Setting ambitious greenhouse gas emissions targets for New Zealand – the case for international fairness/equity
v1.2, 9 July 2018

New Zealand is considering greenhouse gas targets under the proposed Zero Carbon Act, proposing net emissions (CO_2 or all-gas – to be determined) reaching zero by year 2050.[1,2] However, in terms of global urgency,[3] the health gains from equitable mitigation[4], and especially fairness[5,6], this target needs to be more ambitious, before 2040.

A Zero Carbon Act will need to set targets and action that are fast, fair, firm, and founded on Te Tiriti o Waitangi.

In the 2015 Paris Agreement, countries including New Zealand committed to limiting average temperature rise to well below 2°C – and to pursue efforts to limit temperature increase to 1.5°C.[7] Since then, the second draft of the IPCC Special Report on Global Warming of 1.5°C is reporting substantial differences in the harmful effects of global warming limited to 1.5°C compared to 2°C above pre-industrial levels[3] – where the 0.5°C warming difference is critical for vulnerable regions.[8]

Limiting global warming to 1.5°C sensibly[9,10] will likely require global anthropogenic CO_2 emissions to reach net-zero before 2040,[11] together with rapid reductions in other emissions, particularly methane.[3,12]

Within these limits, we need to distribute efforts across countries fairly[13,6] – where due to previous inaction and delay (alongside inaction by other countries)[14], New Zealand needs to work hard to meet our commitments under the Paris Agreement and make a fair contribution to limit warming below 1.5 degrees.[5,6,15-18]

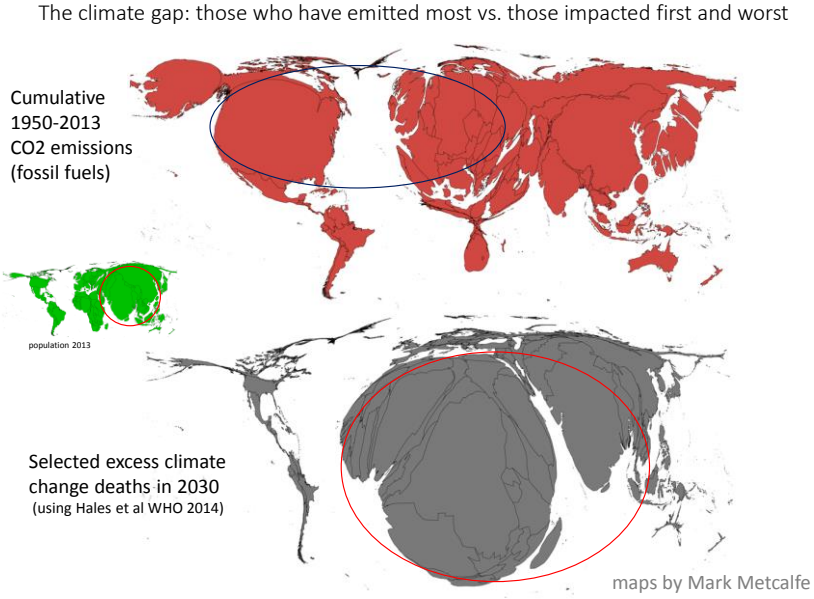
- The Paris Agreement included the principle of 'common but differentiated responsibilities and respective capabilities'.[1] Least developed and developing nations are disproportionately affected by climate change, which they have not caused, and have least capacity to adapt to, let alone mitigate. About 100 countries, with a total population of nearly one billion people but who produce less than 3% of the global emissions, will suffer worst the effects of climate change impacts in the near term.[19]
- Meanwhile, established economies, like New Zealand, historically have had high greenhouse gas emissions and have benefited from activities that cause high emissions; they are in a position, and have a responsibility, to mitigate past actions and contribute rapidly and proportionately more reductions than countries with historically lower emissions; established economies have greater economic capability to make the adjustments that are needed to reduce emissions.[13]

New Zealand has accounted for 0.063% of the world's population, 0.15% of world GDP, 0.16% of world current annual gross GHG emissions, and 0.19% of cumulative gross GHG emissions.[20]

Ultimately what is 'fair' is a value judgement[13], where there are many internationally-accepted models and ways to share emissions and efforts to get to net zero safely across countries.[21-30] These models and frameworks account for factors like historical, current and projected populations, emissions and wealth.

Endnote 1 details the various frameworks possible.

Figure. Density-equalising cartograms. Comparison of (a) cumulative fossil CO2 emissions by country for 1950–2013 vs. (b) the regional distribution of additional deaths from five climate-sensitive health consequences (undernutrition, malaria, dengue, diarrhoeal disease, heat) estimated for year 2030, with (c) country population in 2013

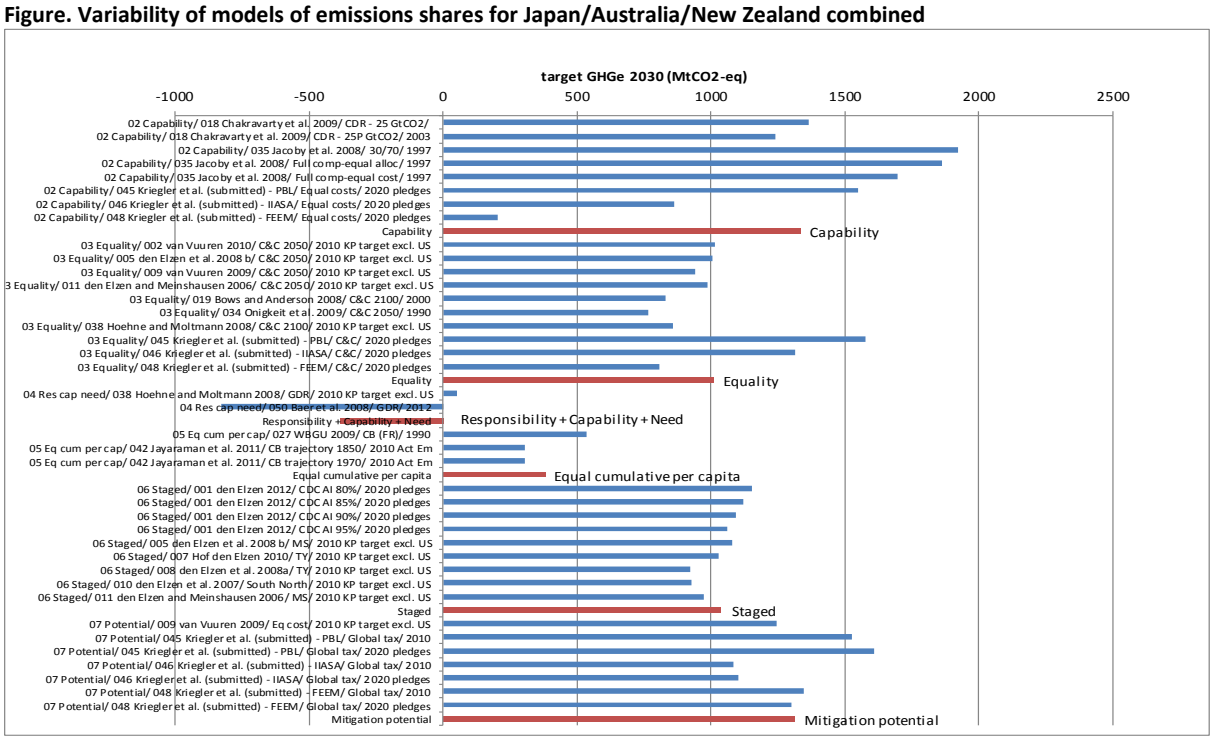


published in NZMJ 2015[6]

sources:

1. analysis of **CERP calculator data http://calculator.climateequityreference.org/** for cumulative fossil CO2 emissions 1950-2013, sourced by CERP in turn from the UNFCCC dataset[1] for Annex 1 countries and the CDIAC dataset[2] for non-Annex 1 countries (see http://climateequityreference.org/calculator-information/gdp-and-emissions-baselines)
[1] Summary data from national reports to the UNFCCC are at http://unfccc.int/ghg_data/ghg_data_unfccc/items/4146.php
[2] Carbon Dioxide Information and Analysis Center (CDIAC), Oak Ridge National Laboratory, US Department of Energy. Its primary national level data set is available at http://cdiac.ornl.gov/ftp/ndp030/CSV-FILES/nation.1751_2010.csv, as Boden TA, Marland G, Andres RJ. *Global, Regional, and National Fossil-Fuel CO_2 Emissions.* Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tenn., USA, 2013. doi 10.3334/CDIAC/00001_V2013.
2. **Hales et al WHO 2014**
Hales S, Kovats S, Lloyd S, Campbell-Lendrum D (eds.). Quantitative risk assessment of the effects of climate change on selected causes of death, 2030s and 2050s. Geneva: World Health Organization, 2014. http://www.who.int/globalchange/publications/quantitative-risk-assessment/en/.
Further data disaggregation to individual countries via linear scaling (as projected $deaths_{country}$ = projected $deaths_{region}$ × projected $pop_{country}$ / projected pop_{region}), solely for mapping software purposes.
Note that excess deaths from coastal flooding are not included in these estimates
3. **mapping by Mark Metcalfe**
Mapping/method based on: Costello A, Abbas M, Allen A, Ball S, Bell S, et al. Managing the health effects of climate change: Lancet and University College London Institute for Global Health Commission. Lancet 2009,373:1693-1733. figure 4.
sourced in turn from Patz et al: Patz JA, Gibbs HK, Foley JA, Rogers JV, Smith KR. Climate change and global health: quantifying a growing ethical crisis. EcoHealth 2007;4:397-405. figure 1.

Figure. Variability of models of emissions shares for Japan/Australia/New Zealand combined



source: Höhne N, den Elzen M, Escalante D. Regional GHG reduction targets based on effort sharing: a comparison of studies. Climate Policy 2014;14(1):122–147. http://www.tandfonline.com/doi/full/10.1080/14693062.2014.849452 and Supplemental content at http://www.tandfonline.com/doi/suppl/10.1080/14693062.2014.849452/suppl_file/tcpo_a_849452_sm2285.xlsx, reporting aggregated models for Japan/Australia/NZ combined (not New Zealand alone)

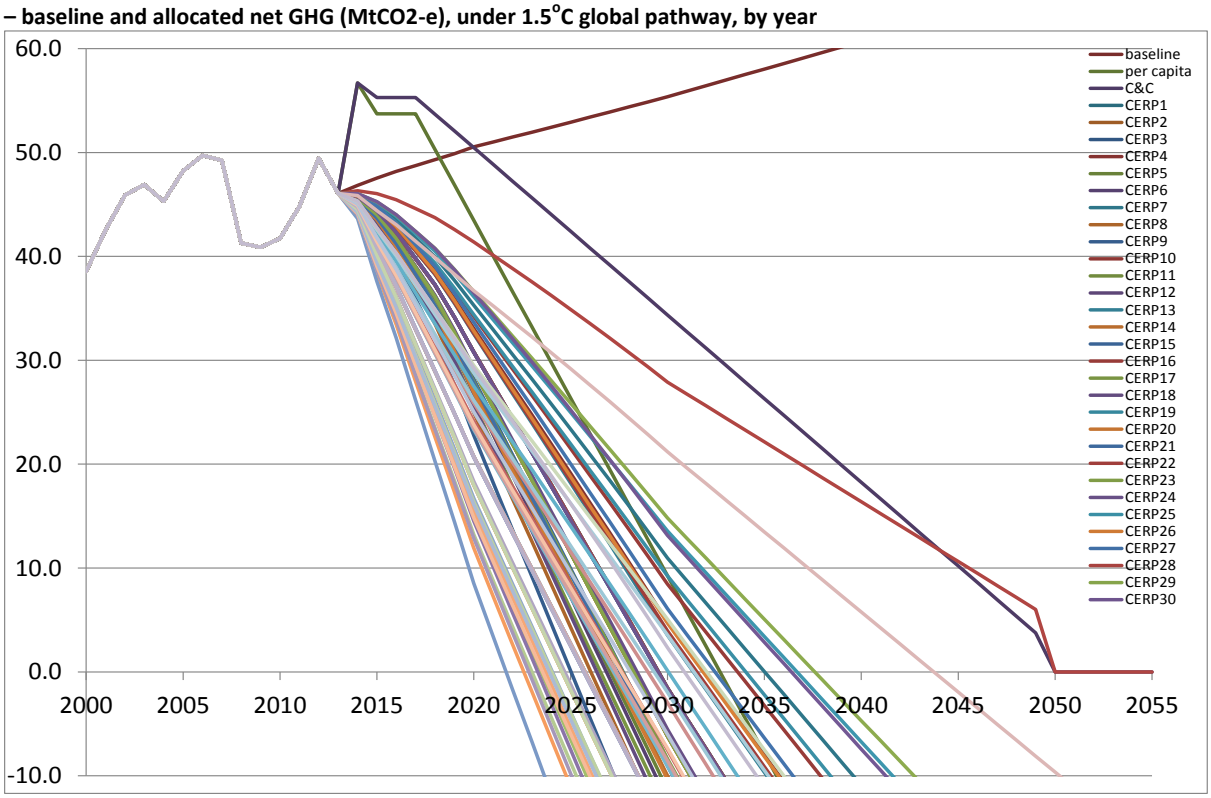
Most health organisations have core values that include equity,[31,32] and this supports parallel approaches that account for fairness in the face of fixed limits.[33] Particular values to note kaitiakitanga (guardianship), aroha (love/compassion), manaakitanga (caring), whakatipuranga (future generations), hauora (health and wellbeing), and tika (integrity/doing what's right). Approaches to the allocation of emissions reductions amongst countries, including New Zealand, need to include these values akin to fairness and equity. Principles of historic responsibility accord with tika and Crown redress of Te Tiriti o Waitangi injustices through within treaty settlements,[13] where countries like New Zealand are wealthy and have benefited from large historic emissions.

Of the various models and frameworks used internationally, the closest to these values seems that of the Greenhouse Development Rights framework (GDRf),[34-37] as used by the Climate Equity Reference Project and which takes the effort-sharing approach. This contrasts with the other model best known by the health sector, Contraction and Convergence,[38-40] a resource/allocative approach that grandparents historic emissions.

Applying both the Climate Equity Reference Project and Contraction & Convergence models to New Zealand, with 72+ scenarios, under a 1.5°C global pathway reaching zero emissions by 2050, indicates general timelines for New Zealand of between year 2022 and 2038 to reach net zero emissions fairly. This is based on both our historical responsibilities and obligations, and our capacity to adapt and mitigate, when compared with other countries.

- For the for 1.5° C emergency global pathway, CERP models allocate NZ year 2030 gross greenhouse gas (gGHG) targets of 26.1 to -6.4 MtCO2-e for 72 scenario permutations (a -57% to-111% change from the 1990 level).
- Modelling for contraction&convergence lies within this range, at 19.1 MtCO2-e (-69%).
- These results translate to achieving net zero GHG emissions for New Zealand between the years 2022 and 2038 for most models, if meeting the Paris COP21 ambition of no more than 1.5°C global warming.

Figure. Models for NZ: per capita, C&C, CERP (72 permutations) – baseline and allocated net GHG (MtCO2-e), under 1.5°C global pathway, by year



Endnote 2 details the modelling methods and sources.

Further content, rationale, sources, modelling assumptions are in 'Background to the NZCPHM's Stance on Setting National GHG Emissions Targets', the NZCPHM's INDC submission, joint editorial Fast, fair climate action crucial for health and equity, and joint presentation 2017 Sharing our global carbon budget.

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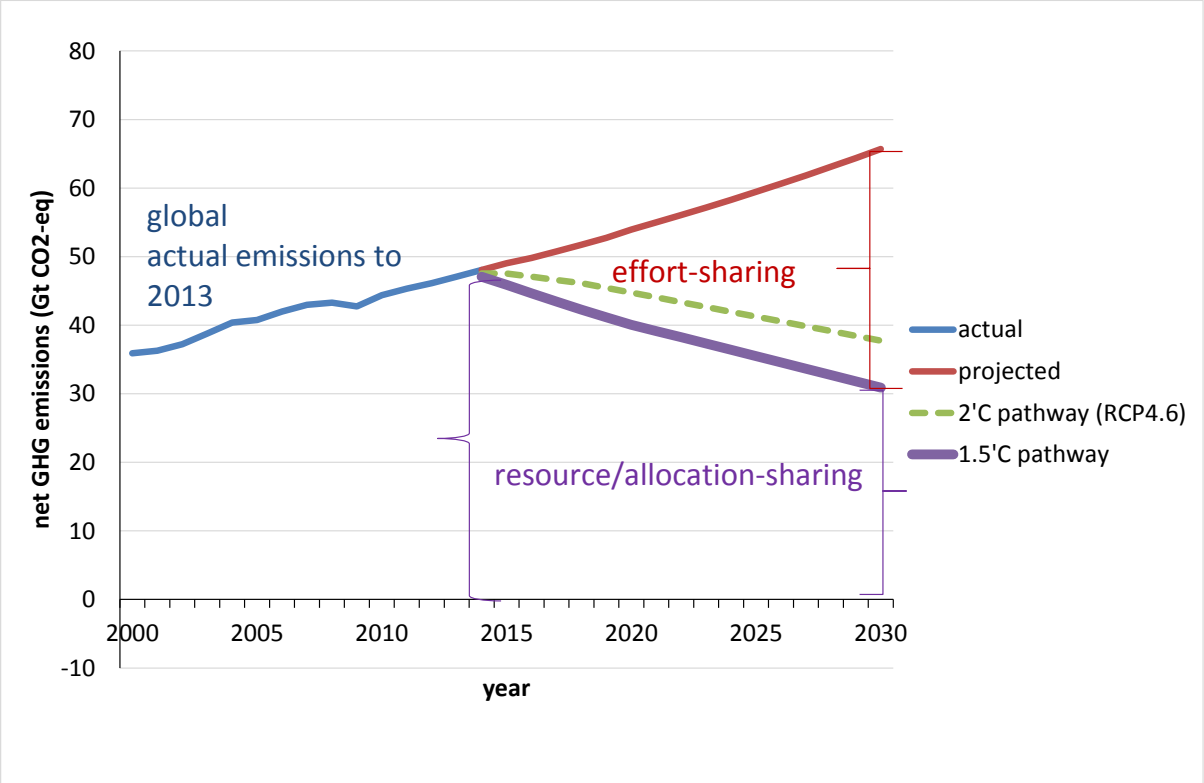
Endnote 1 – Detail of frameworks for sharing

Consistent with the Paris Agreement's principle of 'common but differentiated responsibilities and respective capabilities', there are multiple models and approaches to sharing, but in two main groups:

1. Resource/allocation sharing approaches
2. Effort sharing approaches

Resource/allocation sharing distributes emissions amongst the remaining budget (within global emissions pathway), whereas effort sharing distributes the gap between projected expected business-as-usual BAU (emissions growth left unabated) and what is needed to achieve budget.

Figure. Ways to share 1.5°C – resources vs effort



To help conceptualise the two main approaches, these are depicted in the following figures, preceded by BAU (what's likely to happen if no sharing).

Figure. Baseline (unabated projected emissions)

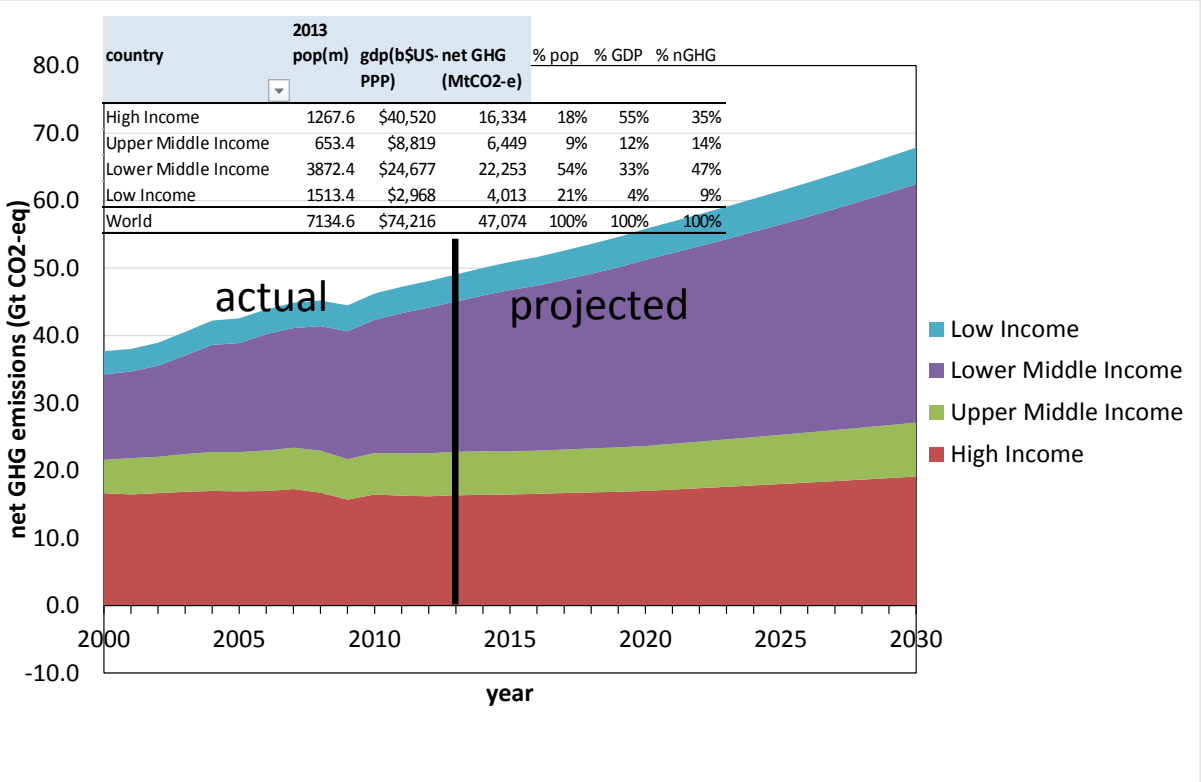


Figure. Effort-sharing

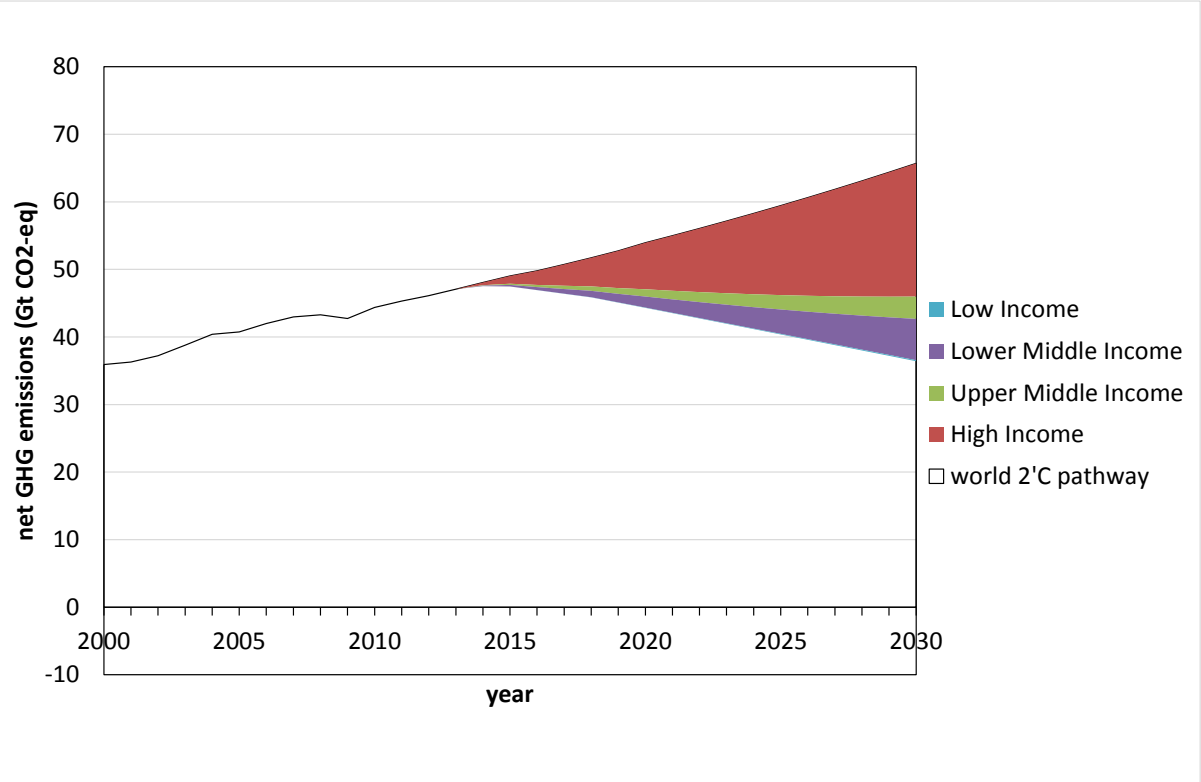
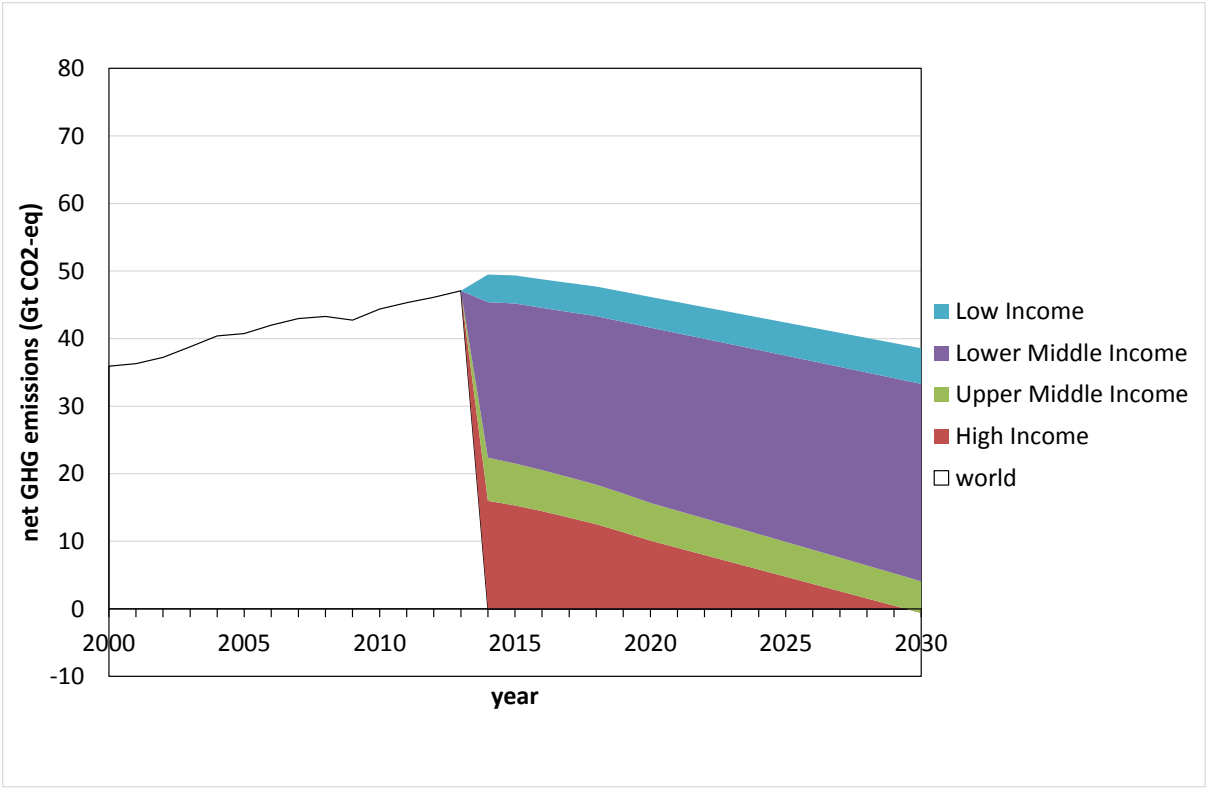


Figure. Resource/allocation sharing



Models/frameworks are catalogued as follows (from Climate fair shares literature, including Different Perspectives on Differentiated Responsibilities):
source: Climate Action Network – International. Fair Effort Sharing Discussion Paper, 12 July 2011.
http://www.climatenetwork.org/sites/default/files/CAN_effort_sharing_discussion_paper_25July2011_v2.pdf

1. Resource sharing approaches

- **Equal Per Capita Emission Rights**
- **Contraction and Convergence (C&C)**
- Common but Differentiated Convergence (CDC)
- One Billion High Emitters (aka the Princeton Proposal)
- The 'Indian Prime Minister's approach'
- Equal Cumulative Per Capita Emission Rights approaches

2. Effort sharing approaches

- Equity in the Greenhouse, South-North dialogue
- Brazilian Historic Responsibility
- **Climate Equity Reference framework (was GDR Greenhouse Development Rights framework)**
- Oxfam approach
- EU approach for Annex I countries

There are three leading frameworks:

1. **Equal Per Capita Emission Rights** is a straightforward approach premised on the equal rights to the atmospheric commons. All countries would be awarded emission allowances in proportion to their population, and would be free to trade them. The total number of allowances granted globally would steadily decrease along a path consistent with an agreed climate stabilization goal.
2. **Contraction and Convergence** (C&C) is a hybrid framework combining grandfathered emission rights with per capita emission rights, with a gradual transition from the former to the latter over a specified number of years. Countries whose emissions start above the global average would receive allowances that gradually trend down to the global average, while countries whose emissions start below the global average would receive allowances that gradually trend up to the global average.
3. **Greenhouse Development Rights (Climate Equity Reference framework)** is a framework wherein the burdens for supporting both mitigation and adaptation are shared among countries in proportion to their capacity and responsibility, as expressed by way of an responsibility and capacity index that is

defined with respect to a "development threshold" – an income level modestly above a global poverty line. Like most frameworks, GDRs could be implemented with an emissions trading system only, with a global fund only, or with a combination of the two. GDRs is a flexible framework, and can be implements in a manner that includes a "luxury threshold" as well as a development threshold, and, if desired, in a manner that takes "embodied emissions" into account in the calculation of national responsibilities. Note also that several Chinese variants of GDRs have also been articulated.

Other frameworks are:

- **Equal Cumulative Per Capita Emission Rights approaches** (three variants) extends the concept of equal per capita rights to cover the entire historical and future carbon budget since (for example) the beginning of the industrial revolution, rather than just the portion of the budget remaining for the future. This approach, which has grown in influence over the last few years, particularly in China, India, and parts of civil society, takes into account the fact that some countries (generally, higher income countries that industrialised earlier) have consumed more than an equal per capita share of the total budget, resulting in a "carbon debt" that may be expressed as a negative allocation for the future.
- **Brazilian Historic Responsibility** is based primarily on historic responsibility for emissions: developed countries are each allocated emissions cuts based on the total contribution of their historic emissions (going back to 1800s) to the current global temperature increase. In the A1/nA1 version, capacity is reflected in the distinction between developed countries and developing country parties, and responsibility is used to quantitatively determine the level of obligation.
- **Oxfam** has proposed an approach, subsequently supported by various other NGOs, that uses a calculated responsibility and capability index to allocate an overall developed country target of 40%, and allows for a climate finance budget of $150bn to be allocated using the same method. Developing countries individual need for financing is assessed in line with available economic capability, taking into account intra-national inequality, and hence climate finance is provided on a sliding scale (below a minimum 'available capability threshold').
- **The EU** has (eg. EU Commission Proposal of 2009) suggested a method for distributing targets amongst Annex 1 countries that includes starting with an overall target for Annex 1 countries of 30% below 1990 levels by 2020 and allocating this target on the following basis: GDP per capita, addressing the capacity to pay for emission reduction within a country and through the global carbon market [capacity]; GHG per GDP, addressing the opportunities to reduce GHG emissions within one economy [capacity/mitigation potential]; Change of GHG emissions between 1990 and 2005, rewarding early action by developed countries to reduce emissions [reward early action/recognize latent mitigation potential]; Population trends over the period 1990 – 2005, recognizing different population trends between countries and as such different pressures on the projected emission evolution [equal rights to pollute]. In other words, the EU approach is highly parameterized and its effort- sharing implications depends upon the exact functions and values that are assigned to distinct parameters. These are typically not well explained or justified in EU proposals. In general, these proposals can be better understood as negotiating frameworks than as effort-sharing proposals.

Endnote 2 – Detail of modelling methods, sources and results

For the for 1.5° C emergency global pathway, CERP models allocate NZ year 2030 gross greenhouse gas (gGHG) targets of 26.1 to -6.4 MtCO2-e for 72 scenario permutations (a -57% to-111% change from the 1990 level). Modelling for contraction&convergence lies within this range, at 19.1 MtCO2-e (-69%). This translates to achieving net zero GHG emissions for New Zealand between the years 2022 and 2038 for most models, if meeting the Paris COP21 ambition of no more than 1.5°C global warming.

Methods
Data sources: Climate Equity Reference Project (CERP)[1] data for NZ and world, with baseline (BAU – no change, no contribution, no pathways) and global emergency mitigation pathways to keep within 2°C and 1.5°C by gas (gross greenhouse gas emissions (gGHG), net GHG (nGHG) = gGFHG + LUCF, fossil CO2 (fCO2), net CO2 (nCO2) = fCO2 + LUCFCO2), and multiple allocative models (288 permutations, 72 for gGHG) provided by Dr Christian Holz. Climate Equity Reference Project Online Calculator[2] version 3.0.0 Data version 7.0.0dev Last modified 7 Apr 2016 17:28:41 PDT.

CERP uses the global emissions pathways of Climate Action Tracker (Climate Analytics, NewClimate Institute, Ecofys, Potsdam Institute for Climate Impact Research (PIK)) for reaching 2.0° and 1.5 °C by 2100, see https://climateactiontracker.org/methodology/global-pathways/, https://climateactiontracker.org/global/temperatures/

Scenarios analysed:

- Key scenarios selected from Höhne et al 2014[3] –per capita, current GDP, current emissions etc.
- Contraction & convergence (GCI, Stott 2012[4])
- CERP (GDRf)[5]
    - GHGs (4 components): fossil CO2 alone; fCO2 + LULUCF = CO2-alone; fCO2+non-CO2 = gross GHG; fCO2+nonCO2+ LULUCF = net GHG
    - mitigation pathway (2): 1.5°, 2.0°C
    - historical responsibility (4): from 1850, 1950, 1970, 1990.
    - responsibility vs. capacity (3): 100%, 50%, 0% Responsibility
    - progressivity (3): no development threshold, $7,500 development threshold, $7,500 development threshold + plus additional progressivity (luxury emissions threshold $50k)

Caveat: CERP had not, at the time of writing (mid-2016), updated its database baseline 1990 emissions for NZ for revised greenhouse warming potentials (GWPs), eg NZ's gGHG emissions for 1990 is recorded in the CERP as 60.71 MtCO2-e, not the revised 66.72 MtCO2-e (Metcalfe 2015)[6]. Likewise, NZ nGHG is 23.39 MtCO2-e with the incorrect CERP baseline without revised GWPs, when it should be 38.07 with revised GWP; hence all modelled allocations may be too low.

Results for New Zealand under the 1.5°C global pathway
For gGHG, NZ's expected emissions year 2030 under baseline = 85.6 MtCO2-e.

[1] Climate Equity Reference project http://climateequityreference.org/
[2] http://calculator.climateequityreference.org
[3] Höhne N, den Elzen M, Escalante D. Regional GHG reduction targets based on effort sharing: a comparison of studies. Climate Policy 2014;14(1):122–147. http://www.tandfonline.com/doi/full/10.1080/14693062.2014.849452 .
[4] Global Commons Institute. http://www.gci.org.uk/index.html; http://www.gci.org.uk/Documents/ICE.pdf, Stott R. Contraction and convergence: the best possible solution to the twin problems of climate change and inequity. BMJ. 2012 Mar 19;344:e1765. doi: 10.1136/bmj.e1765. http://www.bmj.com/content/344/bmj.e1765 , http://www.gci.org.uk/Documents/Stott_BMJ_2012.pdf
[5] Athanasiou T, Kartha S, Baer P. National Fair Shares: The mitigation gap – domestic action and international support. A Climate Equity Reference Project report. EcoEquity & Stockholm Environment Institute, 2014. http://climateequityreference.org/national-fair-shares-the-mitigation-gap-domestic-actions-international-support/; Kartha S, Athanasiou T, Baer P. 'Fair shares' and intended nationally determined contributions: What can we learn from an equity review? SEI Discussion Brief, 2014. http://www.seiinternational.
Fair Shares: A Civil Society Equity Review of INDCs. 130+ international and regional civil society organisations. https://www.oxfam.org/en/research/fair-shares-civil-society-equity-review-indcs, http://civilsocietyreview.org/wp-content/uploads/2015/11/CSO_FullReport.pdf
[6] Annex D. Effect of new GWPs on base emissions values and targets. annex to Graham K. Climate goals for New Zealand in 2030: an ambitious domestic emissions target within an appropriate share of the global budget. Background research paper. Feasible ambition: climate goals for New Zealand in 2030 Climate Protection conference, Wellington, 25 September 2015. https://d3n8a8pro7vhmx.cloudfront.net/orataiao/pages/208/attachments/original/1447792742/150911_Annex_D.pdf

With the 1.5°C pathway, allocation would be 69.0 MtCO2-e (14% increase on 1990 level) on crude per capita model (NZ comprising 0.06% of world population, hence 0.06% of world's efforts required to keep within 1.5°C). Lower targets for other scenarios, including 19.1 MtCO2-e (-69%) for contraction&convergence, and a range of 26.1 to -6.4 MtCO2-e (-57% to -111%) for the 72 CERP gGHG scenario permutations.

Further information on specific scenarios is available in the following tables and graphs.
Other scenarios/gases are available on request

	NZ per capita global budget	C&C	CERP 2.0' max	CERP 1.5' min
2014 nGHG (MtCO2-e)	56.7	56.7	46.06	46.06
2017 nGHG	56.7	56.7	42.7	29.6
remaining net tCO2 budget - NZ	440.4	935.6	865.5	123.9
% of world budget	0.063%	0.134%	0.124%	0.018%
yrs to reach 0 emissions, to stay within budget (linear decrease from 2014)	15.5	33	40.6	8.4
year that NZ reaches 0, to stay within budget	2033	2050	2050	2022
year 2030 nGHG	9.3	34.4	27.90	-41.87
% reduction in 2030 cf 2014	84%	39%	51%	174%

Table: CERP distributive/allocative models for NZ, gGHG (MtCO2-e)), by global emergency pathway (2.0°C, 1.5°C)
non-updated CERP data without revised GWPs

CERP gGHG emissions targets for NZ 2030 (gross MtCO2e)

year	1990	2013	2030	2030	
pathway	baseline	baseline	2.0' pathway	1.5' pathway	scenario
baseline	60.7	76.3			baseline
base case scenarios:	mid-equity settings (50:50% resp/capacity, $7.5k development threshold, no luxury threshold)				
1950 resp			21.65	5.60	as per GDRf; 1950 responsibility
1970 resp			20.84	4.59	when nonCO2 became included in measurments; 1970 responsibility
1990 resp			22.63	-6.87	post-Kyoto; 1990 responsibility
highest modelled CERPf allocation			38.01	26.10	historic resp cuml since 1850, 100% resp (nil capacity), no development threshold (ie regressive)
lowest modelled CERPf allocation			12.53	-6.43	historic resp cuml since 1850, 100% resp (nil capacity), development threshold $7.5k
proxy targets according to responsibility alone (viz cumulative historic emissions):					
1950 resp			36.23	23.89	as per GDRf; 1950 resp, nil equity
1970 resp			34.60	21.86	when nonCO2 included; 1970 resp, nil equity
1990 resp			37.07	24.98	post-Kyoto; 1990 resp, nil equity
nil resp (ie 2013 current)			23.28		nil historic resp, nil equity = contraction&convergence

Distributive/allocative models for NZ, 1.5'C global pathway:

model	1990	2030	% change 1990-2030	
(baseline)	60.7	85.6	41%	(baseline projections - no change, no contribution)
pop (per capita)		64.8	7%	NZ makes per capita contribution (0.06% of world population) to global effort (gap pathway vs baseline), 2015 onwards
GDP		45.5	-25%	NZ makes GDP-based contribution (its % of world GDP, 0.15%) to global effort (gap pathway vs baseline), 2015 onwards
current GHG		29.8	-51%	NZ contributes current GHG gross emissions (its % of world current emissions, 0.16%) for global effort (gap, 2015+)
cuml GHG		20.7	-66%	NZ contributes cumulative GHG gross emissions 1990-current (0.19% of world emissions 1990-current) for global effort (gap, 2015+)
Contraction & Convergence		19.1	-69%	contract&converge (GCI) - transitting over time from grandparented to per capita emission rights. GCI; Stott BMJ 2012 http://www.gci.org.uk/Documents/Stott_BMJ_2012.pdf
Climate Equity Reference framework				Greenhouse Development Rights (GDR) framework fair shares calcs for NZ
- 1990-2013 cuml emissions resp, mid-equity s		-6.9	-111%	- GDR fair shares calcs for NZ, cuml emissions 1990-2013, capability=GDPpc, $7500 development threshold, no luxury threshold
- 1950-2013 cuml emissions resp, mid-equity s		5.6	-91%	- GDR fair shares calcs for NZ, cuml emissions 1950-2013, capability=GDPpc, $7500 development threshold, no luxury threshold
- highest modelled CERPf allocation		26.1	-57%	- GDR fair shares calcs for NZ, historic resp cuml since 1850, 100% resp (nil capacity), no development threshold (ie regressive)
- lowest modelled CERPf allocation		-6.4	-111%	- GDR fair shares calcs for NZ, historic resp cuml since 1950, 100% resp (nil capacity), development threshold $7.5k