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KEY ELEMENTS OF A GLOBAL DEAL ON CLIMATE CHANGE

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1. CHALLENGES, OPPORTUNITIES AND GROWTH

Key messages

- **The world faces an unprecedented challenge which requires urgent global action to sustain growth and guard against the risks of catastrophic climate change.**
- **The global response to climate change must be carefully designed, whilst limiting transactions costs, and without creating additional market distortions, perverse incentives, or promoting protectionism.**
- **The technologies involved will be transformational, but action, if taken now, is both manageable and affordable.**
- **By promoting reduced pollution, improved resource efficiency, and energy security, cost-effective policies can bring about a safer, cleaner, and more prosperous world without jeopardising growth or poverty reduction. By contrast, inaction stands eventually to damage both growth and social stability.**
- **Avoiding the risks of dangerous climate change requires that global greenhouse gas emissions peak within the next fifteen years are halved relative to 1990 by 2050, and then decline to less than 10 Gigatonnes (GT) of emissions (1 tonne per capita).**
- **The developing countries, which by 2050 will account for around eight billion out of a world population of nine billion, and the greater part of global emissions, will have to be fundamentally involved in achieving global emission reductions.**
- **The world should aim for a liquid international carbon market in order to allow for the most effective, efficient, and equitable emissions reductions.**
- **In addition, non-price interventions are required to expand the global market for low-carbon technologies, support common standards, and promote cost-effective reduced deforestation.**
- **Developing countries must draw up emissions reduction plans now, and be able to benefit from scaled-up opportunities to sell emissions reduction certificates.**
- **Developed countries will need to take on immediate and binding national emissions targets, demonstrate that they can achieve low carbon growth, and transfer resources and technologies to developing countries, before developing countries take on binding national targets of their own by 2020.**
- **Existing international institutions will need to evolve in order to deal with the nature and scale of the challenge, coordinate global financial flows, and support vulnerable countries in adapting to the impact of climate change. In the longer term it might be necessary to design and create new institutions.**

The balance of scientific evidence points clearly to the need for all countries to plan credible emissions reduction policies now, if mankind is to avoid substantial risks to future generations. The impact of global warming is already being felt, and future generations face grave risks if activities continue unaltered. Delaying action increases the cost of meeting any temperature or concentration goal, and raises the risks of irreversible impacts as temperature thresholds are exceeded.

Dealing with this issue requires large-scale and urgent international action. Market mechanisms should be central in this, with both economic instruments and discretionary policy being used to provide incentives for behavioural change. The UN Conference of the Parties in Copenhagen in late 2009 will be decisive in determining the post-2012 policy frameworks, and designing an effective institutional architecture. Drafting of the text for the treaty will begin as early as summer 2008, and it is important that this be guided by clear principles based on rigorous analytic foundations and a common understanding of the key challenges. This requires a clear articulation of the fundamental principles for framing a global deal, and it is this aim which defines the scope of this paper.

The challenge is far-reaching, comprehensive, and global: but it is manageable. The activities and technologies necessary to eliminate the bulk of the risks associated with climate change are already available, or can be developed through appropriate policies to support innovation. Policies must be designed and applied carefully. Badly implemented policies can create additional market distortions, introduce perverse incentives, and foster protectionism. Care must be taken to ensure that additional policies are not simply layered on top of existing bad policies, such as distortionary energy market subsidies, trade restrictions, or agricultural policies. Where possible, policies must encourage market-based solutions, minimise transactions costs, and stimulate reform of existing distortion mechanisms.

By providing a strong policy framework to provide the requisite economic incentives, governments can harness the power of markets to find an effective international response to the challenge. For markets and entrepreneurship to work, that framework must be credible, durable, and predictable, while allowing necessary flexibility.

The purpose of this paper is to put forward a coherent set of proposals on global policy that satisfy three basic principles[1]:

- **Effectiveness** – it must lead to cuts in greenhouse gas (GHG) emissions on the scale required to keep the risks from climate change at acceptable levels ;
- **Efficiency** – it must be implemented in the most cost-effective way, with mitigation being undertaken where it is cheapest; and
- **Equity** – it must take account of the fact that it is poor countries that are often hit earliest and hardest, while rich countries have a particular responsibility for past emissions.

[1] We are using these words in their sense in common language. Formal economic concepts are in the same spirit but are sometimes defined somewhat differently.

The purpose of this paper is not to prescribe specific instruments or technologies. Different technologies and different policy instruments can be applied to different sectors and countries. Indeed, the more differentiated the global strategy, the greater the scope for learning, so it is important not to be unduly prescriptive on the details of policy action. However, it is important that all the different initiatives add up to delivering the overall objective. The purpose of this paper is to support the negotiations of a post-2012 global treaty which needs to be agreed by 2009 and translated into national policy and action plans between 2010-2012. It aims to put forward a coherent set of underlying principles that are consistent with the latest scientific evidence, and which explicitly define options and suggest which are more likely to be suitable.

The Kyoto Protocol defined countries as either Annex I or non-Annex I countries. We describe countries as developed and developing countries, which are broadly analogous to those Kyoto definitions. However, there is much variation within these two groups. For example, while there are developed countries that are around five times richer than the global average, there are also developing countries that are significantly richer than the global average. Therefore, when referring to developing countries we will follow the World Bank sub-divisions of low and middle income countries.

We also use the Kyoto Protocol baseline year of 1990 when proposing emissions reductions targets for all countries. Total anthropogenic greenhouse gas emissions in 1990 are estimated to be 41GT compared to approximately 45GT of emissions in 2005, with significant shifts in the international distribution of these emissions over the period.

The scale of the emissions reductions required, and the welcome rapid economic growth in populous parts of the developing world, makes it is necessary for developing countries to play an active role if the deep cuts in emissions suggested in Heiligendamm last June 2007 are to be achieved. By 2050, eight billion out of a world population of nine billion will live in what is currently termed the developing world. It is not in these countries' national interests to allow developed countries to take the lead and then wait to act. Countries with strong emissions growth such as China and India will need to plan to limit and reduce emissions within the next ten to twenty years. For this they will require global cooperation, and they are unlikely to be able or willing to achieve these ambitious reductions without substantial technological and financial support and opportunities to innovate, and ultimately export, low greenhouse gas (GHG) technologies.

Effective action requires:

- Global emissions to fall by at least 50% relative to 1990 levels by 2050, in order to limit the grave risks associated with severe climate change. Emissions will need to decline by less than 20GT per annum in 2050 to less than 10GT over the following decades to fully stabilise GHG concentrations near or below the critical 500ppm threshold;
- Global average per capita emissions that will – as a matter of basic arithmetic – need to be around 2 tonnes(T) by 2050 (20GT divided by 9 billion (billion) people): this figure is so low that there is little scope for any large group to depart significantly above or below it;
- Agreement by developed countries to take on immediate and binding national targets of 20% to 40% by 2020, and to commit to reductions of at least 80% by 2050;

- By 2020, demonstration by developed countries that they can deliver credible reductions, without threatening growth, and that they can design mechanisms and institutions to transfer funds and technologies to developing countries;
- Subject to this, a formal expectation that developing countries would also be expected to take on binding national targets of their own by 2020, but benefit from one-sided selling of emissions credits in the interim;
- Fast growing middle income developing countries with higher incomes will need to take immediate action in order to stabilise and reverse emissions growth, including sectoral targets and, possibly, earlier national targets; and
- A commitment by all countries, regardless of targets, will need to develop the institutions, data and monitoring capabilities, and policies to avoid high-GHG infrastructural lock-in.

Overall global targets and those for rich countries are set out in the next chapter.

Only sound, measured and coordinated policy and timely international collaboration can deliver strong and clean growth for all at reasonable cost. Weak or delayed action stands eventually to choke off growth and be a far more costly option. It is important to weigh up the competitiveness risks and opportunities for firms, countries, and sectors, especially where some countries or sectors apply GHG policies earlier and more ambitiously than do others. There will be losers, and the impacts of transition will need to be managed. However, transition to a GHG-constrained world will create opportunities for companies and sectors that anticipate new markets. Moreover, the evidence to date suggests that few firms are likely to relocate activities to less restrictive jurisdictions. Over-stating the problems relative to the opportunities risks prompting parties to wait for others to move before taking action. By contrast, the expectation of a credible global agreement would sharpen the incentives for companies and governments to move quickly and efficiently.

Backed by strong developed country targets for reductions, carbon prices can be maintained at levels which will provide incentives both for reductions at home and purchases from abroad. The cheapest mitigation options often reside in developing countries, which should take advantage of carbon markets from the outset. The current CDM structure makes it difficult to channel resources to developing countries on the scale required. Moving from a project-based to a wholesale mechanism, perhaps based on sector-specific efficiency targets and credible sector decarbonisation plans, would permit scaling-up in a number of emissions and energy intensive industries. Standardised benchmarks would help to reduce the risk of emissions diversion and relocation, and to alleviate competitiveness concerns in internationally traded sectors. Policies to scale up access to carbon finance in developing countries are discussed further in chapter three.

In addition to being effective, policy action must necessarily also be efficient in keeping the costs of action to a minimum. By putting an appropriate price on carbon, policymakers will oblige consumers and producers to face up to the full social cost of their emissions. Economic efficiency points to the advantages of a broadly comparable global price and coordinated policy based on carbon trading, with openness to international trade so that emissions reductions take place wherever they are cheapest. It is possible to put a price on carbon, explicitly through tax or trading, or implicitly through regulation. A set of proposals to increase the reach and effectiveness of carbon markets is discussed in chapter four.

Reducing emissions from deforestation and degradation is a potentially cost-effective method of limiting emissions, and can yield significant benefits in terms of biodiversity, watershed management, and local livelihoods. Tropical deforestation is an international problem, needing urgent international action. Addressing deforestation requires large-scale public resources and reform of delivery mechanisms, with the long-term aim of integration into carbon markets. Proposals to address deforestation and encourage reforestation/afforestation are examined in chapter five.

For emissions to have been reduced to around 2T per capita in 2050, most of the worlds' electricity production will need to have been decarbonised, while emissions from transport, land-use, buildings and industry will need to have been cut sharply. The importance of technological innovation in delivering this transformation can hardly be overstated. Some cost-effective emissions reductions can be undertaken immediately using known technologies (for example in energy generation and transmission), land use change (for example in reduced deforestation), and energy efficiency. In the medium to longer-term, however, the task is to deliver next-generation low-carbon technologies, especially for the power, transport, industry, and building sectors. Different policy frameworks will be required for different technologies at different stages of development. This will require a major scale-up in public R&D on a global basis, support for demonstration projects, global efficiency or emissions standards, and new public-private partnerships to share risk efficiently. It is particularly important that a systematic plan of action is developed and funded for carbon capture and storage technologies, given their potential to address up to 50% of anthropogenic emissions over the longer-term. Meeting the technology policy goal requires globally coordinated action to pool risks and rewards, exploit economies of scale, and avoid duplication. Early action to develop and deploy technologies stands to maximise the gains from learning and experience, so as to promote cost reductions through induced innovation. In addition to progressively tougher targets and a global cap & trade regime, chapter six argues that any global policy framework should also aim to expand the market for low-carbon technology.

In addition to a fair distribution of the burden of emissions reduction, a further policy response is required to assist those facing the impact of emissions for which they were not responsible, and the cost of which has not been borne by the original polluters. This requires support for adaptation in those countries hardest hit by climate change. The most effective form of adaptation to a changing climate is robust, climate-resilient development. Chapter seven examines how adaptation assistance can be integrated into development spending so as to deliver goals most effectively without substituting for existing commitments.

Implementation must be structured, phased and managed. A credible global institutional structure is essential in order to manage the proposals and the various different steps outlined in this paper. Institutions need to be able to match the scale of the challenge and build trust between members, while being flexible enough to adjust to changing circumstances. Any new structure should build on the expertise of existing institutions. This is considered in the concluding chapter, together with a description of where more detailed for policy and micro-economics analysis will be required to underpin an effective, efficient and equitable global deal in Copenhagen 2009. Implementation and institutions are examined in the final chapter.

2. EMISSIONS TARGETS

Key Proposals

- On the basis of the risks and costs of action and inaction, an appropriate stabilisation target for greenhouse gas (GHG) concentrations would be 450-500 ppmv CO_2e.
- Meeting a 500 ppmv CO_2e target requires a cut in all GHG emissions of around 50% by 2050, relative to 1990 emission levels, and further cuts after that.
- This would imply – as a matter of simple arithmetic – a commitment to per capita emissions by 2050 of around 2T CO_2e as a world average, with little scope for significant deviation.
- All current plans need to be credible, and framed with this world average in mind. All countries will eventually need to take on binding national targets close to this per capita level to achieve these reductions.
- At the COP15 meetings in 2009, developed countries should commit to cutting emissions by 80-90% from 1990 levels by 2050 together with credible interim targets.
- Developing countries will also need to make substantial cuts, but should not be asked to take on binding national targets until developed countries provide the example of lower carbon growth and can demonstrate that institutions and frameworks can provide financial and technological support.
- Developing countries will be expected to play their part in adopting domestic policies by committing to enhanced energy efficiency policies, cheaper technologies and reduced deforestation They should facilitate the involvement of domestic firms in international emissions reductions markets and access to technology. They should also be at the forefront of work to shape a global deal.
- By 2020 developing countries, subject to developed country performance, will need to take on appropriate and binding national targets and current policies will need to be clearly framed with this goal in mind. If binding targets were deemed as necessary now, the risk is that they would be much too high in relation to long-term targets.
- Some fast growing middle-income developing countries may need to take on early sectoral targets, and possibly binding national targets, before 2020.
- Next steps include: examining the details of the interim period between now and 2020, in particular with respect to the evolutionary pathway to full trading; detailing how to allocate responsibilities on emissions between producers and consumers, as this is an important element of the equity story.

2.1. Emissions targets and effectiveness

The science of climate change, together with the estimates of costs associated with reducing greenhouse gas (GHG) emissions, largely determine the appropriate global stabilisation target and emissions path. On this basis, a target to stabilise greenhouse gas (GHG) concentrations between 450 to 500 ppmv CO_2e seems to offer the best balance of projected risks and costs[2]. The calculations in this paper are based on a stabilisation path for 500 ppmv CO_2e.

It is the stock of atmospheric GHGs, measured in terms of atmospheric concentrations, that causes the rise in global temperatures and changes in climate. The current global concentration of GHGs is around 430ppmv CO_2e, and is rising at more than 2ppmv per year. To stabilise concentrations, at any level, annual emissions (the flow of GHGs into the atmosphere) must fall from present rates (around 45GT of CO_2e, and rising) to below 10GTCO_2e as we approach stabilisation. Therefore, stabilising below 450ppmv CO_2e would require emissions to peak within the next few years, with annual declines of 6 to10% thereafter. While this may be feasible, it would likely be expensive, as it would imply scrapping some working capital and introducing expensive new technologies before they have matured. There would be no time, for example, for carbon capture and storage (CCS) projects to be deployed in time for a 2010 peak. A 550 ppmv CO_2e stabilisation target would seem, given current scientific understanding, to be unduly risky.[3]

The nature of the stock-flow system, whereby it is not only the concentrations of GHG emissions that have accumulated that cause the damages, but also the annual flow of emissions that relates to economic activity, gives rise to the urgency of action. Had emissions reduction begun 20 years ago, when the stock was significantly lower, 450 ppmv CO_2e might have been both feasible and affordable. Delay for another 20 years would mean that concentrations would likely approach 500ppmv CO_2e, so that subsequently stabilising at or below 550ppmv CO_2e could prove expensive, requiring a sudden decline in emissions. The costs of meeting a given temperature or stabilisation target will tend to rise for every month that policy action is delayed.

As the Stern Review indicated, maintaining concentration levels below 550ppmv CO_2e is achievable with current and likely future technologies, provided action is early and comprehensive, works with the investment cycle, and allows time for learning and experience.[4] Keeping the cost of mitigation low requires clear targets, early and coordinated action, at scale and across all sectors and countries. Lack of clarity and badly or inconsistently applied policy will increase costs. Getting policy frameworks right is central to delivering low-carbon growth to all

[2] In terms of flows, this target would require, assuming a peaking of emissions within 15 years, annual declines of 3 to 6% thereafter. Stern Review, page 227. The range is the lower half of that suggested in the Stern Review – for explanation, see Appendix.
[3] Work by the Hadley Centre and the IPCC (Murphy et al. 2004 and Raper 2001) suggests that 550ppmv CO2e is associated with a 24% probability of exceeding 4°C, a level at which it is projected that significant and irreversible changes in the world would occur. Stabilisation below 500ppmv CO2e would be significantly less risky (11% probability of exceeding 4°C). For details see Stern p. 220.
[4] Results from a number of bottom-up technology based studies, as well as top-down macroeconomic studies, concluded that the world could stabilise below 550ppmv CO2e for an annual expenditure around 1% of global GDP. Subsequent analyses by Edenhofer (Edenhofer et al, 2006) as well the IEA and McKinsey have indicated lower figures. This is not a trivial amount – it represents a fundamental change in the patterns of energy investment towards low-carbon energy technology – but in terms of growth it amounts to a fraction of a fraction taken off the annual rate, and compares with allocations of up to 5% of GDP on defence and 8 to14% allocated to health. In the absence of this commitment, or were action to be delayed, the costs could be significantly higher.f

countries without inhibiting development or poverty reduction. This will be a key element in a global agreement.

That such stabilisation is achievable and, with good policies, at reasonable cost is not to understate the challenge. Stabilising atmospheric greenhouse gas concentrations at around 500ppmv CO_2e requires a halving of GHG emissions by 2050 relative to 1990 levels, that is, from around 40 GTCO_2e to 20GT CO_2e. It also requires further cuts after 2050, sufficient to bring down global emissions to below 10GTCO_2e as the concentrations approach stabilisation. By comparison, 'business as usual' would likely see global emissions rise above 80GTCO_2e by 2050. Hence global per capita emissions by 2050 will need to fall to an average of around 2T, from 7T CO_2e at present, despite strong per capita income growth (emissions by 2050 must be halved to 20GT in the context of a projected population of 9billion). Most electricity production will need to be decarbonised, while emissions from transport, land-use, buildings and industry will need to be cut very sharply.

2.2. Emissions targets and equity

This target for per capita emissions by mid-century is so low that there is little scope for any major group to depart significantly above or below it. If one or two large countries were to manage only to reduce emissions to, say, 3T or 4T per capita, then it would be difficult to see which other major grouping of countries would will be able to get emissions close to zero: and the global target would be unlikely to be reached. Thus, as a matter of arithmetic, all countries must play their part in aiming for around 2T per-capita emissions by the middle of the century and all emissions trajectories should be designed with this target in mind. All major groups getting to 2T/capita is a pragmatic approach and not a strongly equitable one. It takes little account of the greater per capita contributions of the developed countries to the historical and future contributions to the stock of GHG emissions.

The key message is that stabilising at levels consistent with avoiding the most extreme risks from climate change requires that all major countries transform their economies and reduce emissions to a per-capita level of around 2T CO_2e. For all countries to reach such per capita levels requires early and concerted action. Most developed countries[5] (including Japan and most of Europe) emit around 10-12T CO_2e per capita, with a cluster (including the USA) in the range 20-25T. These economies would therefore need to cut per capita emissions by at least 80% by 2050; for the latter cluster the reductions would have to be 90%. This means taking on stringent targets immediately, with interim emissions reduction of 20 to 40% by 2020. By contrast, developing world per capita reductions are generally lower. The average per capita emissions in China are currently around 5T, and in India are approaching 2T, and these are set to grow rapidly. By 2050, out of a total global population of nine billion, some eight billion will reside in what is currently the developing world. These numbers make clear that a reduction in global emissions of 50% relative to 1990 levels by 2050 simply cannot be achieved without per-capita emissions in developing countries averaging around 2T. Given their inevitable central role in action, developing countries should be at the heart of the process of designing a global deal.

[5] In this document we use the term 'developed' to describe Annex 1 countries and 'developing' for non-Annex 1 countries. The latter are then further distinguished as low- and middle-income countries.

The implications in terms of GHG intensity of output are even stronger. US/EU economies are expected to grow 2- or 3-fold. To reduce their total emissions by a factor of 5, the implications in terms of reductions in emissions per unit of output are multiplicative: each unit of output will need to be associated with an emissions reduction by a factor of 10 to 15 from 1990 levels. This multiplicative effect will also be significant for fast-growing GHG-intensive economies, such as China. Transfers of finance and technologies will be required in order to achieve these reductions effectively, efficiently, and equitably. To be equitable, this must take account of the fact that it is low-income developing countries that are often hit earliest and hardest, while developed countries have a greater responsibility for past emissions.

Current targets are expressed in terms of production, but it is not clear whether producers or consumers should be responsible for emissions associated with products consumed. Further research, looking at the allocation of responsibilities in the context of an equitable deal, is necessary.

Once the challenge outlined by the above basic arithmetic has been recognised, governments across the world ought to commit to credible globally coordinated policies. To do this effectively, all countries will eventually need to adopt appropriate emissions-reduction targets, and by 2020 global emissions must peak and turn downwards. In the period up to 2020 developed countries will need to commit to national binding interim targets in line with Heiligendamm recommendations, while developing countries have the opportunity to avail themselves of one-sided commitments in which they can sell emissions reductions credits, but are not obliged to buy them. We propose that developing countries:

- commit to taking on binding national targets by 2020 subject to a clear demonstration of effective, equitable and efficient action by developed countries.
- commit to shape current policies with this goal in mind;
- be able to benefit from one-sided selling of emissions credits into markets driven by countries with emissions caps; and
- take action to stabilise and reverse emissions growth, including adopting sectoral emissions targets and, possibly, for some middle income countries, adopting binding national targets before 2020.

It seems unreasonable to expect, over the period to 2020, all developing countries to take on targets, unless developed countries can demonstrate that they can deliver reductions cost-effectively and without threatening growth, and can create mechanisms and institutions to transfer funds and technologies to developing countries.

2.3. Emissions targets and efficiency

A global market for carbon implies that emissions reductions in countries taking on targets do not necessarily have to be made domestically. Indeed, it would be highly inefficient to do so, as the cheapest reduction opportunities often reside in low-income countries with low-cost efficiency opportunities, scope for reduced deforestation, or opportunities to invest in new capital and infrastructure. An equitable yet efficient framework relies on the principle that the source of the emissions reductions need not be the same as the source of the payment. Emissions reductions, wherever they may be, can be purchased at the global market rate, thereby

providing an incentive for the cheapest abatement opportunities to be exploited, while the source of the finance is driven by the location and stringency of the emissions caps.

Trading in a global carbon markets thus allows for global targets to be reached at the least cost. This will create substantial financial flows in the first instance, as cheap abatement options across the world attract financial flows. By providing a strong policy framework, governments can harness the power of markets to find effective, efficient, equitable, and international responses to the challenge. For markets and entrepreneurship to work, that framework must be credible and predictable, but allow flexibility too. This is considered in detail in chapter four, while the next chapter considers the role of developing countries in participating at the core of shaping international policy and of global emissions reductions. The remainder of this paper focuses on the detailed principles and mechanisms by which this can be achieved effectively, efficiently, and equitably.

3. THE ROLE OF DEVELOPING COUNTRIES IN MITIGATION AND TRADING

Key Proposals

- Developing countries need to take action now. They need to recognise the long- term target of around 2T CO_2e per capita by 2050, develop credible action plans on this basis, commit to work towards corresponding binding national targets by 2020, and meanwhile participate actively in the carbon markets and in their further development.

- To enable developing countries to adopt binding national targets while maintaining their drive for development and poverty reduction, developed countries need to show that low carbon growth is possible, that financial flows to developing countries will be substantial, and that low carbon technologies will be both available and shared.

- Asking most developing countries to adopt binding national emission targets immediately might lead to unduly high quotas, inconsistent with the ultimate stabilisation goal. Until countries are ready (no later than 2020), we propose a 'one-sided' trading regime, which rewards developing countries for reducing emissions, but does not punish them for failing to do so. During this period they should commit to strong sectoral action supported by the international financial institutions and the carbon markets.

- One-sided trading is the philosophy behind the CDM. However, the current CDM structure makes it difficult to generate carbon finance to developing countries on the requisite scale. The CDM needs to move from a project-based to a wholesale mechanism, perhaps based on sector-specific efficiency targets or on technology benchmarks. This would facilitate scaling-up. Within the reformed mechanism, effective monitoring, verification and regulation are essential.

- The wholesale approach is not possible everywhere, and in some sectors the current project-by-project approach would have to continue. However, the wholesale approach should work in most emission- and energy-intensive industries.

- In internationally traded sectors, standardised benchmarks would also help to reduce the risk of carbon leakage and to alleviate competitiveness concerns.

- Further work includes: detailed conceptual, operational and regulatory work on benchmarks and sector programmes to make wholesale trading effective and workable in practice. This should take into account important differences between industries in terms of structure, competitive conduct and economic performance.

3.1. Role of developing countries

Preventing dangerous human interference with the climate system will require a global cut in greenhouse gas emissions to about half their current level by 2050 (see Chapter 1). Emission reductions of such magnitude cannot be achieved without contributions from all countries, both rich and poor. Already, developing countries account for about 50 per cent of energy-related carbon emissions, and their share is expected to rise to 70 per cent by 2030 in the absence of appropriate policies,.[6] By 2050 they will account for close to 90% of the world population. It is their world and it should be developing countries that lead the design of the programme for action on climate change.

The global abatement arithmetic is such that, under the Kyoto successor treaty, the role of developing countries will have to be scaled up substantially. While much has to be done in the developed world to create a framework appropriate for a global deal, action is required from the developing world too. China, for example, currently emits about 5T CO_2e per person, and India is approaching 2T CO_2e. There has to be recognition that climate stabilisation will require that all countries will need to be around 2T CO_2e on average by 2050 (see Chapter 1). This is essentially pragmatic- if any large group of people is significantly above average a corresponding group must be well below average. The average is sufficiently demanding for it to be unlikely that the latter group could emerge. Getting close to equality of flows in 2050 should not be regarded as strongly equitable since it takes little account of the developed countries' much larger per capita contribution to stocks of GHG.

Achieving growth and developing and fighting poverty must be key objectives for all countries but particularly or the developing countries. The world must recognise that the poorer countries of the world will see emissions grow for some time. But the richer amongst them will need to see emissions start to fall in around ten years and the majority will need to see emissions falling before 2030. But it will not be slower growth that will allow developing countries to achieve this fall in emissions. It will be low-carbon growth using technologies demonstrated and shared by the rich countries as well as their own technological advances and drives for energy efficiency.

Developing countries should start planning on this basis now, setting out credible action plans to achieve such stabilisation targets in the long term. Development plans have to place climate change – both mitigation and adaptation – at their core. Deforestation, in particular, must be a key element.

In principle, the best way of achieving this would be to assign emissions targets to most countries, including major 'emerging emitters' such as Brazil, China, India, and Indonesia. This may not be feasible politically at this stage. The targets that these countries would see as commensurate with their development needs would, in all likelihood, be higher than the 2T CO_2e per capita that climate stabilisation demands, and would not take emissions to the target levels. The more-than-halving of per capita emissions required in China, for example, would have to occur over a period when Chinese GDP is expected rise by a factor of 10 to 16.

Developing countries may not be ready to adopt such targets until there is substantial evidence through actions in the developed countries that:

[6] IEA, WEO (2006).

(i) Low-carbon economic growth is possible;
(ii) Financial flows to countries with cheap opportunities to abate GHGs can be substantial; and
(iii) Low carbon technologies will be available and shared, allowing developing countries to innovate, develop, and ultimately export their own low-GHG technologies.

Nevertheless, part of the credible action plans that developing countries are urged to adopt would involve a willingness to discuss binding caps for middle-income countries by 2020. These caps cannot be decided upon now, but would be subject to performance over the next decade, and would both differ according to local circumstances, and reflect countries' "common but differentiated responsibilities", including historical contributions to emissions. Once countries met certain graduation criteria – for example in terms of GDP per capita or other metrics of economic development – they would be expected to assume industrialised country-style emission caps.

3.2. A one-sided trading mechanism

Developing countries will need to participate actively in the global carbon market in the interim period. In the absence of binding caps this is likely to happen through an expansion of existing baseline-and-credit schemes such as the Clean Development Mechanism (CDM). Developing countries should come forward with their own design mechanisms to make full use of trading opportunities. Effective monitoring, verification and regulation are essential for the integrity of such mechanisms and to ensure sustained support. These mechanisms would be temporary, given that the eventual global mechanism should be cap-and-trade.

Baseline-and-credit has the (political) advantage over cap-and-trade that it is a one-sided mechanism. Countries would not be penalised for remaining above the emissions threshold, but could earn credits by moving below baseline emissions. This is the basic principle behind the CDM.

However, the CDM in its current form is not able to generate or absorb the financial and technological flows needed under a 'global deal'. It has been estimated that climate stabilisation would imply annual carbon flows of US$20-75billion by 2020 and up to US$100billion by 2030. By comparison, the capacity of the current CDM is about 400 project registrations per year, resulting in new financial flows of perhaps US$6billion at current carbon prices.

Moreover, the project-by-project nature of the CDM, and the measurement of emission reductions against an unobservable, project-specific, baseline impose substantial transaction costs in terms of validation, verification, and independent scrutiny. The CDM regulatory process currently takes about 300 days, on average, from validation to registration. Transaction costs can easily reach US$ 500,000 (€325,000) per project.[7]

The parties to the Kyoto Protocol and CDM Executive Board have recognised these problems, and various proposals to remedy the situation are under consideration. However, they may not be sufficient. Regulatory complexity and a high level of scrutiny are inherent in a project-based

[7] Ellis and Kamel (2007).

system such as the CDM. Since monitoring, verification and regulation are critical, this suggests that a different institutional approach may have to be found to reduce transaction costs and achieve the requisite scaling-up of financial flows.

Given that a target-based cap-and-trade is not appropriate for most developing countries in the immediate future, such an approach would still have to be based on the current baseline-and-credit system, but would have to move from a project-based system to a more wholesale approach.

The move from a project to a wholesale approach could take the form of sector targets, or programmatic emission reduction objectives. These would probably be based on efficiency targets, rather than sector caps, although sector caps may be possible for globalised industries such as steel. For example, for each tonne of cement produced using less than an agreed amount of carbon, producers would be eligible to sell the difference as credits. Similarly, a large power utility might sell the sector-wide emission reductions from a reform programme that includes energy efficiency and the roll-out of renewable generation technology.

Consistent with the sustainable development objective of the CDM, the benchmarks could include social and environmental sustainability criteria, for example in terms of local environmental protection or environmental, health, and safety standards. To maintain the incentive to innovate and avoid excessive rents, benchmarks would probably need to be strengthened over time as new abatement opportunities become available.

Defining benchmarks in practice would not be without difficulties. There is a need for standardised efficiency factors to move away from the costly case-by-case argumentation of the current CDM. But there also has to be recognition of local circumstances. Low-wage countries, for example, are likely to adopt more labour intensive production processes, while resource endowments (e.g., wind regimes, water reserves) will determine the local fuel mix. Similarly, different benchmarks may have to be adopted for different products or production processes, for example integrated steelworks and mini mills. If carbon-intensive activities can be outsourced (as with cement), the entire supply chain may have to be considered. Other problems may arise from data limitations, and the potential unwillingness, for competitiveness reasons, of companies and countries to share data.

Standardised benchmarks may therefore not be possible everywhere, and in some sectors the current project-by-project approach might best continue. However, sectors where a wholesale approach might work include most emissions- and energy-intensive industries, including electric power, refining, pulp and paper, metals, and cement. Sector benchmarks may also be a good way of incorporating international transport emissions (airlines, shipping) into the global deal.

More work is however needed to find a solution for sectors with dispersed emission sources (such as agriculture). Another sector that may deserve special attention is land use, land use change, and forestry (see Chapter 4). In particular, the dynamics between afforestation/reforestation (included in CDM) and avoided deforestation would need further thinking to devise policies in order to facilitate financial flows to opportunities for cheap abatement in this sector.

In sectors that are particularly subject to international competition, such as aluminium and steel, the benchmarks would probably mirror the efficiency levels expected from firms in industrialised countries (for example, those used in the allocation of allowances in an emissions trading scheme). In some sectors this might take the form of global sector agreements. Standardised benchmarks would help to reduce the risk of carbon leakage, alleviate competitiveness concerns, and thereby help to preserve free trade in these sectors.

The one-sided nature of the proposed mechanism makes it possible to set fairly stringent benchmarks. Similarly, the mechanism would have to cover a broad set of acceptable technologies, including for example carbon capture and storage (CCS). Both features are important to ensure developing countries, in particular middle income countries, participate actively in the global abatement effort.

4. INTERNATIONAL EMISSIONS TRADING – CAP-AND-TRADE

Key Proposals

- The world should aim for an international cap-and-trade system for three reasons:
    - Managing the risks of dangerous climate change by imposing an absolute limit on emissions (effectiveness);
    - Reduces the costs of action (efficiency); and
    - Generating private sector financial flows to developing countries, which can be used for low carbon development (equity).
- Other policies (e.g. regulation, standards, and taxation) should also be pursued, and can complement a cap-and-trade system. Different countries will differ in their domestic combination of policies but should work towards common effective carbon prices and product standards.
- The power of a global cap-and-trade scheme should be used to generate significant financial flows to developing countries: around $20-75billion per year in 2020 and $50-100billion per year by 2030.
- The emerging global carbon market should build on current institutions and mechanisms (e.g. linking up existing and developing regional carbon markets).
- Further work is needed to better understand how to link existing trading schemes, the role of enabling environments in attracting investment and the data and institutional requirements to allow developing countries to fully benefit from a carbon market.

4.1. Introduction

Putting a price on greenhouse gas emissions should be a central pillar of mitigation policy. It is crucial to make polluters pay for the damages they cause in order to change behaviour on the massive, widespread, and cross-cutting scale necessary to tackle climate change[8]. If there was a clear price to pay for every tonne of CO_2e (or GHG), then consumers and producers across the economy would think hard about whether there were less carbon-intensive products they could buy, or produce. In order to provide the most effective marginal incentive, the price needs to be credible, long-term, and applied across the whole economy. This allows firms to profit from responsible behaviour by investing in low-carbon technologies.

[8] Stern Review, Ch. 14

International cap-and-trade means, first and importantly, that an upper limit is placed on emissions of greenhouse gases. Imposing a fixed quantity target on the world reduces the risk of dangerous climate change impacts and tipping points. It is a clear conclusion from the science that failure to control the total amount of emissions implies a serious risk of catastrophic climate change[9]. A fixed quantity target is therefore a direct link between the science and the policy instrument – making sure policy is effective. Trading in turn allows the required reductions in emissions to be achieved as cost-effectively as possible.

Currently there are several regional and national emissions trading schemes in existence[10]. The EU ETS achieved sales of around $24billion in 2006 (Phase I and II) and CDM sales were around $6billion[11]. Linking, improving and expanding these schemes, designing the right institutional framework, laws, accrediting and monitoring systems is a major challenge. But the world possesses the resources and the experience of successful cap-and-trade schemes to do it, and the potential rewards are huge.

The vision of the international emissions trading regime outlined in this chapter is of a full cap-and trade scheme covering all gases, sectors and including more advanced developing countries by 2020. In the transition to this goal, most of the effort (and demand for credits) will come from developed countries and developing countries will receive finance for low-carbon development through selling credits. To start with this should be based on the institutions and mechanisms that we have (e.g.CDM – see Ch. 3) but modified to be able to work on a much larger scale. Prices high enough to generate a strong response will depend on ambitious and binding national targets. This underpins the 'demand side' and will also ensure strong action domestically. Efficiency requires that the supply side works smoothly and effectively.

4.2. International emissions trading reduces the cost of mitigation

International emissions trading reduces the costs of mitigation by allowing emissions reductions to occur in whatever sector or country they are least costly. Cost-effectiveness is important because it enables the world to take tougher action for given expenditure, allows scarce resources to be spent on other important goals (e.g. health, education) and increases the compatibility of mitigation policy with continued high economic growth and development. Trading allows, for example, an Indian electricity company to increase its profits by replacing a coal power station with a wind-farm and selling its permits on the global market. This benefits the Indian utility but also the EU power company with relatively high abatement costs, that can purchase permits on the international markets to meet part of its target. This is not about rich countries shirking their responsibility, but about them keeping costs down and contributing to the transition to a low-carbon economy in poor countries. And as long as the targets are set correctly rich countries are still likely to do a large part of their abatement domestically.

The benefits from trading could be high. Modelling suggests that the cost reductions could be of the order of 20-80%[12]. The UK government's GLOCAF model[13] suggests that, in 2020, moving

[9] IPCC Working Group 1, and Schellnhuber et al (eds.) Avoiding Dangerous Climate Change
[10] E.g. the EU ETS and the Greenhouse Gas Reduction Scheme in New South Wales, Australia. The US is establishing the Regional Greenhouse Gas Initiative (RGGI) and the Australian government has also announced its intention to set up a domestic emissions.
[11] UNFCCC (2007) Investment and financial flows to address climate change
[12] E.g. Edmonds, Scott, Roop and MacCracken (1999) "International emissions trading and Global climate change" Pew Center Working Paper, and McKibbin and WIlcoxen (1999) "Permit trading under the Kyoto protocol and beyond", Webster, Paltsev and Reilly (2006) "The value of emissions trading", MIT Joint Program on the Science and Policy of Global Change

from completely domestic mitigation policy to a linked international system of regional emissions trading systems could reduce global costs by 70%. The costs to developed countries would be 50% lower. Developing countries would be likely to receive net revenues from trading. The gains look less dramatic by 2050, however, because by then all countries will need to take significant action, and few will have large amounts of spare cheap abatement to sell.

Trading results in a carbon price across sectors and countries. This price spurs private sector R&D and investment in low-carbon technologies by persuading investors that there will be demand for these technologies. To be truly effective, the carbon price needs to be credible and long-term because investors look for returns over long time-horizons and power plants or wind farms take many years to plan and build and last for several decades.

Taxation is an alternative way to put a price on carbon, but arguably is more suited to domestic than to international policy. Agreeing a uniform tax across almost 200 governments (or even just the 20 richest) would be highly difficult. Finance ministries generally consider tax setting to be a sovereign issue that needs to be adapted to individual countries' circumstances. Further, it is difficult for governments to calculate the right level for a tax in order to achieve a given emissions volume target. There would be a temptation for finance ministries to change taxes, and a new government could easily amend the tax – undermining the long-term certainty required to drive investment in low-carbon technologies. And importantly, from the standpoint of both equity and global efficiency, a carbon tax would not automatically channel finance for low-carbon development towards developing countries.

Other policy instruments will also be needed. At the national level countries may want to make use of taxes as appropriate instruments for certain sectors, as they have some advantages over market trading for example they may be more easily administered in some sectors. Indeed, international emissions trading is likely to be necessary but not sufficient to meet a 50% by 2050 goal. There will likely be a need for complementary technology policy, international standards and incentives to energy efficiency in order to drive change at the scale and urgency needed across a diverse range of countries and sectors.

Price volatility is sometimes raised as an objection to cap-and-trade schemes[14]. However, the issue for investors is less about volatility than predictability. Firms habitually deal with volatile input prices, and will develop financial instruments such as futures to hedge against predictable risk. Moreover, as authorities gain experience with cap-and-trade systems, they can be expected to smooth volatility, much as they do in the management of bond markets. [15]

4.3. International emissions trading generates finance

International emissions trading generates finance for developing countries to invest in low-carbon development. A market automatically directs financial flows from purchasers of permits to the sellers. The sellers will tend to be regions with low cost abatement opportunities, and modest targets (or none), i.e. the developing world – for three reasons. First, they tend to have old plant

[13] A model of the global carbon market based on regional MAC curves covering Energy, Forestry and Non-CO2 greenhouse gas emissions. For more detail see: www.occ.gsi.gov.uk/activities/gcf
[14] Nordhaus (2005) "Life after Kyoto: Alternative Approaches to Global Warming Policies", NBER Working Paper
[15] Note that in a world with perfect information and no uncertainty quota and tax policies are interchangeable. They have different properties without full information and with uncertainty.

and machinery, which could be updated with more efficient models. Second, most of the power sector is based around coal. And third, in fast growing economies there is ample scope to install low carbon technologies immediately, rather than waiting for old gas plants to reach the end of their natural life.

Buyers of permits would generally be in the main developed countries, which have relatively high abatement costs and are likely to face high targets. Ultimately, if firms are the trading entities in the system, then firms that own low-cost abatement opportunities and therefore have permits to sell would benefit. And firms which are located in countries facing high targets, and rely on carbon intensive production methods would need to purchase ever more permits at ever higher prices. Of course, the flows will also be strongly shaped by the carbon market design including any restrictions on the buying or selling of permits.

The scale of financial flows from the carbon markets could be large. In a simple arithmetic example, if developed countries cut emissions by 20-40% on 1990 levels by 2020, and even if only 30% of this (2-3Gt CO_2e) was purchased from an international emissions trading scheme at prices of \$10-25/t CO_2e , this would generate flows of \$20-75billion dollars a year. This calculation does not require that developing countries take on national targets, but could be achieved through the scale up of existing mechanisms such as the CDM (see Chapter 3). Even under lower cuts, where the world pursues a goal of stabilising at 550 ppmv CO_2e financial flows from developed to developing countries could be of the order of \$50-100billion per year by 2030[16]. For comparison, total Overseas Development Aid (ODA) to developing countries was around \$100billion in 2007[17]. Developing countries would benefit through trading by receiving net inflows of finance which can be used for low-carbon development. Key beneficiary countries in terms of overall volume would be the large developing economies, such as China and India, but significant flows could also go to Africa, Latin America, and South East Asia, especially if forestry is included in the market.

The size and direction of financial flows from trading depend on the relative targets taken by different countries, and how much effort relative to their business-as-usual emissions it will take to reach the target. Flows will also depend on the relative abatement costs in different countries - flows will go to where the costs are lowest (this also depends on which sectors are included, e.g. forestry). The majority of the flows are likely to come from the private sector, and so will also depend on the investment climate of different regions. Trading rules will also influence the financial flows. Restrictions on how much of a target can be met through international credits will reduce the amount of financial flows to developing countries. High transaction costs and stringent project based verification requirements such as for the CDM can curtail the amount of supply of credits produced. The value of financial flows could well increase in the longer term even though developing countries take on targets and there is less trading, because the carbon price will be higher.

The capacity of firms to benefit from trading will vary widely. Most studies suggest that the competitiveness impacts of mitigation policy are likely to be modest[18]. But there may be valid

[16] See UNFCCC (2007) Investment and Financial Flows to Address Climate Change, and GLOCAF model www.occ.gov.uk/activities/gcf GLOCAF results based on a scenario where developing countries take on small targets by 2030 relative to BAU, but still allowed to grow emissions relative to 1990.
[17] OECD, Debt relief down: Other ODA rises slightly, Press Release 04/04/08 www.oecd.org
[18] See the Stern Review (2006)

competitiveness concerns in a small number of particularly vulnerable sectors (GHG intensive export-oriented sectors). Competitiveness risks should not be overstated and policy must be designed to embrace and manage change so as to take advantage of opportunities while minimising the costs of transition. The losers, who are easy to identify, will likely be more vocal than the potential beneficiaries from new opportunities who may not yet know who they are. Over-stating the risks relative to the opportunities will prompt parties to wait for others to sign up before taking action and delay action. On the other hand, the expectation of a credible global agreement will sharpen the incentives for companies and governments to move quickly and efficiently. Specific sectoral approaches may make sense for some internationally exposed sectors, especially as an interim measure, until all sectors are covered by a carbon price.

4.4. International cap-and-trade is feasible, building on current experience

Developing existing structures and institutions (such as the EU ETS and CDM) into an effective international cap-and-trade system would be a big challenge, but it is possible to learn from successful schemes. The US has operated, since the early 1990s, a successful cap-and-trade scheme for SO_2 emissions. This is estimated to have cut emissions by more than 6.3 million tonnes from 1990 levels, about 40% of total power sector emissions of SO_2. Prior to the launch of the programme, cost estimate had ranged from $3-25billion a year. After the first two years the costs were around $0.8billion a year[19].

The EU Emissions Trading Scheme (ETS), covering over 12,000 installations and around 45% of EU CO_2 emissions (mainly from the power generation and certain other energy intensive industries), has been in operation since January 2005. Phase I (2005-2007) had significant teething problems with initial over-allocation of permits (as a result the carbon price dropped sharply in May 2006 and ended at €0.02/t CO_2 in December 2007).

However, Phase II addresses these concerns and it is clear that the EU ETS has focussed attention on the key design elements for an emissions trading scheme. A scheme must be:

1. Deep – there must be sufficiently ambitious targets to create scarcity and demand
2. Broad – the wider the coverage (sectors and countries), the more can trading reduce costs
3. Fair – it is important to distribute allowances to sectors and firms efficiently and equitably, e.g. through auctioning

For emissions-reduction markets to work well, effective monitoring regulation and verification are very important. A key element of developing these markets is to create credible mechanisms for these tasks.

Several studies have looked at how the EU ETS could be linked with other domestic or regional emissions trading schemes that are being set up or proposed[20]. The Australian government have announced plans for an national emissions trading scheme from 2010[21]. Several US states

[19] Environmental Defense (www.edf.org) and EPA, Acid Rain Program Progress Report 2006 (www.epa.gov/airmarkets/progress/arp06.html)
[20] See e.g. Edenhofer (2007) Towards a global CO2 market, and Jaffe and Stavins (2007) Linking Tradable Permit Systems for Greenhouse Gas Emissions: Opportunities, Implications and Challenges
[21] See www.climatechange.gov.au

are also planning sub-national emissions trading schemes[22]. Linking up existing and planned schemes in developed countries is a pragmatic way of moving towards a global emissions trading scheme. Further work is needed to understand how best to do this, and what sort of investment environments are most likely to attract low-carbon investment, as well as what the data and institutional requirements are needed to allow developing countries to benefit fully from emissions trading.

[22] See e.g. the Regional Greenhouse Gas Initiative (www.rggi.org) or the Western Climate Initiative (http://www.westernclimateinitiative.org/)

5. FINANCING EMISSIONS REDUCTIONS FROM DEFORESTATION

Key Proposals

- Tropical deforestation is an international issue, requiring urgent international action to support tropical forest nations who could lead in proposing mechanisms to reduce the emissions it generates. Success in reducing deforestation can have many co-benefits, including promotion of biodiversity, watershed management and local livelihoods.
- National forest protection policy should be consistent with broader national development strategies.
- Action should be collaborative, and on a scale sufficient to ensure that a decrease in deforestation in one area does not lead to a corresponding increase in another.
- Public resources will be needed on a large scale, together with reform of delivery mechanisms to help in building appropriate institutions and governance structures. Initial planning should be on the basis of funding of $15billion per annum, with revision in the light of pilots and experience, with a view to halving emissions from deforestation in the next decade. Demonstration projects are required for capacity building and to test financing approaches.
- In the medium to long term, forests should be integrated fully into global carbon trading.
- Further research is required in the following areas: mitigation costs of using forests to tackle climate change; technology and institutional arrangements required to audit and verify afforestation/reforestation efforts and reductions in deforestation and degradation more effectively; multilateral funding and carbon trading mechanisms to leverage funds at national level both in the short term and the medium to long term, addressing the challenges of leakage, additionality, permanence, and perverse incentives; linking payments to results and to which forests are not at risk.

5.1. Introduction

Addressing forestry in a global climate change deal, and in particular deforestation and forest degradation[23] in tropical rainforest countries, is essential if overall targets for stabilising carbon emissions are to be met. A total of 13 million hectares a of forests is destroyed every year[24] – an area half the size of the United Kingdom, or one third the size of Japan. According to the International Panel on Climate Change (IPCC), 'forestry' currently contributes 17.4% of global

[23] 'Deforestation' will be used to denote both deforestation and degradation unless otherwise stated
[24] FAO, 2005

annual greenhouse gas emissions, the overwhelming proportion of which comes from burning or decomposition of tropical forests.[25] These emissions include around 5.9Gt CO_2, approximately equivalent to the total annual CO_2 emissions from the USA[26, 27].

Given this scale of emissions from deforestation, any climate change deal that does not fully integrate forestry will fail to meet the necessary targets. Forestry, in particular reduced deforestation, has the potential to make a substantial and relatively immediate contribution to a low-cost global mitigation portfolio that provides synergies with adaptation and sustainable development.[28] Standing forests also perform other significant environmental services, such as the regulation of water supplies and the conservation of biodiversity.

There are many causes of tropical deforestation.[29] It will not be possible to reduce emissions effectively unless these drivers are addressed. Poor local communities are often blamed, but more often it is government incentives and the demand for internationally traded commodities such as timber, palm oil, and soy that drive deforestation. The issue of biofuels is just one example of a policy, pursued by developed and developing nations alike, that may play a role in (indirectly) incentivising deforestation by increasing the demand for agricultural commodities, and thereby increasing the profits to be made from converting forests to agricultural use.[30]

Deforestation occurs primarily because logged timber and/or forest land converted to agriculture is worth more than standing forests. Reducing deforestation will involve reversing this, to make standing forests worth conserving. Consequently, any financing framework that successfully addresses the mitigation costs of reduced deforestation needs to be on a scale sufficient to cover these opportunity costs, as well as any transaction (including administration, implementation, and enforcement) costs, and insurance.

Global estimates for the opportunity costs involved in halving deforestation have ranged from US$ 3 billion[31] to US$ 33 billion annually,[32] with a number of estimates between. There is likely to be a large amount that can be avoided at modest cost although marginal costs may rise substantially with amounts avoided. Much depends on assumptions concerning “leakage” and leakage in turn depends on the scale and effectiveness of action.[33] Recent rises in agricultural commodity prices imply that new estimates may be higher. Further, the administration costs associated with achieving reduced deforestation through national payment schemes (one of a number of options) have been estimated to range from US$ 250 million to US$ 1 billion annually by the 10th year of operation.[34]

[25] Houghton, 2003
[26] IPCC, 2007a
[27] IEA, 2007. World Energy Outlook 2007 estimate for US CO2 emissions in 2005, not including land use change, is 5.8Gt CO2
[28] IPCC, 2007b
[29] See Chomitz et al, 2006
[30] Searchinger et al, 2008; Fargione et al, 2008
[31] The lowest cost in the Grieg-Gran (2006) range, and which does not take into account returns to selective logging before deforestation takes place
[32] Obersteiner (2006)
[33] For example, Blaser et al (2007) estimate $US12.2 billion annually to reduce emissions to zero by 2030.
[34] Grieg-Gran (2006)

5.2. Tropical deforestation is an international problem, needing urgent international action to support tropical forest nations

Forests function as a global public good in the way that they contribute to regulating the earth's climate. Reducing tropical deforestation is therefore an international problem that can be addressed only through international collaboration. There are examples of successful approaches that are working to protect forests and ensure their sustainable use, thereby maintaining their carbon storage function.[35] Any global deal would need to put in place a framework to mobilise international support and provide incentives to build on these successes and scale them. Rainforest nations have led the way by submitting a number of proposals on how to reduce emissions on deforestation.[36] They differ in a number of ways, such as scope (e.g. just deforestation or also degradation), types of mechanism (e.g. national v. project-based performance objectives) and finance source (e.g. markets v. funds). The international community needs to agree a consistent way forward. It will also be important to ensure that the global deal does not lead to perverse incentives, i.e. ensure that incentives that reward reduced deforestation in areas of high forest loss do not lead to deforestation in previously stable forests.

Decisions about how forests are used are made by the nations in which the trees stand. International effort to reduce tropical deforestation must therefore support national and local governments. Their policies need to address the drivers of deforestation in concert with international financial incentives. Current regulations often favour or provide incentives for deforestation. The international community, through multilateral and bilateral aid, can play a role in helping to build national regulatory capacity to ensure maintenance and enhancement of forest cover in the tropics, as well as readiness for participation in a global framework. In addition to building capacity, international support should also be linked to results of emissions reductions and take account of which forests are not at risk.

5.3. National forest protection policy should be consistent with broader national development strategies

Deforestation is also a development issue. An estimated 1.6 billion people depend on forests for their livelihoods.[37] The international community is already working to support developing country governments move towards sustainable development. Forests and forest land need to be seen in this context, so that they can contribute to the national economy, whether providing direct economic benefits, such as timber from legal, sustainably-managed forests, or non-direct public benefits such as the regulation of water supplies, biodiversity conservation or carbon storage.

Finance to reduce deforestation could have a significant impact both on poor rainforest nations and on the livelihoods of poor forest communities. Incentives to increase the value of standing forests relative to conversion to agriculture can go hand in hand with increasing the welfare of these communities. To ensure this, programmes will need to be consistent with national development strategies, and be planned and implemented with forest communities. Deforestation can be reduced by providing greater income earning opportunities, within or outside agriculture, for those who might otherwise be attracted to clearing forest land.

[35] E.g. the Noel Kemff Climate Action Project, Mercado, Bolivia
[36] See: http://unfccc.int/methods_and_science/lulucf/items/4123.php
[37] World Bank (2004)

Establishing and enforcing clear property rights to forested land, and determining the rights and responsibilities of landowners, communities, and the private sector, are particularly important in ensuring that appropriate incentives to reduce deforestation are delivered effectively. But this is a complicated area, and increasing security of tenure can in some cases lead to increased deforestation – by reducing the risk to investors of conversion to agriculture.[38]

5.4. Addressing deforestation should be at sufficiently large scale, particularly to address leakage

Until now, developing countries have not received funding from the international community on a scale sufficient to address the drivers of deforestation. Current global climate rules provide no incentives for reducing deforestation[39] (and only very limited incentives for reforestation and afforestation). One reason for this is that funding proposals have not been of sufficient scale to deal with the concerns that have been raised about 'leakage' (where protection of one area of forest merely displaces deforestation activities to other areas that are unprotected). Leakage can occur at an intra-national or international level, but is an issue where emissions fall outside a shared accounting framework. Intra-national leakage can be substantial if no national accounting framework is used. The potential for international leakage is also significant, and needs to be tackled collaboratively by large-scale involvement of rainforest nations in the global deal.

A necessary step for national and international collaboration is capacity-building in national and local institutions that monitor and control forest land use. Significant support for governments, regions, and communities will be required for them to reduce deforestation successfully, and for civil society to monitor the transparent management of forests. Many rainforest countries are characterised by insecure land tenure; illegal resource exploitation; limited access by vulnerable groups to finance, markets and information; and capture of benefits by elites. Investing in institutional capacity is therefore central. Experience from previous intergovernmental collaboration, such as the Tropical Forests Action Plan (supported by the World Bank, the FAO, and the UNDP in the late 1980s), shows that failure to improve governance and build capacity may result in funds provided for reducing deforestation not achieving their objective.

For any reduced deforestation mechanism to guarantee environmental performance, there will need to be good quality data from an internationally harmonised monitoring system, and verification of emissions from deforestation. This too will need the support of the international community. The FAO already works with governments to advance a common understanding of methodological approaches to assessment of forest resources.

5.5. Addressing deforestation urgently requires large-scale public resources and demonstration activities for capacity building

With deforestation rates high, support from the international community for capacity-building to address deforestation, promote afforestation and reforestation more effectively, and to prepare rainforest nations for entry into a global mechanism, is needed urgently. Near term, support through existing multilateral funding channels, such as the World Bank's recently announced

[38] Chomitz et al, 2006
[39] Although a voluntary carbon market currently exists, worth about US$100 million in its entirety.

Forest Carbon Partnership Facility (FCPF) and/or the UN's Global Environment Facility, can be scaled up. The FCPF will support rainforest nation readiness through funding deforestation emissions data, monitoring systems, and national strategies for reducing deforestation. It will also involve a carbon finance mechanism to implement and evaluate schemes for generating credits for reduced deforestation. In addition there are aid agencies, NGOs and private investors with good track records that are in a position to help mobilise resources rapidly. Putting these systems in place is critical to ensure the integrity/tradability of the new carbon assets and to reduce the risk of governments assuming long-term contingent liabilities in the event that deforestation resumes (e.g. if carbon prices fall below a critical threshold).

These frameworks need to be strengthened and streamlined, however, so that support can be delivered efficiently and transparently, on a significantly greater scale. Internal finance frameworks should be transparent, mutually reinforcing, and enjoy broad support across donor and recipient communities. This is important to avoid duplication of funds and mechanisms.

The Bali declaration on deforestation stated the need for demonstration activities that will test different financing approaches in a variety of contexts. Demonstrating success early, through national and sub-national pilots, will be critical to building the confidence of governments and investors in the potential for land use change to be incorporated into an international framework.

5.6. Support from the private sector

Direct private investment in the global forestry sector has been estimated at US$23 billion in 2005 (compared with US$ 582 million Oversees Development Aid (ODA) in 2006)[40] and accounting for 90% of total forest finance.[41] The private sector has a large role to play in reducing deforestation, through commercialising benefits that forests provide. The sector stands to be heavily involved in financing reduced deforestation through a global carbon market. This might be through working with rainforest nations on schemes to reduce deforestation rates below a national reference level, or direct involvement in reduced deforestation projects. The private sector also has the capacity to bring forward investment opportunities through innovative financial products. The sector is also likely to have a role in the certification of sustainable forest products (such as timber) that derive from a legal source and have been sustainably managed to protect other forest services (such as water regulation and biodiversity). Such products would enjoy increased market access, and a premium in many developed country markets.

5.7. In the medium to long term, forests should be integrated into global carbon trading

Including forestry in the global compliance carbon market at scale, and where capacity exists to earn reduced deforestation credits, would reduce the cost of reaching the world's emissions stabilisation goals because of the relatively cheap abatement that is potentially available. A global compliance carbon market would provide the most effective source of finance at the scale required. The voluntary carbon market accounts for US$100m per year, of which only a small proportion is directed towards avoided deforestation projects.[42] This is insufficient to address the opportunity costs of reduced deforestation. Including forestry within a global compliance system

[40] Karousakis and Corfee-Morlot, 2007
[41] Tomaselli, 2006
[42] World Bank, 2007

has the potential to engage the private sector in the financing of reduced deforestation, which would significantly increase available funding. A global compliance carbon market could be worth US$100 billion in 2030[43], which would constitute a new source of finance. This market could also provide the most efficient source of funds, as investment would be targeted at least-cost mitigation solutions.

Financing mitigation costs should be by transfer from highly industrialised countries to rainforest countries, where 96% of global deforestation takes place.

Reduced deforestation and forest degradation (REDD) and afforestation/reforestation (A/R) should both be included in any trading. Including forests in a single market for all types of carbon (or, equivalently, credits that are freely traded between linked markets) would probably also be the best means of achieving equity across developing countries. For this to be successful and to maintain incentives for emissions reductions in other sectors through a high carbon price, an increase in the potential supply of credits from reduced deforestation should be balanced by an increase in the demand for credits from developed countries. Options also exist for regulating the supply of credits, such as the introduction of a maximum volume or an offset safety valve where the maximum credit limit would depend on the international market price of an allowance. However, we must recognise that the purpose of a market mechanism is to attain an emissions reduction at least cost.

The appropriate blending of public funding with private funding is a key area for further study, recognising that the former is likely to be in the majority in the early stages. That is something that pilots should inform. Further work should also include the appropriate treatment of REDD and afforestation/reforestation at the national and project level based on the overarching principle of reducing emissions. And it should include methods of linking national payments (and eventually markets) to results and to which forests are most at risk. At the same time we must recognise that decisions on how to move to scale must be taken quickly, given the urgency of the problem and that leakage, and thus costs, can be reduced by acting on a larger scale.

[43] UNFCCC, 2007.The paper by the UNFCCC Secretariat estimates that the size of the carbon market is equal to the financial flows from developed to developing countries. This is based on the assumption that trading only occurs through developed countries buying permits for compliance from developing countries.

6. TECHNOLOGY

Key proposals

- Achieving the targets of cutting global emissions by half and reaching per capita emissions of approximately 2T CO_2e by 2050 will require both the widespread diffusion and adoption of currently available low-carbon technologies, as well as the development of new technologies.

- The overall objective for technology policy is to expand the global market for low-carbon technology thus providing incentives for needed innovations. Success would be a competitive supply of low carbon technologies, declining rapidly in cost over time, resulting in the substitution away from higher-carbon alternatives in both production and consumption.

- Achieving this objective requires immediate policy actions across three time horizons:

  (a) **Horizon 1—Diffusing existing low carbon technologies**. Key policy levers include a clear carbon price underpinned by stable institutional arrangements, energy efficiency standards, transitional mandates, public procurement, and sector benchmarking.

  (b) **Horizon 2—Developing and scaling-up near commercial technologies**. In particular CCS, solar, and second generation biofuels. One crucial example would be an international programme for the demonstration of around 30 commercial-scale CCS power stations within the next decade located in both developed and developing countries. Key policy levers include significant public/private collaborations, and mechanisms for assisting developing countries with technology diffusion and adoption;

  (c) **Horizon 3—Creating breakthrough technologies.** Key policy levers include a deep, global carbon market with long-run institutional stability, public funding for basic R&D, incentives for venture investment and private sector collaboration, and educational investments in key skill areas.

- Meeting the technology policy goal requires immediate action on a coordinated global basis. In addition to progressively tougher targets and a global cap-and-trade regime, any global deal should also set the framework for:

  (a) **Globally coordinated standards** (e.g. for electrical goods, buildings, and transport) and open-market policies to encourage faster deployment of existing low-carbon technologies, in particular making the most of existing opportunities for improved energy efficiency;

  (b) **Coordinated public funding** for demonstrating and deploying critical

technologies in both developed and developing countries; and

(c) **Targeted concessional finance** for developing countries around defined (sectoral) programmes to reduce carbon intensity, provide incentives for technology diffusion and adoption, and support developing country R&D and technology export efforts.

- Further work required—designing the national and international institutional arrangements to support the large scale increases in technology research and investment required; developing a more detailed understanding of requirements for successful technology diffusion and adoption in developing countries.

6.1. Introduction

Over the past 100 years, the global economy has developed largely on the back of the increasing application of carbon- and energy-intensive technologies in all major sectors. In recent years this trend has accelerated, driven by (a) surging growth in the developing world (especially China), (b) relatively low energy prices until 2005, and (c) increasing use of coal as the primary energy source for the power sector. The underlying rate of decrease in carbon intensity, defined as tonnes of carbon/GDP, is 1% per year. Hence, given that the world economy continues to grow by 3 to 4% per year, carbon emissions will continue to grow, at 2 to 3% per year under a 'business-as-usual' scenario.

The challenge of significantly reducing emissions whilst maintaining economic growth requires a dramatic shift in the technologies that determine the carbon intensity of the economy. A number of studies indicate that stabilisation can be achieved through the deployment of existing and near-commercial technologies.[44] The innovation of new technologies would further lower the costs of transitioning to a low-carbon economy and thus is highly desirable. But in order for existing technologies to be fully diffused and adopted, and for new innovations to occur, three forms of market failure must be overcome. First is the general failure to internalise the costs of GHG emissions. This would be addressed by an appropriately determined carbon price. Second are market failures that have restricted the deployment of many existing energy efficiency technologies despite rising energy prices, and would likely effect low carbon technologies despite a carbon price as well. These include principal-agent problems (e.g. landlords not having incentives to deploy energy saving technologies in commercial buildings), overly high consumer discount rates, lack of information, government energy subsidies that encourage energy consumption, and energy or carbon costs that are low in individual purchase decisions but high in aggregate terms. Third and finally, are market failures specific to the nature of technology itself. These include lock-in of high carbon technologies due to infrastructure or increasing returns effects, risk aversion in the face of technological or carbon price uncertainty, spillovers of R&D investments that benefit competitors, and learning curve effects that create high prices for early adopters thus discouraging demand.

[44] IPCC 2007, working group 3, and Enkvist, Naucler, and Rosander (2007).

The key message is thus that while a clear, appropriately determined, and institutionally stable market price for carbon is necessary to stimulate the required technology response, it is not sufficient. An effective, efficient, and equitable policy response in this area must not only motivate market forces, but also overcome market imperfections.

6.2. Objectives and time horizons

By motivating market forces and overcoming market imperfections, successful technology policy would have the effect of dramatically expanding the global market for low-carbon technologies. Such a market expansion would create a competitive supply of low carbon technologies, declining rapidly in cost over time, resulting in the substitution away from higher-carbon alternatives in both production and consumption.

Achieving this objective will require policies that meet a number of tests. Policies will need to be: (a) dynamically efficient in linking the degree of support for technologies to their potential or actual performance in reducing carbon emissions; (b) market-based, encouraging competition between different technology suppliers; (c) catalytic in mobilising private sector capital to make investments and take risks; (d) global, opening up and integrating low-carbon technology markets in a way that accelerates their scale-up; (e) equitable, by placing the bulk of the public funding requirements on richer nations[45]; and (f) explicit, making transparent the 'cost per tonne' of delivered abatement of different technology options.

Furthermore, such policies will need to drive priorities over three different time horizons:

Horizon 1—Diffusing existing low carbon technologies. There is an existing set of carbon-efficient technologies that are only partly diffused throughout the global economy. Even today, there is significant international variation in sectoral carbon productivity (e.g. in cement, steel, buildings, power, cars). Achieving best practice with today's technology set could reduce carbon emissions by an estimated 5 to 10GT by 2030. Harnessing the potential of existing low-carbon technologies is crucial: only by making the decision early to invest will countries be able to benefit from the next generation of nuclear energy.

Horizon 2—Developing and scaling-up near-commercial technologies. There is a set of low-carbon technologies that are 5 to 15 years away from economic viability. These include carbon capture and storage (CCS), second-generation biofuels, and various forms of solar. Together, these technologies have the potential to reduce carbon emissions by over 10GT in 2030. But collaboration between private firms, governments, and investors is needed to harness commercial forces and skills to accelerate development and deployment.

Horizon 3—Creating breakthrough technologies. Beyond 2030, the required cuts in carbon emissions will be achieved only through more radical shifts in technology (e.g. zero emissions power supply).These have huge potential, but will require substantial public investment in R&D, the creation of incentives, and actions to reduce risks for investing in, and deploying, such new technologies.

[45] Richer nations include OECD plus the large oil exporters who have strong incentives to find a solution.

Under 'business as usual' the world will expand its infrastructure asset base (power, transport, buildings, industry) by over 40% over the next two decades. Unless policy changes significantly, that infrastructure will be built using today's relatively high carbon technologies. In order to avoid locking-in higher carbon emissions for many decades to come, the process of diffusion, development, and longer-term research needs to begin now.

6.3. Policies for the three technology horizons

Each of the three time horizons and corresponding priorities requires different policy actions:

Horizon 1 Technologies. Policies that would accelerate diffusion of existing low-carbon technologies include:

1. Carbon prices applied globally at a level high enough to induce greater technological switching and investment to reduce energy demand;

2. Globally coordinated standards to raise energy efficiency, especially in the consumer appliances/electronics, auto, and buildings sectors;[46]

3. Transitional mandates (e.g. biofuel or renewable energy useage) or incentives (e.g. feed-in tariffs) to cover initial scale-up and market entry costs and then generate broader spillover benefits;

4. More effective use of public procurement to create lead markets for promising sub-scale technologies (e.g. solid state lighting);

5. Sector benchmarks, considered in the context of a reformed CDM, which could incentivise developing countries to switch to lower carbon technologies in key sectors such as steel, chemicals and cement; and

6. Policies that create appropriate incentives for biofuels, in particular distinguishing them by energy ratio and their impact on land and water use, deforestation, and food prices.

Horizon 2 Technologies. Policy action is also required to accelerate development of Horizon 2 near-commercial technologies, such as second generation biofuels, various forms of solar, and smart grids. But perhaps most pressing of all is carbon capture and storage (CCS). For a 500 ppmv target is to be achieved, electricity generation will need to be near zero emissions by 2050. But given the low cost and energy security advantages of coal (particularly in China and the U.S.), global consumption stands to increase rapidly, almost doubling by 2030 under 'business as usual'. CCS is the only promising solution to this increased use of coal. While CCS has been proven in concept it has not been demonstrated at commercial scale. Experimentation will be required in order to develop and refine the technology and drive costs down the learning curve. An urgent priority must be an international programme to pilot a sufficiently large number

[46] Standards to be specified on a technology-neutral, outcome basis where possible, with built-in dynamic upgrading. US Fridges are a good example: their energy performance improved by 4% per annum from 1972, but increased by 35% in 1993 when minimum performance standards were introduced. See the King Review (King, 2008) for an overview of the potential of standards in the auto sector and recent work by the McKinsey Global Institute on standards and carbon intensity across countries (Bressand, et al. 2007).

of full-scale CCS power stations (e.g. 30 to allow for regional variation in geology, types of coal, and degrees of success) over the next decade in order to bring the technology to commercial readiness.

More generally for Horizon 2 technologies, there is a strong case for policy action that includes:

1. A clear and institutionally stable carbon price to provide incentives for the significant private sector investment and collaboration required;

2. The development of public-private partnerships to catalyse (competing) consortia that would accelerate commercial piloting and scale-up of technologies where market incentives alone are insufficient, or will take effect too slowly;

3. The establishment of global regulatory standards, in particular to address risks associated with carbon storage and second generation biofuels; and

4. Financial support for developing country participation in technology pilots, as well as encouraging 'optionality' in current infrastructure build (e.g. coal plants built with future CCS conversion in mind, and flex-fuel vehicle fleets and infrastructure).

Horizon 3 Technologies. Whilst policies and investments to commercialise Horizon 2 technologies inevitably require policymakers to back specific technologies (e.g. CCS), the longer time frames and uncertainties for Horizon 3 technologies mean that policymakers are likely to be less effective than market mechanisms in 'picking winners'. Thus the key principle for Horizon 3 technologies is that should aim not at picking winners, but rather create the conditions under which such winners will emerge, including:

1. Long-term institutional stability of mechanisms for setting the carbon price, which is critical, given the long payback timeframes of investments;

2. At least a twofold increased in public research and development funding from levels which today are less than 0.1% of global GDP ($10 billion estimated investment in energy R&D in 2005), when overall energy costs are running at 4 to 5% of global GDP; [47]

3. Encouraging an adequate supply of venture and other risk capital through tax and other incentives and a favourable regulatory environment; and

4. Investing in education in critical skill areas, e.g. engineering, chemistry, physics, and biology.

6.4. Global coordination and national initiative

Technology policies have historically been aimed at enhancing national economic and military advantage. But to deal with the global externality of GHG emissions and climate change, technology policy should be about globally replacing high carbon technologies with low carbon ones regardless of national borders. Global coordination would significantly enhance the impact

[47] A recent study estimates that an increase to $30-$80 billion per year by 2050 is needed (Bosetti et al, 2007)

of the policies described in this chapter, including expanding markets for low-carbon technologies, creating common standards, coordinating major increases in R&D, facilitating concessional financing, and establishing global sector performance benchmarks. At the same time country choices are likely to vary as a result of geographical differences and political preferences. An element of diversity can widen the range of experiences. Market-driven decisions and local variation can reveal and teach.

Furthermore, explicit measures are required to ensure that clean technology is transferred to the developing world. In return for increased R&D funding or extended developed-world IP protection, obligations could be imposed on developed world technology providers that new technology be made available to the developing world on a marginal cost basis, or for some reduced license fee (there are examples of such arrangements in the pharmaceutical industry).[48]

Such a *quid pro quo* would need to balance the need for technology providers to earn sufficient profits to incentivise investment, against providing affordable technology access to developing nations with significant abatement opportunities. Policymakers need to keep in mind that many economically attractive technologies fail to diffuse throughout developing countries for reasons other than access and finance.[49] Thus low-carbon technology transfer strategies will need to be tightly integrated with broader development agendas and include the build-up of know-how and skills, and stimulate local demand for low carbon products and services.

Notwithstanding these global issues, there will nevertheless be a need for significant levels of national initiative, as well as mechanisms to transfer gains between winners and losers. Hence action will be required at the national level to remove barriers to diffusion, provide incentives, and develop institutional structures for channelling R&D funds at the national level.

The scale of effort needed is unprecedented, and further work is needed to design in detail the institutional structures that will be required to manage such large increases in investment and R&D, ensure transfers of technology to developing countries are done effectively, and globally coordinate complex policies. And finally more work is needed to better understand the complex interplay between market, social, and behavioral factors that will ultimately determine the pace of technology innovation and adoption, particularly in developing countries.

Given that each tonne of CO_2 has the same effect, regardless of where it is emitted, only a globally coordinated framework for technology policy can achieve the goal of maximum market expansion at least cost for low-carbon technologies. Only a global framework can dynamically link technology priorities to a regime of enforceable targets. And only a global framework can secure the full participation of developing countries.

[48] Another approach would be to offer feed-in tariffs in the developed world to subsidise industry learning on the basis that the resulting technological progress is shared with the developing world at marginal cost.
[49] A recent World Bank study (World Bank, 2008) found that successful technology diffusion within a country is closely linked to its economic growth, and depends on the quality of governance, infrastructure, property rights, education and a host of other factors.

7. ADAPTATION

Key Proposals

- All countries will need to adapt to a changing climate- for example through more resilient infrastructure, buildings, agriculture and enhanced social protection. More detailed risk information will be crucial to this adaptation.

- The poorest countries are particularly vulnerable to the effects of climate change, and will be badly hit by increasingly frequent and severe climate-related disasters and by longer-term climatic stresses and should be a priority for international support.

- Basic development is critical for building adaptive capacity, but climate change will make it more costly and difficult to deliver and to sustain the Millennium Development Goals beyond 2015[50].

- Developed countries, whose emissions have been primarily responsible for climate change, have an obligation to contribute to these additional costs. This involves as a first step, meeting pledges (of at least 0.7% GNI by 2015) to deliver the Millennium Development Goals. Post-2015 the additional costs as a result of climate change of pursuing goals of development and poverty reduction should be a key element in assessing the appropriate scale of development assistance. Auctioning of emissions of allowances represents one potential new source of finance.

- Adaptation assistance needs to be integrated into development spending to deliver development goals in a climate resilient manner, rather than being earmarked for climate-specific projects. This will require involvement of organisations and institutions beyond the UNFCCC.

- In addition to funding, there is a need for better access for poorer countries to markets, technology and information to ensure that development is climate resilient. This needs to be monitored and facilitated by appropriate International Financial Institutions (IFIs).

- Over time, countries' contributions to adaptation should reflect their mitigation efforts, as well as ability to pay and historic emissions.

- Further work is needed to predict, quantify and prioritise the impacts and costs of climate change at a local level.

[50] Human Development Report 2007/8, IPCC 2007

7.1 Introduction: The need for early and strong action

As global temperatures increase, all countries will need to adapt to limit the human, economic and social impacts of climate change. Even the most aggressive stabilisation targets being discussed imply acceptance of a global average temperature rise of 1 to 3^0C. This will lead both to more frequent and severe climate-related disasters (including droughts, flooding and storms) and to longer-term stresses (including changing rainfall patterns, ecosystem degradation, reduced biodiversity and higher sea levels) [51].

These changes will affect poorer countries disproportionately: not only are they typically reliant on climate sensitive industries like agriculture and forestry, but poverty, poor health and limited capacity and resources increase their vulnerability .

There are three issues that need to be addressed to reduce the effects of climate change on poor countries:

- **Mitigation**. Without setting and achieving ambitious stabilisation targets the world will experience greater temperature rises and disproportionately higher damage on a scale which will likely see physical limits to adaptation.
- **Rapid, robust development**. Successful diversified economies and healthy populations with stable governments and good governance are less vulnerable and more resilient to shocks.
- **Addressing the specific risks and impacts** of climate change on development.

Taken together, all this implies that rather than treating adaptation as separate from development, it should be seen as an additional cost and complexity to delivering standard development goals. Specifically, adaptation has the same target outcomes as development- including sustaining or improving social protection, health, security, economic sufficiency- and so spending (whether labelled adaptation or development) ought to be prioritised according to the expected impacts on these outcomes.

The most effective way of achieving this is to integrate climate risk, and the additional resources required to tackle it, into planning and budgeting for and delivering these development goals. This requires a portfolio of adaptation responses, from changing planning, policy and institutions (based on better investment in and access to climate information), to improved access to markets (particularly insurance) and technologies (such as crop varieties) and ensuring climate-sensitive investments are climate resilient. Adaptation should be understood as the impacts of climate change on standard development outcomes, not whether the response to these impacts can be defined as separable from 'standard' development activities.

Estimates of what the additional costs of adapting to climate change will be for developing countries include UNFCCC work with a range of $28-67billion per year by 2030[52],and that of the UNDP which estimates around $86billion per year by 2015[53]. However, these estimates (and others) are highly uncertain both on the scale and timing of the eventual costs. There is a critical

[51] IPCC 2007
[52] UNFCCC, 2007
[53] Human Development Report 2008/9

need for more robust and detailed measurement and forecasting of climate change impacts for individual countries and regions. As understanding of the science improves, there is a need for ongoing research into what the highest priority adaptation investments are by country.

However, an expectation of improved understanding of the scale and nature of the problem in the future must not preclude taking action now, for two reasons:

1. Although the incremental costs of adaptation are likely to be limited before 2015, the climate negotiations in 2009 represent an opportunity to set up the principles and institutional frameworks to scale up action and investment as required.
2. Early no-regrets action is likely to decrease the total cost[54]. As well as addressing basic vulnerabilities through development, no-regrets actions include improving disaster response capabilities to cope with increased climate variability, and integrating climate risks into long-term investment planning (e.g. building climate risks into infrastructure projects reduces the risk of premature failure or obsolescence).

7.2 Equity suggests that developing countries should be helped to adapt

Any global deal will need to commit developed countries to helping developing countries adapt to climate change. The moral imperative to do so recognises not only the disparity in wealth, but also that historic and current emissions from developed countries are the primary cause of climate change. In practice, too, developing countries will look for some adaptation assistance to accompany their mitigation efforts. Integrating adaptation assistance into a global deal has the potential to increase the incentives for countries to push for co-operative international action on climate change.

Developed countries need to provide a suite of assistance measures to developing countries to help cover the additional costs and challenges to development: access to more and better climate information; building the capacity of planning and decision-making functions; increased provision of social protection policies and programmes; access to markets and technologies etc. All of these carry with them a need for additional funding.

7.3 Funding for adaptation in developing countries

Such scale of investment and range of goals cannot be achieved by either the public or the private sector acting alone. Private investment decisions - ranging from local community action through to direct international investment - need to incorporate climate risks as a matter of urgency. Well-informed private enterprise and investment has the potential to drive the bulk of adaptation in many countries, and should be allowed and enabled to do so by the regulatory environment. Public funding (from both local governments and the international community) should focus on two goals. First, it should deliver investment in areas where private initiatives will not be sufficient - including critical infrastructure, water security, small-scale agriculture and social protection. Second, it should catalyse private effort, by delivering access to markets and technology, and incentivising investments and community actions.

Funding from the international community should be flexible in order to cope with a need that will change over time (increasing in line with global temperatures) but predictable enough to allow

[54] Stern Review, 2006

long-term planning. Beyond 2015, sustaining delivery of the Millennium Development Goals will in many cases require more resources than has been anticipated (i.e. the 0.7% GNI ODA target[55]). The Human Development Report 2008/9 suggests that the long-term ODA requirements may be closer to 1% of GNI once climate change is taken into consideration[56].

A dedicated source of additional finance would provide confidence for poorer countries that the money would be both predictable and additional to other aid commitments. As nations and regions move towards cap-and-trade systems, auctioning of emissions of allowances stands to generate substantial new revenue streams. The EU estimates that auctioning revenues in the EU ETS alone may reach €50billion per year by 2020. Diverting some of this revenue to finance adaptation in developing countries would provide some reliability for developing countries and enhance the acceptability in developed countries of these measures.

Contributions should in most cases be based on ability to pay. And this is closely associated with cumulative past emissions, also a relevant criterion. A further criteria for stronger contributions might be a weaker commitment to emissions reductions. In the long term current middle-income countries should be expected to contribute as their economies grow and their GHG emissions increase

7.4 Delivering adaptation assistance

Just as adaptation planning needs to be integrated into development plans and strategies, so adaptation funding should be integrated into development spending at regional, national and local level, ideally by delivery through the same multilateral channels, and not by setting up parallel processes. Money should be spent through national development plans, reflecting overall national priorities, with delivery following the principles in the Paris Declaration: ownership, alignment, harmonisation, managing for results, and mutual accountability.[57] This will allow and incentivise governments to integrate adaptation with their development plans, and keep down both the transaction costs imposed on developing countries (by minimising the range of different institutions, people and systems governments need to deal with) and financial costs of managing a new international mechanism.

Making adaptation funding conditional on demonstrating an incremental (climate change specific) need would fail to address underlying vulnerabilities, may produce perverse incentives and prioritisation by discouraging investment in measures that are not clearly 'adaptation' or 'development' specific[58], and may not be cost-effective[59]. Instead, to meet the criteria of

[55] This target was originally agreed in United Nations General Assembly Resolution 2626 in 1970, and reaffirmed with reference to the Millennium Development Goals in the Monterrey commitment of 2005

[56] Human Development Report 2007/8

[57] This refers to: a) *Ownership* - Partner countries exercise effective leadership over their development policies, and strategies and co-ordinate development actions; b) *Alignment* - Donors base their overall support on partner countries' national development strategies, institutions and procedures; c) *Harmonisation* - Donors' actions are more harmonised, transparent and collectively effective; d) *Managing for Results* - managing and implementing aid in a way that focuses on the desired results and uses information to improve decision-making; and e) *Mutual Accountability* – partner countries and donors enhance mutual accountability and transparency in the use of development resources, helping to strengthen public support for national policies and development assistance.

[58] For an example of the blurred lines between projects focused purely on adaptation and pure on development, see the Word Resources Institute 2007 report 'Weathering the storm'.

effectiveness, efficiency and equity, funding decisions should recognise where climate risks have been incorporated into broader developmental planning.

Allocation of funding between countries will need to reflect a combination of several factors: impacts of climate change; vulnerability to those impacts; capacity for internal investment; commitment and ability of local governments to deliver appropriate outcomes.

Money and other assistance will be best used if national governments are responsible for using funds to deliver broad contracts on issues such as poverty, health and climate vulnerability. Delivery of these goals will need to be monitored and evaluated. Based on this evaluation, recipient governments will in turn need to be held to account by their citizens - who stand to lose most from a changing climate - and the international community. There is also a role for international financial institutions, including the World Bank and International Monetary Fund to monitor, report on and where necessary facilitate non-financial aid such as access to insurance, technology, information and other market-based facilities.

[59] By using separate funding streams with differing criteria to assess activities that should be designed to meet the same end goals of maintaining/improving health, security, wealth etc. As well as making prioritisation more difficult this is also likely to lead to increased transaction costs and lengthy definitional arguments over which projects are eligible for certain funding sources.

8. IMPLEMENTATION AND INSTITUTIONS

Key Proposals

Implementation

- Well-designed action to reduce emissions does not harm growth whereas inaction will eventually undermine growth. Even if action is applied at different speeds in different countries the costs of action are likely to have limited impact on competitiveness. Badly designed or implemented policies, however, can greatly increase costs. Demonstrating these arguments country-by-country is critical to building support for action.
- The overall global policy framework should be effective in reducing the risks from climate change, efficient in doing so at lowest cost and equitable in requiring developed countries to take the lead.
- Demonstrating that these principles can be put to work is crucial for the basic framework for negotiations in the run up to the UNFCCC Conference of the Parties in Copenhagen in late 2009 and to guide national governments.
- Implementation will take place in three key phases of agreement:
  1. at Copenhagen 2009: determine international targets; establish developed country caps; set developing country responsibilities.
  2. 2010-2020: build effective and cooperative institutions on finance and technology as a basis for establishing developing country caps.
  3. post-2020: all countries form part of an international cap-and-trade system and adhere to technological agreements.
- Developing countries, given their large share of world population, should play a strong role in shaping agreements.

Institutions

- There is a substantial set of tasks which require strong elements of international cooperation, including development of targets, building trading mechanisms, supervision and monitoring, promotion of science and technology, and assessment of risks.
- The process must be flexible; it must allow for change in response to advances in knowledge and shifts in circumstances.
- The governance of institutions should evolve to reflect the current structure of the world community.
- The institutions must not be overly prescriptive: there must be a careful balance between those elements of any agreement which are centralised and those which are devolved to local decision.
- Monitoring, verification and certification are essential to promote trust in the system.
- Initial agreements should be delivered through existing structures building incrementally on accumulated experience and knowledge; in the longer term this may evolve into a single International Climate Change Organisation.

Key Elements of a Global Deal on Climate Change

8.1 The case for measured, effective action

The purpose of this paper is to present key principles and high-level proposals and not to prescribe detailed actions. These principles are important, not only to provide the basic framework for negotiations in the run up to the UNFCCC Conference of the Parties in Copenhagen in late 2009, but also to guide national governments in drafting and implementing effective policies. However, any argument on specific proposals will require some understanding of how it can be implemented and the type of institutions required.

8.2 Implementation

Growth, costs and competitiveness

To enact policy, anxieties about growth, costs and competitiveness must be overcome. Analysis should be conducted for each country and these issues need to be settled on the evidence of the numbers. The costs of effectively implemented action at a global level are unlikely to constrain growth. The impact of costs of 1-2% averaged over the next fifty years or so amounts to a fraction of a fraction of a percent off average annual growth for any country. It is akin to a one-off upward kick in a cost index of around 1 or 2%. By contrast, weak or delayed action risks eventually choking off growth.

Analysis at the industry, sector and whole-economy level suggests that extra costs will not have a significant effect on country competitiveness even if policy is applied at different speeds in different countries. Even for GHG-intensive sectors open to international trade, the impact on relative costs and the likelihood of relocation and diversion of pollution is small[60]. Such costs would usually be small in relation to differences in overall wage rates (for example between rich and poor countries) or when compared to annual fluctuations in exchange rates or fossil fuel prices. Nevertheless, for some very energy-intensive tradable industries there is a case for sectoral agreements and agreed phasing as discussed in chapter three. On the other hand, the transition to a GHG-constrained world will create new investment and technological opportunities from clean technologies.

Badly implemented policies can create additional market distortions and perverse incentives or promote protectionism. They may also interact unfavourably with existing policies. This could greatly increase the cost of action. In order to overcome the key market failures and harness the power of markets to find an effective international response to the challenge, a policy framework must be credible, durable and predictable, while allowing long-term flexibility. It should encourage market-based solutions with limited transaction costs. It is inevitable that vested interests will try prevent change, and this only serves to highlight the importance of sensible management of the adjustment process whereby those facing the highest costs are supported and facilitated as well as clear and strong presentation of the evidence.

[60] Stern Review chapter 10; See also Grubb and Neuhoff (2006).

Establishing mutual agreement

Implementation of effective policies will be facilitated by mutual agreement on the timing of action. This requires that agreement is reached over three phases:

1. at Copenhagen 2009: determine international targets; establish developed country caps; set developing country responsibilities, agree first-round REDD model, lay out core elements of technology package;
2. 2010-2020: build effective and cooperative institutions on finance and technology as a basis of establishing developing country caps;
3. post-2020: all countries form part of an international cap-and-trade system and adhere to technological agreements

Developing countries must play a strong role in shaping agreements. With around 5 of current 6billion people and 8 out of 9billion in 2050, it is their world. At the same time, smaller groups such as the G8 summit can play a crucial role. For an agreement to be established and to be implemented, a very strong international spirit from all participants is essential. This could allow strong progress in resolving a number of global problems possibly beyond the issues of climate change.

The cheapest mitigation options often reside in developing countries which should take advantage of carbon markets from the very beginning, thereby ensuring that poor countries can be 'green and grow'.

Moving from a project-based to a broader sector-based mechanisms would permit scaling-up in a number of emissions reductions in GHG and energy-intensive industries. Investment and technology must also be considered in terms of time phases. Urgent action is required to implement energy efficiency policies and halt deforestation. In addition, it will require the application of existing technologies, including renewables and nuclear, and the development and demonstration of newer but established technologies, including carbon capture and storage. Over the longer term, continued investment in research, development and deployment of still expensive technologies, which currently are far from commercialisation, is required.

National policies

At the level of the country, since policies on mitigation and adaptation permeate the economy, they cannot be left to a single ministry: Heads of Government and finance ministries must be involved. Different countries will adopt different mixes of instruments and of technologies depending on their circumstances.

8.3 Institutions

Successful policy implementation will require an effective institutional structure. In the short-term any new structure will need to build on the expertise of existing institutions. Over this period, the process of reaching agreement at the international level rests with the UNFCCC working towards the key meetings at Poznan in 2008 and Copenhagen at the end of 2009. The

development of the agreements necessary will come through many channels of international dialogue, including the G8 summits in Japan in the summer of 2008 and in Italy in 2009.

Other wider groupings such as the G20 which incorporate the voices of the developing countries will be important in extending the base of support for substantive action. Over the same period the climate change capabilities of the existing international institutions including the UNEP, UNDP, the World Bank, the OECD, the IEA and the International Monetary Fund can all be usefully extended.

Successful long term implementation of an agreement reached within the next two years will require the evolution of existing structures and the creation of a new institutional framework which can manage within a single, linked process:

- the development of global and distributed emissions targets timetables and milestones;
- the detailed design of a new more scaled and extensive CDM mechanism;
- the establishment of the trading element of any cap-and-trade system;
- the creation of systems to supervise, monitor and verify delivery against commitments; including any pilot global sector agreements;
- the emerging forestry carbon regime;
- the coordination and increased funding of advances in climate-change related science and low-carbon technology development;
- the development of an improved and joined-up understanding of the potential local risks from climate change and the responses as they develop.
- The development of processes for dispute resolution

What matters most is that across all the elements where some form of governance is required, simple, common principles are applied together with sufficient flexibility to ensure that an overall system is created which matches the particular needs of the issue and sector. Most importantly, this must include the need to draw together all parties from their very different starting points into a single common process with a shared understanding of the nature of the challenge. Four principles must shape those institutional arrangements if sustained progress is to be delivered.

1. First, the governance structure must be designed to build trust around new and largely untested programmes of action. Firm commitments to cap-and-trade systems, agreements to limit deforestation, acceptance of major programmes to share technology with emerging economies and an extension of the Clean Development Mechanism to wholesale and programmatic funding all entail substantial transfers of resources from one country to another. Such transfers, which are likely to grow over time, will require processes to establish credible data, to verify delivery of the promised actions and to confirm that the resources are being used as intended. Proposals to extend the use of carbon capture and storage will equally require firm evidence to confirm the integrity of the storage systems. Monitoring and verification are by their nature intrusive processes but given the scepticism already evident around some examples of carbon trading their development is essential if public acceptance of the financial transfers necessary to achieve a sustained reduction in emissions is to be won and then maintained.

2. Secondly, the process must allow for change in response to advances in knowledge and shifts in circumstances. Even on the bold assumption that agreement is possible within the next two years between all the major global economies much remains uncertain. There are significant deficiencies in the data to be corrected. Atmospheric science continues to advance. So too does the science and engineering around the potential ways forward including sequestration and the development of lower carbon sources of energy supply. In many areas we are still at the experimental stages in the development of new technology. Economic circumstances could alter the level of emissions and the geographic distribution of their source. Each of these factors could require adjustments in the targets set and in the scale and pace of the responsive measures. A rigid agreement which could only be changed through a process of exhaustive negotiation would be inappropriate. In reality, of course, full participation in the initial agreement is likely to be limited to a coalition of the willing – making it even more important the creation of structures which can adjust to incorporate new members over time.

3. Thirdly, there must be a careful balance between those elements of any agreement which are centralised and those which are devolved to local decision. The setting of aggregate targets and the distribution of those targets across countries and through time are political decisions which can only be achieved at the international level. The mechanics of delivery, however, can and should be left to local determination reflecting local economic and physical circumstances. This element of decentralisation should also be used to encourage innovation and technical progress. Targets are essential, but prescriptive solutions should be avoided. One size need not fit all. The international institutional arrangements to manage the transition to a low carbon economy will be unique and given the nature of the problem potentially highly complex. Such complexity combined with inflexibility could undermine, or at best seriously delay, the process of agreement.

4. The fourth principle for the design process is therefore a degree of pragmatism. Instead of constructing a vast and costly new organisation the initial agreements should be delivered where possible through existing structures building incrementally on accumulated experience and knowledge.

On the science of climate change the IPCC has achieved a remarkable degree of credibility and trust over the last two decades. That work should continue. The International Energy Agency has unrivalled expertise in the energy field and with a broadened remit and membership could contribute much to the process, perhaps to the extent of providing the integrating base which will be required particularly in the critical area of data management. The World Trade Organisation has the skills and experience to establish detailed agreements on the development of open markets in low carbon technology and can also oversee the trade implications of a new agreement to reduce emissions which if mishandled could provide the excuse for a new wave of protectionism. An international organisation could manage any agreement to limit deforestation. In addition it would be possible to create new capabilities within the International Financial Institutions to support the twin processes of adaptation and mitigation and establishing the funding structures necessary to support technology transfer and other essential elements of the steps described above.

The World Bank has played a strong role in promoting carbon markets. Along with regional development banks, it can be at the forefront of financing and fostering investments in clean infrastructure and in developing approaches to, and in providing funding for, reduced deforestation. These development banks can play a powerful role in promoting adaptation, including by developing new carbon financing windows. The UNDP and UNEP can help build capacity and promote understanding.

Beyond this group of inter-governmental institutions there exists a mosaic of non-governmental groupings ranging from scientific academies, to the trading markets whose experience can help establish a cost-effective mechanism for achieving reductions at the lowest practical cost, to the network of cities which is focused on the local impact of climate change and to the business community which will in practice be the vehicle for delivery of any global objectives which are set.

Overall, some elements of this network may evolve over time into a single International Climate Change Organisation comparable in terms of impact and authority with the IMF, the WTO and the World Bank. That is for the future; in the meantime institutional construction should not, and need not, delay the implementation of the policies set out here.

8.4 Further work

This analysis has identified one or two key areas from each chapter where more detailed further work is necessary to take this programme forward:

- **Targets.** Further work includes: examining the details of the interim period between now and 2020, in particular with respect to the evolutionary pathway to full trading; detailing how to allocate responsibilities on emissions between producers and consumers, as this is an important element of the equity story. This work should cover a consistent approach to country-by-country emissions trajectories in a way that could inform national decarbonisation and energy efficiency strategies.

- **The role of developing countries in mitigation and trade.** Further work includes: detailed conceptual, operational and regulatory work is needed on benchmarks and sector programmes to make wholesale trading effective and workable in practice. This should take into account important differences between industries in terms of structure, competitive conduct and economic performance.

- **International emissions trading- cap-and-trade.** Further work would be useful to better understand how to link existing trading schemes and the role of enabling environments in attracting investment and the data and institutional requirements to allow developing countries to fully benefit from a carbon market. Modelling of trading schemes is also crucial. Further work is also required to establish forward carbon prices up to and beyond 2020, for example, by use of long dated permits, put options and other long dated instruments that require financial market buy-in and credible long-term institutions.

- **Deforestation.** Further research is required in the following areas: mitigation costs of using forests to tackle climate change; technology and institutional arrangements required to audit and verify afforestation/reforestation efforts and reductions in deforestation and degradation

more effectively; multilateral funding and carbon trading mechanisms to leverage funds at national level, addressing the challenges of leakage, 'additionality', permanence, and perverse incentives.

- **Technology.** Further work is needed in designing the national and international institutional arrangements to support the necessary large-scale increases in technology research and investment; developing a more detailed understanding of requirements for successful technology diffusion and adoption in developing countries.

- **Adaptation.** Further work is needed to predict, quantify and prioritise the impacts and costs of climate change at a local level.

Across the board, we need to build the capacity to accelerate learning and transfer of best practice in terms of policy design. Each country will appropriately develop national policies to achieve decarbonisation targets within the context of wider social and economic goals. This variation in policy response creates enormous potential for international learning. It is therefore critical that policies on e.g. energy efficiency, power sector regulation, biofuels and land-use, becomes the basis for an efficiently implemented global response to the challenge of climate change.

8.4 Conclusions

Climate change is a present reality and a major risk for future generations and yet emissions continue to rise. The reach and complexity of climate change is unparalleled: it has the potential to affect billions of people and is subject to major risks and irreversibilities. The fundamental message of this paper is that urgent action is both necessary and possible. The risks associated with GHG concentrations are clear, even if the job of persuading public opinion still has further to go. It is equally clear that pragmatic steps are available across a range of policies which can make a material difference. The technologies and the policy mechanisms required are known and within reach at a manageable cost. By contrast delay is both risky and expensive, helping lock the world into higher concentrations of GHGs and high-emissions technological infrastructure.

All countries need to plan credible emissions reduction policies now, in order to avoid substantial risks to future generations. Global emissions must peak soon and then approximately halve by mid-century. This means that emissions per capita must average 2T by then. Current emissions per capita average 7T and are rising rapidly. With the bulk of the world's population (eight out of nine billion projected by 2050) in developing countries, this means that all countries in the world need to be close to 2T per capita average if the global target is to be reached. The basic arithmetic and timelines are clear. The challenge now is how such reductions should be delivered.

The overall global policy framework should be designed to satisfy the following three key principles. It must be: **effective** - the frameworks must involve action that can affordably keep risks from climate change at acceptable levels; **efficient** - mitigation should be undertaken where it is cheapest, with carbon pricing and markets playing a central role in determining type and origin of mitigation; **equitable** - commitments must be perceived as equitable which requires rich countries taking a lead - this is a shared problem with differential responsibilities. The

countries where emissions have been lowest are often those most vulnerable to climate change and this requires early support for adaptation. Badly implemented or delayed policies could massively inflate the cost of action by overlooking cost-effective emissions reductions and creating additional market distortions and perverse incentives.

The challenge is far-reaching, comprehensive and global, but it is manageable. The technological transformations and flows of funds required across countries and sectors will be large, the institutional and implementation challenges significant, but the costs of action are affordable and entirely consistent with sustainable growth and development. By contrast, the alternative of inaction or delay is not. The time to act is now.

APPENDIX

The appendix provides briefly some background on two issues: risks and targets; discounting. The reason is that those who would deny the argument for strong action on climate change usually use some combination of three arguments (i) asserting that the risks are small (essentially denying the science) (ii) arguing that in any case emissions reductions cost too much and the world will be good at adapting to whatever comes its way (iii) the effects are in the far future which has little social priority. All of these positions are misguided as was explained in the Stern Review.

The Stern Review also argued that the riskiness and lack of certainty points to strong action. If the scientists are collectively deluded and we choose to act then at fairly modest cost we will find a number of outputs which are valuable irrespective of climate change, including greater energy efficiency, stronger biodiversity, and cleaner production methods. If the scientists are right and we refuse to act, however, then it will be much more costly to act at a later date as future emissions will have built stocks to high levels and extraction of greenhouse gases is extremely difficult. From this basic perspective of risks and potential irreversibilities, common sense points to strong action, particularly given the huge majority of scientific opinion on this subject.

Risks and Targets

This paper has been focused on the key elements of a global deal designed to achieve a major reduction in the severe risks that would arise from business as usual. It points to a desirable target in the range 450 – 550ppm CO_2e and bases its strategies and cost calculations on a target of 500ppm CO_2e. The Stern Review indicated a target in the range 450 – 550 and based its strategies and cost calculations on a target of getting below 550ppm. The reasons that we have chosen to focus on 500ppm rather than 550ppm is that subsequent evidence has indicated that the position is more risky than assumed in the Stern Review. There are 4 basic reasons.

1. Emissions are growing faster that the IPCC trajectory used in the Stern Review. The evidence for this is summarized in the Interim Report of the Garnaut Review (2008).

2. The absorptive capacity of the planet, including of the oceans, appears to be lower than many earlier models had assumed (see IPCC(2007)).

3. The weights in the upper tail of climate sensitivity (the effect on eventual temperature increases on increases in the stocks of greenhouse gases) seem higher than anticipated (Stern (2008)).

4. The physical effect of global warming from a given temperature change, via climate change and directly from the warming, appear to be happening faster than had been anticipated (IPCC(2007)).

Further work on the costs of strong action to keep down emissions, on the other hand, indicate costs which appear to be no higher than calculated in the Stern Review – see McKinsey. Edenhofer, IEA, IPCC, Stern(2008). Nevertheless the costs

of stabilizing at 450 ppm may be substantially in excess of 2% of GDP p.a. (or average each year over the next several decades – see Stern Review, Chapter 13).

Discounting

Some have argued that the very high damage levels associated with inaction which were suggested in the Stern Review were as a result of "discount rates" that were too low in relation to interest rates or rates of return available in the market. Most of such arguments have been badly muddled for some (or sometimes all) of the following reasons. A more detailed discussion is provided in Stern (2008). The mistakes made are described in logical sequence.

1. The future growth paths depend on our choices about policy on climate change (they are "endogenous"). And the variations around average growth paths can be very large. Thus discount rates (the rate of fall of the relative value of a unit of account now (at time zero) and in the future (time t)) depend on the path around which comparisons of benefits and costs occur and on the probabilistic outcome. In this sense they refer to marginal changes. The choices here are between very different paths involving very big changes in patterns of growth. For example, discount rates could be negative for a path where consumption was dramatically reduced (a real possibility from inaction on climate change).

2. There are no relevant markets embodying the relevant choices made by a generation (rather than only individual agents), acting together, for allocating resources over many decades and over centuries. Capital markers covering more than 50 years hardly exist or are very thin.

3. If we look at real rates of returns on money markets over very long time periods (e.g. 50 years or more) we find that for moderately risk-free assets (indexed government bonds) per annum rates of returns are around 1.5 %, quite close to some of the discount rates associated with some of the growth paths in the base case of the Stern Review. For equities the rates are nearer 5 or 6 % but these take no account of externalities and are risky, thus do not represent a benchmark for social risk-free rate of return.

4. The issue at hand involves many goods, in particular standard consumption goods and environmental services, and the relative prices can change dramatically. In particular if we postponed action, invested elsewhere in market instruments, and tried to 'buy down' environmental damage later, the price of such environmental corrective action may have risen dramatically. Another way of saying this is that if environment is badly damaged or our tastes and preferences value the environment more highly relative to consumption goods then the discount rate for doing our accounting in terms of environmental goods is negative.

5. Some writers have even confused a pure time discount rate and a discount rate. The former involves discounting simply because events are in the future, whereas the latter can arise for many reasons, including that future generations may be richer. A pure time discount rate of 2% would imply that someone born in 1970 has twice the social value of someone born in 2005 (assuming they have an identical consumption profile). Many would find that a strange ethical position (although others may not).

These five arguments are relevant to the narrow approach to climate change based on a calculus of perceived costs and benefits to current and future generations. Some other important ethical approaches, including those referring to rights and sustainability go much beyond this calculus.

For all these reasons the arguments in much of popular discussion and, indeed, in much of the professional literature on discounting have often been very confused. Nevertheless, as both the Stern Review and Stern (2008) demonstrate, even if one goes for parameter values implying less weight on richer generations than associated with the base case of the Stern Review, then the costs of no or delayed action can be much higher than those of timely action, particularly when the greater risks which we now see are taken into account. For further technical discussion, in a paper addressed to an academic audience, see Stern (2008).

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