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Climate Goals for New Zealand in 2030:

An Ambitious Domestic Emissions Target within an Appropriate Share of the Global Budget

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"… when a country submits its INDC, it is implicitly choosing a temperature target, the one that would be realised if all other countries were to act in a comparable manner, relative to their share of the global effort required. If a country proposes a contribution that amounts to less than its fair share of the global effort required to keep temperature rise well below 2˚C, then that country is, in effect, proposing an overall global temperature increase that exceeds 2˚C."

Greenhouse Development Rights: Climate Equity Reference Project
http://www.gdrights.org/

"Raising the Ambition Level"

A Possible INDC Submission from New Zealand

September 2015

New Zealand advances the following Intended Nationally-Determined Contribution for the purposes of the UNFCCC-COP 21 in Paris, 30 November to 11 December 2015.

1. **The Global Objective:** New Zealand acknowledges as the global objective the threshold of 2°C post-industrial increase in average global temperature as agreed at COP-16 in Cancun, and the associated Global Carbon Budget (CO_2) as identified in IPCC-AR5 of 2014. New Zealand regards the 2°C threshold as a milestone in the longer-term effort to return the temperature increase to less than 1.5°C.

2. **The Domestic Abatement Target:** New Zealand determines that its domestic abatement potential enables it to reduce its net greenhouse gas emissions to a level ranging from 51.9 Mt to 14.9 Mt. Having regard to this range, New Zealand commits to a level of net greenhouse gas emissions in 2030 of 40 Mt. which represents a reduction of 40% off its 1990 gross greenhouse gas emissions level. New Zealand also identifies an aspirational target of 17.2 Mt. in 2030. Domestic legislation will be introduced, with five-yearly quantitative net emission budgets, from 2015 to 2050 to achieve the Domestic Abatement Target of 40% in 2030, and 100% (zero net greenhouse gas emissions) in 2050.

3. **The National Responsibility Level:** In determining a proportionate share of the Global Carbon Budget, New Zealand acknowledges and reaffirms the principles in the UN Framework Convention on Climate Change 1992. New Zealand's proportionate share is accepted as its National Responsibility Level, which it takes as its Intended Nationally-Determined Contribution (INDC). In accordance with the Global Carbon Budget and the Convention's principles, New Zealand identifies a range in its net greenhouse gas emissions of 5.4 Mt to 23.4 Mt. for its National Responsibility Level. New Zealand recognises 5.4 Mt as the appropriate level for its share of the Global Carbon Budget, in order for the average global temperature increase to remain under the 2°C threshold, thereby meeting the objective of the Framework Convention of preventing dangerous climate change.

4. **International Assistance:** The shortfall between New Zealand's 2030 INDC and its domestic abatement in 2030 will be made up through international emissions trading or financial contributions to the Green Climate Fund and other climate financing mechanisms.

ABSTRACT

This paper provides the research and method by which New Zealand could re-commit to ambitious climate goals for 2030, either in the lead-up to the UN's critical climate conference in Paris in December 2015, or during a subsequent peer review. These goals are determined in the context of the international agreement to keep the average global temperature increase below 2ºC (determined, in turn, by a corresponding Global Carbon Budget). The paper gives a new approach to determining New Zealand's contribution to the global effort at GHG reductions in the Paris Agreement.

The Government's Targets

The Government's stated targets, off 1990 gross emissions level, are: a 5% reduction by 2020; an 11% reduction by 2030 (its recent INDC announcement); and a 50% reduction by 2050. These figures are not domestic abatement targets. They are national responsibility levels for New Zealand, which will, to the extent domestic abatement falls short, be met through international emissions unit trading. In the case of the 2030 INDC target of 11%, it is expected that only one-fifth will be met through domestic abatement, and four-fifths through trading, and it is unclear whether the INDC is net or gross greenhouse emissions. Such a modest domestic abatement target is driven by stated concerns over the monetary cost of emission reductions to economic sectors in New Zealand (households, firms, farms).

Proposed Levels and Targets

With a view to developing a reliable cross-party consensus in New Zealand on climate policy, I advance in this paper, for public and parliamentary dialogue, a new approach to climate policy. The aim is to develop a cross-party consensus that recognises a figure (or a range) for the two critical concepts for 2030:

- our Domestic Abatement Target (what our actual emissions reduction would be in that year);
- our National Responsibility Level (what our share of the Global Budget would be in that year).

Domestic Abatement Target

In determining our Domestic Abatement Target, I do not begin with the question: What is the cost of a specified percentage reduction? Instead, I begin with the question: What is New Zealand capable of in reducing its net emissions in 2030? To explore this 'abatement potential' I adopt a set of 'benign assumptions', namely: (i) optimal policy signals in the form of carbon prices/taxes and complementary measures; (ii) a broad cross-party consensus underpinning business investment predictability; (iii) public-private sector collaboration and commitment; (iv) continuing improvement in technology and best-practice in the three economic sectors (households, firms, farms). On this basis and with expert input in all GHG sectors (energy, industry, agriculture, waste, forestry/land-use), I develop a range of emission reductions, based on 'high ambition' and 'moderate ambition'. I then calculate an overall range of New Zealand's domestic abatement potential, from which I select a feasible mid-point. I also relate the 2030 target figure to the accompanying average annual figure and budget for 2021-30.

National Responsibility Level

In determining our broader National Responsibility Level (NRL), I draw upon recent work by research institutes around the world in apportioning the Global Carbon Budget, country-by-country, using transparent assumptions pertaining to a 'Responsibility/Capacity Index' (RCI). If the assumptions are held constant across all countries and rigorously applied through the on-line global calculator, the total of all countries' responsibility levels equates with the Global Carbon Budget, over any time-period and, within that, for any one specific year. The global calculators employed for determining such proportionate shares are relatively new and the methodology is not fully developed nor universally agreed on. I therefore identify several types, from which I derive a range for the NRL. I have chosen to cite or derive specific numerical values, because the NRL concept is critical to developing a sound relativity across all countries, based on the equity principles in the UN Framework Convention.

Results

Based on the foregoing analysis, I conclude that:

(a) New Zealand's Domestic Abatement Potential is in the range of 51.9 to 14.9 Mt CO_2-e. Having regard to this range, the Domestic Abatement Target for 2030 in net emissions should be 40% off 1990 gross level, i.e. 40 Mt CO_2-e. An aspirational target of 17.2 Mt CO_2-e is possible.

(b) New Zealand's National Responsibility Level is in the range of 5.4 to 23.4 Mt CO_2-e net emissions. Our recommended Level (our INDC) is 5.4 Mt CO_2-e.

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Note:

1. This paper explores the challenge of domestic abatement and national responsibility in detail, and makes operational assumptions that are, by their nature, exploratory. The paper is designed to generate discussion among experts and across the political spectrum within New Zealand, with a view to further revision.

2. The numerical values reported in this paper are not to be taken as definitive. They are the product of calculations that are dependent on assumptions stated in the paper. Two approaches were possible for this analysis. The first was to confine the analysis to a narrative and to omit quantification. The second was to include numerical values for both illustrative and heuristic purposes. I have adopted the second approach, in the judgement the overriding need in the climate negotiations is for a systematic and reproducible 'navigational compass' in determining national responsibilities and capacities with respect to the global budget. In doing so, I acknowledge the caveats advanced about 'embracing uncertainty in climate change policy' (Otto FEL, Frame DJ, Otto A, Allen MR. Nature Climate Change 3 August 2015 *doi:10.1038/nclimate2716*).

1. **Context**

(a) The Objective: the temperature threshold and the global budget

The objective of the 1992 UN Framework Convention on Climate Change is to "prevent dangerous anthropogenic interference with the climate system" (article 1).

In 2010 (COP-16) the Parties translated this into a warming limit of 2°C above pre-industrial levels.[1] World leaders, including the president of COP-21, describe the 2°C threshold as 'essential' for avoiding dangerous climate change.[2]

The 2°C temperature threshold translates into a Global Carbon Budget for the period 1750-2100, most of which has already been used.[3] The Budget is to be apportioned among UN member states according to the principles in the UN Framework Convention. From the IPCC's 5th Assessment Report (2014), the remaining Global Budget (from 2012 onwards) to remain within the temperature threshold (at a 66% confidence level) is 1,010 Gt. On current global emission rates, this is likely to expire around 2035.

Current baseline projections of global emissions show a mean warming of 4.5˚C by 2100. The impact of current policy projections is estimated at 3.9˚C. The impact of current pledges is estimated at 3.0˚C. These temperature increases are in the range of what has been authoritatively termed 'catastrophic climate change'.[4]

The goal identified for COP-21 in Paris is "a protocol, another legal instrument, or an agreed outcome with legal force under the Convention applicable to all parties" – essentially a new global agreement supplementary to the 1992 Framework Agreement that will incorporate obligations on all parties for the period 2020 to '50.

(b) The Concept: intended nationally-determined contributions

All parties are now called upon to announce an 'intended nationally-determined contribution' before the COP-21 in December. It is likely that the Paris Agreement will impose a binding obligation on every state party to specify an INDC, while the precise figure specified will be independent of the Agreement and subject to continuing peer review as the knowledge and insights on climate change and its impacts further unfold. The current version of the draft Paris Agreement acknowledges, *inter alia,* that "the global nature of and urgency of climate change calls for participation/widest participation, cooperation and ambitious action by all Parties".[5] The United Nations, through the Secretary-General, has called for countries to 'raise the ambition level' in submitting their INDC.

In stating its INDC, a country usually specifies a target, most often a percentage reduction off a baseline year (usually 1990). The 'contributions' announced to date, however, make it clear that the INDCs associated with the Paris Agreement are

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[1] The 2˚C threshold is the agreed goal (COP-16, Cancun; 2010). The AOSIS countries urge a 1.5°C threshold, but the main focus of the international community remains on 2°C, as does the research on a normative framework for the global emissions budget and national shares. This paper uses the 2°C threshold for determining New Zealand's target; calculations for a 1.5°C threshold could be separately undertaken. The 2˚C threshold is best seen as a milestone in the longer-term global effort to return global temperature increase to below 1.5°C.

[2] "Threats to peace and security will increase in both number and intensity if the rise in temperature exceeds 2°C – and this rise will happen if we fail to act or take insufficient action. A climate-disrupted planet would be an unstable one. …. [I]t is essential to limit global warming to below 2°C." Laurent Fabius, 'Our Climate Imperatives', International NY Times, 25 April 2015, p. 9.

[3] In relating New Zealand's net greenhouse gas emission-based National Responsibility Level to the Global Carbon Budget, this in effect refers to the remaining net greenhouse gas emissions necessary for New Zealand to appropriately share the world's effective remaining net greenhouse gas budget. The net greenhouse gas emission budget is the conclusive metric from all anthropogenic warming, and is proxied by the 1,010 Gt CO_2 Global Carbon Budget remaining from 2012 onwards identified in IPCC-AR5, where carbon budgets relate to most but not all warming. This is where net greenhouse gas budgets comprise all CO_2 (i.e. fossil CO_2 plus LULCF CO_2) plus net non-CO_2 greenhouse gases, and relate to warming effects that include those of non-CO_2 greenhouse gases; whereas carbon budgets are confined to all CO_2 (i.e. fossil CO_2 plus LULUCF CO_2) without non-CO_2, and relate to warming from CO_2 alone.

[4] See Emissions Gap Report: A UNEP Synthesis (2014) http://www.unep.org/publications/ebooks/emissionsgapreport2014/. Also, Figure B below (p. 9)

[5] Ad Hoc Working Group on the Durban Platform for Enhanced Action, 2nd Session Part 9, Streamlined and Consolidated Text (version 11 June 2015), p. 2.

unlikely to meet the UNFCCC's objective they each claim to have in mind. In October, the UNFCCC Secretariat will assemble all INDCs and seek to develop a coherent framework that provides an estimate of their combined effect on the average global temperature.[6]

Whether it is voluntary or binding, a country's INDC is effectively its commitment to the future climate of the planet. As has been pointed out:

> *"… when a country submits its INDC, it is implicitly choosing a temperature target, the one that would be realised if all other countries were to act in a comparable manner, relative to their share of the global effort required. If a country proposes a contribution that amounts to less than its fair share of the global effort required to keep temperature rise well below 2°C, then that country is, in effect, proposing an overall global temperature increase that exceeds 2°C."*[7]

The INDCs entered to date vary in their stated intent. Some make it clear that their 'contribution' will be met, if necessary, through supplemental trading of international credits. Others are silent on this, implying that their contribution will take the form of a domestic abatement target only, while others confine themselves to sectoral intensity goals. There is no rigorous or coherent global method adopted for the Paris Agreement in ensuring the adequacy of staying within the 2°C temperature threshold.

(c) The Components: national responsibility and domestic abatement

It is, thus, not clear in many cases whether a country is pledging a domestic abatement target or a national responsibility target. This is critical and also complex. It addresses the relationship between national legal obligation, which underpins the negotiations, and the economic theory of global least cost which is employed by all countries to confirm, or avoid, their national obligation.

No country entering an INDC is absolved of the responsibility to ensure that its contribution is adequate to the 2°C temperature threshold. It is therefore necessary to be clear in distinguishing between the two relevant concepts, and how (even whether) it aims to make up any shortfall in meeting national responsibility through domestic abatement.

The following definitions are therefore used here:

National responsibility level:
The net quantitative emissions level (Mt CO_2-e) which a country should accept as its appropriate share[8] of the global emissions level for any particular year.

Domestic abatement target:
The net emissions level which a country is expected to record for that same year. It can be expressed either as a quantitative emissions level (Mt CO_2-e) or as a percentage reduction of the baseline year,

It is possible, but will be rare, for a country's national responsibility level and its domestic abatement target to be identical in any one year. The aggregate of each of the 195 responsibility levels (appropriate shares) will, by definition if comparable variables are entered, equate with the global carbon budget for the 2°C temperature threshold. Most developing countries, however, will find that their domestic abatement target exceeds their national responsibility, and most developed countries will find that their national responsibility level exceeds their domestic abatement target. Very few will have the two levels the same.

The following sections explore these issues for New Zealand – determining first our Domestic Abatement Target, then our National Responsibility Level (our INDC).[9]

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[6] The Australian Climate Authority has compiled a useful manual for the purpose, employing four criteria (capacity, adequacy, responsibility and effort). See *'Comparing Countries' Emissions Targets: A Practical Guide'*, Australian Government Climate Change Authority (March 2015).

[7] Greenhouse Development Rights: Climate Equity Reference Project. http://www.gdrights.org/

[8] In this paper I do not use the phrase 'fair share' but rather 'appropriate share' which, in our view, reflects more accurately the intent in the Framework Convention.

[9] The GWP metrics applied to domestic abatement are based on the updated values (calculated by IPCC AR-4). The metrics applied to national responsibility levels are based on the original values (calculated in IPCC AR-1). It is expected that in coming months, the updated values will be applied to the national responsibility levels.

2. The Domestic Abatement Target

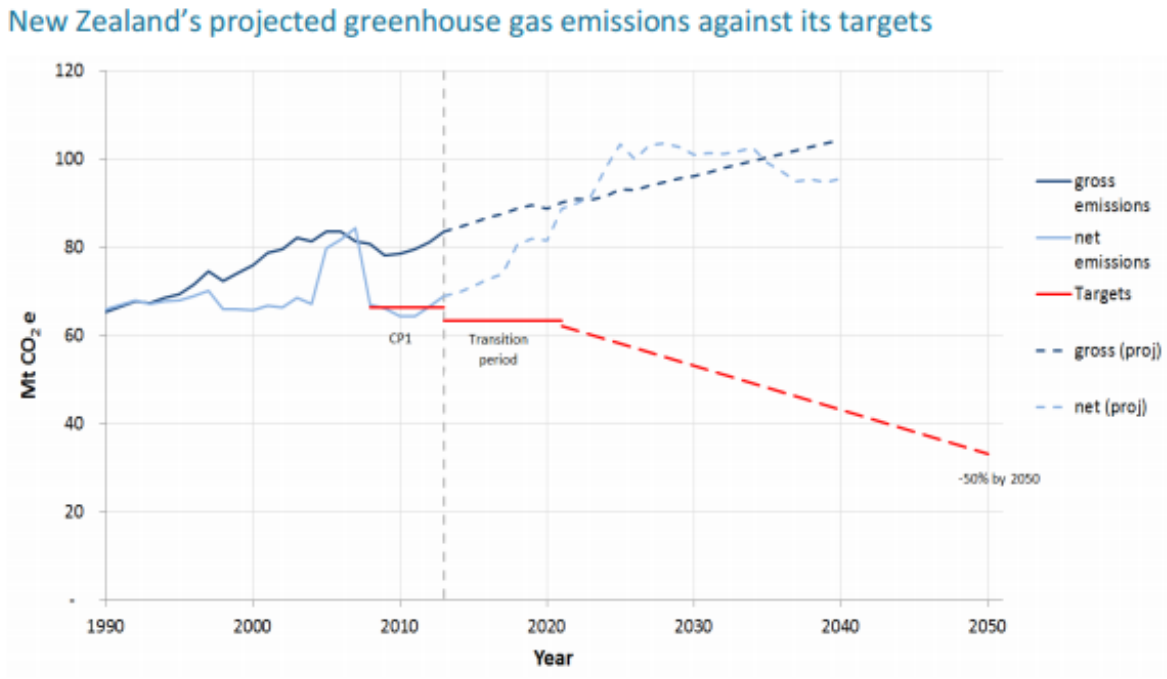
This section explores what an ambitious yet feasible domestic abatement target might be for New Zealand in 2030. I do this in three steps:

(a) Note New Zealand's official emission projections, showing large increases from 1990 to 2050;
(b) Describe the methodology I use for calculating future national emissions;
(c) Estimate, on the basis of (b), a domestic abatement target for 2030 (including a range of potential).

(a) Official Emission Projections 2015-2050

New Zealand's emission projections from 2015 to 2050 are shown in Figure A. The graph shows the increase in New Zealand's projected net domestic emissions (from 66 Mt in 1990 to 100 Mt in 2030) compared with its official National Responsibility Targets (5% by 2020 and 50% by 2050), indicating a 2030 target of 53 Mt.[10]

Figure A
NZ projected GHG emissions against current official NZ targets
Briefing for Incoming Ministers (2014)



Source: Ministry for the Environment: Briefing for Incoming Ministers, 2014, p. 22

The Govt. has compiled two sets of projections for 2030: 'with measures' and 'without measures'.

- The measures are based on the effect of 'key quantifiable climate change policies', namely: the modelled impact of the NZ ETS; official afforestation schemes; and the National Environmental Standard for landfills.
- The measures do not include the impact of other policies, namely: agricultural research and energy efficiency initiatives.

The official projections are shown in Tables 1 and 2.

[10] The ETS Review Panel's Report of 2011 showed the emissions projection to 2050. Since then, the Government has shortened the time-frame to either 2030 (6th National Communication of 2013) or 2040 (BIM of 2014). Also, the figures pertaining to emissions have recently been recalculated, as a result of new IPCC-derived GWP metrics (See Annex D).

Table 1
Actual & projected emissions & removals, by sector, 'with measures', 1990-2030 (Mt CO_2-e)

	1990	2011	2015	2030
Energy	14.9	17.0	18.2	18.3
Transport	8.6	14.0	14.4	15.9
Industry	3.4	5.4	5.0	6.1
Agriculture	30.7	34.4	35.0	39.6
Waste	2.0	2.0	2.0	2.3
Gross emissions	**59.6**	**72.8**	**74.6**	**82.2**
Forestry	-27.0	-15.0	-6.7	2.6
Net emissions	**32.6**	**57.8**	**67.9**	**84.8**

Source: NZ 6th National Communication Table 5.1, p. 100[11]

Table 1 shows that New Zealand's net emissions were projected by 2015 to increase 108% since 1990 when climate change was officially recognised in the first IPCC report, and were projected to increase 260% by 2030. Kyoto accounting methods acknowledge gross-to-net emissions (i.e. from gross emissions in 1990 to net emissions thereafter), so the reported increase is less. The climate, however, does not make that methodological assumption.

Table 2 shows that the effectiveness of official abatement 'measures' on gross emissions by 2030 is zero. The effectiveness on net emissions is minor (4%), and it is notable that even with measures, New Zealand's emissions show a remorseless increase.

Table 2
Comparison of projected emissions, 'with measures' & 'without measures' in 2030 (Mt CO_2-e)

	Without measures	With measures	%
Energy	18.360	18.311	0
Transport	15.904	15.900	0
Industry	6.121	6.121	0
Agriculture	39.598	38.598	0
Waste	2.565	2.315	-9.8%
Gross emissions	**82.548**	**82.244**	**-0.4%**
Forestry	5.908	2.588	-56%
Net emissions	**88.456**	**84.832**	**-4.1%**

Source: NZ 6th National Communication Table 5.16, p. 125

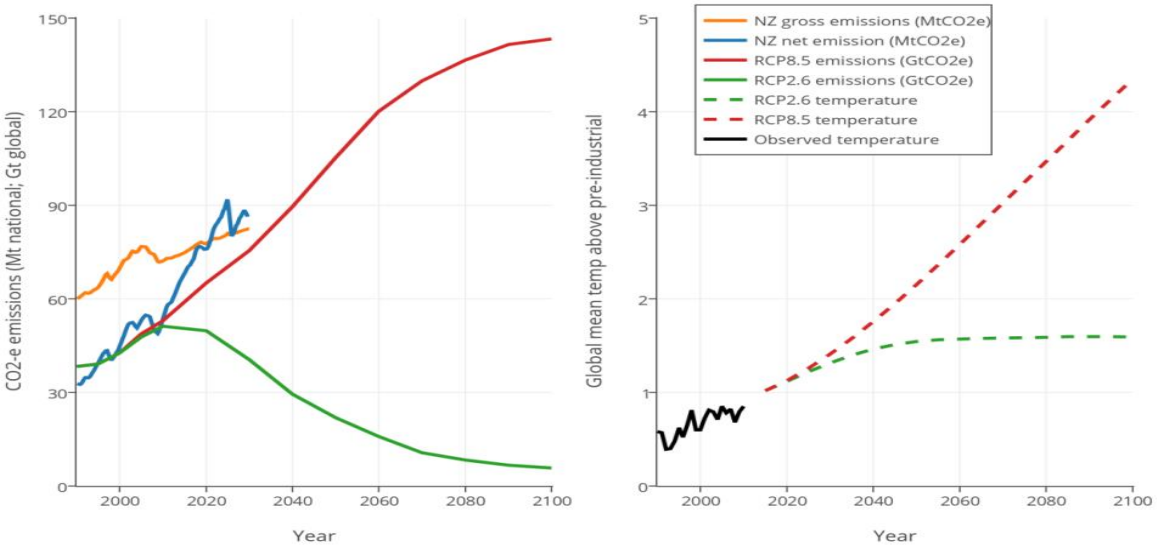
As noted earlier, a country's INDC for 2030 is an implicit commitment by that country to a specific global temperature target. This holds also for its emission projections for the same year. Figure B depicts the consequence for global temperature rise of New Zealand's current emissions projections; calculated on the basis that all countries emulated the NZ projections at a proportionate level. Graphs (i) and (ii) show the impact of NZ policy settings on the global temperature if all other countries emitted proportionately the same. The two graphs, taken together, record our national emissions and the world's global emissions in the context of two of the four Representative Concentration Pathways used by the IPCC; the highest (RCP8.5) and the lowest (RCP2.6) being shown here.

The twin graphs below show that New Zealand's relative emissions are significantly above the highest (worst) scenario (RCP8.5). That scenario (depicted by the red lines and resulting in a temperature increase of 4.3°C) is in the category of what has been described as 'catastrophic' climate change.

[11] The NZ 6NC's reported 1990 base emissions are earlier figures that derive from/are consistent with NZ's 1990-2011 Greenhouse Gas Inventory http://www.mfe.govt.nz/publications/climate-change-environmental-reporting/new-zealands-greenhouse-gas-inventory-1990%E2%80%932011, They therefore differ from other more recently-derived base 1990 figures used in this paper.

Figure B

(i) (ii)



[Notes:

(i) Graph (i) Y axis measures tonnes of CO_2-e emissions. The scale is 0 to 150. NZ emissions are in the millions (Mt.). Global emissions are in the billions (Gt.).

(ii) Graph (ii) (Y axis measures the global mean temperature increase, based on the IPCC-AR5 report (2013/14).

(iii) In both graphs the X axis records the time-period 1990 to 2100.]

(b) Methodology and Assumptions for an Ambitious 2030 Target

I have not undertaken a General Equilibrium Analysis to determine the fiscal and economic impact of the emission reductions calculated in section (c) below. The calculations I have advanced are based on the judgement that ambitious domestic abatement is required of all developed countries between now and 2030, and that the negative impact of anything less than the figures below will impose greater cost to our macro-economic interests.

Two issues require clarification regarding methodology and assumptions I have entered on the calculations for the 2030 Domestic Abatement Target: the UN's reporting and accounting rules; and the role of least-cost abatement methodology.

Reporting and accounting

The rules for reporting and accounting for greenhouse gas emissions to the United Nations are complex. Those governing most of the major sectors – energy, industry and waste – are relatively simple. But the remaining two sectors – agriculture and LULUCF (land use, land-use change, and forestry) in which New Zealand is heavily impacted – are complex and largely unresolved.

With regard to LULUCF, there are fundamental distinctions between the Framework Convention reporting and the Kyoto Protocol rules for reporting and accounting. Although New Zealand has elected to take its 2020 target under the Convention, it remains party to the Kyoto Protocol and has declared that it will continue to apply Protocol rules for its accounting against the target. It is likely that this will also apply to the 2030 target, or at least Kyoto-derived rules will be adopted for implementation of the Paris Agreement.

Under the Protocol, a distinction exists between post-1989 forestry and pre-1990 forest land (natural and plantation):

- For the 1st commitment period (2008-12), it was mandatory for developed countries to report all activities on post-'89 forestry (afforestation, reforestation, and deforestation).[12] These comprise emissions reported under article 3.3. Accounting under article 3.4 for activities on pre-'90 forest land (forest management; cropland management; grazing land management; re-vegetation; wetlands; settlements and other) was optional for this period.[13] New Zealand elected not to declare.
- For CP-2 (2013-20), reporting and accounting continues in the same way for emissions under article 3.3 and, for article 3.4, forest management (FM) is mandatory but the other six categories of activity remain optional. New Zealand has not taken any commitment under the Protocol for CP-2, but has indicated it will continue to act under its rules. It has, however, elected not to be accountable for the six optional categories for this period.

For the 2030 targets, the international rules for declaring and accounting remain undefined. They will be subject to negotiation and agreement, wither at Paris or afterwards. It is not clear that New Zealand will choose to declare all article 3.4 activities for its 2030 Target. It is, however, likely that all activities will be required. In this paper I have included all activities under Kyoto articles 3.3 and 3.4 in the NZ Target – principally for the reason that the climate is supremely indifferent to UN diplomatic negotiations.

Least-cost abatement

Least-cost abatement is the preferred economic principle for pollution-reduction measures, both in the public sector and the private sector. At the micro-economic level, a marginal abatement cost curve (MAC) derives the supply function for modelling the carbon-price fundamentals in emission reductions by corporations. At the macro-economic level, it is of use in official planning for fiscal control of such reductions. It has been cautioned, however, that MAC curves should not be used as abatement supply-curves for the purpose of deciding which measures to implement to achieve a given emission-reduction target. Some options may take decades to implement, and it may in fact be optimal to implement more expensive but higher-potential measures before introducing cheaper measures.[14]

MAC studies have been undertaken in US and Australia (McKinsey & Co) and Germany (Wuppertal Institute). In Australia, a study of a low-carbon pathway to 2030, based on a MAC approach, was initially done by McKinsey in 2008, and this has been updated in 2015 by RepuTex. The latest analysis indicates that "Australia's 2030 emissions reduction opportunities are rapidly decreasing, with policy uncertainty and delays in investment leaving the economy with fewer options to reduce emissions, and a higher cost to implementing GHG abatement projects."[15] In New Zealand, despite initial interest by Treasury the influence of least-cost abatement studies on NZ climate reduction policy has been limited.[16] The most recent study by Landcare shows marginal abatement curves for New Zealand (and the world) for 2027 for six sectors: primary production, secondary energy, manufactured goods (both energy-intensive and non-intensive), value-added agriculture and transport.[17] It appears that these have not influenced current governmental thinking. For analysis in this paper, I consider it more important to explore the technical potential for domestic abatement in 2030. The role of a MAC study in assisting achievement of that target would be left to the proposed independent Climate Commission in submitting its advice to government.

(c) Calculation of a Domestic Abatement Target 2030

In this section I seek to calculate an ambitious, yet credible and feasible, domestic abatement target for New Zealand in 2030. The method involves a two-step process:

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[12] Kyoto Protocol, Article 3.3. Deforestation also included any deforestation of pre-90 forest.

[13] Kyoto Protocol, Article 3.4

[14] "Decision-makers facing abatement targets need to decide which abatement measures to implement, and in which order. Measure-explicit marginal abatement cost curves depict the cost and abating potential of available mitigation options. …. Because the measures required to achieve ambitious emission reductions cannot be implemented overnight, the optimal strategy to reach a short-term target depends on longer-term targets. For instance, the best strategy to achieve Europe's −20% by 2020 target may be to implement some expensive, high-potential, and long-to-implement options required to meet the −75% by 2050 target. Using just the cheapest abatement options to reach the 2020 target can create a carbon-intensive lock-in and make the 2050 target too expensive to reach. Designing mitigation policies requires information on the speed at which various measures to curb greenhouse gas emissions can be implemented, in addition to the information on the costs and potential of such measures provided by marginal abatement cost curves." Vogt-Schilb A. & Hallegatte S. '*Marginal abatement cost curves and the optimal timing of mitigation measures' in Energy Policy* 66: pp. 645-653 (2014)

[15] http://www.reputex.com/publications/market-update/market-update-an-updated-mac-curve-for-australia/

[16] Such studies are known to have been done for Australia, UK, Sweden and Switzerland.

[17] Landcare Research, *'The Climate Mitigation, Adaptation and Trade in Dynamic General Equilibrium (CLIMAT-DGE) Model* (Technical Document, April 2015), Figures 12 & 13, pp. 32 & 33.

(i) Adopt a straight-line abatement from 2015 to zero net emissions in 2050, thereby determining a Domestic Target for New Zealand in 2030;

(ii) Assess the feasibility of such a target by identifying a range in abatement potential for New Zealand in 2030, whose calculations rest on a set of 'benign assumptions'.

The domestic abatement I calculate rests on the view that fiscal policy plus complementary measures should result in successful decoupling of New Zealand's emissions curve from its economic growth curve.[18]

(i) Straight-line abatement

Table 3 shows the decadal target figures which I have calculated on a straight-line basis.

Table 3
NZ Domestic Abatement Levels for Climate Neutrality 2015-50

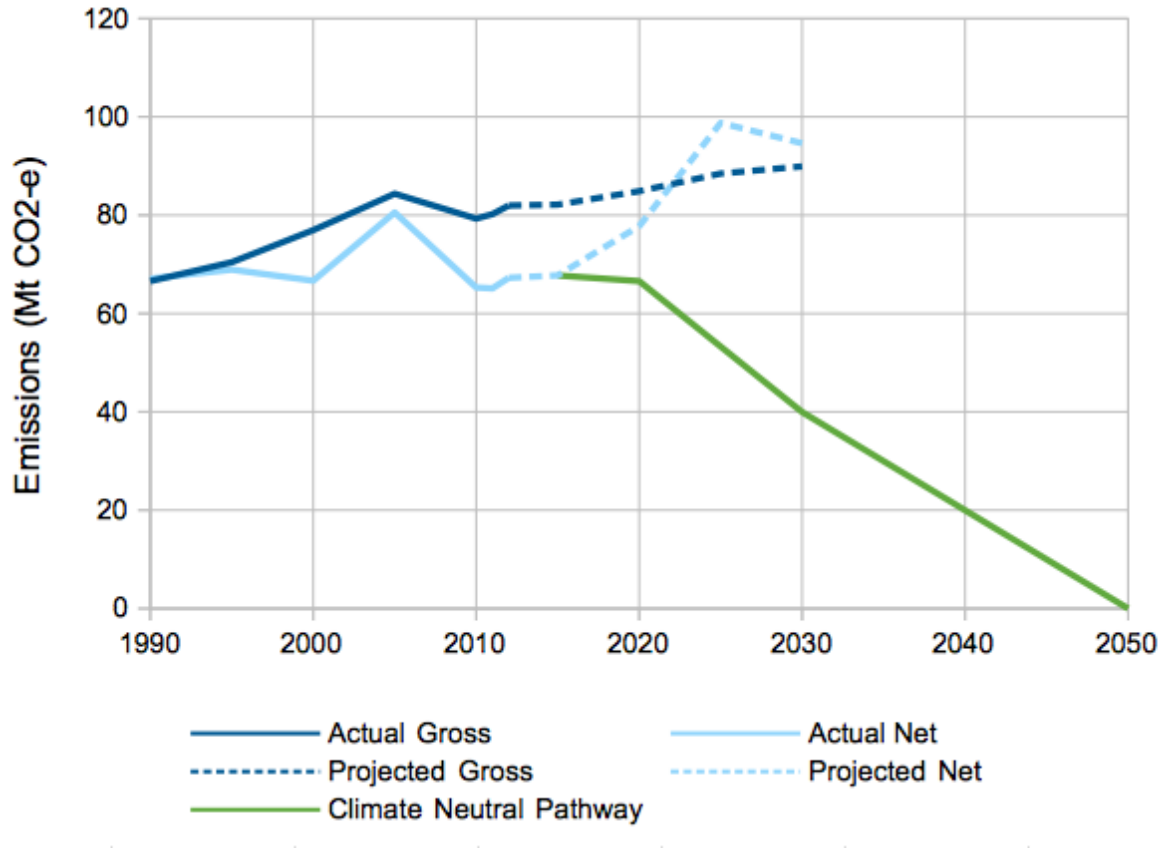
	'Climate neutral' targets				**NZ official projections**	**NZ Govt. targets**	
	% of 1990	*Mt CO_2-e*		*% off 1990*	*Mt CO_2-e*	*% off 1990*	*Mt CO_2-e*
Actual		Gross	Net[19]		Net		Net
1990		66.7					
2012		82.0	67.3				
Projected							
2015					67.8		
2020	100%		**67**	**0%**	77.8	5%	63
2030	**60%**		**40**	**40%**	94.6		
2040	30%		**20**	**70%**			
2050	0%		**0**	**100%**		50%	33

Note:
- *The figures in green are the proposed quantitative emission targets and the corresponding percentage targets, for the years identified.*
- *Govt. projections are taken from Table 1, but recalculated on the basis of the new GWP metrics and the 2014 Briefing to Incoming Ministers.[20] They therefore differ from the figures in Tables 1 and 2, which are based on the old metrics.*

The figures in Table 3 are displayed graphically in Figure C, with the Domestic Abatement Curve projected to 2050.

[18] In stating this, I make no value judgement about GDP economic growth as such in this paper. Separate work has been undertaken for incorporating sustainability indicators into NZ macro-economic planning through amendments to the Public Finance Act 1989.
[19] Net emissions under Kyoto Protocol accounting
[20] Background File Note of 25 May 2015

Figure C
NZ Domestic Abatement Curve for Climate Neutrality: 2015-50 (net greenhouse gas emissions)



It is possible that the climate-neutral pathway could be non-linear, based on a quadratic curve rather than straight-line, with small relative reductions to begin with, but accelerating to large reductions at period end, so that overall area-under-curve ('budget') is kept within limits and the budget for net greenhouse gas emissions is not violated. That is, it would be 'softened' over the first part of the period (2015 to 2030) with a lesser gradient but then 'hardened' over the second part (2030 to '50) as the results of transformational investment take effect. That would result in a lesser target for 2030 of perhaps 35% rather than the 40% selected. I have chosen to retain the 40% target since (a) it more accurately reflects the 'ambition' called for by world leaders, and (b) because the higher target means less NZ financial support required for abatement elsewhere.

(ii) Maximum Potential Abatement

Is it feasible to achieve the abatement reductions identified in Table 3? This section demonstrates that it is.
I have undertaken multifaceted research to explore the feasibility of an ambitious domestic abatement pathway for New Zealand. The question to address is:
What is the maximum (range) of emissions reduction by New Zealand in 2030, adopting the following set of 'benign assumptions':

(i) *An optimal set of price signals, fiscal incentives and complementary measures by Government*
(ii) *Political will based on a cross-party consensus*
(iii) *Commitment in all economic sectors, with public-private sector collaboration*
(iv) *Straight-line improvements in technology in each economic sector*
(v) *Good practice in broader sustainable goals in each economic sector*

Abatement measures and results in each sector (energy, industry, agriculture, waste and LULUCF) depend on a complex mix of value judgements and policy choices. It would be artificial to identify one specific abatement figure for the more complex sectors, and thus for New Zealand as a whole, at least in a predictive sense. I therefore have identified a 'high' and 'moderate' ambition range for the three major sectors, and a cumulative 'high' and 'moderate' range for the country. It is nonetheless possible to derive a single aspirational target from within the range, and I have done this, as well.

In each of the remaining sectors (industry, waste), I have derived specific numerical values based on (a) emulation of good practice elsewhere (primarily EU standards) and (b) transformation from large and polluting emitting practice to clean technology over the 15-year period.

The summary results of such a range, sector-by-sector, are shown in Appendix 1 to this paper. The supporting work for the all sectors is contained in the separate Annex A.[21]The ranges, by sector, are shown in Table 4.

Table 4
Ranges of Domestic Abatement by Sector

	1990	2030			
		Govt. Projections	Potential Abatement		
			Moderate Ambition	High Ambition	Range
Energy	23.8	34.4	**24.0**	**16.7**	**7.3**
Industry	3.3	6.1		**2.9**	**n. a.**
Agriculture	34.4	44.3	**37.7**	**29.3**	**8.4**
Waste	5.1	5.1		**1.5**	**n. a.**
LULUCF			**-14.1**	**-34.5**	**20.4**

Table 4 shows, in effect, a snapshot of 'policy elasticity'. Depending on policies adopted, the range for reductions in gross emissions is significant in energy and agriculture (15.7 Mt combined). But the greatest range for New Zealand to reduce its net emissions is to be found in land use and particularly forestry (20.4 Mt). In the short-term (2016-30), land-use and forestry policy is critical.

The above sectoral ranges are compiled in an overall domestic abatement range in 2030, shown in Table 5 (a).

Table 5 (a)
***'Raising the Ambition'* – The Total Range of Abatement Potential in 2030**

	'Climate Neutral' Targets			NZ Govt. Projections	NZ Govt. Targets	
	Mt CO_2-e		*% off 1990 (gross to net)*	*Mt CO_2-e*	*% off 1990*	*Mt CO_2-e*
Actual	Gross	Net		Net		Net
1990	66.7					
2012	82.0	67.3				
Projected						
2015	82.2	67.8		70		
2030 moderate	**66.1**	**51.9**	**22%**	100		
2030 high	**49.4**	**14.9**	**77%**			

Table 5 (a) shows that, with far-reaching proposals in all sectors, climate neutrality could in fact be reached well before 2050 and that a 2030 target anywhere between 22% and 77% could be entered for New Zealand, subject to policy.

An Aspirational Domestic Abatement Target

Table 5 (b) shows a scenario that reflects an aspirational Domestic Abatement Target for New Zealand in 2030.
While the scenario is close to the highest end of the ambition range as identified in Appendix 1, it is nonetheless technically feasible, adopting the 'set of benign assumptions' and the policies that would be required.

- It incorporates the 'high ambition' levels for gross emissions (energy, industry, agriculture and waste);
- It does not incorporate the highest ambition in LULUCF but includes scenario 7 of the Rapid Afforestation Scheme, which combines climate and biodiversity policies in a mixed tree species planting scheme, commencing with rapid-sequestering exotics over the first 13 years.

The result is encouraging; it shows that New Zealand could, with the correct policies, feasibly reduce greenhouse gas emissions from 66.7 Mt (gross) in 1990 to 17.2 Mt (net) in 2030. This would comprise a 74% reduction.

[21] The information supporting the tables in the annexes is contained in spreadsheets, available on request.

Table 5 (b)
An Aspirational Domestic Abatement Target in 2030 (Mt CO_2-e)

Sector/ Category	Policy	Actual (Mt CO_2-e)		Potential (Mt CO_2-e)	
		1990		2030	
Energy			**23.8**		**15.7**
Electricity	Coal-free (2020); 100% renewable (2030) Low scenario geothermal fugitives	3.5		0.0	
Transport	Light vehicle travel: 2% p.a. decline Light vehicle efficiency: 100gCO2//km Heavy, aviation, marine, rail: flat liquid fuel demand plus 40 PJ biofuel uptake	8.7		6.8	
Other FF combustion	Coal use reduce by 90% off 2015 Liquid fuel use reduce by 40% off 2015	7.6		6.6	
Transformation	Proportionate to oil consumption reduction	2.5		0.7	
Fugitives	Geothermal: Low scenario Other: same as base-line projection	1.5		1.6	
Industry	Emulate EU standards; Tiwai closure; green coke for biomass		**3.3**		**2.9**
Agriculture	Co-benefit scenario:		**34.5**		**29.3**
Dairy	Herd 6,000; productivity 95%; inhibitor effect 0.5	7.4		11.7	
Beef	Herd 3,200; productivity 175%; inhibitor effect 0.3	6.3		5.4	
Sheep	Flock 23,140; productivity 150%; inhibitor effect 0.2	15.8		7.9	
Other		0.9		1.5	
Waste	Emulate UK standards		**5.1**		**1.5**
GROSS			**66.7**		**49.4**
LULUCF	LULUCF (incl. Scenario 7: 50,000 ha pine planted and left over first 13 years, native planted over second 13 years)		0		-32.2
NET			**66.7**		**17.2**

Note: The agriculture emissions, by sector, totalling 26.5 Mt., are based on the old GWP metrics, and the total has therefore been recalculated, on the basis of the new metrics, at 29.3Mt.

QELROs and Decadal Budgets

The two targets addressed in this section (the 40 Mt 'committed target' and the 17.2 Mt 'aspirational target') are specific to the year 2030. To get to either one of those targets, it will be necessary to calculate the corresponding QELRO[22] and budget for the decade 2021-30. The methodology by which this is done is set out in the separate Annex B. A summary of the results is shown in Appendix 2 to this paper. In short:

- The 'committed target' of 40% for 2030, at the emissions level of 40 Mt, results in a decadal Target Budget of 490 Mt., with a QELRO of 49 Mt;
- The 'aspirational target' of 74% for 2030, at the emissions level of 17.2 Mt, results in a decadal Target Budget of 423 Mt, with a QELRO of 42.3 Mt.

A Climate Change Commission

Identifying the optimal policy-mix and pathway for the Domestic Abatement Target would be the task of an independent Climate Commission to recommend to government, similar to the British Committee on Climate Change .[23] The approach set out in this paper illustrates that, technically, an ambitious INDC can be entered by New Zealand for 2030, with a feasible pathway to far-reaching domestic abatement that rests on an effective carbon price signal and broad complementary measures.

[22] 'Quantified Emission Limitation and Reduction Obligation', calculated as the annual average emissions for the decade.
[23] This will be assisted by the work currently underway by the NZ 2050 Pathways Project, whose aim is to produce an interactive tool for users to construct pathways to 2050 based on an inter-sectoral analysis of New Zealand's domestic abatement potential, including by 2030. The work is based on the British model which has a '2050 Calculator' that demonstrates such pathways for the British national objective of 80% abatement (2050/1990). This will, when completed, allow a more accurate judgement of feasible domestic abatement by New Zealand in 2030.

3. **The National Responsibility Level (the INDC)**

What is New Zealand's national responsibility level – its appropriate share – in the global abatement effort?

Continuing debate within the UNFCCC negotiations over the status and applicability of the equity principles contained in the Framework Convention has prevented formal agreement on the national responsibility levels, and resulted in a retreat to voluntary contributions with a peer review process instead.

Outside of the negotiations, however, research and modelling by independent institutes has enabled calculations to be undertaken on an all-gases basis with credible reliance on the principles of equity for determining national shares. In this section, I explore what is possible, and feasible, in determining a National Responsibility Level as an appropriate share of the global carbon budget.

Under this approach, it is recognised that each country's share of global responsibility and capacity best determines its share of the global abatement effort, and provides the legitimacy required for an effective global agreement. A country's share is thus expressed as a sum of domestic abatement plus its support for international abatement elsewhere.

This offers the potential of allowing a meaningful 'top-down' approach to guide the 'bottom-up' approach that is underpinning the preparations for Paris. In our view, using distinguishing terms such as 'top-down' and 'bottom-up' convey a false binary; and if handled skilfully the two approaches positively integrate to good effect.

(a) Choice of Method and Models

Table 6 identifies the main categories of analysis for effort-sharing and describes the various models that are based on them. Considerable work has been undertaken to develop effort-sharing models, with some more developed and comprehensive than others.[24] Each of these models has advantages and limitations. The most well-known are the historical responsibility, economic capacity, contraction and convergence, and marginal abatement cost models. The various models generate different results, reflecting different assumptions and their interplay. However, the more recent models, such as the Climate Equity Reference Framework (CERF), are more developed in that they combine several of the categories in the one model.[25] Details of the Framework are shown in the separate Annex C.

Table 6
Categories of Effort-sharing Proposals

Categories	Choice	Description
A. Responsibility	A	The concept to use historical emissions to derive emission goals was first directly proposed by Brazil in the run-up of the Kyoto negotiations (UNFCCC, 1997), without allocations. Allowances based only on this principle were quantified by only a few studies.
B. Capacity	B	Frequently used for allocation relating reduction goals or reduction costs to GDP or human development index (HDI). This includes also approaches that are focused exclusively on basic needs.
C. Equity	C	A multitude of studies provide allocations based on immediate or converging per capita emissions (e. g. Agarwal and Narain, 1991; Meyer, 2000). Later studies refine the approach using also p.c. distributions within countries (e. g. Chakravarty et al., 2009).
D. Responsibility, capacity & need	A, B	Recent studies used responsibility and capability explicitly as a basis, e. g., Greenhouse Development Rights (Baer et al., 2008); or 'Responsibility, Capability, and Sustainable Development'(Winkler et al., 2011)
E. Equal cumulative p.c. emissions	A, C	Several studies allocate equal cumulative per capita emission rights based on a global carbon budget (Pan, 2005, 2008). Studies diverge on how they assign the resulting budget for a country to individual years.

[24] See the cataloguing the range of models.
[25] The only shortcoming of the CERP model is that it relies on the WRI-CAIT figures, which are presently based on the original GWP metrics. This is being rectified shortly, with an update reflecting the new metrics recommended by IPCC-AR4. As a broad interim adjustment, it is sufficient to increase the figures by 5% to 10% for gross GHG emissions for NZ, more for net emissions.

F. Staged Approaches	A, B, C	A suite of studies propose or analyse approaches, where countries take differentiated commitments in various stages. Also approaches based on allocation for sectors such as the Triptych approach (Phylipsen et al., 1998) or sectoral approaches are included here. Categorisation to a stage and the respective commitments are determined by indicators using all four equity principles. Finally, studies using equal percentage reduction goals, also called grandfathering, are also placed in this category.
G. Equal marginal abatement costs		Modelling studies often use the allocations that would emerge from a global carbon price as a reference case for comparing other allocations.

References: A[26], B[27], C[28], D[29], E[30], F[31], G[32]; full citations in IPCC AR5 WG3 chapter 6
Source: IPCC 5th Assessment Report, Working Group III, chapter 6, 'Assessing Transformation Pathways', p. 458 Table 6.5 (sourced in turn from Höhne, den Elzen, Escalante. Climate Policy 2014;14(1):122–147)

(b) Effort-sharing Models applied to New Zealand

New Zealand is particularly sensitive to the type of model used. In general, the full range over all effort-sharing categories is small for countries that are large and therefore influence the average (e.g. China) or that have an average emission profile (e.g. Mexico). Effort-sharing results for these countries are always average, regardless of the approach. The ranges are larger for countries which are small or have unusual emissions profiles (e.g. Kazakhstan or New Zealand). For these countries, the choice of the effort-sharing approach makes a large difference to their responsibility level.[33]

Applying the various models to New Zealand produces a range of values for its appropriate share of the global carbon budget based on the 2ºC threshold, as shown in Table 7 and Figure D.

The range in gross greenhouse emissions across all possible models is large – from 18.1 to 46.2 Mt (setting aside the country count model and the population *per capita* model, reported below). In our view, the two most appropriate models, having regard to the equity principles, are Contraction - Convergence and the Global Development Rights Framework (where the range in gross emissions is 18.1 to 22.2 Mt). For the reasons advanced above and informed by previous NZ studies, I have used the Climate Equity Reference Framework for New Zealand, and thus the figure of 18.1 Mt. gross emissions.[34]

For net emissions the range between these two models is 5.4 to 23.4 Mt CO2-e. Again, I have selected 5.4 Mt as the most appropriate National Responsibility Level for New Zealand's net emissions.[35]

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[26] Berk & den Elzen (2001)*, Den Elzen et al. (2005); Den Elzen & Lucas (2005)
[27] Den Elzen & Lucas (2005); Knopf et al. (2011); Jacoby et al. (2009); Miketa & Schrattenholzer (2006); Kriegler et al. (2013b) & Tavoni et al. (2013)
[28] Berk & den Elzen (2001)*, Kriegler et al. (2013b) & Tavoni et al. (2013)**, Böhringer & Welsch (2006); Bows & Anderson (2008); Chakravarty et al. (2009); Criqui et al.(2003); Den Elzen & Lucas (2005); Den Elzen & Meinshausen (2006); Den Elzen et al.(2005, 2008); Edenhofer et al. (2010); Hof et al. (2010b); Höhne & Moltmann (2008, 2009); Knopf et al.(2009, 2011); Kuntsi-Reunanen & Luukkanen (2006); Nabel et al. (2011); Miketa & Schrattenholzer (2006); Peterson & Klepper
[29] Baer et al. (2008); Baer (2013); Höhne & Moltmann (2008, 2009); Winkler et al. (2011)
[30] Bode (2004); Nabel et al. (2011); Jayaraman et al. (2011); Schellnhuber et al. (2009);
[31] Bosetti & Frankel (2012); Criqui et al. (2003); Den Elzen & Lucas (2005); Den Elzen & Meinshausen (2006); Den Elzen et al. (2007, 2008, 2012); Hof et al.(2010a); Höhne & Moltmann (2008, 2009); Höhne et al.(2005, 2006); Knopf et al. (2011); Vaillancourt & Waaub (2004); Peterson & Klepper (2007); Böhringer & Welsch (2006); Knopf et al.(2011) Berk & den Elzen (2001)
[32] Peterson & Klepper (2007), Van Vuuren et al. (2009a), Kriegler et al. (2013b) & Tavoni et al. (2011)
[33] http://climateactiontracker.org/methodology/85/Comparability-of-effort.html
[34] Metcalfe S, Woodward A, Macmillan A, et al. Why New Zealand must rapidly halve its greenhouse gas emissions. N Z Med J. 2009;122:72-95. http://www.orataiao.org.nz/file/view/Metcalfe%20et%20al%20NZMJ%202009.pdf; NZ College of Public Health Medicine. Supplement One – Background to the NZCPHM's stance on setting national GHG emissions targets. Wellington: NZCPHM, 2013. http://www.nzcphm.org.nz/policy-publications
[35] Note all of these target values, gross and net, are based on old GWP-based emissions baseline values, see Annex D for further details.

Table 7
NZ National Responsibility Level: Models and Range (Mt CO_2-e)

	Gross 2030	Net 2030	Gross/net 2015-30	Net off 1990*	Description
Baseline projection	95.4	65.2	1,401.8	57%	No change; no contribution
NRL Models					
Country count	-71.8		-85.3	-218%	1/195th of global contribution
Population *p.c.* contribution	74.8		1,218.7	-23%	0.06% global population, from 2015
GDP-based contribution	46.2		964.9	-24%	0.15% global GDP, from 2015
Current emissions-based	41.7		924.1	-31%	0.16% global GHG, from 2015
Cumulative emissions-based	32.7		844.2	-46%	0.19% global GHG, from 1990
Contraction - Convergence					Convergence of p.c. global emissions**
gross	22.2		715.4	-63%	
net		23.4	531.2	-61%	
CER Framework:***					Set of equity principles
gross	18.1		693.3	-71%	
net		5.4	365.7	-91%	

* 'Net off 1990' denotes % change from 1990 gross GHG levels (60.6 MtCO2-e, using old GWPs from NZ's GGI 1990-2011 at http://www.mfe.govt.nz/publications/climate-change-environmental-reporting/new-zealands-greenhouse-gas-inventory-1990%E2%80%932011)
** Some C&C *per capita* models converge at 2050. The data is stable until 2030, so is selected that year for analysis.
*** CER Framework, with selected assumptions identified in Annex C (separate paper).
Source: CER calculator data at http://calculator.climateequityreference.org/ from the Climate Equity Reference Project (CERP), based on GDRf.[36]. ***Data as of 1 September 2015****. Note CERP data have not yet adjusted for new GWP-based emissions baselines and hence targets.*

Thus, as shown in Annex C, for a 2°C pathway, emissions in 2030 need to be as follows:

- Global gross emissions, currently projected to be 68.3 Gt, will need to fall to 35.7 Gt. (4.3 tonnes p.c.);
- Global net emissions, currently projected to be 71.4 Gt, will need to fall to 37.7 Gt. (4.5 tonnes p.c.);

New Zealand has a Responsibility-Capacity Index (RCI) of 0.256; i.e. its share of the Global GHG Budget is 0.256%. On this basis:

- NZ gross emissions, currently projected to be 95.4 Mt, will need to fall to 18.0 Mt. (3.5 tonnes p.c.);
- NZ net emissions, currently projected to be 65.0 Mt, will need to fall to 5.4 Mt. (1.0 tonne p.c.).

[36] Spreadsheets downloadable from http://calculator.climateequityreference.org/. This analysis uses 2'C pathway, cumulative emissions since 1990, mid-equity settings. CERP at http://climateequityreference.org/the-climate-equity-reference-project/; source assumptions/inputs in the CERc in multiple links at http://climateequityreference.org/calculator-about/. Modelling for NZ uses MS Excel pivot tables etc. generate models additional to CERF. CERP data as at **1 September 2015**, v3.0.0/6.8.2s .

Figure D
Distributive/allocative models for New Zealand, 1990-2030
(gross and net emissions Mt CO_2–e)

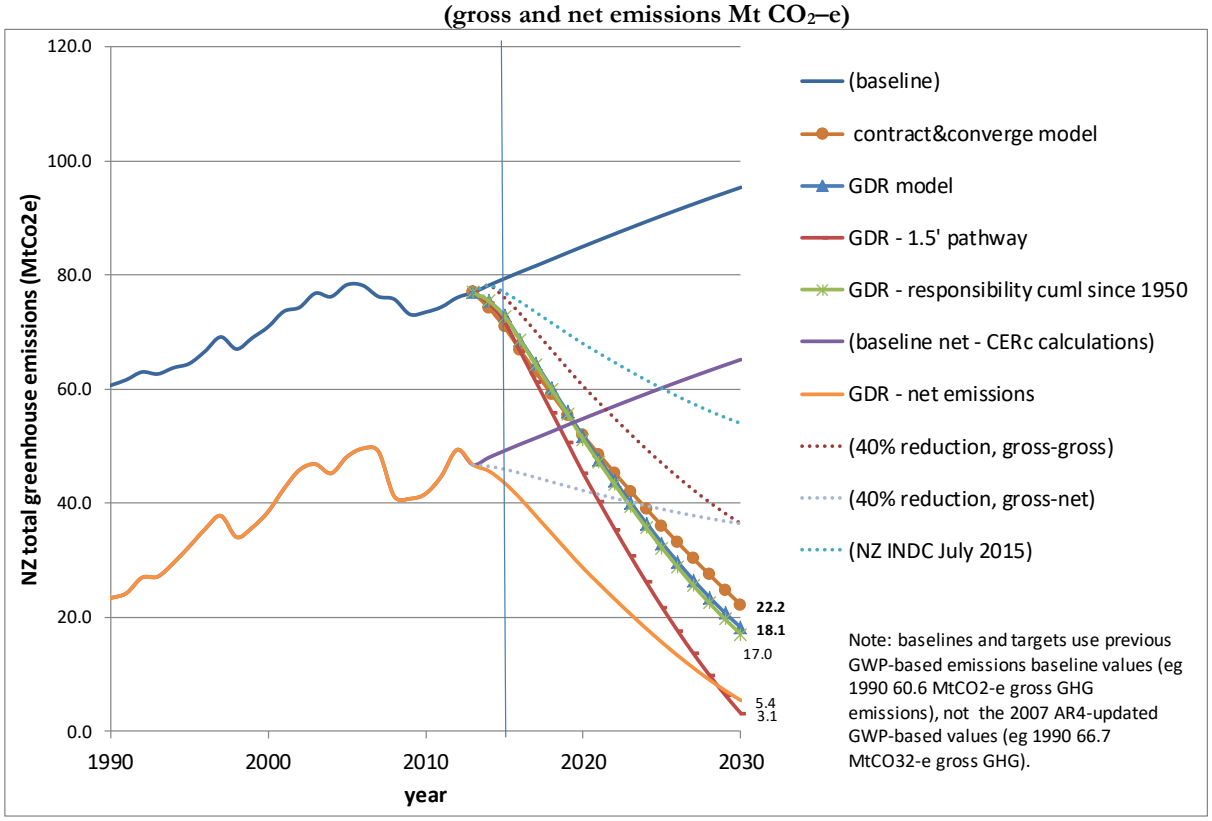
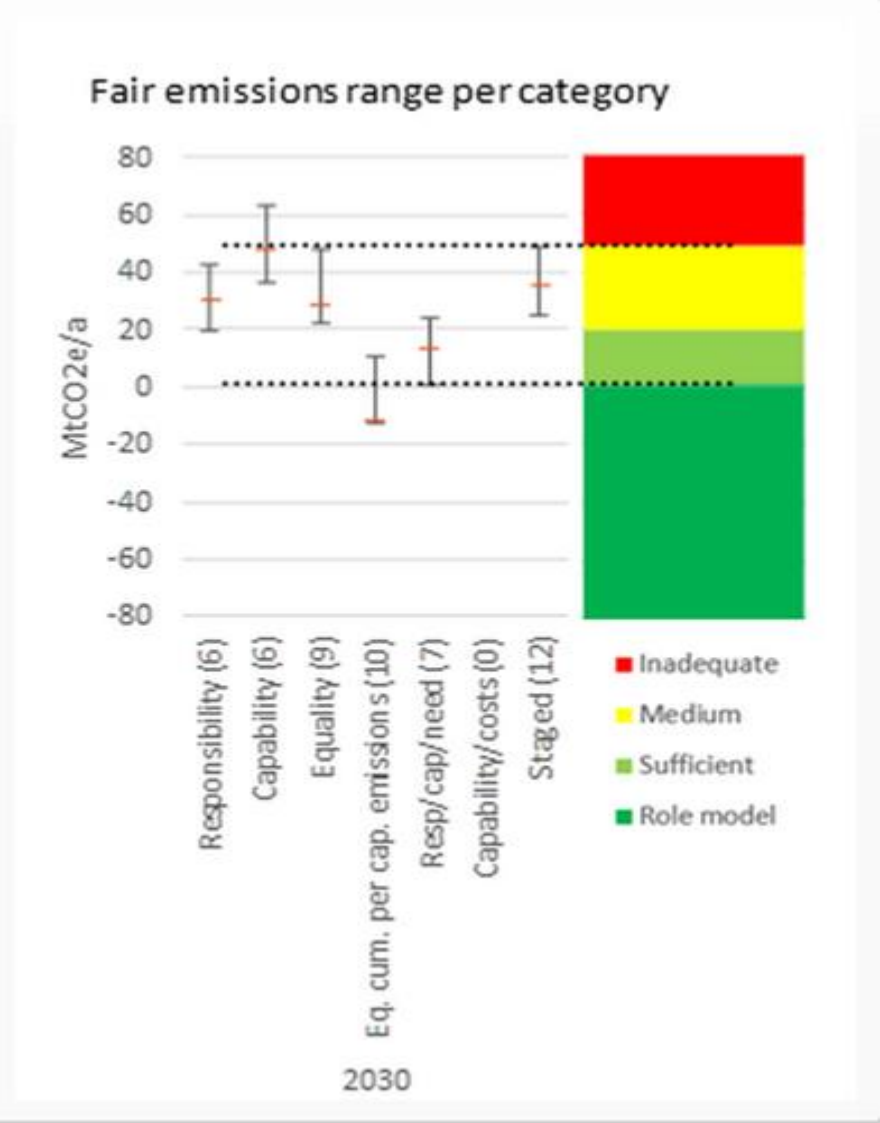


Figure E shows the wide variation in New Zealand's appropriate shares generated by the different models described in Table 6. The figure shows best-estimate mid-points for gross GHF emissions targets, ranging, for the model categories, from -10 Mt to +50 Mt CO_2-e.

Similarly, figures F and G show ranges of values over time for such models based on per capita population, GDP, current emissions, and associated factors.

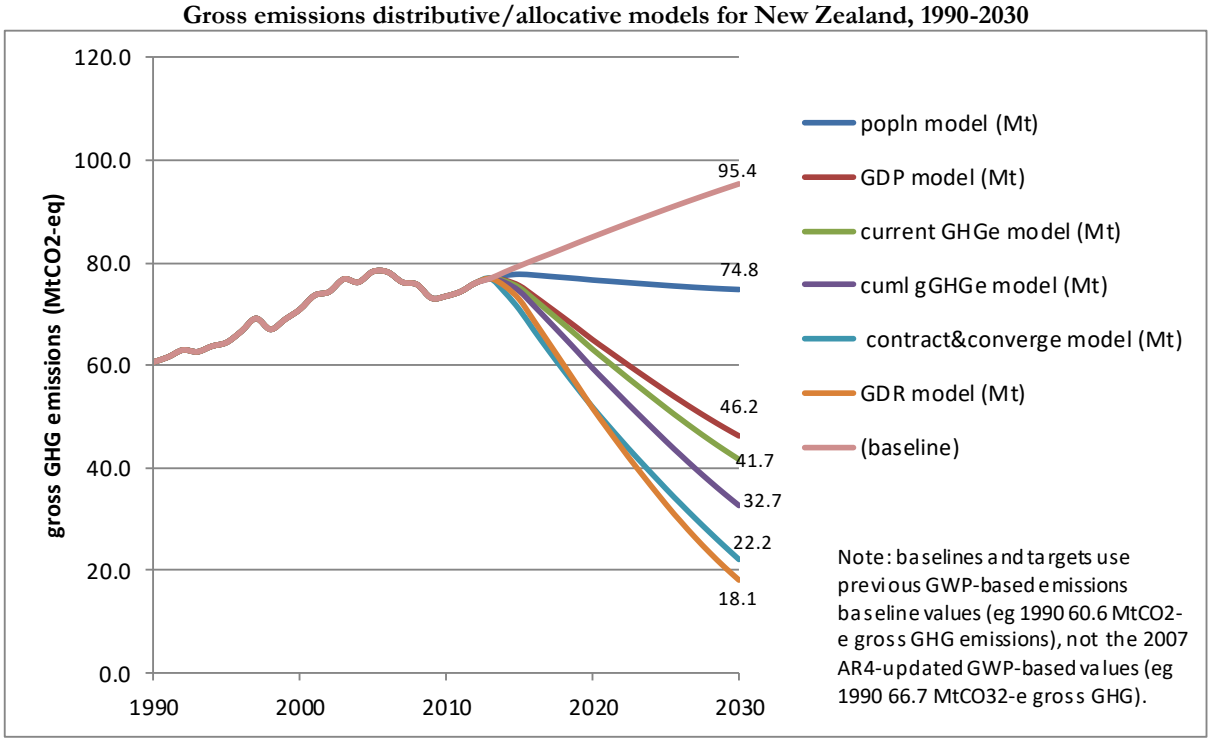
Figure E



Source: Climate Action Tracker, from image at http://climateactiontracker.org/countries/newzealand.html, targets for 2030 for gross GHG emissions.

Best-estimate midpoints for the models -10Mt to +50Mt CO2-e; CERF is the 5th of the 6 bars*
(assumptions etc. at http://climateactiontracker.org/methodology/85/Comparability-of-effort.htm, sourced in turn largely from Höhne et al. Climate Policy 2014;14(1):122–147
http://www.tandfonline.com/doi/abs/10.1080/14693062.2014.849452, source data in Supplemental content at http://www.tandfonline.com/doi/suppl/10.1080/14693062.2014.849452/suppl_file/tcpo_a_849452_sm2285.xlsx)
Targets are unadjusted for new GWP-based emissions baselines.
* The model inputs used by Höhne et al (and in turn Climate Action Tracker) are based on CERF assumptions as published in 2008, which have since been substantially superseded. These are aggregated models for Japan, Australia & NZ combined.

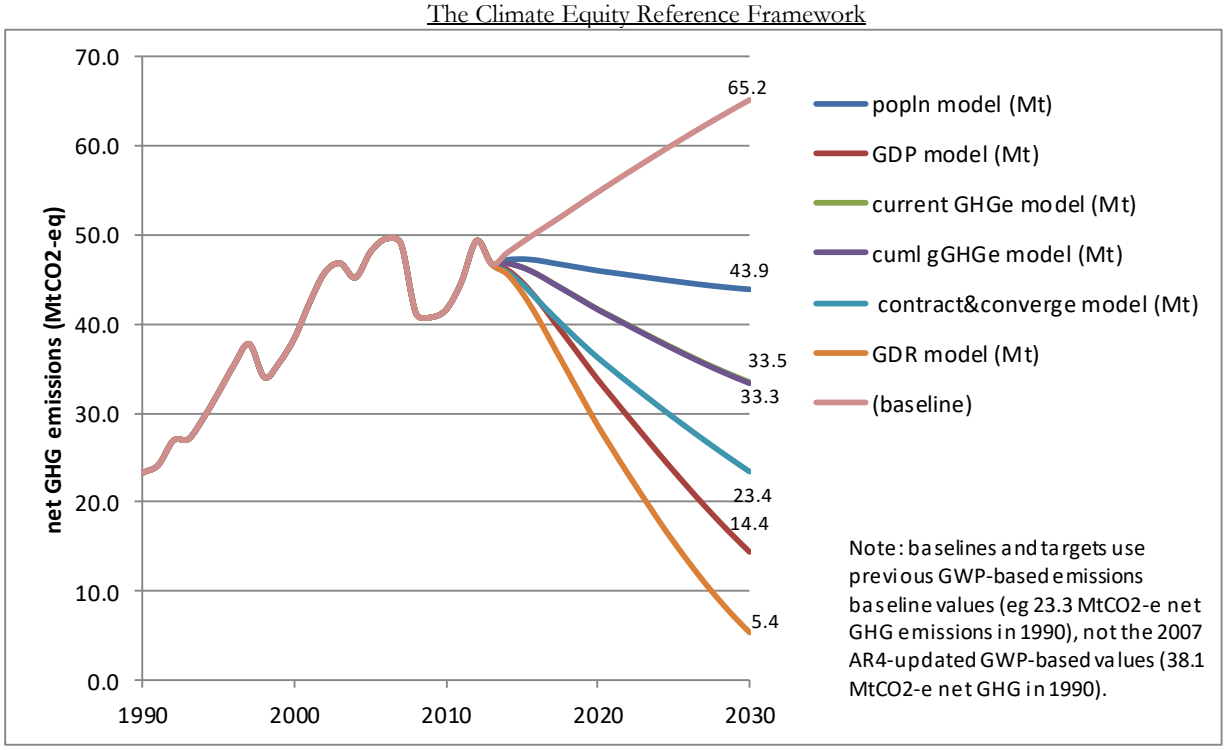
Figure F
Gross emissions distributive/allocative models for New Zealand, 1990-2030



Key:

- popln model: NZ makes per capita contribution (0.06% of world population) to global effort (gap 2'C pathway vs baseline), 2015 onwards
- GDP model: NZ makes GDP-based contribution (its % of world GDP, 0.15%) to global effort (gap 2'C pathway vs baseline), 2015 onwards
- current GHG model: NZ contributes current GHG gross emissions (its % of world current emissions, 0.16%) for global effort (gap, 2015+)
- cuml GHG model: NZ contributes cumulative GHG gross emissions 1990-current (0.19% of world emissions 1990-current) for global effort
- contract&converge model: Contraction & Convergence (GCI) – convergence of per capita global emissions, transiting over time from grandparented to per capita emission rights
- CERF model: fair shares calculations for NZ, using 2'C pathway, cuml emissions 1990-current, capability=per capita GDP, etc.
- (baseline): baseline projections – no change, no contribution

Figure G
Net emissions distributive/allocative models for New Zealand, 1990-2030
The Climate Equity Reference Framework



As Figure E shows, the best-estimate midpoints for the models are -10 Mt to +50 Mt for gross GHG emissions. The CERF model is the fifth of the six bars shown in Figure E. Of the various models available, I have selected the Climate Equity Reference Project (CERP) to study, in more detail, its application to New Zealand.[37] The CERP gives a comprehensive analytical framework involving a number of factors from which to choose, by way of an on-line global calculator that is publicly available and whose methodology can be verified. These qualities make the CERP model the most appropriate one to use.[38] The CERP allows each country to find its share in the global abatement effort for a particular year, based on selected assumptions.[39] It introduces specified parameters: level of global ambition, equity settings, and domestic abatement potential. The settings selected are then applied in the context of a country's demographic and macro-economic indicators (population, GDP, carbon-intensity) to calculate its national share. It is explicitly designed to reflect the UNFCCC's core principles, using flexibly-defined national 'responsibility and capacity indicators':

- A country's 'responsibility' is the derivative of its 'contribution to the problem'

[37] The two main institutes which have developed global-national calculators are (a) a consortium of Stockholm Environment Institute (SEI) and Earth Island Institute, Berkeley, California (Eco-Equity Project); the Global Commons Institute (GCI) http://www.gci.org.uk/; and (c) World Resources Institute, Washington, DC (CAIT Equity Explorer). In this paper, I have used the SEI-Eco-Equity's Equity Reference Calculator.

[38] The only other relevant calculators I have located are the Climate Fair-shares Calculator (which uses the CERF) (http://www.climatefairshares.org/methodology and http://climate-justice.info/wp-content/uploads/2014/12/Infografia_climate_justice_print.pdf) and the Global Commons Institute's Carbon Budget Accounting Tool (CBAT) http://cbat.info/. The GCI's CBAT, which provide Contraction – Convergence model emissions targets, is confined to eight global regions and does not provide data for individual countries; New Zealand appears to be aggregated as part of 'Rest of Asia' (Asia minus China and India).
The World Resources Institute's CAIT calculator only provides indicators, and does not apportion shares.
Information that is publicly available promotes political confidence in the calculations which that is important to the legitimacy of any international agreement. Verification of methodology is equally important; in assessing the ERF methodology, I have had extensive discussion with the relevant institutes, and are satisfied that the framework is sound.

[39] SEI/Eco-Equity www.sei-international.org & www.gdrights.org 'National Fair Shares: The Abatement Gap – Domestic Action and International Support' (Stockholm Environment Institute & Eco-Equity; Nov 2014) http://www.gdrights.org/ accessed 21-2-15.

- Its 'capacity' is its 'ability to pay' (as a function of per-capita income and income distribution).[40]

No CERP report has been compiled for New Zealand as yet,[41] but it is possible nonetheless to use the Calculator to determine our share (NZ's Responsibility and Capacity Index, or 'RCI score').[42] The parameters and the variables for choice per country are shown in Annex C.

- The parameters for scenarios are: global abatement pathway; equity settings for the responsibility- capacity index; inclusion of gases; fiscal policy; historical responsibility; and abatement method.
- The variables I consider most appropriate for New Zealand are: the 2°C global abatement pathway; historical responsibility from 1990; relative weight for Responsibility/Capacity = 0.5; medium progressivity in fiscal policy; land-use emissions included; all greenhouse gases included; and emissions elasticity = 1.0.

The results for New Zealand, based on the above assumptions and choices, are shown in Annex C. The summary of the results for the world and for New Zealand are shown below in Table 8.

Table 8
NZ 'Responsibility-Capacity': The Climate Equity Reference Approach*

	1990 Mt. CO_2-e	2030 Mt. CO_2-e		% of 1990
Global	36,878	Baseline projection	71,426	
		Abatement required	33,685	
		2030 Allocation	37,741	102%
New Zealand	60	Baseline projection	95	
		Abatement required	88	
		2030 Allocation (NRL)	5.4	9%

* Figures for 1990 are gross emissions; those for 2030 are net emissions.
The NZ figure of 60.6 Mt gross for 1990 is based on the original GWP calculations (the recent updated GWPs estimate this to be 66.7 Mt). Further details are in Annex D.

Thus, adopting the CERP model alone, the figure of 18.1 Mt CO_2-e (before adjusting for new GWP-based baseline values) would be New Zealand's National Responsibility Level for 2030 (and our intervening gross greenhouse gas budget for the period 2015-30 would be 693 Mt CO_2-e). It is similar to that derived by using a Contraction & Convergence model, of 22.2 Mt CO_2-e (gross greenhouse gas budget of 715 Mt CO_2-e).

If, however, I were to look to the range of 5.4 to 23.4 Mt identified in Table 7, I would select the more demanding figure of 5.4 Mt as the National Responsibility Level, since it accounts for LULUCF. In the strictest of all worlds, if the global community is to meet the 2°C threshold and if every country, including New Zealand, is to accept the application of an equity framework to the global budget, this is what New Zealand should declare as its INDC.

The Significance for New Zealand of the National Responsibility Level

How closely New Zealand gets to its National Responsibility Level through domestic abatement alone is a policy choice. But if New Zealand chooses not to acknowledge a Level of this magnitude, it is obliged to do either of two things:

- nominate which other country it expects to make up for New Zealand's shortfall; or
- acknowledge the higher global temperature increase which a lower national responsibility level will incur.

Thus, to be true to the 2°C temperature objective, New Zealand should be prepared to make up any shortfall between its 2030 domestic abatement figure and its 2030 National Responsibility Level by supporting global abatement efforts elsewhere.

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[40] 'Capacity', the ability to meet 'responsibility' through domestic action, is essentially a relative term. Since the level of cost-effective domestic abatement is proportional to total global abatement, a country's 'capacity' is not fixed. If a country is trying to meet its responsibility in a cost-effective manner, it will continue to increase its domestic abatement as the global abatement level increases. As the global price rises, a country will do more domestically.

[41] A national report for Norway has been compiled: 'Norway's Fair Share of an Ambitious Climate Effort' http://www.sei-international.org/mediamanager/documents/Publications/Climate/SEI-KN-2014-Norways-fair-share.pdf

[42] The number of variables available, consequent upon the assumptions entered, makes for a potentially complex exercise. The full permutation allows at least 288 scenarios (4×2×4×3×3: 4 GHGs [fossil CO2 alone; fCO2 + LULUCF = CO2-alone; fCO2+non-CO2 = gross GHG; fCO2+nonCO2+ LULUCF = net GHG]; 2 mitigation pathways [1°C', 2°C]; 4 historical responsibility [from 1850, 1950, 1970, 1990]; 3 Responsibility vs. Capacity [100%, 50%, 0% Responsibility]; 3 Progressivity [no development threshold, $7,500 development threshold, $7,500 per capita development threshold + plus additional progressivity (luxury emissions threshold $50,000 per capita)]). The scenario used in the text above is, in our view, the most appropriate one.

Appendix 1 **Domestic Abatement Potential in 2030:**
Emissions Mt CO_2-e (actual 1990 – 2012; potential 2015-2030)

			Actual			Projected	
		1990	2010	2012	2015	2020	2030
Energy	**Sub-total**	**23.8**	**31.9**	**32.3**	**32.9**	**32.9**	**34.4**
	Moderate ambition						**24.0**
	High ambition						**15.7**
	Electricity	3.5	5.4	6.3	4.8	4.1	2.8
	High ambition						0
	Transport	8.7	13.8	13.8	14.4	14.9	15.9
	High ambition						6.8
	Other FF comb.	7.6	8.3	8.6	10.3	10.7	12.4
	High ambition						6.6
	Transformation	2.5	1.3	1.3	1.3	1.3	1.3
	High ambition						0.7
	Fugitives	1.5	2.9	2.4	2.0	2.0	2.0
	High ambition						1.6
Industry	**Sub-total**	**3.3**	**4.5**	**5.3**	**5.0**	**5.3**	**6.1**
	High ambition						**2.9**
	Mineral prod.	0.6	0.7	0.8			
	Chemical ind.	0.3	0.4	0.4			
	Metal product.	2.4	2.3	2.3			
	HFCs/solvents	0.1	1.1	0			
Agricult.	**Sub-total**	**34.5**	**37.7**	**39.3**	**39.3**	**41.5**	**44.3**
	Moderate ambition						**37.7**
	High ambition						**29.3**
	Enteric ferm.	26.3	27.4	28.5			
	Manure man.	0.6	0.8	0.8			
	Agric. Soils	7.5	9.5	10.3			
	Savannah burn	0	0	0			
	Residue burn	0	0.3	0			
Waste	**Sub-total**	**5.1**	**5.2**	**5.1**	**5.1**	**5.1**	**5.1**
							1.5
	Land	4.7					
	Water	0.4					
GROSS		**66.7**	**79.3**	**82.0**	**82.2**	**84.9**	**90.0**
	Moderate ambition						**66.0**
	High ambition						**49.4**
LULUCF	**Sub-total**		**-14.00**	**-14.7**	**-14.4**	**-7.1**	**4.6**
	High ambition						**-34.5**
	Moderate ambition						**-14.1**
NET			**65.3**	**67.3**	**67.8**	**77.8**	**94.6**
	Moderate ambition						**51.9**
	High ambition						**14.9**
		1990	**2010**	**2012**	**2015**	**2020**	**2030**

Note: Figures in black are actual emissions or baseline projections. The figure for LULUCF in 1990 and the consequent net emissions figure are not specified, because Kyoto accounting rules identify 1990 gross emissions as the baseline. Figures in green are estimates – ranging from higher values (moderate ambition) to lower (high ambition). Figures based on new GWPs adopted in IPCC-AR5.

Appendix 2 **QELRO and Decadal Budget (2021-30) of 40% and Aspirational Targets (Mt CO_2-e)**

	Emissions Level (2030)	QELRO (2025)	Budget/Quantum (2021-30)
40% target	40.0	49.0	490
Aspirational target	17.2	42.3	423