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Why New Zealand must rapidly halve its greenhouse gas emissions

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Abstract

New Zealand must commit to substantial decreases in its greenhouse gas emissions, to avoid the worst impacts of climate change on human health, both here and internationally.

We have the fourth highest per capita greenhouse gas emissions in the developed world. Based on the need to limit warming to 2°C by 2100, our cumulative emissions, and our capability to mitigate, New Zealand should at least halve its greenhouse gas emissions by 2020 (i.e. a target of at least 40% less than 1990 levels). This target has a strong scientific basis, and if anything may be too lenient; reducing the risk of catastrophic climate change may require deeper cuts.

Short-term economic costs of mitigation have been widely overstated in public debate. They must also be balanced by the far greater costs caused by inertia and the substantial health and social benefits that can be achieved by a low emissions society.

Large emissions reductions are achievable if we mobilise New Zealand society and let technology follow the signal of a responsible target.

The New Zealand Government has announced a 2020 greenhouse gas emission target of 10–20% below 1990 levels,[1] leading into international climate change negotiations culminating in Copenhagen on 7-18 December.[2,3] This target range has strict conditions attached and, unlike many developed nations, New Zealand has not offered an alternative emissions target if these conditions are not met.[4,5]

We consider New Zealand needs to do much more to adequately respond to the climate change threat. We summarise why health professionals should care about this problem, and why it is our duty (to our patients and the wider public health) to act now, before it is too late.

Why health professionals?

Climate change has been described as the biggest global health threat of the 21st Century.[6,7] Doctors have a professional duty to work to tackle it,[8,9] and health benefits should be fully included in decision-making,[10-12] as should the harms of inaction.

A recent high profile[13,14] review in *The Lancet*[6] noted major threats—both direct and indirect—to global health from climate change. These effects occur through water and food insecurity, threats to shelter and human settlements, population displacement and migration, extreme climatic events, changing patterns of disease,[6,15,16] risks to security (e.g. war), and loss of economic potential.

Direct threats to health are powerful motivators for action—often more powerful than discussions about distant threats to rainfall, ocean currents, and fish stocks. Hence those who manage health effects, such as health professionals, are in a strong position to advocate responses to this global threat, for three reasons.

First of all, health professionals are citizens. Secondly, they are privileged by their education, access to power, and a professionally compassionate role in society. Thirdly, they have the ability to assimilate complex evidence and a role in advocacy for health, making them potential leaders.

Sir Muir Gray in The Times has compared climate change to cholera in 19th Century England as needing an all-encompassing response, saying the medical profession must be in the vanguard of this new revolution in public health for "the health threat that will come to define our age."[14] We have ethical obligations and professional duties to use our best efforts to mitigate climate change in whatever way we can.[17–20]

Impact and equity: by how much should we reduce?

The latest Intergovernmental Panel on Climate Change (IPCC) assessment from 2007[21] reports that a reduction of at least 25–40% of 1990 greenhouse gas emissions levels by 2020 (leading to 80–95% by 2050)[22] is required by the developed world to be confident that the world will avoid 2°C warming. This level of warming was proposed by the IPCC as the climate change 'guard rail'; beyond 2°C the risks of tipping points with dangerous (and potentially unstoppable) climate change increase steeply.[21,23,24]

According to Sir Peter Gluckman, the Prime Minister's Chief Science Advisor,[26] we risk the consequences of a changing global climate becoming another 'tragedy of the commons'[25]—where if collective action is not taken then everyone will suffer.[26] The German Advisory Council on Climate Change (WBGU) has commented that relaxing the trajectory of one country results in other countries picking up the bill, as "there is no carbon offset for Planet Earth as such" (see endnote *).[16]

New Zealand has the fourth highest per capita greenhouse gas emissions in the developed world[27] and one of the biggest increases in gross emissions since 1990 (see endnote †).[28] Calls for a 40% reduction target on 1990 levels by 2020[29] for New Zealand, as with the developed world overall, have been based on climate science (the upper end of the 2007 IPCC 25–40% range for developed countries)[22,24,33] and equity.[30]

Approaches to determining countries' individual emissions targets are described internationally,[16,31–37] often based on defined global emissions budgets (the global amount of tolerable emissions over a period of time) after which the available emission rights can be divided among countries according to different rules (see endnote ‡).[16,32,37]

The 40% reduction target for New Zealand is based on the Responsibility and Capability Index (RCI) approach, instigated in Europe,[32] and which has been adapted by Oxfam International.[34] This explicit, principle-based framework is one of many that incorporates both science and fairness—how much countries have emitted already, and what they can afford; the RCI combines (1) the emission reductions needed globally to limit warming to 2°C with (2) countries' responsibilities (i.e. their cumulative emissions) and (3) their capability to mitigate (using wealth as a proxy for the capability for action) (see following table and later endnotes §, **, and ††).

In Table 1, New Zealand's RCI is 0.34% of UNFCCC Annex I (§) countries' overall target, and is ranked fourth for total greenhouse gas emissions per capita, requiring in fairness a 40.6% reduction by 2020 on 1990 levels (with 40.0% for Annex I countries overall).

Table 1. Mitigation targets—Oxfam International calculations (2009):[34] Fair shares of overall Annex I(§) mitigation target (40% below 1990 levels by 2020)

	1	2		3		4		5	
	RCI (fair share of Annex I target)	Emissions per capita (2005)		2020 mitigation targets, expressed as: Reduction per capita, relative to 2005 levels		Reduction below 1990 level (CO_2e excl. LUC)		Reduction below 2005 level (CO_2e excl. LUC)	
	%	tCO2e	Rank	tCO2e	Rank	%	Rank	%	Rank
Australia	2.29	25.9	1	13.4	1	39.7	9	51.6	8
Belarus	0.34	7.7	13	-2.7	15	19.7	16	-35.4	16
Bulgaria	0.31	9.0	10	-3.0	16	19.8	15	-33.6	15
Canada	3.51	23.4	3	12.8	3	43.0	7	54.7	4
Croatia	0.15	6.9	16	2.3	11	35.9	10	33.6	11
EU *	33.93	10.6	9	4.2	10	44.4	6	39.6	10
Iceland	0.03	14.2	6	7.6	6	48.9	4	53.8	5
Japan	9.71	10.6	8	6.3	7	56.2	3	59.0	3
Liechtenstein	0.00	8.6	12	4.4	9	27.1	11	51.4	9
Monaco	0.00	3.1	17	0.7	12	21.2	13	21.2	12
New Zealand	0.34	18.7	4	9.8	4	40.6		52.3	7
Norway	0.48	11.7	7	8.6	5	71.4	2	73.7	2
Romania	0.72	7.1	15	-1.9	14	21.4	12	-27.1	14
Russian Federation	8.21	14.9	5	-1.8	13	20.2	14	-12.0	13
Switzerland	0.59	7.2	14	6.0	8	82.3	1	82.6	1
Ukraine	1.67	8.8	11	-8.3	17	13.3	17	-94.3	17
USA	37.80	24.5	2	12.8	2	44.6	5	52.4	6
Total: Annex 1	**100.00**	**14.2**		**5.46**		**40.0**		**38.4**	

Metrics: fair share of emissions reductions for each Annex I country (endnote §), calculated using both countries' partial history of past emissions (cumulative emissions for 1990–200538 for responsibility, see endnote **), and their current levels of income (total income above a 'development threshold' for capability, endnote ††).

Key: *Column 1* shows fair shares of any aggregate Annex I mitigation target for individual Annex I countries, based on a responsibility-capability index (RCI);
New Zealand's RCI is 0.34% (its fair share of the Annex I target).
Column 2 is per capita emissions in greenhouse gases (GHG) in 2005;

New Zealanders emitted on average 18.7 tonnes CO2-equivalent GHGs for each person that year, ranking it fourth highest.
Column 3 is 2020 emissions-reductions targets for individual Annex I countries (based on respective fair shares of the total combined minimum reductions target of 40% below 1990 levels for Annex I as a whole), presented in terms of per capita reductions relative to 2005 levels;
New Zealand's target is a 9.8 tonne CO2-equivalent reduction for each person by 2020 compared with 2005.
Column 4 is total reductions relative to each country's 1990 emissions;
New Zealand's target is a 40.6% reduction in CO2-equivalents for each person by 2020 compared with 1990. This ranks eighth out of the 17 countries listed in terms of percentage emission reductions necessary.
Column 5 is total reductions relative to each country's 2005 emissions;
New Zealand's reduction by 2020 therefore translates to 52.3% compared with 2005 (ranked seventh).
LUC is Land Use Change.

Source: Table 4 of Oxfam International 2009[34] http://www.oxfam.org/en/policy/fair-climate-deal-copenhagen pages 10-11,28,30-31. Reproduced with permission of Oxfam New Zealand.

In terms of gross emissions, a 40% reduction below 1990 levels for New Zealand means halving our current emissions (51%) (see endnote †). Our previous inaction[39] (since 1990) has led to this scale of emissions and the need to reduce them so substantially—we cannot afford to delay again.

Future adaptation to catastrophic climate change will be much *less* achievable and affordable. Furthermore, transferring these costs and consequences to future generations would be irresponsible.[26]

Using the latest assessments, even halving New Zealand's current emissions may be insufficient. The latest IPCC assessment is now more than 2 years old, and the science in this area is fast-moving.[33] According to more recent reviews[16,24,33,40–43] (including the UN Environment Programme's 2009 compendium on climate change science[43]), climate change is proceeding at or beyond the upper projections of the 2007 IPCC assessment, with the chair of the IPCC recently quoted as saying "things are going to get substantially worse than what we had anticipated."[44]

A synthesis released in March 2009[24] concluded that atmospheric CO_2 concentrations are already at levels predicted to lead to global warming of 2.0–2.4°C, and to meet the targets proposed by the IPCC, global emissions need to reduce by 60–80% immediately.[24] Calls are mounting for more stringent levels of atmospheric greenhouse gases at 350 parts per million (ppm) CO_2 or CO_2-equivalents or even less[33,40–42,44-46] (CO_2 levels are currently 387.81 ppm CO_2[47]; the current CO_2-equivalent level will be higher[48]).

Action is necessary, but too expensive?

Comprehensive international analyses such as the United Kingdom (UK)'s 2007 Stern review[49] and Australia's Garnaut review[50] point to probable economic *gains* by moving quickly on emissions reductions. Conversely they indicate the greater economic damage long-term from inaction.

To protect New Zealand's economy, including its agricultural advantage, we need to move quickly to reduce emissions.[51]

As described by Lord Stern, the costs of taking action to stabilise the climate will be high but much less than the costs of inaction.[49] Recent analysis suggests that past important costings of adapting to climate change, used to drive global policy, have been at least 2–3 times too low.[52] Delay will be dangerous, and action is needed now.[49] The Stern review also exposed the economic cause of climate change: market failure on the greatest scale the world has ever seen.[49] In short, we have had too cheap a ride.[16]

The World Bank, which in the past has tended to down-play the seriousness of long-term environmental risks, warns that even the current international financial crisis is no justification for inertia over climate change; "while financial crises may cause serious hardship and reduce growth over the short- to medium-term, … the threat of a warming climate is far more severe and long-lasting."[53]

At the time New Zealand's conditional 10–20% target was announced, much publicity had been given to the NZIER/Infometrics report to Government.[54] This report was used by the Government to help decide on the target. However, its macroeconomic modelling approach had been criticised as being the wrong tool for the job and a poor basis for major public policy.[55,56]

The report's key flaws included:

- *Ignoring the effects of climate change itself*. The business-as-usual modelling looked only at the cost to New Zealand of reducing emissions; it completely overlooked the greater costs (including health impacts) of climate change if we fail to reduce emissions in time.[55] For the world as a whole, and most individual countries, the long-term future costs of catastrophic climate change greatly exceed the costs of reducing greenhouse gas emissions to avoid this.[49,50]

- *Using the wrong baseline*. The report ignored New Zealand's established legal commitment under the Kyoto protocol[57] to meet its net emissions target—when it is highly unlikely New Zealand would renege on this commitment. Recalibrating the NZIER/Infometrics results to exclude these sunk costs gives positive improvements in the economy under many assumptions—e.g. pushing technical change in agriculture/land use (see endnote §§) would yield significant gains in emission reductions at low cost.[56,58]

- *Assuming no advances in technology or changes in behaviour despite market signals*. Yet the whole purpose of placing a real price on emissions is to stimulate technological change and influence consumer behaviour, making this assumption implausible.

- *Assuming that New Zealand is an expensive place to reduce emissions*. On the contrary, many agricultural emissions will be cheap to abate, and some will actually profit farmers[58] (see endnote §§). We have abundant renewable energy sources yet can still make substantial gains (endnote ***);[59] forestry has economic potential as a carbon sink (§§). So the 40% target may well be easier to meet in New Zealand than many OECD countries.[51]

- *Ignoring possible international sanctions*. The report did not count the potential economic consequences for exports and tourism of New Zealand appearing inactive and failing to do its fair share.[26]

In essence, the NZIER/Infometrics report was a partial analysis that greatly overestimated abatement costs and ignored the profoundly changing world around us.[55] Compared with unabated climate change, perceived economic 'hardship' is a luxury problem.[37]

Less publicised was the report's conclusion that, if the rest of the world moves to similar regimes, then economic effects on New Zealand may be minimised.[54] A responsible target by New Zealand[26] will help that move.

Such econometric projections inherently cannot and do not indicate the feasibility or engineering involved in reducing our dependence on fossil carbon. However, any lack of current technology (not itself a given—see below) is no reason for inaction, and for the technology to advance needs an acceptance of the reality and urgency of climate collapse.[24,33,60,61]

We must not confine our target setting to what current technology we think is cost-effective; rather, setting the necessary targets can spur the development of the changes we need. Recall the turnaround of US industry in 1942–43 to meet military needs, where President Roosevelt set production targets (for tanks, for example) based on need, not existing capacity.

NZIER/Infometics reported that a 15% emissions reduction target would mean average disposable incomes in 2020 will increase from $38,500 currently to $47,650, rather than $49,000.[62] Thus, if we cut emissions 15%, by 2020 people would still be much richer than today; just marginally less rich than if we took no action. And even this estimated projected shortfall, of about $1500, is overstated, for the reasons stated earlier.[56]

We think discussion of this issue can and should be more balanced.[26] During public consultation, figures of $3200 per capita income loss and doubling of energy costs[63] were widely quoted. These figures were alarmist, selectively reporting only the most extreme of scenarios analysed (a very high carbon price of $500/Ct), and came from work funded by specific interest groups[63] rather than any of the formal advice to Government.[54] Such soundbites should be tempered with health warnings.[56]

The World Bank says that a climate-smart world is within reach if we work together now to overcome inertia; the costs for getting there will be high but still manageable. "There are real opportunities to shape our climate future for an inclusive and sustainable globalisation, but we need a new momentum for concerted action on climate issues before it is too late."[53]

Action is affordable, but not our responsibility?

The Kyoto Protocol concentrates on countries' recent emissions alone. This downplays the importance of historic emissions—their cumulative emissions over time. In this respect, per capita, New Zealand has made disproportionately large historic contributions to the atmospheric greenhouse gas load.[51]

Developing countries are disproportionately affected by climate change.[6,53] As the World Bank notes, this is a crisis that is not of their making and for which they are the least prepared.[53]

While the Oxfam International RCI calculations, described above, allocate equitable shares across Annex I countries, they do not say that a 40% reduction below 1990 levels by 2020 equates to rich countries' full capabilities and overall responsibilities to the world. Indeed, there are good reasons to think that the fair share of Annex I countries involves much more.[16]

Applying measures of responsibility and capability globally, the Greenhouse Development Rights (GDR) framework[32] has assigned more than three-quarters of the total required global effort to developed countries in 2010. Assuming a 2°C pathway, this means significantly stronger obligations[34] for developed countries than the above IPCC 25–40% range for rich-country reductions by 2020.[22]

According to Lord Stern[64] and others[16] there are powerful equity arguments for rich countries paying for all actual greenhouse gases emitted. Viewed from this perspective, even a 40% target for New Zealand may be too weak. We may not want to pay more than we should, but we must still pay our fair share.[65]

A fair deal[32,34] means both keeping global warming as far below a 2°C increase as possible and delivering sufficient resources, so that poor people—who will bear the brunt[6,34,53]—can avoid the worst impacts of already inevitable[26] climate change. The World Bank notes that the poorest and most exposed countries in particular will need help in adapting to the changing climate.[53]

Fairness also dictates that those countries most responsible for past emissions and most able to help, take a lead to cut emissions first and fastest. The World Bank states that advanced countries, which have produced most of the greenhouse gas emissions of the past, must act now, cutting their emissions aggressively.[53] Oxfam International agrees that a fair and adequate global climate regime will require a massive effort across the board to reduce the risks to lives and livelihoods that poor people face first and most.[34]

Although deep emissions reductions in rich countries are critical, Oxfam and the World Bank also say that climate security will now be won or lost depending on cooperative efforts, where rich countries finance large-scale reductions in emissions in developing countries.[34,53] According to the new analysis for WWF International,[37] by 2050 developed nations as a group need to reduce emissions by up to 157% of 1990 levels (GDR methodology); given they cannot cut domestic emissions by more than 100%, developed nations will have to finance substantial emissions reductions in other countries to keep within their share of the global carbon budget (‡).[37]

The World Bank is calling for all countries to act now and act together, saying that no one nation can take on the interconnected challenges posed by climate change;[53] global cooperation is needed.[16,53]

As the Prime Minister's Chief Science Advisor has stated, "This is a global challenge, and a country like ours that aspires to be respected as a leading innovative nation cannot afford to appear to be not fully involved. Indeed, such a perception would compromise our reputation and potential markets."[26]

Neither should we underestimate our country's ability to lead the world on important issues of justice and security. New Zealand has wielded genuine influence on matters such as extending the vote, community child health, abolishing nuclear weapons, and settling colonial grievances. It is our generation's responsibility to now rekindle this influence and lead on the matter of climate change.

Health benefits of action?

The threat of impending climate catastrophe demands urgent and drastic action in its own right.[66] However, "mitigating climate change also presents unrivalled opportunities to improve public health,"[67] especially if we can align climate change, health, and equity goals.[68–71]

Policies to reduce greenhouse gas emissions could also bring about substantial reductions in heart disease, cancer, obesity, diabetes, road deaths and injuries, and air pollution.[67] Such health co-benefits arise because climate-change policies necessarily impact on some of the most important determinants of health, especially energy intake (nutrition) and expenditure (physical movement).[67]

Particular health benefits should include:

- A low carbon transport system that involves more walking, cycling, or using public transport will reduce road traffic crashes, pedestrian and cyclist deaths, urban air pollution, and the impacts of obesity and cardiovascular disease (see endnote ‡‡).[72,73]
- A low fossil-fuel society necessarily means reducing animal-based foods in our diets.[74] Moderation of the use of animal products will—by reducing the amount of saturated fat and meat in the diet—reduce the incidence of cardiovascular disease and bowel cancer,[75] and similarly with carbon-intensive fats and refined sugars for the obesity pandemic.[76]
- Reduced rates of overweight and obesity, as well as obvious health improvements, will also reduce the climate change impacts of extra fuel consumption needed for transporting extra weight and contributing extra food consumption and waste.[77,78] Food itself has important implications for climate change through production, distribution, quantity, composition, and waste.[78,79]
- Improvements in the efficiency of residential energy use could reduce mortality and morbidity from the extremes of heat and cold and reduce the vulnerability of the poor to fluctuations in the price of energy.[80–82]

To give just one example, research in Auckland estimates that shifting 5% of short urban trips by private motor vehicle to bicycles would save each year about 22 million litres of fuel and 0.4% of transport-related greenhouse emissions. The health effects would include 116 deaths avoided annually as a result of increased physical activity, and nominal economic savings of approximately $193 million per year.[83]

These important health co-benefits will dramatically reduce the cost to society from taking strong action to mitigate climate change, and thus failure to count these benefits could have serious consequences.[67] Health professionals have a particular responsibility to ensure that the health benefits of environmental policies are understood by the public and by policymakers.[67]

Our problem, but not achievable?

The potential for runaway climate collapse transcends the public health benefits from such changes as increased exercise, reduced pollution, and improved community engagement. Mitigation alone will need profound reengineering of New Zealand's structure and function.[84]

We need to prioritise mitigation efforts according to effectiveness and cost effectiveness (the ability of each action/technology to effect overall emission reductions versus its cost), and negotiate tradeoffs.[26] The science and fairness simply indicate the extent we need to responsibly reduce our emissions quickly, but do not say how to do this.[26]

However, mitigation ideas are detailed in the 4th IPCC mitigation report,[21] country-specific marginal abatement cost curves,[85–89] and elsewhere.[33,84,90,91] This is apart from known things we can do now in agriculture that should actually profit farmers and protect our key export earning sector (endnote §§).[51,58] Much of this conceptual work has already been done for Australia,[86,92–94] and to a limited extent in New Zealand.[51,84,87–90,95]

Aside from economic instruments,[16,35,36,51,91,96] which are necessary but insufficient in themselves,[97] investment in education and social networking (e.g. transition towns, http://www.transitiontowns.org.nz/) to promote carbon reduction may prove cost-effective. Mitigation technology and ideas will advance with the right signals/environment, including responsible targets. We must not underestimate the technology that already exists[51,58] but simply lacks planning, prioritisation, and implementing.

Agriculture is a significant source of diverse emissions—half of our greenhouse gas emissions[2,98]—with separate causes requiring diverse solutions.[89,99,127] It is incorrect to clump these emissions together.[2] Agriculture is clearly a big part of the problem, and reforming land use could be a big part of the solution. Endnote §§ lists a number of possibilities for Agriculture, as does endnote *** for Energy.

We also need to manage population growth,[100–103] projected to increase 9.9% by 2020 for New Zealand,[104] which will significantly increase the emissions reductions needed (see endnote †††). Our population growth rate is high compared with other OECD countries—mainly from natural increase rather than migration.[105,106] The long-term effects of sub-replacement fertility will not accrue until the mid 2040s, and will be countered by a likely increase in immigration, including climate refugees from the Pacific. Education, employment, and social policies that accelerate our transition to low natural population growth will be a necessary part of any mitigation strategies.

We can design our mitigation policies to improve (rather than reduce) the quality of life of low-income families, and ensure that any financial costs are carried by those who can most afford it.[30] Whether we end up with a genuine Emissions Trading Scheme (ETS) or in effect a carbon tax (see endnote ‡‡‡),[51,96,107,108] policies should be progressive (particularly central government revenue recycling) to protect the wellbeing of low-income households (endnote §§§).

How will we get there?

Since political inaction has delayed progress for so long, action on both national and global scales is now extremely urgent.[33] The next 6 years to 2015, by which time global emissions must peak,[24] will be critical to keeping within the global carbon budget (‡).[16,32,37] Delaying reductions by even only 5 years could have significant consequences. For example, starting absolute global emission reductions around the year 2015 would require annual reductions of 5% (large decreases), but delay to 2020 would require 8–9% reductions (huge decreases, see endnote ****).[16,37]

Addressing climate change is one of the biggest public policy challenges of our time—complex, urgent, and having serious implications for the economy.[65] We need a policy mix that will work effectively and equitably across all sectors and shift the economy to a low-carbon one.[65]

Large-scale acceptance of emission targets by the public is a political necessity.[26] But much of the debate has focussed on potential difficulties with meeting the targets. A more positive and empowering approach would recognise the wealth of innovation and knowledge within the New Zealand population, along with an ability to adapt and get on with it.

There is a large body of indigenous knowledge that has enabled Māori to develop sustainably in Aotearoa for centuries, with significant potential to contribute to national action on climate change. *Tangata whenua* have also adapted to a variety of environmental challenges and worked collectively to develop innovative solutions to social problems.

New Zealand has a proud history of adapting, a ‘can-do’ approach, and working together to counter peril, for example the sacrifices made across society in the world wars. Climate change is the new challenge, calling on this capacity for action and innovation, to again save lives.

Intensified efforts to ensure buy-in of the public are crucial.[33] Greater public awareness is needed of the urgency of climate change and the broad consequences of inaction, which goes beyond just direct immediate economic costs. It is easier to make changes, or accept mitigation effects, if you are convinced of the impact and urgency of the situation. New Zealanders will do what is right if they know it is needed.

In the United Kingdom, the 10:10 campaign[109–111]—where individuals, businesses and organisations commit to cut their carbon emissions by 10% in 2010[33]—shows how people and groups can take action immediately. People are measuring their own emissions and committing to real reductions over a year (not the 11 years for New Zealand[1]). Numerous individuals and organisations have already signed up for 10:10, including the entire British Cabinet,[112] parts of the National Health Service,[113] and Local Authorities. Such small but immediate targets can be meaningful,[111] are achievable with small steps, and are less daunting than long-term targets that are less tangible and more difficult to engage with.

As in the UK,[114,115] difficult choices may need to be made across all sectors of society, the economy, and government to reduce New Zealand’s emissions.[84,88,116,117] Approaches will need to be both top-down and bottom-up.[84,117] Mitigation will inevitably change lifestyle choices.[117] However, many people are changing their

attitudes, actions, and choices already—with sometimes unexpected benefits. With leadership, others too may be willing to make those changes once they know the consequences of inaction and the possibilities for action.

The challenge for New Zealand, health professionals included, is to mobilise society.[33] We need to generate even more social resilience to respond effectively to the emerging realities of climate change.

Such mobilisation for large-scale change across human and natural systems has a strong theoretical and empirical basis;[118–121] engaging the public towards a greater sense of belonging and working to make a difference,[16] wider sustainable views of the economy[117,122–125] with comprehensive not partial economic analyses,[56] and a community of interest with affiliation, goals, norms, and using intrinsic rewards.[33,117,124]

Health professionals cannot be inactive observers of this process. We have a significant role and responsibility to lead this challenge—and we must be involved wherever possible.

We have overspent our atmospheric resources[16,126]—and now need smart sustainable solutions.[33,117] The pace of climate change is accelerating.[16,24,33,40–43] Halving the current level of emissions is urgent, responsible, just, and possible.

Inaction would be negligence and malpractice on a global scale.

What health professionals can do now

Political

- Lobby for an urgent effective all-sectors all-gases Emissions Trading Scheme with an uncapped market price on our emissions. Submissions close **Tuesday 13 October 2009**. www.parliament.nz/en-NZ/PB/SC/MakeSub/a/d/f/49SCFE_SCF_00DBHOH_BILL9597_1-Climate-Change-Response-Moderated-Emissions.htm
- Join the international day of 350 action on **Saturday 24 October** www.350.org.nz, and the global day of action on **Saturday 12 December** www.globalclimatecampaign.org
- Support the 40% emissions target. Sign on at www.signon.org.nz and www.oxfam.org.nz. Spread the word with your address book.
- Lobby widely for other emissions reduction measures by central government.
- Monitor and promote local government initiatives to rapidly reduce emissions at www.sustainablecities.org.nz
- Join a group—us at www.nzchg.webs.com/ or any other climate action group.
- Take the Climate and Health Council pledge at http://www.climateandhealth.org/pledge/

Professional

- Educate and encourage patients and colleagues in climate change action

- Write letters for eligible patients to get subsidised home insulation www.energywise.govt.nz/funding-available/insulation-and-clean-heating
- Make Green Prescriptions (www.greenprescription.org.nz) truly green—advise the health AND climate benefits of increasing transport-related physical activity and eating less meat
- Reduce your workplace footprint—see www.1010uk.org/business

Personal

- Be informed; start with www.tcktcktck.org, http://en.cop15.dk, and watch 'The Age of Stupid' film
- Live smart and healthy—measure and reduce your own household footprint www.sustainability.govt.nz/content/25-easy-steps-towards-sustainability. Start with 10% less in 2010—see www.1010uk.org

For more ideas, come to www.nzchg.webs.com/

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Endnotes:

* According to the German Advisory Council on Climate Change (WBGU), even now there is discord between the industrialised countries and the emerging economies. "Governments still appear to be fixated on the task of supposedly establishing, maintaining or restoring their national economic competitiveness rather than on preserving the natural lifesupport systems which are the basic prerequisite for any form of economic activity. The situation is reminiscent of the nuclear arms race which ended just 20 years ago, when the apparently compelling logic of 'mutually assured destruction' (MAD) brought our civilisation to the brink of the abyss more than once. The climate issue is without doubt a different type of problem, for every country is both the cause and the victim of climate change, albeit to widely varying extents. Nonetheless, the threats to our societies are just as overwhelming and the mutual distrust which prevails today is still as paralysing as the doctrine of MAD in the past."[16]

WBGU notes "the 'social dilemma' concept in game theory aptly describes the current situation, for individual and collective rationality are tragically at odds here. In a social dilemma, players attach more weight to their short-term individual interests than to the long-term mutual benefits of a cooperative solution—thereby ultimately harming everyone, including themselves. With many countries currently inclined to scale down their own climate change mitigation efforts to the bare minimum due to a short-

sighted focus on competitiveness, the international community could well find itself locked into a non-sustainable course for centuries to come."[16]

According to WWF International, "unabated climate change will cost much more socially, economically and environmentally. It will wreak havoc on global food security and freshwater availability, and its impacts will be disproportionately felt by poor and vulnerable communities."[37]

† Source[98]: Energy Greenhouse Gas Emissions 2009. Ministry of Economic Development (Energy Information and Modelling Group), 2009.
http://www.med.govt.nz/upload/68779/Energy%20Greenhouse%20Gas%20Emissions%202009.pdf
Table 1.1: New Zealand Total Greenhouse Gas Emissions and Removals 1990-2007 (kt CO_2-e).

Calculations:

1990 actual (base) = 61,852 CO_2 equivalent (kt), all gases (gross); 2007 actual = 75,550.
Gross emissions therefore increased by 22.1% between 1990 and 2007 (1-[75550/61852]).
If 2020 goal = 61852 less 40%; then this goal = 37,112 kt.
Comparing 37,112 with 2007 actual, the reduction needed is 1-(37112/75550) = 1-0.49 = 51%.

Notes (source: MED[98]): "Gross emissions do not include carbon sinks of land use, land-use change, and forestry (LULUCF), which is included in net emission calculations. Net emissions in 1990 were 43,714 kt CO_2-e, with 51,714 kt in 2007. CO_2 equivalent emissions estimates are based on the global warming potential (GWP) of each greenhouse gas expressed as the effect of 1 kilogram of CO_2 on global warming over a given time horizon. Non-CO_2 emissions are multiplied by the appropriate warming potential to convert to a CO_2 equivalent basis. The GWPs for CH_4 and N_2O are 21 and 310 respectively, which are for a 100-year time horizon; these are from the IPCC Second Assessment Report (1995)."

‡ Global emissions budgets are totals set according to the global amount of greenhouse gases that may be emitted between now and 2050 to keep within the 2°C guard rail, distributed among the world's population per capita.[16,32,37] For example, the German Advisory Council on Climate Change (WBGU) calculates a budget of 110 tonnes left per person between 2010 and 2050 (based on 660–750 billion tons CO_2 globally to have a two-thirds to three-quarters chance of keeping within 2°C warming).[126]

§ Signatories to the United Nations Framework Convention on Climate Change (UNFCCC) are split into three groups: 1. Annex I countries (industrialised countries); 2. Annex II countries (the subgroup of developed countries who pay for the costs of developing countries); and 3. Developing countries.

- Annex I countries agree to reduce their emissions of greenhouse gasses to targets that are mainly set below their 1990 levels. They may do this by allocating reduced annual allowances to the major operators within their borders. These operators can only exceed their allocations if they buy emission allowances, or offset their excesses through a mechanism that is agreed by all the parties to the UNFCCC.
- Annex II countries are a subgroup of the Annex I countries, comprising the member countries of the OECD excluding those that were economies in transition in 1992.
- Developing countries (Annex III) are not expected to de-carbonise their economy unless developed countries supply enough funding and technology.

New Zealand is included in Annex II (and hence Annex I). Annex I countries (industrialised countries) comprise: Australia, Austria, Belarus, Belgium, Bulgaria, Canada, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Latvia, Liechtenstein, Lithuania, Luxembourg, Monaco, Netherlands, New Zealand, Norway, Poland, Portugal, Romania, Russian Federation, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, United Kingdom, United States of America (40 countries and separately the European Union). See http://unfccc.int/parties_and_observers/items/2704.php, http://unfccc.int/parties_and_observers/parties/annex_i/items/2774.php.

** Responsibility under the Oxfam International calculations is based on emissions of all six greenhouse gases included in the UNFCCC, from 1990, when the first IPCC assessment report was published, to 2005, the most recent year of internationally comparable data. The measure includes emissions from land use change and forestry.[38] Responsibility is measured as cumulative emissions over the period 1990–2005.[34]

†† Capability under the Oxfam International calculations is based on the absolute value of a country's gross national income (GNI) that accrues to the population living above a per capita income threshold of $9000 per year.[34]

‡‡ Worldwide, road traffic crashes account for 1.2 million deaths each year and 10 times as many serious injuries.[73] Death rates for pedestrians and cyclists exhibit steep social gradients, and reducing traffic volumes and speeds would have important equity implications. Urban air pollution—much of which is related to transport—causes a further 800,000 premature deaths each year.[72] Walking, cycling, or using public transport instead of travelling by car would reduce the use of energy from fossil fuels; it would also reduce traffic injuries and air pollution. By increasing physical activity it would tackle the output side of the personal energy balance equation, with positive implications for obesity and cardiovascular disease.

§§ Agricultural and land use mitigation.[51,58,79,89,90,99,127] Immediate action can include diet modification (low methane forage crops, charcoal feed, supplementary maize feed, monensin to improve rumen fermentation); soil carbon sequestration, and nitrogen management through grass pasture and other active land management, nutrient budgeting, no-till crop production, crop rotation, fallow periods, new grasses, improving soil drainage, wintering barns, feed pads and standoff pads; changes in management practices and reduced intensity e.g. lower dairy stocking rates; reduced fertiliser use, nitrification inhibitors for crop growth and N_2O reductions; carbon sequestration though biochar; converting marginal agricultural land back to shrubland and/or forest; measuring and monitoring (use of DNDC). Other potential action can be subjected to accelerated research (e.g. dairy genetic selection (including low methane stock); methane vaccine; biofilters).

Forestry has large potential as carbon sinks, both retaining or reforestation with indigenous and exotic forests/bush.

An emerging agricultural mitigation strategy is the use of low carbon-intensive feed stocks as an alternative to high carbon-intensive feed stocks such as palm kernel, used primarily in the dairy industry. Over one million tonnes of palm kernel/nut oil cake were imported in 2008[128] (mainly from Indonesia and Malaysia) at a value for duty of almost $225 million. Of note, imports may be trending downwards, as the 2009 second quarter (Q2) imports were approximately half those of Q1 and less than one-third of Q2 2008 imports. Palm kernel is the main byproduct of the palm oil industry, which is a key cause of rain forest deforestation and release of greenhouse gases.[129,130]

*** Energy mitigation. Although compared with other developed countries (e.g. UK and Australia) we already have a high level of electricity generation from renewables (currently around 70%), we can still make substantial gains in this area. Modelling suggests that a target of 90% electricity generation by renewables is achievable by 2025 with the current technology, and without incurring substantial costs or reducing the security of supply.[59]

New Zealand has the cheapest wind power in the world, because of our high wind speeds and low population density; we are a long narrow country set at right angles to the prevailing winds that are consistent, with suitable sites that are close to major infrastructure and the national grid (which keeps costs down), the technology is available in New Zealand, and New Zealand companies will benefit greatly with wind energy development—including job creation. Our trees grow faster than almost anywhere in the world—not in remote areas but reasonably close to population centres where they can be turned into high-value products plus energy from residues, let alone acting as carbon sinks. We have substantial geothermal and hydro power potential. Our solar and marine energy are also world-class; especially once the tidal/wave energy technology is honed further—and, again, there is economic potential for New Zealand companies through innovation of this technology.

††† Under a business as usual scenario, possible total greenhouse gas emissions in 2020 are projected to be 84.6 megatons (Mt) CO_2-equivalents. This is based on the 17.87 tonnes CO_2-equivalents per capita emissions in 2007 (75.6 Mt CO_2-e total for New Zealand [NZ][98]), and a projected population for NZ of 4.735 million by 2020[104] (where per capita gross GHG emissions derive from total gross emissions for 2007[98] and the estimated NZ population for 2007,[104] and total gross emissions derive from total net emissions and LULUCF[98]). The 2020 projection is 9.1 Mt greater than the 2007 actual (84.6 minus 75.6 Mt), a 12% increase (see Table 2).

Table 2. GHG emissions predicted for 2020, compared with target of 40% reduction from 1990 levels

year	1990	2006	2007	2020
(total net kt CO_2-e)	43,714	53,722	51,714	
(total LULUCF kt CO_2-e)	-18,138	-23,877	-23,836	
total gross kt CO_2-e	61,853	77,599	75,550	84,619
% incremental change			22.1%	12.0%
population (projected from 2006 base, Series 5 medium fertility medium migration)		4,184,600	4,227,900	4,735,400
% incremental change			25.7%	12.0%
gross tons per capita CO_2-e		18.54	17.87	17.87
target (40% reduction on gross 1990)	37,112		37,112	37,112
per capita target (tons CO_2-e)			8.78	7.84
emissions reductions (gross kt CO_2-e)	-24,741		-38,438	-47,507
% reduction needed	-40%		-51%	-56%
per capita reductions (tons CO_2-e)			-9.09	-10.03

‡‡‡ Technically, the Emissions Trading Scheme (ETS) as proposed for New Zealand would not be a genuine ETS as such, but rather an emissions tax, as there would be a cap on prices.[107,108] Urgently needed is an effective all-sectors all-gases ETS with an uncapped market price on New Zealand's emissions.

§§§ Progressive policies to moderate the financial impacts of mitigation efforts will in particular require central government revenue-recycling to programmes that moderate effects on low-income households.[96] This is where the Government will acquire revenue out of either carbon taxation or an emissions trading scheme. Some of this revenue will be used to pay for required carbon credits, but the remaining excess could either go into Treasury's general pool or be directed (tax hypothecation).

Such a scheme is progressive (as opposed to regressive) when taxes are directed to programmes that mitigate inequities (e.g. free insulation for low income households, or public transport subsidies). In the European Union, carbon pricing is said to have had regressive social effects, but there are also signs that the negative impacts can be softened, avoided altogether, or even reversed by revenue recycling.[96]

Arguably, the intensity-based ETS as proposed could be a regressive (not progressive) taxation system, as it provides substantial and unlimited taxpayer subsidy of emitting industries[107,108] for years to come, which is likely to affect other areas of Government spending.

**** The German Advisory Council on Climate Change (WBGU)[16] states that the reversal of the emissions trend must start as soon as possible—for in view of the very limited CO_2 budget, any delay will result in almost unachievable reduction requirements.

"With a reversal of the trend (and the emissions peak being crossed) by 2010, global emissions would need to fall to 50–80 % below the 1990 baseline by 2050, with further reductions towards zero emissions being achieved thereafter. Even a slight delay in the reversal of the trend, i.e. postponement of the peak year to 2015, would trigger annual global emissions reduction requirements of up to 5% (relative to 2008). See Figure 1 below. In other words, the world would then have to meet annual emissions reduction targets equivalent to those established by the Kyoto Protocol for a full 2 decades."[16]

"Delaying the peak year even further to 2020 could necessitate global emissions reduction rates of up to 9% per year—i.e. reductions on an almost inconceivable scale, entailing technological feats and social sacrifices on a scale comparable to those of the Allied mobilisation during the Second World War"[16] (see Figure 1).

Figure 1. Necessary emissions pathways—WBGU calculations (2009):[16] Global emission pathways for the period 2010–2050 with global CO2 emissions capped at 750 Gt during this period

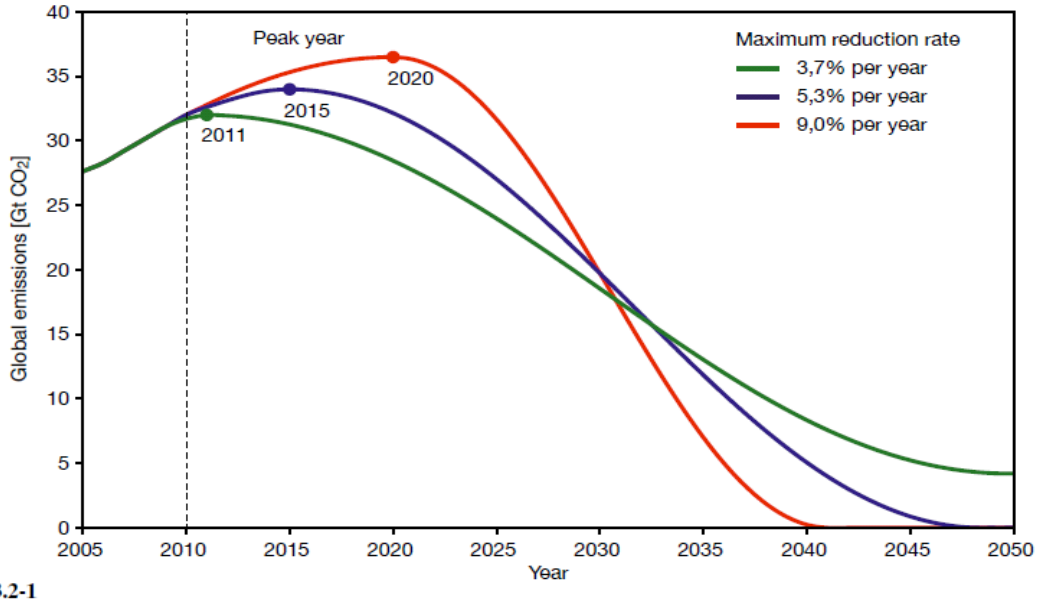

Figure 3.2-1
Examples of global emission pathways for the period 2010–2050 with global CO_2 emissions capped at 750 Gt during this period. At this level, there is a 67% probability of achieving compliance with the 2°C guard rail (Chapter 5). The figure shows variants of a global emissions trend with different peak years: 2011 (green), 2015 (blue) and 2020 (red). In order to achieve compliance with these curves, annual reduction rates of 3.7% (green), 5.3% (blue) or 9.0% (red) would be required in the early 2030s (relative to 2008).
Source: WBGU

Source: Figure 3.2-1 of WBGU 2009[16] http://www.wbgu.de/wbgu_sn2009_en.pdf pages 15-16. Reproduced with permission of the German Advisory Council on Climate Change (WBGU).

References:

1. 2020 target balances economy & environment. Media release by Hon Nick Smith, Hon Tim Groser, 10 August 2009. http://www.beehive.govt.nz/release/2020+target+balances+economy+amp+environment
2. New Zealand's 2020 Emissions Target. Ministry for the Environment (MfE), 2009. http://www.mfe.govt.nz/publications/climate/nz-2020-emissions-target/
3. http://en.cop15.dk/
4. Reklev S. NZ could backtrack on climate target: negotiator. Point Carbon, 29 September 2009. http://www.pointcarbon.com/news/1.1234717
5. Coates B. Guest tracker: sitting down with New Zealand's Climate Ambassador, Adrian Macey. Adopt a negotiator, 2 October 2009. http://adoptanegotiator.org/2009/10/02/guest-tracker-sitting-down-with-new-zealands-climate-ambassador-adrian-macey/
6. Costello A, Abbas M, Allen A, et al. Managing the health effects of climate change: Lancet and University College London Institute for Global Health Commission. Lancet 2009,373:1693–1733. http://www.thelancet.com/journals/lancet/article/PIIS0140-6736(09)60935-1/fulltext
7. Chan M. Climate change and health: preparing for unprecedented challenges. The 2007 David E. Barmes Global Health Lecture, Bethesda, Maryland, USA, 10 December 2007. www.who.int/dg/speeches/2007/20071211_maryland/en/index.html
8. Godlee F. Climate change: permission to act. BMJ 2008;336:0 http://www.bmj.com/cgi/content/full/336/7637/0

9. McMichael AJ, Friel S, Nyong A, Corvalan C. Global environmental change and health: impacts, inequalities, and the health sector. BMJ 2008;336:191–4. http://www.bmj.com/cgi/content/full/336/7637/191
10. Roberts I. The economics of tackling climate change. BMJ 2008;336:165–6. http://www.bmj.com/cgi/content/full/336/7637/165
11. Tong S, Mackenzie J, Pitman AJ, et al. Global climate change: time to mainstream health risks and their prevention on the medical research and policy agenda. Intern Med J 2008;38:445–7.
12. Wiley LF, Gostin LO. The international response to climate change: an agenda for global health. JAMA 2009;302:1218–20. http://jama.ama-assn.org/cgi/content/full/302/11/1218
13. A Commission on climate change. Lancet 2009;373:1659. http://www.thelancet.com/journals/lancet/article/PIIS0140-6736(09)60922-3/fulltext
14. Gray M. Climate change is the cholera of our era. The Times, 25 May 2009. http://www.timesonline.co.uk/tol/comment/columnists/guest_contributors/article6355257.ece
15. Costello A, Maslin M, Montgomery H. Climate change is not the biggest global health threat – Authors' reply. Lancet 2009;374:973. http://www.thelancet.com/journals/lancet/article/PIIS0140-6736(09)61656-1/fulltext
16. German Advisory Council on Climate Change (WBGU). Solving the climate dilemma: the budget approach. Berlin: WBGU, 2009. http://www.wbgu.de/wbgu_sn2009_en.pdf
17. Gill M, Godlee F, Horton R, Stott R. Doctors and climate change. BMJ 2007;335:1104–5. http://www.bmj.com/cgi/content/full/335/7630/1104
18. Gill M. Why should doctors be interested in climate change? BMJ 2008;336:1506. http://www.bmj.com/cgi/content/full/336/7659/1506
19. Griffiths J, Hill A, Spilby J, Stott R. Ten practical steps for doctors to fight climate change. BMJ 2008;336:1507. http://www.bmj.com/cgi/content/full/336/7659/1507
20. Lim V, Stubbs JW, Nahar N, et al. Politicians must heed health effects of climate change. BMJ 2009;339:b3672; Lancet 2009;374:973. http://www.bmj.com/cgi/content/full/339/sep15_1/b3672; http://www.thelancet.com/journals/lancet/article/PIIS0140-6736(09)61641-X/fulltext
21. IPCC, 2007. Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 2007. http://www.ipcc.ch/publications_and_data/publications_ipcc_fourth_assessment_report_wg3_report_mitigation_of_climate_change.htm
22. IPCC, 2007. Chapter 13: Policies, instruments and co-operative arrangements. In: Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 2007. http://www.ipcc.ch/pdf/assessment-report/ar4/wg3/ar4-wg3-chapter13.pdf. Box 13.7 [source for: 80-95% and 25-40% CO_2-equivalent emissions reductions required by Annex I countries by the years 2050 and 2020 respectively on 1990 levels to achieve 450ppm CO_2-equivalents]
23. IPCC, 2001: Climate Change 2001: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change, [McCarthy JJ, Canziani OF, Leary NA, et al (eds.)], Cambridge University Press, Cambridge, UK, 2001. http://www.ipcc.ch/ipccreports/tar/wg2/index.php?idp=0, http://www.ipcc.ch/ipccreports/tar/wg2/pdf/wg2TARspm.pdf
24. Richardson K, Steffen W, Schellnhuber HJ, et al. Climate Change: global risks, challenges & decisions. Synthesis report from conference at Copenhagen 10-12 March 2009. University of Copenhagen, 2009. http://climatecongress.ku.dk/pdf/synthesisreport/
25. Hardin G. The Tragedy of the Commons. Science 1968;162:1243–8. http://www.sciencemag.org/cgi/reprint/162/3859/1243.pdf

26. Gluckman P. Climate change. Wellington: Office of the Prime Minister's Science Advisory Committee, 13 August 2009. http://www.pmcsa.org.nz/climate_change#more-579
27. CAIT UNFCCC. Climate Analysis Indicators Tool (CAIT) Version 6.0. (Washington, DC: World Resources Institute, 2009). http://cait.wri.org. Analysis of table 'Total GHG Emissions in 2005 (excludes land use change) CO_2, CH_4, N_2O, PFCs, HFCs, SF6', http://cait.wri.org/cait.php?page=yearly.
Annex 1 countries in rank order of per capita total greenhouse gas emissions in 2005: Australia (26.9 tonnes CO_2-equivalents per capita), United States of America (23.5), Canada (22.6), **New Zealand (18.8),** Russian Federation (13.7), Norway (11.2), Iceland (11.1), Japan (10.5), Ukraine (10.3), European Union (10.3), etc. For the European Union (27 countries), rank order is Luxembourg (27.5), Ireland (16.7), Estonia (14.4), Netherlands (13.8), Czech Republic (13.7), Belgium (13.2), Finland (13), Germany (11.9), Denmark (11.7), Austria (11.5), Greece (11.5), United Kingdom (10.6), etc.
28. Energy Greenhouse Gas Emissions 2009. Ministry of Economic Development (Energy Information and Modelling Group), 2009. http://www.med.govt.nz/upload/68779/Energy%20Greenhouse%20Gas%20Emissions%202009.pdf
29. http://www.signon.org.nz/
30. Jay M, Marmot MG. Health and climate change. BMJ 2009;339:b3669. http://www.bmj.com/cgi/content/full/339/sep15_1/b3669
31. den Elzen M, Höhne N, van Vliet J, Ellermann C. Exploring comparable post-2012 reduction efforts for Annex I countries. Netherlands Environmental Assessment Agency (PBL), 2008. http://www.pbl.nl/en/publications/2009/Exploring-comparable-post-2012-reduction-efforts-for-Annex-I-countries.html, http://www.rivm.nl/bibliotheek/rapporten/500102019.pdf .
32. Baer P, Athanasiou T, Kartha S, Kemp-Bennedict E. The right to development in a climate constrained world: the Greenhouse Development Rights framework (2nd edition). Heinrich Böll Foundation, Christian Aid, EcoEquity, Stockholm Environment Institute, 2008. http://gdrights.org/wp-content/uploads/2009/01/thegdrsframework.pdf
33. Hawkins R, Hunt C, Holmes T, Helweg-Larsen T. Climate Safety. Wales: Public Interest Research Centre, 2008. http://www.climatesafety.org/
34. Oxfam International. Hang Together or Separately? How global co-operation is key to a fair and adequate climate deal at Copenhagen. Briefing Paper 128, 2009. http://www.oxfam.org/en/policy/fair-climate-deal-copenhagen
35. Reisinger A. Differentiating emissions targets for individual developed countries: economics and equity. Economics Discussion Papers, 2009-41. http://www.economics-ejournal.org/economics/discussionpapers/2009-41
36. Commission of the European Communities. Towards a comprehensive climate change agreement in Copenhagen. Communication from the European Commission. COM(2009) 39 (including technical appendices), Brussels, 2009. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2009:0039:FIN:EN:PDF, http://www.europa-eu-un.org/articles/en/article_8447_en.htm
37. Höhne N, Moltmann S. Sharing the effort under a global carbon budget. Köln: ECOFYS, WWF International, 2009. http://assets.panda.org/downloads/wwf_ecofys_carbon_budget_final.pdf
38. CAIT UNFCCC. Climate Analysis Indicators Tool (CAIT) Version 6.0. (Washington, DC: World Resources Institute, 2009). http://cait.wri.org. As cited by Oxfam International, 2009.
39. Wilson N, Melhuish M. Addressing the threat of climate change: is New Zealand lagging behind? NZ Med J 2007;120:2479. http://www.nzma.org.nz/journal/120-1251/2479/
40. Hansen J, Sato M, Kharecha P, et al. Target atmospheric CO_2: where should humanity aim? Open Atmos Sc J 2008;2:217–31. http://pubs.giss.nasa.gov/docs/2008/2008_Hansen_etal.pdf
41. Schellnhuber HJ. Global warming: stop worrying, start panicking? Proc Natl Acad Sci USA 2008;105:14239–40. http://www.pnas.org/content/105/38/14239.long

42. Monastersky R. Climate crunch: a burden beyond bearing. Nature 2009;458:1091–4. http://www.nature.com/news/2009/090429/full/4581091a.html
43. McMullen CP, Jabbour J. Climate change science compendium. Nairobi: United Nations Environment Programme (UNEP), Earthprint, 2009. http://www.unep.org/compendium2009/, http://www.unep.org/Documents.Multilingual/Default.asp?DocumentID=596&ArticleID=6326&l=en
44. The Times of India. Top UN climate scientist backs ambitious CO_2 cuts. 25 August 2009. http://timesofindia.indiatimes.com/articleshow/msid-4933416,prtpage-1.cms
45. http://www.350.org/understanding-350#14, http://www.350.org/about/science
46. http://www.countercurrents.org/polya280509.htm
47. ftp://ftp.cmdl.noaa.gov/ccg/co2/trends/co2_mm_mlo.txt (July 2009 data, accessed 27 August 2008). Monthly CO_2 data need to be interpreted in light of annual trends (ftp://ftp.cmdl.noaa.gov/ccg/co2/trends/co2_annmean_mlo.txt, compared with monthly fluctuations ftp://ftp.cmdl.noaa.gov/ccg/co2/trends/co2_mm_mlo.txt), and site-specific versus synthesised general estimates (http://cdiac.ornl.gov/pns/current_ghg.html footnote 7).
48. http://www.nicholas.duke.edu/thegreengrok/co2equivalents
49. Stern N. The economics of climate change: the Stern review. Cambridge: Cambridge University Press, 2007. http://www.hm-treasury.gov.uk/stern_review_report.htm
50. Garnaut, R. The Garnaut climate change review, final report. Melbourne: Cambridge University Press, 2009. http://www.garnautreview.org.au/index.htm
51. Bertram G, Terry S. The Carbon Challenge: response, responsibility, and the emissions trading scheme. Sustainability Council of New Zealand, 2008. http://www.sustainabilitynz.org/docs/thecarbonchallenge.pdf
52. Parry M, Arnell N, Berry P, et al. Assessing the costs of adaptation to climate change: a critique of the UNFCCC estimates. London: International Institute for Environment and Development (IIED), Imperial College, 2009. http://www.iied.org/pubs/pdfs/11501IIED.pdf, http://www.iied.org/climate-change/key-issues/economics-and-equity-adaptation/costs-adapting-climate-change-significantly-under-estimated
53. World Development Report 2010: development and climate change. Washington DC: The International Bank for Reconstruction and Development / The World Bank, 2009. http://www.worldbank.org/wdr2010, http://web.worldbank.org/WBSITE/EXTERNAL/NEWS/0,,contentMDK:22312494~pagePK:64257043~piPK:437376~theSitePK:4607,00.html
54. NZIER/Infometrics. Economic modelling of New Zealand climate change policy: Report to Ministry for the Environment, 2009. http://www.climatechange.govt.nz/documents/economic-modelling-of-new-zealand-climate-change-policy/
55. Saddler H. Comments on 'General equilibrium analysis of a 40% reduction in emissions by 2020', a report prepared for the Greenhouse Policy Coalition by Infometrics. Prepared for Greenpeace Aoteoroa NZ. Pitt & Sherry, 2009. http://greenpeace.org.nz/pdf/comments-on-infometrics.pdf.
56. Bertram G. Assessing the costs of climate change policy in New Zealand. Victoria University of Wellington Institute for Policy studies symposium, Wellington, 3 August 2009. http://ips.ac.nz/events/downloads/2009/Countdown%20to%20Copenhagen%20Slides/Geoff%20Bertram.pdf
57. United Nations. Kyoto protocol to the United Nations Framework Convention on Climate Change 1997. http://unfccc.int/essential_background/items/2877.php
58. Agricultural emissions can be cut 13%—at a profit today. Sustainability Council, media statement 2 April 2009. http://www.sustainabilitynz.org/news_item.asp?sID=192
59. Ministry of Economic Development (MfE). New Zealand Energy Strategy to 2050. 2007. http://www.med.govt.nz/upload/52164/nzes.pdf
60. IPCC, 2007: Summary for Policymakers. In: Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. [Parry ML, Canziani OF, Palutikof JP, van der

Linden PJ, Hanson CE (eds)]. Cambridge University Press, Cambridge, UK, 7–22. http://www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4-wg2-spm.pdf .

61. IPCC, 2007. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. [Parry ML, Canziani OF, Palutikof JP, van der Linden PJ, Hanson CE (eds)]. http://www.ipcc.ch/publications_and_data/publications_ipcc_fourth_assessment_report_wg2_report_impacts_adaptation_and_vulnerability.htm
62. Questions and Answers on New Zealand's 2020 emissions reduction target. Ministry for the Environment (MfE), 2009. http://www.mfe.govt.nz/issues/climate/emissions-target-2020/questions-answers.html
63. Infometrics. General equilibrium analysis of a 40% reduction in emissions by 2020. Report prepared by Infometrics Ltd for Greenhouse Policy Coalition, July 2009. http://www.gpcnz.co.nz/includes/download.aspx?ID=103264
64. Stern N. The Global Deal: climate change and the creation of a new era of progress and prosperity. New York: Public Affairs, 2009.
65. Taylor G. NZ is now climate change laggard. NZ Herald, 28 September 2009. http://www.nzherald.co.nz/politics/news/article.cfm?c_id=280&objectid=10599933
66. Rogelj J, Hare B, Nabel J, et al. Halfway to Copenhagen, no way to 2 °C. Nature Reports Climate Change, 11 June 2009. doi:10.1038/climate.2009.57. http://www.nature.com/climate/2009/0907/pdf/climate.2009.57.pdf
67. Roberts I. The health co-benefits of climate change policies: doctors have a responsibility to future generations. JRCP 2009;9:212-213. http://www.ingentaconnect.com/content/rcop/cm/2009/00000009/00000003/art00004
68. Public Health Association of New Zealand. PHA (NZ) Policy: Preventing Global Climate Change. Adopted 5 July 2001. http://www.pha.org.nz/policies/phapolicyclimatechange.pdf
69. Public Health Association of New Zealand. Position statement 2004: Transport and Health. Adopted 27 June 2004. http://www.pha.org.nz/policies/phapolicytransport.pdf
70. Wilson N, Wallace C, Weeber B. The New Zealand Government's energy policies need to consider public health benefits. N Z Med J 2005;118(1216). http://www.nzma.org.nz/journal/118-1216/1513
71. Public Health Association of New Zealand. PHA Submission on climate change targets 2020. 31 July 2009. http://www.pha.org.nz/submissions/09PHAclimatechangesubmission.pdf
72. Woodcock J, Banister D, Edwards P, et al. Energy and transport. Lancet 2007;370:1078–88.
73. Roberts I, Arnold E. Policy at the crossroads: climate change and injury control. Inj Prev 2007;13:222–3.
74. MacMillan T, Durrant R. Livestock consumption and climate change: a framework for dialogue. WWF UK, Food Ethics Council, 2009. http://www.wwf.org.uk/research_centre/?3308/Livestock-consumption-and-climate-change---A-framework-for-dialogue
75. McMichael AJ, Powles JW, Butler CD, Uauy R. Food, livestock production, energy, climate change, and health. Lancet 2007;370:1253–63.
76. Roberts I. Comment and analysis: say no to global guzzling. New Scientist 2007;309:21.
77. Edwards P, Roberts I. Population adiposity and climate change. Int J Epidemiol 2009;38:1137–40. http://ije.oxfordjournals.org/cgi/content/full/38/4/1137
78. Powles J. Why diets need to change to avert harm from global warming. Int J Epidemiol 200;38:1141–2. http://ije.oxfordjournals.org/cgi/content/full/38/4/1141
79. Broatch M. Welcome to the wasteland. Sunday Star Times, 9 August 2009, pp. C1-2.
80. Wilkinson P, Smith KR, Beevers S, et al. Energy, energy efficiency, and the built environment. Lancet 2007;370:1175–87.
81. Howden-Chapman P, Matheson A, Crane J, et al. Effect of insulating existing houses on health inequality: cluster randomised study in the community. BMJ 2007;334:460. http://www.bmj.com/cgi/content/abstract/334/7591/460

82. Chapman R, Howden-Chapman P, Viggers H, et al. Retrofitting houses with insulation: a cost-benefit analysis of a randomised community trial. J Epidemiol Community Health 2009;63:271–7.
83. Lindsay G, Woodward A, Macmillan A. Effects on health and the environment of increasing the proportion of short urban trips made by bicycle instead of motor vehicle. Discussion paper Prepared for the Board of the New Zealand Transport Agency. School of Population Health, University of Auckland, October 2008.
84. Chapman R, Boston J. The social implications of decarbonising New Zealand's economy. Soc Pol J NZ 2007;31:104-136. hosted at http://www.msd.govt.nz/documents/about-msd-and-our-work/publications-resources/journals-and-magazines/social-policy-journal/spj31/31-Pages104-136.pdf.
85. Pathways to a low-carbon economy: version 2 of the Global Greenhouse Gas Abatement Cost Curve. McKinsey & Co, 2009. http://www.worldwildlife.org/climate/mckinseyreport.html
86. Gorner S, Lewis A, Downey L, et al. An Australian cost curve for greenhouse gas reduction. McKinsey Consulting Australia/New Zealand, 2008. http://www.mckinsey.com/locations/australia_newzealand/knowledge/pdf/1802_carbon.pdf
87. ICF International. Analysis of the potential and costs of greenhouse gas emissions reductions. Submitted to Ministry for the Environment, 2007.
88. Important contextual note concerning the report: 'Analysis of the potential and costs for greenhouse gas emissions'. Ministry for the Environment (MfE), 2007.
89. ICF International. Analysis of the potential and costs of greenhouse gas emissions reductions within the New Zealand agricultural sector. Submitted to Ministry of Agriculture and Forestry, 2008.
90. Big affordable climate change: Getting there. Green Party Aoteoroa NZ, 2009. http://www.greens.org.nz/node/21593, http://www.greens.org.nz/sites/default/files/BigAffordableClimateChange_1.pdf
91. Delay T, Grubb M, Willan C, Counsell T. Global Carbon Mechanisms: Emerging lessons and implications. Carbon Trust, 2009. http://www.carbontrust.co.uk/publications/publicationdetail?productid=CTC748
92. Diesendorf M. Paths to a Low Carbon Future Reducing Australia's greenhouse gas emissions by 30 percent by 2020. Sustainability Centre, Australia, 2007. http://www.greenpeace.org/raw/content/australia/resources/reports/climate-change/paths-to-alow-carbon-future.pdf
93. Teske S, Vincent J, Saddler H. Energy [R]evolution: a sustainable Australia energy outlook. Greenpeace International, European Renewable Energy Council (EREC), 2008. http://www.energyblueprint.info/fileadmin/media/documents/national/australia_report.pdf .
94. Targets for our Future: 20% greenhouse gas emissions cuts by 2020 and 60% by 2050. Environment Business Australia, 2007. http://environmentbusiness.com.au/images/stories/targets_for_our_future-_september_07.pdf
95. New Zealand's climate change solutions: an overview. Ministry for the Environment (MfE), 2007 http://www.mfe.govt.nz/publications/climate/climate-change-solutions-overview-sep07/climate-change-solutions-overview-sep07.pdf
96. Dhar D, Macmillan A, Lindsay G, Woodward A. Carbon pricing in New Zealand: implications for public health. N Z Med J 2009;122(1290):105–15. http://www.nzma.org.nz/journal/122-1290/3483/
97. Chapman R. Complementary measures: a framework. Victoria University of Wellington Institute for Policy studies symposium, Wellington, 14 August 2009. http://ips.ac.nz/events/downloads/2009/Countdown%20to%20Copenhagen%20Slides/Ralph%20Chapman.pdf
98. Energy Greenhouse Gas Emissions 2009. Ministry of Economic Development (Energy Information and Modelling Group), 2009. http://www.med.govt.nz/upload/68779/Energy%20Greenhouse%20Gas%20Emissions%2020

09.pdf Table 1.1: New Zealand Total Greenhouse Gas Emissions and Removals 1990-2007 (kt CO_2-e).

99. O'Hara P, Freney J, Ulyatt M. Abatement of agricultural non-carbon dioxide greenhouse gas emissions: a study of research requirements. Report prepared for the Ministry of Agriculture and Forestry on behalf of the Convenor, Ministerial Group on Climate Change, the Minister of Agriculture and the Primary Industries Council. Wellington, 2003. http://www.maf.govt.nz/mafnet/rural-nz/sustainable-resource-use/climate/abatement-of-agricultural-greenhouse-gas-emissions/
100. Acharya SR, Saeed K. An attempt to operationalize the recommendations of the 'Limits to growth' study to sustain the future of mankind. System Dynamics 1996;12:281–304.
101. Coombes R. Population: the forgotten priority. BMJ 2009;339:b3750. http://www.bmj.com/cgi/content/full/339/sep16_2/b3750
102. Wire T. Fewer emitters, lower emissions, less costs: reducing future carbon emissions by investing in family planning – a cost/ benefit analysis. London School of Economics, Optimum Population Trust, 2009. http://www.optimumpopulation.org/reducingemissions.pdf.
103. Optimum Population Trust. Population growth and climate change. 2009. www.optimumpopulation.org/submissions/climatechange09.pdf
104. http://wdmzpub01.stats.govt.nz/wds/TableViewer/tableView.aspx?ReportName=Population%20Projections/Projected%20Population%20of%20New%20Zealand%20by%20Age%20and%20Sex,%202006%20(base)%20-%202061, Series 5 medium fertility medium migration. Sourced from and detailed at http://www.stats.govt.nz/methods_and_services/TableBuilder/population-projections-tables.aspx
105. Ministry of Economic Development, Ministry of Social Development, Department of Labour, Statistics New Zealand. Population and Sustainable Development. Wellington, 2003. http://www.msd.govt.nz/documents/about-msd-and-our-work/publications-resources/planning-strategy/population-sustainable/population-sustainable-development.pdf
106. Statistics New Zealand. Demographic Trends: 2007. Wellington, 2008. http://www.stats.govt.nz/~/media/statistics/publications/analytical-reports/demographic-trends-2007/demo-trends-07-full-report.aspx
107. Fallow B. Carbon bill time bomb for taxpayers. NZ Herald, 17 September 2009. http://www.nzherald.co.nz/business/news/article.cfm?c_id=3&objectid=10597735
108. Oram R. One giant step backwards. Sunday Star Times, 20 September 2009. http://www.stuff.co.nz/sunday-star-times/business/2880926/One-giant-step-backwards
109. http://www.1010uk.org/
110. http://www.guardian.co.uk/environment/10-10
111. Katz I. The beauty of 10:10 is that it's both achievable and meaningful. The Guardian, 1 September 2009. http://www.guardian.co.uk/environment/2009/sep/01/10-10-launch-ian-katz
112. Jha A. Entire cabinet signs up to 10:10 climate change campaign. The Guardian, 3 September 2009. http://www.guardian.co.uk/environment/2009/sep/03/cabinet-signs-up-10-10
113. http://www.sdu.nhs.uk/page.php?page_id=130
114. Building a low-carbon economy: implementing the Climate Change Act 2008. London: HM Treasury/HM Government, 2009. http://www.hm-treasury.gov.uk/bud99_pr_climate_change_levy.htm, http://www.hm-treasury.gov.uk/d/Budget2009/bud09_carbon_budgets_736.pdf .
115. Investing in a low carbon Britain. London: HM Government, 2009. http://www.decc.gov.uk/en/content/cms/news/090423_low_car/090423_low_car.aspx
116. Wilson N, Edwards R, Mansoor O. Economics can be good for health: need for rational policy without the influence of vested interests. N Z Med J 2007;120(1263). http://www.nzma.org.nz/journal/120-1263/2757

117. Sustainable Aotearoa New Zealand Inc. (SANZ). Strong sustainability for New Zealand: principles and scenarios. Auckland, 2009. http://www.phase2.org/documents/SSFNZ_web_310809.pdf
118. Holling CS, Gunderson LH. Panarchy: understanding transformations in human and natural systems. Washington, DC: Island Press, 2002. http://www.resalliance.org/593.php
119. Capra F. The web of life: the new scientific understanding of living systems. New York: Anchor Books, 1996.
120. Westley F, Zimmerman B, Patton MQ. Getting to maybe: how the world has changed. Random House Canada, 2006. http://www.resalliance.org/2038.php
121. Psychology and global climate change: addressing a multi-faceted phenomenon and set of challenges. A report by the American Psychological Association's Task Force on the Interface Between Psychology and Global Climate Change. American Psychological Association, 2009. http://www.apa.org/releases/climate-change.pdf
122. Jackson T. Prosperity without growth? London, Sustainable Development Commission, 2001. http://www.sd-commission.org.uk/pages/redefining-prosperity.html, http://www.sd-commission.org.uk/publications/downloads/prosperity_without_growth_report.pdf.
123. McKibben B. Deep Economy: the wealth of communities and the durable future. 2007
124. Hammel G, Breen W. The future of management. Harvard Business School Press, 2007.
125. Stiglitz JE, Sen A, Fitoussi J-P. Report by the Commission on the Measurement of Economic Performance and Social Progress. Paris: Commission on the Measurement of Economic Performance and Social Progress, 2009. http://www.stiglitz-sen-fitoussi.fr/, http://ipezone.blogspot.com/2009/09/out-now-sarkozy-stiglitz-sen-well-being.html
126. Industrialised nations are facing CO_2 insolvency. Spiegel Online International, 9 September 2009. http://www.spiegel.de/international/germany/0,1518,646506,00.html
127. Growing for good: intensive farming, sustainability and New Zealand's environment (2nd edition). Wellington: Parliamentary Commissioner for the Environment, 2005. http://www.pce.parliament.nz/work_programme/reports_by_subject/all_reports/land_use/growing_for_good
128. Statistics New Zealand. Statistics New Zealand Infoshare table builder records of imports Jan-Dec 2008 (http://www.stats.govt.nz/methods_and_services/TableBuilder.aspx), based on the New Zealand Harmonised System Classification 2007 HS code '2306.60.00.00 Oil-cake and other solid residues; whether or not ground or in the form of pellets, resulting from the extraction of palm nuts or kernels oils' (http://www.stats.govt.nz/methods_and_services/surveys-and-methods/classifications-and-standards/classification-related-stats-standards/harmonised-system.aspx) [accessed September 2009]
129. The Hidden Carbon Liability of Indonesian Palm Oil. Greenpeace, 2008. www.greenpeace.org.uk/media/reports/the-hidden-carbon-liability-of-indonesian-palm-oil
130. Fargione J, Hill J, Tilman D, Polasky S, Hawthorne P. Land clearing and the biofuel carbon debt. Science 2008;319:1235–8. http://www.sciencemag.org/cgi/content/full/319/5867/1235