A Low-Carbon Energy Future:
Breaking the Dependence on Fossil Fuels

White Paper Prepared for the NERI 'Winter Lights' Forum

This paper is written from a personal perspective, and reflects my background as a social researcher and director of CSAFE, an interdisciplinary research centre at Otago University. My own research encompasses social issues related to energy, including co-leadership of the Energy Cultures research programme. In writing this paper I have also been influenced by my attendance at the World Renewable Energy Congress 2011, recent publications, and current affairs. I do not pretend to be an expert in technical aspects of energy – my interest here is rather in presenting an overview of key social, environmental and economic issues which I believe are crucial to any assessment the role of fossil fuels in New Zealand's energy future. I hope they will contribute to debate at the NERI Winter Lights Forum 2011[1].

Executive summary

There is a growing urgency for a major transformation of global energy systems, both to limit greenhouse gas emissions and to achieve greater energy security in the face of resource depletions. Because of the fundamental role of fossil fuels in everyday life, most nations are largely locked into dependence. Some incremental shifts are occurring with new forms of energy and new technologies, but increasingly it is clear that a rapid transformation of entire energy systems is required, including both physical and societal infrastructures. For New Zealand the transition to a low-carbon energy future offers significant opportunities for many businesses, as well as significant environmental and health benefits. Equally it will present difficult challenges to businesses strongly dependent on existing energy systems. The efficacy and cost-effectiveness of carbon capture and storage (CCS), a premise upon which proposals to further develop New Zealand's fossil fuel resources is argued, is as yet unproven. New Zealand may have much to gain by delaying the development of fossil fuel reserves – coal, lignite, oil, gas – for the 10-15 years it will take to determine whether, or not, CCS will become a viable long-term technology with acceptable risks. In the immediate term, New Zealand innovators can contribute globally in developing new energy technologies, but possibly more intriguing is the real potential for New Zealand to make a significant contribution to the world transformation process, by moving rapidly to a system-wide low-carbon economy. Learnings from this process could be globally significant, and many other benefits would accrue, including robust 'clean green' branding spin-offs for New Zealand's products and services.

[1] For more information on the NERI Winter Lights Forum, visit:
www.neri.org.nz/news-and-events/events/winter-lights-2011-neri-thought-leadership-forum/

Urgency

As I write this piece, the news comes through that global carbon emissions reached a record high during 2010[2], and that carbon dioxide levels in the atmosphere have reached a new peak.[3] The chief economist of the International Energy Agency, an organisation respected for its conservative and measured reports, says that staying within a maximum global temperature rise of 2 degrees is now becoming extremely unlikely without "bold, decisive and urgent action, very soon" to significantly reduce emissions resulting from the use of fossil fuels.[4]

To quote Professor Lord Stern of the London School of Economics: "Such warming [beyond 2 degrees] would disrupt the lives and livelihoods of hundreds of millions of people across the planet, leading to widespread mass migration and conflict. That is a risk any sane person would seek to drastically reduce." [5]

By following the "business-as-usual" path we can expect to see an inexorable rise in annual global energy demand, predicted to be 36% by 2030.[6] Ignoring for the moment the climate impacts of energy use, can this extra demand even be met?

Nuclear power is looking less likely as a major contributor to world energy supplies, following the Fukushima disaster. Many countries are reconsidering nuclear power, and some have closed nuclear power plants and halted reactor programs.

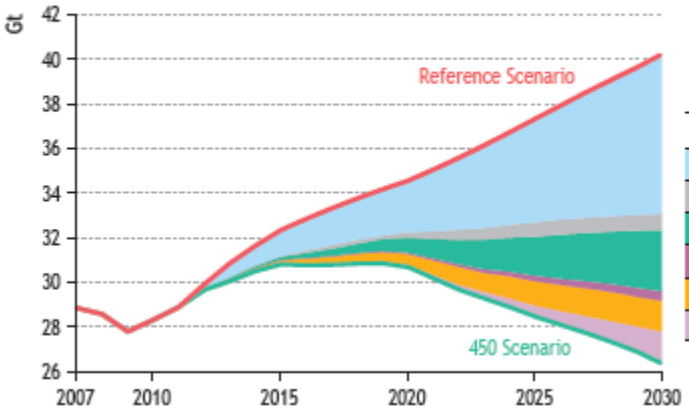
Global crude oil production peaked in 2006[7], and the cost of developing new oil resources, both conventional and unconventional, is likely to continue to rise. This, together with rising demand, will continue to push up oil prices. And ramping up production of fossil-based fuels to achieve BAU will increase carbon emissions to well beyond the 2 degree maxima.

The world is between a rock (catastrophic climate change) and a hard place (energy insecurity).

What are the options? The IEA's graph (Figure 1) shows how energy-related emission reductions could hold the global temperature rise to 2 degrees (the "450 scenario"). Looking at 2020 – only 9 years away – energy efficiency has the major role to play, accounting for 65% of total expected global CO_2 abatement. The rest of the answer lies mainly in renewable energy (18%) and nuclear power (13%). However, the nuclear power prediction is now somewhat unstable given the roll-on effects of Fukushima. The contribution of biofuels and CCS (carbon capture and storage) to the levels of CO2 abatement by 2020 is expected to be negligible, and whilst they do ramp up by 2030, energy efficiency remains the major contributor.

There is little doubt that a low-carbon energy future, involving a shift away from BAU expectations, is the only way to wrangle the globe from between the rock and the hard place.

[2] http://www.guardian.co.uk/environment/2011/may/29/carbon-emissions-nuclearpower
[3] http://www.guardian.co.uk/environment/2011/may/31/carbon-levels-peak
[4] http://www.guardian.co.uk/environment/2011/may/29/carbon-emissions-nuclearpower
[5] http://www.guardian.co.uk/environment/2011/may/29/carbon-emissions-nuclearpower
[6] IEA World Energy Outlook 2009
[7] Fatih Birol, IEA chief economist http://www.abc.net.au/catalyst/stories/3201781.htm



	Abatement (Mt CO_2) 2020	2030
Efficiency	2 517	7 880
End-use	2 284	7 145
Power plants	233	735
Renewables	680	2 741
Biofuels	57	429
Nuclear	493	1 380
CCS	102	1 410

Figure 1. *World energy-related CO_2 emission savings by policy measure in the 450 scenario.* IEA World Energy Outlook 2009, p 211

Path dependency

To achieve a low-carbon energy future in time to avoid catastrophic climate change, the uptake of energy efficiency and renewable energies will need to ramp up at an almost inconceivable rate. This de-carbonisation of the energy system may be "the greatest challenge that mankind has ever faced".[8]

Fossil fuels powered the creation of modern civilisation, and still supply more than 80% of the world's energy supply. Fossil fuel energy is embedded in virtually every food, product, service, and powers most transport and electricity generation. The world is heavily dependent on a fossil fuel infrastructure, which consists not only of the resource and its physical supply chains, but also global market conditions, policies, and business decision-making.

Amongst governments and businesses there is widespread acceptance of the need to shift to a low-carbon future, but achievement is dogged by lack of agreement on the way forward, and lack of commitment to matching actions to targets. It appears that the fundamental (and largely invisible) role of fossil fuels in everyday life has created a path-dependence from which it is almost impossible to steer away. Additionally, decisions are predominantly influenced by a desire for a continuation of business-as-usual. The risky seas ahead require long-term thinking, political commitment, and fundamental changes to the ways in which energy is produced and consumed.

[8] Chairman of the World Renewable Energy Congress, opening speech at the 2011 conference.

Transforming energy systems

Globally, some incremental shifts are occurring with new forms of energy and new technologies, but increasingly it is clear that a rapid transformation of entire energy systems is required, including physical and societal infrastructures.

Economic drivers are producing some shifts in the energy supply mix. The costs of most fossil fuels and nuclear power are rising and look set to continue on this trajectory, and the costs of some renewable energy technologies such as PV and wind are falling and are starting to play a minor but significant role globally in the energy mix. Banks are also becoming risk-averse to investing in carbon-emitting generation[9].

But this rate of change driven purely by relative economics is not enough to achieve climate security. The IEA calls for an 'energy and environmental revolution' which requires an abrupt reversal of present emissions trends (Figure 2).

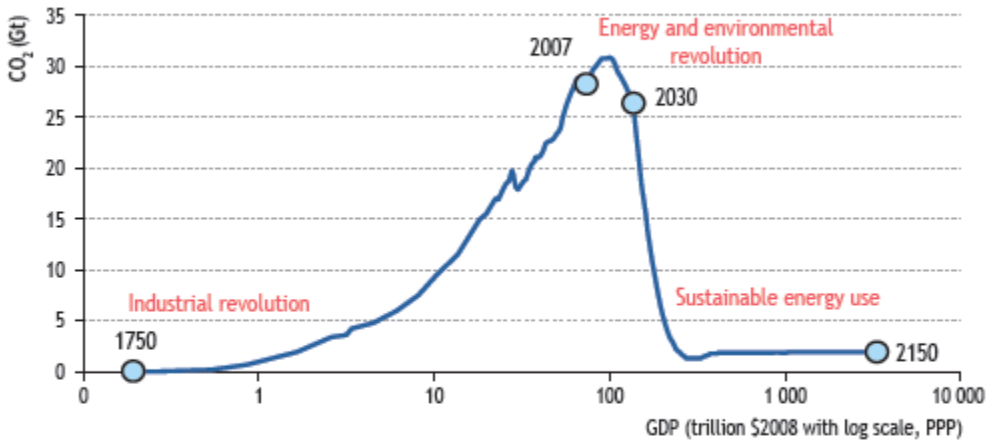
This will involve a rapid decarbonisation of energy systems over the next few years, and a continuation of this trend out to at least 2050, at which point it will presumably be embedded within the world's economic systems.

Importantly, decarbonisation is not just about shifting the balance of energy supplies to more renewable sources. It involves the uptake of new and more efficient technologies in homes and businesses, major changes to transport systems for people and freight, the development of smart grids, distributed generation, alternations to policy and law, adjustments to urban design, and, most fundamentally, changes in the way people think about and use energy in their daily lives.

Making this change happen is not for the faint-hearted, epitomised by the lack of agreement at Copenhagen about who is responsible, who should pay, who should change, and when, and how. There is also a significant gap between the rate of uptake of green energy technologies, and how fast it needs to happen to address climate concerns.[10]

[9] Are the risks of continuing to utilise fossil fuels extending from an environmental argument to a strategic economic one? This certainly seems to be the case in Australia, where a recent report by Deliottes found that no major financial institutions are investing in new coal power projects, beyond some refurbishments. The Australian newspaper The Age has just reported (21 May 2011) that four major banks have rejected funding what was to have been Victoria's first new coal-fired power station in nearly 20 years. Despite the proposed use of new gasification technology that could reduce emissions from the brown coal to a level similar to modern black coal stations, Westpac did not consider it a clean coal project. A Westpac spokesperson explained: "We will continue to consider financing coal projects in the future, but our focus is very much on supporting those projects that use cleaner and more efficient technologies and are making the transition to a carbon-constrained operating environment." (http://www.theage.com.au/national/big-banks-no-to-coal-plant-20110520-1ewxj.html#ixzz1MwzTYExS)

[10] Alan AtKisson, Co-President, The Balaton Group, Speech to World Renewable Energy Congress 9 May 2011



Note: The projected trend approximates that required to achieve long-term stabilisation of the total greenhouse-gas concentration in the atmosphere at 450 ppm CO_2-eq, corresponding to a global average temperature increase of around 2°C. World GDP is assumed to grow at a rate of 2.7% per year after 2030.

Source: IEA databases and analysis.

Figure 2: Historical link between energy-related CO_2 emissions and economic output, and the pathway to achieving a 450 scenario. IEA World Energy Outlook 2009, p 172

Achieving the energy-environment revolution will be made even more challenging by the fact that oil will become increasingly costly to extract, by both economic and environmental measures. The resulting hike in oil prices is likely to have serious implications for the world economy,[11] and may reduce the capacity to achieve the system-wide energy infrastructure changes needed to reduce our exposure to energy insecurity.

Sweden provides a particularly potent example of how systemic change is both possible and positive. Since 1990 they have reduced energy-related carbon emissions by 15% and at the same time achieved 50% economic growth. This has not been spontaneous, but driven by a mix of policy targets, carbon tax, district heating based on renewable energies, an emissions trading scheme applying to the highest emitting industries, and a green certificate trading scheme for encouraging distributed generation. Transport is still a major challenge, but by 2030 Sweden aims to have a fossil-independent transport system using a mix of active transport modes, public transport (already well developed), biofuels and electric vehicles. As well as strong and consistent policies, there is a belief in the leadership role of business and R&D in these transitions. As a result, Sweden is renowned for its cleantech innovations, and there is interest in Swedish products and solutions around the world.

[11] Fatih Birol, chief economist with the International Energy Agency
www.guardian.co.uk/business/2011/feb/22/oil-price-danger-zone-for-world-economy

Risks for New Zealand

In considering the role of fossil fuels in New Zealand's energy future, four key risks are apparent:

Climate Risk. As with all nations, New Zealand faces serious risks from the impacts of climate change. This risk is heightened through our use of fossil fuels. While our total national emissions are minor compared to other nations, our per capita emissions are towards the top end of the global scale.

Energy Security Risk. New Zealand also faces risks of energy security, or more simply put, the impacts of increasing price and/or availability of oil products. Transport is particularly vulnerable: internal freight and personal transport as well as international trade and tourism. More invisible risks lie in the embedded fossil fuel energy in products and services, and the impact of price rises on these.

Path-dependency risk. This is the risk being locked into dependence on fossil fuels and their associated infrastructures, with insufficient flexibility to easily adopt other energy forms in the face of volatile fossil fuel prices.

Image Risk. The vulnerability of New Zealand's 'clean green' global image – of immeasurable economic value to the agricultural and tourism sectors – is a further risk. This could be at risk if, for example, New Zealand were to invest heavily in the prospecting and development of fossil reserves, or fail to play its part in reducing greenhouse gas emissions.

If GHG emissions were not problematic, a partial answer to the *Energy Security Risk* could be addressed by developing New Zealand's own fossil reserves, albeit that this would bring with it a swathe of other questions relating to environmental quality. But this would only be able to address the risk if CCS were viable, reliable and cost-effective. Even so, it would invoke the *Image Risk*, because of the increased local and global concern about other environmental impacts of fossil energy developments.

Accepting that GHG emissions from fossil fuel use are increasingly problematic, CCS has been put forward by the energy industry as a way of addressing both the *Climate* and *Energy Security* risks simultaneously. Proponents suggest that this will enable the continued development of fossil fuel resources. But is CCS a technological and commercial reality? Or is it a dangerous distraction that will weaken or delay achievement of a low-carbon energy system?

It may be the latter. The editorial of a just-released special issue on CCS from the academic journal Global Environment Change concludes: "*Despite evoking considerable enthusiasm in some quarters, the potential for widespread implementation of CCS remains unclear. Technological and economic uncertainties about CCS have combined with a weak or nonexistent set of policy incentives to create a wide gap between early expectations and actual progress towards demonstration and*

commercialisation".[12] In a similar vein, the IEA suggest that CCS is unlikely to have any significant roll-out until the latter half of the 2020s, and even then will only play a minor role in greenhouse gas abatement compared with energy efficiency and renewables. [13]

The efficacy and cost-effectiveness of CCS, a premise upon which proposals to develop New Zealand's fossil fuel resources is based, is thus as yet unproven. On this basis, it seems premature for New Zealand business and government to seek development of further coal, oil and gas deposits. All four of the outlined risks would be heightened.

New Zealand may have much to gain by delaying the development of fossil fuel reserves – coal, lignite, oil, gas – for the 10-15 years it will take to determine whether, or not, CCS will become a viable long-term technology with acceptable risks.

New Zealand as an innovator in systemic change

What would an energy future look like that addressed all four risks simultaneously? And what could the role of fossil fuels be in that future?

New Zealand's advantageous starting-point is that we are far less dependent on fossil fuels for electricity and heating than most other developed nations. Around 70-75% of our electricity is from renewable sources, and most heating is from electricity, geothermal or biomass, so we have minimal lock-in to fossil fuels in these areas. The presence of these renewable electricity schemes contributes to our ability to claim 'clean green' status.

Yet New Zealand can't afford to rest on its laurels. Twenty-seven percent of our electricity was generated from gas or coal in 2009[14]. Consumer energy use per capita has steadily risen by around 1.36% a year for several decades.[15] Energy-related GHG emissions have risen significantly since 1990, with the use of transport fuels the largest contributor and inexorably rising (Figure 3). These trends exacerbate all four risks.

[12] K. Bäckstrand, J. Meadowcroft, M. Oppenheimer (2011) Editorial: The politics and policy of carbon capture and storage: Framing an emergent technology. *Global Environmental Change* 21(2): 275-281, page 279.
[13] IEA World Energy Outlook 2009
[14] MED 2010 New Zealand Energy Data File, p. 103
[15] Emeritus Professor Gerry Carrington, pers. comm..

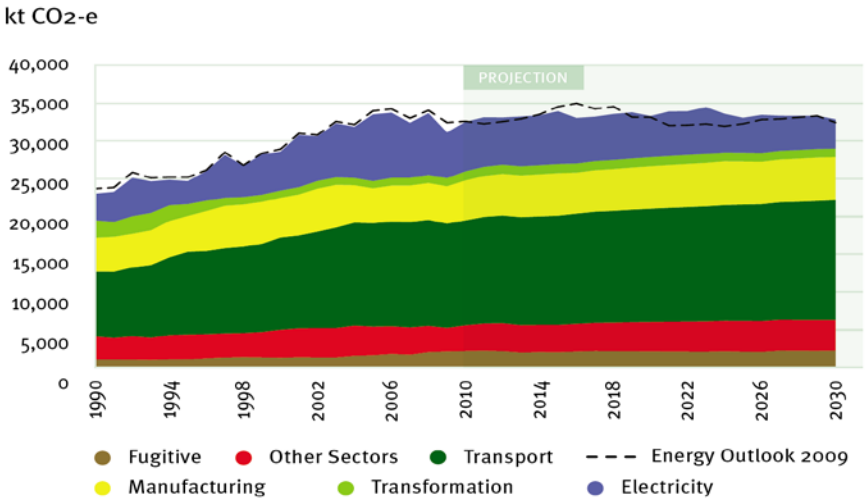


Figure 3: New Zealand Energy Sector Greenhouse Gas emissions.
MED (2011) *NZ Energy Outlook 2010.*

My personal vision is for New Zealand to be at the forefront of **system-wide** change to a low-carbon future. This involves reducing dependence on fossil fuels in all aspects of the economy and society.

To change a system as deeply embedded as the fossil fuel infrastructure requires far more than the appearance on the market of new energy-efficient technologies and renewable energy supplies. The scale and complexity of the change is almost incomprehensible within the short time-frames for action suggested by the IEA and IPCC, which are increasingly acknowledged at national and global political levels.

A systemic change of this *scale* is possibly unprecedented apart from the industrial revolution some 200 years ago. A systemic change of this *rate* is unprecedented in recent times, apart from the rapid growth of the world wide web over the past 15 years. The change is possible, but only if all parts of the system are reconfigured to align with a low-carbon future. This is New Zealand's challenge.

Elements of this reconfiguration include the widespread **adoption** of new technologies by households and businesses; widespread uptake of new forms of energy (or existing forms of energy in new ways); distributed generation; different investment patterns and priorities; smart grids; changes to law and policy; modifications to urban form; construction of new or differently configured physical infrastructure; changes to everyday practices in business and home life; and underlying all of this, a shift in the way people think about energy in their everyday lives.

This reconfiguration is dependent on a long-term political commitment, the right market and policy settings, and inclusion of the public in the significant discussions that must be part of such a major systemic shift. Investment is needed right now while we have a relatively buoyant economy, before oil price instability and the impacts of global warming start to affect global economies adversely[16].

[16] Nicholas Stern (2006) Stern Review on the Economics of Climate Change. HM Treasury, London.

In this vision, fossil fuels will continue to be part of the economy, but used in an increasingly parsimonious way, recognised as a necessary but temporary spanning of the shift to a low-carbon future. If, and when, CCS becomes a mature and reliable set of technologies, it may form part of the 'bridge', but must not be allowed to deflect attention from a concerted and system-wide effort to develop a new infrastructure that supports low-carbon energy in every facet of the New Zealand economy, including the transport system.

New Zealand is enviably placed to take advantage of the opportunities that are always the counterpart to risk. We have the resources, the skilled workforce and the nimbleness to shift the way we do things, as evident in many business sectors. While we are unlikely to lead in the development of renewable energy technologies (apart from niche areas) we have the potential to be world-leading in showing how renewable energy, energy efficiency, demand side technologies, smart grids and people can work together to achieve the 'energy-environment revolution'

Sir Paul Callaghan, outlining his vision for New Zealand's future as a knowledge-based economy, criticised short-term thinking which supports resource exploitation over high-value industries, and argued that a robust attention to environmental quality (as opposed to 'phoney clean and green rhetoric') would not only be hugely beneficial to New Zealand's economy, but also create the kind of society in which highly skilled people will want to live.[17] I support this vision.

The transition to a low-carbon energy future offers significant opportunities for businesses, as well as significant environmental and health benefits. In the immediate term, New Zealand innovators can contribute globally in developing new energy technologies, but possibly more intriguing is the real potential for New Zealand to make a significant contribution to the world transformation process, by moving rapidly to a system-wide low-carbon economy. Learnings from this process could be globally significant, and many other benefits would accrue including robust 'clean green' branding spin-offs for New Zealand's products and services.

I can't finish without a plug for research. At a time of risk, innovation is crucial. The energy-environment revolution is unlikely to have favourable outcomes without investment in R&D. Technology-focused research will be crucial, but equally important will be social science and interdisciplinary research to help understand the complex interactions between people, energy, their technologies and the environment, and help reshape these for a low-carbon future.

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My sincere thanks to Gerry Carrington, Rebecca Ford and Maria Ioannou for their helpful comments on earlier drafts of this paper.

[17] Otago Daily Times 25 May 2011

The National Energy Research Institute (NERI)

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