Deciding our future in Copenhagen: will the world rise to the challenge of climate change?

Nicholas Stern

Policy brief
December 2009

Grantham Research Institute on
Climate Change and
the Environment

Centre for
Climate Change
Economics and Policy

The Grantham Foundation for the Protection of the Environment

E·S·R·C Economic & Social Research Council

LSE The London School of Economics and Political Science

University of Leeds

Grantham Research Institute on
Climate Change and
the Environment

The Grantham Research Institute on Climate Change and the Environment was established in 2008 at the London School of Economics and Political Science. The Institute brings together international expertise on economics, as well as finance, geography, the environment, international development and political economy to establish a world-leading centre for policy-relevant research, teaching and training in climate change and the environment. It is funded by the Grantham Foundation for the Protection of the Environment, which also funds the Grantham Institute for Climate Change at Imperial College London. More information about the Grantham Research Institute can be found at: **http://www.lse.ac.uk/grantham**

**Centre for
Climate Change
Economics and Policy**

The Centre for Climate Change Economics and Policy was established in 2008 to advance public and private action on climate change through rigorous, innovative research. The Centre is hosted jointly by the University of Leeds and the London School of Economics and Policy. It is funded by the UK Economic and Social Research Council and Munich Re. More information about the Centre can be found at: **http://www.cccep.ac.uk**

Deciding our future in Copenhagen: will the world rise to the challenge of climate change?

Nicholas Stern[1]

[1] Nicholas Stern is I.G. Patel Professor of Economics and Government, Chair of the Grantham Research Institute on Climate Change and the Environment, Chair of the Centre for Climate Change Economics and Policy, and Director of the India Observatory, at London School of Economics and Political Science. He wishes to express his gratitude to Melinda Bohannon, Alex Bowen, Su-Lin Garbett-Shiels, Nicola Ranger, James Rydge, Chris Taylor and Bob Ward for their guidance and support.

Executive summary

The United Nations Climate Change Conference in Copenhagen begins on 7 December and we can see the outline of a global agreement emerging. However, the crucial specifics of that agreement, including emissions reduction targets for the major emitters and finance for mitigation and adaptation in developing countries, are not yet settled and will require strong political commitment to conclude. The world faces a stark choice. Do we collaborate and agree a strong framework agreement that decisively cuts the devastating risks posed by climate change and rapidly opens up the opportunities offered by low-carbon economic growth to overcome poverty and promote prosperity? Or, do we give way to division, lack of ambition and delay, allowing the risks to the climate to grow to dangerous levels?

Given what is at stake, essentially the future peace and prosperity of the planet, world leaders must now recognise that Copenhagen is the most important international gathering of our time. A strong framework agreement with the necessary political commitment at the highest level of government can and must be reached in Copenhagen. There can be no excuses for failure.

There is both a fierce urgency for leadership, and a big opportunity for both poor and rich countries. The developed world must face up to its responsibilities on both development and climate change. Action on the necessary scale will require radical change, and significant finance and investment. If we choose to, wisely and decisively, we can not only manage the profound risks of climate change, we can also find a much more attractive and stronger form of growth: a growth that can last and that helps us overcome world poverty. Indeed we must approach this discussion by recognising that the two defining challenges of our century are managing climate change and overcoming poverty. And if we fail on one we will fail on the other. I believe that the developing world, if the rich world plays its part, will accelerate its actions and we can together create an international collaboration which can transform the way the world works together.

Three issues are the key to agreeing an effective and equitable framework in Copenhagen.

First, we must recognise what we have to achieve in terms of global emissions of greenhouse gases. In order to have a reasonable, around 50 per cent, chance of avoiding an increase in global average temperature that exceeds 2°C above pre-industrial levels, we must reduce annual worldwide emissions from the present level of just under 50 billion tonnes of carbon-dioxide-equivalent to well below 20 billion tonnes by 2050 (or as sometimes expressed, at least 50 per cent below 1990 levels). There are a number of possible emissions paths which could meet this target and control total cumulative emissions over the period to the level necessary, but all of them require us to reduce global annual emissions to well below 35 billion tonnes by the mid-point of 2030 and much less than 20 billion tonnes by 2050. These are the key figures that must guide any agreement on national targets for emissions reductions. By focusing on these totals for global annual emissions, and not percentages relative to earlier levels, we can concentrate on where the science takes us, on the overall path of annual emissions over the next few decades. In other words, we must focus on whether the planned national emissions targets are consistent with the constraints of the global emissions totals implied by responsible action on the climate, and whether the total emissions planned by each country, when 'added up', meet these constraints.

If we are to have a path which meets these constraints, has cumulative emissions consistent with 2°C, and does not imply implausibly large or rapid cuts before or after 2020, then global annual emissions should be around 44 billion tonnes by 2020.

Second, the need for national targets both to add up and to be equitable means that rich countries, including the European Union, Japan and the United States, should achieve emissions reductions of at least 80 per cent by 2050 compared with 1990. Developing countries, including China and India, also need to limit the growth of, and start to decrease, their emissions, but in ways that are consistent with their ambitions for continued economic growth and the reduction of poverty. By 2050 the world average of per capita emissions must be around 2 tonnes of carbon-dioxide-equivalent, compared with around 7 tonnes per capita now (and the USA is over 20, Europe around 10 and China around 6).

Third, given the relative wealth of rich and poor countries, the rich countries' responsibility for the bulk of past emissions, and the urgent need for action, developing countries must receive reliable and substantial support from the rich nations for their climate action plans. This is necessary both for these plans to deliver emissions reductions on the scale required, and to overcome the additional challenges that climate change will pose for their efforts to tackle poverty. Developed countries should show the extent of their commitment by providing US$50 billion per year by 2015, rising to US$100 billion in 2020, and progressing to around US$200 billion during the 2020s as effective low-carbon and adaptation programmes are developed and implemented. Whilst these sums are substantially smaller than the overall investments that are necessary, as developing countries would also be making substantial investments, they are crucial and help to realise great benefits to the entire world. Crucially, financial support should be additional, beyond existing official development assistance. While these might sound like large sums, US$50 billion is around 0.1 per cent of the likely gross domestic product of the rich countries in 2015, and is very small compared with the likely costs we will face if we do not secure a strong international agreement to tackle climate change. The immediate priorities for spending should be halting deforestation, supporting adaptation in African and other vulnerable nations, and supporting technological change throughout the developing world.

We have seen major advances and a gathering momentum over the past few weeks and months. At Copenhagen, we are now seeking an organisational framework with strong political commitment rather than a formal treaty. A formal treaty can follow in 2010 if the political framework is clear. But without such a framework, settled at the highest level, progress on a treaty or similar agreement will be impossible. Now is the time for heads of government to take charge – only they can forge such an agreement.

Country after country have been raising their ambitions for controlling emissions. Assembling these ambitions, it is now clear that if countries move together and find extra margins of action, we can reduce global annual emissions to 44 billion tonnes of carbon-dioxide-equivalent by 2020, and set the world on a responsible path. If current ambitions for emissions reductions across the world are settled, financed and delivered, we may be only a few billion tonnes short of where we need to be. But enhancing finance and delivery are major tasks, and finance, in particular, remains contentious.

We can now see that it is possible to achieve an agreement that is effective, efficient and equitable. It will allow us to avoid the biggest risks of climate change, to overcome poverty worldwide, and to usher in an exciting new era of prosperity based on sustainable low-carbon growth. Through innovation and investment in new greener and more energy efficient technologies in the next two or three decades, the transition to the low-carbon economy can be the most dynamic period of growth in economic history. And the low-carbon world we can create will also be quieter, cleaner, more energy-secure and more biologically diverse. Let us not allow mistrust, pessimism and lack of ambition to take us stumbling into profound dangers. Instead let us have real vision and leadership in both developing and developed countries which seize the opportunities offered by Copenhagen, for us, our children and future generations.

1. Introduction: managing climate change and overcoming poverty

The two defining challenges of the 21st century are overcoming poverty and avoiding dangerous climate change. If we fail on one, we fail on the other. Unmanaged climate change will irretrievably damage prospects for development during the course of the century, and action on climate change which hinders development over the next two decades can never build the global coalition on which action on climate change depends.

Annual global emissions of greenhouse gases are likely to be about 47 billion tonnes of carbon-dioxide-equivalent next year. These emissions will add to the concentration in the atmosphere, which is about 435 parts per million of carbon-dioxide-equivalent. The concentration is rising by about 2.5 parts per million each year, and is currently more than a third higher than it was before industrialisation in the 19th century. If we carry on with 'business as usual' emissions, the atmospheric concentration could reach 750 parts per million of carbon-dioxide-equivalent by the end of the century, almost three times the pre-industrial level.

Basic physics tells us that increasing the concentration of greenhouse gases in the atmosphere causes the Earth to warm. If the atmospheric concentration were to reach 750 parts per million, there would be a significant probability that global average temperature will rise 5°C or more above pre-industrial levels. It is more than 30 million years since the global temperature was that high. A rise of 5°C or more would transform the climate across the planet: coastlines would be re-drawn by rising sea levels; the paths and flows of rivers would be subject to major change; and some areas would become deserts while others would be inundated. The human species has only been around for 200,000 years at most and has no experience of trying to survive under such conditions. We know that a global average temperature that was 5°C lower than today (which occurred around 20,000 years ago during the last Ice Age) dramatically altered where species, including humans, could live. It is difficult to contemplate how much lives and livelihoods, in both the developed and developing world, would be disrupted by such profound and fundamental changes, but it is highly likely that there would be massive movements of people, probably hundreds of millions, with the risk of conflict that would be severe, prolonged and global.

We know only too well the impact of poverty around the world. But what may be less well-known are the risks to which poor people will be most exposed and vulnerable from increases in global average temperature of much less than 5°C. In a world ravaged by climate change, the struggle against poverty would become still more difficult for hundreds of millions, probably billions, of people. This would make the fundamental challenge of advancing along the dimensions of the Millennium Development Goals (MDGs), such as reducing child mortality and eradicating extreme poverty and hunger, even harder. It is likely that progress would be stopped and reversed.

This is the future we risk creating for ourselves, our children and future generations if we do not tackle greenhouse gas emissions. We must never, in our examination of the details and difficulties of action, forget the magnitude and nature of the stakes. The potential costs of inaction are immense; far higher than any plausible estimates of the costs of action. Yet trying to deal with climate change by shackling growth and development over the next two or three decades would damage, probably fatally, the cooperation between developed and developing countries that is necessary for effective action on climate change. Thus we must see the problems of climate change and development as inextricably linked.

A core element of the world's response to these two challenges must be a global agreement on climate change at the United Nations conference in Copenhagen in December. In the short time remaining before Copenhagen, governments around the world must come together to agree the key elements of a practical and specific organisational framework with strong political commitment (a political agreement, for brevity). It is clear now that this will not contain all the details of a formal treaty, but it must be clear on the basic targets on emissions reductions and finance for adaptation and mitigation, and on specifics about deforestation and technology. It should prepare the way for a formal treaty next year. The agreement must lay the foundations for a future era of dynamic low-carbon growth that succeeds in both cutting emissions and in sustaining the growth in developing countries which will be crucial to the reduction of poverty. And it must have strong political commitment at the highest levels of government.

Progress over the past two or three months, with greater ambition and specificity of plans from individual countries, has created a strong momentum. And the focus on a clear framework now allows direct involvement of heads of government on the key issues. With such direction, work on detail can be taken to completion; without it, such work will be impossible. A shared and collaborative framework is necessary, which builds on countries' commitments and intentions, to form the basis of an international agreement. This approach allows countries with emerging plans to settle their policies and, where necessary, complete legislation in their parliaments with the confidence that others are moving forward in a cohesive way.

A strong political agreement in Copenhagen must include the following:

- Commitment by all countries to play their part in reducing global emissions of greenhouse gases by more than 50 per cent (compared with 1990 levels) over the next four decades; this is necessary to give ourselves a reasonable chance of avoiding a temperature rise of more than 2°C above pre-industrial levels.
- Clear and binding commitments by rich countries to reduce their emissions domestically and collectively by at least 80 per cent by 2050 relative to 1990 levels, with credible targets for 2020, 2030 and 2040.
- Clear commitments by rich countries to provide US$50 billion per year by 2015 to help developing countries tackle greenhouse gas emissions and to adapt to the impacts of climate change, rising to US$200 billion per year in the 2020s.
- National plans for each developing country, outlining actions for slowing and reversing the growth in their emissions and for adapting to those impacts of climate change that cannot now be avoided.
- An ambitious agreement on boosting research, development, demonstration and deployment of energy efficient and low-carbon technologies, and on the sharing of technologies and know-how.
- An internationally-funded strategy for halting deforestation, which is one of the most effective ways of reducing emissions.
- The restructuring and scaling up of carbon markets, with improved regulation and development of new programmes or sector-based mechanisms to boost cost-effective reductions in emissions.
- A registry, or schedule of actions, to capture domestic commitments, creating transparency and trust, and to help track progress towards global targets.
- An effective system to measure, report and verify emissions from countries on a regular and frequent basis.
- A global fund to assist adaptation, focusing initially on those developing countries and communities that are most exposed and vulnerable to the impacts of climate change.
- A climate finance architecture that builds on existing structures, including bilateral and multilateral flows, established under the guidance of the United Nations Framework Convention on Climate Change (UNFCCC), which facilitates the blending of climate finance and other forms of investment and development finance.

A political agreement founded on these 11 elements will meet the key principles of: effectiveness (leading to emissions cuts on the scale required); efficiency (implemented in a way that keeps down costs); and equity (supporting developing countries that will be hit earliest and hardest by climate change and taking account of differences in wealth, technologies and historical responsibilities). All of these 11 elements are understood and recognised by the countries that have been negotiating ahead of the meeting in Copenhagen.

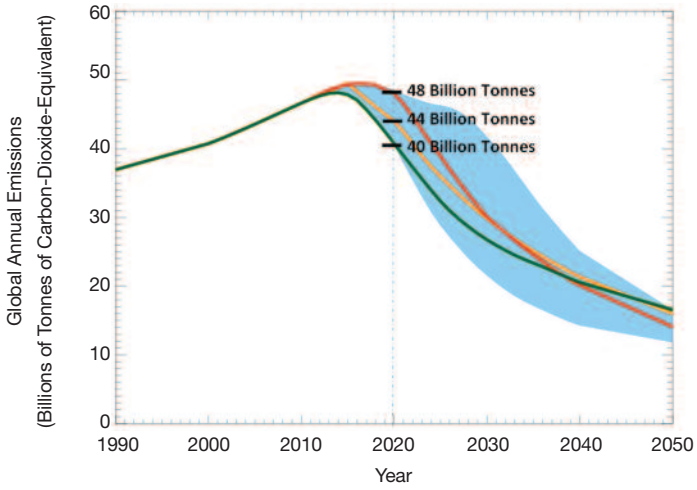
2. Global targets for reducing greenhouse gas emissions

To manage the risks of climate change, the world must act together and commit to, and achieve, targets for emissions reductions. A shared understanding has emerged around the scientific assessment of 'dangerous climate change' i.e. we should try to prevent greenhouse gas concentrations from rising beyond a level that would lead to a 50-50 chance of global average temperatures rising by more than 2°C. To achieve this, atmospheric concentrations should not increase above about 500 parts per million of carbon-dioxide-equivalent and should eventually be stabilised well below 450 parts per million.

All credible paths for global annual emissions meeting this criterion need to peak within the next 10 years and reduce by 2050 to less than half their levels in 1990 i.e. to much less than 20 billion tonnes of carbon-dioxide-equivalent. Comparison of the paths clearly demonstrates that slower action now would have to be compensated for by stronger action in future years, in order to reach the desired target: essentially we have to place strong limits on cumulative emissions.

Research by my colleagues Alex Bowen and Nicola Ranger at the Grantham Research Institute on Climate Change and the Environment, with help from the Hadley Centre at the UK Meteorological Office, shows that there is a range of possible emissions paths that, from the perspective of the climate science, give a 50 per cent chance of limiting a temperature rise to no more than 2°C: all of the paths would require us to halt the growth in emissions within the next 10 years. Figure 1 illustrates three emissions paths consistent with the 2°C goal: the path that starts to reduce annual global emissions most rapidly reaches 40 billion tonnes of carbon-dioxide-equivalent in 2020, and the slowest passes through 48 billion tonnes.

Figure 1: Paths for global annual emissions that lead to a reasonable chance of a temperature rise of no more than 2°C



The findings of a simulation of plausible emissions paths that lead to a probability of 50 per cent of limiting global warming to no more than 2°C above pre-industrial levels (Bowen and Ranger, 2009)[2]. The blue shaded region shows the envelope containing simulated emissions paths consistent with this goal, based on a low aerosol emissions scenario. Paths towards the upper end of this envelope in 2020 continue towards the lower end of this envelope in 2050 (and vice versa). The green, orange and red lines represent three plausible emissions paths passing through 40, 44 and 48 billion tonnes of carbon-dioxide-equivalent in 2020, respectively. Each path leads to a median estimate of warming of 2.0°C above pre-industrial levels under a low aerosol emissions scenario (and 1.9°C under a high aerosol scenario).

[2] 'Mitigating climate change through reductions in greenhouse gas emissions: the science and economics of future paths for global annual emissions'. These results are based on the Hadley Centre climate model MAGICC. There are some key uncertainties. The majority of this uncertainty is in the response of the Earth's system to human emissions of greenhouse gases and is due to carbon-cycle feedback, with a smaller contribution from climate sensitivity. This uncertainty, of at least +5 to -10 billion tonnes (skewed towards the negative end), provides the basis for adopting early targets for big emissions reductions to maintain the option of moving to a more ambitious path if new evidence indicates the need for stronger action. For 2050, an uncertainty of about ±4 billion tonnes of carbon-dioxide-equivalent is estimated for each emissions path due to, in particular, the uncertainties relating to aerosol emissions and abatement options for different gases.

If we only cut emissions to 48 billion tonnes by 2020, we will have to reduce global emissions steeply at around 4 per cent per year afterwards, and by much more than 50 per cent by 2050. Such a rapid fall in emissions each year after 2020 would be considerably more expensive than stronger earlier action. It would also give us less room for manoeuvre if evidence emerges that implies larger emission reductions are required (e.g. because models suggest that a rise of 2°C would be too dangerous or that such a rise, for any given policy, is more likely).

Given the current rate of increase in global annual emissions and the limited extent to which most individual countries have implemented strong domestic policies, it seems unlikely that we would be able to reach 40 billion tonnes of carbon-dioxide-equivalent by 2020, even though this would likely make subsequent reductions more manageable.

Therefore, we should be aiming to reduce global annual emissions to no more than 44 billion tonnes of carbon-dioxide equivalent by 2020. We may take this as a 'climate responsible' level which it would be risky to exceed. If we reach 44 billion tonnes in 2020, we will need to steadily reduce emissions to much lower than 35 billion tonnes in 2030 and less than 20 billion tonnes in 2050[3] to have a reasonable, 50 per cent, chance of limiting the rise in global average temperature to no more than 2°C. This path implies that the atmospheric concentration would peak at no higher than about 500 parts per million of carbon-dioxide-equivalent and would then decrease to below 450 parts per million.

If these emissions targets are to be met without affecting ambitions for growth, particularly in developing countries, then the emissions intensity of output (emissions divided by an output measure such as GDP) will need to change drastically over the next decades. For example, if China and India were to double their emissions over each of the next two decades (consistent with a 7 per cent growth rate in GDP and thus a doubling of output each decade), their annual emissions would reach around 15 billion tonnes and 4 billion tonnes, respectively, in 2020, and then around 30 billion tonnes and 8 billion tonnes, respectively, in 2030 – this is clearly not consistent with the need for total world emissions to be below 44 billion tonnes in 2020 and well below 35 billion tonnes in 2030. A solution must be found in which the rich countries lead in reducing their emissions per unit of output, but which also enables the fast-growing developing countries to achieve growth whilst cutting their emissions. But achieving these goals could unleash a new era of dynamic growth and prosperity and lay the foundations for a more sustainable future.

[3] This assumes that net emissions cannot fall to zero beyond 2050.

3. How close are we to achieving the 'climate responsible' target in 2020?

Tables 1 and 2 outline the commitments, targets, proposals and intentions of the major emitters. They do not cover the plans for other countries, although many of them are ambitious relative to their size, such as Norway's commitment to reduce emissions by 40 per cent by 2020 compared with 1990 levels, and the pledge by the Maldives to be 'carbon neutral' by 2019. I have attempted to make these assessments up-to-date as of the end of November 2009; they are subject to subsequent revision.

Table 1: Commitments, targets, proposals and intentions of UNFCCC Annex I (developed) countries for 2020

Country	Description	Summary
USA	Recent announcement that USA is prepared to table an emissions reduction of 17% below 2005 levels (4% below 1990 levels) and additional provisions to buy up to 0.7 billion tonnes of forestry credits and around US$3 billion for technology and adaptation. Longer-term goals set out a path to a reduction of 83% below 2005 levels (80% reduction below 1990 levels) in 2050. Currently 15% above 1990 levels.	4% below 1990 levels. Plus support for reducing deforestation?
EU	Committed to reducing emissions to 20% below 1990 levels (currently 12.5% below) and 30% below 1990 levels as part of an ambitious global agreement. Indicated willingness to pay its share of significant finance flows from developed to developing countries, including public finance that could support additional mitigation (including REDD).	20-30% below 1990 levels. Public finance for additional mitigation.
Japan	Committed to reducing emissions by 25% below 1990 levels as part of an effective and comprehensive agreement at COP15.	25% below 1990 levels.
Russian Federation	Committed to reducing emissions by up to 25% below 1990 levels. Emissions in 2007 were 36% below 1990 levels.	25% below 1990 levels.
Canada	Committed to reducing emissions to 20% below 2006 levels (equivalent to 3% below 1990 levels).	3% below 1990 levels.
Australia	Proposed to decrease emissions to 5-25% below 2000 levels (11-33% below 1990 levels). Adoption of the most ambitious target of a 25% reduction depends on five conditions being met[4]. If all the conditions are not met, but there is an international agreement with all major emitters, the target would be 15% below 2000 levels.	11-33% below 1990 levels.

[4] http://unfccc.int/files/kyoto_protocol/application/pdf/australia010609.pdf. Reductions compared with 1990 levels based on recently revised UNFCCC data.

Table 2: Commitments, targets, proposals and intentions of UNFCCC non-Annex I (developing) countries for 2020

Country	Description	Summary
China	Existing policies, such as the energy intensity target in the current Five Year Plan and 2020 targets for renewable and nuclear, would reduce emissions by about 10% below 'business as usual' (BAU) in 2020. Recent announcement that China will reduce emissions intensity of output by 40-45% below 2005 levels by 2020.	Domestic policies lead to reduction of 10% below BAU in 2020.
India	Plans and policies outlined in National Plan and in the 11th Five Year Plan. Many are not quantified but domestic policy initiatives with policy targets collectively amount to a deviation from BAU of at least 7%.	Policies lead to reduction of at least 7% below BAU in 2020.
Brazil	Announced target to reduce its emissions to 36% to 39% below 2020 levels (roughly 1/3 below 1990 levels), conditional on external financing. Level of finance requirements not yet clear so it is not certain what is Brazil's own action and what requires support. Previously announced a National Action Plan that would reduce emissions to reduce by about 25% below BAU.	36% to 39% below BAU in 2020, with external financial support.
Indonesia	Pledged to reduce emissions by 26% below BAU unilaterally and 41% below with international support (around 1/6 to 1/3 below 1990 levels). The 26% target is to be achieved through reduced emissions from deforestation and land use change.	26% below BAU in 2020 unilaterally, 41% below BAU conditionally
South Korea	Unilateral pledge to reduce emissions by 30% below their defined BAU (around 4% below 2005 levels).	30% below BAU in 2020.
South Africa	Existing domestic policies expected to reduce emissions by about 10% below BAU. Government intention to follow a peak and decline scenario which allows for the initial build-up of base-load capacity; would equate to around 20% below BAU levels.	10% below BAU in 2020.
Mexico	National plan (PECC) sets out detailed policies up to 2012 that are being enacted which are likely to reduce emissions by around 5% below BAU in 2020. Overall strategy to reduce emissions by 50% by 2050 implies emissions being around 20% below BAU in 2020.	5% below BAU in 2020, but longer term goals imply greater ambition.

Some of the intentions have not yet been legislated as national commitments or action plans, and others are reliant on particular conditions being met. This is particularly the case for the intentions of developing countries, such as Indonesia and Brazil, where delivery of the high-ambition targets is dependent on international support. As these countries have increased their scale of ambition, they are understandably looking again at what international support would be required. This highlights the importance of developed countries providing proportionate financial support in order to help translate this into delivery.

These tables show that all the major emitters have set out their willingness to take significant action to reduce their emissions compared with 'business as usual' (BAU), while their plans reflect a diverse range of national circumstances.

What do these commitments add up to and how far away would the world be from achieving the emissions target of 44 billion tonnes in 2020? Tables 3 and 4 quantify some of the existing mitigation intentions, conditional offers, plans and commitments by developed countries[5]. Table 4 lists estimates of the implicit emissions reductions by developing countries from existing policies compared with BAU. As a first step, these tables consider the domestic policy commitments of only India and China, and assume other developing countries follow a BAU trajectory.

Putting the totals in Table 3 and 4 together, these intentions and policies collectively would result in global annual emissions of about 48.5-49.1 billion tonnes of carbon-dioxide-equivalent in 2020, depending on whether high or low intentions are considered. This already represents a saving of 5 to 11 billion tonnes, depending on what assumptions are made about BAU, so in this sense the world already 'intends' to achieve more than half of the reductions that are required. The 'low intentions' in the tables would result in a gap of 4.5-5.1 billion tonnes of carbon-dioxide-equivalent compared with a 'climate responsible' level of annual emissions of 44 billion tonnes in 2020. Incorporating anthropogenic peat emissions would increase the gap to 6.0-6.6 billion tonnes, if it is assumed that they will stay at current levels up to 2020.

Offsets by developed countries would shift the balance of actual emissions and would imply finance flows to developing countries. We must be transparent about 'adding up' and avoid double counting; we should be estimating actual emissions country-by-country.

Table 3: Current intentions by developed countries for 2020 (billions of tonnes of carbon-dioxide-equivalent)

Country	Low intentions	2020 emissions (billions of tonnes)	High intentions	2020 emissions (billions of tonnes)
USA	17% below 2005	5.9	17% below 2005	5.9
EU	20% below 1990	4.5	30% below 1990	3.9
Japan	25% below 1990	1.0	25% below 1990	1.0
Other developed countries		5.1		5.0
Total		**16.3**		**15.7**

Note: reflects announced plans at the time of writing (end of November 2009).

[5] As these 'plans' etc can take a variety of forms, they will be referred to as intentions henceforth, but this also includes commitments, pledges, conditional offers and other forms of plans.

Table 4: Policies and expected emission reductions by developing countries and from international aviation and shipping (billions of tonnes of carbon-dioxide-equivalent)[6]

Country	Current policies	Emissions savings in 2020 (billions of tonnes)	2020 emissions (billions of tonnes)
China	Energy intensity target: increase by 20% by 2010	0.5	
	Renewable energy target: 15% by 2020	0.5	
	Nuclear energy target: 75 GW by 2020	0.3	
	Total		11.2
India	Solar mission: 20 GW by 2020	0.03	
	Renewable electricity target: 15% by 2020	0.07	
	Forest cover target: increase by 6 million hectares by 2017	0.07	
	Total		3.6
Other developing countries			16.8
International aviation and shipping			1.2
Total: developing countries and interntional aviation and shipping			**32.8**

Note: estimates here assume BAU emissions for other developing countries. See text for discussion of qualifications relating to measures set out in Table 4.

It should be emphasised that the estimates of emissions in Table 4 do not include recent proposals of action by developing countries such as Indonesia, Brazil and South Korea (see Table 2). The impacts of these intentions, if they are supported (in the case of, for example, Indonesia and Brazil, remembering that counting offset finance as 'support' requires an assumption that these countries do more than outlined here), could provide additional mitigation of around 2.5 billion tonnes. This would reduce the estimated total of annual global emissions in 2020 to 46 or 47 billion tonnes, just 2 or 3 billion tonnes short of the target of 44 billion tonnes.

If emissions targets are to be met without affecting ambitions for growth in developing countries, emissions intensity will need to change drastically over the next few decades. In other words, we have to break the link between growth in output and growth in emissions.

[6] Estimates in this table are sensitive to uncertainties over assumptions about BAU. Assumptions about developing countries' emissions from forestry and energy are subject to a high degree of uncertainty. Changes in assumptions about levels of these emissions will affect estimates of the volume of emissions reductions that would need to be delivered. Anthropogenic emissions from peat are excluded – incorporating these would add about 1.5 billion tonnes globally. This would provide an additional argument to go further in mitigation action, including specific action to reduce emissions from peat. Recent downward revisions in estimates of emissions from deforestation may counterbalance possible peat emissions to some extent. There should also be increased efforts to clarify current, and hence likely future, emissions to reduce this uncertainty.

A possible scenario, which would allow growth in all countries to be combined with climate responsibility, would be for India to cut its emissions per unit of output by a factor of two by 2030, and China, the USA, EU/Japan and Indonesia/ Brazil[7] to reduce their emissions per unit of output by a factor of 4.[8] This would mean annual emissions in 2030 would reach about 7 billion tonnes in China, about 4 billion tonnes in India, about 3 billion tonnes in the USA, about 3 billion tonnes in the EU/Japan together, and about 4 billion tonnes in Indonesia/Brazil together (with growth rates of 2.5 per cent per year in the rich countries and 5 per cent per year in Indonesia/Brazil). This would still mean that this group of countries, with around half the world's population in 2030, would, at a total of 21 billion tonnes, be responsible for around two-thirds of the 'available' emissions of much less than 35 billion tonnes. This scenario would require all major emitters to act immediately to reduce emissions per unit of output, underpinned by rapid technological progress.

A reduction in emissions per unit of output by the USA and China by a factor of 4 by 2030, compared with levels in 2010, would be equivalent to a 50 per cent improvement each decade. For the USA this would be equivalent to reducing emissions by about a third below 2005 levels[9] by 2020, and would deliver an additional mitigation cut (beyond a reduction of 17 per cent below 2005 levels) of 1.4 billion tonnes. Less in the first decade would require more in the second. China already has an ambitious commitment to reduce its energy intensity by 20 per cent, as part of the current Five Year Plan, and targets for renewable and nuclear energy for 2020. Further targets in subsequent Five Year Plans up to 2020, in the form of reduced emissions intensity (as anticipated by President Hu in his speech to the United Nations on 22 September 2009), could deliver significant additional mitigation. Emissions intensity is already falling as part of the industrial development of China, and in response to existing policies. Assuming continued strong economic growth of 7 per cent per year, an emissions intensity improvement of 40 per cent would result in emissions being constrained to 20 per cent above 2010 levels, representing a saving of 0.4 billion tonnes beyond existing policies. A target of 50 per cent would result in emissions being constrained to 2010 levels, equivalent to an emissions saving of 2.2 billion tonnes beyond existing policies.

This shows that if the USA and China could commit to further improvements in their emissions intensity, against a back drop of strong economic growth, then the remaining gap of 2 or 3 billion tonnes, to reach the target of 44 billion tonnes in 2020, can be filled. The most recent announcement by the USA (emissions reduced by 17 per cent below 2005 levels by 2020) is equivalent to a reduction in emissions intensity of 45 per cent between 2005 and 2020[10], while China has proposed a 40-45 per cent reduction in intensity between 2005 and 2020[11]. Consistency with meeting strong long-term global climate goals would seem to require greater ambition, with reductions in emissions intensity of closer to 50 per cent over a decade, rather than 40-45 per cent over 15 years. And similarly for further initiatives from other major groups.

Clearly there are significant challenges involved in delivering such reductions, but none of these are insurmountable and the required reductions could probably be achieved using current technologies and carefully designed policies. Technological progress would open up a further range of options.

This analysis shows that existing commitment by developed and developing countries can take us most of the way to achieving a target for global annual emissions of 44 billion tonnes in 2020, which is consistent with a 2°C emissions path. This shows that agreeing actions that are consistent with a 2°C emissions path is feasible in Copenhagen. If these existing intentions could be settled, financed and delivered, then the remaining gap can be filled through a combination of:

- Developed countries delivering their high intentions or going further than existing commitments.
- Other developing countries, particularly China (given its size), coming forward with further domestic intentions as part of a global deal, and indicating what they could do with international support.
- Developed countries providing finance to support mitigation in developing countries that is not counted as an offset against their mitigation goals (or if counted as an offset, represents part of more ambitious goals).
- Incorporating reductions in international emissions from aviation and shipping[12].

[7] The EU and Japan have been grouped together because they start with similar emissions per capita and have similar emissions per unit of output: they also have similar 2020 targets. A corresponding argument holds for grouping Indonesia and Brazil together in the sense that their shared problems of deforestation make them the world's third and fourth largest emitters.

[8] See Stern, September 2009 'Action and Ambition for a Global Deal on Climate Change', lecture delivered at Columbia University (http://www.lse.ac.uk/grantham/).

[9] It would be 36 per cent assuming 2010 emissions are around 2005 levels (slightly above in 2007 pre-recession) and a growth rate of 2.5 per cent (33 per cent with a growth rate of 3 per cent).

[10] Based on an annual growth rate of 2.5 per cent.

[11] This is roughly consistent but possibly less ambitious than previous policies and modest in relation to historical trends (China's emissions intensity fell by 45-50 per cent between 1990 and 2005).

[12] For example, if we set a target of 20 per cent below 2005 levels for international aviation and shipping emissions , that would lead to around 0.5 billion tonnes of additional mitigation (if any offsets that were purchased were additional to current targets).

4. A Copenhagen agreement for a low-carbon future: how can we, and will we, achieve and finance the necessary reductions in emissions and support adaptation?

I turn now to the core elements of a global agreement that could achieve emissions reductions at the level required. We must ask, in particular, how action on both adaptation and mitigation could and should be financed. And we must ask further what is required in the coming days to achieve such an agreement, and what are the obstacles?

It is clear that the starting point for an enduring global deal must be leadership by the rich countries: they have the wealth, technology and main responsibility, through past emissions, for our difficult starting point. They must demonstrate through their own actions that low-carbon growth is possible whilst strongly supporting mitigation and adaptation in developing countries. There are three main parts to the role that the developed world must play:

(i) Strong performance over the next two decades towards meeting targets for 2020 and 2030 that are tough and fully consistent with a path to reductions in annual global emissions to well below 20 billion tonnes of carbon-dioxide-equivalent by 2050. By putting in place strong policies and measures to achieve emissions cuts, the developed world will drive the level of overall global ambition.

(ii) Clear commitments by rich countries to provide US$50 billion per year by 2015 to help developing countries take action on emissions reductions and adapt to the impacts of climate change. This should rise to US$100 billion per year in 2020 and US$200 billion in the 2020s; adaptation alone is likely to require about US$100 billion per year by then[13]. Analyses by McKinsey & Company, the International Energy Agency and others point to necessary support for mitigation in developing countries upwards of US$100 billion per year by the 2020s[14]. See following discussion about priorities for spending.

(iii) The development and deployment of new technologies for low-carbon economic growth, with developed countries sharing ideas and supporting developing countries to deploy, adapt and develop technologies.

For their part, developing countries, although they have contributed less to the build-up of greenhouse gases in the atmosphere than the richer industrialised countries, should nonetheless establish and implement their own climate change action plans, starting as soon as possible. Whilst they must start now if global goals are to be achieved, it is reasonable that their progress should depend on continuing evidence of strong action by the developed countries on the requirements described in the previous discussion. We cannot avoid the conclusion, however, that the realisation of the necessary global targets, and timely peaking of annual global emissions, will require strong climate change action plans in developing countries now, with support from developed countries. The arithmetic is clear: 8 billion of the 9 billion people likely to be on the planet in 2050 will be in the currently developing world. With a global 'emissions budget' of less than 20 billion tonnes, average annual emissions for the global population of 9 billion would have to be around 2 tonnes per capita. Even if emissions from the 1 billion people in the currently developed world were to be zero, the average for the 8 billion in the developing world would have to be, at most, 2.5 tonnes per capita; and recall that China is already close to 6 tonnes per capita.

The mechanisms for support should be organised around the climate change action plans of poor countries; it is their development, and thus it is for them to formulate their own plans to move towards low-carbon economic growth, consistent with their own endowments, skills and circumstances.

Financial support from developed countries for action by developing countries will be crucial to achieving international agreement. There is very strong, and understandable, feeling about the inequality of both where we are now and how the impacts of climate change are likely to occur; rich countries have been responsible for the bulk of past emissions and poor countries are likely to be hit earliest and hardest. And now poor countries must find a low-carbon route to growth and poverty reduction, whereas rich countries took the high-carbon route. Whether or not these feelings are justifiable, and many would suggest they are, they are a political reality.

[13] See, for example, the analysis of the Human Development Report 2007-08 which indicated adaptation costs in relation to achieving the Millennium Development Goals of around US$85 billion per year by 2015.

[14] See also Stern 2009, 'Blueprint for a Safer Planet' (published by Bodley Head in the UK) or 'The Global Deal' (published by Public Affairs in the USA) for further discussion of these figures.

The support could be provided, in part, around specific global programmes on, for example, deforestation or technology. A major part is likely to be sought through direct support by developed countries for the action plans of developing countries. In either case, the support should be beyond existing commitments on official development assistance (ODA); in other words, additional. Support for adaptation (or better put, development in a more hostile climate) should be substantial.

The UK Prime Minister, Gordon Brown, has proposed finance for mitigation and adaptation by developing countries of US$100 billion per year by 2020; the EU has worked with numbers that are consistent with this figure – in both cases the carbon markets are assumed to make some contribution. A clear commitment on US$50 billion by 2015 is now needed by the rich world. Developing countries are making their climate change action plans now and are seeking reliable support over the next few years. Further, it would be hard to take seriously a commitment of US$100 billion per year by 2020 if specificity and clarity about a sum of around US$50 billion per year in 2015 cannot be delivered. Small 'start-up' sums are under discussion too and are important, but it will be crucial to have clarity about substantial support around 2015 and beyond to 2020.

The developed world cannot credibly articulate (correctly) the immensity of the issue and the 'crucial role' of developing counties, but then claim that US$50 billion per year by 2015 is unaffordable or unjustified. US$50 billion is just over 0.1 per cent of the current gross domestic product of the rich countries, and is very small compared with the likely costs we will face if we do not secure a strong international agreement to tackle climate change.[15]

The immediate priorities for spending could be, for example, US$10-15 billion per year for adaptation in Africa and other vulnerable countries, and a similar sum each for deforestation and technology. There are now strong plans for combating deforestation in a number of countries, particularly Brazil and Indonesia but also a number of smaller countries such as Guatemala and Papua New Guinea. The focus for spending on technology should be on: research and development on key innovations for developing countries; demonstration and deployment support for the crucial technologies for longer-term mitigation goals; and supporting the innovative capacity of developing countries through, for example, national or regional innovation centres. Support for these activities at the level required would not be easily funded from carbon flows through, for example, the Clean Development Mechanism (CDM). The CDM, or its successor, is intended to support a shift in emissions reductions from rich country A to developing country B to reduce overall costs, and does not therefore contribute to the planned reductions in developing countries that have been discussed here. Nevertheless the CDM will have an important role to play and should be reformed to allow for greater simplicity and scale of action, including through programme and sector arrangements.

How might the contributions be divided amongst the rich countries? Table 5 lists the GDP of rich countries in absolute terms and as a percentage of the total. Table 6 presents estimates for total and per capita emissions in 2010, and planned emissions in 2020 based on current commitments. These factors could provide an initial guide to possible breakdowns of contributions by the rich countries.

The USA accounts for 36 per cent of the total GDP of rich countries. It is also currently the biggest total emitter among rich countries and is likely to remain so (with per capita emissions around twice that of Europe and Japan). These factors, taking into account its share of income, share of emissions, and the relative magnitude of its planned emissions reductions (far lower than most other rich countries), might indicate that a contribution by the USA of about 50 per cent to the total public finance (within a US$50 billion sum) would be sensible and responsible.

There is no great purpose, however, in being overly formulaic and losing agreement on the overall amount by quarrelling over the division. We must be very clear that for the rich countries the sums involved are very small in relation both to the size of the problem and the resources found for smaller and more short-term crises. The EU must make a strong contribution. It has been in the forefront of analysis and action and must demonstrate that leadership now. Breakdowns that are settled now can still be adjusted over time.

The UK has a valuable role to play as a global leader in the debate on finance. But strong leadership should now be translated into strong commitments, for 2015 and beyond. The UK has a share of around 6 per cent of the total GDP of rich countries, and a corresponding contribution to the funds required by 2015 would be around US$3 billion per year (6 per cent of US$50 billion). By going beyond this, perhaps to US$4-5 billion per year by 2015, the UK would be showing that it is ready to translate its leadership on analysis and debate into action. The forthcoming Pre-Budget Report is a key opportunity for the UK to state its intention and make clear financial commitments to the developing world, both for the immediate (2010-2012) and short term (up to 2015).

[15] Stern Review (2006).

Table 5: GDP of rich countries in 2008

Country	GDP (US$ trillions)*	Percentage of rich countries' total GDP
USA	12	36%
Euro Area**	9	27%
Japan	4	11%
UK	2	6%
Canada	1	3%
Other***	6	18%
Total	33	100%

*2008 GDP at 2000 prices
**Euro area includes Austria, Belgium, Cyprus, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Malta, the Netherlands, Portugal, Slovak Republic, Slovenia and Spain.
***Other includes Australia, Czech Republic, Denmark, Hungary, Iceland, Korea, Mexico, New Zealand, Norway, Poland, Sweden, Switzerland and Turkey.
Source: OECD

Table 6a: Estimates of emissions by rich countries in 2010

Country	Per capita emissions (tonnes of carbon-dioxide-equivalent)	Total emissions (billions of tonnes of carbon-dioxide-equivalent)	Percentage of rich countries' emissions
USA	21.2	6.7	45.6%
Euro Area	8.5	2.8	18.9%
Japan	11.0	1.4	9.5%
UK	11.1	0.7	4.6%
Canada	23.8	0.8	5.5%

Source: Derived from CAIT (WRI) and Global Carbon Budget. Per capita emissions are estimated using figures from the United Nations World Population Prospects database.

Table 6b: Planned emissions reductions by rich countries in 2020

Country	Per capita emissions (tonnes of carbon-dioxide-equivalent)	Total emissions (billions of tonnes of carbon-dioxide-equivalent)	Change in total emissions between 1990 and 2020
USA	17.0	5.9	-4%
Euro Area*	7.3	2.4	-30%
Japan	8.1	1.0	-25%
UK	7.5	0.5	-34%
Canada	15.5	0.6	-3%

Source: Per capita emissions are estimated using figures from the United Nations World Population Prospects database.

The politics both of raising money and of showing additionality would be easier if there were new sources of funding which are related to climate change. Examples include: (i) national carbon taxes; (ii) national permit auction revenues; (iii) international auction revenues, as in the Norwegian proposal[16]; and (iv) international transport levies. Rough calculations of revenue potential can be made by noting that 1 billion tonnes of carbon-dioxide-equivalent with a tax or price of US$30 per tonne would yield US$30 billion per year. Annual emissions from aviation and shipping are around 1.8 billion tonnes of carbon-dioxide-equivalent. Annual emissions from Annex I countries[17] are currently around 18 billion tonnes and, if just 10 per cent of this were used as a tax base for funding support for developing counties, it would yield US$54 billion per year at a price of US$30 per tonne. It is clear how different numerical examples could be constructed.

A mix of sources of finance is likely to suffer less from fluctuation than a single source. Specific earmarking can give greater confidence about delivery and additionality.

It is important to consider the dynamics between public and private finance. Strong public action on finance will trigger private sector investment, generating a multiplier effect that will significantly increase financial flows to developing countries in future years. It is also important to recognise, however, that public and private funds are not substitutes. While public funds are likely to be required for much of the necessary adaptation investment, to support the development of climate change action plans and to directly support some mitigation action where no private investment is available, private funds will constitute an important source of finance for many mitigation activities. Public finance will also be necessary, perhaps in partnership with the private sector, where, for example, the risk profile of a particular project deters private sector investment. Therefore public and private finance play different but supporting roles, and both are key. We should not forget that private finance and investment do not come for free. Future interest, capital repayments and dividends are basic to these flows.

Lastly, the mechanism for the delivery of finance is critical. The administration of funds should be simple and efficient, and should promote mutual trust. The number of new institutions should be limited, and existing development channels should be used where possible. The Regional Development Banks (e.g. the African Development Bank), with the support of other multilateral and bilateral institutions, should play a leading role in administering the funds for Africa, in order to avoid adaptation and mitigation becoming separated from development, and to provide a strong local element in governance. Adaptation, mitigation and development are inextricably intertwined in terms of action, and it could be very damaging if institutional structures have the effect of trying to separate them. And given the origins of the issues at hand, there is a very powerful case for much stronger than present involvement of developing countries in governance.

Even with the present financial constraints, this is no time for rich countries to argue for a delay in delivering on their financial responsibilities. If there have ever been credible reasons for borrowing and public debt, this is surely one of the strongest. In correcting this huge market failure due to greenhouse gas emissions, we can make future generations better off with little or no impact on the living standards of current generations, by leaving a legacy of a much better environment and somewhat higher debt: a key insight here is that a market failure leads to inefficiency which means that sound policy can increase the welfare of both current and future generations[18]. Surely our children and grandchildren would approve of such borrowing, which will protect their future and the future of their planet. Whilst they can pay off debt, much of the damage resulting from inaction on climate change would be severe and irreversible.

[16] See 'Norway's Proposal to Auction Assigned Amount Units: Implementation Options', The Center for Clean Air Policy, September 2009 (http://www.regjeringen.no/upload/MD/Vedlegg/Rapporter/Norways_Proposal_to_Auction_Assigned_Amount_Units_090911.pdf)

[17] Annex I emissions in 2005, excludes LULUCF. Source: CAIT (WRI).

[18] See, for example, Stern (2009), Presidential address to the European Economic Association, August 2009.

5. Leadership and decision

We recognise the problems and understand what must be done to combat climate change. What we need now is leadership and collaboration to achieve a global deal. Collaboration on climate change will have to be on a scale that is greater than any the world has seen before. The comprehensive nature of the decisions that must be taken, including on patterns of growth, finance, technology and trade, clearly requires leadership at the highest levels of government. If we succeed on climate change, we will make collaboration on all our other important international issues far easier. Indeed, bringing issues together, at least implicitly, may mean that it is easier to move forward on any one of them. That kind of perspective, looking across the full breadth of issues relating to climate change, including future growth and international relations, and putting them together, can be provided only at Presidential or Prime Ministerial level. It cannot arise from trade ministers talking about trade, environment ministers discussing the environment, and finance ministers working on financial issues.

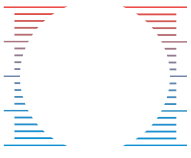
As can be seen from the examination of potential reductions in emissions, the past few weeks and months have brought strong and enhanced initiatives from many countries around the world. We are now, assuming countries can finance and deliver on their intentions, not far away from putting ourselves on a climate responsible path by 2020. But there is still a significant extra margin of emissions reductions to find, and difficult challenges remain on finance.

In the last few days before Copenhagen, and at the meeting itself, we must seek political leadership that is not only thoughtful and measured, but also courageous. That leadership must set out the compelling scientific and economic case for strong action. It must show not only that there are severe dangers for a planet in peril, but also that if we act sensibly and strongly, starting now, we can dramatically reduce those risks at reasonable cost. That leadership must be courageous too in confronting the short-term, narrow and often confused ideas of self-interest which will make a lot of noise and argue for postponement of action, or in some cases, for little or no action. It must show that the necessary finance will be made available. It is a time for clarity and strength in vision, decision and implementation.

That leadership can and must be inspirational as well. Strong action on climate change will not only protect the lives and livelihoods of our children and grandchildren, it will allow them to experience something of the wonder of the natural environment that we have the privilege of seeing now. Low-carbon growth will deliver this and much more. It will create an industrial revolution which will drive growth in the coming decades. It will bring communities together: we can have, for example, public transport, recycling and re-using, and combined heat and power, only in communities. It will lead to a more co-operative world where we have a much better chance of dealing with the many global problems, including deep poverty above all, that we face and will face as common citizens of a small planet.

Low-carbon growth is indeed an inspirational story. But it is also a practical story, indeed the only practical story. We have a short window of opportunity to turn it into a reality. Whilst it is time for leadership at the highest levels, we must all contribute to the creation of this reality: from my own world of the university and of policy analysis; from those who will invest in the new opportunities; and from those who will change the way they consume. We know what we have to do; the prize is enormous. The people and politicians of the world, community by community, nation by nation, will now determine whether we can create and sustain the international vision, commitment and collaboration which will allow us to take this special opportunity and to rise to the challenge of a planet in peril.

Grantham Research Institute on
Climate Change and
the Environment



Centre for
Climate Change
Economics and Policy