

# **A Conceptual Framework to Assist Decision Making on International Climate Change Policy**

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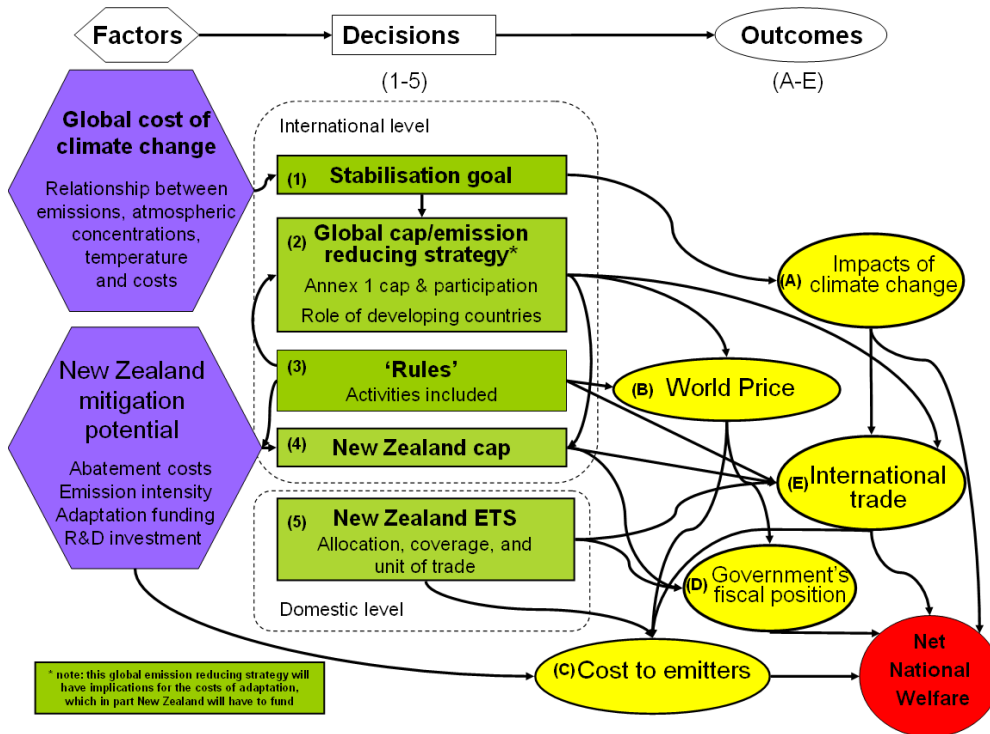
## **Discussion Paper**

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**Conceptual framework**

Over the next few years decisions will be made on an international climate change policy framework to succeed the current Kyoto Protocol. These decisions will have outcomes that will directly and indirectly affect Net National Welfare (NNW) in New Zealand. To assist negotiators with making decisions which, given certain constraints, optimise NNW, the following conceptual framework has been developed. Every decision is influenced by either a pre-determined factor, or another previously made decision. Each decision will have implications for specific outcomes which affect NNW.



**Figure 1: Conceptual framework of the factors, decisions and outcomes which affect net national welfare, within the context of international climate change negotiations**

The four key decisions<sup>1</sup> that will be made at the international level, will be:

- (1) the concentration for atmospheric greenhouse gas (GHG) stabilisation;
- (2) the global 'cap', or 'emission reducing strategy', necessary to achieve this goal, and the level of participation of various countries;
- (3) the rules around what emitting or sequestering activities are included in the cap, and what emission reducing activities can be sourced from outside the cap; and
- (4) New Zealand's net emission reduction responsibility target<sup>2</sup> ('cap').

The other important decision, which may impact on NNW but will certainly affect the distribution of these impacts, will be how responsibility is devolved to emitters under the New Zealand Emission Trading Scheme (NZ ETS).

<sup>1</sup> It will be a more iterative process in reality - rules ideally being decided before commitments

<sup>2</sup> It is important to note that this target represents the level of emissions that New Zealand is responsible for – not what domestic emissions will be. This ensures emissions are reduced globally where it is least costly to do so.

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### *New Zealand position on key decisions*

The first decision, on a long-term stabilisation goal for atmospheric concentrations of GHGs, will be primarily driven by the scientific relationship between concentrations, global mean temperatures, and resulting climate change impacts and associated costs. The Intergovernmental Panel on Climate Change (IPCC) has recently published its Fourth Assessment Report, which synthesises a number of studies which have modelled these relationships. While the results of these studies will certainly be an influence, the stabilisation goal will ultimately be determined by what Governments see as the maximum level of acceptable 'impacts' – a trade-off between the costs and benefits of reducing emissions.

With respect to the second decision, on a global emissions reducing strategy, while there is a reasonably clear relationship between any long-term stabilisation goal and the required 'cap' on global emissions, how these 'rights' to emit are allocated between various countries will be extremely controversial. Many developing countries, for example, argue that their emissions should not be capped, as it is the industrialised countries that are responsible for much of the current concentration of GHGs in the atmosphere. Given this, the likely global emission reducing strategy to come out of international negotiations will be a cap on developed countries emissions, and some form of commitment from developing countries to reduce emissions below business as usual (BAU) – particularly the major emitters<sup>3</sup>. Broad participation in commitments will also be necessary to ensure that competitiveness-at-risk and leakage issues are adequately addressed, with the emissions from developed countries not simply shifting to developing ones. The outcome of more countries participating within this strategy will also be a direct reduction in the world price for carbon, and possibly some positive indirect effects on export revenues – in particular land based commodities. New Zealand should therefore support broad participation by other countries in a global emission reducing strategy, in particular those countries, or sectors within countries, with which our economy competes.

The rules around what types of activities are included within the developed countries' cap, and the types of emission reducing activities which can be sourced from outside the cap (i.e. flexibility mechanisms such as the Clean Development Mechanism (CDM)), is the third decision that will need to be made. These rules have major implications for the world price of carbon and international trade, and will directly affect New Zealand's mitigation potential. In general, the more emitting or sequestering activities included in the rules, the lower the world price, and the less negative impact on NNW. Furthermore, the inclusion of certain activities, such as allowing avoided deforestation to be eligible for CDM status, may have positive effects on commodity prices of New Zealand exports, which could increase international trade and enhance NNW. However, it will be important that the environmental integrity of these credits is ensured, while at the same time improving the cumbersome nature and high transaction costs of the current arrangement. Some people also argue that broadening

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<sup>3</sup> This paper assumes that the global emission reducing strategy is a combination of a cap on developed countries emissions, and some form of voluntary obligation, or emission intensity target, within developing countries. Of the possible decisions around a strategy this probably is the first best outcome for New Zealand, and it is certainly the outcome that most of the current Annex 1 parties are promoting. It is however possible that if a multilateral agreement between developed countries is not reached over the next couple of years, a regional type approach may be adopted. In time, analysis will be needed on a New Zealand position to this approach. It may also be possible that some developing countries sign up to a cap, although this is unlikely.

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the activities eligible for CDM status may depress the world price, and provide insufficient incentive for the necessary investment in low-carbon technologies, and therefore recommend increasing the stringency of the caps in response. Including activities such as international aviation and shipping within a cap will help alleviate this concern, by increasing the demand for credits; however, it may have negative consequences for New Zealand on trade and NNW – although these effects may also be felt indirectly through trade barriers and consumer reaction if transportation fuels were excluded. The rules which determine what activities are included in a global emission reducing strategy, therefore, have some major implications for NNW in New Zealand, and it will be important that negotiators understand the likely outcomes before agreeing to any specific decisions.

The fourth decision, around an acceptable New Zealand cap or responsibility target, will primarily be driven by the cap which developed countries as a whole sign up to, and the domestic mitigation potential of New Zealand compared to other participating developed countries. With a large agricultural base and high renewable electricity generation, both the potential and cost of reducing emissions in New Zealand make it comparatively more difficult than other developed countries. Given our unique profile, New Zealand may have a good case for taking on a significantly less stringent target than other developed countries; however, further work is required to quantify the level of relative stringency. While the benefits to NNW of a less stringent target are clear (with fewer permits to purchase), some people argue that there may also be a positive effect on NNW of unilaterally imposing a greater target *ex post* negotiations – if the environmental/climate change ‘branding’ benefits can be shown to increase export revenue more than the increase in compliance costs<sup>4</sup>.

The final decision, around the design of an ETS, will primarily affect the distribution of costs in New Zealand, rather than the magnitude of these costs. However, the magnitude of the costs of the ETS will be affected by domestic abatement costs relative to the world price, the accessibility of international credits, and how the Government decides to recycle any surplus revenue into the economy. The ETS decisions around free allocation will also be determined, in part, by the participation of other countries in the global emission reducing strategy – with some level of support potentially justified for competitiveness-at-risk and leakage issues. While the ETS is the key domestic policy, it is also important to recognise that other policies, such as the bio-fuels obligation, moratorium on thermal generation, and some energy efficiency measures, may also impose some costs on the economy. This paper does however focus its analysis on the impacts of the ETS.

This paper discusses each of the key decisions in turn, and presents a more detailed evaluation of their relationship to outcomes, and potential impact on NNW. It then proposes a set of likely scenarios for future decisions, and based on their impact on NNW, recommends a more specific New Zealand position on each decision.

### ***Decision 1: Global stabilisation goal***

Atmospheric concentrations of GHGs have increased sharply over the last century and under a range of BAU scenarios are forecast to reach five times their historical level by

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<sup>4</sup> It is also important to consider how the New Zealand public feel about the Government accepting a much less/more stringent target than other comparable developed countries

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the end of this century<sup>5</sup>. There is a close relationship between concentrations of GHGs in the atmosphere and temperatures on the earth. Table 1 presents the relationship between particular stabilisation concentrations, temperature increases, and the emission reductions required to achieve these concentrations.

Category	Additional radiative forcing (W/m <sup>2</sup> )	CO <sub>2</sub> concentration (ppm)	CO <sub>2</sub> -eq concentration (ppm)	Global mean temperature increase above pre-industrial at equilibrium, using "best estimate" climate sensitivity <sup>a), b)</sup> (°C)	Peaking year for CO <sub>2</sub> emissions <sup>c)</sup>	Change in global CO <sub>2</sub> emissions in 2050 (% of 2000 emissions) <sup>c)</sup>	No. of assessed scenarios
I	2.5-3.0	350-400	445-490	2.0-2.4	2000 - 2015	-85 to -50	6
II	3.0-3.5	400-440	490-535	2.4-2.8	2000 - 2020	-60 to -30	18
III	3.5-4.0	440-485	535-590	2.8-3.2	2010 - 2030	-30 to +5	21
IV	4.0-5.0	485-570	590-710	3.2-4.0	2020 - 2060	+10 to +60	118
V	5.0-6.0	570-660	710-855	4.0-4.9	2050 - 2080	+25 to +85	9
VI	6.0-7.5	660-790	855-1130	4.9-6.1	2060 - 2090	+90 to +140	5
Total							177

Notes:

- <sup>a)</sup> Note that global mean temperature at equilibrium is different from expected global mean temperatures in 2100 due to the inertia of the climate system.  
<sup>b)</sup> The simple relationships  $T_{eq} = T_{2,CO_2} \times \ln([CO_2]/278)/\ln(2)$  and  $\Delta Q = 5.35 \times \ln([CO_2]/278)$  are used. Non-linearities in the feedbacks (including e.g., ice cover and carbon cycle) may cause time dependence of the effective climate sensitivity, as well as leading to larger uncertainties for greater warming levels. The best-estimate climate sensitivity (3 °C) refers to the most likely value, that is, the mode of the climate sensitivity PDF consistent with the WGI assessment of climate sensitivity and drawn from additional consideration of Box 10.2, Figure 2, in the WGI AR4.  
<sup>c)</sup> Ranges correspond to the 15<sup>th</sup> to 85<sup>th</sup> percentile of the Post-Third Assessment Report (TAR) scenario distribution. CO<sub>2</sub> emissions are shown, so multi-gas scenarios can be compared with CO<sub>2</sub>-only scenarios.

Note that the classification needs to be used with care. Each category includes a range of studies going from the upper to the lower boundary. The classification of studies was done on the basis of the reported targets (thus including modelling uncertainties). In addition, the relationship that was used to relate different stabilization metrics is also subject to uncertainty (see Figure 3.16).

**Table 1: Concentrations, temperatures and emissions (source: IPCC)**

There is general consensus that to avoid some of the most extreme impacts of climate change global mean temperatures need to increase by no more than 2-3 degrees Celsius above post-industrial levels<sup>6</sup>. Using the information presented in the table above, and taking a conservative estimate<sup>7</sup>, this would require GHG concentrations to stabilise between 445 and about 535 ppm CO<sub>2</sub>-equivalent.

### Outcome A: Impacts of Climate Change

The level at which emissions are stabilised will have important implications for the magnitude and distribution of the physical impacts of climate change. These impacts could be quite large, even if a consensus is reached to stabilise emissions at the lower end of the concentration range. The impacts will also be unevenly distributed across the globe. New Zealand, for example, may experience some moderate increases in agricultural productivity and reduced health expenditure due to a warmer climate. It may however be subject to increase storm damage, and severe droughts. The impact of these direct effects on NNW will need to be considered<sup>8</sup>.

The other set of more indirect impacts which will affect NNW in New Zealand will be those that are experienced by other countries. For example, with rising sea levels it is likely that immigration to New Zealand from small island states in the Pacific will increase. This may have either positive or negative consequences on NNW.

<sup>5</sup> IPCC – 900ppm (relative to about 280ppm average in pre-industrial times)

<sup>6</sup> Recent evidence predicts that with 2.7degrees warming the Greenland Ice Sheet (and potentially the West-Antarctic) will start an irreversible melting – adding 6-12m to sea level

<sup>7</sup> This paper generally assumes the maximum desired increase is about 2.8 degrees – associated with the IPCC global stabilisation goal of 445-535ppm (Category I and II)

<sup>8</sup> MED and MAF have recently undertaken some work to quantify the impacts of climate change on New Zealand – further work is however required

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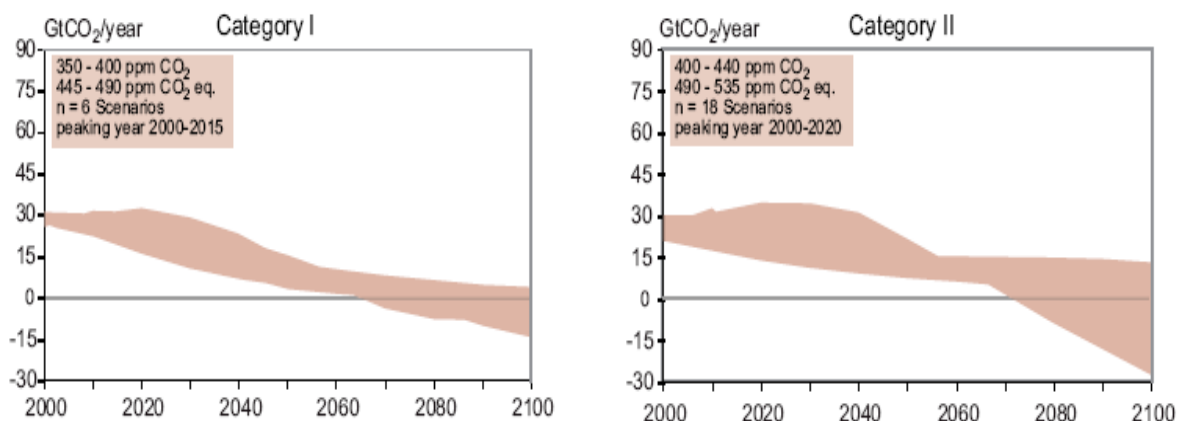
Furthermore, the effects of climate change will disrupt the supply and demand for commodities which New Zealand imports and exports. On the supply side, the loss of Amazonian forests through wild fires will increase the price of timber on international markets, while severe heat waves in Europe could reduce livestock numbers and increase prices of meat and wool. These impacts would positively affect NNW in New Zealand. On the demand side, if severe weather events disrupt economic activity in other countries, it may reduce demand for New Zealand exports, with negative affects on NNW.

The physical impacts of climate change on NNW are extremely difficult to accurately determine, however it will be important that when a decision is made on a stabilisation target the likely impacts on NNW of the associated warming are at least considered.

### **Decision 2: Global cap/emission reducing strategy**

Stabilising concentrations at these levels will require large cuts in global emissions, relative to BAU. While the figures in table 1 only relate to CO<sub>2</sub> emissions (and assume non-CO<sub>2</sub> emissions grow at BAU), the approximate range of CO<sub>2</sub> reductions that would need to be achieved by 2050 is between 30 and 85% below 2000 levels. This is reasonably consistent with conclusions of the Stern Review, which found that stabilising at around 550ppm CO<sub>2</sub>-e would require global emissions of *all* GHGs to be around 25% below current levels by 2050, and to get to 450ppm, without overshooting, global emissions would need to reduce by 70% below current levels by 2050<sup>9</sup>. Taking the average of Stern's range (~50%) and relating it to 1990 levels, there would need to be a 35% reduction below 1990 levels of global GHGs by 2050<sup>10</sup>.

There is also a range of medium-term (2020-30) global emissions reduction targets that are required, and given that this is the likely timeframe in which negotiations will be made, this period will be the focus of this paper. As with any long-term goal, there are a number of ways of progressing towards it in the short to medium term. Figure 2 illustrate the range of possible reduction pathways for global CO<sub>2</sub> emissions, to ensure concentrations stabilise between 440-535ppm.



**Figure 2: Stabilisation pathways (source: IPCC)**

<sup>9</sup> Stern Review – executive summary (pg. xi)

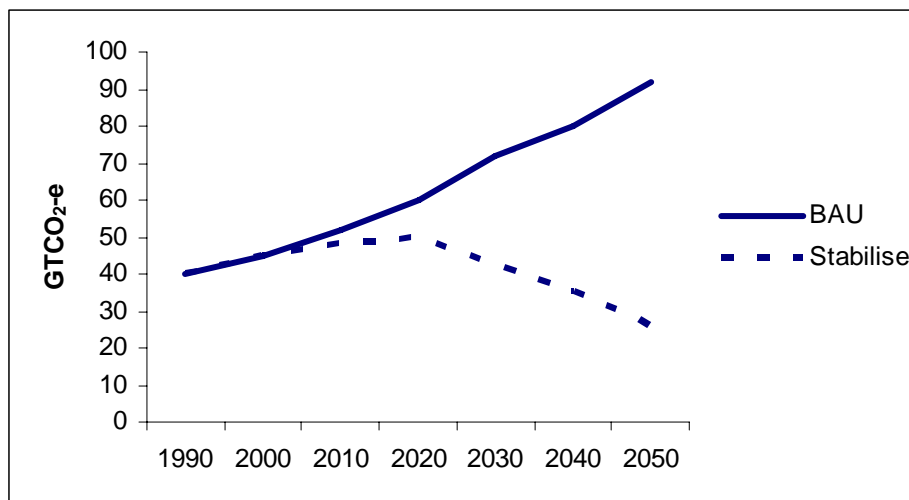
<sup>10</sup> Using IPCC AR4 figures for 1990 levels, and assuming annual growth between 2000-2004 is similar to 2004-2006 (i.e. emissions in 2006 were approximately 52.5GT)

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To stabilise GHG concentrations at around 450-535 ppm would therefore require 'CO<sub>2</sub>-only' emissions in 2020 and 2030, to be on average about 24 and 21.5 GT/year respectively<sup>11</sup>. Relating these 'CO<sub>2</sub>-only' emissions to 1990 levels, stabilising emissions in this range would require a 15% reduction compared to 1990 levels by 2020 and a 20% reduction on 1990 levels by 2030<sup>12</sup>.

There have been a range of other studies that have addressed multi-gas (*all* GHGs) reduction scenarios. In these scenarios reductions in both CO<sub>2</sub> and non-CO<sub>2</sub> GHG emissions can be used to meet any mitigation pathway, which means on average the absolute reductions in CO<sub>2</sub>-only gases are less. To achieve stabilisation at around 550ppm it has been estimated that global emissions in 2025 would need to be no higher than 25% above 1990 levels<sup>13</sup>. To stabilise emissions at the lower end of the spectrum by 2025 (i.e. 450ppm) would require greater cuts in emissions. A synthesis of studies by the Dutch environmental agency has modelled the global reductions required by 2020 to ensure concentrations are stabilised somewhere in the range of 450-550ppm, and found that global GHG emissions in 2020 need to be no more than 25% above 1990 levels<sup>14</sup>.

While all of the above data refers to global emission reduction targets, it is important to determine what share of responsibility is placed on developed and developing countries to reduce their emissions. It is clear that the majority of current concentrations in the atmosphere are due to developed countries, and over the short term emissions from the developed world will continue to be greater than the developing world. Figure 3 illustrates global emissions under a BAU scenario, and compares this with the emission levels required to stabilise between 450-550ppm.



**Figure 3: BAU global emissions and stabilisation pathway (source: IPCC data)**

<sup>11</sup> Taking the midpoint of emissions in the two scenarios and averaging it

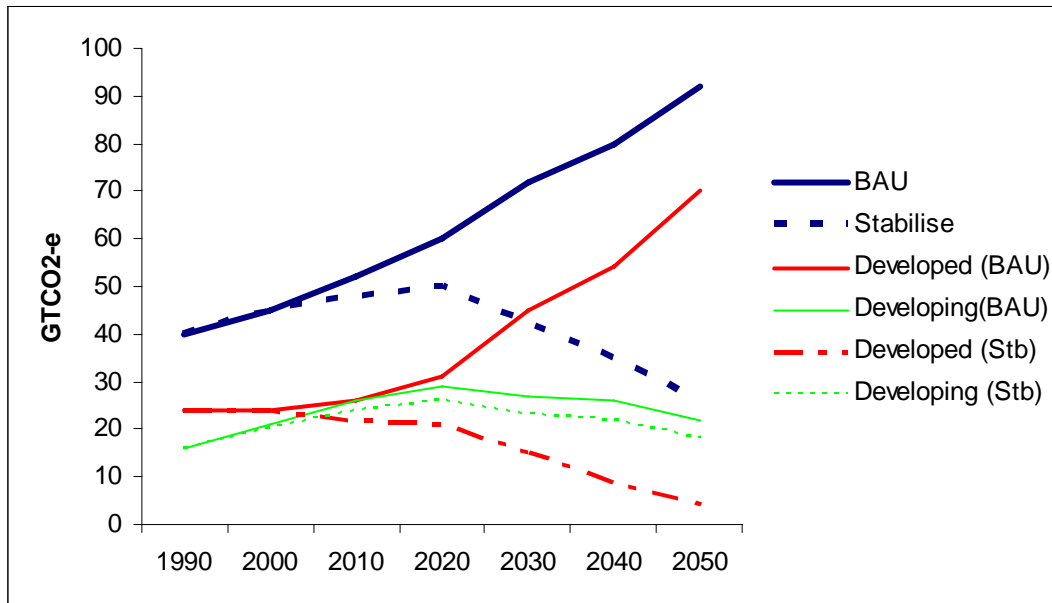
<sup>12</sup> Using 24 and 21.5 GT relative to figures in IPCC AR4, for 1990 CO<sub>2</sub> levels (27.5GT)

<sup>13</sup> Assuming 1990 GHG emissions of 40GT, 2000 of 45GT (from IPCC AR4 WGIII p.g. 4) and growth in emissions is the mid range of the SRES non-mitigation scenarios (BAU) = 57.5% increase in GHG emissions between 2000-2030. BAU emissions in 2025 would be about 66GT. Reduction of 25% below BAU emissions are estimated in *Vuuren, Eickhout, Lucas and Elzen (2006) The Energy Journal*, which equates to about 50GT. This is approximately a 25% increase on 1990 levels.

<sup>14</sup> See [http://www.feem-web.it/potsdam/files/den%20elz\\_ppt.pdf](http://www.feem-web.it/potsdam/files/den%20elz_ppt.pdf)

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As discussed, to reduce *global* emissions to ensure the 'stabilisation' scenario above, developed countries will need to take on more responsibility than developing countries. The precise share of this responsibility is difficult to quantify, however it will be essential that during the negotiations a decision is made on when, and how, a developing country can be integrated within either the developed countries' cap, or any voluntary commitment to reduce emissions. New Zealand should therefore support the 'Russian Proposal', which aims to develop guidelines by which developing countries can be integrated into the global emission reducing strategy.



**Figure 4: Emission reductions required by developed countries<sup>15</sup>**

Assuming that under this Proposal developing countries do not face any emission reduction targets, but do have some deviation below BAU, and that all major developed countries and all GHGs are included in the cap<sup>16</sup>, to ensure that the global stabilisation target is met, developed countries would be required to emit about 25% below 1990 levels by 2020. This would require approximately 10GT/year emission reductions in 2020, and on average about 6GT/year between 2013 and 2020.

The IPCC have reached similar conclusions to those illustrated in figure 4, and recently stated that developed countries as a group would need to reduce their emissions significantly by 2020 (10–40% below 1990 levels) and to still lower levels by 2050 (40–95% below 1990 levels), to stabilise concentrations between 450-550ppm<sup>17</sup>. To ensure the lower end of the stabilisation target is achieved (450ppm), a 25-40% reduction

<sup>15</sup> This graph uses IPCC data for the aggregated 'BAU' and 'Stabilise' scenarios, and splits the contribution from developed/developing countries in a way that results in developed countries reducing emissions by approximately what the IPCC have stated is required. It assumes that some of the countries which are classed as 'developing' in 2010 will become 'developed' during 2010-2050 – hence the reduction in absolute emissions from developing countries.

<sup>16</sup> The key will be to have the United States involved – if not, the rest will have a huge task. The same argument holds if only some gases, such as CO<sub>2</sub>, are included, or if some sectors, such as aviation/shipping fuels are not – see 'the rules' section for more detail.

<sup>17</sup> Technical summary of IPCC AR4 (pg. 90). It is not explicit, but this would require some of the current developing countries to join the developed countries class.

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below 1990 levels by 2020 is required<sup>18</sup>. In August 2007, the UNFCCC recognised the IPCC recommendations that developed countries need a 25-40% reduction on 1990 levels by 2020, and that this range laid the groundwork for the Bali Conference<sup>19</sup>.

The above analysis has provided an approximate amount of emission reductions that are required by participating countries each year between 2013 and 2020, to ensure that global concentrations are stabilised between 450-550ppm. It is important to note that the analysis does however assume full participation from all developed countries, and contributions from developing countries. The following section on rules will, in part, discuss the outcomes where this assumption does not hold.

### ***Decision 3: The rules***

The next key decision that needs to be made is the rules around what activities can be used to realise these emission reductions. The first set of activities to include is those that are covered by the cap – for example whether aviation fuels are introduced or if full carbon accounting is used (emissions from soils etc.). The second type of activities is those that can be sourced from outside the cap - often referred to as ‘flexibility mechanisms’, or ‘Clean Development’ projects – for example avoided deforestation in developing countries.

The cost of achieving the required level of emission reductions will primarily be driven by the rate of participation by countries in a new international agreement, and the rules by which these emissions reductions can be realised. If we assume that all countries participate in the post-2012 regime, and that all activities associated with GHG production or storage are included, the emission reducing opportunities can be illustrated through a ‘global’ abatement costs curve – i.e. the total amount of potential reductions available during a set period (2013-2020 - see figure 5).

In order to build this curve, emission reducing activities need to be categorised, and for each category a cost per tonne of reductions determined (vertical axis), as well as an approximation of the amount of emissions (horizontal axis) that can be reduced at this price. Figure 5 is for illustrative purposes only<sup>20</sup>, and presents some of the global emission reducing potential during the period 2013-2020. It is worth noting that while there are considerable ‘negative cost’ measures<sup>21</sup> that are assumed to have yet been realised, many commentators, including the IPCC, are not convinced that they will actually be realised without intervention beyond pricing carbon.

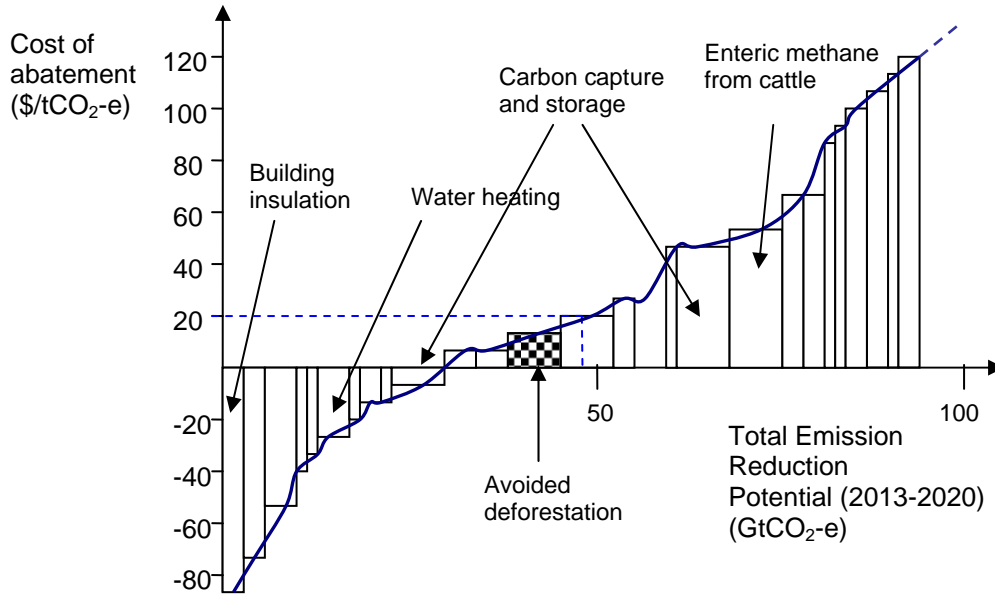
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<sup>18</sup> For both 450 and 550ppm case, developing countries need to also make deviations from BAU

<sup>19</sup> UN Press Release – Vienna August 2007

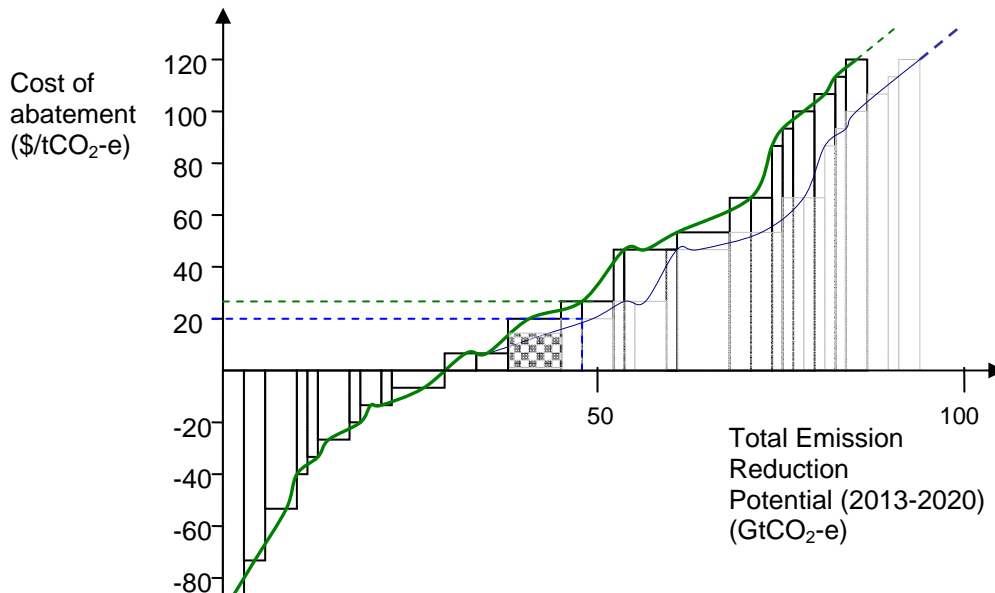
<sup>20</sup> The abatement costs curves in Figure 5-7 are indicative costs, based in part on the McKinsey study on global abatement costs. The types of activities which are included on the graph, and the relative costs of abatement, are however indicative of a real world scenario.

<sup>21</sup> In developing abatement costs, it is important that any co-costs or co-benefits of emission reductions are also included in the analysis. For example, the co-benefits of insulating your home included healthier and warmer environments and savings on your power bill. Planting trees also has co-benefits such as flood prevention and potentially biodiversity enhancements. Quantifying these benefits is however difficult and it is important that each case is treated separately, for example the benefits on biodiversity of protecting tropical rainforest and certainly greater than increasing exotic plantations.



**Figure 5: Indicative global abatement cost curve**

From the previous analysis in the paper, it was determined that to ensure concentrations were stabilised at 450ppm, the emissions reductions required during 2013-2020 were *at least* 6GT/year, or 48GT over the entire period<sup>22</sup>. Assuming that the international trading market operated efficiently, and the least-cost abatement opportunities were realised first, using the data in figure 5, the ‘world price’ of carbon would be approximately \$20/tonne. If however, under the rules some activities were not permitted to be used – for example avoided deforestation, this would shift the cost curve and could result in an increase to the world price of carbon (in the hypothetical example in figure 6 - to about \$25).

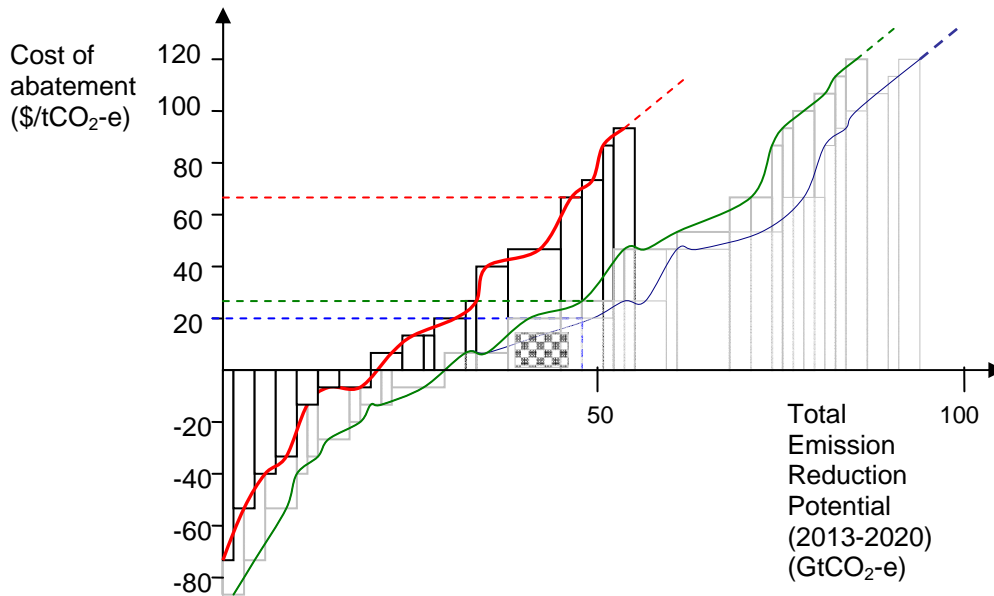


**Figure 6: Impact on world price of removing some emission reducing opportunities**

<sup>22</sup> This assumes that all emission reductions are ‘additional’ to BAU. Some people also argue that allowing too many types of activity (e.g. avoided deforestation) may suppress the world price of carbon, and not encourage the necessary investment in new technology.

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If, however, emission reducing activities, such as avoided deforestation were not allowed under the rules, *and* some countries chose not to participate in the negotiation or some gases/activities were excluded (and these countries or activities *continued to emit BAU*) the world price of carbon, to achieve the same level of emission reductions, could increase dramatically.



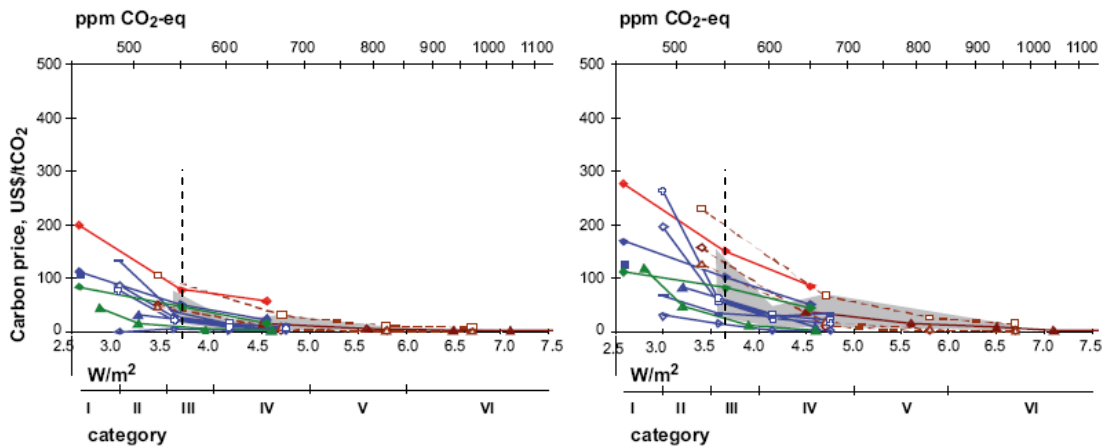
**Figure 7: Impact on world price of reducing opportunities and countries participating.**

However, it is important to recognise that if certain countries do not participate in a future regime, or if particular activities are not included, it is likely that through some form of trade barriers, the price will indirectly flow into these countries or products. For example, the French President is advocating for an EU import tariff to be placed on all non-Kyoto signatories.

Notwithstanding this point, the clear conclusion from figures 5-7, is that to minimise the world price negotiators will want as many emission reducing activities and as many countries as possible included in a future agreement.

### *Outcome B: The world price*

As illustrated, decisions around participation, and the rules by which participants operate, have huge implications on the world price. While it is impossible to know what decisions will be made in the future, there have been a range of studies that have made some assumptions to predict a future world price on carbon. The IPCC 2007 Fourth Assessment Report has synthesised a number of the more recognised models, and provided an approximate range between 2030 and 2050.



**Figure 8: World price of carbon in 2030 (LH pane) and 2050 (RH pane)** (Source: IPCC)

The dashed vertical line in figure 8 represents the maximum concentration that would ensure GHGs in the atmosphere remain below 535ppm. The prices to the left of this line represent the range of likely scenarios from various models. While it is impossible to accurately determine an average price, as many of the models use different assumptions around participation and rules, a conservative figure in 2030 is likely to be somewhere around US\$50/tonne and in 2050 around US\$100. This range is lower than another synthesis report’s findings, conducted by Stanford University<sup>23</sup>, which found the mean of carbon prices from 18 of the world’s leading models, between 2000 and 2100, as follows:

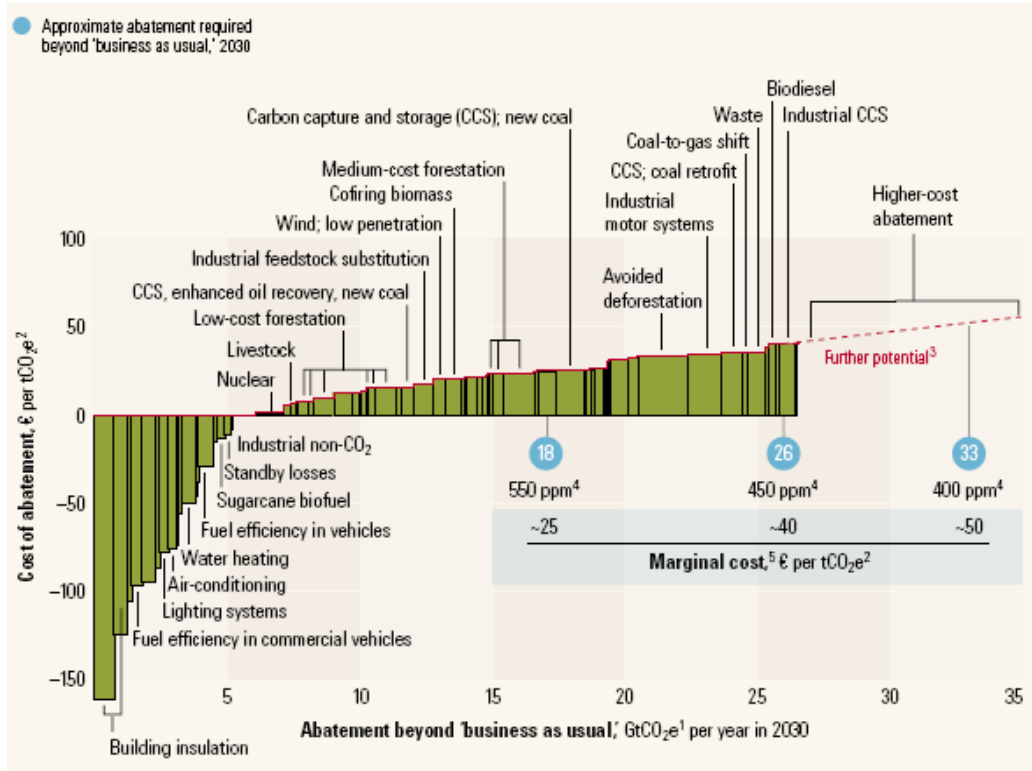
	2000	2025	2050	2075	2100
<b>CO<sub>2</sub> only</b>	2.7	101.3	314.2	406.2	877.0
<b>Multi-gas</b>	2.0	57.8	158.7	241.8	480.3

**Table 2: World price of carbon (\$US)** (Source: Stanford University)

The figures in table 2 highlight another important point, discussed earlier; trying to reach any specific stabilisation with only certain gases (in this case CO<sub>2</sub>) results in a much higher world price. The McKinsey Institute has also done a report on global abatement costs, and predicted that stabilising between 450 and 550 ppm will result in a much lower price in 2030, of approximately 30 Euros (US\$43). Figure 9, reproduced from the McKinsey report, also illustrates some of the abatement opportunity types, and the approximate quantity of GHG emissions reductions required (around 22GT/year) in 2030.<sup>24</sup>

<sup>23</sup> Energy Journal 2006 – *Overview of EMF Multigas mitigation and climate change*

<sup>24</sup> The quantity of emission reductions which McKinsey have determined would be required in 2020 are very consistent with those in figure 4 (from the IPCC data)



**Figure 9: Global abatement cost curve and required emission reductions to stabilise concentrations between 400-550ppm (source: McKinsey 2006)**

While a price in 2030 is a useful signal for what may result in the future, given that the next commitment period is likely to be between 2013 and 2020, it is important that a gauge of approximate prices in the nearer term is determined.

With prices trending steadily upwards between 2000 and 2100, it is clear that a price in 2013-2020 is likely to be somewhere below \$US50 and above the current price of around \$US11<sup>25</sup>. This range is reasonably consistent with results from modelling undertaken by the Australian Greenhouse Office, which predicted that prices would rise from \$US8 per ton of carbon in 2008 to \$US34.40 per ton of carbon by 2020.<sup>26</sup> Assuming a straight line increase, and averaging the result over 2013-2020, it is likely that the world price would be approximately \$US25/tonne during 2013-2020.

#### **Decision 4: The New Zealand cap**

While the decisions around a stabilisation goal, a global emission reducing strategy to achieve this goal, and rules by which activities are included, will have huge implications on NNW through their impact on the world price, the other major contributor to NNW will be the target that New Zealand signs up to. The factors that will influence this target will be the decision on the cap for developed countries as a group, and how New Zealand's mitigation potential, given the activities deemed eligible under the rules,

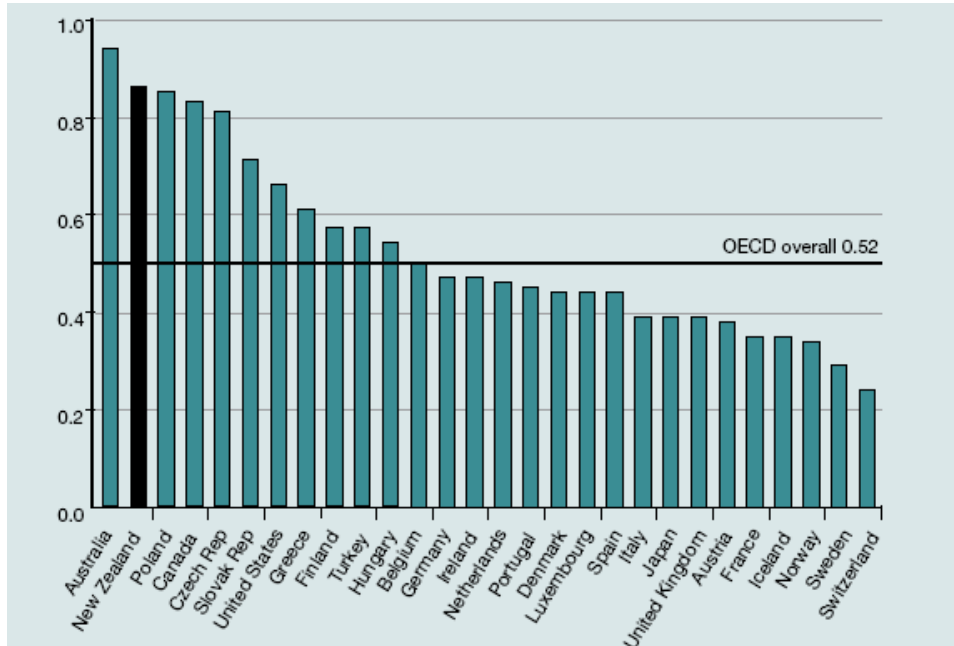
<sup>25</sup> Average current trading price of CDM credits – (June 2007: Treasury website)

<sup>26</sup> Modeling Results for the Kyoto Protocol - Australian Greenhouse Office - Warwick McKibbin

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relates to other developed countries potential. The mitigation potentials of participating developed countries will be used to determine an appropriate sharing of responsibility of the aggregate cap – with the primary indicator of how much responsibility each country takes on being the relative costs of reducing emissions within their economy<sup>27</sup>.

The New Zealand economy is very emission intensive, with the second highest emissions/unit GDP in the OECD (a good proxy for ‘developed’ countries).



**Figure 10: GHG emissions per unit of GDP (2004)** (source: Skilling 2007)

If reducing emissions required emission intensive industries to shut down, with the lost capital moving offshore, the impact on GDP of reducing emissions in New Zealand would be much more than other countries. It is however possible to substitute some forms of economic activity for others, which offsets to some degree the cost of reducing emissions. Furthermore, there may be technology that is readily available that can be adopted to reduce emission intensity per unit output. Unfortunately for New Zealand, relative to other developed countries the opportunities for substitutes and the availability of technology at reasonable costs are very limited, currently. This is primarily because of our unique emission profile.

<sup>27</sup> Other factors will also be considered, including the level of investment being made in mitigation technology, the amount of funding allocated to adaptation – in particular for developing countries, and other indicators such as relative GDP. More work is required in this area, to determine exactly where New Zealand sits relative to other developed countries.

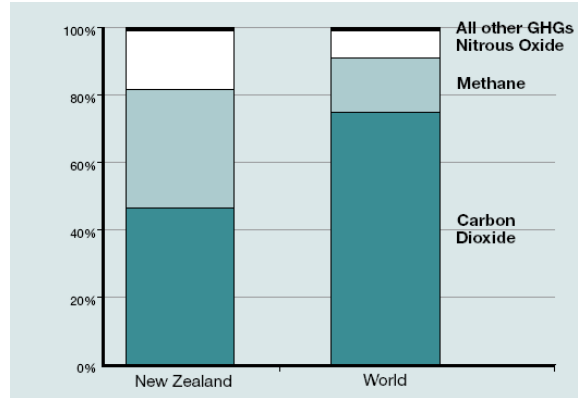


Figure 11: GHG emissions – proportion of each type (source: Skilling 2007)

New Zealand’s emissions profile is quite different from the world average (and even more so when compared to other developed countries) - with about 50 percent of emissions coming from methane and nitrous oxide. As discussed, the opportunities to reduce these emissions are limited, and mostly very costly. New Zealand’s electricity generation is also unique – primarily from low emission (renewable) sources. This has two implications. First, the same extent of low cost emission reductions available to many developed countries from fuel switching (coal to gas) is not available here. Second, our electricity is much less emission intensive than other developed countries, so that conserving electricity or increasing the efficiency of the use of electricity gives smaller reductions in emissions in New Zealand than it does in countries with more emission intensive electricity. To illustrate how this unique profile increases the cost of reducing emissions, it is useful to refer back to abatement cost curves.

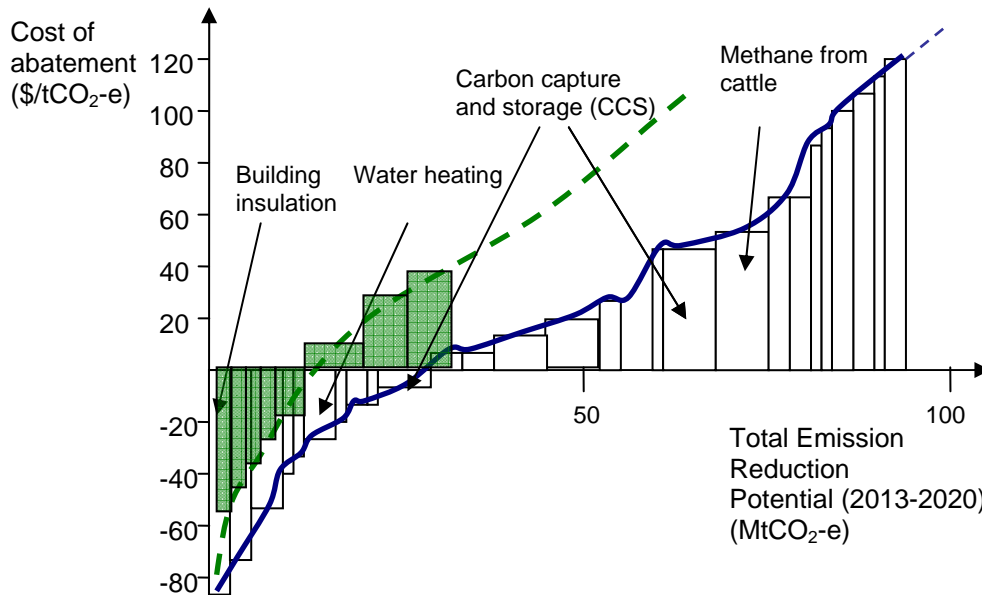


Figure 12: Indicative abatement costs<sup>28</sup> - developed countries (solid line) and New Zealand (dashed)

<sup>28</sup> The real costs are unknown, however, the fact that emissions in countries such as the UK and Australia have stayed relatively stable since 1990, indicates that there were, and probably still are, more cost-effective abatement opportunities than in New Zealand.

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The solid line represents an indicative average abatement cost for developed countries. Compare this profile with an estimate of the opportunities which New Zealand has (the dashed line and shaded boxes), which assumes that less than half of the efficiency gains can be realised through building insulation, water heating and CCS, and the quantity of emissions from methane are much greater, it is clear that for any given emission reduction quantity, the costs for New Zealand would be much higher. This cost profile will of course change, depending on the inclusion of various activities in the rules. For example, the inclusion of international aviation and shipping fuels will tend to increase our relative cost profile (given our tourism and trade industries) while the inclusion of total carbon accounting for soils may either increase or decrease relative costs. New Zealand should therefore be able to negotiate a lower target than other developed countries.

Given the importance of the rules on determining mitigation potential, it will however be important that, unlike with the Kyoto Protocol negotiations, New Zealand does not sign up to a domestic target before a decision has been reached on what activities are included within the framework.

### **Decision 5: The New Zealand ETS**

The in-principle decisions are the NZ ETS will have major implications for how the world price is transferred through the New Zealand economy. Some activities, such as liquid fuels, will be exposed to the full cost of carbon, at the world price, for every tonne of emissions from 2009. Others, such as agriculture and industry, receive some level of free allocation, and therefore only have to pay for emissions beyond this level<sup>29</sup>. The decision around when sectors are covered under the ETS, and how much free allocation they receive, going forward, will dictate how the costs of meeting the New Zealand cap are shared amongst emitters/consumers and government/taxpayers.

#### *Outcome C: Cost to emitters*

The costs faced by emitters will be driven by the amount of permits which they receive for free, their abatement costs, and the world price. The impact of free allocation is relatively straightforward, with the number of permits times the world price simply being a wealth transfer to the emitter. The costs of reducing emissions in each sector, relative to the world price, will determine the amount of emission reductions within each sector. To illustrate how abatement costs and the world price affect the decisions of firms to reduce emissions, and the impact on costs, it is helpful to use a simple example within agriculture.

In the agriculture sector, it is widely agreed that there are few low-cost abatement opportunities. There are some opportunities which currently exist for reducing nitrous oxide through nitrogen inhibitors, and at a higher price some sort of substitution to other forms of land-use may be possible. However, there may be even greater potential at even higher prices for a new technology to become financially viable which reduces methane from animals. To illustrate how an individual farmer may choose to reduce

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<sup>29</sup> All sectors are of course 'exposed' to the full price of carbon of all emissions

emissions (assuming that some sort of incentive is devolved to the farm level<sup>30</sup>), a hypothetical abatement cost curve has been developed in figure 13 – defined by the line AE. As with other abatement curves there is a given level of abatement available for each activity (x axis), at a given price (y axis).

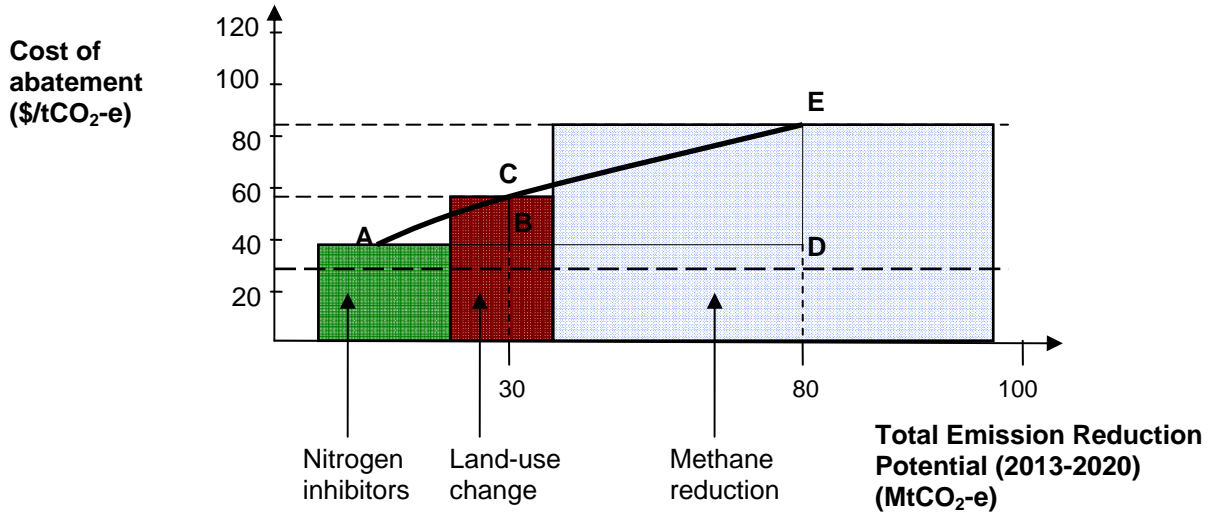


Figure 13: Indicative abatement cost curve for agriculture<sup>31</sup>

In the example above, with a world price of around \$NZ30, the agriculture sector as a whole will simply have to pay this price for every tonne of emissions above what it receives free allocation for (there are no emission reducing opportunities below this world price). However, if the price were to move to the upper limit of the likely range (around \$NZ55) there would be 30MT of emission reductions. The gains to NNW would be the producer surplus - area of triangle ABC. If the price moved to around \$NZ85, there would be some land-switching and the methane reducing technology may become financially viable – resulting in reductions of about 80MT and gains to NNW of area ADE. While there is currently little evidence around abatement costs, and many will only be known once the price of carbon is signalled to emitters, it is clear that gains to NNW can be made by passing on some of the costs to emitters<sup>32</sup>.

As discussed, it is however important that in passing the costs onto emitters, the result is a reduction in net emissions, rather than simply shifting those emissions to countries who do not have their emissions capped. If the overall global emission reducing strategy is attempting to reduce emissions in all countries below BAU, it is necessary that any leakage effects are included in any judgment of the effectiveness of policy.

<sup>30</sup> While farmers face an incentive to change to less emission-intensive land-use, unless the technologies for reducing methane/nitrogen emissions are accepted as an emission reducing activity (i.e. the emission factors for cows/nitrogen use can be altered), they are not rewarded for reducing these emissions in terms of the carbon costs.

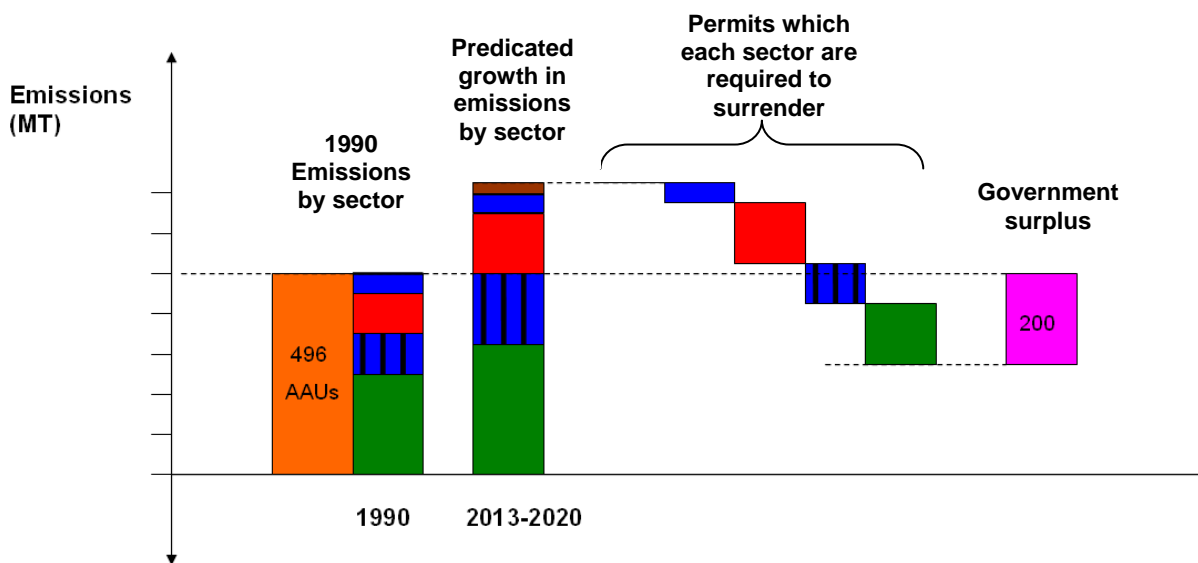
<sup>31</sup> As with other curves, the actual costs are unknown, and some argue that the co-benefits of some of the mitigation activities (i.e. biodiversity and flood prevention from planting trees, or nutrient reduction in rivers from the use of nitrogen inhibitors) actually make some of the mitigation opportunities reasonably cost-effective.

<sup>32</sup> This assumes that the permits which are available to Government as identical to those available to business, and that the transaction cost differences are negligible

Outcome D: Government's fiscal position

The second important outcome, when considering impacts on NNW, is how the Government's fiscal position is affected by decisions on a New Zealand cap and allocation within the ETS, and how any revenue generated is recycled back into the economy.

Assuming that the in-principle decisions within the ETS relating to allocation are finalised in the current form, the responsibility that the scheme places on domestic emitters is around a 50% reduction below 1990 emissions between 2013 and 2020, and a 70% reduction below 1990 levels by 2020. Figure 14 illustrates that if the Government were to sign up to 1990 levels over this period, there would be approximately 200MT of surplus credits which it could sell on the international market at the world price<sup>33</sup>.



**Figure 14: Indicative domestic emissions and Government surplus.**

(From bottom of 2013-20 columns up) green: agriculture; blue and black stripes: industrial processes; red: liquid fuels; blue: stationary energy; brown: deforestation; grey: waste.

[Note: it is assumed that all emission reduction credits from forestry and devolved to the sector]

With the range of reductions required for developed countries as a whole being somewhere between 10 and 40% reduction below 1990 levels, it is very likely that the Government will be in a position of surplus credits between 2013 and 2020, unlike in commitment period one (CP1) where a significant deficit is forecast. The magnitude of this surplus will in part be due to emission reductions that occur through the world price being higher than domestic abatement opportunities (as discussed in the previous outcome), and also by what level of responsibility the Government signs up to. For example, if a 10% reduction below 1990 levels was negotiated, from figure 14 it can be

<sup>33</sup> There are a range of assumptions in this model around growth in emissions, and that there is no auctioning of Crown AAUs. It is however a reasonable estimate of a likely surplus, given the current decisions around allocation within the ETS. This assumption around allocation within the ETS is however likely to change, with pressure from industry to increase the level of free allocation. This will result in a smaller surplus for Government

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derived that about 160MT of credits would be surplus – which at \$NZ30/tonne, would equate to about \$5 billion of extra Government revenue during 2013-2020.

### *Outcome E: International trade*

The third key outcome, which will impact on NNW, is how supply and demand for New Zealand exports is affected by decisions around the rules and participation. For example the impacts of rules around the inclusion of avoided deforestation on prices of timber, will have some flow on effects for our timber exports<sup>34</sup>. Another example, which has been recently illustrated, is how demand for abatement opportunities within the liquid fuel sector have put pressure on fertile land to produce bio-fuels, which in turn increases the costs of feed-stocks and therefore world agricultural commodity prices. Take for example the increased demand for biofuels in the United States, which in 2006 resulted in more than a third of the total US maize crop being processed for biofuels (nearly 50% increase on 2005), and a near doubling in the price of maize. Maize is a key component of feedstock for non-pastoral farming, and while it is impossible to determine precisely how much affect the increased price has had on agricultural commodity prices, it is fair to say that *some* of the recent \$2billion dollar increase to the dairy farmers' payout was due to the increased demand for biofuels in the United States. Given New Zealand's exports are dominated by the land-based, primary production, sector, our export industry will benefit from rules that result in the inflation of prices of primary commodities.

The competitiveness of our export sector will also be affected by whether countries with competing firms accept any responsibility for emissions, and if they pass this on to these emitters. This issue is closely related to leakage, as simply putting a price on activities in New Zealand which are highly mobile may result in those activities shifting offshore, with potentially an increase in emissions. To address both competitiveness and leakage issues, the Annex 1 countries should promote the introduction of sectoral targets within developing countries for industries such steel, aluminium, cement etc. While a cap on emissions would be ultimately desirable, introducing a price directly into these sectors would result in the world price for these commodities reflecting the cost of carbon, which would ensure the competitiveness of New Zealand firms is not harmed. The same case would hold for agriculture emissions, although the chance of any sectoral target in this area would seem small – given that many of the producers are small scale farmers, unlike the large multinational industrial firms<sup>35</sup>.

Another important consideration is how New Zealand's domestic caps, or potentially even actual domestic emission, affect our clean green brand, and flow on effects for international trade. Recent work by the New Zealand Institute has questioned the current value of this brand, with evidence that there have only been small shifts in consumer preferences for low-carbon products. However, with public awareness growing, it is likely that in the future consumers will probably pay a greater premium for imports with low-embedded carbon, or from countries who are taking responsibility for

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<sup>34</sup> Some preliminary work my MAF has estimated that the gains to halting illegal logging (which is in part linked to avoided deforestation) are potentially worth around \$200million per annum.

<sup>35</sup> It is however important that simply waiting for sectors in other countries to face a price on carbon *before* introducing a price in New Zealand would not be equitable in terms of global emission reducing strategy. Furthermore, by introducing a price in New Zealand before overseas competitors may result in emission reducing technology being developed that can be exported to the competing firms in developing countries in the future.

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emissions. Some people, therefore, argue that exporters may benefit from New Zealand differentiating itself from other international participants, and taking on board unilaterally tougher targets, or prioritising domestic emission reductions. This may also have some potential spill-over effects, in terms of developing and distributing low-carbon technologies.

Given the complex nature of these relationships, and potentially large gain in terms of trade for New Zealand, it would be useful to undertake future modelling analysis, potentially working alongside trade modellers, to identify the likely impact of rules on commodity prices, and the affects of domestic emission reductions and targets on New Zealand's export brand, and the flow on impacts to NNW.

### Impacts on NNW

#### *Empirical work done*

Determining the overall impact on NNW of decisions made on international, and domestic, climate change policy, is a complicated task. The outcomes which directly affect NNW will be the level of the world price and how it is transferred through the economy, and any shift in demand or supply of New Zealand exports. These outcomes will be driven by decisions at both the international and domestic level.

As discussed, the world price has major implications for NNW, and there have been a number of studies which have predicted the likely range of prices over the next 100 years. This paper has predicted an approximate price during 2013-2020 of about \$US25/tonne – with decisions under the ETS determining how this price is passed through the economy. General equilibrium modelling has been undertaken recently to quantify the impact of the ETS on New Zealand's NNW<sup>36</sup>, given the in-principle decisions around coverage and allocation, and assuming carbon prices within this range. The modelling also made an assumption that the Government would recycle any revenue from the sale of surplus credits by reducing business taxes.

With a carbon price of \$NZ25/tonne the impact of the ETS on private consumption in 2012 is about -0.2% and in 2025 about -0.7%. With a price of \$50 the impact is -0.3% in 2012 and at \$100 is -2.2% in 2025. While these figures are relatively small, it is important to recognise that three specific components of the conceptual framework developed within this paper, are either ignored or an assumption is made that may not hold. Given the potential implications on NNW it would be useful if further empirical work was undertaken to address these issues.

#### *Further analysis required*

The modelling undertaken by Infometrics assumed that technology was exogenous, therefore ignoring how investments in new technology may reduce abatement costs<sup>37</sup>. Figure 13 has already illustrated the gains to NNW that can be made by abating emissions rather than purchasing credits internationally at the world price, and while it

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<sup>36</sup> Infometrics – Impacts of the ETS (2007). As with most GE models it uses consumption as a proxy for welfare.

<sup>37</sup> The emission reductions which the modelling predicted were therefore due only to substitution between different activities (such as switching from coal to gas, or bio-fuels)

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is important to factor in transition costs and the impact on total investment pattern in New Zealand, it may well be that the reductions in consumption are at the high end of the likely range. To help quantify this, further modelling will therefore be useful, which made technology endogenous by using information about abatement cost curves<sup>38</sup>.

Another issue which was largely ignored was the impact of climate change policy in other countries on the international trade of New Zealand exports. One component of this is whether international firms which compete with New Zealand exports face a price on carbon. While the data above assumes that none of the firms which New Zealand exporters compete with face a price on carbon, a run of the model was done where *all* competitors faced a price. In this scenario, with a price of \$100/tonne, private consumption in 2025 fell by -1.4%, compared to -2.2% in the earlier run. While it is unlikely that firms in developing countries which export agricultural products will face a price on carbon, there may be some gains to NNW that can be made if sectors such as cement, aluminium and steel are included within the global emission reducing strategy.

Finally, an assumption was made around how the Government would recycle any surplus revenue – with a simple choice made that business tax would be reduced by an equivalent amount. While this may be the most efficient choice, it is important to consider the impact on NNW of other possible options.

### **Likely scenarios and implications for negotiations**

The recommendations above have highlighted some further modelling that could be carried out to get a better understanding of the likely impacts on NNW. It would also be useful to understand, and potentially model, what outcomes are likely in terms of carbon prices and shifts in demand for New Zealand exports from decisions made at the international level. The final section of this paper identifies some of the likely scenarios for future decisions, and makes some initial recommendations for a New Zealand position – given the evidence presented in this paper on the possible outcomes. This is by no means a final set of recommendations, as many of the decisions are still to be made, and much of the data still needs to be sourced.

#### *Stabilisation goal:*

The negotiations around a stabilisation goal are likely to focus on an acceptable temperature increase and corresponding concentration level. The European Union has focussed on 2 degrees Celsius as an acceptable temperature increase, which corresponds to an approximate concentration level of around 450ppm. This is at the lower end of the 450-550ppm range which is generally considered as an appropriate concentration target.

The outcome of a higher concentration goal will be fewer emission reductions and a relatively lower world price resulting in higher NNW. However, a higher concentration goal will result in greater global impacts of climate change, which, depending on the distribution of these costs, could reduce NNW.

#### *Global emission reducing strategy:*

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<sup>38</sup> Work on determining these cost curves is currently being undertaken

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To *ensure* any particular stabilisation goal will require global emissions to be capped at a certain quantitative level. Capping global emissions from 2013 onwards is however extremely unlikely, with a more probable scenario being a cap on developed countries emissions, and some form of commitment for developing countries to reduce emissions below BAU. The number of countries which participate in this strategy will have major implications for the world price, the reductions that New Zealand will have to make, and the prices of New Zealand exports.

Without a cap on the emissions of all major developed countries such as the United States or Australia, and commitments to reduce emissions from some of the larger developing countries, or emission intensive sectors within these countries, the reductions that New Zealand, and other developed countries will need to make, to ensure emissions are stabilised at 450-550ppm will require an extremely high world price. Furthermore, the competitiveness of New Zealand firms relative to those in the non-committing countries would be negatively affected. Given the global stabilisation goal, and the likely impacts on NNW of achieving this goal with only small contributions for other countries, it is clear that New Zealand should only sign up to an agreement in which the emissions of all the major developed countries are capped<sup>39</sup>, and the larger developing countries make commitments to reduce emissions below BAU – possibly through emission intensity targets for certain industries such as cement, aluminium and steel manufacturing.

### *Rules:*

The decisions around what activities are included within the developed countries 'cap', and what activities can be sourced from outside, will also have major implications for the world price and international commodity prices.

With respect to what activities are covered by the cap, the discussions at future international negotiations are likely to focus on bunker fuels (aviation and shipping) and the treatment of land-use, land-use change and forestry (LULUCF). As with participation, the greater the number of activities covered, the lower the world price will be. This is because there may be cost-effective emission reducing potential that is otherwise unrealised if it is not included. While reducing the world price is an outcome that New Zealand would generally desire, and would therefore support the inclusion of more activities within a future regime, (such as bunker fuels), there are other considerations – in particular the impact on New Zealand's emission profile. In respect to bunker fuels, given our location New Zealand has a relatively high proportion of emissions from international transportation, however, as discussed, this would reduce our domestic mitigation potential, on average, and could result in a less stringent target being adopted.

With respect to LULUCF, the likely scenarios are a complete removal of forest sinks from the accounting, or a move to full-carbon accounting, where all emissions and sequestration from forests and soils is included. During CP1 New Zealand has relied heavily on our forest sinks, and the same will be true between 2013 and 2020. We would therefore want to ensure sinks are included in any future regime, although, as with the inclusion of bunker fuels, the sinks are a mitigation option that will probably increase the stringency of the New Zealand target. With respect to full-carbon

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<sup>39</sup> The cap for developed countries as a whole would be somewhere in the range of 10-40% below 1990 levels by 2020, to ensure stabilisation in the range of 450-550ppm.

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accounting, it is unclear whether New Zealand's emission profile will either increase or decrease, therefore, as with bunker fuels, it seems logical to include this activity.

Avoided deforestation relates to emission reductions that can be sourced from outside the cap, and this issue will probably be one of the most important decisions that will need to be made at the Bali negotiations. As discussed, including avoided deforestation will result in cost-effective emission reducing activities being available, which will reduce world prices. Furthermore, it would result in a reduction in timber supplied to international markets which would increase timber prices, with resulting positive flow on effect to New Zealand exports. New Zealand would therefore want to support the inclusion of avoided deforestation (assuming of course these are additional emission reductions), however would want to ensure that these projects were awarded credits that were linked to the international trading market (rather than a separate fund).

*New Zealand cap:*

The cap that New Zealand signs up to will be largely determined by the costs and opportunities of reducing emissions relative to other developed countries. The other considerations include how much investment the Government is doing in research and development, and funding adaptation in developing countries. Given the relatively high abatement costs in agriculture, the small opportunity for emission reductions in electricity efficiency measure, and the large amount of funding currently being given to agricultural research, there could be a good basis for New Zealand to argue a relatively low cap. More work will however need to be done to accurately determine our domestic abatement costs, and in time it is expected that the UNFCCC will design a framework for determining how to allocate responsibility under the aggregate cap to participating countries<sup>40</sup>. Furthermore, given the importance of the rules on determining mitigation potential, and therefore a fair share of the responsibility, New Zealand should not sign up to any domestic target unless the decisions around what activities are included have been made.

The implications for the New Zealand cap are two-fold. Firstly, the direct result of a less stringent cap will be a greater surplus of credits and more revenue for the Government to recycle back into the economy (assuming the final decisions around allocation mean there is a surplus). On this basis, we should push for as low a target as possible. However, there are some potentially negative implications of negotiating a lower target – primarily through the impact on our 100% pure, clean green brand, which has some value for international trade and tourism. The trade-off between accepting a more stringent cap, and the benefits for trade and tourism, will need to be considered. It may well be that NNW is enhanced by the Government unilaterally imposing a greater responsibility than what it signs up for.

### Initial recommendations for further work

This paper has identified some key gaps in analysis, which once completed would assist with negotiations on international climate change policy. This includes:

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<sup>40</sup> The UNFCCC has started to discuss factors that will contribute to determining mitigation – *Synthesis of information relevant to the determination of the mitigation potential and to the identification of possible ranges of emission reduction objectives of Annex I Parties.* (July 2007)

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- Conducting empirical analysis, or undertaking further research of international studies, on the relationship between decisions on participation by countries in a global emission reducing strategy and the activities included within this strategy, and the world price on carbon and impact on international commodity prices;
- Deriving sectoral abatement cost curves for New Zealand, and generating data to assist with the determination of the domestic mitigation potential;
- Undertake further general equilibrium modelling to incorporate these abatement costs, and with sensitivity analysis around alternative methods of government expenditure of the revenue from surplus credits; and
- Developing a better understanding of the likely scale of direct and indirect effects on New Zealand associated with increased global mean temperatures.