**The problem with Methane**

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In the consultation on the zero carbon bill, the government asks for views on which net-zero target is the right one for NZ and gives three options:

a) “**Net zero carbon dioxide by 2050 (but not other gases like methane…).”** This option is wrong because the warming effect of methane is so great that it needs to be reduced rapidly (not ignored) if NZ is to play its part in the global reduction effort.

b) **“Net zero long-lived gases and stabilised short-lived gases by 2050.”** There are two problems with this option



Firstly, any more lenient future reduction effort with methane compared to CO2, is, deviously, counting methane’s “short-lived” factor twice. To explain: when the annual amount of methane emitted is stated in our ghg Inventory, it is given in Mtns of CO2equivalaent. This means that its short-livedness is already accounted for by using its GWP100 value of 28 times the warming of CO2. This enables us to say that methane makes up 43% of our ghg emissions while CO2 makes up 44%. Now, if we adopt option b), and we say again that because methane is a short lived gas we are only going to stabilise it, but reduce CO2 to net zero, then we are double counting methane’s short-livedness. Surely if its shortlivedness has been counted in the inventory already, then both CO2 and methane, (both measured in CO2e) must be treated equally, i.e. both reduced the same!

Secondly, it is not stated at what level short-lived gases (methane) are to be stabilised. If they are currently at an unsustainable level, they need to be reduced, not stabilised. Central to deciding at what level to stabilise, is the issue of how methane is measured against CO2. I maintain that both GWP 100 and GWP 20 (measuring methane’s warming effect over a 100-year time frame, 28x Co2, and over a 20-year timeframe, 86xCO2) seriously underestimate the warming effect of methane compared to CO2. I have concluded (and discuss below) that the 1.2 Mtns of methane which New Zealand emits annually is more damaging to the atmosphere than our 34 Mtns of CO2 gross and several times more damaging than our net CO2 emissions of 11.76Mtn CO2. Methane emissions need to be seriously reduced, not “stabilised.” In fact, a greater effort needs to be put into reducing methane than into reducing CO2. This is the reverse of what you are proposing in option b)

c) “**Net zero emissions by 2050: this target would reduce net emissions across all greenhouse gases to zero by 2050.”** This assumes that because methane can’t be sequestered by forests it would have to be offset by negative CO2 emissions, so that when our CO2, N20 and CH4 emissions and the forest sink are all added together, the outcome is net zero greenhouse gas emissions. This option suffers from the same weakness as b), i.e. how do you equate 1.2 Mtns of methane against 34Mtns of CO2 and net them off. Once again, I believe that the GWP method seriously undercounts methane.

**Conclusion**: I support c) but suggest that CO2 levels would have to be hugely negative in order to offset the enormous warming effect of methane and methane would have to be enormously reduced to make this realistic, i.e. be stabilised at much closer to zero. I do understand that this would mean we would have to lower the number of cows, sheep and deer in the country. If that is what is required to save the human species from extinction, then that is what we have to do.

The following analysis sets out to establish the warming effect of our current methane emissions and to model a reduction scenario and its effect on our atmospheric warming.

**The Analysis**

The crucial factor about greenhouse gases is how much they warm the planet. Now methane is a much more powerful warming agent than CO2 although it breaks down over 10 years or so but there is still 5% of it left after 50 years. While it is obvious that CO2 accumulates in the atmosphere because it lasts for centuries, the accumulation of methane is much harder to visualize. Basically the 1.2 Mtns of methane NZ produces each year is added to previous years’ emissions which are in the process of breaking down. So, unless the annual amount of methane emitted reduces, which it hasn’t in NZ over the last 26 years, methane is still slowly accumulating in our atmosphere. What NZ needs to do and what I have modelled, is calculate what sort of reduction in the annual output of methane would be required for methane levels to a) stop rising, and b) reduce over time to a level where NZ could say that it was honestly playing its part in the global effort to prevent more than 2 degrees of warming. Our government defines this effort as reaching net-zero emissions by 2050 which to my mind has no scientific basis, but that is another story. My contention is that the public does not realise that getting to net zero when we include methane is impossible without radical changes to our economy; planting a billion trees or switching transport to electric vehicles will not get us there.

**Measuring Methane**

As mentioned in option b) and c) above, how we measure Methane compared to CO2 is critical and there are three ways of doing this

1.Measuring its effect over 100 years which is the international standard. Under this measure it is a 28 times more potent greenhouse gas than CO2. So, for NZ the 43% of our emissions that methane causes, is achieved by 1.2 million tonnes of methane, while the 44% of our emissions caused by CO2 requires 34 million tonnes of CO2. My problem with this measure is that for most countries it doesn’t matter too much because only 15% of their emissions are methane. However, for NZ, methane makes up 43% of our emissions and our economy is hugely reliant on the products which cause these emissions. Another problem is that we don’t have 100 years in which to save the planet from disaster. It is a convenient evasion to count the effects of methane over 100 years when our target for net-zero emissions is only 32 years away! This measure seriously underrates the serious warming effects of methane.

2.Measuring its effect over 32 years. While this is more honest, it rates methane as 77 times more powerful than CO2, but it still underrates the warming effect of methane. We are having to deal with methane from next year onwards, therefore I contend that we need to look at the immediate effect of the methane that we are emitting this year and next.

3.A third way of assessing methane’s warming is to track its effect on a year by year basis. To do this I have started at 1990, the first year for which the NZ inventory gives reliable figures. The results of these historical emissions are shown in Table 2. Several assumptions are made

* New Zealand’s annual methane emissions have hardly risen since 1990, but have varied within a narrow band from 1.15 Mtns in 1993 to 1.27 Mtns in 2005. I have averaged this at 1.22Mtn which is precisely the level it was at in 2015.
* I have constructed a breakdown curve for methane, Table 1, based on two statements. Firstly, that methane breaks down over 9-12 years and secondly Dr David Frame’s observation that 5% of methane remains after 50 years. Thirdly, I have calculated the GWP 100 and GWP 20 for my curve at 17 and 62.2 respectively. Therefore, I am confident that although it is not based on exact scientific data, it is a good approximation and, more importantly, a conservative one. In other words, my graph also comfortably underestimates the warming effect of methane and its dire conclusions are therefore an understatement.

Table 1 How methane breaks down over 100 years



**Explanation of Table 1.**

Column 1 is the table for the graph on the right

Column 2 is the equivalent units of CO2 required to achieve the same atmospheric warming. Taking the effect of one unit of methane as being 120 times greater than a unit of CO2 in the year that it is emitted.

Column 3 is the accumulated methane which, divided by 20, gives the averaged effect of the methane over 20 years. Note that these GWPs are well below those given by the EPA and used in the NZ greenhouse gas inventory

Note that years 22 to 100 have been omitted from this essay to save space, but they have been used to calculate GWP 32 and GWP100.

**Table 2A and 2B. New Zealand’s historical methane emissions and their breakdown pathway**

Explanation for table 2A

Column 1 shows the breakdown trajectory from table 1 above. Note these figures are not included in the annual totals, which begin from column 2 They merely illustrate the breakdown curve from which all other values are calculated

**Table 2A. Methane breakdown 1990-2002**

Column 2 shows how NZ’s 1.22 Mtn of methane emitted in 1990 breaks down over 28 years to 2018. This identical trajectory is also applied to every subsequent annual emission of 1.22 Mtns

Each row from 1990 down shows the sum of emissions for that year. These obviously include the emission from that year plus the partially broken-down emissions still in the atmosphere from previous years.

 **Table 2B. Methane breakdown 2003 to 2018**

**Explanation of table 2B**

This table continues tracking methane emissions from 2003 until 2018, the present day. The latest available stats are from the 2016 inventory, therefore, in light of the small variation from the 1990 to 2016 period, it is assumed that annual emissions will remain at 2016 levels for 2017 and 2018.

On the right hand side are the annual totals for all the years 1990 to 2018 (i.e.from both table2A and 2B). The first column shows that with annual emissions stable at 1.22, methane increasingly accumulates in the atmosphere. By 2018 its warming effect shown in column 2, measured in CO2 equivalents is 1673 million tonnes whereas the warming effect of the accumulated gross CO2 since 1990, shown in column 4 is only 959 Mtns, a bit over half that of methane

Column 3 lists NZ annual CO2 emissions 1990 to 2016, then assumes level emissions for 2017 and 2018.

Column 4 shows accumulated CO2 emissions 1990 to 2018. Note that the total by 2018 of 959 Mtns is only 57% of the annual emissions of methane. The conclusion from this is that NZ has a much bigger job reducing methane than CO2, especially since methane can not be sequestered by trees.

The next step is to project methane emissions forward to 2050. For this we assume a reduction of 3% year from 2019. In other words each year’s methane emissions are 3% less than the previous year. There are two aspects to note: A) The reduction will be in a curve, meaning that it starts off steeper then flattens out. B) The level of methane (unlike CO2) can never drop below zero

**Table 3. Annual methane emissions assuming a 3% year on year reduction from 2019. Note that the complete spreadsheet forTable 3 can be found at** [**www.climatefirstnz.org**](http://www.climatefirstnz.org)

**Table 3A 2018-2037**



**Explanation of table 3A**

Column 1 shows the 2018 methane emissions and how they break down through to 2037, assuming a 3% reduction beginning in 2019. Each column thus represents each year’s methane and what happens to it over the next 19 years.

On the other hand, reading across each year row gives the total amount of methane present in the atmosphere and doing its warming in any one year. For example, in 2020 (the third row down) 1.15 Mtns of methane is put into the air to join the 1.17 Mtns left in the atmosphere from last year. It is also added to the 1.2 Mtns left from 2018. Therefore, in total there will be 3.47 Mtns of methane in the air warming the atmosphere in 2020.

Note that the figure at the top of each column is the initial methane emissions from each year, and thus is reducing at 3% year on year.

Table 3B, accumulated methane from 2038 to 2050. And totals from 1990 to 2050

 **Explanation of Table 3B**

This table tracks what happens to NZ’s methane from 2038 to 2050 and on the right side gives the totals for all years 1990 to 2050 as derived from Tables 2, 3A and 3B.

The first column shows the Mtns of methane emitted in each year. Notice most importantly, that emissions peak in 2021 and begin to reduce until by 2050 they are back to 1997 levels.

Column two shows the actual warming effect of each year’s column one emissions by multiplying by 120, the amount that methane warms relative to CO2 in the year it is emitted.

Column three shows NZ’s net CO2 emissions from 1990 to 2016. This is calculated by subtracting the forest sink from the gross CO2 emissions. Level emissions are assumed from 2017 and 2018 and a straight-line reduction to zero in 2050 Remarkably, NZ had negative net CO2 emissions for many years. What is also remarkable is the drop in net CO2 emissions from 2007 to 2008 of 64% because of the Global Financial Crisis. This demonstrates the strong link between increasing CO2 and economic growth. The huge fall in CO2 was caused by a simultaneous drop in both forest harvesting and industrial activity.

Column four is the accumulated CO2 emissions from column three. Notable here is that because of our negative emissions from 1990 to 1999, our cumulative CO2 emissions remained negative until 2005. As well, even by 2050, our accumulated emissions were only 304 Mtns. This is less than one third of the warming effect of our methane emissions in that year!! It is also far less than our permitted CO2 budget based on NZ’s population as a percentage of the world’s population of 660 Mtns.

The conclusion from this model are:

1. That New Zealand could easily reduce its CO2 emissions to zero by 2050, and even have negative CO2 emissions as in the 1990 to 1999 period.
2. That our major task is reducing methane emissions, not CO2.
3. Reducing methane is much harder because it can not be sequestered by forests, but only by a reduction in methane emissions themselves.
4. A reduction of more than 3% year on year will be needed, because, although after 2021 methane levels have stabilised and are falling, they are still at a hugely too high level.
5. If option c) becomes NZ’s choice there is almost no chance that CO2 levels can become negative enough to offset methane’s warming with merely a 3% annual reduction in methane emissions.
6. How a 3% reduction could be done, still needs work. Assuming that all livestock sectors made equal reductions, a 3% reduction in the 4.8 million dairy stock numbers would be 144,000 fewer each year, or 343 fewer average farms each year.

(Note that the above analysis uses real-time methane emissions. A similar analysis using GWP 100 and GWP32 is a work in progress and not finalized in time to meet the submission deadline. I will submit it soon and hope that it will also be considered.)