Ministry for the Environment
Manatū Mō Te Taiao

– 9 SEP 2016

16-O-01102

Simon Johnson
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Dear Mr Johnson,

Thank you for your email received through the For Your Information website of 17 August 2016 requesting the following information under the Official Information Act 1982 (OIA):

> "a copy in pdf format uploaded to the For Your Information website of the report 'Potential long-term pathways to a low carbon economy for New Zealand', Wellington, Ministry for the Environment, August 2014".

The document requested was prepared as part of background analysis conducted to inform development of policy options on New Zealand's 2030 emission reduction target (ie, our Intended Nationally Determined Contribution under the Paris Agreement). The document you have requested was not formal advice to the Government or Ministry policy.

I am releasing the document in part, with a redaction made under section 9(2)(g)(i) of the OIA (to maintain the effective conduct of public affairs through the free and frank expression of opinions to Ministers of the Crown).

Under section 28(3) of the OIA, you have the right to ask the Ombudsman to review my response to your request.

Yours sincerely,

Roger Lincoln
Director, Climate Change

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Potential long-term pathways to a low carbon economy for New Zealand

Purpose

This paper is part of preparations to provide advice on New Zealand's Nationally Determined Contribution to be tabled under the new global agreement on climate change in 2015. The primary questions this paper informs are:

1. How long could it take to reduce emissions from the New Zealand economy to a level consistent with a two degrees Celsius (2°C) global climate goal?
2. Given possible scenarios for timing of global action on emissions, how soon should New Zealand start acting on its emissions?
3. Which actions would be the highest priority to start now to maximise the chance of achieving a low-emissions economy by year x?
4. What international contribution from New Zealand would be consistent with a plausible, long-term, low-emissions pathway?

This paper is not intended to:

5. Explore a full range of metrics to assess New Zealand's 'fair share' of a short or long-term global emissions reduction goal[1].
6. Quantify the cost of domestic emissions reductions.
7. Make the case for or against government intervention to achieve a particular level of domestic emissions abatement.

1 Executive Summary

New Zealand has stated that it will do its 'fair share' on climate change and has also gazetted a target of a 50% reduction in New Zealand's emissions from 1990 levels by 2050. To-date New Zealand has met international climate mitigation commitments mainly through a combination of forest removals and international offset purchasing.

The timing and level of global climate change mitigation action is profoundly uncertain. This means traditional forecasting approaches lose relevance due to the widening of uncertainty as we extrapolate into the future. Scenarios are a useful tool for thinking about the future in such an environment. Being able to test our decisions against different potential states of the world is more insightful than a single-point prediction of the future. The scenarios in this paper for global action on climate change and possible New Zealand emissions budgets are not predictions of the future. They are plausible outcomes which provide a context in which to consider and begin to evaluate possible long-term New Zealand responses to the climate change challenge. Having done this work, as time passes, and information about the actual path we are on

[1] The paper uses the working hypothesis that we are aiming to limit global warming to less than 2 degrees and that a "contraction and convergence" approach to achieve equal per capita emissions by 2050 is a plausible criterion for New Zealand's fair share.

emerges, we may be able to deduce how best to respond depending on which of the scenarios is more reflective of reality.

New Zealand's 'optimal' strategy on climate mitigation is likely to be contingent on action by the rest of the world. In the absence of ambitious, global action on emissions, and a low international carbon price, international purchasing appears preferable to substantial domestic reductions for New Zealand in the short-term. If there is ambitious global action on emissions and a sustained, high carbon price, then domestic emissions reductions are likely to offer better outcomes for New Zealand in the long-term. [**Note**: *Treasury have stated they do not consider this means there is a case for government intervention to achieve a particular level of domestic abatement, given that access to international markets should lead to efficient decisions about the split between domestic and international abatement.]*

It is not possible to predict when, or if, ambitious action on emissions by a significant number of important emitters will occur. However, there is a limited window of opportunity to begin substantial global emissions reductions, beyond which the UNFCCC's stated goal of limiting temperature rise to 2°C becomes unfeasible. This is because both the global and New Zealand economies have 'inertia' and cannot be changed to reduce emissions 'overnight'. The transition to a low emissions economy is a long-term undertaking due to the scale of change required in energy, transport, built environment, food production and other systems.

This paper presents some possible carbon 'budgets' for New Zealand based on convergence to equal per capita carbon dioxide (CO_2) emissions in 2050, while keeping within a 'global 2°C' budget. The paper assesses whether the domestic economy could change rapidly enough so that emissions remain within these '2°C budgets' and to meet the '50% by 2050' target.

Contraction and convergence is a relatively easy metric to calculate and reflects equal 'responsibility' for emissions. However, the results of this metric imply widely different levels of abatement effort (cost) should be taken across countries as it doesn't take any account of different emission profiles. [**Note**: *Treasury considers the 'contraction and convergence' approach applied in this paper to be an inappropriate measure of 'fair share'. Treasury also considers that any targets New Zealand takes should be contingent on the actions of others.*]

The CO_2 emissions budgets (10th, median and 90th percentile)[2] for New Zealand prepared with this method are shown in Figure 1 along with business-as-usual (BAU) gross emissions[3]. The 90th percentile contraction and convergence budget is consistent with the 50% by 2050 target. Multi-gas emissions budgets (including methane and nitrous oxide) were also derived for New Zealand, although confidence in their validity is limited.

[2] The spread of budgets arises from the spread of results in IPCC modelling – which assembles modelling results from a large number of research teams around the world.

[3] Forestry emissions and removals are not shown, as their impact depends heavily on the accounting rules applied.

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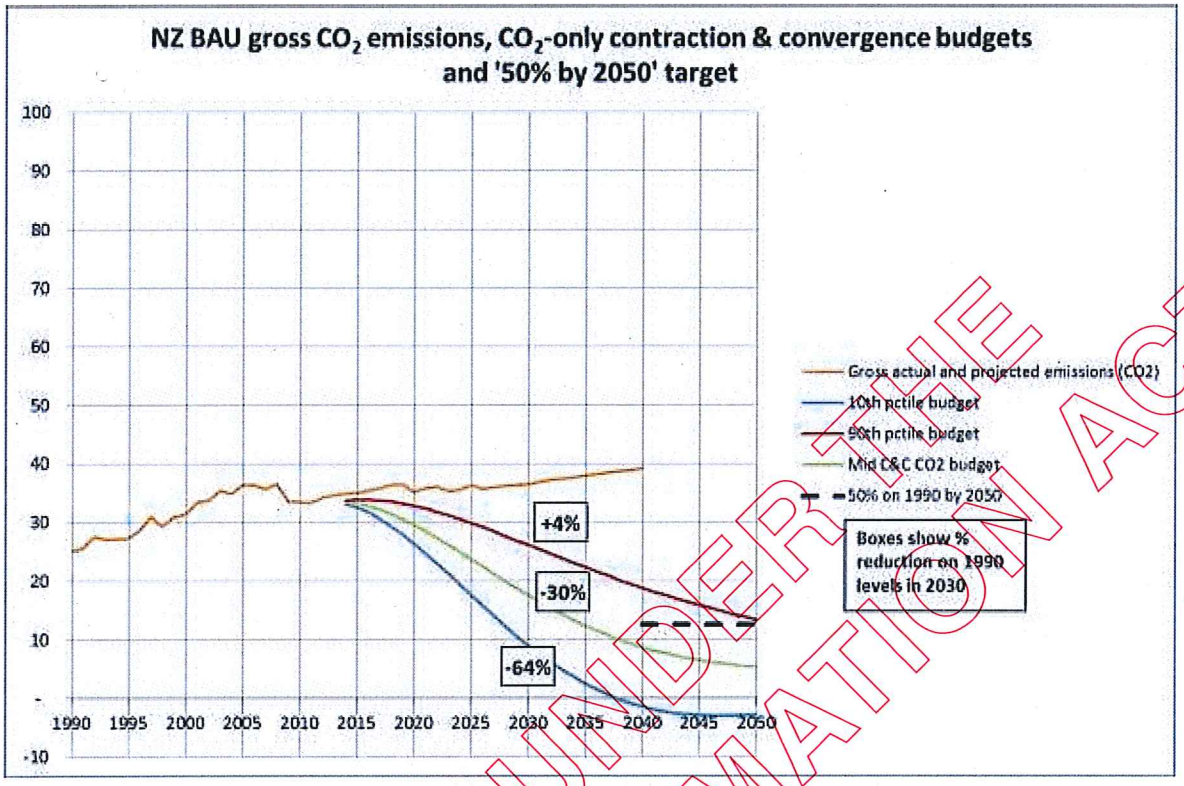

Figure 1 NZ's gross actual and projected CO_2 emissisons compared to some CO_2 budgets

The budgets shown in Figure 1 imply that domestic carbon emissions would have to change at rates of up to 7% per annum to comply with the median budget (or up to 3-4% to comply with the 90th percentile budget). The domestic economy is likely to be able to change to reduce carbon emissions at rates of around 3-4% based on standard asset lifetimes and turn-over rates for most sectors. This suggests that the New Zealand economy could change quickly enough to meet the 90th percentile budget, but not the median budget, without replacing assets before the end of their life.

To illustrate in more detail some possible changes in the New Zealand economy that would achieve these rates of change, two plausible 'Low Carbon pathways' out to 2050 were constructed for New Zealand. These assume renewable energy technology is rolled-out at standard asset turn-over rates[4].

The broad mechanisms used to reduce emissions are 1) switching to renewable energy, 2) reduction in travel demand and 3) CO_2 removals by new 'energy forests', grown to provide feedstock for biofuels. Table 1 shows the main features of each Low Carbon pathway.

[4] Data on asset lifetimes were derived from a variety of (mostly) New Zealand-specific sources

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Table 1 Main features of the two Low Carbon pathways. Rows 1-4 show features shared by both pathways Rows 5-9 show features on which the two pathways differ..

	Emissions area	Pathway 1	Pathway 2
1	Electricity supply	All new baseload supply is renewable	
2	Electricity demand	No abatement assumed from efficiency measures	
3	Transport – light vehicles	Electric vehicles are 63% of vehicles entering fleet from 2025 [**NOTE**: *EECA considers this rate of uptake to be challenging but plausible*]	
4	Industrial process heat	Switch all coal (by 2030) and around half gas (by 2050) boilers to wood fuel	
5	Petroleum industry	Reduce fugitive and petroleum processing emissions in proportion with growth of domestic biofuels industry	
6	Transport – demand reduction	No demand reduction from BAU	Shifts towards compact urban form, increased vehicle occupancy and decreased discretionary travel result in 23% reduction in urban vehicle kilometres travelled vs BAU by 2050
7	Transport – biofuels	100% of land transport liquid fuel demand from domestic biofuels by 2050	50% of land transport liquid fuel demand from domestic biofuels by 2050; 50% from imported biofuels
8	Energy forests (source for biofuels)[5]	Plant 50K Ha pa of new 'energy forests' to 2020 and 80K Ha pa in '20s and '30s. **[NOTE:** *MPI CONSIDERS PATHWAY 1 AFFORESTATION RATES TO BE IMPLAUSIBLE*]	Plant 15K Ha pa of new 'energy forests' to 2020 and 36K Ha pa in '20s and '30s. [**NOTE**: *MPI CONSIDERS THESE AFFORESTATION RATES PLAUSIBLE BUT CHALLENGING*][6]
9	Agriculture	New energy forests displace 5% of agricultural emissions by changing land-use	New energy forests displace 2% of agricultural emissions by changing land-use

Low Carbon pathways (energy emissions only) are shown against the previously derived CO_2-only budgets in Figures 2 and 3 (at the end of this document). Low emissions pathways for all gases, including forest removals, are shown against a 50% by 2050 target (all gases) in Figures 4 and 5. The coloured wedges in these graphs show abatement achieved from different sources. Note that the projected BAU emissions (all gases) assume some improvement in agricultural emissions efficiency.

Answering the questions in the purpose statement

1. *How long could it take to reduce emissions from the New Zealand economy to a level consistent with a 2°C global climate goal?*

The analysis approach taken in this paper suggests it is only just possible to reduce New Zealand's gross domestic CO_2-only emissions rapidly enough to meet a 'contraction and convergence budget' for New

[5] This is additional to the 10K Ha per annum already assumed under business as usual projections

[6] Afforestation rates have previously reached Pathway 2 levels for short periods. Conditions necessary to drive such rates include:

(i) High fuel prices in New Zealand (SCION suggest $2.75 would be required for petrol);

(ii) The availability of technology to profitably convert wood to fuel at scale;

(iii) That energy forestry would be more profitable than competing land uses, and that investors could be confident that the price and demand for biofuel would be stable in the long term;

(iv) That energy forests would be financed by the private sector;

(v) Landowners are prepared to change land use (may be limited by social drivers and option value)

Zealand consistent with a 2°C global climate goal. Domestic pathways which achieve this reduce gross CO_2-only emissions by around 50% on 1990 levels by 2050. Higher rates of change are theoretically possible, but would likely incur higher costs. Different allocation methods (than contraction and convergence) to determine New Zealand's 'fair share' of a global budget would produce substantially higher or lower values for New Zealand's 'budget' and could therefore change this conclusion.

Both Low Carbon pathways assume that 'new energy forest' sinks are a potentially significant contributor to New Zealand's *net, all-gases* emissions reductions in the medium-term. Energy forests remove CO_2 from the atmosphere during forest growth, displace fossil fuels for transport and displace some agricultural emissions by land-use change. For example, in the case of domestic production of biofuels to meet 100% of liquid fuel demand from land transport (Pathway 1), the forest sink *offsets* around two-thirds of remaining energy, agricultural and other emissions in 2050 (in addition to the reduction in energy sector emissions already described). **[NOTE:** *MPI considers Pathway 1 afforestation rates to be implausible, and Pathway 2 rates to be plausible but challenging*]

International recognition of this forest sink would depend upon the accounting rules applied. Here a 'reference level' approach is assumed, which recognises afforestation removals while factoring out cyclical harvesting emissions on the basis that the energy forests comprise a large, stable carbon pool. Afforestation would be credited for removals, but only up to the level of the long-term storage – [withhold under section 9(2)(g)(i)] . After 2050, the forest sink offset would no longer be available, assuming new planting rates drop to zero once sufficient energy forests are established.

2. *Given possible scenarios for timing of global action on emissions, how soon should New Zealand start acting on its emissions?*

The analysis in this paper suggests that the New Zealand's gross CO_2 emissions could be reduced at around the same maximum rate as that achievable globally (in IPCC scenarios). If New Zealand decides to make its domestic mitigation action contingent on action by the rest of the world, then starting New Zealand action at the same time as the rest of the world would therefore allow comparable progress by New Zealand towards its share of a global goal based on a contraction and convergence metric.

3. *Which actions would be the highest priority to start now to maximise the chance of achieving a low-emissions economy by year x?*

If it were desired to increase the certainty of achieving such an emissions pathway to 2050 then it would be urgent to put in place now policies which incentivise relevant investments by asset owners. The relevant sectors whose assets turn-over at less than the critical 7% per annum rate (implied by the median budget) are boilers, power plants, forests (some crops), transport infrastructure and buildings. If action were delayed, then accelerated asset turn-over rates, and higher costs, would be required to stay within a given emissions budget for CO_2.

Relevant policies include those that send long-term signals about future potential carbon prices and biomass demand, transport and planning policy. In addition, R&D policies in agriculture, and in general, are likely to increase the range of abatement options available and create new, lower-emissions goods and services. Improved energy efficiency is not modelled in this paper, but could decrease the cost and increase the feasibility of achieving a given 2050 target.

Uncertainty in key emissions drivers, including energy prices, agricultural and forestry commodity prices, and technology progress mean business-as-usual emissions and the cost of achieving particular levels of domestic abatement are highly uncertain. A crucial area of technological uncertainty for New Zealand is agricultural emissions reductions from productivity gains and abatement technologies. No assumptions have been made about possible progress in this area in New Zealand beyond those achieved in 'business as usual' projections. Plausible rates of progress in reducing agricultural emissions through R&D outputs are in the order of decades. Nor are any assumptions made about afforestation that might be achieved under BAU.

4. *What international contribution from New Zealand would be consistent with a plausible long-term low-emissions pathway?*

In the medium-term, both Low Carbon Pathways return *energy sector-only* emissions to around 1990 levels by 2030. In other words, they would be consistent with achieving a '0% by 2030' target for CO_2-only (excluding forestry removals).

In terms of emissions for *all gases* and sectors, including agriculture and removals by forests, total net emissions are around +10% on 1990 levels in 2030 for Pathway 1 and +17% in Pathway 2.

Other conclusions and further work

The conclusions in this paper are similar to those made at a global level by the IPCC: that plausible rates of change mean emissions pathways which keep the world within a 2°C budget are highly challenging, and that delayed action increases the cost of staying within a given emissions budget.

Considerable further work should elaborate on the initial analysis in this paper, including:

- More sophisticated modelling of long-term abatement potential in the energy sector and interactions with other parts of the economy, and assessment of energy efficiency potential
- More in-depth analysis of global and New Zealand scenarios for agricultural and forestry 'budgets' and emissions pathways, including interaction with climate change impacts and adaptation
- Development and evaluation of different long-term strategies for New Zealand agriculture and forests taking account of emissions, food security and other objectives
- Scenarios which test a broader range of assumptions for uncertain variables including technological progress, energy prices and other important drivers identified in the systems-mapping workshops.
- Continued development of systems-maps of emissions drivers, including identification of key points of intervention for potential mitigation policies

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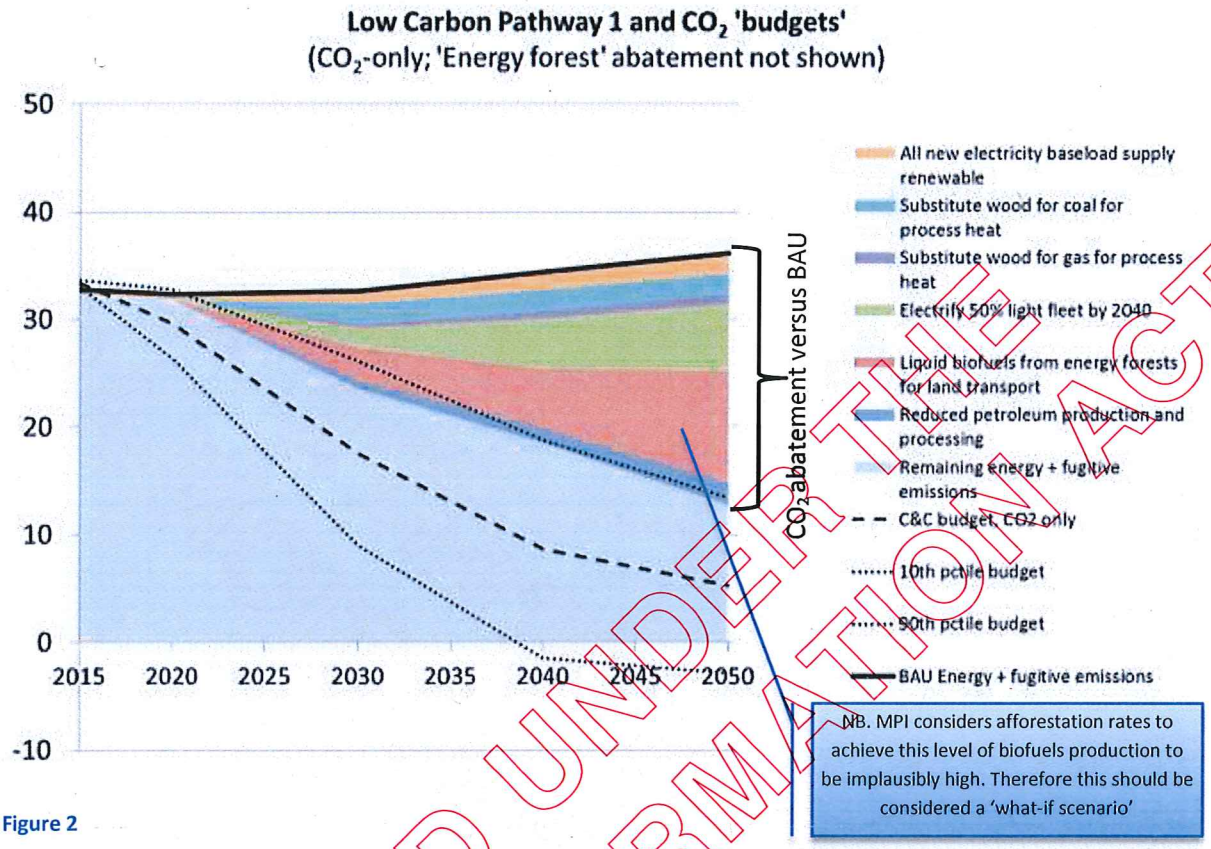

Figure 2

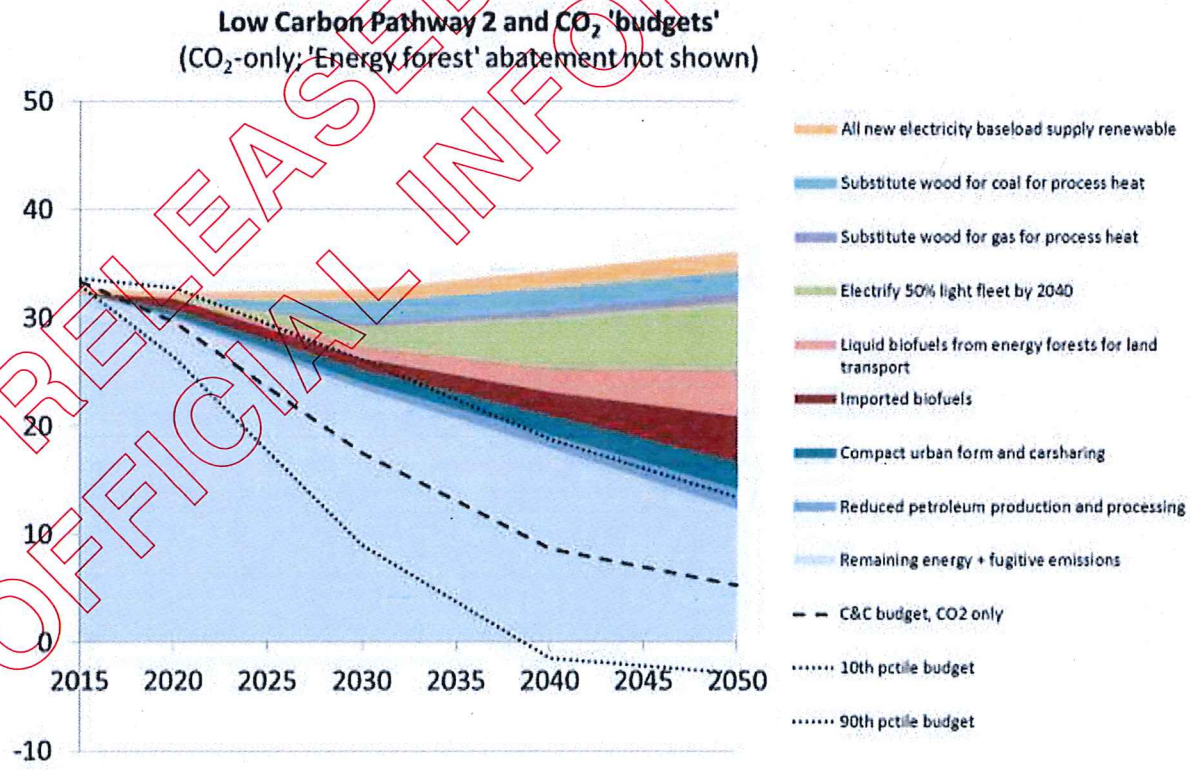

Figure 3

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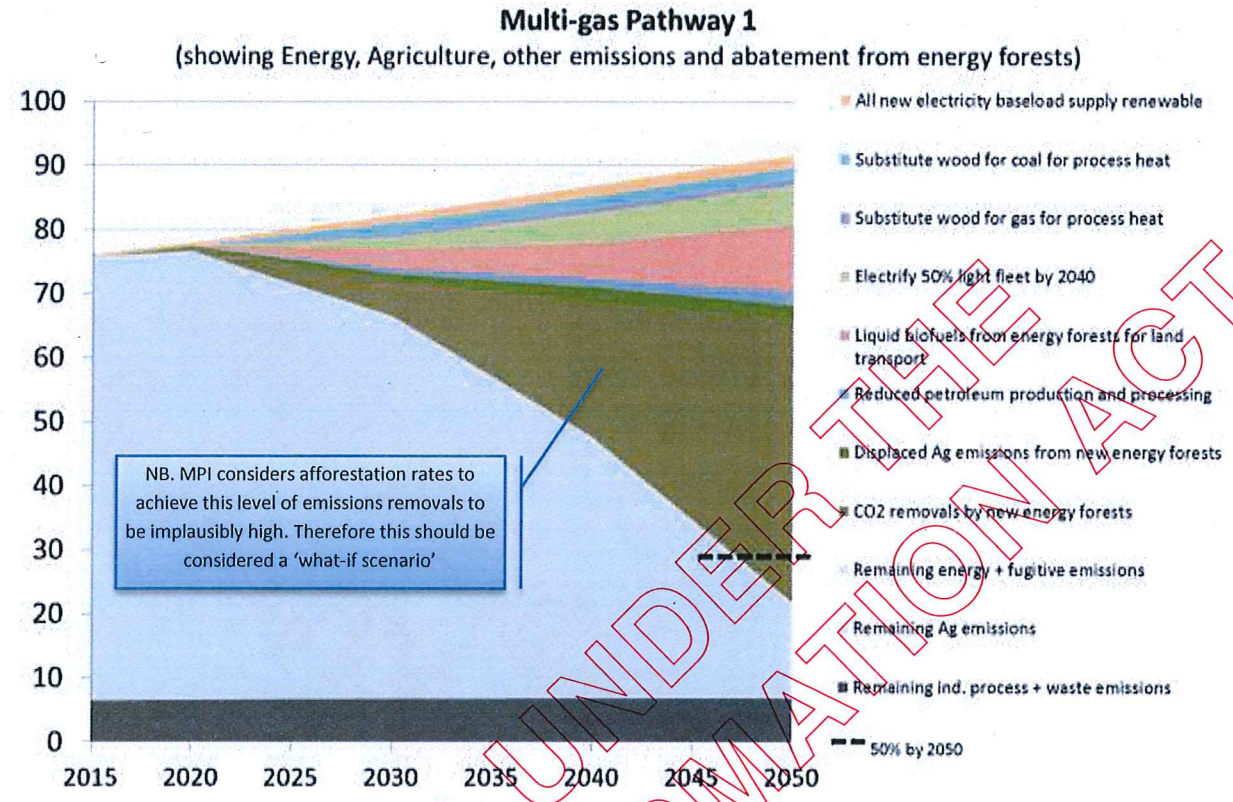

Figure 4

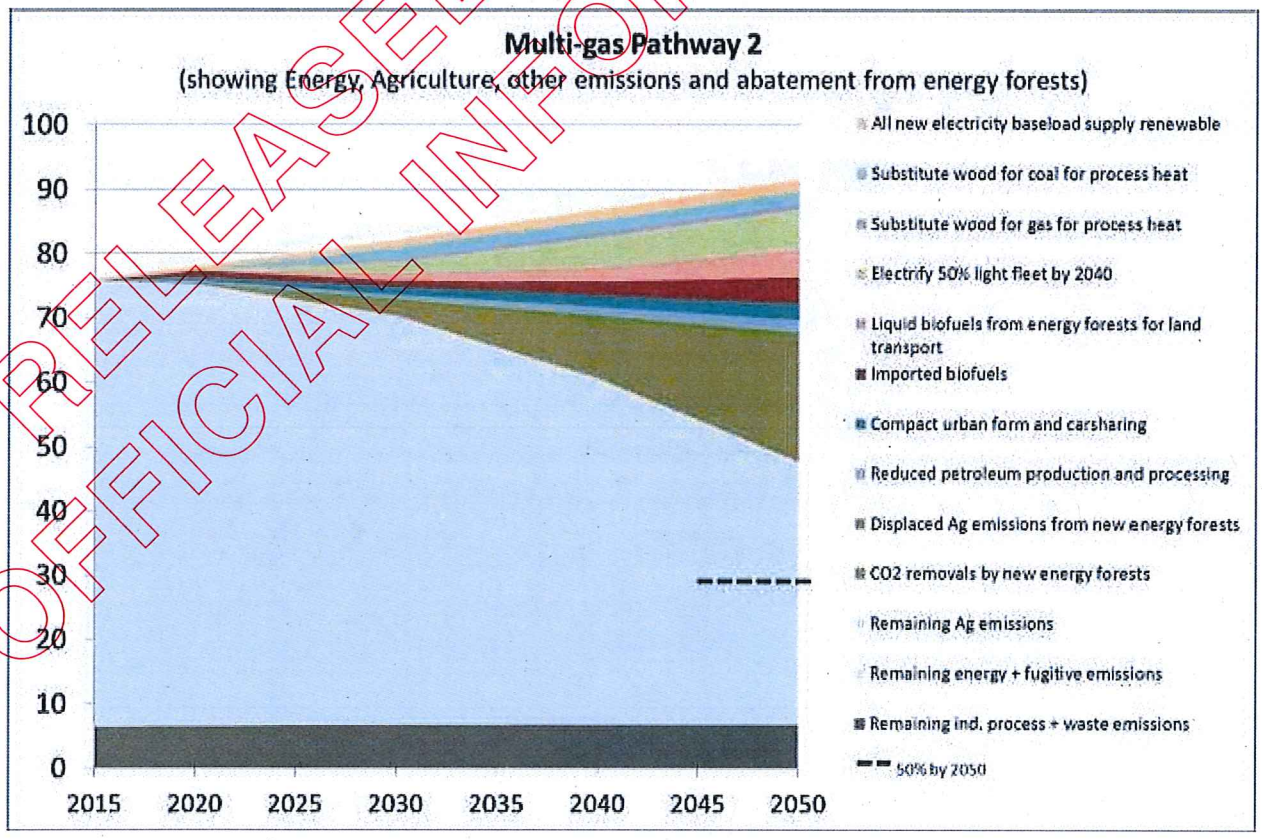

Figure 5