TOWARDS GLOBAL AGREEMENT

9

Key points

Only a comprehensive international agreement can provide the wide country coverage and motivate the coordinated deep action that effective abatement requires.

The only realistic chance of achieving the depth, speed and breadth of action now required from all major emitters is allocation of internationally tradable emissions rights across countries. For practical reasons, allocations across countries will need to move gradually towards a population basis.

An initial agreement on a global emissions path towards stabilisation of the concentration of greenhouse gases at 550 CO_2-e is feasible. 450 CO_2-e is a desirable next step. Agreement on, and the beginnings of implementation of, such an agreement, would build confidence for the achievement of more ambitious stabilisation objectives.

All developed and high-income countries, and China, need to be subject to binding emissions limits from the beginning of the new commitment period in 2013.

Other developing countries—but not the least developed—should be required to accept one-sided targets below business as usual.

The international response to climate change is too slow and patchy to be effective. The discussion is conducted at an abstract level, and outside any requirements that numbers being discussed 'add up' to a global solution.

How can we build on existing international frameworks and negotiations to deliver an international agreement that is sufficiently ambitious to avert high risks of dangerous climate change?

A satisfactory international agreement will be difficult to reach. The prospects depend on the level of global community interest in mitigation. They depend on close communication across countries, over the years ahead, directed at developing a set of requirements which add up, and which, taken together, are widely seen as being fair.

With increasing international knowledge of the urgency of the risks, the political possibilities in the period ahead will widen.

An effective international global agreement to limit the risks of climate change will need to cover two main areas. First, the quantum of mitigation effort needs to be agreed. By how much will emissions be reduced, worldwide, and in each country? Second, while each country will be responsible for achieving its climate change mitigation goals, mechanisms for international collaboration will need to be in place to support national action. The most important of these will be international trading of emissions entitlements and public funding for technological development and adaptation.

These two areas are covered by the Kyoto Protocol, which takes as its starting point the global stabilisation goal of the United Nations Framework Convention on Climate Change (UNFCCC) and allocates emissions limits to most developed and transition countries. The Kyoto Protocol also introduces mechanisms for international collaboration. As argued in Chapter 8, while the Kyoto Protocol is not an adequate global response to climate change, any future, more effective response will have to build on it. There is no time to start again.

This chapter covers the first of the two areas: reaching agreement on global and national climate change mitigation goals. Chapter 10 discusses mechanisms for international collaboration.

9.1 Agreeing on a global goal

Determining limits over time on global emissions involves striking a balance between the benefits associated with smaller and slower climate change and the costs associated with greater and faster mitigation. The appropriate extent of mitigation is defined by the point at which the additional gains from mitigation are similar to the additional costs. In the end, judgment is required on the level of climate change that corresponds to this balancing point.

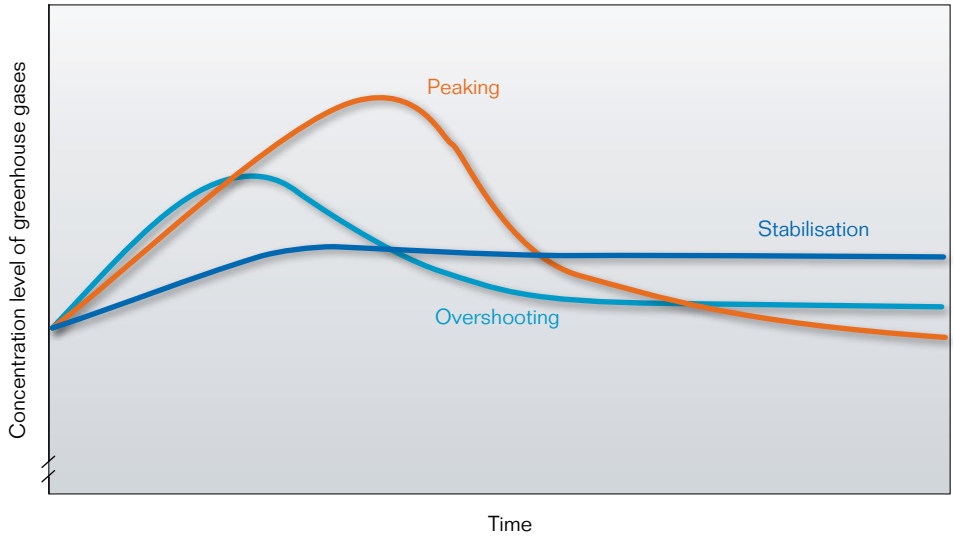
Targeted limits on climate change can be defined at three levels. At the highest level they can be defined in terms of impact or global temperature increase. At the next level they can be defined in terms of the profile for concentration of greenhouse gases in the atmosphere, which drives temperature increases. And at the third level, they can be defined in terms of emissions of greenhouse gases, which drive atmospheric concentrations.

9.1.1 Impact goals

Targets for global mean temperature compress the multiplicity of possible impacts (ranging from glacial melting to increased weather-related calamities) into a single variable. The European Union, for example, has argued that global mean warming should not be allowed to exceed 2°C from pre-industrial levels (Council of the European Union 2007).

Endorsement of a temperature threshold (and therefore of any target derived from it, for example, greenhouse gas concentration) cannot imply indifference to other factors. There may be tipping points associated with particular temperature thresholds, but the thresholds are not known with certainty.

Figure 9.1 Different concentration goals: stabilisation, overshooting and peaking



9.1.2 Concentration goals

Global warming increases temperature with a long lag. It might take more than a century after stabilisation of greenhouse gas concentrations for a new equilibrium temperature to be reached. Any goals in terms of temperature need to be translated into goals for the atmospheric concentration of greenhouse gases.

Chapter 2 introduced various types of concentration goals: stabilisation, peaking and overshooting (Figure 9.1). Most attention has focused on stabilisation scenarios, and the UNFCCC goal of the 'stabilization of greenhouse gas concentrations in the atmosphere' (Article 2).

However, as discussed in Chapter 2, special challenges are introduced by the need to reduce greenhouse gas concentrations to low levels. There is great difficulty in moving directly to that outcome from where the world is now. Whether the ultimate aim is stabilisation or prolonged decline after an initial rise (peaking), there is a good chance that the optimal response to climate change will need to involve a period (of uncertain duration) during which concentrations fall. This assumes that emissions can be brought below the natural level of sequestration. Reducing emissions below this level would probably require the development and deployment of technologies for carbon capture, such as new approaches to biosequestration.

The Review modelled two global mitigation scenarios (Chapter 4). The 550 scenario is a stabilisation scenario at which the concentration of greenhouse gases in the atmosphere approaches 550 ppm carbon dioxide equivalent (CO_2-e) and stabilises at around that level thereafter. The 450 scenario is an overshoot scenario under which concentrations peak at around 500 ppm CO_2-e and then stabilise at around 450 ppm CO_2-e. Any lower stabilisation objective, for example at 400 ppm CO_2-e, would need to involve a longer period of overshooting.

9.1.3 Emissions goals

Any concentration profile has an associated emissions trajectory. (An emissions trajectory defines the flow of greenhouse gases that converts, through various physical and chemical processes, into a stock of greenhouse gases in the atmosphere.)[1]

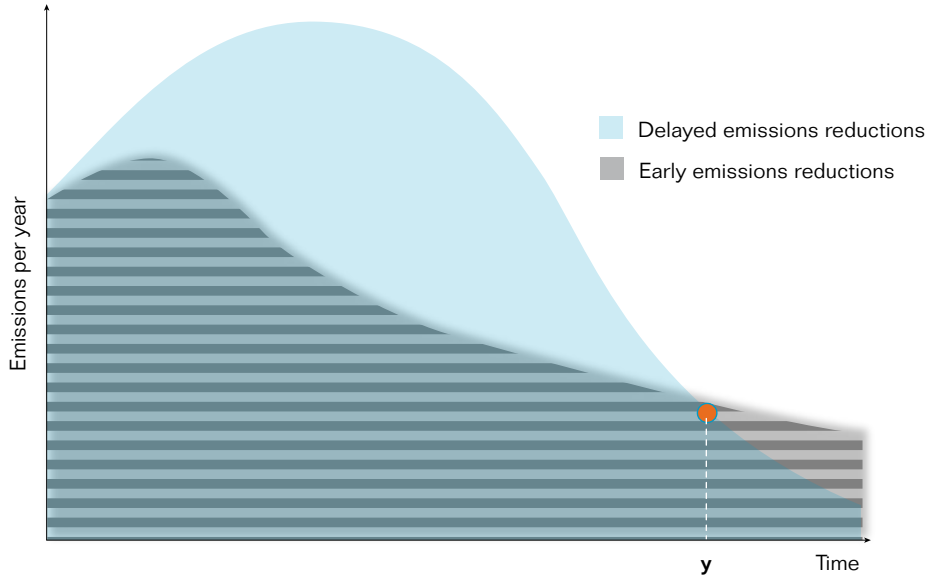
There are different ways in which goals for emissions can be expressed:[2]

- **End-period emissions**—This is the most common way of announcing targets (for example, that emissions will be reduced by 50 per cent by 2050). The advantage of this approach is simplicity. The disadvantage is that a target at one point of time says nothing about the rate at which emissions should approach that target level, and so does not constrain cumulative emissions or the concentration profile at that point of time (see Figure 9.2).
- **Annual emissions**—Since a concentration profile implies annual values for emissions, annual targets for emissions can be articulated. The disadvantages of this approach are complexity and inflexibility. There may be little difference in the environmental impact of two trajectories that end with similar concentrations but that have different annual emissions levels. However, the two paths could have quite different costs.
- **Cumulative emissions**—This is the budget approach, by which the total emissions determined by a target concentration profile over a number of years are summed up into a single target budget. In this approach, year-to-year variation from the target profile is allowed; what matters is to the total emissions over a number of years.

The benefit of the budget approach is its flexibility: it allows intertemporal trade-offs and smoothing. Variations in timing would have to be large to have material environmental impacts. Variations within five-year periods as proposed in Chapter 14 would not have material effects.

The Review makes extensive use of emissions trajectories (see, for example, Chapter 12) to express emissions goals, and budgets to provide intertemporal flexibility.

Figure 9.2 Different cumulative emissions from the same end-year target (y)



9.2 What form should national commitments take?

Once a global goal has been agreed, responsibility for its achievement needs to be allocated among countries. Unless all major economies agree to limit their emissions, it will be impossible to ensure that action at the global level adds up to an effective mitigation effort.

While any global agreement will emerge from negotiations—especially between the major emitters, and in particular between the two largest emitters, China and the United States—it is useful to spell out basic principles that could provide a framework for reaching agreement.

Proponents of price-based emissions control have argued for the adoption of national carbon taxes (Cooper 2000; Nordhaus 2008), or a common global carbon tax (Stiglitz 2006). Hybrid policies combining quantity and price controls have also been proposed, principally through emissions cap and trade schemes, but with a government-backed price cap as well (Roberts & Spence 1976; McKibbin & Wilcoxen 2002, 2008; Pizer 2002; Murray et al. 2008). A variant of the hybrid scheme has the price cap agreed internationally. [3]

At the heart of the economic argument for price control is uncertainty about abatement costs. The theory of prices versus quantities for pollution control (Weitzman 1974) shows that such uncertainty will invariably lead the policy to under- or overshoot the optimum. Imposing a quantitative target will lead to higher or lower marginal abatement costs than expected, while a given tax rate will lead to

a greater or lesser abatement effort than expected. The resulting efficiency costs are thought to be lower under a price-based instrument for stock pollutants such as greenhouse gases, so getting the price wrong under a tax imposes smaller welfare losses than getting the quantity wrong under a quantity target.

Proponents of price-based emissions control have pointed out that a common global carbon tax or an agreement on an internationally harmonised price to apply in domestic permit trading schemes would avoid both questions of distribution between countries inherent in a cap and trade system, and the potentially destabilising effects of large-scale international financial flows.

While the introduction of a tax-based mitigation system would take the world significantly forward, only an international agreement that explicitly distributes the abatement burden across countries by allocating internationally tradable emissions entitlements has any chance of achieving the depth, speed and breadth of action that is now required in all major emitters, including developing countries.

There would undoubtedly be some advantages in relying instead on a carbon tax to provide the foundation for an international agreement. International trade in permit entitlements and a global carbon tax applied in all countries at a common rate would both give rise to a common international permit price. The carbon tax would avoid contentious international discussion of the allocation of entitlements. The political economy pressures for distortion are more easily avoided with a carbon tax. The simpler carbon tax would have lower transaction costs. Further, the certainty of the price under the tax would be seen as having advantages for business, although uncertainty about emissions pricing within a cap and trade scheme must be viewed in the context of the manifold other demand and supply shocks, especially the natural price volatility in the energy and resource sectors. In particular, within a cap and trade system, demand for and price of permits can be expected to fall in response to any large increase in the price of fossil fuels. This would be to some extent stabilising, unlike the rigid application of a fixed carbon tax. As a fixed carbon price cannot be expected to generate any particular abatement outcome, the tax rate would need to be adjusted from time to time. This would introduce a source of policy uncertainty that need not be present in quantity-based systems.

There are several reasons, however, why a quantity-based international agreement—where countries take on quantitative commitments to limit and reduce emissions, differentiated according to broadly accepted principles, with trade in emissions rights between countries (cap and trade)—is more likely to succeed than a tax-based one.

First, the tradable emissions entitlements approach builds on current international architecture and national practice. Quantitative targets have been the dominant form of greenhouse gas commitments so far. As in the Kyoto Protocol, quantitative targets frame the various existing and emerging national and regional climate goals and emissions trading systems, as well as the negotiations about national target commitments for the post-2012 period. The urgency of the situation means that current efforts need to be built on, not overturned. While different architectures could in theory be designed that might be superior, time has run out for new approaches and periods of trial and error.

Second, a cap and trade scheme provides incentives for developing country participation. Crucially for the goal of international cooperation, targets can be differentiated between countries without sacrificing economic efficiency. Under a price-based regime, commitments could be differentiated among countries by agreeing on lower emissions penalties for developing countries, but this would compromise the efficiency of the global mitigation effort and do less to provide a level playing field for emissions-intensive industries.

International trading in emission entitlements allows financial flows between countries. Such financial flows could offset abatement costs in developing countries, drawing them into an international policy framework.

Third, setting quantitative targets can control emissions levels more directly than setting emissions prices. This allows the extent of commitments to be more easily communicated. This could become more important as climate change risks become more urgent and the possibility of catastrophic damage from climate change gains recognition.

Fourth, trajectories and budgets can be implemented with flexibility over time and between countries to prevent cost blow-outs of the sort feared by advocates of carbon taxes. Flexibility can be provided by defining emissions budgets over a number of years, allowing intertemporal flexibility across commitment periods, by allowing substitution between different greenhouse gases, and by allowing international trading of emissions rights.

Fifth, the adoption of national limits gives countries freedom to apply their own preferred mix of policies. A quantitative commitment under an international agreement does not mean that *domestic* policies need to be framed in quantity terms. A country could choose to introduce a tax on domestic emissions, regulation aimed at reducing emissions, a domestic emissions trading scheme, or a combination of these instruments. Some countries would undoubtedly choose to achieve their mitigation objectives through carbon taxes and regulation (the choice of domestic instruments is explored with respect to Australia in Chapter 13). International supervision of emissions commitments would be limited to monitoring emissions. By contrast, adoption of a carbon tax would require more intrusive international oversight (Frankel 2007). It would be necessary, for example, to ensure that countries did not offset a carbon tax by an increase in fossil fuel subsidies. Given the different tax treatment of fossil fuels around the world, it would be difficult, if not impossible, to ensure that national carbon taxes were both additional and comparable.

Carbon taxes could play a useful role in international commitments in some areas (Chapter 10). In the foreseeable future, it is not realistic to expect every country to be subject to quantity limits. It would be reasonable in such a situation for countries not subject to quantity limits to be under international pressure to introduce an offsetting carbon tax on the main trade-exposed, emissions-intensive industries. The revenue raised by such a tax would be retained by the government that imposed it. Such sectoral approaches would also be viable for emissions control in international aviation and shipping.

9.3 A graduated approach to national commitments

The Kyoto Protocol allocates internationally tradable emissions rights to countries that belonged to the OECD in 1992 and transition economies. This group excludes a number of high-income countries including Singapore, the Republic of Korea, Mexico and Saudi Arabia. Note that the Republic of Korea and Mexico are now members of the OECD. Many more countries will join the ranks of high-income countries in the years to come.

The principle that all high-income countries should adopt binding commitments to limit their emissions would receive widespread support. There is also broad agreement that developing countries need to take on greater obligations, although no political resolution of this issue has been in sight. So far, developing countries have resisted taking on emissions targets. The 2007 Bali Roadmap calls on developing countries only to take *actions* to reduce emissions, in contrast to the *commitments* to be taken on by developed countries. How can a way be found through this conundrum?

Clearly, differentiation is needed within the group of developing countries. The poorest, least developed economies are not ready for a national approach. They could be involved in the mitigation effort through offset mechanisms such as a strengthened Clean Development Mechanism, and international sectoral agreements where applicable (see Chapter 10).

But middle-income countries such as South Africa and Brazil and many others need to do much more. Some argue for a highly flexible approach, which would allow 'different countries to assume different types of international commitments—not only absolute targets, but also indexed targets, taxes, efficiency standards, and so forth' (Bodansky 2007: 65). Too many options, however, would make comparative assessment impossible, and therefore invite dilution of effort. Lack of a common framework would also obstruct international trading, which is the most likely route for developing countries to receive large-scale financing in support of their mitigation efforts.

Most developing countries cannot initially be expected to sign on to targets that would require them to buy emissions rights from other countries if they exceeded their emissions budgets. One-sided targets—also referred to as opt-out or non-binding targets (Philibert 2000)—could be a helpful expedient for a transitional period. With a one-sided target, countries could benefit from taking on a commitment by going further than their target required and selling emissions rights, without obligation to buy if they missed the target.

Allowing countries to adopt one-sided targets has a cost. It increases uncertainty about whether countries will follow through with their target commitments. To achieve similar global abatement as with binding targets for all countries, the countries with binding targets would need to take on more stringent commitments in order to reduce any shortfall from countries that opted out (Jotzo & Pezzey 2006). The existence of an opt-out option might weaken the resolve of national governments to

follow through with mitigation policies, particularly where there are vested interests to be tackled or politically difficult decisions to be made, such as the removal of subsidies on petroleum products.

While recognising the drawbacks of one-sided commitments, the Review also recognises that most developing countries, given their low income per capita, would simply not be prepared or, in many cases, able to purchase emissions permits internationally. The risk associated with such an obligation would prevent many from accepting a binding target in the first place. The Review therefore supports the use of one-sided targets for most developing countries, to facilitate immediate uptake of target commitments and as a transitional measure in place until perhaps 2020. After that, these countries would be expected to accept binding targets.

Some argue that developing countries should be given targets set, at least initially, at their business-as-usual levels. Under this approach, promoted by Stern (2008), the Commission on Growth and Development (2008) and Frankel (2007), developing countries would only reduce emissions below business-as-usual levels if developed countries paid them to do so. Essentially, this approach amounts to an expansion of the Clean Development Mechanism to an economy-wide level.

The flaw with this business-as-usual approach is that it would put the entire burden of emission reductions on developed countries, and constraints on developed countries alone cannot reduce emissions enough to avoid high risks of dangerous climate change. Since developed countries account for a falling share of global emissions (see Chapter 4), it is unrealistic to hope to achieve substantial cuts in global emissions in this way. Developing country targets, albeit one-sided, need to be below business-as-usual levels.

The Review's proposal—for middle-income developing countries to adopt one-sided emissions targets below business as usual—goes further than most, if not all, current proposals for developing country commitments. Given the rapid growth in emissions, any less ambitious international agreement would be an inadequate response to the urgency of the problem. In the Review's framework, developing countries will have incentives to agree to such an approach: the prospect of financial gain through international selling of permits and access to international public funding in support of both mitigation and adaptation.

The Review's proposal thus requires identification of three groups of countries based on level of commitment. At the top of the income range, countries are subject to binding emissions commitments. At the bottom, countries are subject to minimal commitments. In the middle, countries are subject to one-sided commitments below business as usual. How should countries be assigned to these three groups?

It is in the global interest for as many countries as possible to be in the group with binding targets. This group should at a minimum consist of all countries currently in Annex I of the UNFCCC plus all other high-income countries. Where the high-income threshold is drawn would be a matter for negotiations.

China is a special case. Because of the country's size, current and prospective economic growth, geopolitical importance and emergence as the world's largest emitter, no global agreement would be effective unless China took on binding

targets. China's fiscal, economic and technological position would allow it to do so. Of course, because of its lower income status, China's targets would not be as stringent during a transition period as those of developed countries.

The first group, if it did include China, existing Annex I members and other high-income countries (using, for this purpose, the World Bank per capita income threshold of US$11 000), would account for approximately three-quarters of global emissions of carbon dioxide from fossil fuel combustion, the main source of greenhouse gases.

The second group, expected to take on one-sided targets, would comprise most of the developing countries. This would include all members of the US-led Major Economies Meeting process not in the first group. As discussed in the next section, countries' emissions limits would be set using per capita principles. This group would account for almost all of the remaining quarter of present-day emissions from fossil fuels.

The third group would comprise countries classified as 'least developed' by the United Nations and any other developing countries that, on an objective assessment, do not yet have the necessary preconditions for a national approach—for example, those experiencing conflict or lacking the prerequisites for reliable emissions accounting. Countries in this group would be welcome but not required to take on one-sided targets. They would be able to host Clean Development Mechanism–type activities and sell offset credits, and would be expected to place a carbon tax on emissions-intensive industries producing in large amounts tradable goods that were the subject of global sectoral agreements.

It is worth reiterating that the proposed arrangements are intended only as a short transitional stage directed at achievement of a sound long-term international approach. At an early future point, desirably 2020, countries in the third group would be expected to take on one-sided targets, and countries in the second group binding targets. Countries would graduate from group to group over time.

9.4 Principles for allocating emissions entitlements across countries

In the approach outlined in the previous section, all except the least developed countries would have national emissions limits, albeit of differing types. This leaves the crucial and contentious question of how emissions rights are to be allocated across countries.

This is the question upon which the prospects of effective international agreement over the next two years will stand or fall. There are as many different possible international allocations as there are human minds to contemplate them. All can be dismissed if they do not 'add up' to a global total that meets the requirement of avoiding unacceptable risks of dangerous climate change. The proposals put forward here add up. They are based on principles that are thought to have a chance of global acceptance. Others, abroad and perhaps in Australia, can develop other proposals that also add up. These can be compared with the Review's proposal,

with a view to arriving at one proposal that adds up and has wide support from heads of governments of major economies in advance of the Copenhagen meeting in December 2009.

9.4.1 Towards agreement on principles

Under the Kyoto Protocol, emissions budgets for Annex I countries for 2008–12 were defined as percentages of 1990 emissions, ranging within a relatively narrow band from 92 per cent to 110 per cent of base year emissions around the average allocation of 95 per cent, with further differentiation within the European Union. Differentiation between countries was negotiated on an ad hoc basis, with little reference to underlying principles for allocation across countries, although on average richer countries signed up to larger reductions.

In future negotiations, involving a greater number and more diverse array of countries, simply requiring somewhat differentiated reductions from a historical base, as under the Kyoto Protocol, will not underpin international agreement. The stark differences in per capita emissions levels across countries would need to be factored in. Emissions entitlements for the lower-emissions countries, which typically are also at a relatively low income level, would need to continue to grow for some time, but at a slower pace than currently anticipated under business as usual. Emissions entitlements in the richer countries would need to fall.

Leaving emissions reductions to politics, negotiations and arm-twisting, without explicit criteria, would prove deeply problematic. While politics and special circumstances will inevitably have some role, agreement on basic principles for allocation will be critical if the pace of coordinated international mitigation action is to quicken. An allocation framework based on simple principles, if it received widespread international support, could facilitate international negotiations, and in the meantime guide individual countries' commitments ahead of a new international agreement.

To be effective, a future international policy regime will require the mitigation effort to be distributed using principles that are widely accepted as being fair and practical. To be widely accepted, principles to guide the allocation of a global emissions budget across countries will need to be simple, transparent and readily applicable. To be considered fair, they will need to give much weight to population. To be considered practical, they will need to allow long periods for adjustment towards positions that give weight to population.

Various principles have been suggested. The UNFCCC emphasises *capacity*, with its call for greater and earlier mitigation effort by developed countries (those with more capacity). Graduation of a country to a more stringent level or type of commitment once it reaches some income threshold is a common feature of many proposals. Examples are the Pew Center Pocantico Dialogue (Pew Center on Climate Change 2005), the South–North Dialogue's proposal in Ott et al. (2004), and the São Paulo proposal (BASIC Project 2006). Section 9.3 argued that countries should take on more stringent types of commitments as they move from low to middle to high income status.

Some countries emphasise *responsibility*, and argue that future emissions rights should take account of how much each country has drawn historically on the atmosphere's total capacity to absorb emissions. Current industrialised countries have contributed a disproportionate share of past cumulative emissions. Historical responsibility was formally introduced to the UNFCCC by the government of Brazil (UNFCCC 1997), which called for mitigation to be shared on the basis of the contribution to climate change of countries' past emissions.

It has also been argued that emissions rights should be based on the *effort* required to meet the limits imposed. Effort could be measured in terms of the impact of mitigation action on national GDP. However, this approach takes no account of differential starting points, and would require comparing the future state of the world to the counterfactual of what would have prevailed in the absence of the scheme.

Underlying all these approaches is a concern with international *equity* made explicit in many allocative proposals. For example, the recent Greenhouse Development Rights framework (Baer et al. 2007) would apply equity considerations comprehensively to include adaptation costs and domestic income distribution. It is difficult, however, to see how broad agreement on what is equitable could be achieved in anything other than a very simple framework.

9.4.2 A per capita approach

While all of these approaches have strengths and weaknesses, the approach that seems to have the most potential to combine the desired levels of acceptability, perceived fairness and practicality is one based on gradual movement towards entitlements to equal *per capita emissions*. An approach that gives increasing weight over time to population in determining national allocations both acknowledges high emitters' positions in starting from the status quo and recognises developing countries' claims to equitable allocation of rights to the atmosphere.

Any allocative formula that does not base long-term emissions rights on population has no chance of being accepted by most developing countries. Indeed many developing countries would argue that a per capita approach does not go far enough as it does not address the issue of historical responsibility. The International Low-Emissions Technology Commitment and the International Adaptation Assistance Commitment proposed by the Review (Chapter 10) are both intended to provide additional support to developing countries and so to address the issue of historical responsibility (along the lines suggested by Bhagwati (2006)), thereby making it possible to defend a per capita approach to emissions allocation.

The per capita approach is also broadly consistent with the emerging long-term emissions-reduction goals of several developed countries. Per capita emissions of developed countries are today well above the global average of about six tonnes of CO_2-e. Per capita emissions in, for example, the United Kingdom, Japan and the United States are (as of 2000) 11.5, 10.6 and 21.6 tonnes respectively. Under the long-term emissions-reduction goals announced by or anticipated in these countries, these levels would fall by 2050 to 3.9 tonnes (United Kingdom), 4.0 tonnes (Japan) and 2.7–5.5 tonnes (United States, using the commitments made by the

two presidential candidates). These levels are all below today's global per capita average, and close to the 2–3 tonnes per capita average that stabilisation scenarios summarised by the IPCC (2007), together with UN population projections, suggest will be required for stabilisation at 450 to 550 ppm CO_2-e.[4]

Indeed, it is inevitable that if global per capita emissions fall to as low as 2–4 tonnes per person by 2050, then (though variation in national emissions levels will still be possible through the trading of emissions rights) the current stark divergences in national per capita emissions entitlements will diminish over time.

The per capita approach has the virtue of simplicity. Equal per capita emissions is a natural focal point, and contestable computations based on economic variables do not need to enter the allocation formula.

9.4.3 Contraction and convergence

A precise version of the per capita approach, often referred to as 'contraction and convergence' (Global Commons Institute 2000), has figured in the international debate for some time. It has been promoted by India and has been discussed favourably in Germany and the United Kingdom (German Advisory Council on Global Change 2003; UK Royal Commission on Environmental Pollution 2000). Recent reports have shown increasing support for variations on this general approach—see, for example, Stern (2008) and the Commission on Growth and Development (2008).[5]

Under contraction and convergence, each country would start out with emissions entitlements equal to its current emissions levels, and then over time converge to equal per capita entitlements, while the overall global budget contracts to accommodate the emissions reduction objective. This means that emissions entitlements per capita would decrease for countries above the global average, and increase (albeit typically at a slower rate than unconstrained emissions growth) in countries below the global average per capita level. Emissions entitlements would be tradable between countries, allowing actual emissions to differ from the contraction and convergence trajectory.

The contraction and convergence approach addresses the central international equity issue simply and transparently. Slower convergence (a later date at which per capita emissions entitlements are equalised) favours emitters that are above the global per capita average at the starting point. Faster convergence gives more emissions rights to low per capita emitters. The convergence date is the main equity lever in such a scheme.

The group of rapidly growing middle-income countries, such as China, would have practical difficulty with a straight convergence towards equal per capita emissions. They are already around the global per capita average for greenhouse gas emissions, and would find it difficult to stop the rapid per capita growth in their emissions immediately. To account for this, the per capita approach could be modified to provide 'headroom' to allow these countries to make a more gradual adjustment, without immediately needing to buy large amounts of emissions entitlements from other countries. (See section 9.5 for more detail.)

Some argue that relying on just one criterion is simplistic. The UNFCCC itself states that developed countries' national policies to limit emissions should take into account 'differences in these Parties' starting points and approaches, economic structures and resource bases' (Article 4.2(a)). Submissions to the Review raised similar points about Australia's circumstances and resource endowments.

Contraction and convergence does take differences in starting points as the main consideration in the early years, gradually shifting the weight towards population. Moreover, country differences are handled within the per capita approach by allowing those with emissions-intensive economies to buy emissions entitlements from those with economies of lower emissions intensity. This maintains the competitiveness in emissions-intensive industries of countries with tight allocations relative to existing emissions, and with competitive advantage in emissions-intensive industries after taking carbon externalities into account—with one condition. All substantial economies must be subject to constraints that generate similar carbon prices, or, more generally, costs associated with operating within a carbon constraint. For the domestic producer of emissions-intensive goods, the higher international price for the product compensates in an economically efficient way for the need to buy permits.

Would a population-based allocation encourage environmentally damaging global population growth? This is unlikely, as population growth is decided by far more fundamental economic and social determinants. The argument is not relevant to countries—mostly developed countries and first of all Australia, the United States and Canada—where population is growing through immigration.

Another argument sometimes raised against per capita approaches is that emissions entitlement trajectories for some low-growth developing countries could be above their underlying emissions growth trajectory, allowing them to benefit from the sale of excess permits while making minimal mitigation efforts themselves. However, the opportunity to sell surplus permits is a part of the incentive for developing countries to participate in the global regime. In any case, the potential transfers, while large in some cases, are not large in comparison with other recent changes in international payments and transfers—for example, associated with fluctuations in commodity prices.

Some submissions to the Review argued that a per capita approach would be against Australia's interests because of our current high per capita emissions. This is mistaken for several reasons.

First, Australia's biggest national interest is in effective international action, and an emphasis on population is going to be required in any practicable allocation rule. While Australia would gain from an international agreement that recognised only our own special circumstances, all countries' special circumstances would then need to be recognised. Striving for such a system would be against Australia's national interest because it would create large difficulties for international agreement, and thus delay global mitigation action. Moreover, such an agreement would have its environmental benefits diluted by special pleading. Everyone would find a reason not to do very much.

Second, Australia's ongoing strong immigration and population growth means that it will be easier to cut emissions in per capita rather than absolute terms. Australia's population growth rate is above the world average. The Garnaut–Treasury reference case suggests that Australia's population will increase proportionately by almost three times global population through this century. If emissions entitlements and targets are framed in per capita terms, countries with growing populations will receive greater absolute allocations. Population growth considerations are centrally important to equitable distribution of the adjustment burden among Australia and other developed countries.

Third, reducing over time Australia's per capita emissions entitlements to the global average would not mean the end of Australia's emissions-intensive export industries. If the adjustments occur within an effective global agreement—towards which the allocation principle suggested here is directed—their continued expansion would be possible through permit purchases. Where Australia produces emissions-intensive goods for export, it is logical to cover the emissions from that production with purchases of emissions rights from international markets.

9.5 Modelling a per capita approach to the allocation of emissions entitlements

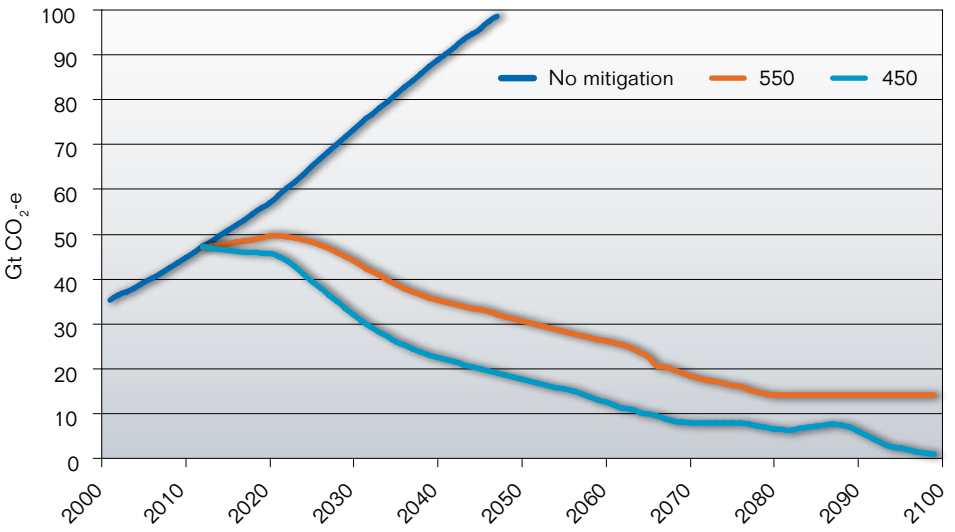
What would national emissions allocations look like under a per capita approach to the allocation of emissions as part of a global cooperative effort to mitigate climate change? The Review addressed this question in relation to the two global mitigation scenarios it modelled, the 450 ppm and 550 ppm scenarios (section 9.1.2).

Global emissions trajectories consistent with the cumulative emissions modelled to achieve the 550 stabilisation and 450 overshooting objectives are shown in Figure 9.3. They illustrate what global emissions trajectories could look like in a world of early and comprehensive mitigation. Both scenarios would represent a daunting short-term challenge, as illustrated in Table 9.1. The 550 trajectory peaks at 2021 at a level only 5 per cent above 2012 levels, and the 450 smoothed trajectory by 2020 is 3 per cent below 2012 levels. This is against a backdrop of global emissions in recent years increasing by about 2.5 per cent a year.

Table 9.1 2020, 2050 and 2100 global emissions changes for the two global mitigation scenarios, relative to 2001 (per cent)

	Change in global emissions over 2001		
	By 2020	By 2050	By 2100
550	40	-13	-60
450	29	-50	-98

Figure 9.3 Emissions trajectories for the no-mitigation, 550 and 450 scenarios, 2000–2100



The trajectory for the 450 overshooting scenario at 2050 is close to the 50 per cent reduction in emissions relative to 2000 agreed by the G8 in Japan in July 2008. This level is at one end of the range defined by the IPCC (2007) for the most stringent stabilisation scenario, which is -50 to -85 per cent (on the 15th and 85th percentile of studies). The 550 reduction target for 2050 lies close to the middle of the relevant IPCC range (-30 per cent to 5 per cent).

This global emissions trajectory needs to be allocated between countries in the form of tradable emissions entitlements. Box 9.1 explains the assumptions used to determine national allocations based on the approach outlined in the previous section.

Box 9.1 Allocating the global emissions limit between countries using modified contraction and convergence

The main principle used by the Review to allocate emissions between countries is 'modified contraction and convergence': the idea that over time the entitlements of countries to emit should increasingly be linked to their population. A gradual shift to equal per capita allocations is a practicable principle for the allocation of emissions between countries. To give effect to this basic idea, three questions need to be answered.

First, what is the starting level of emissions from which countries converge? Convergence begins in 2013. For Annex I countries that ratified the Kyoto Protocol, the starting point is their Kyoto compliance levels, so that countries do not gain an advantage from not complying with pre-existing commitments. The one exception to this is successor states to the former Soviet Union, whose Kyoto targets are well above their business-as-usual levels.

Box 9.1 Allocating the global emissions limit between countries using modified contraction and convergence *(continued)*

There is a clear case for allowing the excess permits from the Kyoto period to remain legitimate and bankable, but not for the Kyoto special deal to be perpetuated. The former Soviet Union, the United States and all non-Annex I countries converge from their no-mitigation levels in 2012. Japan and Canada, both of which ratified the Kyoto Protocol but show domestic emissions well above Kyoto compliance levels in 2008–12, are required to make up the deficit in subsequent years. The modelling results therefore show large emissions entitlement reduction requirements for these two countries, especially Canada, by 2020 relative to 2012.

Second, what is the convergence date by which all countries have equal per capita emission allocations? The convergence date selected is 2050. This provides a substantial adjustment period, and, given the prominence of 2050 in the international debate, it is a natural focal point.

Third, how do countries move from their starting points to equal per capita emissions entitlements at the convergence date? It can be argued that an equitable solution would require that all countries move quickly to the convergence level. This is not practical, however, as time for adjustment is required to avoid unnecessary increases in costs. The basic rule applied is that countries' allocations converge in a linear manner, faster if possible or necessary, and with an initial transitional period for developing countries.

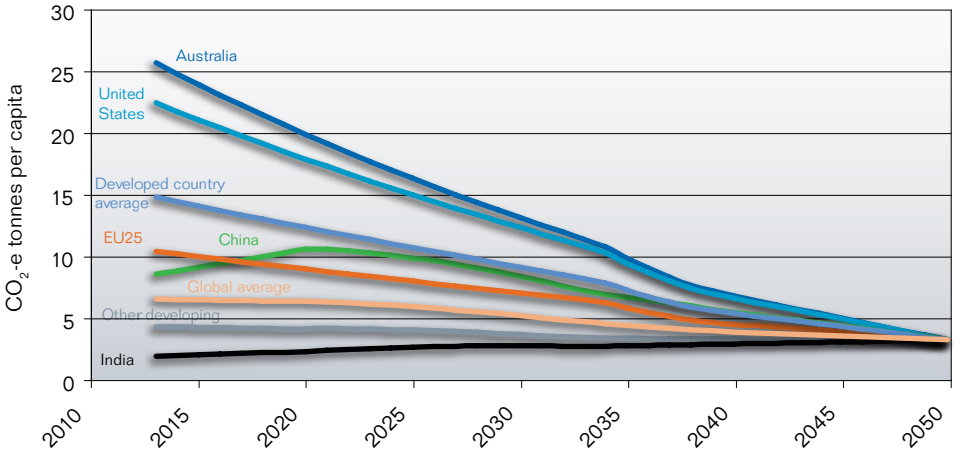
The transitional period is designed to limit the adjustment that developing countries might have to face in the initial years. This would increase the probability of their participation in a post-2012 agreement. It takes the form of allowing developing countries growth in emissions allocations at half the rate of their GDP, if this is greater than the growth in allocations under the convergence rule. The 'headroom' provided through the use of an intensity target in this way (Baumert et al. 1999) applies until 2020 or until such countries reach the developed country average, whichever occurs first. A growth of emissions at half the rate of GDP or less is implied by China's announced goals for reductions in energy intensity and its commitment to increase the proportionate role of low-emissions sources of energy. This would be an important factor in making the approach work for the world's largest emitter.

This provision of headroom is a modification to the standard contraction and convergence approach. It recognises that some developing countries will need a transitional period before they will adhere to a linear convergence line. This will be the case for rapidly growing developing countries, and for those with per capita emissions that are already relatively high, in particular (but not only) China.

Deforestation emissions are treated separately. Allocations for deforestation emissions are linearly reduced from starting levels to zero over a 30-year period.

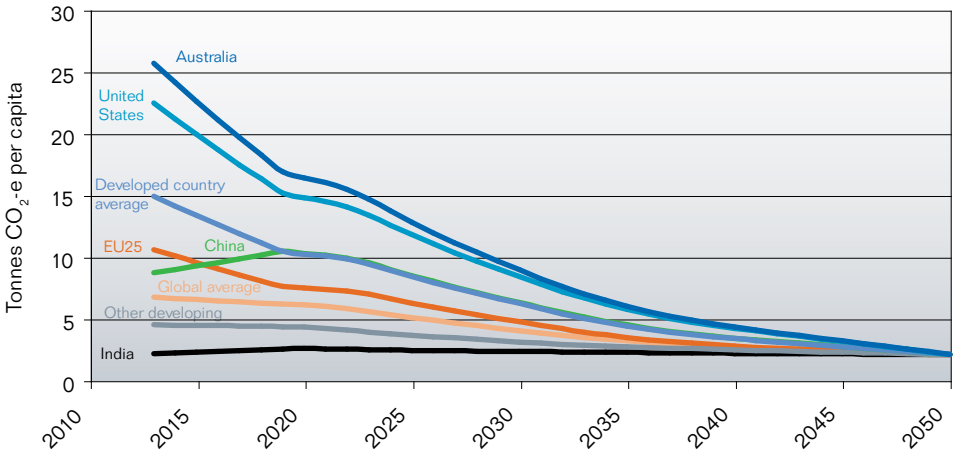
The results for this method—the per capita approach—are shown in Figure 9.4 for the 550 scenario and in Figure 9.5 for the 450 scenario. The much greater stringency involved in the 450 scenario is evident.

Figure 9.4 Per capita emissions entitlements for the 550 scenario, 2012–2050



Note: The graph starts in 2012. Australia's 2012 starting value assumes Kyoto compliance, as do those for the EU25. Other countries start at their emissions level given by the reference case (the no-mitigation scenario) in 2012.

Figure 9.5 Per capita emissions entitlements for the 450 scenario, 2012–2050



Note: The graph starts in 2012. Australia's 2012 starting value assumes Kyoto compliance, as do those for the EU25. Other countries start at their emissions level given by the reference case (the no-mitigation scenario) in 2012.

The resulting allocations of emissions entitlements to different countries and regions are shown in Table 9.2, in terms of percentage reductions over 2001 and over the Kyoto compliance commitment 2008–12 (or over 2012 for countries and regions with no Kyoto compliance commitments). Table 9.3 provides comparable data on changes in emissions entitlements in per capita terms.[6]

What is the appropriate base against which to compare commitments to reduce emissions in future? If the international community at Copenhagen were to build a set of commitments to reductions in emissions, what would be the logical base period from which to calibrate commitments? The Australian Government's current policy commitments relate to 2000. European commitments go back to 1990—the base year for the commitments under the Kyoto Protocol.

It would seem to sit more comfortably alongside the logic of the Kyoto Protocol to calibrate new commitments from the compliance period of that agreement, 2008 to 2012. This would reflect the understandings reached at Kyoto. It would reward overperformance, and not underperformance, against those understandings.

Table 9.2 shows that the Australian medium-term commitments under the Review's proposed allocation method represents a reduction of 17 per cent in absolute terms from the Kyoto commitments for the 550 reduction target, and 32 per cent for the 450 target. This is close to the developed country average in each case (16 per cent and 32 per cent respectively). It follows that Australia's per capita reductions in emission entitlements from the Kyoto compliance base to 2020 would be substantially greater than for developed countries as a whole and for each of the other developed countries (Table 9.3).

Table 9.2 Emissions entitlement allocations for 2020 and 2050 relative to 2000–01 and Kyoto/2012 (per cent)

	550				450			
	2000–01 base		Kyoto/2012 base		2000–01 base		Kyoto/2012 base	
	2020	2050	2020	2050	2020	2050	2020	2050
World	40	-13	6	-34	29	-50	-2	-62
Developed countries	-15	-76	-16	-77	-31	-86	-32	-87
Australia	-10	-80	-17	-82	-25	-90	-32	-90
Canada	-33	-80	-14	-75	-45	-89	-30	-86
EU25	-14	-69	-14	-69	-30	-82	-31	-82
Japan	-27	-75	-15	-71	-41	-86	-32	-84
United States	-12	-81	-17	-82	-28	-89	-32	-90
Developing countries	91	50	21	-5	85	-14	18	-45
China	210	-4	34	-58	195	-45	27	-76
India	98	230	35	126	97	90	35	30

Note: Australia's allocations over the 2000–01 base are relative to 2000 actuals, and are rounded. Unrounded figures (also relative to 2000) are -10%, -80%, -27%, and -89%. All other countries' allocations over the 2000–01 base are relative to the 2001 no-mitigation scenario.

The 2020 reduction figures for Japan and especially Canada relative to 2001 are large because convergence for developed countries that ratified the Kyoto Protocol begins with 2008–12 Kyoto compliance levels. For these two countries, Kyoto compliance levels for 2008 to 2012 are well below 2000 levels, whereas for EU25 and Australia the Kyoto compliance levels are at or above 2000 levels. Therefore, the same reduction below 2008–12 compliance levels is a much bigger reduction below 2000 levels for Japan and Canada. Since the United States did not ratify the Kyoto Protocol, its starting point is actual projected emissions in 2012, as for developing countries (Box 9.1).

One of the striking features of this set of allocations is that there is little variation in the 2050 reductions in emissions entitlements for developed countries. The required reductions from developed countries are in a fairly narrow range of 70 to 80 per cent for the 550 scenario and 80 to 90 per cent for the 450 scenario.

There is more variation in developed countries' 2020 targets. Canada's required reduction is exceptionally high in absolute terms from a 2000 base, but not from the Kyoto compliance period because its emissions have increased, not decreased as required by Kyoto.

The story is quite different for developing countries. The variation across developing countries reflects their different starting points, and the growth between 2001 and 2012 that needs to be taken into account. In many cases, their emissions are allowed to increase significantly, reflecting their low per capita starting points.

There is little difference between the 450 and 550 scenarios for developing countries up to 2020. They are protected in this period by the proposed transitional measures that allow their emissions entitlements to continue to grow. After 2020, developing countries' allocations under the two scenarios diverge markedly. It is likely that many developing countries would hold actual emissions below their entitlements, and that many developed countries would honour their commitments in part by purchasing permits.

The importance of population can be seen from Table 9.3, which presents the same data as Table 9.2 but in per capita terms. In per capita terms Australia is called on to do more than Europe, Japan and the United States, because the allocative

Table 9.3 Emissions entitlement allocations expressed in per capita terms in 2020 and 2050 relative to 2000–01 and Kyoto/2012 (per cent)

	550				450			
	2000–01 base		Kyoto/2012 base		2000–01 base		Kyoto/2012 base	
	2020	2050	2020	2050	2020	2050	2020	2050
World	14	-41	-2	-50	4	-66	-10	-71
Developed countries	-22	-79	-19	-78	-37	-88	-34	-87
Australia	-30	-90	-27	-88	-40	-95	-40	-93
Canada	-43	-86	-21	-80	-54	-92	-36	-89
EU25	-17	-69	-15	-69	-33	-82	-32	-82
Japan	-25	-69	-13	-64	-40	-82	-30	-80
United States	-26	-86	-23	-86	-40	-92	-37	-92
Developing countries	49	-5	10	-30	45	-46	7	-60
China	179	-13	29	-60	166	-50	23	-77
India	53	112	23	71	52	22	23	-2

Note: Australia's allocations relative to the 2000–01 base are relative to 2000 actuals, and are rounded based on absolute values. (Unrounded figures consistent with Table 9.2 values are: -31%, -88%, -42%, -94%.) All other countries' allocations relative to the 2000–01 base are relative to the 2001 no-mitigation scenario. See also notes to Table 9.2.

approach requires Australia to reduce its current high per capita emissions entitlement to the global average. As high per capita emitters, Australia, Canada and the United States have more 'distance' to move than the EU and Japan. In per capita terms, Australia's required reductions from the Kyoto compliance commitment for 2008–12 and from 2000 are similar.

At the 2007 Bali climate change negotiations, a particular range of emissions reductions received prominent attention. It was proposed that developed countries (strictly Annex I countries) consider emissions reduction targets in the range of 25 to 40 per cent by 2020 over 1990 levels. This target range stems from an IPCC (2007) analysis for a 450-type trajectory. The equivalent range for a 550 trajectory is 10 to 30 per cent. The emissions reduction targets for developed countries modelled by the Review are consistent with these Bali ranges, but at the lower end in terms of stringency, reflecting the limited progress made between 1990 and now towards mitigation.

The 1990 starting point is deeply problematic, because it does not recognise the effects of the Kyoto agreement on differentiation in emissions entitlements growth between 1990 and the Kyoto compliance period. It happens to be highly favourable for successors to centrally planned economies, whose emissions dropped sharply through the transition out of communism, and for Western European economies whose energy sectors were transformed by the easier availability of natural gas in the 1990s.

Relative to 1990, Australia's proposed targets under the Review's approach are at around the average for developed countries in absolute terms and much higher in per capita terms. They are the same percentage reduction as for 2000, as under Kyoto accounting rules Australia's emissions were almost the same in 1990 and 2000.

The allocative approach adopted takes no account of what might happen in a no-mitigation world. This would always be counterfactual, would lend itself to special pleading, and would be impossible to use as the basis for allocating emissions across countries. Nevertheless, it is a fact that Australia's rapid underlying emissions growth may require greater effort for Australia than others to comply with any comprehensive international agreement. For Australia, as a country likely to have comparative advantage in a range of emissions-intensive industries, the flexibility provided by international trading in entitlements is of considerable importance.

The Review estimates that the emissions allocations are only about 10 per cent below business as usual for developing countries, including China, by 2020. This suggests that the allocative approach adopted here is realistic. Developing countries need to be brought on board, but a transition period is required during which emissions allowances can keep growing. The relatively slow start for developing countries provides them with incentives and opportunity to reduce emissions below their allocations, and to sell surplus entitlements.

9.6 Reaching agreement on 550 or 450: is it possible?

The objective of climate change negotiations must be to define a consistent set of national allocations that would add up to a global emissions trajectory which in turn would allow the atmospheric concentration of greenhouse gases to settle at specified levels. The numbers presented in this chapter add up to 450 and 550 objectives.

Of course, other sets of allocations could also add up to 450 or 550. If some countries do less, others will need to do more. The two sets of allocations presented in this chapter are illustrative of what will be required. Do the proposed allocations suggest that global agreement around a 450 path is possible, or is a 550 path the best that can be hoped for?

It is important to distinguish between the short term, up to 2020, and the long term, up to 2050. The 2007 Bali Roadmap calls for agreement on a 'long-term global goal for emission reductions' (UNFCCC 2007). The G8 recently (in July 2008, in Japan) endorsed a long-term goal of a reduction in global emissions of 50 per cent by 2050. As noted earlier, this is consistent with the 450 path (Figure 9.4).

But is the world ready to commit to a 450 target in the short term, up to 2020? Not yet. No developed country or group of countries has indicated a willingness to cut emissions by 2020 to the extent implied by the 450 ppm target. The European Union comes closest, but even its 30 per cent conditional offer (relative to 1990) falls short of the 36 per cent that would be required of it under the 450 agreement (see Table 5.4 of the Review's supplementary draft report (Garnaut 2008)).

Canada's target is instructive: its current 2020 commitment would translate, the Review estimates, to a reduction of 10 per cent over 2000 levels—less than would be required of it in a 550, let alone a 450, world.

In another example, commitments by the US presidential candidates for 2050, if translated into 2020 targets with a starting point of 2012, convert into reduction commitments of around 10 to 15 per cent over 2000, again consistent with a 550 rather than a 450 agreement. (Similar targets are given or implied by various US climate change bills.)

Of course, smaller reductions could be asked of developed countries were the developing world prepared to commit to more, but we have already assumed that the developing world will reduce emissions by around 10 per cent below business-as-usual levels by 2020, which itself would be a significant achievement. The Review's judgment is that the contribution required of developing countries up to 2020 to achieve the 550 ppm path would exhaust what might optimistically be expected of them, and that the additional reductions to achieve 450 ppm would have to come from the developed countries.

Beyond 2020, additional and more demanding emissions reductions would have to come from developing countries. As Table 9.2 shows, the 450 target would require a 13 per cent reduction in emissions by developing countries in 2050 relative to 2001.

In the short term, therefore, a 450 agreement seems out of reach, unless developments over the next year transform the attitudes of developed and developing countries alike. Of course, major changes in the political outlook are not out of the question, with a new US President and Congress, a Chinese government beginning to make progress on its own energy efficiency and low-emissions energy goals, and the recent scientific evidence underlining the urgency of the question. Australia should encourage this possibility by announcing its preparedness to make its proportionate contribution—an absolute reduction in entitlements of 25 per cent on 2000 levels by 2020—if there is an effective global agreement around 450.

In the meantime, a post-2012 agreement consistent with stabilisation at 550 ppm seems to be possible. This would be a major achievement in itself, setting new standards of international cooperation in this area of policy, and holding promise of avoiding the worst outcomes from human-induced climate change.

Once the world has embarked on a 550 path there is a reasonable prospect that confidence would increase in all countries, and especially in developing countries, that strong mitigation was consistent with the continuation of desired rates of economic growth. The reality of income from sale of permits from developing countries, of progress with low-emissions technologies, and of developed country support for adaptation would build confidence in the international arrangements. Early progress on emissions reduction would reduce fears about the compatibility of mitigation with economic growth. Growth in confidence would make it possible to reconsider mitigation ambitions in an early successor to the Copenhagen meeting.

Notes

1 Just as with converting from concentration levels to temperature increases, so too converting from emissions to concentration levels involves uncertainty, in particular involving climate–carbon cycle feedbacks, the treatment of which can reduce permissible cumulative emissions associated with atmospheric stabilisation targets by 20 per cent or more (Jones et al. 2006).

2 The issue of aggregating over different greenhouse gases is not tackled here (see Chapter 3).

3 A price-based commitment is an example of an input-based commitment. Another variant of input-based commitments is the 'sustainable development policies and measures' approach, which would directly reward countries (normally developing countries) for implementing agreed policies (Winkler et al. 2002).

4 For the actual commitments made by these countries, see Chapter 8. UNFCCC data has been used as a baseline. All population projections are the 2006 medium variant projections from the United Nations. The exact global per capita emissions average at 2050 under the various stabilisation scenarios depends heavily on the trajectory of emissions through time, as well as on future population growth.

5 Neither report uses the term 'contraction and convergence', but both point to the need for all countries to aim for equal per capita emissions over the 'long term' (Commission on Growth and Development 2008) or by 2050 (Stern 2008). Stern (2008: 10) notes that this approach 'is a pragmatic … one. It should not be regarded as strongly equitable since it takes little account of the developed countries' much larger per capita contribution to stocks of greenhouse gases.'

6 The year 2001 is the base year in GTEM, the computable general equilibrium model used by the Review.

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