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Averting dangerous climate change: accelerating the energy transition

Abstract

This enquiry starts with a brief review of climate change 'timing' issues, exploring concerns about the urgency of climate change policy action. Turning to policy, it evaluates the comforting nostrum of most economists, that a price on carbon will address the decarbonisation challenge most effectively. Doubts about carbon price-based top-down strategies force consideration of the nature and pace of a low-carbon energy transition; the level of community support for addressing climate change and energy issues; and the need for an integrated set of policy mechanisms to accelerate New Zealand's energy transition. A coherent approach needs also to consider framing, vision and awareness-building. In concluding, the question of democratic change under a rapidly tightening time constraint is examined.

Introduction

This enquiry has a political economy focus, but it begins with a discussion of climate science. The very recent and intensely destructive storm, 'Sandy', gives another foretaste, as Katrina did, of climate change to come. A more energetic and damper atmosphere, higher sea surface temperatures and higher ocean levels will in future raise the chances of such destructive weather events and impacts. Mr Obama, in his 6 November 2012 victory speech, said "We want our children to live in an America that… isn't threatened by the destructive power of a warming planet."[1] But will he act on this, and when?

A graph of meteorological, hydrological and climatological events collated by Munich Re, the world's largest reinsurer, shows a menacing upward trend and curvature (Hoeppe, 2011). Such trends and events prompt us to ask: How soon are more drastic climate change impacts likely to be felt, and how much time do we have to avert such impacts? How rapidly are we running out of time under a 'business as usual' trajectory? I also ask what forces are acting *against* solving in good time this problem of climate change mitigation. That is the first part of this enquiry.

The rest of this enquiry is on public policy and the political economy of climate action. I consider the nostrum of most economists, that a price on carbon will best address the decarbonisation challenge. Doubts about top-down strategies force us to consider the nature and pace of a low-carbon energy transition; the level of community support for addressing climate change and energy issues; and the need for an integrated set of policy mechanisms to accelerate New Zealand's energy transition. A coherent approach needs also to consider framing, vision and awareness-building. In concluding, I return to the question of democratic change under a rapidly tightening time constraint.

[1] http://politicalticker.blogs.cnn.com/2012/11/07/transcript-obamas-victory-speech/

Timing

The modellers indicate that the time left to take total global emissions over a peak and drastically cut emissions now appears very short (Wei et al., 2012)[2]. But exactly how short we cannot be sure. Some modellers suggest 5-10 years to start coming down from that peak, less time if the global rate of emission reduction is slow (Anderson & Bows, 2011; Hansen, Sato, & Ruedy, 2011).[3] Other modelling suggests that if the global rate of emission reduction is a more stringent 3 to 5% per year from now, we may just stay within the 2C 'guardrail' (Friedlingstein et al., 2011). PriceWaterhouse Coopers just last week estimated that current emissions now point to 6°C of warming unless rates of emission reduction exceed 5% per year, a rate not observed since records began (PriceWaterhouseCoopers, 2012). To investigate briefly how much this matters, consider three further issues related to ***timing***:

a. First, three tipping point risks:
   The Greenland ice sheet may pass an irreversible deglaciation threshold at *around* **1.6°C** above pre-industrial temperatures, according to a recent 'best estimate' of the tipping point (Robinson, Calov, & Ganopolski, 2012). This ice sheet's melting will, over time, raise the oceans an average of around 6 metres. Amazon rainforest loss may also pass a tipping point at around **2C** of warming (Jones, Lowe, Liddicoat, & Betts, 2009). A third tipping point could be in the overturning circulation that affects the deep oceans, according to New Zealand scientist Ron Prinn, who leads a modelling group at MIT (Prinn, 2012). Prinn estimates that **2.7C** of warming could be a critical tipping point in regard to ocean circulation. [4]

   Given social and economic momentum, it seems to be just a matter of time before we pass the first two of these likely tipping points. But the 2.7C tipping point could be further away, perhaps towards the end of the century. Current emission reduction pledges put us on a trajectory to perhaps 3 to 3.5 C by 2100 (Hohne et al., 2011). Unless decisive action is reached on the Durban negotiating track, it seems *unlikely* we will move far off a 3C path.

b. Second, capital lock-in:
   The current global economic trajectory locks in more and more emissions-generating capital, which understandably investors will be reluctant to write off.[5] Our global investment track is not currently consistent with staying inside the 2C guardrail, and every year's delay in acting to cut emissions is extremely costly, assuming the world community will be moved to accelerate action in future to try to avoid warming above 2C (International Energy Agency,

[2] Blok et al provide a picture of emission trajectories to 2100 under the assumption that Cancun pledges are implemented.
[3] Some articulate observers such as Kevin Anderson and Alice Bows of the Tyndall Centre in the UK now argue that climate change mitigation commitments are incompatible with shorter term economic growth Anderson, K., & Bows, A. (2012). A new paradigm for climate change. [10.1038/nclimate1646]. *Nature Clim. Change, 2*(9), 639-640.
[4] Prinn remarks that carbon concentrations and climate sensitivity (the response of the climate system to greenhouse gas forcing) also matter for the overturning behaviour. His conclusion is that decline in the overturning was followed by recovery in all modelled 'scenarios' where 'final' temperature stayed below 2.7C, but collapse in the overturning occurred above 2.7C (e.g.in the case of a scenario with GHG concentration of ~500 ppme, climate sensitivity of 4.5C and final temperature of 3.1C).
[5] McKinsey and Company stated in 2009 that 'a delay of 10 years, with action starting in 2020 instead of 2010, would … make it challenging to limit global warming to the 3 degree Celsius threshold…' McKinsey & Company. (2009). *Pathways to a low-carbon economy: version 2 of the global greenhouse gas abatement cost curve*. New York: McKinsey & Company,.. Elapsing time and the momentum in the world economic system may mean that it is now close to impossible.

2011b). This IEA report states:

> If internationally co-ordinated action is not implemented by 2017, we project that all permissible CO_2 emissions in the 450 Scenario [a scenario which gives a roughly even chance of staying below ~2°C warming] will come from the infrastructure then existing, so that all new infrastructure from then [2017] until 2035 would need to be zero-carbon. This would theoretically be possible at very high cost, but probably not practicable in political terms. (p.205).

c. Third, fossil fuel reserves:
We now, globally, have perhaps five times as much in proven fossil fuel reserves as we can afford to extract and burn, if we are to be reasonably confident of staying under the 2C guardrail, but despite this, the ongoing investment of fossil fuel companies, and our own obdurate habits, continue to increase the risk of future oil and gas consumption (Hansen et al., 2012; Leaton, 2011; McKibben, 2012). This investment path reveals either ignorance or a wilful blindness to the urgency of climate change mitigation.

What these three points together suggest is that although the human community is dicing with huge risks, it is showing little understanding of these risks, but more importantly, little grasp of the ***timing*** issues. In the past, uncertainty has been seen by some as a basis for delaying action, but this is a pernicious inversion of logic. As Jim Hansen, the eminent climate scientist noted earlier this year, his grim 1988 picture of the consequences of global warming was 'too optimistic' (Hansen, 2012). Given the stakes, and the uncertainty with an adverse downside (Weitzman, 2011), there is a strong case for immediate action to cut emissions as steeply as possible.

A price on carbon: losing its gloss?

Turning to climate policy, there is now a strong case for doubt about whether a price on carbon will in practice work to avert highly dangerous climate change, given the timing constraints. Price is the preferred incentive mechanism for change, among most economists. But concerns now arise as to whether a price sufficient to make a critical difference is likely to be widely enough adopted internationally, 'ín time'. Obama's approach will of course be critical.

Many are concerned at the downturn in international carbon prices, a fall accentuated by the depreciation of 'certified emission reduction' units (Stock, 2012). In New Zealand's case, emitters can buy without restriction carbon units under the emission trading scheme (ETS), so the local price has been falling sharply recently. The application of the ETS itself has been narrowed by the current government (agriculture's entry is now delayed indefinitely, and the 1 for 2 discount extended indefinitely). The most recent coup de grace is the government's walking away from the second commitment period under the Kyoto Protocol, putting at risk New Zealand's hard-earned reputation in environmental policy, built up by Ministers such as Simon Upton and David Parker.

Even at a significantly higher projected price than the $3 per tonne of CO_2 that currently prevails, that is, at $25/tonne rising to $50 by 2015 and then stabilising, New Zealand's emissions would be little affected by the price on carbon (Ministry for the Environment, 2009, p. 99). MfE put the overall impact of the ETS (together with other policy measures) at around a 13% reduction below business

as usual by 2020 (*ibid*, p.103), as shown in Figure 1,[6] but projected emission levels by 2020 would still have been *well above* 1990 levels. This is evidently contrary to the Government's conditional "-10 to -20%" target for 2020 (Government of New Zealand, 2009): it is likely that the Government is preparing to resile from this aspiration also, as policy measures to reach it have been weakened. To give an idea of what would be needed to realise the aspiration, MED's high carbon price ($100/tonne) scenario would only cut energy emissions by ~7% by 2030 (Ministry of Economic Development, 2011, p. 11).

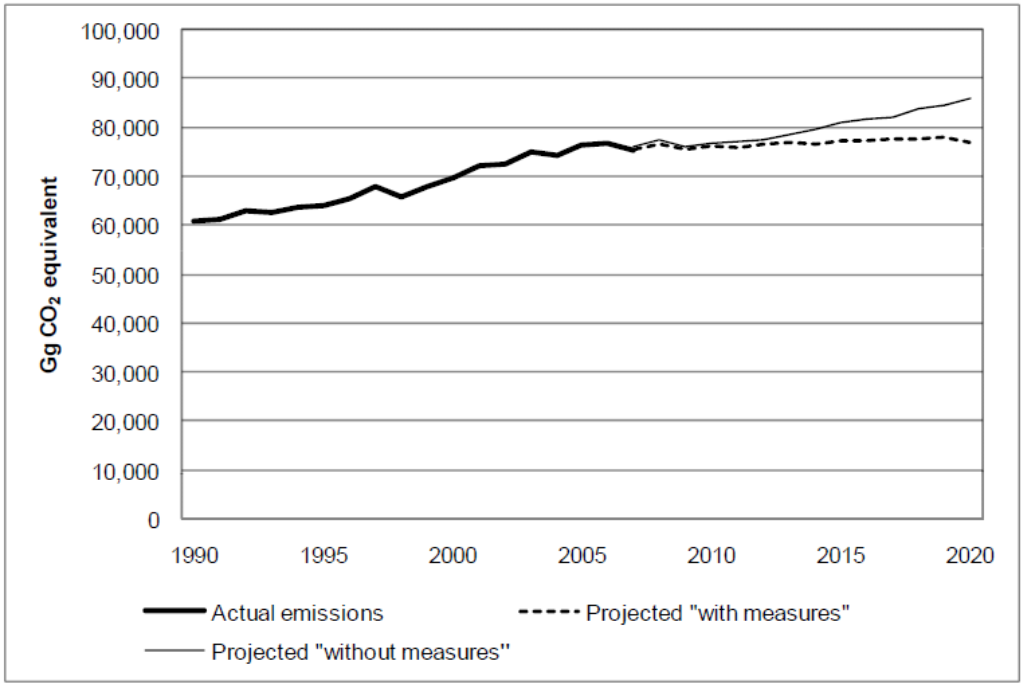

Figure 1: Comparison of NZ's actual and projected total emissions, "with policy measures" versus "without measures", 1990–2020. The ETS is New Zealand's flagship policy measure. (MfE, 2009).

Is the approach beloved of economists and many politicians therefore enough in the real world? Conventional economists tend to think about 'optimising' climate change, by aiming for the level of emissions which equates the marginal abatement cost of carbon with the 'social cost of carbon'. The marginal abatement cost is the cost 'at the margin' of cutting emissions by one tonne. The social cost of carbon represents the damage avoided by saving one further tonne of emissions, i.e. the benefit of abating that last tonne. Recent work suggests this could be of the order of US$100-400 per tonne, depending on a range of factors, including 'discount rates', which reflect how we value the lives of future generations, and how we think damages will increase with global temperatures (Ackerman & Stanton, 2011; Hope, 2006).

If we were to adopt the precautionary principle and an insurance framework, taking into account the risks of nasty climate surprises (Weitzman, 2011), the price of carbon might indeed need to be set in the hundreds of dollars per tonne. This would then have a fighting chance of changing the global trajectory of emissions. To give a New Zealand example, a price of say NZ$200/tonne would have

[6] The two sectors most likely affected are energy (-31%) and forestry (-64%) but transport emissions barely fall (-1%). Overall, 'gross' emissions (total excl. LULUCF) are projected to fall 10.4%; 'net' emissions fall 13.5%. NB: 80,000 Gg = 80 Mt.

the effect of lifting petrol prices around 40 - 50c/litre (Government of New Zealand, 2009; Ministry of Economic Development, 2011, p. 11), i.e. still less than a quarter, on current pump prices. Anything less than a tenth of this amounts to tokenism.

A more general concern relates to institutional dynamics – the time it takes to introduce and experiment with price-based strategies, and to move prices up, something that cannot be done overnight. Boyd et al (2011) state: 'Critics argue that the pursuit of carbon markets as the preferred option has lost us more than 10 years in the battle to keep climate change within tolerable levels. The time required to create them, manage them and deal with the problems they inevitably raise (additionality, fungibility) has meant that 10 years on we have poorly performing carbon markets (from the point of view of seriously reducing emissions) and other alternatives that could have been more effective have been successfully sidelined.' An American commentator, Joseph Romm, noted in 2008 that it had taken a full decade from 1997's Kyoto Protocol for the EU to get a price (then US$40/t$CO_2$) in place, and even then coal fired power stations were still being pursued by utilities in four EU countries. He argued that there was not sufficient time to wait another decade for the US to find out whether a cap-and-trade scheme would work there (Romm, 2008). I would add that there is little doubt that a carbon tax would be simpler and faster than emissions trading for countries such as the US to implement, and Australia's experience has been positive.

Top-down solutions

The primacy of a carbon price remains, warts and all, an article of faith among many. An associated article of hope has been that a top-down 'global' treaty approach is likely to be the main solution to the climate change crisis. This is based on the assumption that such an approach – including a Kyoto-type UN-mandated reduction target – could avoid free riding and offers the best chance of getting all the major players on board. But a top-down approach has been facing formidable obstacles in certain countries, especially the US and Canada, which to date continue to free ride; such behaviour could well stymie wide implementation, despite some hopeful signs from Durban in 2011 (Macey, 2012; Pearce, 2011). As noted, New Zealand has now walked away from committing to a Kyoto second commitment period; it remains to be seen whether New Zealand's commitment under the Framework Convention will have any integrity.

Differing views on a top-down approach reflect differing ***world*** views, as highlighted by writers on cultural theory (Verweij et al., 2006). In the US, views seem to reflect increasing political polarisation, especially between individualists, hierarchists, egalitarians and fatalists. These fault lines are accompanied by an erosion of belief in science, and arguably a gradual erosion of effective democracy in that country under intense corporate lobbying on matters such as climate policy (A. Clark, 2010). There is a large gap in the US between the public and climate scientists (Anderegg, Prall, Harold, & Schneider, 2010): for example, among the public, ***58%*** agree that "human activity is a significant contributing factor in changing mean global temperatures" while among climate scientists who (one assumes) understand long-term climate processes, agreement is ***97%*** (Doran & Zimmerman, 2009). Despite the US public's awareness deficit, it is notable that a substantial majority of the US public have for some time wanted the government to do more about climate change (Brewer, 2004). But little action has eventuated. This may be because most Americans consider climate change a low priority. A 2011 poll of policy priorities for the US government found that

"respondents put dealing with climate change second-to-last out of 22 options" (Markowitz & Shariff, 2012, citing a Pew Research Centre study). The "climate silence" noted in the US election campaign this year by a number of journalists supports this finding (Roberts, 2012)[7]: rather than a serious discussion of climate policy, the Presidential candidates vied to explain how they would extract more fossil fuels to keep fuel prices down for Americans.

Some observers have pointed to ***multi-level solutions*** as an alternative strategy where national governments are evidently failing. The late Elinor Ostrom's articulate plea (Ostrom, 2010) is an example. US thinkers often shy away from national level responses due to the political complexity and intransigence seen at that level, and sometimes an inclination to trust individual or local community level responses. But such thinkers do not adequately confront the issue of whether a range of actions at multiple scales below the supranational – i.e. local, city, county, state, national – would add up to 'going far enough, fast enough'. The recent experience of regional emission trading systems in the US, for example, suggests that effective action at regional level is slow. But the jury is out on the collective impact of sub-national action. It may be that action by cities around the world, and by regional groups, states and communities really could add up to 'enough, in time'. As psychologist Niki Harre points out, individual and community level responses are important anyway, as they engage people in a positive process of changing behaviour (Harre, 2012).

In this difficult context, I explore briefly what a small country like New Zealand might do to play a more activist role that has some chance of addressing the real challenges of climate change particularly in terms of energy solutions that reduce carbon emissions. I set aside the issue of New Zealand's negotiating role in international fora, noting only that New Zealand needs to get its domestic policy 'right' or it risks losing its remaining credibility internationally.

New Zealand's low-carbon energy transition

Some empirical evidence is available on how a transition to low-carbon energy might progress in New Zealand. However, the data are patchy and lessons are therefore suggestive only. I offer examples of findings and initiatives in key transition arenas, particularly transport and energy. But first, I examine some evidence on how New Zealanders think about climate change action.

Sense of urgency and commitment

What is the evidence on how prepared New Zealanders are to act, or alternatively, do they feel powerless and immobilised by the climate change problem? This is important in order to gauge how likely New Zealand politicians and the public would be to accept policies necessary for major changes in everyday energy and transport practices.

The picture is mixed. In a fairly typical 2009 poll, for example, about 43% of 500 respondents saw climate change as a serious or very serious concern, lower than the concern expressed about education, health, the cost of living and most other nominated issues (Stuart, 2009) Climate change ranked 8th of 9 issues. When asked whether humans are having an impact on world climate patterns, 22% rated human impact on climate as 4 or less on a 10 point scale, whilst 41% rated humans as

[7] Also, http://climatesilence.org/data/

having a very direct impact on climate, i.e., 8–10 on the scale. That is, considerably more New Zealanders (than not) viewed human impacts as significant. This result is similar to that of another survey (nationwide, n = 1003) which found that 38% of the New Zealand public strongly believe (9 or 10 on a 1–10 scale) that humans or animals have a direct impact on climate change (TNS Conversa and the New Zealand Institute of Economic Research, 2008). In a (n~600) 2010 poll limited to environmental issues, respondents identified climate change as the most important 'global' issue, but as less important for New Zealand than water pollution and water related issues (Hughey, Kerr, & Cullen, 2010). This cluster of results suggest that a majority of New Zealanders are generally aware of humans' impact on climate change, with almost as many viewing it as a serious concern; however, they tend to see it as less important than other environmental issues, at least for New Zealand.

What about views on climate policies? The 2009 poll just mentioned found a small majority supported an ETS if costs imposed were not high (Stuart, 2009). The Business Council for Sustainable Development commissioned polls over the 2007-2010 period which suggested that 65-76% of New Zealanders believe that climate change is a problem to be dealt with 'now' or 'urgently' (ShapeNZ, 2010). A Wellington region study (n=192) found that 70% reported that they had taken action in relation to climate change, and – perhaps not surprisingly – those who saw the risks of climate change as high were more likely to have taken action. When asked 'How soon should climate change be dealt with?', the mean score on a 1-5 scale was 4.3, suggesting a sense of urgency. This study also found that, when asked about the commons dilemma (e.g., *'Feeling that other individuals will not change their actions even if I do'*), respondents did ***not*** indicate that the dilemma had much influence on their behaviour (mean scores on the three questions about the commons dilemma[8] were 2.8 on a 1-5 scale). Similarly, when asked about whether a sense of powerlessness influenced their behaviour, respondents' scores indicated relatively *little* influence (mean 2.7 on a 1-5 scale)[9] (Aitken, Chapman, & McClure, 2011).

An important insight for shaping policy on climate change mitigation comes out of the evidence just mentioned about New Zealanders' political priorities. It is clear that New Zealanders place great weight on *health* services and health outcomes compared to many other priorities, including economic growth (Growth and Innovation Advisory Board, 2004; Rose, Huakau, & Casswell, 2005). An interest in the health and quality-of-life *gains* that carbon mitigation policies could potentially create can be coupled with concern about the adverse impacts of climate change itself, to promote activist climate policies. The emphasis would be on the co-benefits of policy measures, such as the health benefits of active travel. Some groups, such as *Ora Taiao*[10]*,* and individuals are working in this vein (Howden-Chapman, Chapman, Capon, & Wilson, 2011), and the WHO's great work on this theme is worth leveraging off (World Health Organization, 2011a, 2011b).

How do New Zealanders view technological solutions to the carbon mitigation issue, including the challenge of transforming NZ's energy system to, say 100% renewable electricity? Some evidence

[8] The additional two questions on the commons dilemma were: 'How influential have the following factors been in shaping your own decisions about actions that might affect climate change? - *Unfairness associated with bearing the cost of change whilst others do not';* and *'…-Other countries or people not taking equivalent action currently'.*

[9] The three questions about powerlessness were 'How influential have the following factors been in shaping your own decisions about actions that might affect climate change? - The feeling that climate change is too big for my actions to have an impact; …- The feeling that my actions will not affect the outcome of climate change; …-The feeling that my contribution is just a drop in the ocean and so is insignificant.'

[10] http://www.orataiao.org.nz/

suggests New Zealanders are very positive about clean energy technologies, and tend to be optimistic about technological solutions to environmental issues. For example, an EECA-commissioned 2008 survey by AC Nielsen found that 86% of New Zealanders surveyed were supportive of wind farms in New Zealand (EECA, n.d.), and a Business Council for Sustainable Development survey found that New Zealanders preferred wind and solar to gas by 77% and 69% respectively, v. 10% (New Zealand Business Council for Sustainable Development, 2008). However, whether and to what extent wind power or another form of power is supported by particular communities is much more complex, and depends on the size of the power development, the local site, as well as environmental, institutional and economic factors (Barry & Chapman, 2009; Graham, Stephenson, & Smith, 2009).

What I conclude provisionally from this patchwork of indications is that New Zealanders on the whole ***do*** want to be active on climate change, and they are likely to favour policies that have co-benefits in terms of other goals such as health, quality of life, energy security, and – very likely – long-term economic gain, arising for example from enhancing New Zealand's clean, green reputation.

Energy transition policy elements

What are some of the important elements in a low-carbon energy transition in New Zealand? Consider just three: phasing out energy subsidies, tackling the tough nut of transport energy use, and moving toward 100% renewable energy.

Internationally, New Zealand takes a principled, almost purist stance on subsidies, perhaps conscious of the evidence that energy subsidies are responsible for a great deal of waste and unnecessary carbon emissions.[11] But a notable current energy subsidy is to the smelter at Tiwai Point, which takes around 14% of the country's total electricity at an undisclosed but low price. The closure of the smelter, although necessitating help for some workers, would be a welcome potential contributor to a sustainable energy transition. The case for closing the smelter will strengthen if aluminium prices weaken further and Rio Tinto demands a lower price. Already, there are strong reasons to doubt the logic of using 800 MW, a valuable slice of renewable electricity capacity, on the production of an energy-intensive commodity in falling demand, given that alternative production sources are now more energy-efficient[12], in nations such as China. New Zealand can reroute the electricity, through an upgraded national grid, to other users, so that job losses in Southland (which has low unemployment) would be offset by job and economic gains elsewhere in New Zealand. Smelter closure would also allow the closure of the old Huntly coal powered station to be brought forward, further reducing New Zealand's emissions.

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[11] Fatih Birol, chief economist of the IEA, estimated in January 2012 that '37 governments spent $409bn on artificially lowering the price of fossil fuels in 2010' (Clark, D. (2012). Fossil fuel subsidies: a tour of the data. *Guardian.co.uk* (19 January).. The subsidies significantly lift oil and gas consumption and disadvantage renewable energy technologies, which received only $66bn of subsidies in the same year. Birol's estimate is that a phase-out would avoid three quarters of a billion tonnes of CO_2 a year by 2015, rising to ~2.6 bn tonnes by 2035. He is reported to argue that such cuts could provide around *half* the emissions reductions needed over the next decade to reach a trajectory limiting warming to 2C.

[12] Further analysis would need to consider the extent to which a shift in aluminium smelting to China would reduce overall carbon emissions taking into account the carbon intensity of China's electricity.

Electric vehicles are likely to be another significant element in the energy transition. Even as a techno-skeptic, I can foresee a sharp reduction in the cost of production of batteries, which currently constitute over half the cost of battery-EVs. One international study suggests electricity could provide 44% of transport energy by 2050 (Teske, Muth, & Sawyer, 2012, p. 14), with 70% of that transport energy from renewables. A New Zealand study (Duncan et al., 2010) envisages almost 400,000 EVs could be on the road by 2025, requiring only another 180 MW of electricity system capacity. Overall carbon emissions could be cut, due to reduced tailpipe emissions, by 1.5 to 3 million tonnes per year by 2040 (Duncan, et al., 2010, p. 63). Similarly, MED's modelling concludes that EVs may become more widely available and reasonably competitive by around 2030, but significant take-up will depend on oil and carbon prices going significantly higher.[13]

It is also worth considering whether New Zealand would be blazing an altogether pioneering trail if it set its sights on 100% renewable energy. New Zealand at present is about 'three-quarters renewable' in terms of electricity (77% in 2011), and 39% renewable in terms of total primary energy supply (Ministry of Economic Development, 2012, p. 9). Denmark, a country in many ways similar to New Zealand, but with a longer record of minority governments (no party with a majority since 1909) has a target of 35% renewable energy by 2020 (i.e. ***below*** New Zealand's current level), and 100% by 2050. The Danish Energy Agency estimates that costs will "work out at EUR 1 per day per household over the next 40 years" (Baird, 2012, p. 41). Given the ***greater*** diversity of New Zealand's renewable energy endowment than Denmark's, could New Zealand be as ambitious as Denmark?

How much confidence should New Zealanders have in the development and implementation of new energy technologies? A key conclusion from high level studies of various energy innovations – from CCS to solar power – is that technological transitions take time to mature. What are called 'sustainability transitions' in the literature (Bergek, Jacobsson, Carlsson, Lindmark, & Rickne, 2008) are likely to take even longer, as solutions tend to be more complex than just a move to the next profit-making technology. One conclusion in a US study is that the gap between new research and technology breakthroughs and widespread development is usually a matter of decades, but there are – encouragingly – some areas of new, more sustainable technology such as wind energy and photovoltaics where the upturn in patents has foreshadowed, with a relatively short (5-7 year) gap, the upturn in technology rollout (Rau, Toker, & Howard, 2010). But in terms of widespread adoption of new technologies, energy expert Vaclav Smil cautions that "energy transitions… are inherently prolonged affairs whose duration is measured in decades or generations, not in years." (Smil, 2011, p. 218). In New Zealand, there is considerable uncertainty over how long grid-tied PV electricity prices may take to reach grid parity (Watt, 2009, Table 8.1); but recent dramatic international price reductions in PV suggest it might be only a few years (U.S. Department of Energy, 2010).

Would a high price on carbon accelerate the transition to new technologies in New Zealand? One recent New Zealand study (Kear & Chapman, In review) looked, *inter alia*, at whether a substantial carbon price would significantly affect certain energy investment decisions. The study examined

[13] MED's "Reference Scenario sees sales of full electric (EV) and plug-in hybrid (PHEV) vehicles growing to a market share of *13% of all new light private vehicles sold* in 2030 and these vehicles making up around 5% of all vehicle kilometres travelled that year." (Ministry of Economic Development. (2011). *New Zealand's Energy Outlook 2011: Reference Scenario and Sensitivity Analysis*. Wellington: MED.) Under their higher oil price (US$130/bbl by 2030) "sensitivity" scenario, battery electric and plug-in hybrid electric vehicles account for *17%* of new private car purchases in 2030. In a separate "high emissions" ($100/t$CO_2$) price sensitivity case, "electric vehicle demand increases to 2 PJ per annum by 2030 while biodiesel demand increases to 3.4 PJ. Combined, these represent less than 2.5% of total transport energy demand in 2030." (p.11).

electricity **storage/reserve generation options**, clearly an issue in the NZ context, where there is increasing availability of intermittent wind and (eventually) solar, but people still wish to have a reliable enough power supply to be able to turn on their heat pumps at peak hours such as 6pm on a winter's night. Among the study's results were that pumped hydro was seen by most experts in the sector as prohibitively costly (as well as environmentally difficult), even though it was almost universally viewed as technically capable of providing renewables support and peak power adequacy. Utility-scale batteries were seen as not currently cost-effective, with very high storage costs per kWh and most likely only to be used in NZ for very high-value applications where there is a strong technical advantage, such as the six-second instantaneous reserve. A price of carbon of around NZ$100/tCO2, however, was seen as making these technologies much more competitive; that is, climate change mitigation was seen as a strong driver of possible take-up of these storage options.

Of course, investment decisions about reserve generation are only one aspect of the electricity market that would be influenced by a carbon price at a significant level. It is also interesting to examine recent MED modelling data on energy generation under a significant carbon price, namely, a $100/tonne scenario. Overall, MED concluded that such a price (assumed in that scenario to be reached by 2020 and then held) would generate a 7% fall in total energy emissions (Ministry of Economic Development, 2011). But there would be significantly different impacts in different energy sectors, e.g.:

- Petrol transport demand would fall only 0.8% relative to the reference ($25/t) scenario
- Wind generation would increase 80%, and coal generation would fall by 36%
- Electricity prices would rise by 8%.

It would be foolish to say that New Zealanders would welcome these changes, but they might be palatable if the energy security and other benefits of renewables investment were well explained. It is also beyond the scope of this paper to assess the scope for social and behavioural change in the **transport** sector. However, the MED estimates of the low proportional impact of a carbon price in the transport sector indicate the difficulty of changing behaviour in this sector, especially in the short run. Currently work is going on in areas such as active transport promotion (e.g. Chapman et al., 2012), and studies of changes in the configuration of cities and the likely impact this may have on carbon emissions over time (Chapman, 2008). In addition, a detailed study of work on electric vehicle take-up in New Zealand is underway.[14] An early finding of this study is that significant reductions in carbon emissions are possible if EV takeup is high (which implies some government encouragement), and if recharging of EVs is undertaken largely off-peak.

Implications for New Zealand's policy mix

The New Zealand picture sketched here of a range of technological and policy options, and a public sympathetic to mitigation action, suggests there is a strong case for an active transition to a green, low-carbon economy. There will be some resistance from special interests such as the pro-fracking fossil fuel community,[15] and also resistance arising from a lack of awareness, particularly of the ever-

[14] Clover, D.; PhD thesis in preparation, VUW
[15] http://www.stuff.co.nz/taranaki-daily-news/news/7920818/Fracking-vital-for-energy-sector-report

changing and complex picture of the science of climate change. There may also be resistance from the well-off in New Zealand, who are likely responsible for the lion's share of household emissions (Brand & Boardman, 2008). The lag in awareness and could be addressed by central and local government, working with the expert community, to raise understanding of the enormity of the risks associated with climate change and the ongoing use of fossil fuels, and the difficult policy issues.

New Zealand's low-carbon energy transition will need a mix of mutually reinforcing policies, as each policy measure is inadequate by itself to make much of an impact in moving to a plausibly 'safe' emission trajectory. Of course, each policy measure also has its difficulties and costs, and the lead times are long.

Recognising that a very high carbon price (e.g. $400/tonne) is politically implausible, *complementary* policy measures are needed. But a significant price definitely still needs to be part of the mix. And *multi-level* responses are needed, from central to regional and local government, and also involving households and individuals. Cities are critical here. The current insistence that the Resource Management Act should not accommodate mitigation is inconsistent with a multi-level enabling approach. There is a good case for amending the RMA, given the political constraints on raising the price of carbon, and recognising that a national policy approach premised on 'one price solves all' is obdurate.

These so-called complementary policy measures and a credible carbon price can be integrated under a *'green economy'* umbrella. The current economic track risks embedding an outdated extractive economic model, and fossil fuel dependent infrastructure, especially in transport and the industrial sectors (Ministry of Economic Development, 2011). The current government has nodded in the direction of green growth but done little (Green Growth Advisory Group, 2011). A rapid transition to a green economy as currently espoused by the OECD, WHO and others (Bowen & Fankhauser, 2011; Jacobs, 2012; OECD, 2012; World Health Organization, 2011a), does represent a credible alternative model, although debate continues about the sustainability of growth in the medium term (Heinberg, 2010; Martínez-Alier, Pascual, Vivien, & Zaccai, 2010). New Zealand can expect the international trend towards greening the economy to gather way, as countries emerge from the current period of economic difficulty, and as awareness grows of the negative impacts and risks of unmitigated climate change. Investment in greening the economy, especially the energy sector, is also likely to help sustain other economies (Harvey, 2012). Would New Zealand not wish to be a front-runner in this transition?

Coherence in terms of vision, messaging, and awareness building is also vital as part of a New Zealand low-carbon energy transition. There are some early signs of alignment between enlightened members of the business sector (Pure Advantage, 2012), social enterprise organisations such as the Hikurangi Foundation,[16] progressive local government, 'green' NGO groups such as *Ora Taiao, 350.org.nz* and *Generation Zero*, [17] and the academic community, including groups such as the NZ Centre for Sustainable Cities.[18] All these organisations understand the need to raise awareness about the risks of climate change, and the need to keep the pressure on for carbon mitigation.

[16] http://www.hikurangi.org.nz/
[17] http://www.orataiao.org.nz/ ; http://www.350.org.nz/ ; http://generationzero.org.nz/
[18] http://sustainablecities.org.nz/

But the difficulties of raising public awareness need also to be borne in mind. Berkeley's George Lakoff argues that modern liberal democracies are suffering from a problem of embedded conservative framing and engrained worldviews that require a fundamental challenge, and that embedding a more progressive set of frames is a desirable but long, probably decadal, process (Lakoff, 2010). As he states:

> What is needed is a constant effort to build up the background frames needed to understand the crisis, while building up neural circuitry to inhibit the wrong frames. That is anything but a simple, short-term job to be done by a few words or slogans. (p.74)

In short, the task of building awareness around climate- and energy-related behaviour is non-trivial.

There are, however, signs of emerging support, for a vision going beyond incremental change, one instead that involves a radical rethink of energy use – for example, rethinking the needs of the big sectoral energy users such as transport, industry, and housing. There is growing antipathy, for example, towards the Roads of National Significance, currently limited transport choices, sprawling urban development and so on. And there is a widespread desire and active trend to build low-carbon transport systems, local energy systems, low-energy housing, and a firmer basis for international competitiveness (University of Auckland & Vivid Economics, 2012).

Democracy and climate change

The transition challenge is a 'wicked' combination (Rittel & Webber, 1973) of the increasingly urgent time pressures generated by climate change, the need to overcome policy and public attention fatigue, maintaining sufficiency of motivation in the face of economic and other distractions, and handling deliberate political resistance, including from some less visionary incumbent companies and parts of the establishment (Boston, 2010; Pralle, 2009). If the mitigation delays of the last five years, due largely to the global financial crisis, are repeated, or there are further delays simply because of the difficulty of significantly lifting the global carbon price in the face of political opposition, then the dangers of moving past the 2C guardrail become extreme.

In this context, and as we witness growing climate destabilisation over the next decade, we may well see growth in the movement to rethink the conventional wisdoms of the present generation and establishment, such as the primacy of economic growth. It is possible we will also see a new focus on radical policy change *within one generation*, as advocated by Generation Zero among others – the timeframe that climate change now forces upon us (Monbiot, 2009). As writer Nicky Hager recently noted, young people in New Zealand can be underestimated (Hager, 2012). There is evidence that they ***do*** understand the nature of the climate change crisis, and – importantly – are not likely to be demotivated by 'scientific realism' or brutal honesty about the size of the policy and behavioural challenge,[19] as long as they see a positive way forward.

However, there is a darker risk, a connection between climate destabilisation and loss of democratic capacity to take action. Envisage, for example, the economic, social and political breakdown that scorching drought and extreme storm events are likely to engender in countries from Russia to India and the US, in anything between 10 and 30 years' time. Given that less than 1C of global warming

[19] http://grist.org/climate-change/2011-12-16-brutal-logic-and-climate-communications/

can currently send 56% of the US into drought and extreme temperatures, to cite 2012 data, and unleash some nasty coastal flooding, 2 to 3C would bring much greater intensity of destabilisation. While it is unclear exactly how climate change will play out, increased flooding, drought and growing-season disruption to impact food prices could lead to political crises in a number of countries.

The deficit in understanding of climate change mentioned earlier could prove highly problematic for informed democratic decision making on climate change. Consider the finding of a survey conducted at the 2010 Cancun climate summit, among 500 accredited attendees from around the world. This found that 94% agreed that "without strong public support, real action on climate change will never be made at the international governmental level" and, "when asked what constituencies need to be more involved, respondents ranked the general public number one, ahead of heads of state, business, NGOs and UN organizations." Some 58% said that "the general public does not understand the meaning of 'climate change' well or at all, and only 5% said the public understands it 'very well.'" (Steinfeldt, 2010).

Alongside this is the finding of increased polarisation – what some call the entrenching of climate change as part of a 'culture war'. Essentially, as the public has become more worried that solving climate change may require drastic lifestyle changes, the issue has become more polarised. Hoffman (2011), writing in the US, says: "there appears to be a deepening schism between the skeptical and convinced logics, one that rests on foundational arguments that are based on different worldviews, different issues, and different frames to communicate them"(Hoffman, 2011, p. 18). In short, there is *not* a social consensus in a number of developed countries, on climate change, nor on the means to tackle it. Given the urgency of the issue, and the slenderness of the zone of cooperative decision making, polarisation is a profound problem.

It has been observed that "above 2°C of warming, any notion of development rather than merely a process of damage limitation will be lost..." (Mabey, Gulledge, Finel, & Silverthorne, 2011). It is likely that the damage limitation problem and social polarisation will be more extreme if warming exceeds 3C. A loss of the Indian monsoon could precipitate massive instability on the subcontinent, for example, especially if it coincided with the sort of Russian grain embargo seen in 2010 (Trenberth, 2011). In a political environment of instability and uncertainty, international cooperation may well break down, leading to international inertia, political stalemate and an extended, worsening climate crisis.

We can expect that economic and political uncertainty will threaten the stability of democracies, from India to the US. It is notoriously difficult for governments to look outwards, take long term, sustainable decisions that protect future generations and minority interests, and even maintain freedoms, at times of crisis. People under stress turn inwards and reach for simple solutions that offer apparent stability, while trying to protect shorter-term interests and their own narrow community. The Tea Party-influenced trajectory of the US right wing suggests this is beginning to happen today. The recent US election campaign featured Mitt Romney mocking President Obama for even thinking of trying to mitigate climate change.[20] Romney, ironically noting that "President Obama promised to begin to slow the rise of the oceans, and to heal the planet", pledged to "help you and your family". The pitch is to step back from action on climate change, and pander to narrow

[20] http://grist.org/news/romney-uses-the-bully-pulpit-to-mock-climate-change/

self-interest. While the Republicans cry that "The most powerful environmental policy is liberty",[21] it appears that liberty is being reframed as the freedom to ignore climate destabilisation.[22]

Fortunately, there is something of a backlash developing in the US against extreme polarising propaganda. The Heartland Institute in May 2012 ran a very short-lived billboard campaign mocking 'belief' in global warming, associating it with the 'Unabomber', Ted Kaczynski (see Figure 2 below). But the Institute had to cancel the campaign when a number of objecting donors withdrew their funding from the Institute. While the climate deniers in the US have not gone away, they are on the back foot at present, in the wake of hurricane Sandy.

Figure 2: Billboard in Chicago. Photograph: Heartland Institute, courtesy of the Guardian.co.uk,

Nevertheless, history suggests that we must be on the alert for an erosion of democracy in the face of crisis, and a time of burgeoning climate change is not likely to be conducive to rational and

[21] http://grist.org/politics/energy-and-environment-in-the-gop-platform-they-said-what/

[22] A 'Climate Silence' group responded to this 'joke': http://grist.org/politics/the-most-brutal-ad-youll-see-this-election/
It is also worth noting that we have a reasonable picture of what Americans think, thanks to a late 2011/early 2012 poll of over 2000 US adults, conducted by Leiserowitz and colleagues (Leiserowitz, A., Maibach, E., Roser-Renouf, C., & Hmielowski, J. (2012). *Global Warming's Six Americas, March 2012 and Nov. 2011*. New Haven, CT: Yale University and George Mason University.) The poll divided Americans into 6 groups, from the dismissive (10%) to the alarmed (13%). Majorities of the Alarmed, Concerned, Cautious and Disengaged say that humans are capable of reducing global warming, but that it is "unclear at this point" whether humans will "do what's needed." Between 20 and 27% of all the groups except the Dismissive believe that humans could reduce global warming, but "are not going to do so because people aren't willing to change their behaviour." Only 6% or less in each of the six groups felt humans will "successfully reduce global warming" (p.6). While there is hope with those who see outcomes as 'unclear', there is a danger of pessimistic thinking setting in -- we may have a self-fulfilling prophesy effect, as Moser (Moser, S. C. (2010). Communicating climate change: history, challenges, process and future directions. *Wiley Interdisciplinary Reviews: Climate Change, 1*(1), 31-53.) points out. So many Americans are inclined to think that humans will not "do what's needed" about climate change that little may end up being done. This view may be entrenched if Americans selectively focus on China's *growth* in fossil fuel emissions (207% over 1990-2009 v. the USA's 7%) and ignore the USA's much greater carbon footprint per capita – 17 tonnes in 2009 v. China 's 5 tonnes (International Energy Agency. (2011a). *CO2 Emissions from Fuel Combustion*. Paris: IEA.).

progressive ideas and reform. This brings us full circle to the timing issue: the gathering storm leaves little time for complacency if we are to retain a democratic future.

Conclusion

To conclude, I will go back to a simple framing of the climate change problem that motivates this enquiry:

1. In the spirit of scientific honesty, it is vital that the public understands that destabilisation of the world's climate system is accelerating and is likely to soon become irreversible, not just within our lifetimes, but possibly within a decade or so.
2. This is not just an economic issue, although there are important economic and other consequences to climate destabilisation. It is more importantly a political-ethical issue – is it fair to future generations to destroy climate stability, essentially for a temporary extension of our current prosperity?
3. There are solutions available, and they centre on changes to our energy system. They are not expensive, especially compared to the damage that climate destabilisation will cause, but sustained behavioural change is needed.
4. Changes to our energy system will require rapid policy change across a wide range of sectors, but are doable. They cannot be achieved by individual behaviour change alone. They require collective public policy action.
5. Given the gaps in public understanding of the climate threat, a critical part of the political action needed is to increase awareness. But this is not enough. Effective change will require giving careful attention to issue framing, particularly framing solutions in positive terms, explaining the co-benefits of action, and communicating a positive vision effectively. And this will need to take place against a background of progressive climate destabilisation.
6. As the climate change threat grows, the remaining opportunity for democratic decision making about rational climate policy diminishes; this constitutes another critical argument for urgent action.

It has been observed many times that humans are not good at responding to threats that are distant in time and space (Wright, 2005). Many people prefer to ignore early warning signs of climate instability and crisis, thus risking an even more extreme crisis in future (Schendler & Trexler, 2009). This enquiry has attempted to examine what can be done in what has been called the "Time of Useful Consciousness". This aeronautical term means "the time between when one loses oxygen, and when one passes out, the brief time in which some life-saving action is possible."[23] I have suggested some ways in which we can use this brief interlude. I suggest we act very smartly, in both senses of the word.

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[23] I am indebted to my daughter Amy for pointing this out. See http://ndbooks.com/book/time-of-useful-consciousness

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