SUBMISSION TO THE NEW ZEALAND PRODUCTIVITY COMMISSION

ON ITS DRAFT REPORT: "LOW-EMISSIONS ECONOMY"

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1. Background to submission: I led the development within the Engineering Department at the University of Cambridge of the teaching on 'Present and Future (National) Energy Systems' in the five years up until my retirement in 2016. My colleagues asked me to take the lead because of my involvement in 2006-9 as Chief Scientific Advisor to the Department of Communities and Local Government for the United Kingdom: my main concern there was energy use in buildings, comprising 45% of all energy use (and CO_2 emissions) in the UK. Between November 2016 and March 2017 I spent four months at the MacDiarmid Institute at Victoria University where I researched the hard data which enabled me to make a detailed critique of a Royal Society of New Zealand April 2016 report on 'Transition to a Low Carbon Economy for New Zealand'. This report was lacking most of the hard data needed to make quantitative assessment of its own 40+ recommendations in terms of value-for-money, scope for emissions reductions and the ability of the New Zealand economy to undertake such a transition. My findings were that three recommendations made full environmental and economic sense (reforestation, greater use of wood for building materials rather than paper, and research on methane reduction from ruminants), about eight made no difference per se (such as awareness raising or product labelling), and most of the rest would, to a greater or lesser extent, degrade the New Zealand economy and/or be ineffective in significantly reducing New Zealand emissions of CO_2. The extra research contained in the present draft report from the Productivity Commission is in large agreement with my findings. My paper on this subject 'Decarbonising the New Zealand Economy: an Engineering-based Reality Check' has been lodged with Treasury, the Ministry for the Environment and the Productivity Commission.

2. Most important point: Emissions of CO_2 into the atmosphere is a global problem. The normal think globally, act locally approach has not been adhered to. The elephant in the room is the Belt and Road Initiative (BRI) of the Chinese Government[1], which does not rate any mention in the draft report. This is simply the largest civil engineering project ever undertaken in the world, linking China to Europe by super-fast rail and a multi-lane motorway infrastructure with new cities along the route. A parallel expansion of ports in South Asia and Africa will produce a major expansion of the old sea lanes for trade. Over the last 20 years 600 million people have moved from rural poverty to middle-class city dwelling in China. The BRI will do the same for over 2 billion people along the new routes over the next 20-30 years[2]. Some 700 coal fires power stations will be built with Chinese funds[3] to provide energy for these cities. The estimate is that the extra annual carbon emissions from this project will eventually add up to twice the level of Chinese emissions today[4] which are 26% of all world emissions today (and over 250 times the emissions of New Zealand). Using data from the World Bank and BP, it is estimated that a further 2.5 billion people joining the middle class between 2015 and 2035 will

[1] http://english.gov.cn/beltAndRoad/

[2] Raising 2B people out of poverty is a part of the UN sustainable development goals.

[3] http://www.straitstimes.com/asia/east-asia/chinese-firms-to-build-700-coal-plants

[4] http://www.climatechangenews.com/2017/12/11/belt-road-countries-emit-triple-chinas-carbon-warns-official/

add a further 40% to the energy demand during that period, over 85% of that coming from fossil fuels. We are on course so far[5]. The new emissions from BRI alone will be over 500 times the emissions of New Zealand today, and 1000 times the emissions in 2050 if New Zealand should succeed in halving its emissions by then. Most of BRI will be energised by fossil fuels or nuclear technology as the current generation of renewables is too small by a factor of order one hundred to cope. There has been less than one percentage point change in the fraction of the total energy provided to the world by fossil fuels over the last 20 years and only 2% over the last 40 years[6]. Appeals to action in New Zealand on the basis of 'tragedy of the commons' arguments are also wide of the mark given the Chinese expansion plans. It is simply not the case that New Zealand emissions reduction will have <u>any</u> measureable effect on anyone's future climate in the face of the scale of the extra Chinese contributions. Measures to reduce emissions can be taken on a no-regrets basis (i.e. there are sound reasons for moving forward other than CO2 emission reductions per se). Because New Zealand investments in mitigation will have no direct return, scarce New Zealand resources should be husbanded to adapt to the changing climate as, when and if the need arises in the future. The original Ministerial Terms of Reference excluded the possibility of the New Zealand economy suffering in pursuit of climate mitigation and that is very wise in the global context just described. The Commission's Final Report should begin by confirming this wisdom, and shape the rest of the final report accordingly, with a restatement of the actual rationale of the climate mitigation policies, and the urgency of action at the scale proposed, in the light of the BRI reality.

3. A second omission from the draft report is any consideration of the change in peoples' attitudes and behaviour patterns. In the developed world the attitudes and behaviour around drink-driving, smoking in confined public spaces and unprotected sex have all changed remarkably over the last 40 years. If there was a move to regard the profligate use of any resources, especially materials and energy, as deeply antisocial, the levels in reduction of CO2 emissions would be greater in the short term than any change brought about by technological innovation. Colleagues in Cambridge have estimated that we could live simpler lives on half of today's daily consumption of energy per person without major compromises to our standard of living: fewer flights, smaller and lighter cars, simpler meals, fewer things, …[7] The draft report confines itself to economic levers to drive behaviour change, but a social campaign is complementary. The downside of such a change in public attitudes and behaviour would be rather less economic activity than business as usual, and the Commission may consider that to be incompatible with the Ministerial Terms of Reference.

4. Relying on technology innovation is not a get-out-of-gaol card in this case. It is easy to be seduced by advances in technology over the last 100 years, but of all the energy sources we use today, only two forms (nuclear fission and solar photovoltaics) were not around in Biblical times. Even if the scientific breakthroughs occurred tomorrow (say in nuclear fusion) it would take 40 years for the engineering and technology developments to enable major infrastructure investments to be made on the scale that would impact the world economy at the 10% level. The Moore's Law of progress of the IT revolution is all about doing more calculations with fewer electrons, and this exponential growth paradigm is simply not applicable to energy. The energy density of fossil fuels is as nearly high as we can get with normal materials, and eclipsed only by the energy density of the nucleus[5]: the energy density of state-of-the-art batteries is 50,000 lower than petroleum. The science today is investigating

[5] M J Kelly, 'Lessons from technology development for energy and sustainability', Materials Research Society Energy and Sustainability <u>3</u>, 2-13, doi:10.1557/mre.2016.3, (2016)

[6] https://qz.com/1144207/the-worlds-astonishing-dependence-on-fossil-fuels-hasnt-changed-in-40-years/

[7] B. Bajzelj, J.M. Allwood, and J.M. Cullen, 'Designing climate change mitigation plans that add up', Environ. Sci. Technol. <u>47</u>, 8062 – 8069 (2013)

per cent changes to the efficiency of batteries that will not lower this ratio by very much at all. If there had been any real and practical alternatives to fossil fuels at any time in the last 200 years, the world would have jumped on them. In the 40 years since the oil shock of the 1970s prompted the search for alternative energies, wind and solar energy together still provide only 1% of world energy use.

5. The modelling in the draft report shows how one could meet the 2050 targets of the previous Government with some heroic efforts. For forestry to be a continuing sink of CO2, mature trees will have to be harvested and used in durable building and furniture products. What is unknown at present is the sustainability of this process over centuries: can the soil sustain repeated 30-year cycles of harvesting trees?

6. My studies of retrofitting UK housing to improve energy efficiency came up against the problem of affordability. It is estimated that of order £50,000 (NZ$100,000) would be needed to do a retrofit that would halve the energy consumption of an average house: deep insulation of all walls to the exterior (including underfloor), treble glazing or vacuum glass, and modern appliances and lighting. £5000 would not cover the windows. The saving of 50% on energy bills is typically £1000 per annum[8]. No one lends on a 50-year payback, and energy prices would have to rise steeply in real terms to change this conclusion. Housing is different in New Zealand, but of similar low quality in terms of the thermal envelope, and a similar price hike in the real cost of energy would be needed to make a serious retrofit of existing buildings viable. One will have to wait centuries until they are rebuilt to higher standards.

7. Technology transitions are not painless. In the USA it is the wealthier people who can afford to invest in solar panels on their roofs, and to collect the subsidy inducements on offer that flow from selling their excess energy to the grid at above market prices[9]. It is the poor who are left with ever rising electricity bills as the energy and distribution companies try to pay their way with higher costs and fewer customers. This will not happen in New Zealand for electricity, but will happen for any transition to electric cars that includes a step rise in petrol prices to drive the transition. The poor, and especially the rural or small town poor, stand to be disadvantaged into the foreseeable future if subsidies are misdirected.

8. One should be careful in emulating the UK Climate Change Committee (CCC) without a deep and critical analysis. According to the CCC, UK emissions of CO_2 have dropped from 42% from 1990 to 2016, but this has been accompanied by a growth in the balance of payments deficit for manufactured goods by 15-fold from £10Bpa to £150Bpa in the same period[10]: the UK has deindustrialised and survives because of a surplus on services, much earned by trading in the City of London. The share of the UK economy comprising manufacturing halved from 25% in 1988 to 12% in 2006, while the service sector grew[11]. The UK used to make its own aluminium with coal, gas and nuclear-based electricity: it now imports its aluminium from China where it is predominately made with coal-based electricity. As a consequence, UK CO_2 emissions are down but the world emissions are up: this seems not to be the source of any embarrassment in the public debate. Carbon Brief has an independent take[12]: "Even

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[8] M J Kelly, 'Energy efficiency, resilience to future climates and long-term sustainability: the role of the built environment', Philosophical Transactions of the Royal Society A 368 1083-9 (2010)

[9] Gretchen Bakke, 'The Grid: The Fraying Wires Between Americans and Our Energy Future' (Bloomsbury, USA) 2016

[10] https://commonslibrary.parliament.uk/economy-business/economy-economy/uk-trade-a-deficit-in-goods-but-a-surplus-in-services/ , https://i0.wp.com/secondreading.uk/wp-content/uploads/2017/11/110917-2.png?ssl=1

[11] https://www.economicshelp.org/tertiary-service-sector/

[12] https://www.carbonbrief.org/mapped-worlds-largest-co2-importers-exporters

though domestic emissions have fallen 27% in the UK between 1990 and 2014, once CO_2 imports from trade are considered this drops to only an 11% reduction. Similarly, a 9% increase in domestic US emissions since 1990 turns out to be a 17% increase when trade is included." With the New Zealand export economy based mainly on primary production, the UK is not a good example to follow. The draft report draws attention to the trade-offs between cost, environment and security of supply, and any New Zealand Climate Authority should act under the aegis of all three, not just the environment as in the UK context, to provide a more balanced picture.

9. One only finds the downsides of technologies once they have been fully deployed. In the case of electric vehicles, the greater weight of the battery means that particulates associated with current braking systems will be emitted in greater density than for current cars, although regenerative braking will limit the increase. In other countries where the grid electricity is more fossil fuel based, the net emissions savings at the car level do not fully offset the additional emissions at the electricity generator. The New Zealand grid capacity will need to increase by over 50% to cope with a full fleet of electric vehicles, and the Manapouri plant, if made available by a closure of aluminium production, will only provide about a quarter of what is needed: where will the rest come from? This needs planning and agreement up front to avert the gross embarrassment of electricity shortages down the line. One should also note that both concentrated solar power plants (Abengoa in Spain and Ivanpah in California) are in bankruptcy protection – their performance simply did not live up to expectations, and both attract and kill protected birds, a felony for any person in the USA. Recent concerns have been raised on the leaching of toxic materials from solar panels in the field and disposal of panels wrecked by the hurricanes in Puerto Rico[13]. These add up to a general lesson on technology: new is not always better overall.

10. The draft report is correct in emphasising the future uncertainty of the world. It is worth putting this in an historical context. William Stanley Jevons urged the UK to abandon the industrial revolution in 1866, as when the country ran out of coal in about 2100, the collapse of society would be so terrible that it was better not to go down that route and instead revert to the lifestyle of the 18th century[14]. Was he right? We still don't know, but are fairly certain he was not. Did people suggest that Wellington be abandoned after the 1855 earthquake? It is my assertion that the concerns of the long-term future climate have been so over-sold that the worst is highly unlikely to happen, and that in the interim volcanism, earthquakes and biosecurity are much more likely to pose real and present problems that should engage New Zealanders and consume New Zealand resources. The protection of city shorelines in New Zealand in the event of sea level rise should learn from the timing of the building of the Thames Barrier downstream from London. The East of England is sinking rather faster than sea-level is rising, but by the 1980s, a simple actuarial calculation showed that a Thames Barrier built then would recover its costs by savings from averting London flooding in the lifetime of the barrier being built. Similar calculations will govern the rise of the barrier by a further metre this century.

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01.06.2018

[13] https://www.forbes.com/sites/michaelshellenberger/2018/05/23/if-solar-panels-are-so-clean-why-do-they-produce-so-much-toxic-waste/#5782ca68121c

[14] W. Stanley Jevons, 'The Coal Question', 2nd ed. (Macmillan and Co., London, UK, 1866)