novel scientific concepts to an existing policy content. https://climateanalytics.org/media/gwp_star_briefing_final.pdf

Meinshausen, M. and Nicholls, Z. (2022) GWP* is a model, not a metric. Environmental Research Letters, 17(4): e041002. https://iopscience.iop.org/article/10.1088/1748-9326/ac5930

Shindell D, Sadavarte P, Aben I, Bredariol TdO, Dreyfus G, Höglund-Isaksson L, Poulter B, Saunois M, Schmidt GA, Szopa S, Rentz K, Parsons L, Qu Z, Faluvegi G and Maasakkers JD. The methane imperative. Front Sci (2024) 2:1349770. doi: 10.3389?fsci.2024.1349770

"One could evaluate the contribution of emissions relative to preindustrial levels using GWP, which would show the large warming impact of present-day methane emissions. However, some countries and companies have used GWP* to suggest that since keeping current methane emissions constant does not add additional future warming, continued constant high levels of methane emissions are therefore not problematic and a reduction of their methane emissions is equivalent to CO_2 removal. This use of GWP* to justify the continuance of current emission levels essentially ignores emissions responsible for roughly half the warming to date and appears to exempt current high methane emitters from mitigation. This is neither equitable nor consistent with keeping carbon budgets within reach. Many current high emitters are wealthy groups, and the use of GWP* to evaluate changes relative to current levels implies the wealthy consuming or profiting from a large amount of methane-emitting products (such as gas, oil, or*

cattle-based foods) has no impact, whereas the poor, who currently consume little, would be penalized for consuming more. Policymakers should also consider impacts beyond climate when choosing policies affecting methane."

Ocko, I.B., Sun, T., Shindell, D., Oppenheimer, M., Hristov, A.N., Pacala, S.W., Mauzerall, D.L., Xu, Y. and Hamburg, S.P. (2021) Acting rapidly to deploy readily available methane mitigation measures by sector can immediately slow global warming. Environmental Research Letters 16(5): 054042.
https://iopscience.iop.org/article/10.1088/1748-9326/abf9c8

Reisinger, A., Clark, H., Cowie, A.L., Emmet-Booth, J., Gonzalez Fischer, C., Herrero, M., Howden, M. and Leahy, S. (2021) How necessary and feasible are reductions of methane emissions from livestock to support stringent temperature goals?. Philosophical Transactions of the Royal Society A, 379(2210): 20200452.
https://royalsocietypublishing.org/doi/10.1098/rsta.2020.0452

Reducing emissions from the livestock sector now

Livestock is the single biggest source of human-made methane. Reducing methane associated with meat and dairy is therefore a critical lever that will influence how quickly or slowly the world heats up in the near-term. Methane is a superheating gas, around 80 times more potent than carbon dioxide over a 20 year period. But it is relatively short lived, which means, if we drastically cut methane emissions now, we can pull the climate emergency brake and can have an immediate effect on slowing temperature rise in our lifetimes.

It is possible to make significant cuts in livestock methane right now by stopping meat and dairy expansion and reducing herd sizes. We don't need to, and don't have time to, wait for silver bullet technological breakthroughs. With the right policy settings, farmers can be supported now to transition to more plant-based and ecological farming methods that use fewer inputs and sustain smaller herds. This would have many co-benefits for animal welfare, freshwater health, air quality and human health. Furthermore, this is increasingly what customers both here in Aotearoa and overseas want, and expect from food producers.

As a recent investigation by Changing Markets Foundation revealed, the livestock industry has been very effective at delaying policy intervention to reduce emissions from the meat and dairy sector, both here in Aotearoa New Zealand and globally. We encourage the Panel to review their report and the following three international Greenpeace reports to provide a counter-perspective to that of the industry:

- Turning Down the Heat: Pulling the climate emergency brake on big meat and dairy (with a special focus on methane)
- Less Is More: Reducing meat and dairy for a healthier life and planet
- Ecological Farming: The seven principles of a food system that has people at its heart

SUBMISSION to THE MINISTRY ADVISORY PANEL

MINISTRY of the ENVIRONMEMT

THE REVIEW of METHANE in NEW ZEALAND

METHANE

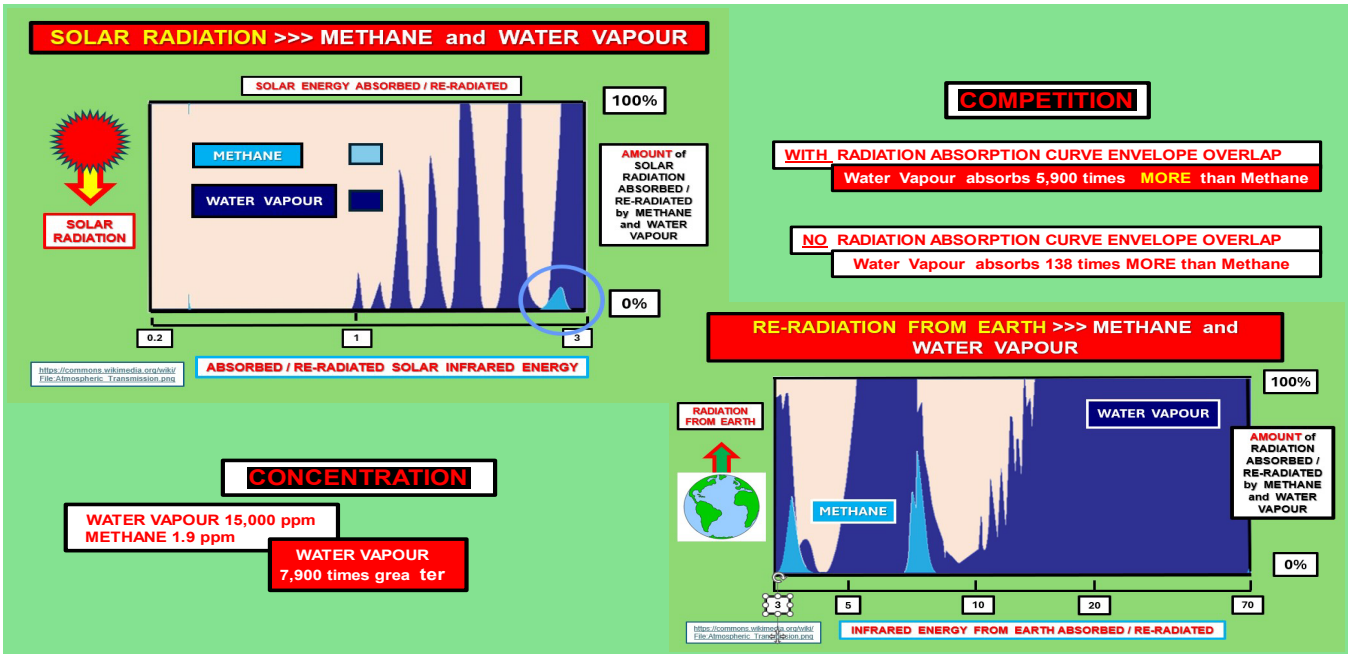
WHY METHANE in the ATMOSPHERE is LESS EFFECTIVE with ELECTROMAGNETIC RADIATION THAN THE OTHER STRONGER GREENHOUSE GASES GHG's -- WATER VAPOUR and CARBON DOXIDE

TECHNICAL REASONS WHY THE FARMING INDUSTRY SHOULD BE ENCOURAGED and STIMULATED …. RATHER THAN TAXED

The PRIMARY reason that methane in the atmosphere is less effective with both incoming solar radiation and outgoing re-radiation from planet earth is that methane's has a very limited operational radiation bandwidth (operation range) compared to all other major GHG's.

This is demonstrated visually and quantitatively in the following graphs based on data taken directly and only from the Worldwide Web
[Reference: https://commons.wikimedia.org/wiki/File:Atmospheric_Transmission.png]

The first graph *below* clearly shows that the methane absorption / re-radiation curve envelopes are smaller both in width *(potential absorption wavelength range)* and magnitude *(amount absorbed)* than those for the number one GHG water vapour. The methane radiation envelopes are almost totally covered by the water vapour gas infrared absorption envelopes. Methane has only 1 very small band in the incoming solar range and only 2 in the longer wavelength re-radiation range *(as shown by the light blue envelopes).* All 3 methane bands can potentially absorb / re-radiate only less than 70% of the energy over their wavelength ranges or frequency spans. In stark contrast, the methane envelopes are almost completely covered by the far higher concentration and more effective water vapour.



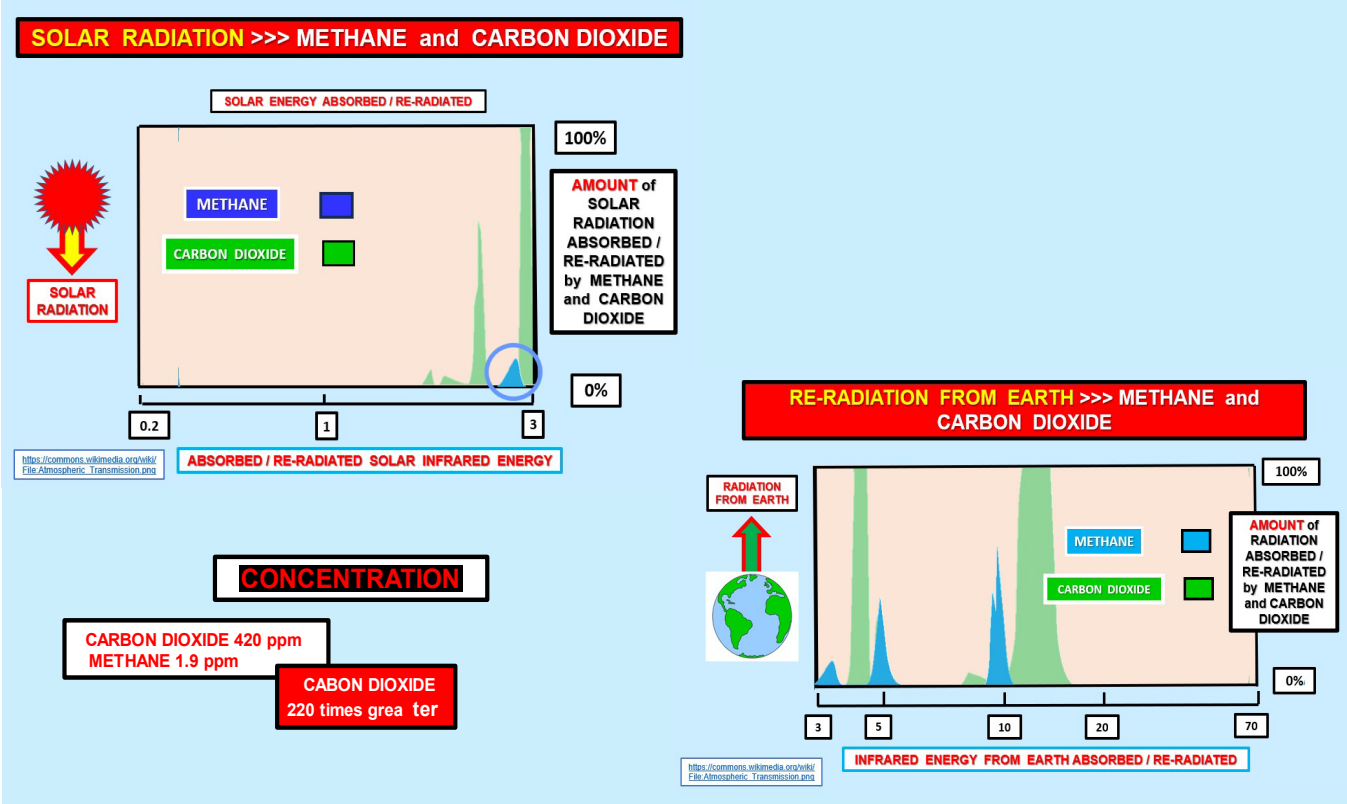
It must also be highlighted that the mean water vapour gas concentration in Australasia is about 15,000 ppm *(parts per million)* whereas methane is only 1.9 ppm. In addition, water vapour is

100% naturally produced while methane is only about 50% naturally formed *(about 1 ppm).* This means that water vapour is over 7,800 times more concentrated in air than both naturally produced methane or any other methane emitted from processes or farming.

The highlight in the graph with the overlapping radiation envelopes shows conservatively that water vapour is over 5,900 times more radiation effective than the total methane in the atmosphere. The details of how this was determined using the area under-the-care method are presented in Appendix 1.

That evidence alone is enough to 'annihilate' the *over*-emphasis of methane as an effective atmospheric GHG in any contribution to weather changes. Hence, any taxing or undue constraints on New Zealand farmers cannot be scientifically justified. Unsupported evidence could place unreasonable extra costs on farmers and thus affect New Zealand's export markets and our economy. The evidence presented here clearly provides technical support to the Methane Science Accord.

In addition, and to be fair, we must also examine the comparative radiation effects of methane's closest rival, carbon dioxide. This is demonstrated in the next graph for both incoming solar and exiting re-radiation. It is based entirely on the same Worldwide Web reference cited above (details in Appendix 1).

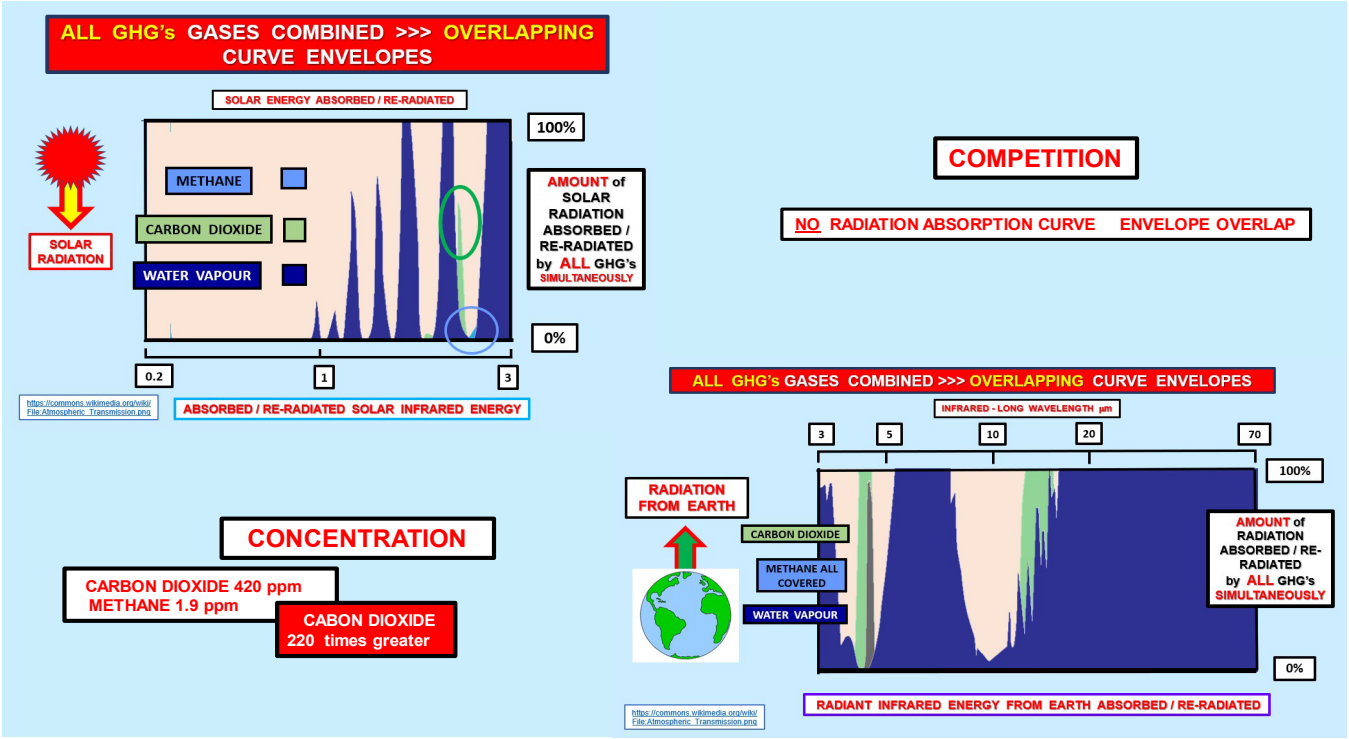


This second graph clearly shows that the infrared absorption / re-radiation curve envelopes for methane are also smaller than those for carbon dioxide both in bandwidth *(potential absorption range)* and magnitude *(amount absorbed).* A big difference here is that the extent of radiation envelope overlap is far less than to than methane and water vapour. This demonstrates that methane and carbon dioxide act mainly as independent entities in the atmosphere with respect to infrared radiation. Carbon dioxide has 3 absorption bands operating at 100% and 1 at about 70%. All 3 methane bands operate at less than 70% absorption levels at their respective wavelength or frequency spans. However, it is most important to see that both are very low in

atmospheric concentration with methane at 1.9 ppm and carbon dioxide at 420 ppm. This is exacerbated as over 90% of carbon dioxide is naturally produced (380 ppm) [50% methane is natural, or about 1 ppm].

To complete the radiation-GHG landscape we must examine all 3 major GHG's simultaneously. We see in the 3rd graph below that the naturally produced water vapour radiation curve envelopes overlap both methane and carbon dioxide extensively. Water vapour is clearly dominant in both the incoming solar range and the longer wavelength re-radiation back for planet earth.

Details are also presented in Appendix 1 to show water vapour is not only 5,900 times more radiation effective that methane, but also 350 times more effective than the man-made portion (from vehicles, power plants and industry) of carbon dioxide. This also highlights radiation curve-overlap compensation and thus competitiveness over the same wavelength bands. Indeed, this is highly significant and severe errors can result if this is omitted or ignored. *[These findings are quite similar to the more recent published research results from the independent work of Wijngaarden et al. who do not use the data source material cited here].*



*See **APENDICES***

The details of the **'area-under-the-curve' method** are presented in APPENDIX 1.

Also **28 additional non-radiation GHG effects** are summarized in APPENDIX 2.

APPENDIX 3 outlines that there are other major engineering effects and driving forces including the massive phase-change effects that must also be considered outside of only the radiation issue by itself. Further visual evidence and data are presented in a Video LINK in APPENDIX 3.

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APPENDICES

Appendix 1

HOW THE ABSOLUTE ABSORPTION QUANTITIES of EACH GREENHOUSE GHG WERE DETERMINED USING THE INFRARED ENVELOPES

Appendix 2

28 ADDITIONAL NON-RADIATION GREENHOUSE GAS and OTHER INTERACTIONS

Appendix 3

WHY CLIMATE AND WEATHER CHANGES ARE NOT JUST CAUSED BY INFRARED RADIATION (with UTube Video LINK)

APPENDIX 1

HOW THE ABSOLUTE ABSORPTION QUANTITIES of EACH GREENHOUSE GHG WERE DETERMINED USING THE INFRARED ENVELOPES

CARBON DIOXIDE, METHANE, NITROUS OXIDE, WATER VAPOUR

Note: *Water vapour gas concentration used here is 1% of the atmosphere (10,000 ppm)*

CONCLUSION

WATER VAPOUR'S CLEAR SUPERIORITY OVER ALL OTHER GREENHOUSE GASES IN ATMOSPHERIC RADIATION

BASED ON PUBLISHED RADIATION DATA https://commons.wikimedia.org/wiki/File:Atmospheric_Transmission.png

WATER VAPOUR IS 35 TIMES MORE RADIATION-EFFECTIVE THAN THE *TOTAL* ATMOSPHERIC CARBON DIOXIDE

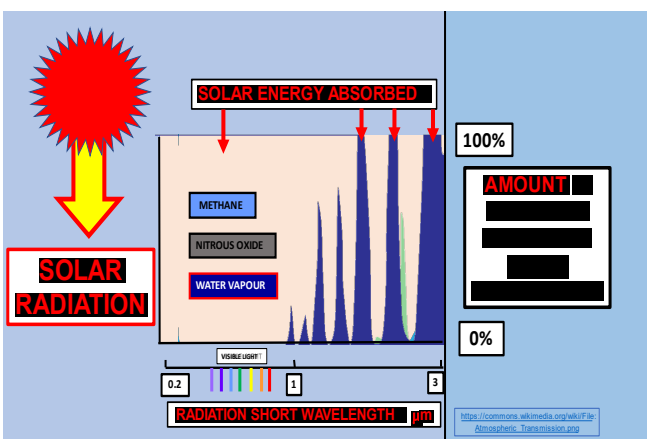
WATER VAPOUR IS 5,900 TIMES MORE RADIATION-EFFECTIVE THAN METHANE

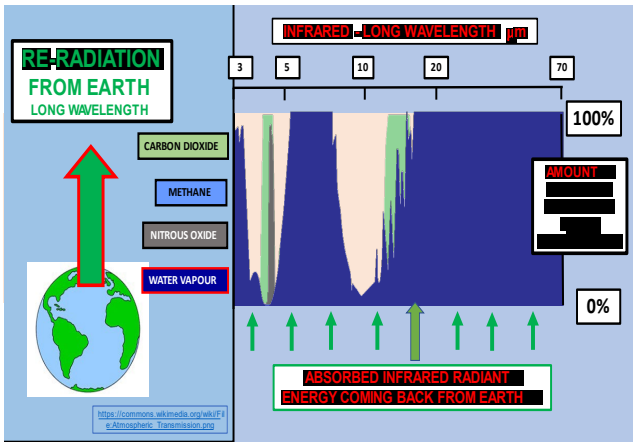
WATER VAPOUR IS 1,400 TIMES MORE RADIATION-EFFECTIVE THAN NITROUS OXIDE

WATER VAPOUR IS 700 TIMES MORE RADIATION-EFFECTIVE THAN MAN-MADE CARBON DIOXIDE

WATER VAPOUR IS 37 TIMES MORE RADIATION-EFFECTIVE THAN NATURAL CARBON DIOXIDE

CONCENTRATION WATER VAPOUR is 24 TIMES GREATER IN CONCENTRATION THAN CARBON DIOXIDE: OVER 5,000 TIMES GREATER IN CONCENTRATION THAN METHANE: 33,000 TIMES GREATER IN CONCENTRATION THAN NITROUS OXIDE





Interaction of radiation with Atmopheric greenhouse gases (incoming solar and outgoing re-radiation from earth). Published data: https://commons.wikimedia.org/wiki/File:Atmospheric_Transmission.png

Most radiation curve envelopes ***OVERLAP***. There is a radiation-GHG competition over almost the entire radiation range. Also the more highly concentrated GHG's 'swamp' the lower concentration ones, and reduces their radiation-interaction effectiveness. Some envelopes are completely hidden by the highest concentration GHG water vapour. In one case, a carbon dioxide enevlope entirely covers one nitrous oxide curve. Hence, we must examine EACH GHG separetely, and then check for curve overlap, compensate, and re-determine their competitive effectiveness.

Concentration First:

Water vapour New Zealand: 1% [1% (10,000 ppm used here: later analyses uses 1.5% (15,000 ppm)
ALL other **GHG's** in NZ **TOTAL**: 0.04172% *
Carbon Dioxide 0.0415%* + Methane 0.00019% + Nitrous Oxide 0.00003%. [*0.042% used later]

Water vapour concentration is 24 times greater in concentration than ALL the GHG's in Air.
Water vapour concentration is 24 times greater in concentration than Carbon Dioxide; over 5,250 times greater in concentration than Methane; and over 33,300 times that of Nitrous Oxide.
Water vapour is over 90 times greater in concentration than Carbon Dioxide in the tropics.

But concentration is only one factor. The graphical data above (and in the Appendix below) show how water vapour also dominates with ALL radiation as well. It is far more radiation-effective. Detailed analysis are presented below (and in the Appendix).

TOTAL RADIATION-EFFECTIVENESS ALLOWING FOR COMPETITION AMONG ALL GHG'S and COMPENSATION FOR ALL OVERLAPPING RADIATION CURVES

Incoming Solar: Range 0.2 to 3 micrometres (μm) *[See Page 1 and Appendix 1]*

Outgoing Earth radiation: Range 3 to 70 micrometres (μm) *[See Page 1 and Appendix 1]*

OVERALL CONCLUSION

WATER VAPOUR TOTAL RADIATION COMPARISON

1. Water Vapour is 35 times more radiation-effective than the **TOTAL Carbon Dioxide**
2. Water Vapour is 37 times more radiation-effective than ***NATURAL* Carbon Dioxide**
3. Water Vapour is 702 times more radiation-effective than **MAN-MADE Carbon Dioxide**
4. Water Vapour is 5,901 times more radiation-effective than **Methane**
5. Water Vapour is 1,475 times more radiation-effective than **Nitrous oxide**

The areas under each GHG spectral curve (envelope) are taken directly from the published data https://commons.wikimedia.org/wiki/File:Atmospheric_Transmission.png When GHG curve envelopes overlap, their separate and independent effectiveness in that specific wavelength range, is then assessed and the relative area calculated. This gives the *EFFECTIVE maximum energy ABSORBED/RE-RADIATED by each GHG* in the competitive atmospheric environment.

Maximum possible Area $\mathbf{A_m}$ for 100% radiation absorption/emission = (70 - 0.2) μm x 100% = 6980 units

GREENHOUSE GAS	AREA UNITS ABSORBED	% AREA UNITS	COMMENTS
Water Vapour	5,901	84.5%	84.5% of ALL Radiation
Carbon Dioxide Total	168	2.4%	
Carbon Dioxide Natural		2.3%	95% natural CO>2
Carbon Dioxide Man-made		0.12%	<5% Man-made CO>2
Methane	1	-	Almost totally overlapped
Nitrous Oxide	4	0.06%	Almost totally overlapped
ZERO Absorption	906	13.0%	

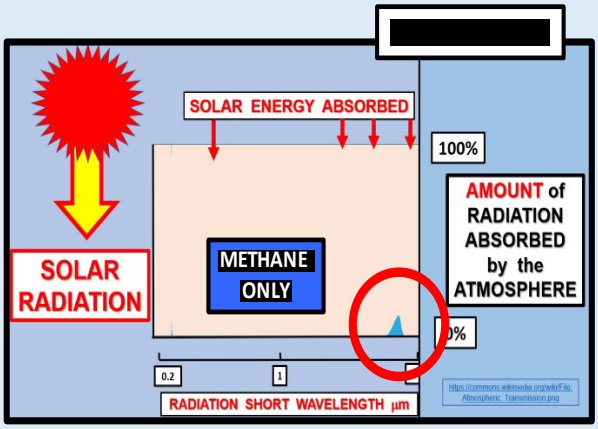
WATER VAPOUR CLEARLY DOMINATES OVER CARBON DIOXIDE, METHANE, and NITROUS OXIDE in ATMOSPHERIC RADIATION - BASED ON CERTIFIED PUBLISHED DATA

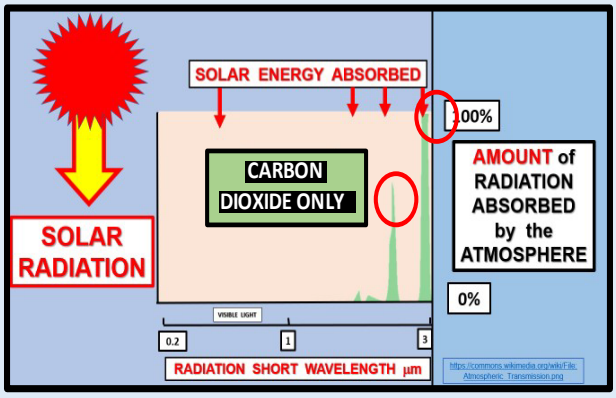
9(2)(a)

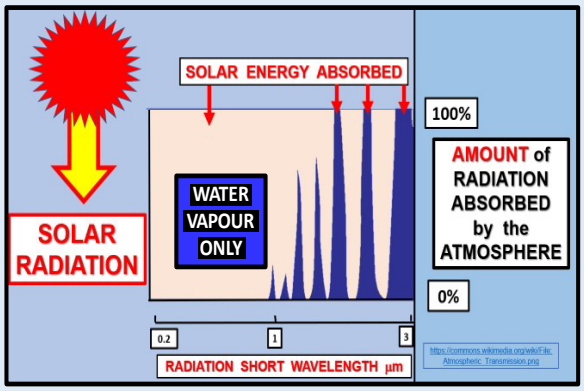
Actual graphical data used

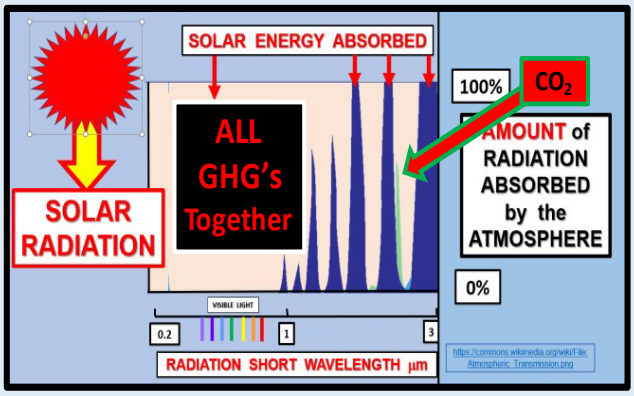
Actual data for electromagnetic Solar radiation and re-radiation back from planet earth isolating the contributions of EACH GHG separately

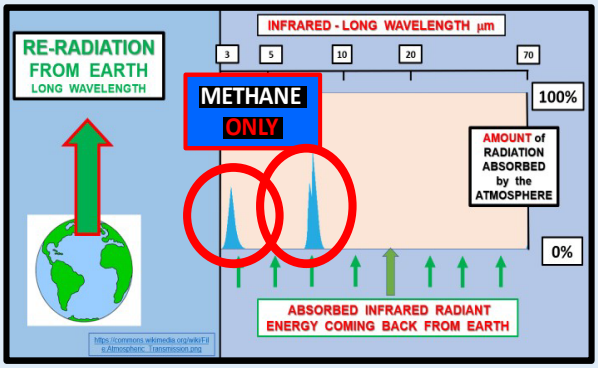
https://commons.wikimedia.org/wiki/File:Atmospheric_Transmission.png

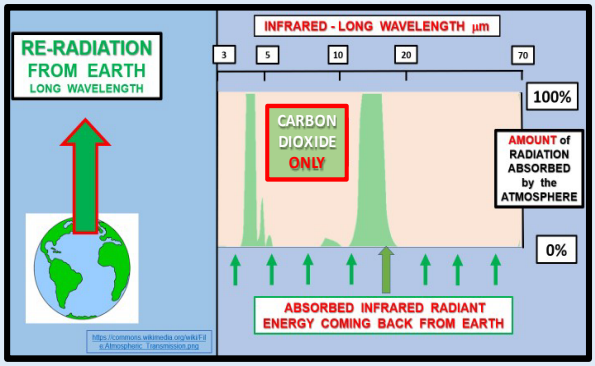


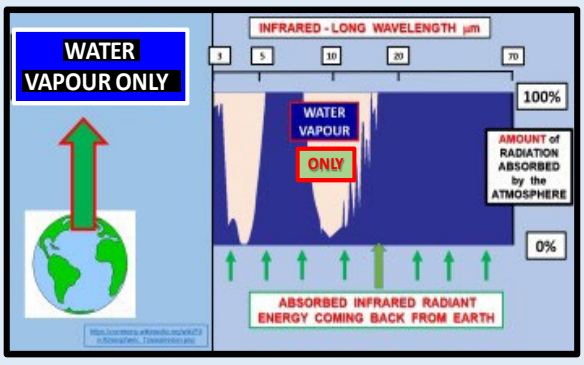


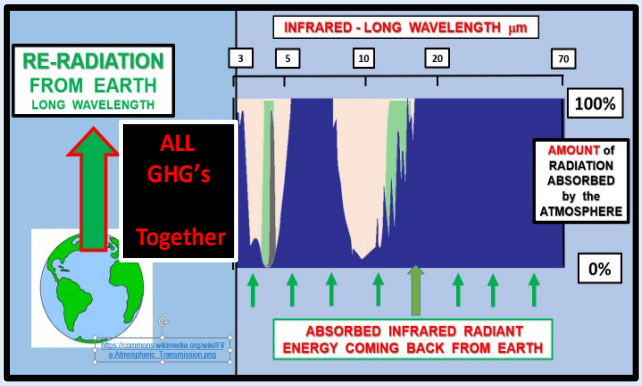












9(2)(a)

PART 1

CONTRIBUTION of EACH GREENHOUSE GAS EXAMINED SEPARATELY AND INEPENDENTLY AS IF THEY DID NOT INTERACT/OVERLAP

A: INCOMING SOLAR RADIATION: Range 0.2 to 3 micrometres (μm)

Using the **area under the spectral curve** for each GHG by itself as the EFFECTIVE potential maximum energy ABSORBED by that GHG, and disregarding overlap initially.

BASIS: Maximum Possible Area = (3 - 0.2) μm x 100% = 100 x 2.8 = 280 area units

GREENHOUSE GAS	AREA UNITS	% AREA UNITS
Water Vapour	116	41.4 %
Carbon Dioxide	20	7.1 %
Methane	2.5	0.9 %
Nitrous Oxide	0.8	0.3 %
ZERO absorption	140.7	50.2 %

SOLAR RADIATION ABSORPTION / RERADIATION COMPARISON with water vapour from the Table (disregarding overlap initially) **…**

1. Water Vapour is 5.8 times more radiation effective than the TOTAL Carbon Dioxide
2. Water Vapour is 6.1 times more radiation effective than *NATURAL* Carbon Dioxide
3. Water Vapour is 116 times more radiation effective than MAN-MADE Carbon Dioxide
4. Water Vapour is 46 times more radiation effective than Methane
5. Water Vapour is 145 times more radiation effective than Nitrous oxide

B: OUTGOING RE-RADIATION FROM EARTH: Range 3 to 70 micrometres (μm)

Using the **area under the spectral curve** for each GHG by itself as the EFFECTIVE potential maximum energy ABSORBED by that GHG **(**disregarding overlap initially).

BASIS: Maximum Possible Area = (70 - 3) μm x 100% = 100 x 67 = 6700 area units

GREENHOUSE GAS	AREA UNITS	% AREA UNITS
Water Vapour	5900	88.0 %
Carbon Dioxide	435	6.5 %
Methane	41	0.6 %
Nitrous Oxide	48	0.7 %
ZERO absorption	276	4.1 %

Re-RADIATION ABSORPTION / RERADIATION COMPARISON with water vapour from the Table ..

1. Water Vapour is 13.6 times more radiation-effective than the TOTAL Carbon Dioxide
2. Water Vapour is 14.3 times more radiation-effective than *NATURAL* Carbon Dioxide
3. Water Vapour is 271 times more radiation-effective than MAN-MADE Carbon Dioxide
4. Water Vapour is 144 times more radiation-effective than Methane
5. Water Vapour is 123 times more radiation-effective than Nitrous oxide

C. ALL RADIATION ABSORPTION: Combined Solar Radiation and Re-radiation back from Earth Range 0.2 to 70 micrometres (μm) (disregarding overlap initially)

Using the **area under the spectral curve** for each GHG by itself as the EFFECTIVE potential maximum energy that could be ABSORBED by that GHG.

BASIS: Maximum Possible Area = (70 – 0.2) μm x 100% = 100 x 69.8 = 6980 area units

GREENHOUSE GAS	AREA UNITS	% AREA UNITS
Water Vapour	6,016	86.2 %
Carbon Dioxide	455	6.5 %
Methane	43.5	0..6 %
Nitrous Oxide	48.8	0.7 %
ZERO absorption	416.7	6.0 %

SOLAR RADIATION and RERADIATION ABSORPTION COMPARISON with water vapour from data above and with EACH GHG considered as fully effective (non-interactive) …

1. Water Vapour is 13.2 times more radiation-effective than the TOTAL Carbon Dioxide
2. Water Vapour is 13.9 times more radiation-effective than *NATURAL* Carbon Dioxide
3. Water Vapour is 264 times more radiation-effective than MAN-MADE Carbon Dioxide
4. Water Vapour is 138 times more radiation-effective than Methane
5. Water Vapour is 123 times more radiation-effective than Nitrous oxide

Reminder: ALL the above are for all separate GHG envelopes to show there maximum radiation absorption potential possible. That cannot ever happen in our real atmosphere!

##

PART 2

ACTUAL EFFECTIVE CONTRIBUTION of EACH SEPARATE GREENHOUSE GAS WHERE THEY COMPETE WITH OTHER GHG's

OVERLAPPING GHG ENVELOPES

A: INCOMING SOLAR RADIATION: Range 0.2 to 3 micrometres (μm)

Using the area under the spectral curve for each GHG and modifying the 'effective envelope area' when they overlap. The EFFECTIVE potential maximum energy ABSORBED by that GHG after compensation.

BASIS: Maximum Possible Area = (3 - 0.2) μm x 100% = 100 x 2.8 = 280 area units

GREENHOUSE GAS	AREA UNITS	% AREA UNITS
Water Vapour	116	41.4 %
Carbon Dioxide	5	4.3 %
Methane	0.2	0.07 %
Nitrous Oxide	0	0 %
ZERO absorption	158.8	56.7%

SOLAR RADIATION ABSORPTION / RERADIATION COMPARISON with water vapour from data above …

1. Water Vapour is 23.2 times more radiation-effective than the TOTAL Carbon Dioxide
2. Water Vapour is 24.4 times more radiation-effective than *NATURAL* Carbon Dioxide
3. Water Vapour is 464 times more radiation-effective than MAN-MADE Carbon Dioxide
4. Water Vapour is 580 times more radiation-effective than Methane
5. Water Vapour is infinitely greater in radiation-effective than Nitrous oxide

B OUTGOING RADIATION FROM EARTH: Range 3 to 70 micrometres (μm)

Using the area under the spectral curve for each GHG and modifying the 'effective envelope area' when they overlap. The EFFECTIVE potential maximum energy ABSORBED by that GHG after compensation.

BASIS: Maximum Possible Area = (70 - 3) μm x 100% = 100 x 67 = 6700 area units

GREENHOUSE GAS	AREA UNITS	% AREA UNITS
Water Vapour	5785	86.3 %
Carbon Dioxide	157	2.3 %
Methane	1	0.01 %
Nitrous Oxide	6	0.09 %
ZERO absorption	751	11.2 %

ABSORPTION COMPARISON with water vapour for RE-RADIATION …

1. Water Vapour is 37 times more radiation-effective than the TOTAL Carbon Dioxide
2. Water Vapour is 41 times more radiation-effective than *NATURAL* Carbon dioxide
3. Water Vapour is 368 times more radiation-effective than MAN- MADE Carbon dioxide
4. Water Vapour is 5,785 times more radiation-effective than Methane
5. Water Vapour is 964 times more radiation-effective than Nitrous oxide

C. TOTAL COMBINED POSSIBLE RADIATION ABSORPTION: Solar plus re-radiation back from Earth Range 0.2 to 70 micrometres (μm)

Using the area under the spectral curve for each GHG and modifying the effective envelope area when they overlap. The EFFECTIVE potential maximum energy ABSORBED by that GHG after compensation.

BASIS: Maximum Possible Area = (70 – 0.2) μm x 100% = 100 x 69.8 = 6980 area units

GREENHOUSE GAS	AREA UNITS ABSORBED	% AREA UNITS	COMMENTS
Water Vapour	5,901	84.5%	84.5% of ALL Radiation
Carbon Dioxide Total	168	2.4%	
Carbon Dioxide Natural	160	2.3%	95% natural CO>2
Carbon Dioxide Man-made	8	0.12%	<5% Man-made CO>2
Methane	1	-	Almost totally overlapped
Nitrous Oxide	4	0.06%	Almost totally overlapped
ZERO Absorption	906	13.0%	

WATER VAPOUR TOTAL RADIATION COMPARISON

1. **Water Vapour is 35 times more radiation-effective than the TOTAL Carbon Dioxide**
2. **Water Vapour is 39 times more radiation-effective than *NATURAL* Carbon Dioxide**
3. **Water Vapour is 737 times more radiation-effective than MAN-MADE Carbon Dioxide**
4. **Water Vapour is 5,901 times more radiation-effective than Methane**
5. **Water Vapour is 1,475 times more radiation-effective than Nitrous oxide**

9(2)(a)

APPENDIX 2

28 ADDITIONAL NON-RADIATION GREENHOUSE GAS and OTHER INTERACTIONS

9(2)(a)

It is widely claimed that the main cause of weather changes and developed climate patterns results from GHG's and Radiation. Here it is shown that there is far more!!

We certainly must add ….

DIRECT **RADIATION to >>> LIQUID WATER** **[71% of the planet is ocean + cloud water droplets]**

DIRECT **RADIATION to >>> SOLID MATTER** **[29% of the planet is land and solid matter]**

Some mechanisms even amplify the GHG-Radiation process, especially when the **only** phase-change gas is water vapour (GAS-LIQUID-ICE).

1. **EVAPORATION**:
   - **(a)** 71% of the Earth's surface area is ocean. Incoming solar radiation directly impacts **LIQUID** water as oceans, lakes, and rivers. 423 trillion tonnes of water evaporate/ year (13 million tonnes/second). This evaporation is caused mainly by direct solar energy absorption *to* **liquid** surface water **[NOT a greenhouse gas effect]**
   - **(b)** Liquid water can evaporate without external solar radiation (energy can come from within the liquid itself causing evaporative cooling) **[NOT a greenhouse gas effect]**
   - **(c)** Liquid water can evaporate into the atmosphere even when there is NO temperature difference between the water layer and atmosphere (with or without solar radiation-water absorption) (*Reason*: When the atmosphere is not saturated with water vapour ie partial pressure lower than the vapour pressure) **[NOT a greenhouse gas effect]**
   - **(d)** Liquid water can evaporate into the atmosphere in certain cases when the air near the interface is at a lower temperature (no external solar radiation needed) (partial pressure lower than the vapour pressure) **[NOT a greenhouse gas effect]**
   - **(e)** Liquid water can evaporate into the atmosphere when the air *flowing* across the interface is *not* already saturated with water vapour (a concentration driving force: not a temperature driving force) **[NOT a greenhouse gas effect]**
   - **(f)** Liquid water evaporation into the atmosphere can be augmented just by an increase in interfacial surface area: waves, winds, impacting raindrops, and other surface flow disturbances **[NOT a greenhouse gas effect]**
   - **(g)** Temperature gradients immediately below the liquid ocean surface can cause convective liquid mixing and thermal gradients, augmenting evaporation and thus the production of water vapour **[NOT a greenhouse gas effect]**

2. **ATMOSPHERIC HUMIDIFICATION – WATER VAPOUR CHANGES**
   - (a) Water vapour can move in air without radiation due to differences in pressure, humidity (water vapour concentration), and/or air density (non-thermal driving forces). Convection and diffusion occur **[NOT a greenhouse gas effect]**
   - (b) Water vapour concentrations in the atmosphere can change due to the interactions of adjacent moving air having a different level of moisture-vapour content (humidity

difference). Examples: breezes, winds, thermals, gales
[NOT a greenhouse gas effect]

(c) Water vapour concentrations can change in the air due to the local presence of liquid water; water droplets, mists, rain, fogs, ice crystals etc
[NOT a greenhouse gas effect]

(d) Water vapour concentrations in the atmosphere can change when water vapour sublimates and goes directly from gas to ice, ice crystals, or snowflakes
[NOT a greenhouse gas effect]

(e) Water vapour concentrations can change in the air when the water vapour-liquid water equilibrium (dew point) is exceeded
[NOT a greenhouse gas effect]

(f) Water vapour concentrations can change in the air when that moist air comes into contact with cooler solid surfaces e.g. condensing as dew
[NOT a greenhouse gas effect]

3. **CONDENSATION in the ATMOSPHERE**

(a) Gaseous water vapour and/or existing liquid water molecules can combine to form small liquid droplets in clouds, mists, or fogs
[NOT a greenhouse gas effect]

(b) When atmospheric water vapour condenses to form fogs, mists, or clouds *(phase changes),* it gives up large amounts of thermal energy as latent heat
[NOT a greenhouse gas effect]

(c) Liquid water in clouds, mists and fogs can evaporate back again to form water vapour (gas) if the air is not saturated with water vapour
[NOT a greenhouse gas effect]

(d) Liquid water in clouds, mists and fogs can evaporate to form water vapour (gas) with-or-without a temperature change (concentration-difference driving forces)
[NOT a greenhouse gas effect]

(e) Gaseous water vapour can condense and amalgamate with either, other existing water vapour molecules, and/or, other liquid water molecules to grow clouds, mists or fogs
[NOT a greenhouse gas effect]

(f) Gaseous water vapour can transform straight to ice crystals or snow particles without going through the liquid phase *(sublimation: latent heat transfer)*
[NOT a greenhouse gas effect]

4. **PRECIPITATION**

(a) Miniscule water droplets can aggregate to form larger, less-buoyant water droplets, that can then fall by gravity as rain to cool the air, then sea and land
[NOT a greenhouse gas effect]

(b) Water droplets can freeze and amalgamate to form larger, less buoyant ice and snow particles and precipitate towards the planet's surface, cooling the atmosphere, land, and sea
[NOT a greenhouse gas effect]

(c) Large falling rain droplets can pass through a cold atmospheric layer and freeze to form ice crystals or snow particles
[NOT a greenhouse gas effect]

(d) Snow particles or ice crystals can melt and produce liquid cold rain drops by energy absorption, or transfer straight to water vapour
[NOT a greenhouse gas effect]

(e) Raining water droplets can vaporise to form water vapour either by thermal energy transfer and/or by mass transfer driving forces (unsaturated local atmosphere) {termed 'virga': visible rainfall does not actually reach the ground} **[NOT a greenhouse gas effect]**

(f) Falling ice and snow particles can, by sublimation, transfer directly to gaseous water vapour **[NOT a greenhouse gas effect]**

THREE OTHER FACTORS

- Water *vapour* can increase or decrease in concentration without any temperature change, or even when the temperature is lowered. A Humidity Chart reveals that adiabatic humidification can occur. These mechanisms do not require solar radiation directly, and are not widely understood, and are therefore: **NOT greenhouse effects**
- Massive convective mixing operations worldwide in rain, winds, gales, storms, hurricanes, tornadoes and more, must all be factored in. Either thermal driving forces caused by temperature differences AND/OR mass transfer driving forces caused by concentration or humidity differences, density differences, can all cause large weather-change effects: **NOT greenhouse effects**
- It must also be pointed out that solar radiation can also DIRECTLY heat planet Earth and all solid materials on it, and 'excite' various molecules so that they re-radiate long-wave thermal energy (in addition to direct reflection of incoming solar radiation, the scattering of radiant energy, and the convective mixing movement of all atmospheric gas molecules colliding with the earth): **NOT a greenhouse effect**

Most importantly overall, it must be seen that there are not just temperature-gradient driving forces (heat transfer), but also concentration-humidity driving forces (mass transfer driving forces). *[Of course, there are also momentum driving forces in convective mixing, and as well, pressure difference and density difference driving forces]*. These additional mechanisms cut right across the false notion that water vapour concentration depends only on temperature-rise which could possibly be caused by other non-condensable GHG's. Even NASA misses this point in some published web articles, as the water / water vapour system is seen only to be a passive feedback greenhouse gas system (not a non-forcing action), caused by the earth heating up. In some cases (Wikipedia), water vapour is wrongly excluded as an *active* and *controlling* GHG altogether. In reality, it is by far the strongest GHG (water vapour is 96% of all greenhouse gases in New Zealand; 24 times higher than carbon dioxide, and 500 times great in concentration than man-made caron dioxide). Wikipedia is therefore incorrect in reporting that; and complicit in failing to correct that false proposition!

It is scientifically inaccurate and dishonest to isolate "radiation - low concentration/non-condensable greenhouse GASES like CO>2 and CH>4" without fully endorsing: {direct radiation - LIQUID water interactions), {direct radiation – SOLID matter exchanges}, {radiation - water vapour excitations}, as well as all the other thermal and non-thermal humidity driving forces in winds, thermals, gales, rain, storms, hurricanes, tornadoes, Trade Winds, Jet streams, El Nino's, La Nina's, atmospheric pollution, and incomplete combustion particulates. All are significant! The impacting effects of ocean currents, ocean conveyor belts, cloud dynamics, and sun-spot activity, and amore, must also be added as very important drivers in all weather-change operations.

It is no wonder that simplified mathematical models fail to grapple with all these additional mechanisms in climate change scenarios, and therefore their to predictions are erroneous. This is made worse by the complete ignorance of **phase change, or change-of-state,** as well (liquid water >>> water vapour> >> liquid water >>> solid ice crystals >> liquid water or vapour).

9(2)(a)

https://www.researchgate.net/publication/351801451

APPENDIX 3

WHY CLIMATE AND WEATHER CHANGES ARE NOT JUST CAUSED BY INFRARED RADIATION

https://www.youtube.com/channel/UC5Owyggc78UgDQCjboah5ww

Weather Changes and Climate Patterns are **NOT ONLY** due to **radiation**. There are many other **non-radiative actions** occurring day and night that play enormous roles *(convection, conduction, latent-heat transfer, evaporation, turbulent mixing, diffusion, water condensation, evaporative cooling, high-and-low pressure systems … and more … and the earth's rotation plays a big part).*

We MUST include:

1. **'THE NATURAL WATER CYCLE'** The ongoing cycle of evaporation, humidification, condensation of water vapour to minute droplets, droplet amalgamation with-and-without cloud formation, and then droplet growth and precipitation as rain, snow or hail. Radiation is only involved in some of these process-changes as they also occur night-and-day.

2. **'THE NATURAL CO_2 - BIOLOGICAL AND CHEMICAL CYCLE'** Photosynthesis is vital as it 'extracts' the carbon atoms from molecules of atmospheric carbon dioxide gas to form carbohydrates, bicarbonates, sugars, and more. From those come all the cellulose and other complex larger organic molecules in every plant and crop *(flowers, fruit, leaves, petals, juices, colours, etc).* Indeed, CO_2 is the critical 'feedstock' for all plant life. Marine phytoplankton does the 'photosynthesis-action' in the oceans and lakes taking in large quantities of CO_2 to produce shells and molluscs. Both systems supply our necessary

O_2. Also, some of this energy is chemical and bio-chemical energy in both sea and air, and these 'energy effects' plus humification, are significant and often disregarded or omitted.

3. **'THE MASSIVE MIXING ACTIONS'** Turbulence and mixing are powerful in both the atmosphere and oceans *[Thermals, winds, storms, rain, snow, Jet streams, El Nino's and La Ninjas as well … PLUS … ocean currents, conveyor belts, tides, waves etc..].* Thermal *(heat)* energy, Kinetic *(motional)* and even Potential energy *(elevational)* effects simply must be included in ALL bulk motion processes worldwide and these have enormous impacts on weather and weather changes. Radiation may play some part in some of these!

Of course, almost all energy comes originally from the Sun as electromagnetic radiation. Solar radiation travels 150 million kilometres towards earth through outer space *(essentially a vacuum at -273 ^{0}C)* and does absolutely nothing in space as there are no molecules to interact with. Radiant energy *(mainly the infrared portion),* largely 'favours' solids *(earth)* and liquids (*clouds, oceans, droplets, lakes),* as well as a few atmospheric gases, termed greenhouse gases GHG's (ALL *GHG's total less than 1.5% of the total atmosphere in Australasia)*. In most cases, radiation MUST be 'transmuted' to thermal, kinetic, and chemical energy, before it has any 'observable' effect.

The most radiation-effective GHG by far is water vapour *(of the order of 1 -1.5 % of the atmosphere in New Zealand and 4 % in the tropics)*. Water Vapour is 100% *naturally* produced and is the **ONLY** GHG that is both: (1) condensable and (2) able to change state *(gas > < liquid > <solid)* in the atmosphere. These TWO additional mechanisms make water unique: far different from the other GHG's.

ALL the *remaining* **non**-condensable GHG's combined TOTAL less than 0.043% of the entire atmosphere. The total atmospheric carbon dioxide is about 420 ppm (parts per million) and the naturally produced amount (380ppm) exceeds 90%. About 50% of methane is naturally produced (1 ppm). Surprisingly this leaves a total of *only* about 41 ppm of ALL GHG's that are man-made (0.0041% of the total atmosphere); that is the total amount generated from mankind's industrial processes, power generation, and transport systems.

IF we consider the effects of radiation separately, we must evaluate far more than just concentration (amount) and how much each gas can possibly 'absorb' and instantly re-radiate. These issues must include: GHG '**effectiveness',** GHG '**competition'** and GHG **'uniqueness'.** Full data are available on the Web: * https://commons.wikimedia.org/wiki/File:Atmospheric_Transmission.png

Also, we must examine ALL the radiation ENVELOPES of the published radiation-curve data* and see how and where they **OVERLAP**. The overlapping higher-concentration GHG's dominate and make the lower-concentration GHG's less effective (even ineffective), in the radiation-competition operating in the same range. That simply MUST be factored in! IF not, the effect of the 4 factors considered here will be skewed, or even wrong.

INDEPENDENT and SEPARATE PROOF

Water vapour ALONE 'swamps' almost ALL other GHG-RADIATION interactions*.

It is easy to show** that the **Total** 100-year increase in CO_2 (110 ppm) is surpassed by water vapour *within a few hours* by normal daily-temperatures increases. Only a daily 0.5 ^{0}C air-temperature can increase the water vapour far more than the total 100 year-gain of CO_2. And water vapour is the strongest GHG by far. But what makes a mockery out of IPPC and many Press statements, is that the CO_2 110ppm increase can be easily exceeded by a **small rise in**

<u>Relative</u> Humidity *(as low as 3%)* with ***<u>NO</u>* temperature change at all.** This happens every day. It does not take 100 years! ### **Water vapour is over 30 times higher in concentration than CO_2, 35 times more radiation-effective than CO_2, and 700 time more radiation-effective than man-made portion of CO_2.**

As mentioned, CO_2, CH_4, and N_2O are **non**-condensable. Combined they are about 1/35th of the stronger condensable GHG water vapour *(only 1/90th in the tropics).* Simply and scientifically, these non-condensable GHG cannot be proven to be of any great consequence anywhere in the world.

All this can be independently and easily verified / proven from the radiation spectral data on the Web*, incorporating radiation 'competitiveness, effectiveness, and uniqueness'.

** https://www.lenntech.com/calculators/humidity/relative-humidity.htm

<u>DIFFICULTIES in MATHEMATICAL MODELLING</u> It is totally impossible to carry out accurate, analytical climate modelling without incorporating water droplets. There are significant surface interactions between water vapour and water droplets including: droplet surface tension forces, inter-droplet mass transfer and thermal energy transfer driving forces, as well humidity driving forces adjacent to each droplet. The droplet surface-area change as cloud droplets combine is huge. Amazingly, the surface-area change is over 42 times the surface area of planet earth per hour, from the 13 million tonnes/second evaporated, condensed, and precipitated worldwide.

Humidity is least-well understood by most. The absolute humidity (mass of water vapour per unit mass of dry air) can go *up* even when the temperature goes *down (termed adiabatic humidification).* This cuts across all logic, but makes mathematical modelling virtually impossible, without 'guessing' some of the major parameters in the combined heat and mass transfer gradients and dynamics.

All this is made worse by the complete misunderstanding and over-simplification that CO_2 simply goes up about 2 ppm+ *(parts per million)* per year. The media, government bodies, and many other scientific establishments, simply believe and state that. In reality, CO_2 goes up about 10 ppm in 6 months and down 8 ppm in the very next 6 months on a worldwide scale. This repetitive skewed oscillation is superimposed on a steady exponential CO_2 increasing curve, corresponding with the seasonal 'greening of the world' and the huge increases in crop yields in both hemispheres sequentially every 6 months, over several recent decades.

Not all the world is experiencing a uniform and reproducible temperature rise. Averages have no *functional* meaning, as any averages over a day, vary widely at any one specified location, and vary simply by elevation, location, winds and more. For averages not to be mis-weighted, measurements at each location must be taken at the same time each day, and seasonal changes must be factored in. An average in a zone could be meaningless if the terrain varies considerably.

Unfortunately, when the media and others use the term 'Climate Change', they focus mainly, and often only, on the temperature *(thermal differences).* Their mantra: "1 ^{0}C to 1.5 ^{0}C by 2030 or 2050". *[Actual temperatures go up-and-down 5-15 ^{0}C each day so that cannot be a true and serious issue, as no one dies from that].* Other meteorological factors are usually omitted disclosing bias, or perhaps ignorance. Temperature-difference is simply <u>one</u> factor to 'explain' heat-effect differences, and thermal energy transfer! *(sunshine hours, precipitation, wind, snow, season etc*)

But there is far more! We have massive kinetic energy differences, concentration differences, humidity differences, density differences, pressure and vapour-pressure differences, chemical

and bio-chemical driving-force differences, collision impact driving-force differences … as well! We must also refocus on the enormous turbulent and mixing forces and movements in winds, storms, rain (and more) … in addition to the slower, but still powerful, macro-movements in the oceans (currents, tides, conveyor belts, waves, as well). These are kinetic energy difference-driven effects and show the danger of simply over-using thermal energy concepts and simple heat balances.

> **What other key factors are missing or neglected** in addition to the natural water cycle, the carbon dioxide cycle, and massive convective mixing?

PHASE CHANGE: Firstly, consider the *unique* characteristics of the substance water in the atmosphere. Clearly water (liquid, vapour, solid) is dominated by **phase-change** (**change-of-state).** Added to the obvious evaporation, condensation, and precipitation mechanisms, there is the transfer to the solid-water state (ice particles and snow particles). Also, ice can go straight to water vapour without passing through the liquid state (*sublimation)*. No; CO_2 and all the other non-condensable GHG's do not, and indeed cannot, do any of that. The CO_2 mantra misses all that!

EQUILIBRIUM: Secondly, the overall EQUILIBRIUM principle is a most valuable concept. In this world, we *ONLY* have driving-forces and resistances in ALL processes. ALL process actions are moving energy and matter toward the stable final-state of equilibrium (see a summary of 'driving-force differences' above). Equilibrium is rarely reached, but it clearly shows the severe danger of myopically selecting CO_2 as the single and key factor. In fact, anyone who declares CO_2 (and other non-condensable GHG's gases) only, without including phase-change, is openly confessing that they do not understand the vital significances of both driving force-resistance and phase change.

CO_2 is not the enemy. Incomplete combustion *(minute unburned particles),* atmospheric dust from all sources (eg rubber tyres), chemical and bio-chemical pollution, are. These should be our focus.

> Just as well that the 'water vapour >><< water liquid water' system in 'The Natural Water Cycle' is **self-compensating**, **self-regulating**, **self-buffering**, and **self-restoring**.

##########

A concise overview with diagrams and pictures is presented in the **UTUBE Video January 2023:**

https://www.youtube.com/channel/UC5Owyggc78UgDQCjboah5ww

9(2)(a)

CH4 Global Submission to the Methane Science Review

- Thank you for the opportunity to make a submission on the Methane Science Review. The central points of our submission are as follows:
    - Reducing biogenic methane is key to reducing New Zealand's overall emissions, and New Zealand's export future.
    - Deploying methane inhibitors such as CH4 Global's Methane Tamer^{MT} can make substantial contributions to methane reduction targets over the next two Emission Budget periods.

About CH4 Aotearoa

- CH4 Aotearoa is a subsidiary of CH4 Global, which was founded in New Zealand in 2018. Building on CSIRO research in Australia and technology developed at CH4 Global's R&D facility based at NIWA's Northern Aquaculture Park, we have succeeded in commercialising seaweed-based feed supplements to reduce methane emissions from livestock and CH4 Global is now the world's first company selling this inhibitor tool into commercial markets.
- Natural compounds in asparagopsis seaweed prevent methane gas from being formed during the digestive process of ruminant animals. This has been shown to reduce enteric methane emissions by up to 90% in beef and dairy cattle as well as sheep, with no adverse effects to livestock, their products, or the environment, when used at the optimal level defined in independent scientific publications.
- In 2022, we introduced Methane Tamer^{TM}, our revolutionary methane-reducing feed supplement formulation targeted for beef feedlot cattle. Take-off agreements are in place to supply supplements for over 40,000 cattle in the coming year as our production capacity increases. And we have announced supply to the entire South Korean market of 4 million cows through a partnership with globally recognised Lotte International. In the coming months other global markets partnerships will be announced for commercial products.
- Working together with our commercial partners, we are advancing toward our 2030 target of reaching 150 million cattle—10% of the world total—on all six habitable continents, which will prevent the emission of 1 gigatonne of CO2 equivalent.
- We grow our seaweed in New Zealand and Australia, in controlled aquaculture facilities enabling us to produce a high quality, low-cost raw material that is then formulated into its final finished stable product form as Methane Tamer$^{TM.}$.

The proposed agricultural emissions reduction strategy Is feasible

- The agricultural emissions reduction plan assumes that there are effective strategies in place to accelerate the development of mitigation tools and technologies to reduce on-farm emissions.

- This is presented in the plan as an upside opportunity with the potential for a reduction of 3.1 to 15.3 Mt Co2-e. We agree that this opportunity exists and is realisable (but not with the current policy settings).
- With the right policy settings and urgency, we believe it would be possible to reduce agricultural emissions by up to 15.3 Mt Co2-e in the second emissions budget period.

About methane inhibitors

- Agricultural emissions account for 53% of NZ's total emissions and agricultural methane emissions alone account for 43% of NZ's total emissions.
- Methane inhibitors are key to New Zealand reaching its climate goals without reducing stock numbers.
- Reducing methane is vital to New Zealand's trade future – using methane inhibitors can allow our exporters to market their produce at a low carbon premium and meet the increasingly stringent demands of climate-conscious overseas consumers. It has recently been reported that NZ dairy farmers are no longer the most carbon efficient In the world, and as farmers in other markets take up the available inhibitor tools, New Zealand's relative position will continue to decline, thus putting our export trade at risk.
- Dairy methane emissions are by far the largest single contributor to NZ's total emissions (22%) as well as being the easiest sector to implement solutions. Therefore, there needs to be greater focus (in terms of targets, funding and regulatory support) on dairy methane tools to be able to make a meaningful reduction in NZ's emissions by 2030.
- CH4 Global's Methane Tamer™ product uses asparagopsis, a natural seaweed native to New Zealand and South Australia, which has been proven to reduce methane emissions in sheep and cattle by up to 90% in continuous feeding systems. This solution could be readily adapted to support pasture-fed dairy.

NZ Dairy industry position

- As the dominant player, Fonterra has led the way by committing to reduce scope 3 methane emissions intensity (emissions per unit of milk output) by 30% by 2030.
- AgriZeroNZ's goal is even more ambitious in setting an absolute 30% reduction in biogenic methane and nitrous oxide emissions by 2030.

The current regulatory system is a barrier to innovation in this space

- Our product, called Methane Tamer™ uses as its main ingredient, a natural plant native to NZ called Asparagopsis seaweed.
- Asparagopsis and other seaweeds have been eaten by animals and humans for centuries.
- It is completely legal to provide animals with these products as an animal feed right now, without any need for registration.

- But under the current ACVM regulations, the need to register as a Vet Medicine only arises if seaweed is sold expressly as a methane inhibitor (i.e. a different marketing claim)
- Whether it's sold as an animal feed or a methane inhibitor, it's the same base product (dried asparagopsis seaweed), so it makes no logical sense, that one application is safe and the other (in much smaller quantities) isn't.
- Therefore, the Government needs to accelerate the recently announced Ministry of Regulation enquiry aimed at streamlining the ACVM regulatory regime for agricultural inhibitors, to address the unnecessary red tape that is stifling innovation in this space.
- This would allow farmers to continue to access overseas markets, to market their products with a low-carbon premium to the rest of the world, as well as creating jobs manufacturing methane inhibitors here in New Zealand.

Summary

- The proposed emissions reduction plan for agriculture assumes a potential upside opportunity that could be realised through the use of proven methane inhibitors.
- Failure to grasp this opportunity would be a tragedy – a missed opportunity to impact climate change, to show global leadership, to maintain NZ's international competitiveness and to support NZ farmers.
- With the right policy settings and urgency, we believe it would be possible to reduce agricultural emissions by up to 15.3 Mt Co2-e in the second emissions budget period.

For this opportunity to be realised, there needs to be significant change to NZ's policy settings:

- Encouragement for, and investment in, the commercialisation on NZ farms of proven inhibitor products that are already being used in other countries.
- Changes to the regulatory regime to remove unnecessary red tape that is stopping investment in adapting overseas inhibitor tools for NZ farming systems and which will eventually slow down the commercialisation of the current batch of early-stage inhibitor tools.
- Removal of the disincentives (including addressing misinformation about methane emissions) that are working to slow-down or frustrate the adoption of the tools that are available today and that may be available in the future. Farmers need to positively embrace these technologies to ensure rapid and effective implementation.

The first step towards addressing the methane emissions reduction opportunity is to implement a solution across the accessible dairy herd in New Zealand:

- An inhibitor tool could reduce daily methane emissions by 70-80%. Used across the milking season by up to 50% of dairy farmers by 2030, this could reduce total dairy methane emissions by up to 25%.

- This single application alone could deliver more than half of the upside opportunity of 15.3 Mt by 2030.
- An urgent large-scale adoption of a proven methane reduction tool could ensure that the 2035 NDC is met, thereby avoiding costly offshore carbon credits.

9(2)(a) , CH4 Aotearoa Ltd

9(2)(a) CH4 Global Inc

Public Interest Law and Science Initiative Inc.

Submission of the Public Interest Law and Science Initiative inc.[1], 9(2)(a), on:

Inquiry into Biogenic Methane – 5 November 2024

Thank you for the opportunity to make this submission.

This submission makes the following key points:

1. Prime Minister, Jim Bolger's Cabinet, approved New Zealand's entry into the UN Framework Convention on Climate Change, recognising that we could never meet methane targets but that would be defensible until new technology unlocked the means to do so. That technology has yet to emerge;
2. Furthermore, the major caveat to climate action is to ensure the preservation of food. Clearly, reducing the New Zealand herd size runs counter to that imperative. Further, every carbon molecule embedded in our livestock, has been sourced from atmospheric CO2. Our agricultural sector is a net sink.
3. In the Terms of Reference, paragraph 10 identifies that ~91% of biogenic methane emissions come from the agriculture sector with ~9% from waste. But this omits what is likely a much more significant contribution from micro-organisms, known as "methanogenic archaea ", that consume organic material in wetlands, peat bogs and coal seams and emit significant, but unaccounted for, biogenic methane as a consequence and which would render any efforts in the agricultural farming sector pointless.
4. It also omits that biogenic methane is part of a virtuous loop, whereby carbon dioxide, sourced from the atmosphere, is recycled into plant material that is consumed and reformed into methane, that eventually is oxidised back into carbon dioxide – so says Dr Kevin Trenberth.
5. Methane science:
    a. confirms it is a short-lived gas. Stabilisation of methane emissions means that there is no further contribution to global warming. If we are to reduce methane emissions by reducing the dairy herd, then this will effectively mean the dairy industry are doing the heavy lifting for

Background to the Public Interest Law and Science Initiative

The Public Interest Law and Science Initiative inc ("PILSI") is a not-for-profit organisation with members made up from the legal and scientific community, including planners, economists, sea level experts, statisticians and other academics, as well as members of communities and community groups concerned with the honest and robust application of science in law and policy making.

We are concerned about the use of false narratives, supposedly underpinned by science, to win support for what would be otherwise, unpopular policies.

Our mission is to be an honest broker and simply let science speak to power.

[1] Public Interest Law and Science Initiative Inc. (pilsi.org.nz)

[2] 9(2)(a) has a Masters in Climate Change Science and Policy and was an Expert Reviewer for the Intergovernmental Panel on Climate Change;'s Sixcth Assessment Report, Working Group 1, The Physical Science Basis.

and on behalf of other industrial sectors that emit carbon dioxide – an unfair outcome.

b. to avoid criticism of a 'whitewash' the Panel must engage, evaluate and comment on the science described in the van Wijngaarden and Happer paper "*The Dependence of Earth's Thermal Radiation on Five Most Abundant Greenhouse Gases*".[3] This paper suggests methane is saturated at current levels and so adding or reducing atmospheric volumes neither adds nor reduces warming with any significance.

1. The Bolger Cabinet Minutes

It is evident from the Bolder Cabinet Minutes that approved New Zealand's entry to the UNFCCC, that the biogenic methane targets would not be met. But that this would be justified.

Minutes of the Cabinet Strategy Committee (CSC (92) M 19/4) record a meeting held on 27 May 1992, with RT Hon JB Bolger as Chair. The title is "Convention on Climate Change: New Zealand Signature" and they record the Committee's agreement that the leader of the New Zealand delegation to the Earth Summitt to be held in Rio De Janeiro, Brazil in June 1992, be empowered to sign the framework convention on climate change.

Annexed to the Minutes is a briefing paper (CSC (92) 57 prepared by the Office of the Minister of External Relations and Trade which with the same title but dated the day before, 26 May 1992.

That paper summarises the various key terms of the framework convention. Paragraph 9 addresses New Zealand's idiosyncratic situation with significant biogenic methane emissions. It states (in full):

> "The convention guidelines require countries to address all greenhouse gases not covered by the Montreal Protocol on Substances that Deplete the Ozone Layer, not just CO2. New Zealand has significant agricultural methane emissions and an unknown level of nitrous oxide emissions from human-induced sources. In the absence of significant scientific and technological advances, we do not expect to be able to make significant progress on either methane or nitrous oxide emissions before 2000. Other countries will be in a similar position. As the convention specifically recognises the need for technology to be available to enable countries to deal with emissions and also recognises differences in economic circumstances, **we believe New Zealand's inability to reduce emissions in these areas can be adequately justified in our reporting**." (emphasis added).

As the need for technology to meet methane targets has yet to emerge and with New Zealand's economy still highly dependent on our agricultural economy, New Zealand's position remains the same as it was in 1992 when the briefing paper was issued: we remain economically dependent on processes that result in methane emissions and there is no viable technical solution available to reduce these emissions (although the Crown Research Institute, AgResearch, has developed a genetically modified ryegrass that could significantly reduce methane emissions from animals).[4]

2. Food Security

[3] Available at https://arxiv.org/pdf/2006.03098.
[4] https://www.rnz.co.nz/news/country/397727/new-grass-could-reduce-methane-emissions-from-animals

Article 2 of the UNFCCC outlines the ultimate objective of the UNFCCC, which is to stabilise greenhouse gas concentrations to prevent dangerous anthropogenic interference with the climate system, but to also ensure that food production is not threatened.

This objective is inferred into "any related legal instruments that the Conference of the Parties may adopt."[5] Indeed the Paris Agreement's preamble explicitly recognises "the fundamental priority of safeguarding food security and ending hunger, and the particular vulnerabilities of food production systems to the adverse impacts of climate change"2.

Consequently, any emissions target that serves to make food production more difficult, expensive or limiting, would be inconsistent with the Paris Agreement and UNFCCC.

In addition, biogenic methane is part of a biogenic carbon cycle, meaning the carbon is continuously recycled between the atmosphere, plants, and animals. The carbon embedded in methane originates from atmospheric CO2, making it part of a natural, circular process rather than a net addition to atmospheric carbon levels.

3. Unaccounted for Biogenic Methane

There is evidence of a significant, natural methane source that should be accounted for. This relates to methane associated with methanogenic archaea, the same microbes responsible for ruminant methane. These microbes also digest peat, coal and other organic material in wetlands.

Soil tests show high levels of soil methane in parts of Taranaki, suggesting elevated sources of methane. Similarly, coal bed methane, the product of methane sourced from methanogens, has equally been observed in parts of the Waikato. Peat bogs that are prevalent North of the Kapiti Coast (figure 1) have been observed to seep methane.

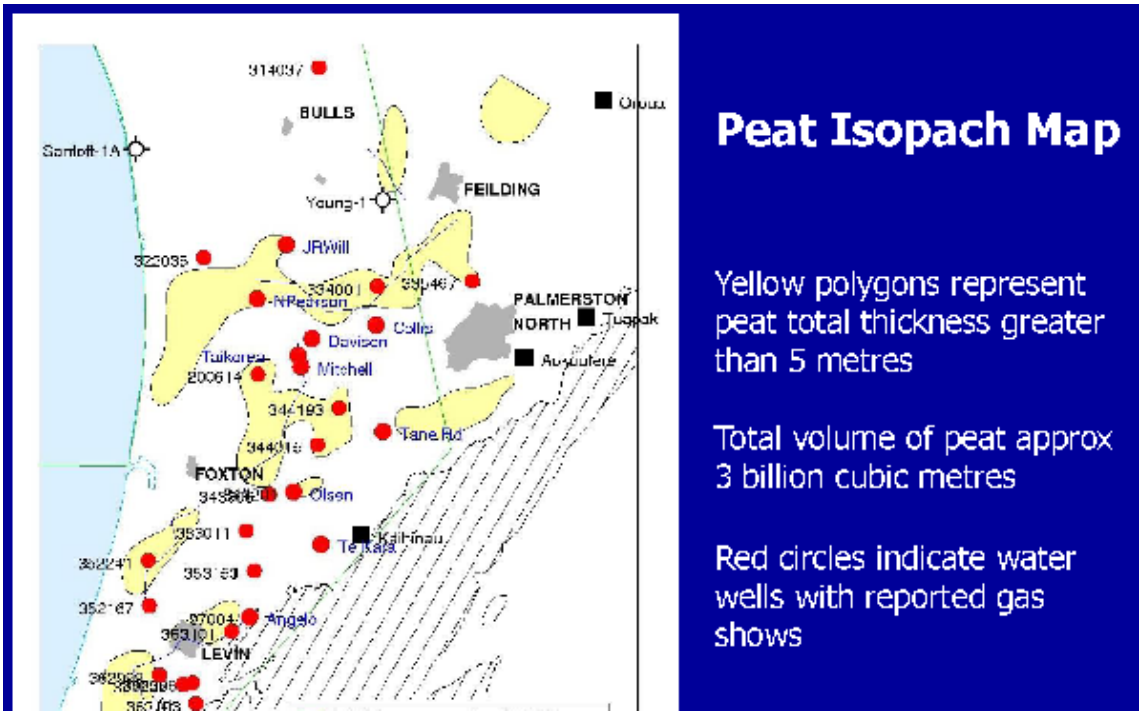


Figure 1: Slide from Hugh Green Energy Limited

[5] Article 2, UNFCCC.

The MethaneSAT data, when available, should be assessed to supplement the known sources of methane described in the Terms of Reference with consideration as to whether any reduction in biogenic emissions from the NZ ag-sector, will have any material difference on the gross emission profile.

Note the orphan cattle herd in India outweighs the entire cattle herd in New Zealand. The orphans are those cows that no longer produce milk and due to their religious significance are not killed, but 'set free' to wander the Indian country-side. Emissions from this source are similarly not accounted for.

4. Methane part of a virtuous loop

Methane sourced from the New Zealand cattle herd are part of a virtuous loop. This was described by Dr Kevin Trenberth in an opinion piece published by Auckland University "*Taxing cow burps isn't the best climate solution*." [6]

Dr Trenberth quite rightly points out that:

> "*Biogenic methane comes from all sorts of livestock – cattle, sheep, goats, deer and even buffalo – and it has a circular life.*
>
> *It originates as carbon dioxide in the atmosphere that is taken up by grass and other plants during photosynthesis. Those plants are eaten by animals and then methane is burped out during digestion, or released as flatulence or through decaying manure.*
>
> *Once released, methane stays in the atmosphere for about a decade before it becomes carbon dioxide and is taken up by plants again.*
>
> *Some carbon is temporarily stored as meat, leather or wool, but it too is eventually recycled. The amount of methane from livestock would be stable were it not for rising demand for animal protein by the ever-increasing global population, leading to increasing livestock on farms*."

Consequently, there is very little scientific support for imposing hardship on the NZ farming community, when the science shows doing so will have no effect at all.

5. Methane Science

Professor Trenberth confirms that short-term nature of methane in the atmosphere suggests that we should focus on other emission savings, so that point won't be repeated.

The paper by W. A. van Wijngaarden and W. Happer, titled "The Dependence of Earth's Thermal Radiation on Five Most Abundant Greenhouse Gases," investigates how the concentrations of the five most significant greenhouse gases—water vapor (H2O), carbon dioxide (CO2), ozone (O3), nitrous oxide (N2O), and methane (CH4)—affect Earth's thermal radiation.

It finds a doubling of methane would have a trivial effect on global warming.

The Abstract states:

> "The atmospheric temperatures and concentrations of Earth's five most important, greenhouse gases, H2O, CO2, O3, N2O and CH4 control the cloud-free, thermal radiative flux from the Earth to outer space. Over 1/3 million lines having strengths as low as 10^{-27} cm of the HITRAN database were used to evaluate the dependence of the

[6] https://www.auckland.ac.nz/en/news/2023/02/14/taxing-cow-burps.html

forcing on the gas concentrations. For a hypothetical, optically thin atmosphere, where there is negligible saturation of the absorption bands, or interference of one type of greenhouse gas with others, the per-molecule forcings are of order 10^{-27} cm W for H2O, CO2, O3, N2O and CH4. For current atmospheric concentrations, the per-molecule forcings of the abundant greenhouse gases H2O and CO2 are suppressed by four orders of magnitude. The forcings of the less abundant greenhouse gases, O3, N2O and CH4, are also suppressed, but much less so. For current concentrations, the per-molecule forcings are two to three orders of magnitude greater for O3, N2O and CH4, than those of H2O or CO2. Doubling the current concentrations of CO2, N2O or CH4 increases the forcings by a few per cent. These forcing results are close to previously published values even though the calculations did not utilize either a CO2 or H2O continuum. The change in surface temperature due to CO2 doubling is estimated taking into account radiative-convective equilibrium of the atmosphere as well as water feedback for the cases of fixed absolute and relative humidities as well as the effect of using a pseudoadiabatic lapse rate to model the troposphere temperature. Satellite spectral measurements at various latitudes are in excellent quantitative agreement with modelled intensities."

Regarding methane the authors conclude, based on their figure 5 (reproduced below) that doubling methane in the atmosphere would add ~0.7 W m^{-2} which is trivial.

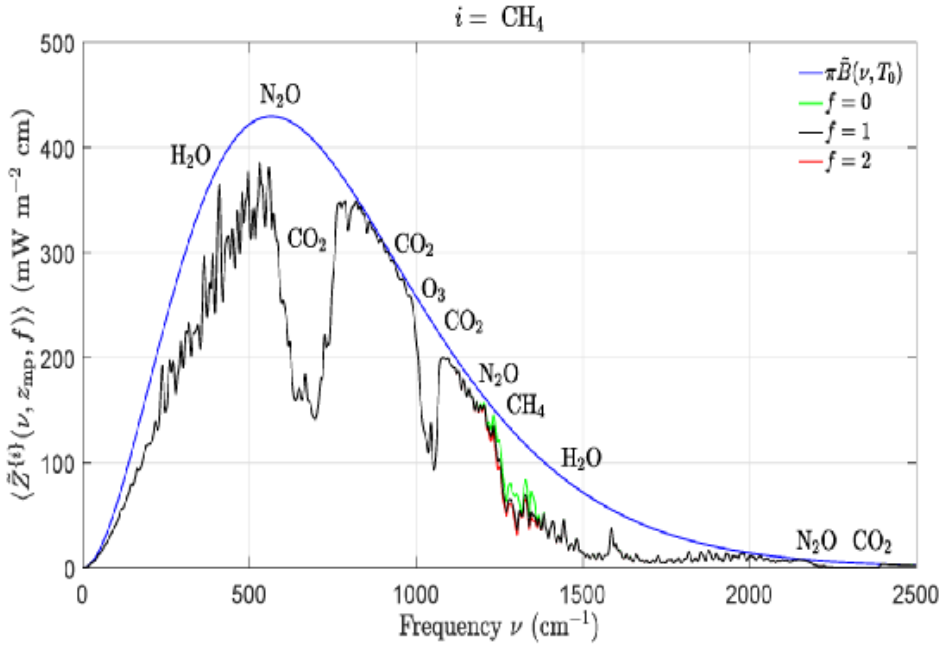


Figure 5: Effects of changing concentrations of methane, CH_4, on the filtered spectral flux $\langle\tilde{Z}^{\{i\}}(\nu, z_{\rm mp}, f)\rangle$ of (44) at the mesopause altitude, $z_{\rm mp} = 86$ km. The blue and black lines have the same meanings as for Fig. 4. The green line is $\langle\tilde{Z}^{\{i\}}(\nu, z_{\rm mp}, 0)\rangle$ with the CH_4 removed but with all the other greenhouse gases at their standard concentrations. The red line is $\langle\tilde{Z}^{\{i\}}(\nu, z_{\rm mp}, 2)\rangle$ with twice the standard concentration of CH_4 but with all the other greenhouse gases at their standard concentrations. Doubling the standard concentration of CH_4 would cause a forcing increase (the area between the black and red lines) of $\Delta F^{\{i\}} = 0.7$ W m^{-2}, as shown in Table 2.

In addition, due to the short time methane spends in the atmosphere, it is likely impossible to double its current volume in any policy relevant period.

To the author's knowledge this work has been open for critical review for some years now but without any substantive critique being provided demonstrating how it may be flawed.

The author is aware that Professor Frame was dismissive of the authors in a 'Farmer's Weekly" edition in September 2023[7], wrongly describing them as having no climate qualifications.

That's quite incorrect. Happer is without doubt an expert in the interaction of radiative energy with molecules, which is at the heart of the greenhouse effect.

He was one of the co-authors of "*The Long-Term Impacts of Increasing Atmospheric Carbon Dioxide Levels*", a 1982 publication based squarely on the findings of the JASON Technical Reports from 1979 and 1980.

Freeman Dyson, a close friend of Happer's until his death and a contributor to the quantum electrodynamic theory, was also involved, as well as Charles Keeling and Roger Revelle – 2 scientists that are well known as having climate change qualifications.

Happer went on to be the Chair of the JASON committee, and was a member for near 30 years, and was the head of energy research, including climate change, at the US Dep't of Energy. His resume remains on the Princeton website.[8]

Van Wijngaarden is a highly credentialled nuclear physicist that has, from time to time, been asked to opine of climate related matters and is a referee for the journal *Climate Dynamics.* He has worked with scientists at Environment Canada to analyse archival data of humidity, temperature and precipitation and recently studied over ¼ billion hourly values of temperature and relative humidity observed at 309 stations located across North America during 1948-2010 – see his full CV.[9]

The author approached VUW's Emeritus Professor School of Chemical and Physical Sciences, Dr John Lekner, for his initial thoughts on the paper and he felt it 'looked ok' and recommended a closer review by appropriately qualified physicists and chemists. It would benefit from a comment by the likes of Oxford University's, Professor Raymond Pierrehumbert, who has published extensively on the interaction of energy and molecules in the climate space.

A web search indicates that the main criticism of the paper appears to be that its conclusions fall within the range of IPCC sensitivity – if so, it would be helpful if that could be clarified.

Conclusion

In conclusion:

1. New Zealand committed to the international climate legislation on the express understanding and advice that it would not meet methane targets but that this would be defensible in the absence of a technical fix;

2. Any interference in New Zealand's food supply, will run contrary to the food security imperative that takes precedence over emission reduction policy;

[7] See https://www.farmersweekly.co.nz/news/tackling-methane-myths-across-spectrum/
[8] Available at https://dof.princeton.edu/people/william-happer.
[9] Available at https://wvanwijngaarden.info.yorku.ca/files/2024/01/WvWCV.pdf?x45936.

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3. The impact that NZ's agriculture industry is tiny and is likely outweighed by natural methane seeps that are as yet, unquantified, but known to exist. Not to mention the much greater impact by non-productive beef.

4. NZ's leading climate scientist, Dr Kevin Trenberth, has articulated what everyone in the climate science fraternity knows: the biogenic methane is part of a virtuous loop that does not, in itself, add to greenhouse gases or global warming;

5. The science suggests that methane is not a significant driver of global warming. Your report should address the van Wijngaarden and Happer paper.

This enquiry was in regard to the science so this submission makes no submission as to the appropriate next steps – needless to say, that the prior Climate Chane Minister's commitments were ill-informed, economy harming and need to be revised.

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SUPPLEMENTARY SUBMISSION

re

The Global Methane Budget 2024

To: The Ministerial Advisory Panel on Biogenic Methane

1. I refer to my principal submission dated 15 September 2024. This narrow supplementary input is occasioned by, and limited to, a subsequent publication by the CSIRO self-styled as the *"Global Methane Budget 2024".*

2. The CSIRO publication, which claims to be based on the preprint *Saunois et al* (2024), carries no scientific weight whatever. However, because of its proximity in time and space to the Panel's work, it seems appropriate to comment on three of its more tendentious claims.

Increase of 260% since 1750

3. Project director Pep Canadell says: "*We have seen higher growth rates for methane over the past three years… This increase means* ***methane concentrations in the atmosphere are 2.6 times higher than its pre-industrial (1750) levels"***.

4. In the previous paragraph, Canadell says "***reliable measures began in 1986"***.

5. The CSIRO does not share the source of its unreliable 1750 estimate. Nor does it explain why it defines "pre-industrial" as being 100 years earlier than the 1850-1900 period used by the IPCC and most climate researchers.

Humans cause most methane emissions

6. ***"Human activities are responsible for at least two-thirds of global methane emissions****, adding about 0.5°C to global warming that has occurred to date"*

7. The CSIRO says that a summary paper of the Global Methane Budget 2024 is available through Environmental Research Letters. (*RB Jackson et al* 2024)
8. That paper explains that its top-down methodology is based on 2010-20 satellite data. The CSIRO models **assume** that 100% of the increase in methane emissions since 1750 has been caused by humans. They also **assume** that the hydroxyl field always remains constant over time so as to "*attribute changes in methane concentrations to altered emissions rather than to altered atmospheric oxidative capacity"*. The models' attribution to various human-caused and natural primary sources is a "black box" process employing "inverse systems" which can be neither reviewed nor replicated.

9. We can, however, be quite confident that this inaccessible attribution system is wrong – because, apart from estimates for wetlands, all of the Earth's known sources of natural methane emissions are simply omitted from the budgetary process:

   "Estimates for other natural sources such as geological [seepages], termites, permafrost, rivers, lakes and reservoirs available in the literature lack sufficient measurements to analyse temporal changes in methane emissions and, as a result, trends cannot currently be calculated for these sources"

10. The CSIRO attributes 67% of all methane emissions since 1750 to human activities. This is inherently improbable given the relatively small human and livestock population a quarter-millennium ago, and the fact that usage of hydrocarbons was, for most of the period, a tiny fraction of what it is today. Although the paper is agnostic regarding fluxes in natural sources of methane, one could assume that seepages, termites, etc have remained *relatively* stable over the period.

11. Massive reservoirs of natural methane are locked up in permafrost and sea ice (hydrates) and more than ever has been released into the atmosphere with increases of GMST over the past 40 years. Much the same can be said of and

12. In AR6 WG1, **table 12.12** from chapter 12 page 1856 shows the climate change impact drivers or "CID"s (changes with exceed an impact/noise ratio of one) that have already become detectable in the observed data. While no change has yet emerged in respect of most CIDs, including notable exceptions are the shrinkages of permafrost, as well as river, lake and sea ice. In all likelihood, the outgassing from permafrost alone would exceed emissions from the world's ruminants.

13. The assumption that 100% of the measured increase in atmospheric methane since 1750 is attributable to human activities is incompatible with the IPCC findings that statistically significant reductions in permafrost have recently occurred.

O.5°C from human methane

14. *"**Human activities** are responsible for at least two-thirds of global methane emissions, **adding about 0.5°C to global warming that has occurred to date**"*

15. The 0.5°C attribution is derived from the CSIRO's misleading claim that global methane emissions are predominantly anthropogenic. Some of the flaws in this claim have been set out above. Other reasons to disbelieve the 0.5°C figure are:

    - The paper offers no researched data, experiments, or scientific reasoning in support of its 'added warming' figure – which therefore appears to be no more than guesswork.

    - As the earth has warmed by 1.1°C since 1850, according to IPCC AR6 WG1, the CSIRO would have us believe that the contributions of CO2 and CH4 have been approximate equal. But if the warming attributable to CO2 over the last century is less than 0.6°C, then the equilibrium climate sensitivity (ECS) of CO2 must be far less than the uncertainty range of 1.5°- 4.5°C adopted by the IPCC. To the extent that nobody believe this, nobody can believe the wild exaggerations of the CSIRO.

    - Ironically, the "three large ensembles included come from CMIP6 models with ECS values ranging from 3.0°C to 5.6°C" – despite the fact that "the observations sit well outside the CMIP6 model ensemble". The preferred scenario is SSP5-8.5.

    - The observed global warming of 1.1°C is net of a (unknown) higher figure that has been theoretically offset by certain cooling effects from human-caused aerosols. Presumably, the CSIRO paper has imagined a large figure and then selectively chosen to attribute all of these offsets to CO2 and none to CH4. (Even this biased approach would explain only a fraction of the error).

    - The paper states that methane has added 0.5°C "to global warming that has occurred to date". However, as methane has a brief atmospheric life (before being offset by an equal and opposite sink) all of this 0.5° must have been aggregated over the past decade. Yet,

according to the IPCC, **total** warming is occurring at a rate of only 0.13°C/decade. The CSIRO estimate is not only wrong but is clearly absurd.

- Peer-reviewed journal papers such as *Coe et al* (2021) and *Schildkneckt* (2020) have calculated from Hitrans data that the ECS of methane (ie the warming impact of doubling its atmospheric concentration) is **0.6°C**. Wilson Flood calculated a similar figure a decade ago and the current highly-detailed work of Van Wijngaarden and Happer (2023) has since confirmed it.

- Accordingly, to cause additional warming of 0.5°C, methane concentration would have needed to increase from 1.0ppm to its current 1.8ppm since about 2014. This gallop contrasts starkly with the heading of the CSIRO paper: *"Methane emissions increase by 20% in 20 years"*. At that 1% pa rate of increase, the added warming impact would be approximately one-tenth of the CSIRO's claim.

- The IPCC (AR6, WG1) estimates that the forcing effect of adding 1.1 ppm of atmospheric methane since 1750 has been about 0.5W/m2. During that period, the RF caused by CO2 increased by 2.17W/m2 – over four times as much. This is consistent with most other scientific assessments which attribute 80% of anthropogenic warming to CO2 in any given year.

Consistent with Paris Agreement

16. *"For net-zero emission pathways consistent with the Paris Agreement, which is stabilising temperatures below 2°C from pre-industrial levels, anthropogenic methane emissions* ***need to decline by 45 per cent by 2050, relative to 2019 levels****."*

17. This statement, which relies upon GWP100 and assumes that all long-term and short-term gases can be usefully and accurately aggregated, makes the same errors as those that characterise the Panel's TOR 5(f). When the assumptions are changed the "need to decline" also changes – and sharply reduces

18. As the IPPC's AR6 has found that GWP100 overstates the warming impact of methane by up to 4 times, we can presumably reduce the CSIRO's calculation from 45% to **11.25%**. If the calculation used comparable volumes in lieu of comparable mass, it could reduce further to a required reduction of about **4%** by 2050.

19. This entire issue is fundamentally flawed. It first (wrongly) assumes that methane emissions will add massive additions to future warming – expressed as CO2-e – and then (understandably) concludes that these impacts need to be rapidly reduced.

20. The CSIRO paper implausibly implies that human-caused methane will increase at the rate of 1%pa on a BAU basis. If so, it will take another 100 years to double and thereby increase global temperatures by 0.6°C. For the quarter-century between now and 2050, that increase would cause additional warming of 0.15°C. If emissions were reduced by 45%, this sacrifice would contribute a temperature reduction of a theoretical seven-hundredths of a degree! Such a microscopic figure is not even measurable by current thermometer systems!

21. The calculations of net-zero pathways that are relied upon by the CSIRO, and TOR 5(f), are based on quite different arithmetic – which leads them to believe that the additional warming caused by a 25% increase in methane emissions by 2050 would be 3-4 times greater than 0.15°C. If they were to focus upon "additional warming" rather than emissions, and recognise that short-term flows cannot be added to long-term stocks, they would recognise that methane has very little to do with the net zero ambition.

22. All of the foregoing relates to the CSIRO estimate of a 20% increase in global methane emissions over 20 years. The same paper acknowledges that Australasian emissions have been *reducing*.. It would be entirely consistent with the Paris Agreement objectives to set no targets at all for the further reduction of New Zealand livestock emissions.

Conclusion

23. In my submission, the Panel should accord no weight whatever to the estimates and opinions set out in the *Global Methane Budget 2024*

9(2)(a)

28 September 2024

SUBMITTERS:

9(2)(a)

TO:
The Methane Target Review Panel
c/- Chair, Professor Nicola Shadbolt

19th September 2024

INTRODUCTION:

We are sheep and beef farmers and intergenerational environmentalists, farming 1,500 hectares in North Otago. We are strong believers that all farmers are proud guardians of natural resources, essential members of the economy, and play a key role in diverse provincial communities. We breed Angus cattle and Perendale Sheep genetics for other farmers throughout New Zealand and Australia. Our focus is on efficient, sustainable production of red meat and tangible environmental work.

We were the recipients of the Gordon Stephenson trophy as the 2012 winners of the New Zealand Farm Environment Awards. 9(2)(a) is a member of the Global Farmer Roundtable representing New Zealand, Lincoln University Sir Ron Trotter Gold medal recipient and a New Zealand Young Rural Achiever.

Current New Zealand methane targets lack any scientific or fiscal rationale.

It is a national travesty that our Agricultural sector has focused on spending large sums of money on researching how to reduce methane, before the 'problem' has even been substantiated. This should have been the first step.

Methane mitigation methods are simply a proxy for a methane tax – both are an unwarranted cost on farm profitability and a distraction from genuine productivity. The New Zealand Agriculture sector finds itself in the politically embarrassing situation that almost NZD $1Billion has been spent to date on methane mitigation methods, often referred to by those that are well-paid to do so as "the holy grail". We urge the Methane Review Panel to put these fiscal follies aside and focus on fact and science - not be swayed by underlying pressure to justify expensive mitigation projects.

The level of understanding of science of the ruminant methane cycle within agricultural sector leaders and regulators is of grave concern. The Methane Review Panel to urged to undertake a full and transparent assessment of the

science around methane before making any recommendation on Methane Targets (if any). It is crucial that your panel do not enter into giving recommendations on 'trade offs' and 'social priorities' when assessing methane targets.

You will note within this submission we do not refer to the 2.8 Million hectares of native vegetation that have been protected by sheep and beef farmers on their land when discussing Methane Reduction Targets. Sequestration should sit outside any Methane Target review. It is of concern that some review panel members have been heard to suggest that this vegetation will help offset the financial burden of unrealistic methane targets. These areas are the farmer's own asset and if they are used as an offset to somehow 'soften the blow to "marginal" land owners' then this is unethical and unacceptable. Sequestration should not be used to make up for wholesale inaccurate modelling of emissions on the other side of the ledger. Sheep and Beef farmers on Class 6 and 7 land are not expendable pastoral peasants to be conveniently used by the dairy sector as an offset.

EXECUTIVE SUMMARY:

We call for Methane Emissions Reduction Targets for Ruminant livestock in New Zealand to be abandoned and replaced by accurate modelling of ruminant methane's impact (or otherwise) on global temperatures, even before any sequestration is taken into account. If the Methane Review Panel have been charged with the mandate of defining our New Zealand livestock sector's positioning (and hence any reduction targets around this) then accurate modelling will show that NO reduction targets should be in place at all – if a genuine definition of 'No Further Warming' is used.

New Zealand can be a global leader by demonstrating a pathway of continued pastoral efficiency, diversity and integrated environmental practices that take all areas into account including biodiversity, freshwater management and dynamic rural communities. Methane Emissions have become a perilous distraction against making genuine environmental gains in all facets of agriculture.

Current Climate Change Commission Agricultural Emissions reduction targets for New Zealand's ruminant livestock are ill-informed, untenable and incognisant of science and reason.

10% by 2030 and 24-47% by 2050 reduction targets are not only non-scientific, they will have serious implications for the future of our environment, economy and living standards (especially our lower socio-economic sectors).

Low-impact food production in New Zealand will be substituted for more intensive farming both here and offshore, at a tangible cost to all facets of our environment, poor animal welfare outcomes, high fossil fuel use and a myriad of unintended consequences due to accelerated land use change.

If the Methane Review Panel do take a stance that naturally cycling methane needs to be reduced, this sets a reckless precedent for all other forms of methane emissions around the world – including subsistence-farmed ruminants in developing countries, wetlands and rice paddy fields (responsible for circa 21% and 20% of global methane emissions respectively).

If New Zealand considers itself to be an exemplar in environmental initiatives and sustainable food production then current Methane Reduction targets need reassessed to a level below a 1% reduction/ year, or dispensed with completely. They should be replaced with demonstrating to the rest of the world how to farm ruminant livestock on pasture in the most efficient way possible while continuing to produce world-class red meat and milk protein in a transparent, non-subsidised free-trade, free-range manner.

SECTION 1 – ISSUES TO CONSIDER

1(a) Absence of Scientific rationale to decrease ruminant methane emissions:

Professor David Frame and other scientists have modelled the warming contribution of New Zealand ruminants to be 4 millionths of one degree C per year or less. This figure is both inconsequential and insignificant.

New Zealand farms 1% of the world's ruminants. If we include all of the other 99% of the worlds ruminant emissions it equates to (at worse) 0.00396 degrees C contribution to warming per year. If the rest of the worlds ruminants also lowered their emissions to the same maximum target of New Zealand that equates to a mere 0.0019 degrees C warming per year.

These figures are so trivial that they are virtually impossible to measure, yet the destruction of our livestock sector whether through taxes or vaxes will be substantial and swift.

There is no rational requirement for any regulation of methane targets – with reductions averaging over 1% per year, following a 6.17% reduction between 2017-2023 (Stats New Zealand) and an escalating fall beyond this over the past 12 months, with a concerning 1.4 million stock unit decrease in the sheep and beef sector.

Estimates of methane emissions are subject to a high degree of uncertainty, with published estimates having a + or - 40% margin of error.

Confusion around GWP100 and GWP* is concerning despite originally well intended development to assist the IPCC through formulation of a CO2

equivalent metric, GHG properties are vastly different and widely misunderstood.

The choice of one formula over another could potentially alters a farmer's liability by 300% to 400% which demonstrates that any reduction target of ruminant biogenic methane is hard to substantiate yet could be devasting to farming and New Zealand's GDP.

1 (b) Absence of Economic rationale to decrease ruminant methane emissions:

New Zealand currently produces enough food for 40 million people - 10 times our population. There is little wonder that our emissions per capita are at a higher percentage driven by food production than those countries that simply import the majority of their food requirements yet have substantial fossil fuel emissions.

Unsubstantiated emissions targets create a seismic downwards shift in the economy. Whilst this will have an enormous impact on businesses in all sectors of the economy, it will have an even heightened effect on those citizens most at risk - low income earners (with the cost modelled at circa $8,000 per household/year through heightened food and fuel costs coupled with lower levels of crown support - due to the $800 Million NZD less tax collected every time our GDP decreases by 1%.).

It is important to note that if New Zealand were to play an important role in reducing worldwide emissions, we would in fact be asking our primary producers to increase our agricultural production, given that we are the most efficient pastoral producers in the world when water and resource use/kg product and carbon emissions/kg product are analysed. We should not fall into a trap of comparing our emissions trajectory per kg of product with highly intensive offshore factory-farming fossil-fuel dependant feedlot systems – when in fact all production factors need to be considered, including allowing natural animal social behaviour in our low-input, free range pastoral systems.

1 (c) Absence of acknowledgement of serious unintended consequences if the Methane Review Panel endorse even the lower end of the scale of current Climate Change Commission target ranges:

Destruction of Rural Communities

A regulatory impact of the current targets (even at the low end of the scale) show that economic growth could slow by $5-12 billion per year between 2020 to 2050 – a loss of around $300 billion, a drop by 50 percent from current levels by 2050 – which is both ironic and unpalatable, given that this is the

same timeframe that the primary sector was asked to double productive capability.

This is from heightened costs of methane interference (vaccines, boluses, genetic gain loss of productive traits if selecting for "low" methane genetics) and/or a lowered stocking rate if farmers choose to continue a low-input form of pastoral farming and simply have to drop their stock numbers to meet irrational methane targets. Our sheep, beef, deer, organic and regen farming operations simply cannot afford to do so and will go out of business.

To put this into further context, that is effectively shutting down one provincial town every year between now and 2050. Our small town of Oamaru processes 1 million stock units per year through our biggest employers whom are our two meat processing plants. If these companies were to shut down (as we have modelled the current targets would eventually lead to) then our entire town shuts down – including one of our three high schools, at least 6 primary schools and our entire local tourism sector.

We have already lost 1.4 million of sheep and beef stock units over the past 12 months in New Zealand, our downwards trajectory is both concerning and escalating at an alarming rate.

Erosion of our current 'value added' product premiums

Any regulation that overrides a current niche advantage that many of our New Zealand products fetch (for example Silver Fern Farms zero-carbon Beef) will erode premiums currently sought in the market place. Why would any global consumer pay more for a 'low carbon' product if the government forces farmers to do this anyway through regulation. No rational consumer would ever pay more for what then essentially becomes a run of the mill baseline commodity due to poorly thought-out regulation. Any emission reductions should be left to a commercial line-of-sight for individual products, not our entire agricultural sector per se. Commercial forces should be at play here, not regulatory forces.

Depreciation of the value of our current low-input pure protein advantage

Vaccines, Boluses, GE/GMO designed to allegedly reduce methane emissions in livestock risk by interfering with natural biological systems may potentially destroy our natural pastoral-raised protein status, let alone the practicality of administrating these products that are touted as a solution to an unproven problem. While vaccination for unwanted diseases is common practice, an additional vaccination that has no benefits to the animal and that interferes with natural rumen processes may face consumer, regulatory and animal welfare pushback, risking our high Quality-Assurance, pasture raised status for little more than a headline saying we are "doing our bit". All that we will be doing by supporting these interferences will be making multinational

companies even wealthier. There will be no way to prove that farmers have even used these products, let alone proof of any measurable difference to the atmosphere.

Risking our production efficiency trajectory that we have worked so hard to gain over the past 30- 40 years.

An example of this is the circa $50 million of taxpayer and farmer money that is currently being wasted in selecting sheep and cattle for supposed 'low methane' genetic traits. From a production and a genetic point of view this is irresponsible and ill-informed at best – selecting livestock on a political trait will mean through the theory of genetic selection substitution that other productive traits (such as growth efficiency) and animal welfare traits (such as parasitic resilience, conformation and survival) will be put at risk through selection of this non-productive trait.

There is concern that selection for supposed 'low methane' emitters on pastoral land will result in breeding sheep and cattle with smaller rumens that require a high-quality feed all year round. The reality is this is not possible in a real-life hill country low-intensity pastoral system, will lead to poor animal welfare outcomes and will lend itself to a factory feedlot type of farming system. Is this the way in which New Zealand farming wants to be viewed by the world? Why would we give away our pastoral free-range, low-input, innovative and efficient genetic advantage to turn to intensive factory-farmed animals just to tick one very narrow quasi-heroic box to say we are "doing our bit".

Cessation of practical, tangible environmental initiatives by farmers

On a farm level, even though we have a large mortgage and a high-cost burden due to inflation in our expenses, as a modest family-owned farm, we still try and set aside circa $10,000- $15,000 per annum for environmental initiatives every year (such as the 130,000 trees our family have planted over the past 35 years, including native riparian areas). Let us be clear - if we are forced to decrease our already sustainable methane production further (through stock reduction, or the cost of unwarranted 'mitigation methods' - both are effectively the same thing) then we will be forced to cease ALL other environment initiatives – including the time that we spend on our local catchment group projects, hosting schools and all of our native tree planting.

Mass Afforestation of introduced species. Exponential pest invasion.

Low-intensity family farms such as ours and other sheep and beef, high country and organic/low input farms (all of whom utilise low-impact sustainable practices) will be hit first, hit hardest and may even cease to exist within two decades due to increasing land use change pressure and lack of financial viability under punitive methane reduction targets. These will be

replaced by large corporate-style intensive farming operations coupled with mass afforestation of non-native forestry.

Sheep and Beef farms are proud guardians of 2.8 Million hectares of native vegetation and this is under risk due to land use pressure towards afforestation that will be escalated under methane reduction target regulation costs.

SECTION 2 – THE SOLUTION

1/ Reduction targets for methane need to be reconsidered and based on robust science and modelling. This is a vital role for the Methane Target Review Panel and one that needs to be more than a pre-determined desktop exercise.

2/ SCIENCE and an open mind to ALL new and emerging science needs to be upheld by the Methane Target Review Panel.

All methane from all sources makes up 0.00019% (1.9 parts per million by volume)

How could anyone suggest that 0.000000285% (0.00019% X 15% X 1%) of the atmosphere is capable of influencing worldwide temperatures. Science and reason need to combine to work out a way forward. Painting ourselves into a target reduction corner is not a way forward. Focusing on mitigating a non-issue is also not a way forward. It is scientifically and economically foolish. All Methane Review Panels recommendations should be on the targets only and not take into consideration mitigation methods.

3 / If New Zealand wants to be a climate-change hero, the answer is already here. Dynamic, sustainable, free-range pastoral farming systems that are achieving world-leading productivity without resorting to feedlot, factory-farming systems that any Methane Reduction targets will lead to.

We should be sharing our innovative pastoral farming practices with the rest of the world, not apologising for them.

This intellectual powerhouse of knowledge could be shared with the rest of the world in an 'Agri-hub' concept – New Zealand farmers demonstrating how a tangible matrix of all environmental considerations can be put into practice in pastoral farming, hence assisting in making other farmers around the world more efficient (without resorting to high-impact, intensive feedlot farming).

If the Methane Target Review Panel genuinely understand and acknowledge robust science and modelling around climate change and the science of methane, then no methane reduction targets should be in place at all.

We wish to speak to this submission in person to the Methane Target Review Panel.

Thank you for the opportunity,

9(2)(a)