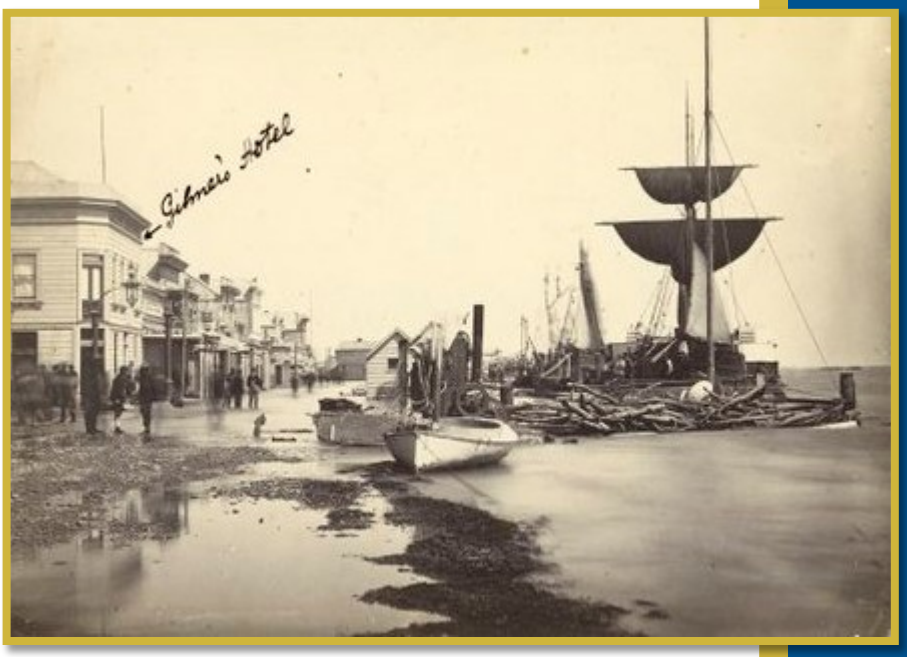
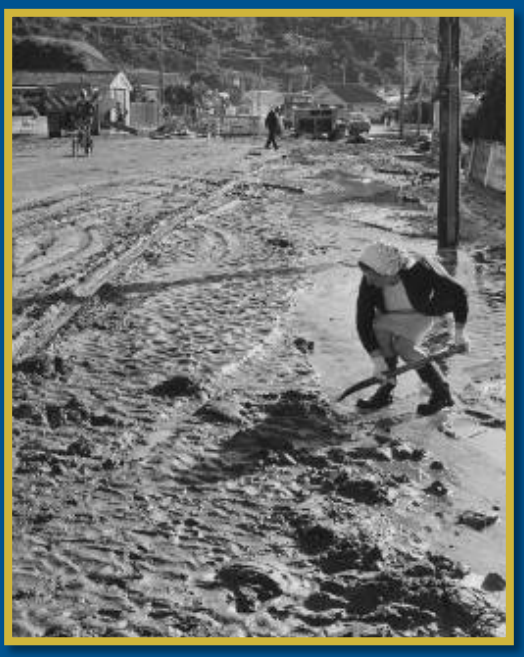
Submission to Productivity Commission on its draft report “Low-Emissions Economy” April 2018





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Greymouth 1967: *Flooding on Mawhera Quay, Greymouth. Perkins, J (Mr), fl 1967: Photograph album and loose prints. Ref: PA1-o-415-04. Alexander Turnbull Library, Wellington, New Zealand. /records/23051394*

Lower Hutt 1977: *Mrs Garrett shovelling mud left by flooding. Dominion Post (Newspaper): Photographic negatives and prints of the Evening Post and Dominion newspapers. Ref: EP/1977/1288/16-F. Alexander Turnbull Library, Wellington, New Zealand. /records/22823794*

Willis St, Wellington 1960: *View of a manhole storm water drain flooding on Willis Street after a downpour, Wellington City. Dominion Post (Newspaper): Photographic negatives and prints of the Evening Post and Dominion newspapers. Ref: EP/1960/2413-F. Alexander Turnbull Library, Wellington, New Zealand. /records/30630456*

Stoke's Valley 1976: *Three houses in Ngahere Street, Stokes Valley, destroyed by floods. Dominion post (Newspaper): Photographic negatives and prints of the Evening Post and Dominion newspapers. Ref: EP/1976/4663/28A-F. Alexander Turnbull Library, Wellington, New Zealand. /records/22845150*

About the Author

Sean Rush is the owner of Spindletop Law, a Wellington based incorporated law firm practicing in the fields of oil, gas and energy (http://www.spindletop.co.nz/). Sean has a Masters in Petroleum Law and Policy (with distinction) from the University of Dundee's Centre for Energy Mineral Petroleum Law and Policy.

Over a 25-year career, mostly in the UK, advising oil, gas and energy companies across the world, Sean has contributed to policy "think tanks", for example, the "PILOT" government-industry think tank for UK Oil and Gas, the International Bar Association's working group on the regulatory response to the "Macondo" blowout and more recently in researching and reporting on the opportunities for Maori participation in the oil and gas sector here in New Zealand. It was Sean who first floated the idea in the "PILOT" forum of splitting out the oil and gas function of the UK's Department of Energy and Climate Change into a separate, industry funded agency (now the Oil and Gas Authority) which would champion the interests of the taxpayer as the industry there moved into its twilight years.

Sean's first interest in climate change matters came in 1999 when he wrote an article analysing the UK's Climate Change Levy. At that time the science was accepted by him without question. However, he found it odd that politicians always felt the need to promote the 'science as being settled' – surely it is or it isn't? In 2007 he read and then watched Al Gore's *"An Inconvenient Truth"* but was troubled when it became apparent that small tricks were being played to over-emphasise the nature of global warming.[1] That led to a determination to 'find out for himself' and since then he has read widely in a personal capacity and found that there is a clear 'them and us' battle being played out online between sceptics and alarmists with such visceral that it became clear that online blogs would not advance his understanding. In 2016 he took a post-grad course at Victoria University of Wellington, SCIE401: Climate Science and Decision Making. That course whilst helpful in understanding mainstream views served to reinforce his concern that sceptical views were being ignored.

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[1] Gore had said there was a complex relationship between CO2 and warming, an implication being that temperatures had historically risen as a result of CO2 increases. The implication is incorrect. Also use of forlorn polar bears and the shot of a South American glacier calving being used to visualise Artic melting to elicit an emotive response just seemed odd.

Executive Summary

Key points

- Climate change is real but the final consequences of continued emissions of greenhouse gases from human activities remains unquantified. Observational evidence suggests that catastrophic outcomes are unlikely and that planetary warming will continue, if at all, along the very lowest range modelled by IPCC scientists.

- International geopolitics creates a barrier for long-term domestic policy planning. The Commission should take into account that the Paris Agreement is under threat due to the absence of support from the United States. Further, many "developing countries" have made very little in the way of commitments and their emissions (for example, China's "belted road initiative") will swamp any measures that New Zealand might implement.

- That is not to say that New Zealand does nothing, but a measured response tracking the science and trade partners should be adopted.

- International mitigation opportunities were excluded from the Report's terms of reference. This is a mistake because the potential for New Zealand to meet ambitious targets will only be fulfilled by access to international opportunities. Consequently, the report losses considerable utility by not addressing international opportunities for which a framework is expected to be advanced at COP24 in Poland this year.

- The scenarios modelled by the Commission appear to be mutually exclusive when the likely outcome is a mix. "Bankable" projects in the decarbonisation space are almost certainly going to be developed by existing, credible organisations utilising existing or emerging technologies. Policy initiatives can facilitate "Scenario 3 – Stabilising Decarbonisation", but it is unclear how "Scenario 2" can realistically be expected to evolve without policy measures that have the effect of closing down a large section of New Zealand's industrial sector.

- It is suggested that New Zealand's efforts be benchmarked against peers and that a "top-quartile" scenario be modelled.

- The recommendation that subsidies for oil and gas should be removed because they stifle innovation in renewables should be reconsidered. A "subsidy" is where the Government pays money to incentivise an activity. Reducing the tax take is a different mechanism, the elimination of which, will not free up any surplus R&D capital for renewables.

- Conversely, the Government should be incentivising oil and gas exploration and development to maximise petroleum royalty revenues that can bankroll the clean tech transition.

- Outside of agriculture (which the Report correctly acknowledges that New Zealand leads) New Zealand is a technology taker. A sensible strategy would be to partner with trading partners in the development of new technology that, if successful, can be customised for use in New Zealand. There does not seem to be any valid reason why New Zealand should expend R&D capital trying to solve energy system issues in competition to major economies whose budget for R&D in this space is in the order of many thousands than that of New Zealand.

- The case for a state-owned entity acting as a "decarbonisation champion" is made to provide a firm signal to the investment community. As a "blue sky" idea the Government could capitalise this entity with its interest in the Kupe Field and Huntly Power Station with further support from petroleum royalties.

- The “champion” would be introduced to the private sector and be tasked with identifying and making a business case to adopt proven technology and financing of any necessary infrastructure and market development. Ownership of the “champion” would be open to energy industry participants with also the opportunity for public participation via a public listing. Internationally, the “champion” would look, on behalf of itself and other Kiwi businesses, for opportunities to earn international mitigation credits pursuant to Article 6 of the Paris Agreement.

- In support of the “champion” and to promote the growth of income and well-being, the resurrection of a state funded civil engineering and labour organisation, in the nature of the old Ministry of Works, is proposed. Whilst providing the labour force needed to implement the construction of infrastructure needed for decarbonisation, it would also integrate with Government initiatives to address long-term unemployment and reduce rates of recidivism.

- This submission considers the introduction of a “Zero Carbon” Act for New Zealand as premature and considers the performance of the UK’s legislation to be failing because its genesis was to secure a political moral high-ground rather than to meaningfully address climate change. This submission suggests that light touch regulation, as a more flexible and market led tool, is the appropriate response for New Zealand in the short to medium term.

- Light touch regulation would see the introduction of a climate change regulator who would be tasked with ensuring compliance with targets set by the Climate Change Commission with broad statutory powers to facilitate emission reduction initiatives and assure the efficient operation of the domestic New Zealand ETS and its links to international markets. He/she would also be responsible for the allocation of New Zealand’s emission units, ensure forestry or other ‘sinks’ were not acting anticompetitively and to identify and make recommendations regarding market failures.

Prologue

"We are confronting three rather different narratives. The first I would call the IPCC WG1 [working group 1 – the physical science] narrative. This narrative, while broadly supportive of the proposition that increasing greenhouse gas concentrations are a serious concern, nevertheless, is relatively open about the uncertainties and even contradictions associated with this position, and its public pronouncements tend to be vague with ample room for denial, carefully avoiding catastrophist hyperbole while also avoiding outright rejection of such hyperbole. The first narrative is very much the narrative of many of the major supporters of the global warming agenda.

The second narrative is that of what are referred to as 'skeptics.' To an extent, not generally recognized, there is considerable overlap with the first narrative. Thus, although skeptics might agree that alpine glaciers have been retreating since the early 19th Century, they are also aware that alpine glaciers were largely absent during the medieval warm period, and that their more recent retreat preceded by well over a century the period when anthropogenic greenhouse warming became moderately significant. Moreover, skeptics generally regard the fact that virtually all models 'run hot;' ie, their projections for the period 1979 to the present for the most part greatly exceed observed warming, strongly supports low climate sensitivity. They generally believe in testing the physics underlying the positive feedbacks in sensitive models rather than averaging models. Skeptics also are much more open to the numerous known causes of climate change (including long period ocean circulations, solar variability, and the various impacts of ice), and do not regard CO2 as the climate's ultimate 'control knob.' The main difference between these first two groups, however, is that the second group openly opposes catastrophism while the first group does not.

The third narrative is that of the political promoters of climate alarm including many of the environmental NGO's, and most of the mass media. The promoters of this narrative also include many of the contributors to WG2 (impacts) and WG3 (mitigation) of the IPCC. The latter generally emphasize alleged consequences of the worst case scenarios presented by WG1. It is this narrative for which the science is largely irrelevant. Few scientists will endorse the notion that the planet is at risk, though this is standard fare for the catastrophists. It is also this narrative that invariably claims virtually unanimous support. Such claims generally rely on bogus studies which, moreover, dishonestly conflate the points on which both the WG1 and the skeptical narratives agree, with the third catastrophic narrative. Anyone looking at any statement concerning global warming will readily identify which narrative is in play. Unfortunately, for most people, the third narrative is all they will see."

Richard Lindzen, 2015.[2]

[2] Concluding remarks from the text of a lecture delivered on August 20, 2015 to the 48th session: ERICE international seminars on planetary emergencies by Richard S. Lindzen, Alfred P. Sloan Professor of atmospheric sciences (Emeritus) Massachusetts Institute of Technology. http://euanmearns.com/global-warming-and-the-irrelevance-of-science/ - last visited 6 June 2018.

Introduction

Opening Remarks

I would like to congratulate the Productivity Commission ("**the Commission**") for the compilation of the draft report *"Low-Emissions Economy"* April 2018 ("**the Report**"). These comments are intended to be a constructive addition to your analysis based principally on the writer's perspective which includes a mix of oil/gas/energy policy expertise, considerable personal research on the science and politics underpinning climate change, an understanding of international markets, commercial practices and behaviours and as a father of two children under four, and the son of two parents over 70. This is my submission and has not been prepared on behalf of any client or industry association.

On the one hand the climate change challenge excites me. My specialty is in the financing, construction and use rights associated with infrastructure and so the possibility of a complete retrofit of New Zealand's energy systems is of considerable interest and opportunity. On the other hand, my review of the science and politics of climate science suggests there is much less certainty around the theory of anthropogenic global warming ("**AGW**") than is popularly thought and broad agreement between the mainstream and sceptics that catastrophic outcomes are highly unlikely. However, my conclusion is similar to that of Gareth Morgan's, expressed in his book "*Poles Apart*."[3] CO2 is a greenhouse gas. It causes some warming on its own, somewhere around 1°C without a further positive feedback – the nature of feedback is where debate is still ongoing with observations currently matching sceptical claims. Nevertheless, if we keep putting more greenhouse gases ("**GHGs**") in the atmosphere it will cause problems eventually and oil and gas are finite resources anyhow so transitioning is a good idea. But my firm view is that our response must be measured, well thought out and in tandem with our trading partners and, most importantly, one that does not cause undue hardship.

I will structure my comments along the lines of the Report's five-part structure, although will not necessarily address all the content in each part (unfortunately other professional commitments limit this, otherwise, optimal approach). My comments are primarily directed at the energy sector although research around agricultural emissions is certainly an area that New Zealand should continue to lead.

In my experience, Lindzen's comments reproduced in the Prologue are absolutely correct. Interestingly, although the actors participating in the First (the "**sceptics**") and Second (the "**mainstream**") Narratives have much more in common in terms of agreement, they do not speak collaboratively.[4] Comments I have received from mainstream advocates in respect to sceptical views on, for example, the true nature of the "water vapour effect",[5] have been dismissive and personal, suggesting sceptics had to move to this new position, even though Lindzen has been banging on about the lack of a water vapour effect since the mid-1990s.[6] However, the mainstream and the Third Narrative (the "**alarmists**") communicate closely via peer reviewed publications and at various climate related conferences and meetings of the parties, and even on NGO boards and activist

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[3] *Poles Apart: Beyond the Shouting, Who's Right About Climate Change?* May 8, 2009 by Gareth Morgan and John McCrystal

[4] See Gareth Morgan's "*Poles Apart*", the title of which reinforces this point.

[5] The "water vapour effect" refers to one of the foundational planks of the theory anthropogenic global warming where increased CO2 leads to incremental warmth enabling the atmosphere to hold more water vapour, a powerful greenhouse gas, which adds further and potential, catastrophic, warming.

[6] See R. Lindzen, "ON THE SCIENTIFIC BASIS FOR GLOBAL WARMING SCENARIOS", Environmental Pollution 83 (1994) 125-134, available at https://www.sciencedirect.com/science/article/pii/0269749194900302

events. This, even though the alarmist narrative is not supported by the mainstream. For example, the IPCC's latest report AR5, had this to say about catastrophic outcomes:

> *"'Abrupt climate change' is defined in this IPCC fifth assessment report (AR5) as a large-scale change in the climate system that takes place over a few decades or less, persists (or is anticipated to persist) for at least a few decades and causes substantial disruptions in human and natural systems. There is information on potential consequences of some abrupt changes, but in general there is 'low confidence' and little consensus on the likelihood of such events over the 21st century."* [7]

The point of the above opening remarks are to demonstrate that the claims of "*catastrophic warming*", "*tipping points*", "*we must do something immediately*" belong to Lindzen's third narrative and, whilst should not be dismissed, should not be the focus of the Commission's analysis as they might limit the opportunities of continuing to grow incomes and well-being by unnecessarily elevating the costs and pace of transition.[8]

Indeed, indulging in the Third Narrative will militate against the delivery of a report with integrity that provides robust advice in regard to regulatory, technological, financial and institutional system reform and deployment to optimise a transition to a lower net emissions economy.[9]

Part 1: Setting the Scene

The Need for Stable and Credible Climate Policy Settings

The Commission notes:

> *"Underwriting a long-term reorientation of the economy away from fossil fuel dependency requires policy stability decoupled from the short-term ebb and flow of politics … it requires a broadly shared commitment to steady progress."* [10]

To date, in my observation at least, little other than the alarmist narrative has been given to the public, and indeed to politicians. Us "non-scientists" have been told simply to believe, even though the key aspects to the anthropogenic global warming ("**AGW**") theory and understanding its primary weaknesses, many of which are openly documented in IPCC literature but seldom publicised, can be viewed and understood with some perseverance (and help from credible sources). Securing that *"broadly shared commitment to steady progress"* will require ordinary New Zealanders to be convinced that completely retrofitting New Zealand's economy is firstly necessary and will make any difference in the long term. Rhetoric around showing *"leadership"* and demonstrating how *"it can be done"* so that so-called developing countries can find an equal measure of commitment amongst their own populations (to the extent leaders of some of these developing nations ask their populations) ignores asking the hard questions that when answered by our democracy provide a mandate for action.

The challenge of securing public momentum to adhere to long-term commitments is not, in the context of climate change, insignificant and the nature of the evolving science is a barrier, not helped by the political objectives of UN proponents of alarmism that are not supported by the science. To

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[7] TS, page 70, TFE.5 – irreversibility and abrupt change.

[8] One of the two "broad questions" that should guide the enquiry under the Terms of Reference ("**TOR**").

[9] The second "broad question" that should guide the enquiry.

[10] PCE218, p.17.

reinforce this challenge, a brief "warts and all" overview of aspects of the IPCC, the science gatekeepers in this area, follows. Whilst it is acknowledged that it is merely one perspective, it follows a narrative most New Zealanders (including policy makers) will not have heard – but need to.

IPCC Assessment Reports

First Assessment Report[11]

The First Assessment Report ("**FAR**") issued in 1990 must have been disappointing for the proponents of human-caused climate change at the United Nations Environmental Programme ("**UNEP**") and the World Meteorological Organisation ("**WMO**"). Nasa's James Hansen had been slammed by the mainstream for his evidence to congress in 1988 (when Hansen's collaborators arranged for him to give evidence on the warmest day of the year and then fiddled with the air-conditioning so it did not work. As such everyone was sweating while Hansen described the unbearably hot Summer as something to get used to) but it started the modern 'global warming' clamour (and ending the "global cooling" one popular in the 1970s). However, the FAR was sceptical that late 20thC warming could be attributed, at that time, to human activity. It disconnected the link between CO2 and warming by showing greater warming during the Medieval Warm Period when CO2 levels were similar to pre-industrial times.

It similarly observed pre-industrial CO2 levels during the mid-Holocene when temperatures were also higher than the present (see figure 1 below). This was a major blow to efforts to get a Convention signed up to halt CO2 emissions. It needed scientific support that was not forthcoming. That inconvenient truth did not stop the UN going ahead anyway with the United Nations Framework Convention on Climate Change being signed up in 1992. However, it being merely a "framework" the obligations were not onerous and it contained no binding emissions targets.

Second Assessment Report

For the Second Assessment Report released in 1995 (the "**SAR**"), a similar equivocal message was drafted in to Chapter 8 "Detection and Attribution". The chapter was underpinned by work done for a peer reviewed publication, *Barnett et al.*[12] The 'et al' included Phil Jones and Keith Briffa of the University of East Anglia is Climate Research Unit (of "ClimateGate" fame covered below) and R.S Bradly who would go on to find fame as one of Michael Mann's co-authors of the "Hockey Stick" also described below.

The working group 1 ("**WG1**") (the physical science) scientists approved the final conclusions to be drawn from the main body of the report at a meeting in Asheville, USA in 1995. The draft conclusion to Chapter 8 (Detection and Attribution), paragraph 8.6, *"When will an Anthropogenic Effect on Climate be Identified"*, agreed by the scientists, read:

> *"Finally, we come to the most difficult question of all: 'When will the detection and unambiguous attribution of human-induced climate change occur?' In the light of the very large signal and noise uncertainties discussed in this Chapter, it is not surprising that the best answer to this question is, 'We do not know'."*

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[11] The author is grateful for the research undertaken by Bernie Lewin in regards to the history of the FAR and SAR and, in particular, the commentary on the development of the 'discernible' human influence claim. This research is set out coherently in his book "*Searching for the Catastrophe Signal – the origins of the Inter-Governmental Panel on Climate Change*" and has been helpfully made available to the author. Much of the story on the SAR can be found on Mr Lewin's website: "*Enthusiasm, scepticism and science*".

[12] Submitted for publication 17 July 1995, prior to the SAR, but not published until 1996 in The Holocene 6,3 (1996) pp. 255-263 available at: http://www.geo.umass.edu/faculty/bradley/barnett1996.pdf

This was consistent with *Barnett et al.* However, Ben Santer, a co-author of *Barnett et al,* was the Chapter 8 (Attribution and Detection) coordinating author. His draft of the Summary for Policy Makers ("**SPM**") contradicted the text of the main report as it stated: *"Taken together, these results point towards a human influence on climate".* It was an odd conclusion to draw from a co-author of *Barnett et al* which underpinned a different conclusion made in the main body. Nevertheless, the contradicting draft SPM and WG1 report were then circulated to Government representatives for comment prior to plenary session scheduled to be held in Madrid.

US officials in Washington picked up on the absence of support in the body of Chapter 8 for Santer's SPM conclusion saying: *"What is missing is the strength of scientific assurance with which this statement is made".*[13]

At the Madrid plenary session, delegates approved the following for insertion into the SPM: *'Nevertheless, the balance of evidence suggests that there is a discernible human influence on global climate'."* Santer then re-wrote the text in the main body to reflect this change, which resulted in the 'discernible' human influence headline[14] even though it had not been accepted at the last meeting of scientists in Asheville. The final text that appeared in the SAR, Chapter 8, paragraph 8.6, sent a completely different message to that agreed in Asheville. It stated:

> *"The body of statistical evidence in Chapter 8, when examined in the context of our physical understanding of the climate system, now points towards a discernible human influence on global climate."*

IPCC co-chair for WG1, John Houghton, at the time the Director of the Climate Research Unit at East Anglia, where Jones and Briffa worked, said in 2008:

> *"In Madrid in 1995, the IPCC scientific assessment process, based on the findings of the latest research, was sorely tested. Had the science not come through unscathed, the integrity of the panel would have been seriously questioned, and governments would have faltered on taking urgent action on climate change, such as the signing in 1997 of the Kyoto Protocol."*

The problem was that the scientists that approved the text in Asheville were not in Madrid – it was a 'plenary' session for Government representatives and senior IPCC officials where they agree on what the Summary for Policy Makers should say and, on this occasion, changed the text of the report to fit the political narrative. The 'latest' research was Santer's unpublished study which had been discussed and rejected in Asheville. When it was finally published, well after the SAR, it was criticised (Michaels and Knappenberger (1996))[15] for cherry picking the temperature data (starting at a 'peak' and ending in a 'trough') – had the full data-set been used the 'human fingerprint' disappeared. Nevertheless, the genie was out of the bottle. The odd thing is that Jones, Briffa, their boss and co-chair for WG1, John Houghton, were highly influential in IPCC matters and were comfortable with Santer's alterations giving it an informal 'peer' review. Nevertheless, *Barnett et al*, which Jones, Briffa and Santer had all contributed to, went on to be published in 1996 with an opposite conclusion to what the SAR, also released in 1996, came to. This did not appear to be a

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[13] Letter 15 November 1995 from Day Mount (Deputy Assistant Secretary, Acting Environment and Development) to Sir John Houghton and co-lead author WG1 attaching comments on the SPM.

[14] The "discernible link" claim was squarely at odds with the FAR and linked human activities with global climate change. The media seized on this as 'science has spoken' with one voice and the alarmist narrative went into overdrive. What wasn't reported was that Santer's analysis was based predominantly on human emissions of aerosols (dust like particles) had cooled the planet, not that CO2 was warming the planet. But, hey, why ruin a good story…

[15] Michaels, Knappenberger, Nature 384, 552-553 (12 December 1996).

source of embarrassment or debate, as leading journals closed ranks in their support of Santer and the IPCC.

A year after the SAR's release, and largely due to the political momentum it created, Kyoto was signed. The influence of "Washington" was acknowledged by Bill Clinton who is on record saying: *"The United States delegation, at the direction of the Vice President … showed the way."*[16] The Vice-President of course was Al Gore a proponent of the 'Third Narrative'. The scientific merit of his movie, *An Inconvenient Truth* was evaluated by the UK's High Court who ruled that it can only be shown in schools with guidance notes to prevent political indoctrination. Judge Michael Burton ruled that errors had arisen "in the context of alarmism and exaggeration" to support Mr Gore's thesis on global warming[17] - it was these inaccuracies that first made the author question the science.

It was influential to New Zealand's decision to ratify the Kyoto treaty. A briefing for Ministers, including the Prime Minister, in advance of a meeting on 20 March 2000 in regard to the Government's intention to ratify Kyoto, included an annex containing background on the state of scientific knowledge on climate change. It recited Santer's "discernible human influence" claim without qualification to support ratification.

For example, Santer, had included an important caveat that was not mentioned in the briefing (caveats or possible beneficial scenarios never make the headlines). He said that *"Our ability to quantify the human influence on global climate is currently limited because the expected signal is still emerging from the noise of natural variability, and because there are uncertainties in key factors."*

That was awkward but justified, even if ignored by the press and Government officials. The FAR had identified the Medieval Warm Period without CO2 increases noting: *"exceptionally warm in western Europe, Iceland and Greenland (Alexandre 1987, Lamb, 1988)"* and that *"This period of widespread warmth is notable in that there is no evidence that it was accompanied by an increase of greenhouse gases."* (See figure 1 below reproducing figure 7.1 of FAR showing 'global' temperature variations).

[16] See http://www.presidency.ucsb.edu/ws/?pid=53688 last accessed 7 June 2018.

[17] As reported in *The Telegraph* 11 October 2007. The Court found 9 alleged errors that are worth the reader reviewing given that similar claims (sea level rise, Pacific atolls sinking, disappearance of snow of Mt Kilimanjaro) are being made now available at https://www.telegraph.co.uk/news/earth/earthnews/3310137/Al-Gores-nine-Inconvenient-Untruths.html.

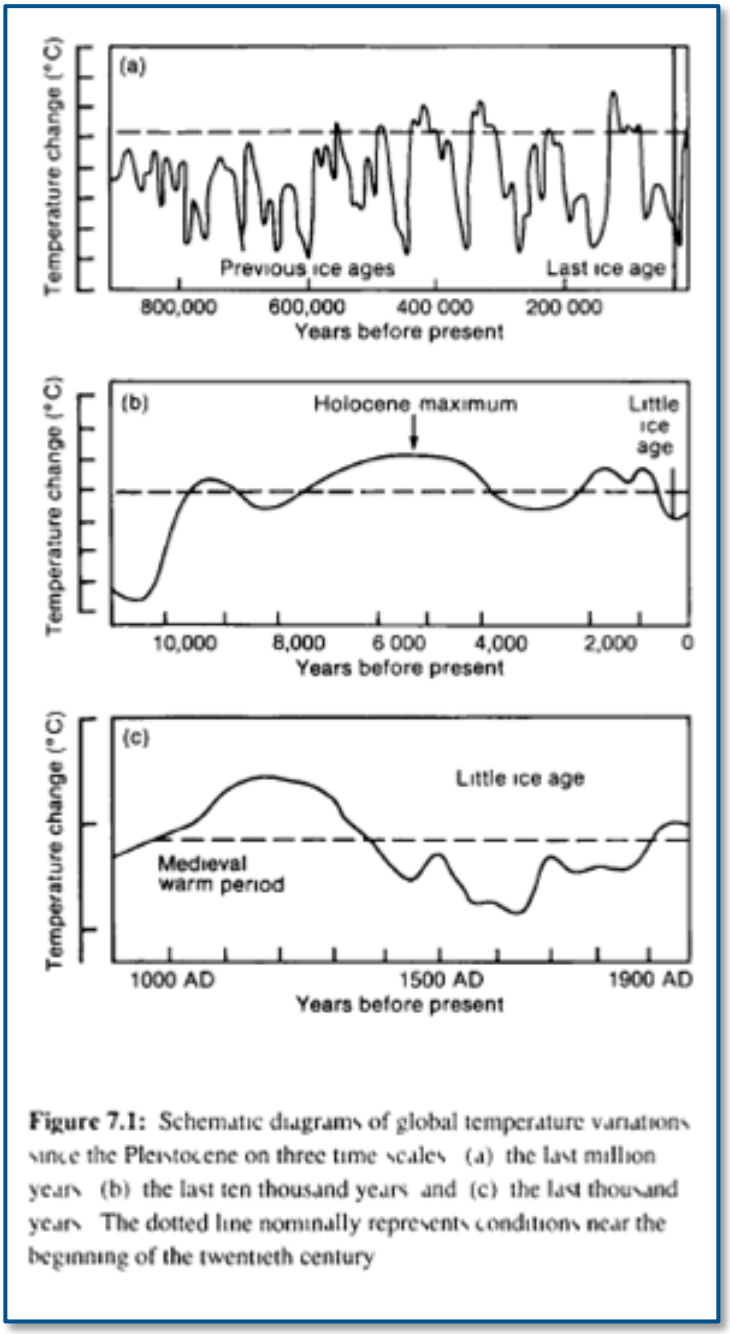


Figure 7.1: Schematic diagrams of global temperature variations since the Pleistocene on three time scales (a) the last million years (b) the last ten thousand years and (c) the last thousand years The dotted line nominally represents conditions near the beginning of the twentieth century

Figure 1: *Figure 7.1 of FAR Chapter 7, page 202*

Third Assessment Report

So in the Third Assessment ("**TAR**") enter Michael Mann and his hockey stick that smoothed out all the historic peaks and troughs over the last 1,000 years, removing both the MWP and Little Ice Age "LIA" which had been settled science for decades. It used paleoclimatic data from tree rings as a proxy for temperatures – an accepted but often unreliable technique.

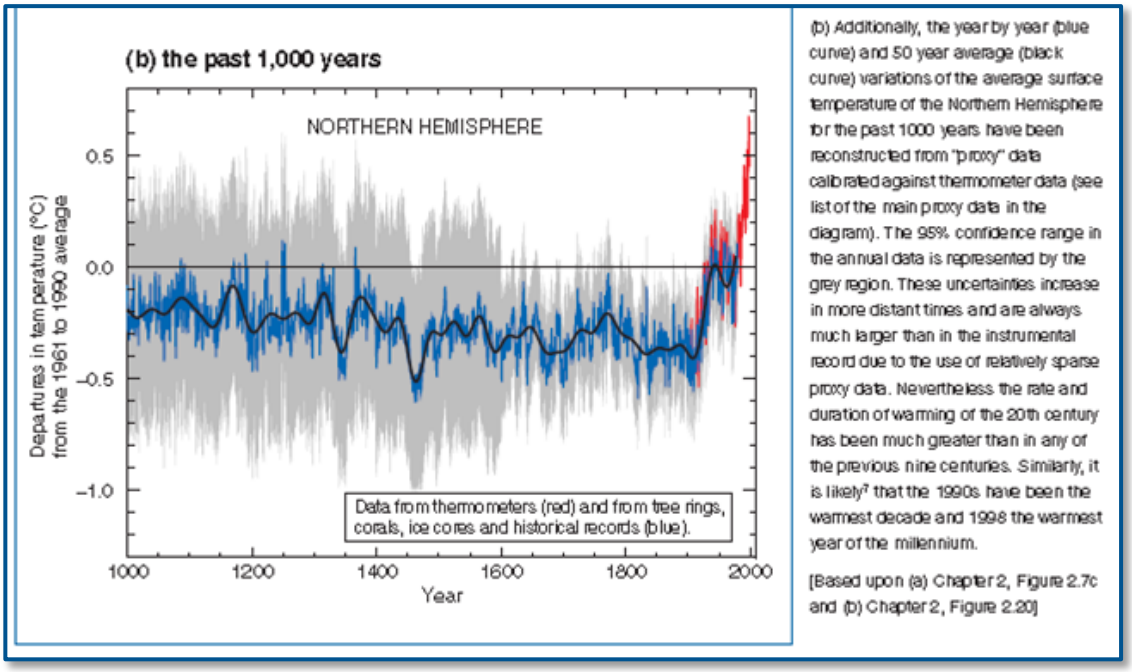


Figure 2: *The "Hockey Stick" from the SPM IPCC TAR*

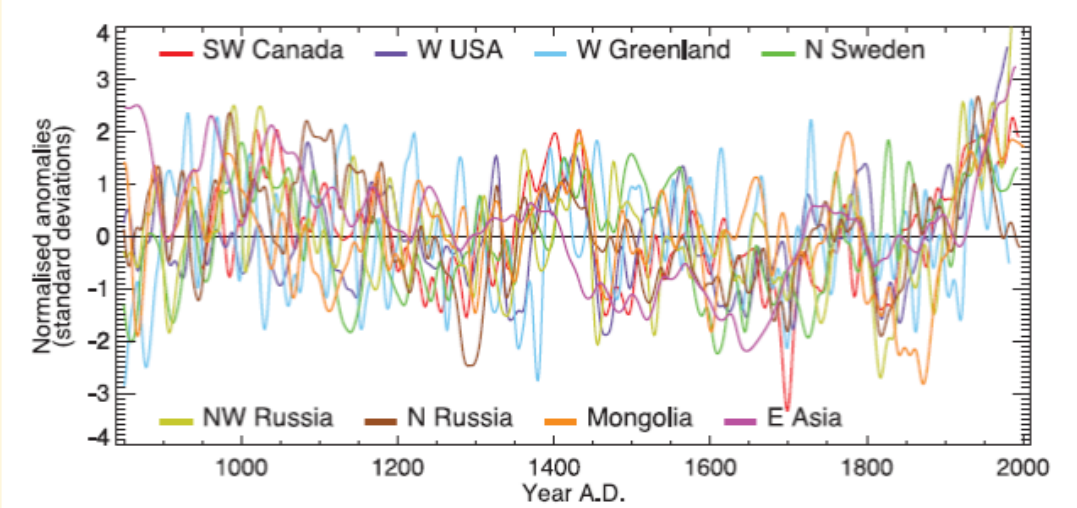
The 'hockey stick' removed the 'natural variability' problem by illustrating, graphically, that 20thC warming was so unusual it fell outside the bounds of what could be expected by natural variability – it appeared in multiple places in the TAR (above is from page 3 of the SPM), was embraced by politicians, especially Al Gore, and the press. It should never have been given any weight because the actual proxy data used (North American bristlecone tree rings) showed cooling in the mid to late 20thC undermining the validity of these tree rings as a proxy for temperature. But the decline was obscured by splicing in the instrumental record (from thermometers/satellites) from around 1850, 'hiding the decline' as thermometers recorded 20thC warming. It also helped that Mann, like Santer had been, was the relevant Lead Author and accepted his own work as representative of the latest 'peer reviewed' science.[18]

There was such an outcry after the TAR that several enquiries were held and, although Mann considers that his work is/was still valid, the key point which may or may not be Mann's fault at all, is that the hockey stick was deliberately selected to underpin a strong political narrative which could not be robustly defended by the underlying science. The exchange between leading authors is summarised at this link by statistician and mining executive, Steve McIntyre, who figured out how statistical smoothing, a valid tool, was used to flatten the pre-20thC period temperature series. It all came out in the 'ClimateGate' email release from The Climatic Research Unit at the University of East Anglia beginning 17 November 2009 – Mann, Jones and Briffa featuring prominently.

[18] However, the TAR's "peer review" process also let in the melted Himalaya's claim that was found to have been made by a tourist operator. See also *The Delinquent Teenager Who was Mistaken for the World's Top Climate Expert* by Donna Laframboise, chapters 15 and 16 and the 'Citizen's Audit' annexed. Laframboise is a Canadian investigative journalist who researched the background of the Lead Authors for the TAR and found that a third of them had undisclosed connections to environmental NGOs.

Fourth Assessment Report

The Fourth Assessment Report (**AR4**), quietly retired Mann's 'hockey stick'. The headlines told us how certain the IPCC were about the human influence on the climate whilst the press ignored the reinstatement of the Medieval Warm Period, albeit now a shade cooler than in the FAR in 1990.[19]



Box 6.4, Figure 1. *The heterogeneous nature of climate during the 'Medieval Warm Period' is illustrated by the wide spread of values exhibited by the individual records that have been used to reconstruct NH mean temperature. These consist of individual, or small regional averages of, proxy records collated from those used by Mann and Jones (2003), Esper et al. (2002) and Luckman and Wilson (2005), but exclude shorter series or those with no evidence of sensitivity to local temperature. These records have not been calibrated here, but each has been smoothed with a 20-year filter and scaled to have zero mean and unit standard deviation over the period 1001 to 1980.*

Figure 3: *IPCC AR4, Chapter 6, page 468*

Fifth Assessment Report

The fifth assessment report, AR5, is relied upon by every city council, regional council, government department and others to inform their decision making. However, like prior assessments, the selection process for participants was not subject to the same open process, for example declarations of conflicts of interest or bias, as that of elected officials.[20]

The challenge for AR5 was to address the somewhat awkward problem that there had been no warming of significance since 1998 despite the CO2 in the atmosphere continuing to rise exponentially.[21]

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[19] Even that conclusion is under challenge as new studies suggest a millennial pattern of warming, that has a cooling trend – see Kobashi, T.*et al*. 2010. *Persistent multi-decadal Greenland temperature fluctuation through the last millennium*. Climatic Change 100: 733-756 and Asteman *et al, Tracing winter temperatures over the last two millennia using a NE Atlantic coastal record* Clim. Past Discuss., https://doi.org/10.5194/cp-2017-160. Manuscript under review for journal Clim. Past. Discussion started: 9 January 2018

[20] It concerns the author that IPCC scientists, whether Kiwis or not, are not elected, publicly screened or accountable. Conflicts, such as membership or support of activist NGOs, should be publicly declared. This issue was subject to a recommendation of the InterAcademy Council's "*Climate change assessments - Review of the processes and procedures of the IPCC*", October 2010, available at http://reviewipcc.interacademycouncil.net/report/Climate%20Change%20Assessments,%20Review%20of%20the%20Processes%20&%20Procedures%20of%20the%20IPCC.pdf and has now been addressed, partly, in a Conflicts of Interest Policy that has now been implemented. "Strongly held personal views" may introduce bias and should be disclosed. Some New Zealand based current or former IPCC lead Authors have associated themselves with environmental activist groups which might be interpreted as bias.

[21] IPCC AR5 WG1, Chapter 6 page 494.

A detailed assessment of the "hiatus" in global mean surface warming over the prior 15 years was set out in AR5 at section 9.4.1, box 9.2 where it was concluded that natural variability combined with cooling from the sun/volcanic activities were responsible.[22] AR5 found it is "extremely likely" that more than half of the observed increase in global average surface temperature from 1951 to 2010 was caused by the anthropogenic increase in greenhouse gas concentrations and 'other anthropogenic forcings'. AR5 goes on to say that *"the best estimate of the human-induced contribution to warming is similar to the observed warming over this period"* although the observed warming in that period was nominal compared to that modelled[23] and could in part be attributable to anti-pollution measures adopted globally in the 1970s, such as the Clean Air Act in US, that removed cooling particulates arising from human activities. It was openly acknowledged that an analysis of the full suite of CMIP5[24] historical simulations revealed that 111 out of 114 realisations ran "hot" compared to the HadCRUT4 trend *"ensemble"*, i.e. actual observation. This AR5 illustrated this in the following graph appearing at IPCC 2014a TS64.

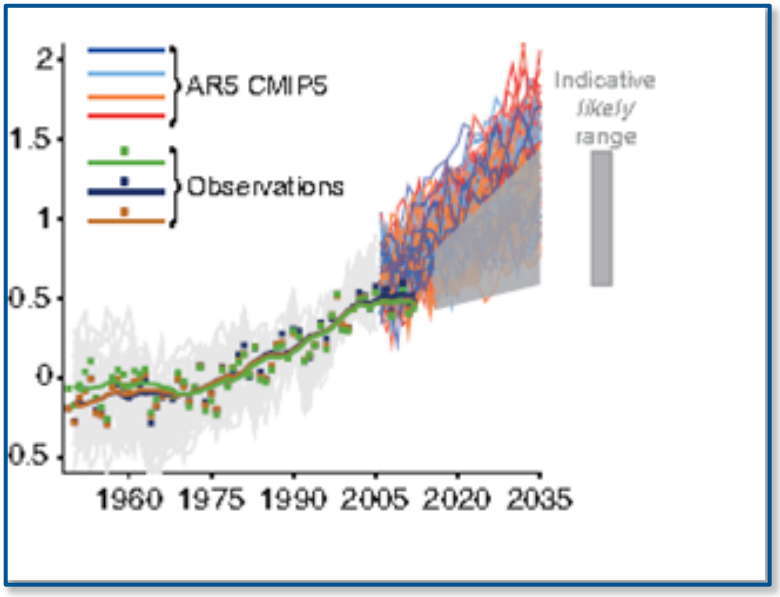

Figure 4: *IPCC graph highlighting the divergence between "modelled" temperatures and "actual" temperatures*

This anomaly was considered in a more recent study (*Lewis and Curry*) published online in April this year by the American Meteorological Society.[25] There the authors conclude that:

> *"The implications of our results are that high best estimates of ECShist, [the proxy for ECS [equilibrium climate sensitivity] that historical period based studies estimate), ECS and TCR [the Transient Climate Response] derived from a majority of CMIP5 climate models are inconsistent with observed warming during the historical period (confidence level 95%). Moreover, our median ECS and TCR estimates using infilled temperature*

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[22] AR5, chapter 9, page 769, box 9.2 – climate models and the hiatus and global mean surface warming over the past 15 years.

[23] AR5 SPM D.3, page 17, bullet 1.

[24] Coupled Model, Intercomparison Project Phase 5.

[25] *The impact of recent forcing and ocean heat uptake data on estimates of climate sensitivity* American Meteorological Society *Journals Online* 23 April 2018, (print version to be published in the *Journal of Climate* Volume 31 No. 13 July 2018) available at https://journals.ametsoc.org/doi/abs/10.1175/JCLI-D-17-0667.1.

data imply multicentennial or multidecadal future warming under increasing forcing of only 55−70% of the mean warming simulated by CMIP5 models."

The same point was made by John Cristy, Professor of Atmospheric Science, Alabama State Climatologist, University of Alabama in Huntsville, USA.[26] He used IPCC AR5 data to compare the models with actual data he had obtained from three sources: (i) satellites;[27] (ii) balloon[28] and (iii) "Reanalyses"[29] to test the accuracy of the models, drawing the same conclusion as *Lewis and Curry*.[30]

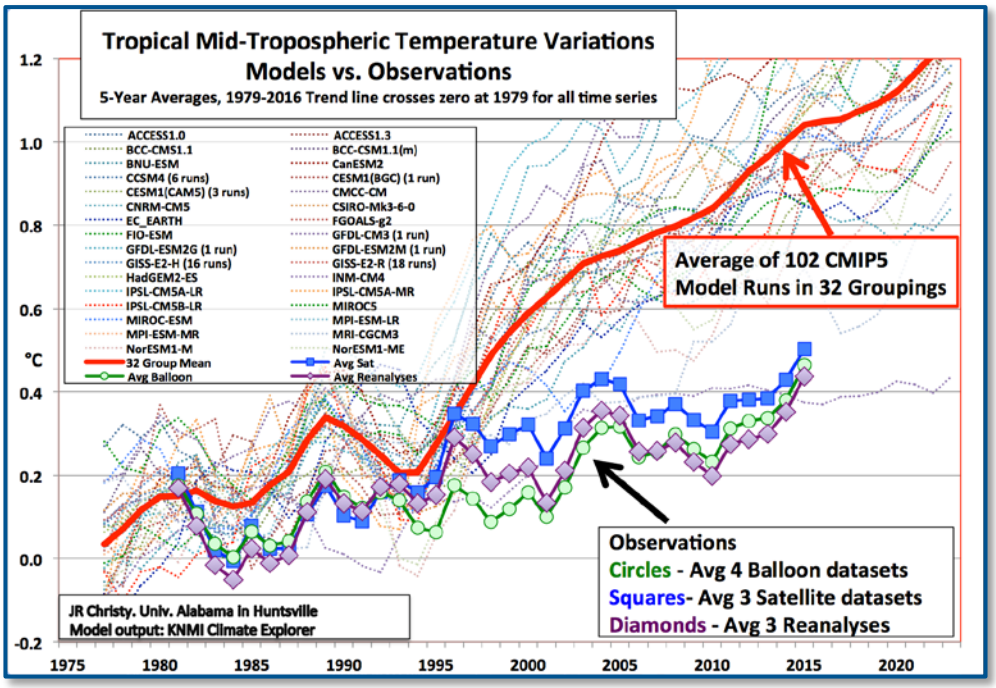

Figure 5: *Cristy's Figure 2: Five-year averaged values of annual mean (1979-2016) tropical bulk TMT as depicted by the average of 102 IPCC CMIP5 climate models (red) in 32 institutional groups (dotted lines). The 1979-2016 linear trend of all time series intersects at zero in 1979. Observations are displayed with symbols: Green circles - average of 4 balloon datasets, blue squares - 3 satellite datasets and purple diamonds - 3 reanalyses. See text for observational datasets utilized. The last observational point at 2015 is the average of 2013-2016 only, while all other points are centred, 5-year averages.*

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[26] Testimony of John R. Christy, Professor of Atmospheric Science, Alabama State Climatologist, University of Alabama in Huntsville, of the U.S. House Committee on Science, Space & Technology, 29 Mar 2017, available at https://science.house.gov/sites/republicans.science.house.gov/files/documents/HHRG-115-SY-WState-JChristy-20170329.pdf

[27] There are three sources, UAH (University of Alabama in Huntsville), RSS (Remote Sensing Systems, San Rafael CA) and NOAA.

[28] The sources of the balloon datasets are RAOBCORE and RICH (University of Vienna, Austria), NOAA and UNSW (University of New South Wales, Australia).

[29] The sources of the Reanalyses are ERA-I (European Centre for Medium-Range Weather Forecasts (ECMWF) – ReAnlaysis-Interim), NASAMERRAv2 and JRA-55 (Japan ReAnalyses).

[30] Cristy notes: "We do not use surface temperature as a testable metric because models, to varying degrees, are tuned to agree with the surface temperature observations already – i.e. they've been given the answer ahead of time - thus a comparison of the surface would not be a valid scientific test (Hourdin, F.T. et al., "The art and science of climate model tuning", 2016, doi:10.1175/BAMS-D-00135.1. and Voosen, P., "Climate scientists open up their black boxes to scrutiny", 2016, Science, 354, pp 401-402. DOI:10,1126/Science.354.6311.401)."

Otto et al[31] suggested that the Transient Climate Response ("**TCR**") of some of the models in the CMIP5 ensemble with the strongest climate response to increases in atmospheric CO2 levels may be inconsistent with recent observations…" [i.e. the hottest models do not approximate the hiatus]. A similar point was made in the more recent study published in *Nature*[32] suggesting the high end of warming would be constrained to no more than 4.5°C.

When the more recent observational evidence of surface warming (over half of which is attributed to CO2 released by human activities) is contrasted with pre-1945 warming (which, due to the comparatively low volumes of CO2, which is not regarded as dominated by CO2 released by human activities) then some comfort might be taken knowing that the planet has undergone accelerated warming of a nature similar to the post-1980s period, without catastrophic consequences.

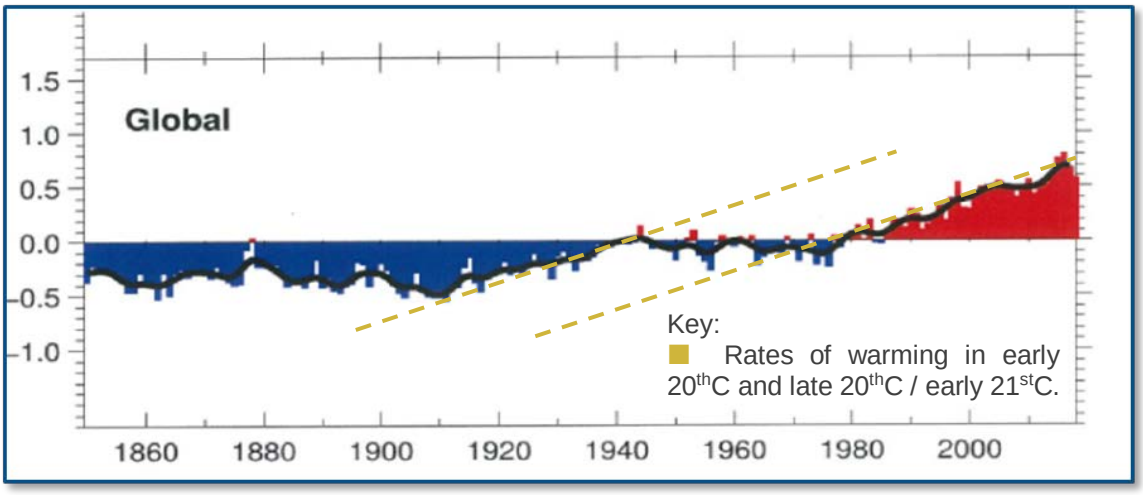

Figure 6: *HadCRUT4 Global temperature surface time series (accessed 6 June 2018)*

If the two 30 year warming periods (approximately 1914 – 1944 and 1980 – 2010) are carefully considered, we find warming of similar rates. In fact, if the two periods are 'spliced' (see figure 7 below) to eliminate post-1944 cooling then global temperatures only reach and stay consistently above 1944 levels in around 1988, rising for 10 years before the hiatus commenced after the 1998 el Nino spike.

[31] Letter to the editor published in Nature Geoscience | VOL 6 | JUNE 2013 | page 415. www.nature.com/naturegeoscience.

[32] Cox et al, "*Emergent constraint on equilibrium climate sensitivity from global temperature variability"* Nature 553, 319-322 (18 January 2018) available at https://www.nature.com/articles/nature25450.

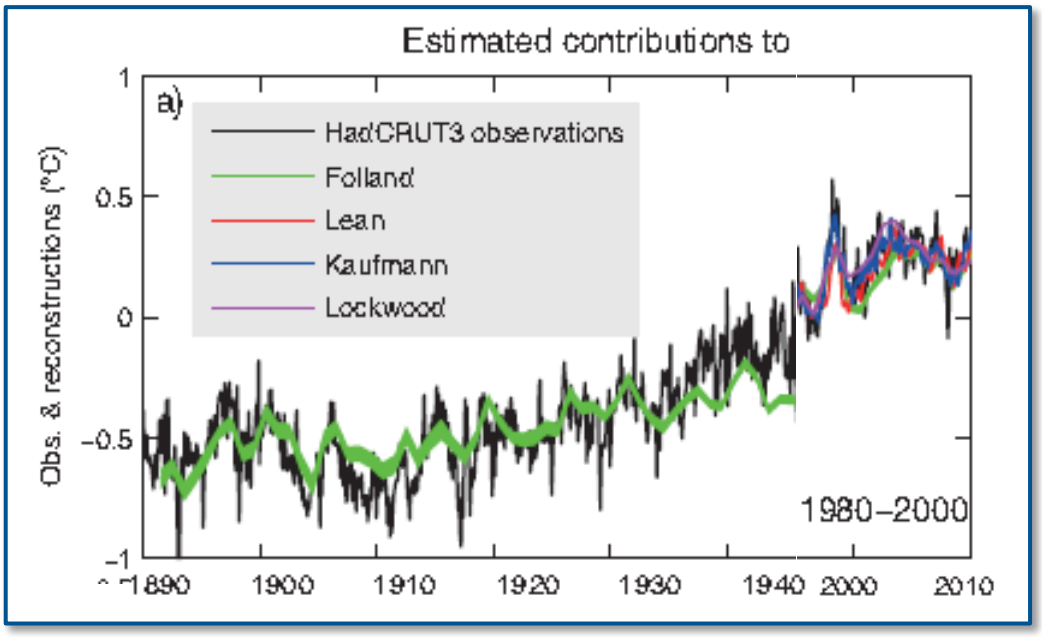

Figure 7: *Chart from Fig 10.6 IPCC AR5, page 888, modified to remove the post 1944 cooling period and recovery to 1944 peak (~1945 - ~1988).*

Furthermore, when the historic performance of the 'models' is considered (figure 8 below), even with the advantage of knowing what the temperatures were, they fail to recreate the warming from 1914 through to the 1944 peak and sharp decline thereafter (black line vs red line) and underestimate natural warming (blue line) which, because of the absence of significant volumes of atmospheric CO2, or other human factors must have been the dominant factor pre-1950s.

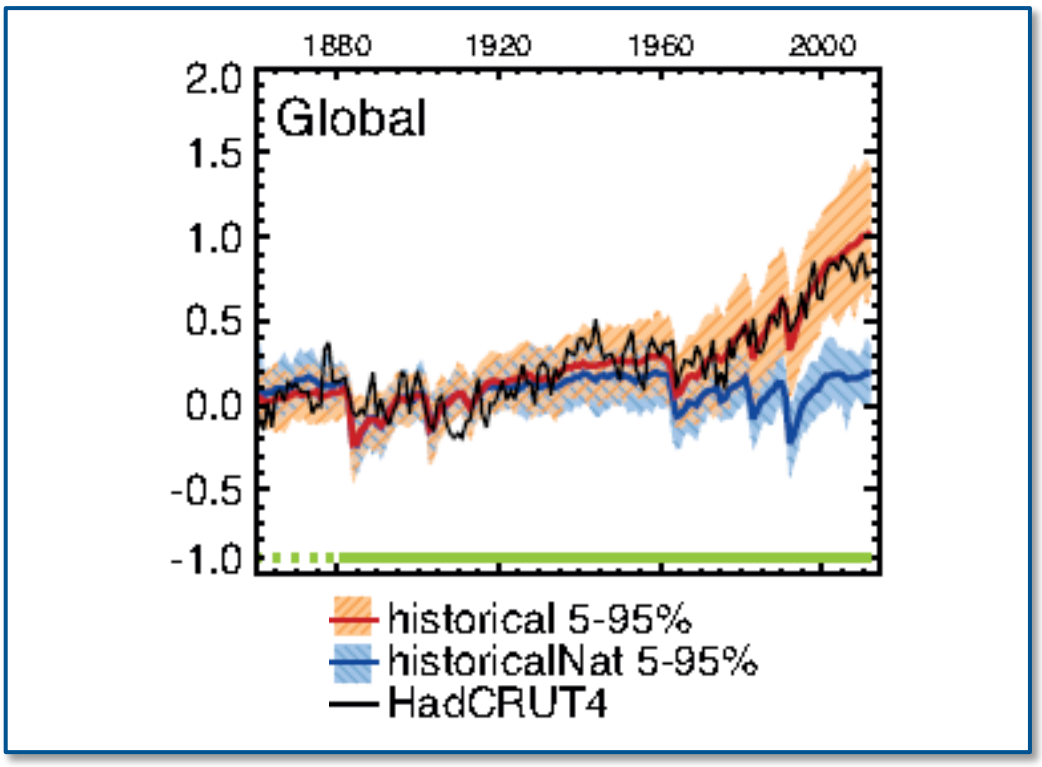

Figure 8: *Excerpt from Figure 10.7, Global land, ocean and continental annual mean temperatures for CMIP3 and CMIP5 historical (red) and historicalNat (blue) from IPCC AR5, WG1, Chapter 10, page 889.*

Claims the IPCC has become "Politicised"

In March 2010, the InterAcademy Council (IAC) [33] was requested by the United Nations Secretary-General and the Chair of the IPCC to conduct an independent review of IPCC processes and procedures. Some had been outraged with how the "FAR" had been finalised. The infiltration of the TAR by scientists associated with environmental NGOs and the ClimateGate email release also lent weight to the suspicion that the IPCC was acting as an 'advocacy group' for policy makers rather than as a repository of scientific knowledge. One contributor noted:

> *"The summary of my experience with the IPCC is that it is managed with particular outputs in place before the assessments are even started. The Lead Authors have almost complete control with respect to what is accepted in their Chapter, and what is ignored…. The IPCC is actually a relatively small group of individuals who are using the IPCC process to control what policymakers and the public learn about climate on multi-decadal time scales."*[34]

In a personal email exchange between Professor John Cristy¸ Professor of Atmospheric Science, Alabama State Climatologist, University of Alabama in Huntsville, USA, and the author, it was put to him that IPCC proponents disagreed with his testimony (noted above) because of his selective use of data (he had not used surface temperatures for reasons explained in footnote 26 above). He replied:

> *"That a current IPCC author would be critical of a completely reproducible result that clearly demonstrates IPCC model failures is to be expected. Please note, lead authors are now essentially chosen for their views, as there hasn't been a skeptical author chosen since Dick Lindzen [author of this submission's prologue] and me back in 1998."*[35]

Professor Cristy is a leading sceptic and views might be somewhat biased but it echoes comments made by Massey University's Dr Mike Joy. Mike is an environmental scientist and is at polar opposites to the author when it comes to the ongoing role of the oil and gas industry. But we korero from time to time. In an exchange where I was advocating for hydrogen, "as envisaged by the IPCC" Mike responded:

> *"as for the IPCC it is incredibly political and I know two lead authors who have given up because of the politicisation."*[36]

The IAC terms of reference did not include a review of past practices but it produced an extensive report[37] with a host of recommendations, including the need for a balance of views to be represented, rules around declaring conflicts of interest and bias, governance, transparency and communication. The Conflicts of Interest policy was approved and should now be in force however all declarations of conflicts and bias are held by the Secretariat and not disclosed publicly – a constraint that severely undermines the intent of the policy.

The policy directs that:

> *"…it is expected that IPCC author teams will include individuals with different perspectives and affiliations. Those involved in selecting authors will need to strive for*

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[33] The InterAcademy Council (IAC) is a multinational organization of science academies created to produce reports on scientific, technological, and health issues.

[34] Roger Pielke sr, *"My Comments For The InterAcademy Council Review of the IPCC" June 16 2010 available at https://pielkeclimatesci.wordpress.com/2010/06/16/my-comments-on-questionnaire-on-ipcc-processes-and-procedures/*

[35] Email exchange *Rush – Cristy* 8 June 2018. Referenced with approval from Professor Cristy.

[36] Email exchange *Rush – Joy* 7 April 2018. Referenced with approval from Dr Joy.

[37] Climate change assessments: Review of the process and procedures of the IPCC, October 2010

an author team composition that reflects a balance of expertise and perspectives, such that IPCC products are comprehensive, objective, and neutral with respect to policy. In selecting these individuals, care must be taken to ensure that biases can be balanced where they exist."

The strive for balance would appear to contrast with Professor Cristy's experience about the exclusion of scientists with sceptical views. The IPCC policy also raises the question of whether bias has been disclosed by those New Zealand scientists who have openly supported activist organisations advocating alarmist views.

It is submitted that these concerns need to be publicly addressed and resolved before widespread support of decarbonisation initiatives will be forthcoming from ordinary New Zealanders.

Developments since AR5

In addition to the above post-AR5 studies acknowledging that the models are 'running hot' the science since AR5 continues to evolve.

Nitrogen Not a Limitation

AR5 had theorised that around half of all anthropogenic CO2 emissions since the pre-industrial time, had been naturally sequestered, predominantly the ocean.[38] The ability for terrestrial plants to sequester CO2 was considered limited by the availability of nitrogen in the atmosphere. For centuries, the prevailing science had indicated that all of the nitrogen on Earth available to plants came from the atmosphere. But a new study from the UC. Davis indicates that more than a quarter comes from the Earth's bedrock.[39] The findings have significant implications in regard to the ability of land-based plants to act as the terrestrial carbon sink. If plants sequester more, then CO2 from terrestrial human activities may be being absorbed at a faster rate. Co-lead author, Ben Houlton, a Professor in the UC Davis Department of Land, Air and Water Resources and Director of the UC Davis Muir Institute, commented:

"This runs counter to the centuries long paradigm that has laid the foundation for the environmental sciences. We think that this nitrogen may allow forests and grasslands to sequester more fossil fuel CO2 emissions than previously thought."

Reconsideration of Methane

A paper published on 4 June 2018 co-authored by Victoria University's Professor Frame (and Adrian Macey, New Zealand's first climate change ambassador) invites policy makers to reconsider the *"one-size fits all"* approach for dealing with emissions. Methane, is a short-lived GHG and consequently it can only affect climate in the very short term. Professor Frame is quoted as saying:

"Under current policies, industries that produce methane are managed as though that methane has a permanently worsening effect on the climate. But this is not the case. Implementing a policy that better reflects the actual impact of different pollutants on global temperatures would give agriculture a fair and reasonable way to manage their emissions and reduce their impact on the environment." [40]

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[38] IPCC AR5, Technical Summary, page 51.

[39] Houlton et al *Science* 06 April 2018, vol.360, issue 6384, pp.58-62 – *Science* – see commentary from the UC Davis.

[40] Methane - see commentary Oxford University. Allen et al *"A Solution to the misrepresentations of CO2 – equivalent emissions of short-lived climate pollutants under ambitious litigation"*, npj Climate and Atmospheric Science 1, Article no: 16 (2018).

I note the Report addresses this point in Section 3, but the importance of this work to the Commission's analysis and final report cannot be understated. If fugitive emissions of natural gas do not have a meaningful and ongoing effect on global temperatures then it seems pointless expending capital, which could be applied to hydrogen or CCS, in their capture, while global CO2 levels continue to rise – all current gas fields in New Zealand are in decline and with them, their fugitive emissions, so they will not be adding to the stock of methane. Furthermore, they are expected to have ceased producing long before 2050, meaning that any fugitive emissions in the interim will not present a barrier to achieving an emissions target in 2050. New fields that are projected to produce past 2050 could be required to be fugitive emissions free, a strategy to which the industry is beginning to apply its considerable engineering expertise, or fund offsets. This, as an environmental framework, is not dissimilar to that set out under the United Nations Law of the Sea where new offshore facilities constructed after 1998 had to be designed to be removed after cessation of production.

Sea Level Not Rising

A recent study by Auckland University's, Paul Kench, found that Pacific atolls, like Tuvalu, are actually growing in size and not being submerged by rising sea-levels. Kench's research team studied more than 600 coral reef islands in the Maldives, Fiji, Tuvalu, Marshall Islands and the Great Barrier Reef. Using aerial photos and satellite images, they found 40 percent had grown, 40 percent had stayed stable and 20 percent had shrunk.

This otherwise 'good news' was not greeted with joy by proponents of AGW, Kench noted in a radio NZ interview. He also noted that trying to publish his findings in a quality peer reviewed publication was not easy because it ran contrary to the mainstream narrative.

As of today, the Wellington tidal gauge shows that sea-level is rising at the same rate as it always has.[41]

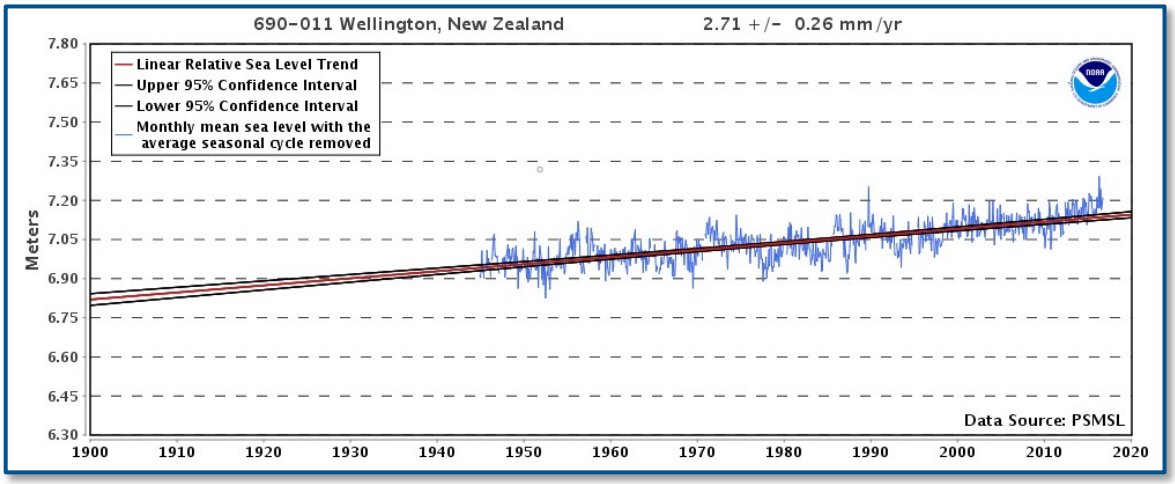

Figure 9

CO2

Turning to CO2, the Commission state at page 24 of the Report:

> *"Because CO2 can stay in the atmosphere for hundreds of thousands of years, reducing CO2 emissions to net zero levels – where removals of CO2 by carbon sinks offset CO2 emissions – is a crucial part of stabilising global temperatures (Allen, 2015). As long as*

[41] See http://www.sealevel.info/MSL_graph.php?id=wellington. This needs to be reconciled with an even more recent study suggesting that Antarctica is losing ice at an exponential rate. See Nature volume 558, pages 219–222 (2018).

the world continues to emit more CO2 than is absorbed and the stock of CO2 continues to rise, the climate will keep warming (World Bank, 2015).

Further, the world has a finite amount of CO2 that it can emit to keep global temperature rise below 2°C (and 1.5°C), widely known as the global carbon budget. This budget is being used up rapidly. The IPCC (2014b) estimates the global carbon budget, as at 2011 for a 2°C threshold, is about 1000 gigatonnes (Gt) of CO2. If global CO2 emissions continue to rise at current rates, this budget will be used up by around 2036 (Chapter 8)." [42]

One of the founding principles of the theory of anthropogenic global warming is that CO2 is a "long-lived" gas and this has been repeated by the Parliamentary Commissioner for the Environment ("**PCE**") and indeed by the Commission in its report.[43]

The suggestion that CO2 is a "long-lived" gas is only half correct. In response to a question on this issue,[44] the PCE admitted that CO2 in fact turns over in the atmosphere over about a 4 year period. However, a significant part is returned back to the atmosphere within a few years until being permanently removed, in particular, by the oceans (although the removal of nitrogen as a limitation might mean more is sequestered on land). This has been modelled by the IPCC (using the Bern model) which suggests that over half of a CO2 "pulse" permanently falls out of the atmosphere within a 0 to 20 year period – that half qualifies as a "short lived" GHG. Only between 20% and 30% remains after 500 years and it is that fraction that the PCE considers to be "long-lived" (full letter from the PCE is annexed as Schedule 1).

In box 2.1 the Report states:

"While human activity increases the stock of CO2 in the atmosphere, some natural processes remove CO2 from the atmosphere. This process is known as carbon sequestration, and the reservoir where CO2 is stored is called a carbon sink…"

The report goes on to note the value of trees as a carbon sink but does not describe how New Zealand's oceans are acting as a carbon sink, both in regard to New Zealand's share of global CO2 emissions (0.17%) and the sequestration of emissions sourced from outside of New Zealand.[45]

If the planet's biosphere is permanently sequestering ~50% + or more of all human emitted CO2, then New Zealand is already acting as a sink for the planet by sequestering ~0.5% + of anthropogenic CO2 emissions, whilst only emitting 0.17% itself. This South Pacific 'sink' is recognised in AR5 Chapter 6 (figure 10 below):

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[42] Page 24 of the Report.

[43] See box 2.1, page 24 of the Report.

[44] Letter from the parliamentary Commissioner for the Environment to Sean Rush dated 24 April 2018.

[45] New Zealand, by definition, includes the terrestrial surface as well as the extended continental shelf which makes up 1% of the globe.

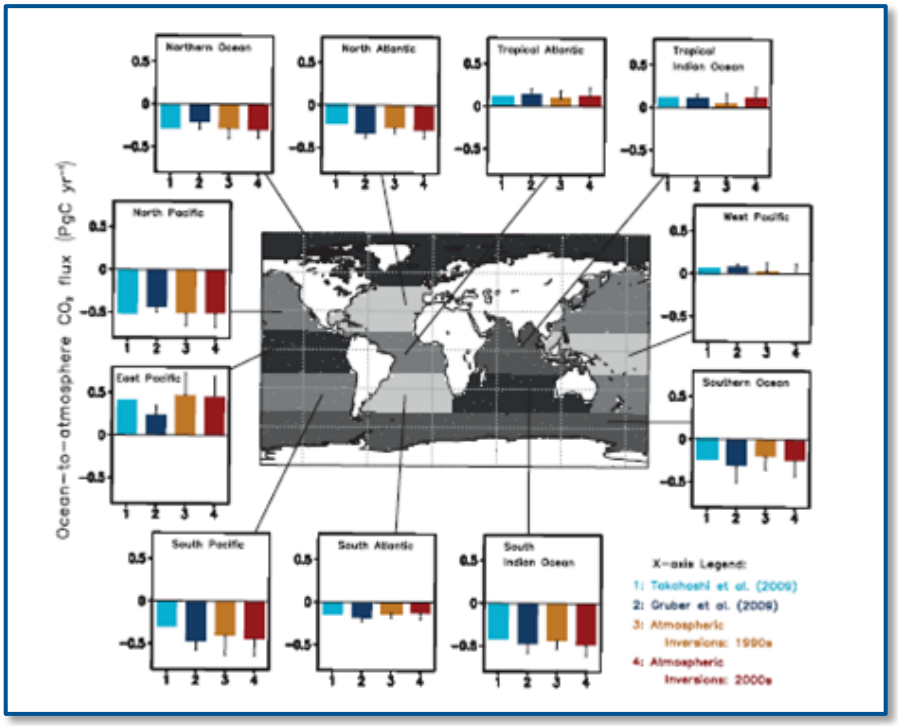

Figure 10: *IPCC AR5, Chapter 6, from Figure 6.15, page 502. This shows that the area of Ocean surrounding New Zealand (South Pacific) acts as a significant net carbon 'sink'.*

Consequently, the Commission's focus on new forests as "sinks", whilst meritorious, needs to also consider the larger natural sinks available in terrestrial New Zealand and its continental shelf. The key here is to account for CO2 emitted, not on a per capita basis, but per square kilometre. It is understandable that New Zealand, which is sparsely populated and of considerable land mass (if New Zealand was in Europe it would be one of the larger countries), has high emissions per capita due to the need for extensive transport but is tiny if the accounting is done per square kilometre (the converse being true for most 'developed' nations, e.g. Japan). An inventory of emissions and sinks is envisaged under Article 7 of the Paris Agreement which requires New Zealand to record CO2 in from all sources and out from all sinks. This type of analysis was undertaken for Australia's EEZ[46] with similar conclusions. However, it is not clear to the author whether accepted carbon accounting methodology would preclude the utilisation of a natural endowment, such as the EEZ, as a 'sink' for the purposes of calculating national carbon budgets. It is however noted that Bhutan has been able to claim 'net carbon negative' status[47] because of its natural forest sinks that sequester three times more than its emissions.

It is an interesting idea, but New Zealand cannot avoid its responsibilities to reduce anthropogenic emissions, but oceanic sequestration could offer an additional "sink" for consideration by the Commission and highlight exactly which countries are contributing to the global net stock of atmospheric CO2.

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[46] See "*Significance of the oceanic CO2 sink for national carbon accounts*", Ben I McNeil, Carbon Balance Manag. 2006; 1: 5. Published online 2006 Jul 21. doi: 10.1186/1750-0680-1-5, available at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1550387/.

[47] See Prime Minister Tobgay's address to the UN General Assembly Sustainable Development Summit, 25th Sept 2015: *"…we are carbon negative. We are perhaps the only country in the world to be a net carbon sink."* Available at http://track0.org/countries/.

International Mitigation

The Paris Agreement envisages international mitigation options.[48] It is recognised that the Commission's TORs excluded the use of such mechanisms in compiling its report. In my view that is a mistake, but perhaps understandable given the historic purchase of carbon credits by the New Zealand government from questionable sources. However, Paris envisages much more than the purchase of carbon credits. The export of low emission technology and fuels is a valid way of securing emissions units from the international market. For example, the Huntly power station, majority owned by the Government, was constructed to be dual powered by coal and lower emitting gas. An enhancement would be to install a steam methane reformation ("**SMR**") unit to enable it to run on hydrogen.[49] The successful, and economic, application of this technology, with CCS, could be applied to hundreds of coal-fired power stations throughout South East Asia. Indeed, the proponents of the Belt and Road Initiative envisage the construction of some 700 coal-fired power stations throughout South East Asia and across through to Africa in order to support the initiative and bring some 2 billion people into the middle class. That project alone is likely to double, some say triple, China's current CO2 emissions which, in themselves, represent 26% of global emissions. Hydrogen technology coupled with New Zealand coal or gas as a feedstock, could make significant reductions in emissions that are currently projected, thereby earning New Zealand international emissions units that could be applied to meeting any target set by the Government. Australia is already contemplating hydrogen exports from coal.[50]

It is likely that the most ambitious targets will be unachievable (whilst maintaining growth and well-being) without earning some form of international mitigation credits. Consequently, the Report loses significant utility by omitting the possibility that nearly all of New Zealand's mitigation could be sourced via international action.

The Durability of Paris

The Paris Agreement's 'non-binding' status creates difficulties in relying on it for long term domestic policy and investment. It is founded, not just on non-binding commitments to limit emissions, but also a 'quid pro quo' where developing nations receive access to a "green fund" to develop low emissions alternatives. Approximately half of that fund is to be contributed by the United States, who have signalled an intention to withdraw. Without US funding the Paris Agreement will be in great peril of failing as developing nations are unable to access the funds needed to build clean-tech infrastructure and revert to more conventional sources of energy. It is a reality, no matter how unpalatable it may be.

Furthermore, even under Paris, just one project, China's Belt and Road Initiative will swamp anything we, here in New Zealand, may do by a magnitude of several hundreds, if not more. That project, and others, needs to exhibit a path to decarbonisation to make any efforts undertaken in New Zealand, that imperil its economy, economically rational.

A "Plan B" need not necessarily be developed provided our response is measured and in line with rational forward planning, that does not cause undue hardship, in preparation for the day when oil and gas runs out.

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[48] Article 6, Paris Agreement.

[49] Similarly Manapouri power could be utilised for hydrogen from electrolysis if the aluminium smelter closed.

[50] See Australia's AGL to host coal-to-liquid hydrogen export trial for Japan's Kawasaki Heavy.

Conclusions

To properly set the scene it is important to understand the way the science has evolved and continues to evolve. Recent discoveries can change the carbon budget and a satisfactory explanation for the 'hiatus' has still yet to be presented and may even open the door to a greater role for natural variability and a lesser role for CO2. The political nature of the IPCC remains a concern as well as the exclusion of credible, if sceptical, scientists from IPCC processes. Earning the public's trust requires transparency. A thorough review of historic IPCC processes and the development of an archive of the New Zealand Government's reliance and response to IPCC initiatives and reports is proposed.

Catastrophic claims of alarm must be treated with caution, as the IPCC suggest, and be replaced with rational decision making that balances the needs of the present with those of the future, considering how uncertain that future is both as a consequence of the emerging science, innovations, Paris and other geopolitical developments. New Zealand can and should prepare for a transition but, in energy matters, be technology takers and adopt the most appropriate technology for non-agricultural emissions reductions that emerges from better funded and technically advanced trading partners. In the meantime, we use gas and focus on afforestation.

Recommendations:

- All New Zealand IPCC scientists and those in positions of influence to publicly disclose conflicts and bias in accordance with IPCC guidelines.
- An enquiry by the PCE on IPCC process, alleged politicisation and balance.
- Consideration of the use of New Zealand's offshore as a sink and how that might be accounted for.
- The publication of a true and complete archive of New Zealand's Ministerial decisions, and supporting papers, its scientists who have participated in IPCC assessments, positions taken, instructions to delegates and scientific opinions that is open to the public.

Part 2: Low Emission Pathways

Comment on scenarios of technology development[51]

The challenge for the Commission and, for New Zealand generally, is that unlike other historic examples where society has transitioned, the technology has underpinned momentum. For example, the construction of the railways in the 1800s, hydro power stations throughout the 20th century and even the "Think Big" projects. In each case, tried and trusted technology underpinned those projects and enabled our society to transition in an economic manner thereby preserving our "well-being". That is not the case with the current challenge – decarbonising New Zealand is not currently technically feasible without involving trade-offs. For example, footnote 11 of the Report notes that *"making aluminium steel is an emissions-intensive manufacturing process. New substitute materials may emerge that use a manufacturing process that is less emissions-intensive"*. That is of small comfort to the well-being of the people of Invercargill or Glenbrook.

In addition this submissions recommends that New Zealand's 'ambition' must stay in step with its trading partners. A "first in class" outcome is not desirable due to the potential for collateral damage

[51] Page 49 of the Report.

to the economy. The corporate world often targets a "top-quartile" performance to ensure robust, defensible performance, without the deleterious effects that arise from moving focus away from other important, if less emblematic, imperatives. Consequently, it is recommended that the Commission identify a 'basket' of peer nations against which decarbonisation efforts may be benchmarked and that pathways be identified and modelled that will deliver a top-quartile performance in both emissions reduction and the growth of incomes and well-being.

It is also suggested that the Commission focus on pathways that build on existing industries and infrastructure. Investment in new technology needs to have sufficient certainty to make it bankable. It cannot be "assumed" to develop at some time later this century and expect to be funded and embraced.

Furthermore, although it may not be the Commission's intention, the three scenarios modelled appear to be presented as mutually exclusive alternatives. However, it can be expected that a role for policy will be needed for each scenario to drive a change from the status quo. Traditionally, New Zealand has used light touch regulation to foster competition coupled with, initially, voluntary commitments under industry codes which, if proven ineffective may be replaced by regulation. The setting of the Paris NDCs by the previous government after consultation with industry demonstrated a willingness by industry to collectively work towards attainable emissions reduction. A light touch approach might be appropriate in the short-term as technology emerges. This is elaborated on further in Part 4.

Because incentives to decarbonise have yet to manifest themselves as viable profit centres, it might be argued that the government should develop a State-Owned Enterprise ("**SOE**") to champion changes in energy source, transmission and use. This is no different to what previous governments have done when constructing the railways, hydro-dams and even the gas transmission system and petrochemical plants. Doing so would be consistent with state participation theory which would normally exclude government participation in private sector activities except where market failures prevent the proper development of otherwise uncommercial activities.[52] Here environmental externalities are not being accounted for. This proposal is developed in more detail in Part 3.

Consequently, a blend of the three scenarios is the more likely outcome but could be commenced rapidly with light-handed policy directives that can steadily rachet up over time but building on the existing industry structures noted in Scenario 3 – stabilising decarbonisation, led by an SOE. Banks will lend to an SOE or existing successful businesses who are implementing low carbon technology incrementally. It is much harder to secure financing as a new start with technology that is unproven or not in existence.

The suggestion that renewable generation would reduce in cost to the point where coal-fired generation which is costs, closes, needs to be rigorously tested given coal-fired generation is underpinned by enormous sunk costs. Similarly, the suggestion that *"aluminium and steel plants choose to close in response to expectations that global technological developments and market shifts will reduce demand for these products"* [53] – is incorrect as aluminium and steel can be made in China who has made no commitment to reduce CO2 emissions other than to say they will peak in 2030. The true position is that our industries will be forced to close because they cannot compete with developing nations who have lower carbon ambitions resulting in "carbon leakage".

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[52] Padmore, G. (1992) '*Government participation in mining projects: fiscal, financial and regulatory implications for developing countries*.' Natural Resources Forum 16(2), pp 132 – 140.

[53] I am aware of efforts to develop carbon-fibre from crude oil/gas as a viable substitute for steel and cement in buildings, but it will be many years away.

The reliance on as yet undeveloped technology in the modelling, with respect, is a shortcoming in the report. How can one invest in technology that has not developed? How can the Government develop policy? The technologies that are emerging are worthy of more focus: EVs, hydrogen vehicles, hydrogen power generation, CO2 power generation,[54] carbon capture and storage.

Emissions

The Report notes[55] a *"notable result is that all pathways are feasible"*. It goes on to refence the two CO2 reduction targets and how they play out under the six pathways. There does not appear to be any reference to the effect on the economy and in particular how each pathway will grow the economy and well-being as required the TORs.

In regard to prices, has the Commission considered international influences in the higher priced scenarios? Presumably if New Zealand regulates a high price, domestic actors may choose to invest offshore either to secure international mitigation credits which are below the New Zealand regulated price, or simply to avoid crippling carbon prices. For example, scrubbing CO2 from a coal-fired power station with sequestration costs in the order of $US60 to $US90 a tonne irrespective of location and is reducing.[56] Also the technology to remove CO2 from the air (direct air capture) is reducing in price from US$600/tonne to currently between $US94 and $US232.[57] Would a New Zealand actor pay more than that to achieve domestic credits?

Recommendation:

- That a 'basket' of peer nations be developed against which decarbonisation efforts may be benchmarked and that a best estimate blend of the three scenarios be identified and modelled to deliver a top-quartile performance in both emissions reduction and the growth of incomes and well-being.
- Commission to model the international and domestic response to high and low carbon pricing and make recommendations as to how to treat industries who will otherwise be subject to 'carbon leakage'.

Electricity, Transport and Industry

The modelling undertaken for this section[58] is impressive but it is not clear whether the growth in generation expected from wind and geothermal is indeed possible to meet the expected shortfall in demand currently met by petrol/diesel and natural gas. Geothermal is not, as is more popularly believed, and endless supply of heat. In fact, geothermal reservoirs are very similar to gas reservoirs in that the geothermal reservoir declines in heat requiring either a new well to be drilled at another location into a "new reservoir", or else to shut the depleted reservoir in for an indeterminate period in

[54] This is a very recent development brought to the writer's attention. The technology developed by "NET Power" drives a turbine with a loop of hot, pressurised CO2. A combustor then ignites a mixture of natural gas and oxygen heating the CO2 in the loop that drives the turbine. Excess CO2 is captured and used for sequestering. See this LINK.

[55] Page 57 of the Report.

[56] Professor Michael J Kelly presentation Wellington, May 2018. slides available at: http://www.spindletop.co.nz/wp-content/uploads/FENandEI.05.2018.pdf. Note Professor Kelly will be back in New Zealand in December 2018 and is very happy to discuss.

[57] See "Breakthrough on scrubbing CO2 from atmosphere" *Pipelines News North 7 June 2018, available at* http://www.pipelinenewsnorth.ca/news/breakthrough-on-scrubbing-co2-from-atmosphere-1.23328406.

[58] Page 60 of the Report onwards.

order that the reservoir reheats. Unfortunately, the period taken for reheating varies and is unpredictable. In addition, geothermal projects emit fugitive CO2 emissions. Gas plants do not.

Similarly, wind is less efficient than hydro, gas or geothermal. A 'back of the envelope' calculation would suggest the following:

Huntly's nameplate generation is ~950 MW/h. Windmills produce ~2 MW/h each at a cost of US$3.5 mm (~NZ$5 mm). So we would need 475 windmills at $5 mm each = NZ$2.375 billion. But windmills are only 40% efficient so we would need over double bringing cost to ~NZ$5 billion and that does not account for the fact that the best places, to site windfarms are already gone. Nor does it account for back-up (hydro/coal/gas/diesel?) for when there is no, or very little, wind at all i.e. what happens when we get the situation below?

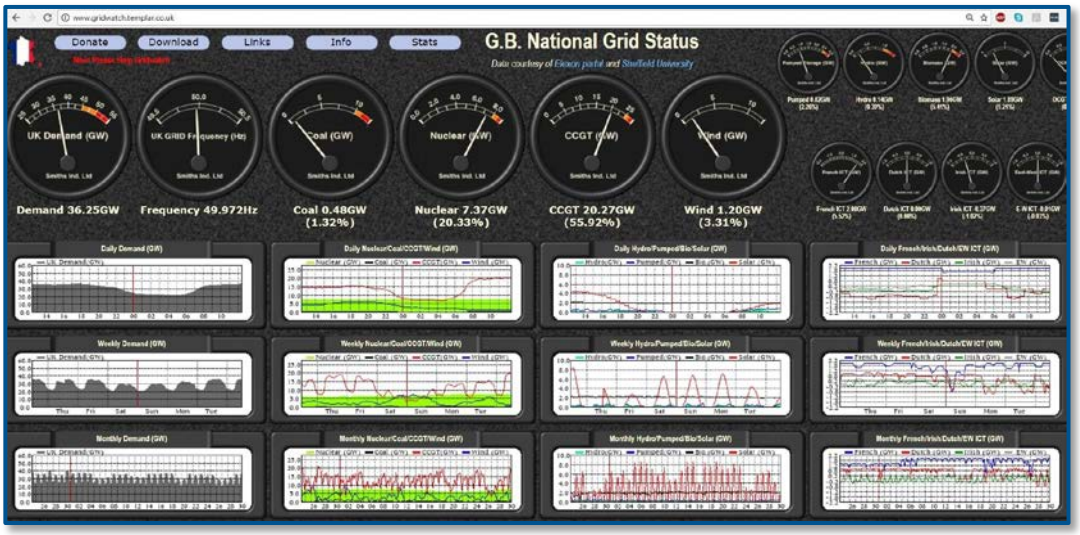

Figure 11: *UK's National Grid stats showing wind contributing 3.31% to total generation – for real time updates go to http://www.gridwatch.templar.co.uk/*

What is also absent is any modelling around hydrogen and fuel cells. First Gas and Powerco are conducting research into the forward use of their pipeline infrastructure with a transition to hydrogen under consideration. In the UK, the city of Leeds is being trialled to change out natural gas for hydrogen developed from natural gas via steam methane reformation – a technology that is tried and trusted and even in use in New Zealand. Figure 12 below shows the "roadmap for the UK" that was included in a report published in 2016.[59]

Similarly, a roadmap for hydrogen implementation has been developed for South Australia.[60]

[59] Hydrogen and fuel cells: Opportunities for growth, a roadmap for the UK – see THIS LINK.

[60] See THIS LINK.

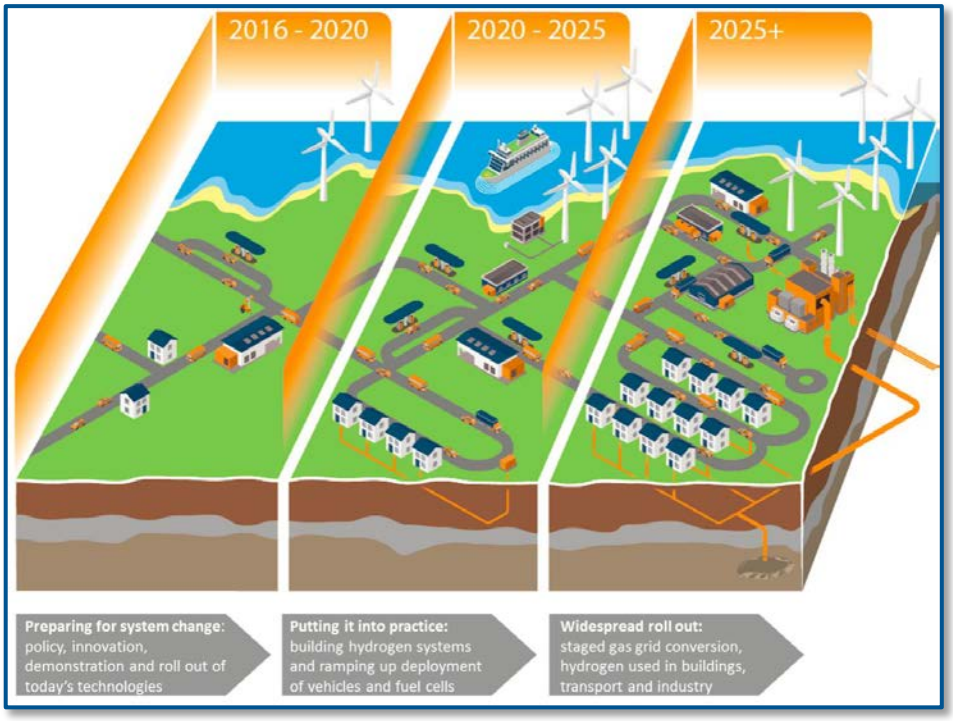

Figure 12

The attractiveness of hydrogen for process heat, transport and power generation is that it acts as an effective store of energy, a major advantage over electricity sourced from renewables. Accordingly, the New Zealand government could transition Huntly to run on hydrogen and in one fell swoop would eliminate close to 50% of emissions caused by thermal generation without anyone losing a job or interruption to industry. Hydrogen is addressed in Section 3 of the Report but dismissed as being too costly if extracted from water using electrolysis. The UK plans to rely on methane so perhaps that should be modelled using existing or newly discovered gas or imported LNG.

A final point: what is the cost (in $$) – benefit (in emissions reduction) analysis of:

(i) moving New Zealand from 85% renewable electricity generation to 100%; and

(ii) the loss of revenue to the Treasury from the closure of steel, aluminium, methanol as a proportion of GDP and comparison to their proportionate contribution to New Zealand's gross emissions? And the effect on growth and well-being?

In conclusion, the report would benefit from scenarios that blend those proposed in a manner that provides bankable decarbonisation projects based on existing or emerging technology. The repeated comments throughout the Report that New Zealand *"will look very different in 2050"* as "old" technology is replaced by "new" are not necessarily true, particularly if the transition is incremental based on predictable cross-party policy, bankable projects and utilising existing or familiar businesses models.

Recommendations:

- A detailed cost-benefit analysis comparing the costs, areal requirements, production emissions, and operating life for substituting non-renewable energy sourced from coal, gas and petrol/diesel with renewables.
- Modelling of the cost-benefit of introducing SMR at Huntly (or electrolysis at Manapouri) and required cost of carbon for it to be economic.

Part 3: Policies and Institutions

Transport / Electricity

The impressive research compiled by the Commission makes clear that transport, and its expansion, is a critical area to address. Eliminate petroleum/diesel powered motor vehicles and a significant piece of the emissions problem disappears. However, replacement with EVs comes with issues identified by the Commission in its Report. Can there be a second-hand fleet? What will be the effect on New Zealand's electricity grid? What about trucks, ships and aircraft? And is it in fact practical?

Professor Michael Kelly FRS FREng Emeritus Prince Philip Professor of Technology, University of Cambridge, UK, points out the following statistics:

- Benmore Dam: Maximum capacity = 540MW, largest dam in NZ Filling one car at a petrol pump = 0.6MWh delivered in 2 minutes is 18MW of energy (~2 min at pump).
- If we can speed up charging car batteries to the same as petrol filling, the Benmore Dam at full capacity could supply 32 vehicles simultaneously! 4M road vehicles in NZ. Total use of liquid fuels/year[61]= 250pJ= 8GW cts.
- Current NZ hydro capacity: 3GW continuous: serves 400 cars simultaneously, each for 2 minutes. (In 2014, NZ hydro generation produced 24,094 gigawatt-hours).
- Electric engines three times as efficient in car as petrol: need 33% of energy.
- Time between refills: 20,000/3 minutes = 5 days.
- Need to double the grid just for EVs. The Report suggests only 45%.[62]

Whilst there has been some discussion regarding the above calculations, the point that Professor Kelly makes is that there are significant engineering and practical challenges in changing out New Zealand's petroleum motor vehicle fleet for EVs. Concept Consulting make a similar point suggesting that de-carbonisation efforts be prioritised, presumably ranked by cost/benefit or 'bang for your carbon buck' which this submission supports.[63] Inevitably, trade-offs will be necessary whether it be an area of New Zealand's countryside for wind, environmental consequences of another Clyde Dam, or even the depressurisation of geothermal energy in some of our tourist hotspots. Consequently, a halt on future imports of motor vehicles powered by petrol would be sensible, but only if practical alternatives are available, particularly to poorer New Zealand.

New Zealand should also not forget shipping – a sector that is critical to New Zealand economy. The International Maritime Organisation is now moving to eliminate traditional, high sulphur, fuel. The immediate "clean" replacement is diesel but the medium to long term solutions emerging are LNG and methanol. New Zealand ports will need to stock one or the other – methanol is the obvious choice. If we cannot fuel ships in port, then the cost of every good imported or exported will increase as ships call in to Australia for fuel, making goods at home more expensive and abroad less

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[61] http://www.mbie.govt.nz/info-services/sectors-industries/energy/energy-data-modelling/technical-papers/pdf-library/Liquid-fuel-use.pdf.

[62] Presented in Wellington by Professor Kelly, 1 May 2018, slides available at: http://www.spindletop.co.nz/wp-content/uploads/FENandEI.05.2018.pdf. Note Professor Kelly will be back in New Zealand in December 2018 and is very happy to discuss.

[63] See Concept Consulting's "*Electricity generation implications of large-scale fuel switching from gas to electricity*" April 2018, available at http://www.gasnz.org.nz/uploads/Implications-of-gas-to-electric-switching-v03.pdf.

competitive. We therefore need to maintain domestic supplies of gas as feedstock for methanol production and oil to off-set feedstock costs of diesel.

Hydrogen

As noted in the Report, hydrogen is being developed for use by heavy vehicles and would appear to be the closest thing to a "silver bullet" as we have to replacing fossil fuels with emission free fuels with minimal change to existing infrastructure, lifestyles or processes. In time, it would be financeable under standard project finance principles or, if being added to a regulated asset base (e.g. a steam methane reformation unit at Huntly or electrolysis at Manapouri) the cost could be recovered under a standard tolling mechanism, through the regulated return mechanism already in place and/or be developed as a PPP.

Innovation

The Report states[64] that *"innovation comes in many forms and is unpredictable"*. Consequently, it is not "bankable" until it arrives.

Innovation in agricultural matters is clearly an area in which New Zealand should and is leading. Whilst there will always be a need to customise energy solutions for the New Zealand conditions, it is difficult to see how New Zealand can solve puzzles such as hydrogen from electrolysis, fuel from trees, nuclear fusion, carbon capture and storage when billions are being spent on these problems elsewhere. In line with what was noted previously, New Zealand is a technology taker. We should identify those technologies that are best suited for New Zealand and then innovate to customise and implement them into New Zealand. Partnering with trade partners would be a sensible approach rather than working in isolation and in cost ineffective competition.

There are three "innovations" in reference to the oil and gas industry that could be considered:

1. Gas from the Kapuni Field is CO2 rich. It used to be sold to Methanex who would use the CO2 in their process to increase methanol production. That ceased in 2004 when existing supply contracts expired and Kapuni gas was needed to supply the spec gas market due to declining gas supplies from other fields. Recommencing that supply would increase the volume of methanol manufactured, thereby sequestering more CO2 in methanol related products.

2. Most oil and gas fields include a flare stack for excess gas. When this methane is flared, it releases CO2 into the atmosphere. Given what we know about the short-lived atmospheric residence time of methane (as above), consideration should be given to venting that methane which, although doing so would increase the stock of methane into the atmosphere, that methane "falls out" after a short period, which is better than the alternative, which is CO2, part of which is long-lived. Of course, new fields should be encouraged to make use of excess methane or reinject it.

3. In the United States CO2 is sold to oil companies to enhance oil production from older fields. The result is the permanent sequestration of CO2 and enhanced oil production. The price of CO2 fluctuates with that of oil. In New Zealand natural gas is used instead because it is easily accessed and supplied. But there are sources of CO2 emissions near to older Taranaki oil fields and if hydrogen was extracted from methane at Huntly then a residual balance of CO2

[64] Page 109, chapter 5 of the Report.

would need sequestration opening the possibility of injection into existing or former oil fields or even into the aquifers offshore.[65]

Aside from CO2 injection for oil lift, commercial carbon capture and storage ("**CCS**") is an emerging technology worth watching. The UK is partnering with Saudi Arabia and Mexico as part of the "Very Large Decarbonisation Partners"[66] it is said that:

> *"The company's major-market patented and globally patent pending suite of technologies hold the potential to sequester atmospheric CO2 at the levels stipulated by the Paris Climate Change Accord of December 2015. Specifically, it could remove volumes of CO2 sufficient to arrest the progression of climate change and potentially reverse harmful effects being experienced from unmitigated CO2 emissions of human origins."*

The Report addresses CCS in Chapter 13.7 and the recommendations at R13.3 and R13.4 are supported. In particular, Huntly could act as a Northern 'hub' both for hydrogen supply (from steam methane reformation) and for CCS aggregation and dispatch South[67] – supplying hydrogen for process fuel to New Zealand Steel and other Northern gas users and collecting CO2 from its own activities and the likes of Marsden Point and shipping it by pipe to oil fields/Methanex for commercial use or for sequestration at locations the Report identifies. Discussions with First Gas, the transmission system owner, indicates a willingness to consider adapting its pipes as suggested.[68]

Subsidies for Oil and Gas

The conclusion that New Zealand subsidises upstream oil and gas activities is incorrect. There are incentives that facilitate drilling rigs staying in New Zealand and the government has funded 3D seismic previously. However, these investments have paid off for the taxpayer's benefit and if, for instance, the Barque prospect develops in the way its proponents would hope, then the royalty revenues alone would fund a significant portion of new clean technology. Relocating our "high emitting" gas to another country where it is comparatively "low emitting" delivers a win/win for both countries and the environment – the direct opposite of 'carbon leakage' and something to be encouraged.

Similarly the suggestion that maintaining or enhancing a secure supply of oil and gas will frustrate efforts to develop renewables is not necessarily correct. All New Zealand oil is exported. The entry of new gas from existing permits in Taranaki should be encouraged as it provides the transition from coal, feedstock for methanol/ammonia and can itself be decarbonised to hydrogen. If New Zealand adopts hydrogen from SMR, which provides a means of storing electricity, then the consequent adaptation of infrastructure will facilitate a transition to hydrogen from electrolysis in time.

Any new offshore find that can be commercially produced will almost certainly be underpinned by exports, either of LNG, ammonia or methanol. New Zealand's internal energy market need not be affected and the focus can remain on renewables. This is, in effect, the Norwegian strategy: export the majority of oil and gas, pocket the revenues, invest in clean-tech. A similar story may be told

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[65] To the extent existing lines could not be modified to ship CO2, pipelines would need to be laid but South of Huntly, they would follow the existing corridor, which eliminates a significant proposition (maybe over half) of the cost.

[66] See *"UK Environmental Coalition Pursues Very Large Scale Decarbonization Technology in Support of Government's Recently Announced Clean Growth Initiative"* http://ecorpstim.com/press/vlsd-press-release-june-2018/.

[67] This 'hub' proposal was suggested by "Motu", see *"Motu Note #25"* New Offset Options for New Zealand, bottom, final page https://motu.nz/assets/Documents/our-work/environment-and-resources/climate-change-mitigation/emissions-trading/Offset-options-for-NZ2.pdf.

[68] Meet with First Gas 4 April 2018 and confirmatory email exchange Rush – Gerritsen 12 June 2018.

about the Caribbean islands of Trinidad and Tobago. Due to large gas discoveries their gas business accounts for over a third of GDP with the majority being exported as LNG, ammonia or methanol.

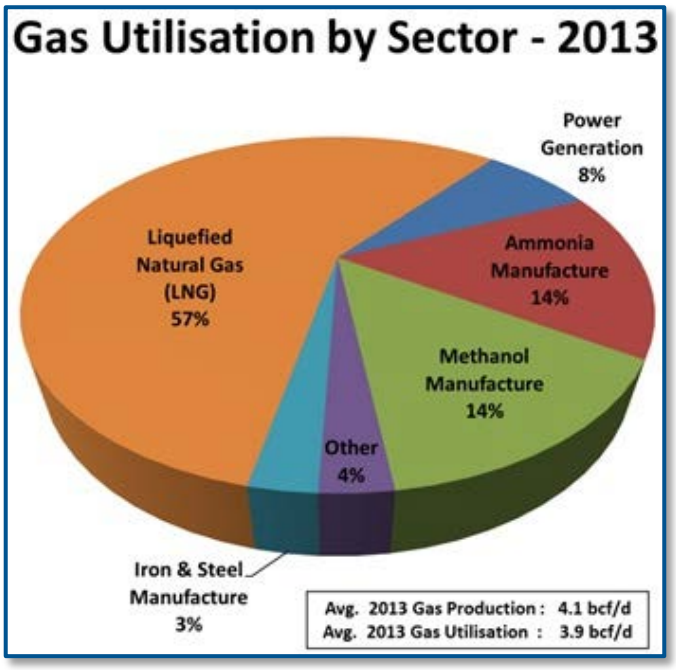

Figure 13: *Trinidad and Tobago gas use profile, 2013*[69]

There is also a great story, one of many, around the economic activity generated by the construction of just one of their many offshore platforms.

> *"BG Group is the operator of two off-shore blocks in Trinidad and Tobago, one of which is the North Coast Marine Area (NCMA). This block contains six gas fields, including the Poinsettia field. Phase 3c in the development of the NCMA included a new drilling and production platform on the Poinsettia field. The platform consisted of a 10,000 ton jacket, fabricated on the Gulf coast of the United States, and a 4,200 ton deck (the topside), constructed in Trinidad by TOFCO Ltd. TOFCO Ltd is a 50/50 joint venture between CMC of Louisiana, the United States (with construction facilities in Harvey and Houma) and Welfab Limited, a Trinidadian services company. The Poinsettia topside was constructed in the TOFCO fabrication yard in La Brea, on the west coast of Trinidad. In a case study prepared by BG Group, it was reported that an estimated 99 percent of the 1.1 million hours work on the Poinsettia topsides were undertaken by Trinidadian nationals, demonstrating a particularly high level of local content in all management, technical, and administrative positions."*

LNG developments are now going ahead in other less developed nations, including Mozambique, Equatorial Guinea and Papua New Guinea. Australia has made a huge investment in LNG and is now turning its focus to the export of hydrogen.[70] New Zealand should be incentivising this trend, not frustrating it.

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[69] From http://www.energy.gov.tt/our-business/lng-petrochemicals/.

[7070] Reuters press report, 12 April 2018, available at https://www.reuters.com/article/us-japan-hydrogen-australia/australias-agl-to-host-coal-to-liquid-hydrogen-export-trial-for-japans-kawasaki-heavy-idUSKBN1HJ0ET.

Technology Taking

New Zealand has invested heavily over our short history in hydro, not without significant risk and environmental consequences. Now is the time to allow others to develop the technologies that New Zealand needs in regard to transport and be "technology takers" as recognised in the Report. It is unrealistic to expect New Zealand to be "leaders". Unlike Germany, New Zealand cannot write an $US800 billion cheque on an experimental transition for its energy system. If New Zealand gets it wrong, it will cause hardship for the present and future generations which will be compounded by any deleterious effects arising from climate change that will arise irrespective of our efforts – funding for adaptation must be available, even the priority.

Investment

There is considerable challenge in attracting and retaining investment in climate change infrastructure. I agree that it would need stable and credible climate policy but, whilst domestic policy is something within the control of the Government, what plays out internationally is out of the Government's control. We need to recognise that most of the signatories to the Paris Agreement have no firm commitments to reduce emissions and were incentivised to ratify by the promise of a wealth transfer. Many are nations that are commonly regarded as corrupt, broke or even rouge. Quite how New Zealand with its 150 years of sparsely populated and miniscule emissions has ended up in the same "club" as the high polluters of Europe and North America, is a question I regularly ask. Why are the nuclear powers, including China, Russia, India, Pakistan and Israel afforded "developing" status even though each country has a history of civilisation that is thousands of years longer than New Zealand's and with almost certainly significantly more accumulated GHGs. I also ask myself why is it that because New Zealand has had good, corrupt free and transparent democratic governance, that has resulted in enrichment and prosperity for its people, it is now having to subsidise those countries who choose different less successful means of governance and are consequently still 'developing'?

That aside, the point to be made is that stability in climate change policy at an international level is out of the hands of the New Zealand Government. Investors want a level playing field. If New Zealand's 'ambition' goes materially beyond that of its key trading partners, then investors will choose to invest in jurisdictions where aggressive carbon pricing is not a barrier resulting in 'carbon leakage'.

That's said, incremental investment, led by the Government, based on policy settings in step with our trade partners and peers, provides the right kind of environment to attract private sector finance, provided any market failures are addressed.

Market Failure and State Intervention

As set out previously, in my view the externalities of the environmental cost have resulted in a market failure which should be corrected, initially at least, by the Government. One need only look to Norway as to how that might be achieved. Rather than shutting down a potential source of revenue, there the government utilises oil and gas production revenues to fund clean technology and innovation. A large oil and gas discovery can be country-changing for New Zealand and provide the revenues required to bankroll a clean-tech revolution. Exploration offshore should be encouraged by:

1. Entering into a framework treaty for regional cooperation with the likes of China, Thailand, Indonesia and India (the proponents of the "Belt and Road Initiative"), whereby preferential royalty rates will be offered to each country's respective national oil company in return for commitments that resulting discoveries will be applied towards lower emitting energy sources – supplying New Zealand gas to the 700 or so coal fired power stations scheduled for construction.

2. A commitment to the New Zealand public that petroleum revenues would be applied to the green fund and be utilised exclusively for clean technology investment.

Offshore Wind[71]

As set out already, wind as a replacement for hydrocarbons is a challenge. In addition to the cost, space is also a problem. In the UK offshore wind has solved that latter issue and has been developed based on private sector finance underpinned by Government subsidies. The onshore UK network has been divided into three areas and responsibility for system operations has been awarded to three licensed transmission operators[72] with exclusive rights to build and maintain transmission assets in a defined geographic area. Prices are regulated through a five-year price control period that sets the maximum revenue they can receive from charges levied on network users.

In the offshore, the Crown Estate held a competitive tender process to award leases for nine offshore zones, within which a number of individual wind farms would be situated. The bidding closed in March 2009 with over 40 applications from companies and consortia and multiple tenders for each zone. The Government has legislated for the separation of ownership and operatorship of the offshore transmission lines. This means that a system operator cannot own the transmission lines or generation capacity. As a result, ownership of the transmission lines is being shifted to risk averse institutional investors who are comfortable earning a utility rate of return from tariffs charged to electricity generators who are transporting their electricity to market. Where a generator seeks connection to the grid it will undertake a competitive tender process whereby the successful offshore transmission operator ("**OFTO**") will design, build, fund and manage the construction and connection of the transmission lines. It will operate the lines thereafter under an operations and maintenance ("**O & M**") contract, for a 20-year period in return for a stream of revenue that is calculated under a cost-of- service model.[73]

Underwriting the investment is the Government commitment to provide subsidies by using contracts for differences ("**CfDs**"). CfDs promise generators a guaranteed price for the sale of their electricity where profit is capped to a maximum and collared to a minimum so that price uncertainty is removed giving the investor the certainty needed to make a long term, low risk investment.

Unfortunately, New Zealand does not have the scale of opportunity at present to attract investors in the way the UK has and funding to underpin investment from the Government would need to be carefully considered. If 'wind pathways' offshore have been identified, then the Government should introduce enabling legislation by which areas may be licensed for wind farm development. If the market demand for electricity develops, as predicted, then guaranteeing a regulated rate of return might attract institutional investors without necessarily costing the Government anything by way of 'top-up' payments.

The Case for a Carbon Champion

A case can be made to develop new infrastructure, in the way Vogel did with the railways and Muldoon did with "Think Big". Those projects addressed the absence of private sector appetite at the time but ultimately proved to be highly successful for New Zealand, delivering returns on investment, employment, skills enhancement and a lump sum by asset sale. A "feebate", as suggested in the Report, encourages electricity generation but does not appear to deliver anything back to the Government. They instead deliver greater market share for electricity generators and transmission operators. Investment by the Government in infrastructure it owns and that is supported by market development tools such as a feebate type structure, that promote an ongoing revenue

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[71] This analysis was submitted in 2012 as part of the author's thesis: *Access to Infrastructure on the UKCS: The Past the Present and…a Future* which examined various regulated utility models as part of an analysis around use of offshore oil and gas facilities. Some aspects are likely to have changed in the interim.

[72] National Grid, Scottish Power and Scottish Southern and Energy.

[73] See the UK's first OFTO Transmission Capital Partner's business model at http://www.transmissioncapital.com/.

stream, is supported – not dissimilar to Muldoon's subsidization of LNG/CNG conversions which provided the market that paid a return on the Think Big LNG/CNG plants.

The financing and development of the Maui field, Maui pipeline and connection to Huntly with New Zealand State oil company, Petrocorp, partnering 50:50 with private sector oil companies and with the Ministry of Works doing the onshore construction, resulted in huge benefits for the nation, including a multi-billion-dollar pay-out when Petrocorp was sold to Fletchers. Not only did Petrocorp steer New Zealand's fledgling oil and gas industry, delivering new discoveries and infrastructure, it also was responsible for the training for many New Zealanders who are leaders of the industry today, both home and abroad.

Consequently, as a Government investment strategy, the Commission might consider the formation of a State-Owned Enterprise (or similar) charged with addressing the present market failure, arising from environmental externalities that are not accounted for currently. This decarbonisation 'champion' could be capitalised by a mix of Government petroleum revenues, its holding in Kupe and Huntly/Manapouri and (voluntary) equity injections from energy sector stakeholders and a public listing.

Domestically, this national 'champion' would establish centres of expertise for each low emission technology that would transition to 'regional hubs.' Hubs are important as they facilitate the development of industrial clusters of supply chain support services and expertise.[74] It would also identify and make a business case to take the technology that has been proven to work abroad and finance the construction of any necessary infrastructure and market development requirements – financing could be by way of conventional debt/equity, classic project finance or PPP. Franchising might be considered. The 'champion' would then be able to charge a regulated rate of return via a tolling structure for use of new infrastructure that would be subsidised to avoid any undue hardship arising. In time it would be expected that the subsidy would disappear, and market forces would determine tolling charges and cost of energy to the consumer.

Internationally, the champion would look for Article 6 opportunities to earn international mitigation credits.

The ultimate aim would be for the 'champion' to be owned 100% by the private sector, delivering a lump sum return to the taxpayer. Key advantages:

- Allows Government intervention to address market failure arising from unaccounted for externalities, in line with sound economic theory;
- Introduces a Government controlled entity to the private sector to:
    - steer progress as required by the Climate Change Commission;
    - implement wider policy objectives (e.g. skills shortage; employment; 'just transition');
- Puts petroleum royalties and assets to 'work' to deliver clean-tech to New Zealand;
- Mitigates public perceptions that de-carbonisation is too hard, too costly and of no benefit;
- Follows a path undertaken by Petrocorp which gives an opportunity for 'lessons learned';
- Allows every New Zealander and the energy sector to have a stake in de-carbonising New Zealand;

[74] For a discussion on industrial clusters more generally see Shakya M, Clusters for Competitiveness – A practical Guide & Policy Implications for Developing Cluster Initiatives, International Trade Department, World Bank, Washington DC, February 2009, page 1.

- Facilitates private sector participation and finance;
- Offers an exit-route via the private sector; and
- Addresses the 'fragmentation and weaknesses in the national innovation system" identified in the Report.[75]

The below wire diagram, figure 14, is offered for discussion.

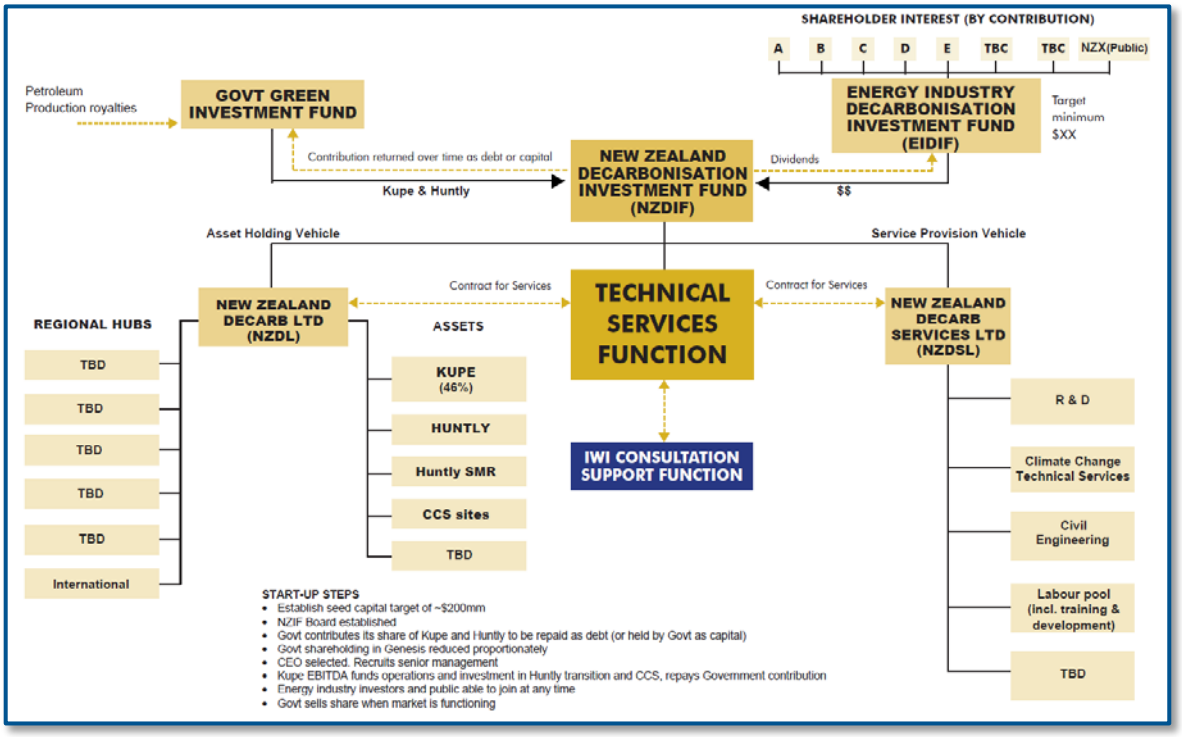

Figure 14

Resurrection of the "Ministry of Works"

To support the activities of the State champion and give effect to the TORs' requirement (that ideas that 'grow incomes and wellbeing" should be part of the broader conversation), resurrecting a state funded civil engineering and labour organisation, in the nature of the old Ministry of Works ("**MoW**") is proposed ("NZ Decarb Services Ltd" in the wire diagram at figure 14).

In the 1970s and 1980s New Zealand ran overstaffed railways and MoW. Both organisations attracted criticism, but they performed an important public service – they gave unskilled workers, who would otherwise draw the unemployment benefit, a job and purpose.

The Ministry of Works agreed to construct the Kapuni and Maui gas transmission pipelines providing gas to the North Island and significant employment opportunities:

> *"The pipeline laying began with two separate crews, each with around 180 men, working on trench diggers, banding machines, pipe-liners, welders, bulldozers and trucks. Work progressed at a rate of two to three kilometres a day on easy ground, but was often stalled on rougher contours.*

[75] Paragraph 16.5.

Pipeline 'camps' were set up and followed the men as they progressed along the route, feeding and housing them." [76]

Given the likely need for new build infrastructure providing plenty of scope for both skilled and unskilled employment the Commission might consider a Ministry of Works type entity to support the State 'champion' in delivering new infrastructure.

The idea is to not only supply the necessary engineering talent but also to address long term unemployment and recidivism rates by introducing training and employment underpinned by decarbonisation efforts.

As such, consideration might be given to integrating the 'State champion' + 'MoW' ideas with the Department of Correction's education and training programme (including "industry training") and 'work to release' scheme.[77] In the authors experience, as an ex-criminal defence lawyer, a good job delivers more freedom and choice. People make better choices to keep freedom. They go to work and keep out of trouble.

Recommendations:

- Commission to consider the effect on New Zealand's import/export competitiveness should the global shipping fleet move away from using conventional fuel.
- Commission to consider the viability and emissions reductions arising should CO2 rich gas from, for example, the Kapuni Field, be directed to Methanex's feedstock for methanol.
- Commission to consider the health, safety and other aspects to abandoning the flaring of methane and substituting it for venting and calculate the incremental benefit to the environment.
- Commission to identify opportunities for the injection of CO2 for enhanced oil recovery as part of its CCS recommendations in Chapter 13.7.
- Commission to reconsider its analysis of subsidies applying to the upstream oil and gas industry and to work with the promotions team at New Zealand Petroleum and Minerals to consider whether a commercial off-shore discovery, away from Taranaki infrastructure, will have any effect on New Zealand's internal energy market and, if so, is the Government already adequately empowered to mitigate such effects.
- The Commission to work with MFAT and NZP&M to consider the viability of bilateral or regional cooperation in the spirit of Article 6 of the Paris Agreement with proponents of the 'belt and road initiative' whereby preferential royalty rates may be applied to new discoveries in return for commitments that resultant gas will displace proposed coal-fired generation.
- Consideration of the 'carbon champion' SOE and related supporting service function with expertise in civil engineering and labour pool and possible integration into long-term unemployment initiatives and employment-related measures to reduce recidivism.

[76] Source: Puke Ariki - the Taranaki Story - Kapuni.

[77] See http://www.corrections.govt.nz/working_with_offenders/prison_sentences/employment_and_support_programmes/education_and_training.html.

Part 4: Laws and Institutions

> *"The long-term nature of climate change (literally spanning generations) and the deep uncertainty associated with the future, presents a credible commitment problem in formulating a long-term policy response."* [78]

This point is well made and reinforces much of what has been stated already in regard to caution, incremental build utilising familiar business practices, industries and expertise using policy initiatives to implement successful technologies as they emerge.

The UK's experience of legislating climate change targets has yet to be stress tested. Like the "Brexit" referendum, it was a political move by David Cameron. As the new leader of the opposition he wanted to change the image of the Conservative party from the 'old (anti-EU) white men' to a new environmentally sensitive party. It does not mean that legislation should not be considered but the Report's underlying research, "*Examining the UK Climate Change Act 2000: Research Note*" notes that "*High-level rhetoric in support of the Act has therefore not been matched by commitment to specific climate policy solutions*,[79] This is possibly because the reason underpinning the UK's legislation was not related to climate change but all to do with politics – is the position in New Zealand materially different?

The targets legislated in the UK to date have, as I understand, been 'low hanging fruit'. The next target will require significant financial and political commitment and test the electorate's appetite. In New Zealand there are doubts that ordinary Kiwis fully appreciate the implications of de-carbonising New Zealand's economy and that inevitably as efforts ratchet up, there will be a backlash from the electorate which will bring political pressure to adjust targets. Concern with a legislated approach, as suggested in the Report, centres on the inflexibility it introduces to a subject that is constantly undergoing change both in the underlying science, technology, geopolitics and domestic support. The United States, on the other hand, has shown that market forces can be used to lower emissions. Perhaps a position somewhere in between lies the solution for New Zealand.

Light Touch Regulation

As noted previously, New Zealand has successfully used light touch regulation for sector monopolies that can be coupled with, initially, voluntary commitments under industry codes which, if proven ineffective may be replaced by regulation. The ETS is a market led tool and is best left to operate according to market norms, with support from a regulator and the SOE 'champion' suggested earlier. A light touch approach might be appropriate in the short to medium term as technology emerges and evidence of a higher ambition is exhibited by the United States and major emitting developing nations.

The benefits of a light touch approach are that it allows participants in the sector to figure out for themselves how to adapt, by market forces, reducing the possibility of unintended consequences and market distortions. It also does not bind Governments to rhetorical targets that might prove impossible to achieve or politically infeasible. It is unnecessary to legislate targets where market mechanisms are properly in place and backed by a market regulator where financial penalties for a failure to comply may be levied.

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[78] Chapter 7 key point 1, page 159.

[79] *"Examining the UK Climate Change Act 2000: Research Note"* 1 September 2017, Teresa Weeks. Page 4. Available at: https://www.productivity.govt.nz/sites/default/files/Examining%20the%20UK%20Climate%20Change%20Act%202008.pdf.

A Climate Change Regulator

Drawing upon research undertaken in regard to designing energy policy.[80] A number of parallels emerge. A variation on the standard structure applicable to energy would be as follows:

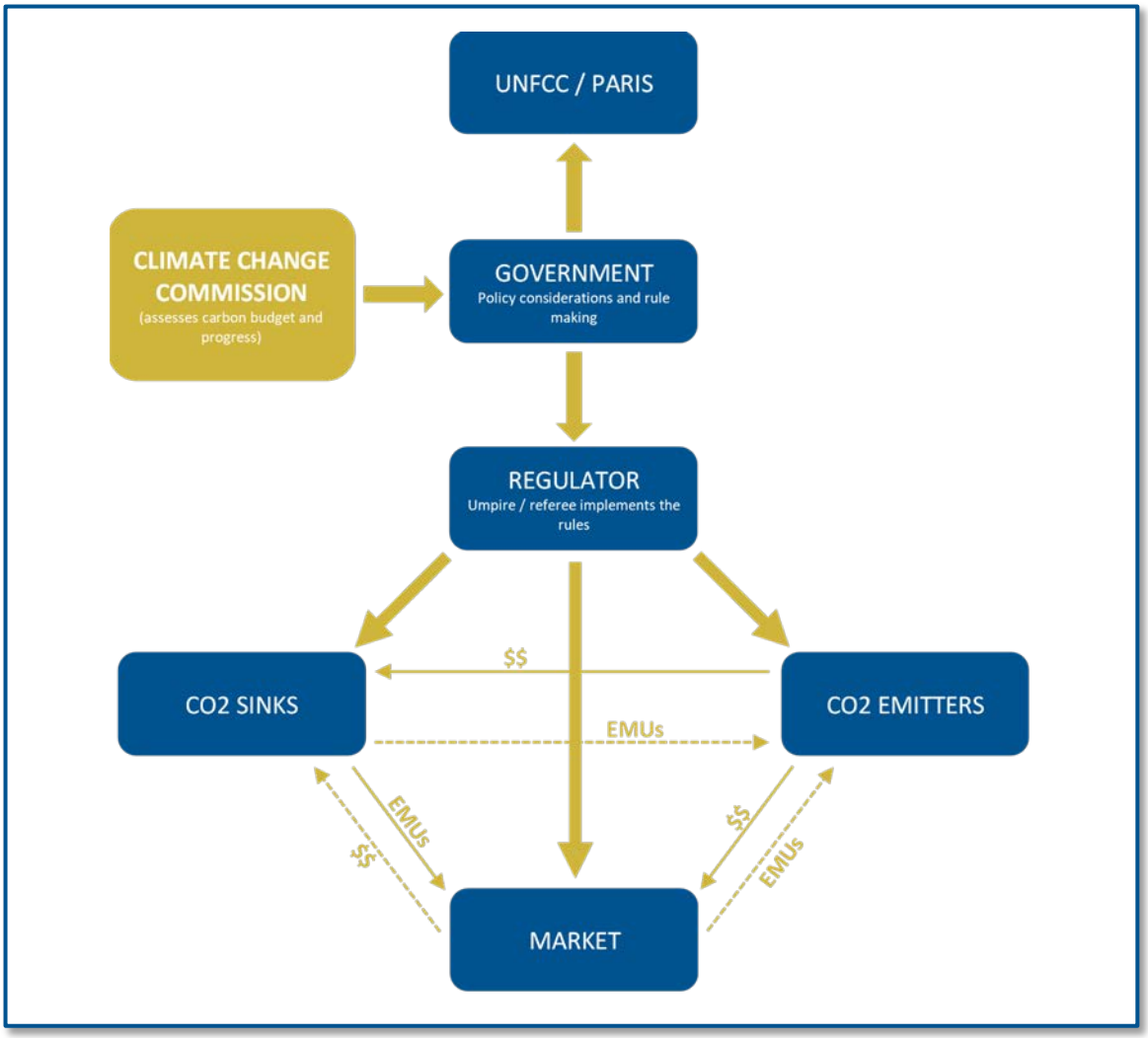

Figure 15

Looking at the model adopted in many jurisdictions for the regulation of competition, the regulatory function is shared between an independent regulator and the Minister (although in practice the Minister delegates his/her statutory authority to the regulator). In this instance, the "regulator" would be tasked with ensuring compliance with targets set by the Climate Change Commission with broad statutory powers to facilitate emission reduction initiatives and ensuring the efficient operation of the domestic New Zealand ETS and links to international markets. He/she would also be responsible for the allocation of New Zealand's emission units, ensure forestry or other 'sinks' were not acting anti-competitively and to identify and make recommendations regarding market failures.

[80] Master's in petroleum law and policy (with distinction), University of Dundee's Centre for Energy and Mineral Petroleum Law and Policy.

Recommendations:

- Commission to consider whether a statutory response to achieving climate change targets limits the flexibility that policy makers will need to the point where the constraining nature of legislation becomes a hinderance to achieving meaningful targets.
- Commission to consider whether market led regulation can achieve climate change targets without the constraints afforded by statute.

Part 5: Achieving a Low Emissions Economy

Part 5 of the Report provides a summary of what has been said previously. It is not the author's intention to cover those aspects again, but the following observations on paragraphs 16.1 through to 16.7 (page 401-408 of the Report) are offered.

Laws and Institutions

New Zealand climate change policies have not had any significant negative effect on our economy to date. New Zealand should identify a basket of peer group nations against which it may benchmark its progress towards decarbonisation. A common strategy in the corporate world is to achieve "top-quartile" performance and that would be my recommendation.

Upon completion of that benchmarking a clear strategy can be defined building on many of the recommendations in the Report.

It is clear that a significant role will need to be played by the State. The introduction of a SOE "carbon champion", funded by petroleum revenues, could capture the public's imagination and put decarbonisation activities on a strictly business level, albeit with support from the Government.

Emissions Pricing

Emissions pricing is key, however, it must be acknowledged that to achieve a "first in class" zero emissions target, many businesses will become unprofitable and will close. Either the public embrace that truth and provide a mandate for the Government to act, or the mandate will be for less ambitious targets in line with the basket of nations – an honest, apolitical, conversation with the public is needed to secure durable and long-lasting support. This submission does not support a "first in class" response that achieves zero emissions but with considerable negative economic consequences but favours of a "top quartile" performance that ensures New Zealand is among the higher performing nations in terms of achieving emissions reductions but leaves some flexibility to ensure growth and well-being is maintained.

EVs

EVs offer part of a solution to the reduction of emissions from transportation but other technologies emerging, such as hydrogen and biofuels, also offer solutions that do not suffer the same shortcomings experienced by EVs (in particular the storage and transportation of energy to sites where it is most needed). The Report notes that hydrogen and biofuels are the more probable solution for heavy vehicles, aviation and shipping – if technology is able to make solutions in the heavy vehicle space, then it is almost certain that those solutions will be equally applicable to passenger motor vehicles. Accordingly, whilst hydrogen and biofuel technology is emerging, the Government should be very cautious about funding significant infrastructure to support EVs.

Afforestation

Afforestation is the obvious source of new carbon sinks. In time it is possible that anticompetitive conduct will lead to the inefficient allocation of land to the market, hindering the development of "sinks". Consequently, a regulator for the ETS could be considered to address market conduct that leads to distortions and inefficiencies. A Government land 'buy-back' programme should be initiated.

Mobilising Capital Towards Low Emissions Investments

If the Government expects the private sector to invest in the low emissions economy, then it is only fair that the Government should lead the charge. There are numerous examples in the energy space where the momentum for private sector investment has been created and continued by a long-term Government strategy led by an SOE-type vehicle. As noted in the Report, the Government investment across the board in climate change initiatives is fragmented and, to date, largely centres on R&D, climate science and international negotiations. This submission challenges the Government to signal that it is prepared to fund, on its own or with the private sector, meaningful decarbonisation projects throughout New Zealand. Norway offers a template of sorts for doing so whereby petroleum revenues are redirected towards clean tech solutions. So rather than isolate the oil and gas industry, and let it wither and die, the challenge would be put to it squarely to deliver production royalties to provide a win:win for both jobs and decarbonisation efforts.

New Zealand Will Look Quite Different in 2050

The Commission might reconsider this message as it needlessly creates uncertainty and nervousness given that the route through to 2050 has not been clearly defined. Ironically, aspects of New Zealand will look like it did in 1950 if many of the proposed measures are successfully introduced. That is not a bad thing and perhaps might be a better way of characterising our end destination.

Schedule 1

Parliamentary Commissioner
for the Environment
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Wellington 6146

24 April 2018

Dear Mr Rush,

RE: A Zero Carbon Act for New Zealand: Revisiting Stepping stones to Paris and beyond, March 2018. Official Information Act Request

First, allow me to apologise for the delay in responding to your request. So far as we can determine, your original email never reached our servers, which means we did not receive any indication of its existence – our IT support people have confirmed this to be the case. Only when the Ombudsman contacted us did we learn of your request. Nonetheless, I am sorry your query went without reply.

You have asked about the statement in my report *A Zero Carbon Act for New Zealand* in which I described carbon dioxide as a long-lived greenhouse gas. This contention is based on the IPCC fifth assessment report, which states that the average time an individual molecule of carbon dioxide stays in the atmosphere (also known as the 'turnover time') is about four years. This is because of the rapid exchange between the atmosphere and the ocean and terrestrial biota. However, a large part of that carbon dioxide is returned to the atmosphere within a few years. Thus, the adjustment time of carbon dioxide in the atmosphere is actually determined by the rate of removal of carbon from the surface layer of the oceans into its deeper layers (IPCC, 2013a).

The decay of a perturbation of atmospheric carbon dioxide following a pulse emission is usually approximated by a sum of exponentials. Figure 8.SM.4 (see below) from the IPCC fifth assessment report (IPCC, 2013b) shows the impulse response functions for carbon dioxide from the five previous IPCC assessment reports. It illustrates that the fraction of carbon dioxide remaining in the atmosphere after a pulse emission is around 20–30% after 500 years. It is on this scientific basis that I referred to carbon dioxide as "long-lived".

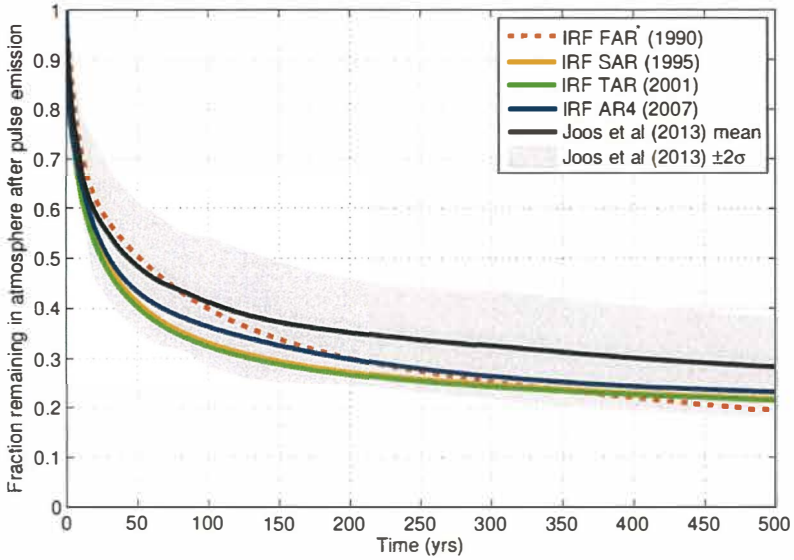

Figure 8.SM.4 | The impulse response functions (IRFs) from the five IPCC Assessment Reports. The First Assessment Report (FAR) IRF (dotted) is based on an unbalanced carbon-cycle model (ocean only) and thus is not directly comparable to the others. The Second Assessment Report (SAR) IRF is based the CO_2 response of the Bern model (Bern-SAR), an early generation reduced-form carbon cycle model (Joos et al., 1996), and uses a 10 GtC pulse emission into a constant background without temperature feedbacks (Enting et al., 1994). The IRF was not updated for the Third Assessment Report (TAR), but a different parameterisation was used in World Meterological Organisation (WMO)/United Nations Environment Programme (UNEP) Scientific Assessment of Ozone Depletion: 1998 (WMO, 1999) The Fourth Assessment Report (AR4) IRF is based on the Bern 2.5CC Earth System Model of Intermediate Complexity (EMIC) (Plattner et al., 2008). A pulse size of 40 GtC is used and includes temperature feedbacks. The Fifth Assessment Report (AR5) IRF is based on a model intercomparison and uses a pulse size of 100 GtC and includes temperature feedbacks (Joos et al., 2013). Apart from FAR, the changing IRF in each assessment report represents increasing background concentrations and improved models.

With respect to your request for any notes, correspondence, guidelines or documents regarding the figures contained in your email, reviewed during the preparation of my report: no such materials exist.

Thank you for your interest in the work of this office. I hope this response answers your question.

Yours sincerely,

Simon Upton
Parliamentary Commissioner for the Environment

References

IPCC (2013a), "Annex III: Glossary", *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, https://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5_AnnexIII_FINAL.pdf.

IPCC (2013b), "Anthropogenic and Natural Radiative Forcing Supplementary Material", *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, https://www.ipcc.ch/pdf/assessment-report/ar5/wg1/supplementary/WG1AR5_Ch08SM_FINAL.pdf

Schedule 2

CLIMATE CHANGE MATERIALS (in addition to those footnoted)

Publications

An Inconvenient Truth: The Planetary Emergency of Global Warming and What We Can Do About It, Al Gore, Rodale, Inc. 26 May 2006.

Principles of Planetary Climate, Raymond Pierrehumbert, Cambridge University Press, 2010.

Flaws in applying greenhouse warming to climate variability, Bill Gray, The Global Warming Policy Foundation, GWPF Briefing 30.

Searching for the Catastrophe Signal: The Origins of The Intergovernmental Panel on Climate Change, Bernie Lewin, The Global Warming Policy Foundation.

Available on Amazon

TITLE	AUTHOR
Climate Change: The Science of Global Warming and Our Energy Future	Edmond A Mathez
Lukewarming: The New Climate Science that Changes Everything	Patrick J Michaels
The Fable of a Stable Climate	Gerrit van der Lingen
Mirrors and Mazes: A Guide Through the Climate Debate	Howard Brady
The Madhouse Effect: How Climate Change Denial is Threatening Our Planet, Destroying Our Politics and Driving Us Crazy	Michael E Mann
Climate Change Reality Check: Basic Facts that Quickly Prove the Global Warming Crusade is Wrong and Dangerous	Calvin Fray
Human Caused Global Warming	Ball PhD
An Inconvenient Deception: How Al Gore Distorts Climate Science and Energy Policy	Roy Spencer
The Rightful Place of Science: Disasters and Climate Change	Roger Pielke
The Hockey Stick and the Climate Wars: Introduction to the Hockey Stick	Brandon Shollenber
A Disgrace to the Profession	Mark Steyn
Climate Change: IPCC Report and its Critics	Mbark Ballahi
Climate Change: The Facts	Dr John Abbot
Storm Warnings: Climate Change and Extreme Weather	Scientific American
Climate Change: Evidence and Causes	The National Academy
Climate: The Counter Consensus	Prof. Robert Carter

TITLE	AUTHOR
Climate Change Natural or Manmade?	Joe Fone
Heaven and Earth: Global Warming, the Missing Science	Ian Plimer
How to Cure a Climate Change Denier	Paul Caruso
The Carbon Crunch	Dieter Helm
Climate of Extremes: Global Warming Science They Don't Want You to Know	Patrick J Michaels
The Greatest Hoax	Senator James Inhofe
An Appeal to Reason	Nigel Lawson
The Propaganda Bureau	Andrew Montford
The Hockey Stick and the Climate Wars: Dispatches from the Front Lines	Michael E Mann
The Politically Incorrect Guide to Global Warming and Environmentalism	Christopher C Horner
Climategate: The CRUtape Letters	Steve Mosher
Confessions of a Greenpeace Dropout: The Making of a Sensible Environmentalist	Patrick Moore
Global Warming: Alarmists, Sceptics and Deniers; A Geoscientist Looks at the Science of Climate Change	G Dedrick Robinson
The Delinquent Teenager Who Was Mistaken for the World's Top Climate Expert	Donna Laframboise
Don't Sell Your Coat: Surprising Truths About Climate Change	Harold Ambler
The Inconvenient Sceptic: The Comprehensive Guide to the Earth's Climate	John Kehr
Air Con: The Serious Inconvenient Truth About Global Warming	Ian Wishart