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WIDER Annual Lecture 11

The Climate Change Challenge

Kemal Derviş

In cooperation with the United Nations Development Programme (UNDP).

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FOREWORD

The WIDER Annual Lecture is one of the highlights in the UNU-WIDER calendar. The occasion provides an opportunity for a distinguished speaker to present his or her views and ideas on a topic related to global development. The 11th lecture in the series was given at the Marina Congress Center in Helsinki on 6 March 2008 by Kemal Derviş, head of the United Nations Development Programme in New York. The chosen topic was the global challenges posed by climate change.

Although Kemal Derviş has spent his whole career working on issues concerned with development, climate change has only recently claimed much of his attention. Along with many others, he now views it as 'a central issue that we have to tackle: it is a central issue for this century'. This shift of opinion in part reflects a change of emphasis. The problem of climate change used to be viewed in terms of intergenerational injustice arising from negative externalities and excessive energy use by current generations. Nowadays the focus is more likely to concern the possibility of future catastrophic scenarios, and the actions today that can help insure against these events. It is the global analogue of improving building regulations in order to reduce the chance of future damage from earthquake.

The United Nations has played a prominent role in drawing attention to the existence and significance of climate change. It is also likely to have a key role in the future, as countries grapple towards collective solutions to global warming. However, as Derviş points out, climate stability is a classic example of a global public good, so achieving agreement is likely to pose special challenges.

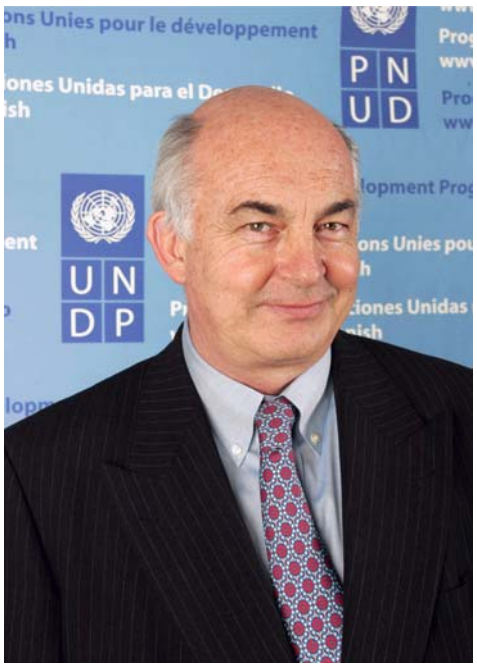
The first requirement is a broad consensus on the appropriate target for reductions of greenhouse emissions. This is a non-trivial exercise given the disparity of scientific opinion regarding the link between greenhouse gases and climate change, and the different views of economists towards the aggregate costs and benefits of alternative courses of action. However, deciding how the costs of climate change mitigation will be shared is a far more difficult task. Agreeing a fair allocation of the burden is likely to strain relations not only between developed and developing countries, but also within the developed world.

This Annual Lecture stresses the development side of climate change, in particular the plight of poor nations—and poor groups within countries—who have contributed least to the stock of greenhouse gases, and yet face the prospect of a disproportionate effect on their livelihoods and health. It is undoubtedly one of the greatest potential obstacles to improvements to welfare in the developing world.

On the grounds of prudence, Derviş argues for early action to address climate change. He also recommends flexibility in terms of the precise targets and timetable, the way they are formulated, and the means by which they may be achieved. Multiple instruments will be required, and novel technologies must be explored to see how energy patterns can be changed. Most importantly, all of the major players in the world need to be involved in the process of seeking solutions to the undoubted problems of climate change.

Anthony Shorrocks
Director, UNU-WIDER

ABOUT THE AUTHOR



Kemal Derviş has been the head of the United Nations Development Programme, the UN global development network, since August 2005. He is also the Chair of the United Nations Development Group, a committee consisting of the heads of all UN funds, programmes, and departments working on development issues at the country level.

Prior to his appointment with UNDP, Kemal Derviş was a member of the Turkish Parliament representing Istanbul from November 2002 to June 2005. During this time, he represented the Turkish Parliament in the Constitutional Convention on the Future of Europe and was a member of the joint commission of the Turkish and European Parliaments. He was also active in the Centre for Economic and Foreign Policy Studies, a Turkish NGO working on economic and political issues.

From March 2001 to August 2002, Kemal Derviş was Minister for Economic Affairs and the Treasury, without party affiliation, of the Republic of Turkey. He was responsible for Turkey's recovery programme after the devastating financial crisis that hit the country in February 2001. In August of 2002, after the crisis was overcome, he resigned from his Ministerial post, joined the Republican People's Party (centre-left) and was elected to Parliament in November of the same year.

Kemal Derviş earned his Bachelor (first class honours) and Master's degrees (with distinction) in economics from the London School of Economics, and his PhD from Princeton University. From 1973 to 1977 he was a member of the economics faculties of the Middle East Technical University and then Princeton University. In 1977 he joined the World Bank where he worked until he returned to Turkey in 2001.

At the World Bank he held various positions including Division Chief for Industrial and Trade Strategy and Director for the Central Europe Department after the fall of the Berlin wall, a position where he later coordinated the World Bank and donor community's support to the peace and reconstruction process in the Balkans, particularly in Bosnia. In 1996 he became Vice-President of the World Bank for the Middle East and North Africa Region where he was active in supporting the Middle East Peace Process. In 2000, Kemal Derviş became Vice-President for Poverty

Reduction and Economic Management where he was responsible for the World Bank's global programmes and policies to fight poverty. He was also responsible for operational coordination with other institutions, including the United Nations system, the IMF, and the WTO on international institutional and policy issues.

Kemal Derviş has been an active participant in various European and international networks including the Global Progressive Forum and the Progressive Governance Network. He was a member of the International Task Force on Global Public Goods co-chaired by Ernesto Zedillo, former President of Mexico, and also a member of the Special Commission on the Balkans chaired by Giuliano Amato, former Prime Minister of Italy. He has cooperated with the Global Economic Governance Programme at Oxford and the Center for Global Development in Washington DC. Kemal Derviş is currently a member of the Commission on Growth and Development, a body sponsored by the World Bank and others and chaired by the Nobel Prize-winning economist Professor Mike Spence. He is also a member of the Commission on the Measurement of Economic Performance and Social Progress established by Nicolas Sarkozy, President of France, and chaired by the Nobel Prize-winning economist Professor Joseph Stiglitz. Mr Derviş serves on the advisory committees of the Centre for Economic and Foreign Policy Studies (EDAM) and the Turkish Economic and Social Studies Foundation (TESEV). He is also an adviser to the Institut de Prospective Economique du Monde Mèditerranèen (IPEMed). All of these activities have had the common objective of finding ways to make globalization a more stable and inclusive process and to advance international cooperation.

Kemal Derviş has published many articles in academic journals as well as current affairs publications on topics ranging from mathematical models of growth and social mobility and quantitative models of trade, to European enlargement and transatlantic relations (in English, Turkish, French, and German—he is fluent in all four languages). A book entitled *General Equilibrium Models for Development Policy*, which he co-authored, was published by Cambridge University Press in 1982, and became a widely used textbook in development economics in the 1980s. In cooperation with the Center for Global Development, he has published a new book entitled *A Better Globalization* (Brookings Press 2005), which deals with global development issues and international institutional reform.

1 INTRODUCTION

It is a pleasure and an honour to deliver the WIDER annual lecture. UNU-WIDER is an institution that has done excellent work to advance our knowledge on the challenges of development and of addressing global issues. I have chosen climate change—both a global and developmental challenge—as the topic of my lecture. Even though I have been practicing economics, and development economics in particular, for almost three decades, I must confess that climate change was not very much on my mind until rather recently. Indeed, during the first meeting of the Commission on Growth and Development in early 2006, convened by the World Bank with the participation of distinguished academics and policymakers from around the world, I remember that we did not really discuss climate change at that meeting. However the final report, to be issued in May 2008, very much addresses the issue as an integral part of the analysis of long term growth.

The change has occurred over the last two years. Climate change has become a central topic for development and growth economists, as well as for policymakers worldwide. Much of the credit should go to the United Nations (UN) family, because it was under UN auspices that the Intergovernmental Panel on Climate Change (IPCC) was created in 1988. The IPCC has brought together thousands of scientists from around the world, and the sequence of reports it has issued have established, on strong scientific grounds, that climate change is happening, that it is significant, and that it is clearly linked to human activity.

The United Nations Development Programme (UNDP) decided to focus the 2007/2008 Human Development Report (HDR) on climate change and human development, so a significant part of my lecture will be based on data and findings from this report (UNDP 2007). But the lecture presents my personal perspective only, not an official position. There is no official UNDP position today, except that climate change is a problem and that we need to deal with it. The UN is not and cannot be an actor in the policy negotiations that should lead to an international climate deal. The role of the UN is to present the facts, facilitate the debate and negotiation, and provide a framework. But it is up to the sovereign nations of the world to reach the policy conclusions and policy solutions that are needed. The UN helps countries, but it does not and should not try to impose any solutions.

Climate change has so many dimensions—from the physical sciences to economics, from domestic politics to foreign policy, from environmental to social issues—that obviously I will not be able to touch on all of them. I will however focus on what I see as the important elements to consider in defining the contours of a global approach to address climate change. Beyond its intrinsic importance, a discussion of

climate change is also an opportunity to look into the wider challenge of policy towards the provision and financing of global public goods (of which climate stability is a prime example). This is one key dimension of international cooperation, which differs from development assistance for poverty reduction as such. Both of these dimensions however are present in the climate change challenge, so I hope that the discussion in this lecture might provide broader insights into the types of challenges that the international community, including the UN, faces, when it comes to the provision of global public goods.

The lecture is organized into four sections. First, I outline the two key reasons why I think there is a growing consensus that significant action on climate change needs to start now. Second, I analyse the Human Development Report's proposal of avoiding dangerous climate change—that corresponds to stabilizing concentrations of greenhouse gas emissions at a level consistent with keeping temperature increases below 2 degrees Celsius—given current emissions and the targets that would be required to meet the stabilization goal. Third, I consider the challenge of mitigating climate change in light of the need to expand energy access for development. The two issues cannot be disassociated from each other since the vast majority of greenhouse gas emissions are directly linked to our current patterns of energy use. Finally, I conclude with a discussion of the contours of a global approach to address climate change, which I believe must be grounded in the principle of common but differentiated responsibility (as established in the United Nations Framework Convention on Climate Change—UNFCCC) along with long term flexibility in implementation.

2 ADDRESSING CLIMATE CHANGE: TWO ARGUMENTS FOR ACTING NOW

The debate on climate change has evolved in recent years from being about whether climate change is a serious problem, towards being about when and how to address it, especially in light of the IPCC's latest report (2007). I do think that addressing climate change is an imperative that we have to address now for two main reasons, which I will elaborate upon in this section.

First, while the catastrophic effects of climate change that would be harmful to the whole of humanity are not likely to happen immediately, and while there is still uncertainty as to the exact scale and timing of these effects, we know that they are definitely possible. Scientists have been typically surprised by the acceleration of some of the phenomena underlying these effects. In addition, inertia in greenhouse gas concentrations and complex feedback mechanisms in climate systems imply that what we do now cannot easily—if ever, in some cases—be reversed. This

justifies taking action now as insurance against these possible catastrophic effects that would affect everybody.

Second, we now know with certainty that climate change will have a more immediate effect on many of the poorest people in the world. While in the short run some of the colder climates may even benefit from climate change, populations that live in lower latitudes will suffer (and are very likely already suffering) overwhelmingly negative effects. Those that are concerned with development and poverty reduction, as enshrined in the Millennium Development Goals (MDGs), cannot ignore the urgency to mitigate the effects of climate change and help those affected to adapt to climate change.

2.1 Insurance against Catastrophic Outcomes

The scientific evidence that our climate is changing is now overwhelming. The link between greenhouse gas emissions and human activity is also well established. However, there still remains a huge amount of uncertainty regarding the processes that mediate between greenhouse gas emissions, their concentration in the atmosphere, the effects of different concentrations on climate, and what changes in climate will mean for biodiversity, agriculture, sea levels, and many other 'climate dependent' characteristics of our planet. There is uncertainty as to how fast all of these processes will unfold.[1] We are in the process of reducing that uncertainty. In some cases it seems the phenomena are happening faster than earlier IPCC reports and other scientists had predicted. So on balance we should be concerned about climate change even though catastrophic outcomes are not expected to take place in the short run and there is uncertainty as to processes, outcomes, and timing.

Given that mitigating climate change requires investment, how much should we invest and when? Some economists—even recognizing that climate change was dangerous—considered that not a lot needed to be done immediately because they analysed the issue as a challenge of smoothing consumption optimally over time.

To do so, they used a growth model that includes an intertemporal utility optimization framework where the social discount rate plays a key role.[2] This is essentially the kind of framework that is used to analyse the construction of a road, a port, an airport, or other types of public investments. If a social discount rate that is close to the one used to assess these investment decisions is applied to the case of climate change, then the results of the model would suggest that some kind of mitigation might need to be taken. But given that the damages inflicted by climate change take place in the long term, using those social discount rates would imply that climate damages seen from today's perspective would be relatively small, as

1 See for example, Tol (2002).

2 See Frankhauser (1995); Frankhauser and Tol (2003); and Nordhaus and Boyer (2000).

would the level of immediate investments needed to address the problem. The real action would only have to come later.

If a lower social discount rate is used then the situation changes. There are strong ethical and technical reasons for using a lower social discount rate, as proposed in recent and influential economic analysis of climate change.[3] The choice of the 'right' social discount rate for analysing climate change has been the focus of much controversy, involving in part rather technical arguments and bringing to the fore difficult theoretical and empirical challenges that have troubled economists for a long time.[4]

However, some economists view the issue somewhat differently. Increasingly, the decision to address climate change is analysed more as one of preventing catastrophic risk rather than a normal investment decision that relies on standard public expenditure analysis that aims at smoothing consumption optimally. In other words, we do not know with certainty what will happen and when, but we do know that catastrophic outcomes are possible.

Barrett (2007) describes a situation where there is the possibility that an asteroid measuring several kilometres in diameter might hit the Earth. There might be only a 10 per cent probability, or indeed an unknown probability, but if it does hit, it could basically destroy parts of the Earth completely. Nobody will sit and hope for the best because there is only a 10 per cent probability this may happen. If there was even a low probability that such a catastrophic event would take place, people would try to do something about it. The fact that the probability is low is not necessarily a reason for inaction given the scale of the potential damage.

Some of the catastrophic effects of climate change would not, therefore, be unlike Earth being hit by an asteroid. These include, for example, the melting of the Greenland and West Antarctic ice sheets, which would result in very large sea level rises changing the world's physical and human geography. Changes in the thermohaline circulations (the 'conveyer belt' of ocean heat that determines much of the earth's climate) affecting the Gulf Stream would lead to dramatic changes in global weather patterns. Climate tipping-points could be reached, unleashing self-reinforcing multiplier feedback effects—e.g., saturated carbon sinks, releases of methane from arctic permafrost thawing—that can dramatically amplify temperature increases.[5]

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3 For example, Mendelsohn et al. (2000); and Stern et al. (2007).

4 See Arrow (1995); Dasgupta (2007); Dietz et al. (2007); Hamid et al. (2007); Heal (2008); and Hope (2006).

5 See Bryden et al. (2005); IPCC (2007); North Greenland Ice Core Project (2004); Rapley (2006); and Stern et al. (2007).

If we knew with certainty the probabilities of these events, then a slightly modified version of the intertemporal optimization framework incorporating risk modelling could be used. But we do not know the probabilities of those catastrophic events. The practical effect of this uncertainty—not knowing the probabilities—is that the consumption optimization framework no longer works. We know, however, that catastrophic events are possible and that the damage they can inflict is so large that they could be devastating for the whole of humanity. So acting to mitigate climate change is justified under this framework because it is like taking insurance against uncertain but potentially catastrophic outcomes. Economic growth theorists will see the difference between these two approaches. Indeed one of the strongest growth theorists of our generation, Martin Weitzman (2007; 2008), is a leading figure in presenting the analyses in terms of catastrophic risk insurance, rather than consumption smoothing.

Therefore, while there is uncertainty as to the magnitude and timing of the damages, we know that they might be very large and that they are real possibilities, so we must take some form of insurance against that risk by starting to mitigate. But when should we start, given that these outcomes are not likely to occur in the short run? What is done today in terms of emissions cannot be easily undone. The heat trapping gases that we emit into the atmosphere remain there for a long time, at least a century, if not longer. If we make a mistake today in underestimating the effects of emissions, it is not the kind of mistake that we can correct easily next year: we cannot speedily take back those gases. So the most prudent forms of insurance are to be taken sooner rather than later. Action to mitigate climate change should start now by taking insurance on behalf of humanity's future generations.

2.2 Distribution Concerns

Much of the early analysis on climate change was not examined in a development framework. The world was modelled as one country and the issue was to discern the optimal climate and growth policies for the country called 'the world' with a representative citizen. Even in the analysis of catastrophic outcomes, taking insurance is justified on behalf of the whole of humanity, that is, on behalf of this 'one-country' world. But this is insufficient. We have to analyse climate change in a multi-country world because we know that the impact of climate change will be very different depending on where one lives.

While climate stability is an almost perfect example of a global public good—the provision of which requires universal mitigation because the same quantity of heat trapping gas emitted in Helsinki, Istanbul, Chicago, or Berlin will have the same effect on concentrations as if they had been emitted elsewhere—the impact of climate change is differentiated.

For example, while in some areas of the world agriculture may actually improve, at least in the short run,[6] this will not be the case in some of the poorest countries. Cline (2007) predicts that developing countries will suffer an average 10–25 per cent decline in agricultural productivity by the 2080s, assuming 'business as usual', and ignoring carbon fertilization. Declines will be much steeper in some countries. For example, India may face a decline of 30–40 per cent of agriculture productivity, Sudan a 56 per cent drop, and Senegal a 52 per cent fall.

The poor will also suffer from heightened water stress and scarcity. Changed run-off patterns and continued glacial melting will have significant implications on water availability, interacting with already severe ecological pressures on water systems.[7] Central Asia, Northern China, and the northern part of South Asia face serious vulnerabilities associated with the retreat of glaciers. Many of Asia's great river systems are likely to experience an increase in flows over the short term, followed by a decline as glaciers melt. These river systems provide water and sustain food supplies for over two billion people.

Climate change will also increase the exposure of the poor to extreme weather risks. Climate change science points to intensified tropical storms, more frequent and widespread floods, and drought. Climate disaster risks are skewed towards developing countries: while 1 in 1,500 people were affected annually by climate disasters in OECD countries between 2000 and 2004, in developing countries as many as 1 in 79 people were affected.[8] Monsoon floods and storms in South Asia during the 2007 season displaced over 14 million people in India and 7 million in Bangladesh. Over 1,000 people lost their lives across Bangladesh, India, southern Nepal, and Pakistan. Globally, the one billion people who live in urban slums, on fragile hillsides, or flood-prone river banks are among the most vulnerable to such extreme weather events.

Climate change is also putting heavy pressure on numerous ecosystems, many of which supply vital services for the livelihood of the poor, including fisheries and forest products. The bleaching of coral reefs is one example of ecosystem deterioration. Over 60 countries, many of them in the Caribbean and Pacific region, rely on the coral system for their economic growth, with their population depending on it for their livelihood and nutrition. If the rapid bleaching of the coral reefs (recorded in countries such as Indonesia) is not stopped, 30 million small-scale fishers in the developing world will suffer the consequences.[9] Loss of environmental resources like wetlands also contributes to reduced resilience in the face of climate change. The world's wetlands provide a range of ecological

6 See Deschenes and Greenstone (2007).

7 See Barnett et al. (2005); Huntington (2006); and Warren et al. (2006).

8 See Anthoff et al. (2006); Dasgupta et al. (2007); and UNDP (2007).

9 See Reaser et al. (2000); and UNDP (2007).

services, harbour biodiversity, sustain fish stocks, and provide agricultural, timber, and medicinal products. They also buffer coastal and riverside areas from storms and floods, protecting human settlements from sea surges.

There is also the likely impact of climate change on health. The IPCC (2007) in its Fourth Assessment Report, projected that climate change related exposures are likely to affect the health status of millions of people, particularly those with low adaptive capacity. This is likely to happen through increases in malnutrition and consequent disorders; increased injury, disease, and death due to heat waves, floods, storms, fires, and droughts; the increased burden of diarrhoeal disease; the mixed effects on the range and transmission potential of malaria in Africa; and increased frequency of cardio-respiratory diseases due to higher concentrations of ground-level ozone related to climate change.

The negative health impacts of climate change will be greatest in low income countries. Although climate change will bring some benefits to industrial countries—such as fewer deaths from cold weather—there will be many more negative effects in the poorest countries.

So the world cannot be taken as if it were one country: the geographical impacts will vary and cause large 'distribution' issues. This is a huge developmental challenge because the impacts of climate change in the short run and medium term will be potentially devastating and, in some cases, surely devastating, for some of the least developed and most vulnerable regions of the world, and for some of the poorest people in the world.

Given the inertia in greenhouse gas concentrations, the world is already committed to at least some changes in climate, independent of the ambition and timing of any mitigation action we may decide to take. And as noted, these changes will overwhelmingly affect the poorest and most vulnerable in a negative way, which makes adaptation to climate change an imperative for these populations.

To conclude, there are two key dimensions to the climate change challenge. Possible catastrophic outcomes for humanity as a whole—no matter where one lives—represent a long run challenge and there is a strong case to start taking insurance by initiating mitigation now. The shorter term urgent development challenge is that progress by the poorest people in the world would become much more difficult if we do not act against climate change, both in terms of mitigation and adaptation.

3 AVOIDING DANGEROUS CLIMATE CHANGE

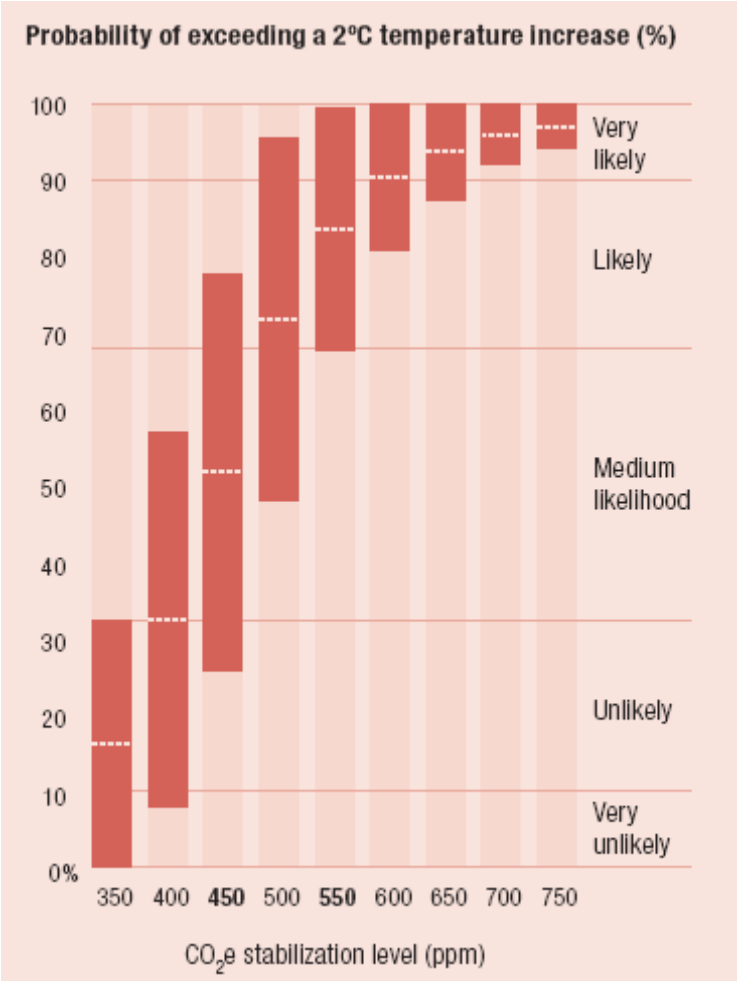
There is a general agreement among many scientists and environmentalists that an increase in average global temperature of about 2 degrees Celsius (°C) compared to pre-industrial levels is a prudent goal to limit the risk of dangerous climate change. UNDP's 2007/2008 HDR adopts this goal and suggests that concentrations of heat trapping gases in the atmosphere need to be stabilized at around 450 parts per million (ppm) of CO_2 equivalent by around 2050 to give us an even chance of meeting that goal. The issue then becomes to determine the evolution of the flow of emissions that would be consistent with the stabilization of the concentration at the desired level. Addressing this issue is not an exact science and is subject to much uncertainty. But drawing on the latest IPCC report and modelling work commissioned especially for the report, the 2007/2008 HDR suggests possible answers for a global emissions target (UNDP 2007). This section describes what this would imply for the path of emissions of developed and developing countries, and analyses these implications in light of differences in current emissions across countries and in terms of different ways of accounting for emissions.

3.1 A Global Emissions Target Consistent with the Goal of Stabilizing Concentrations

Currently the concentration of greenhouse gases in the atmosphere is at about 380 ppm of CO_2 equivalent. This includes not only carbon dioxide (CO_2) but all greenhouse gases that trap heat in the atmosphere, such as methane and nitrous oxide, amongst others, but is net of the cooling effects of aerosols. The radiative effect of these other gases can be translated into what would be equivalent in terms of CO_2 concentrations—leading to the measure of CO_2 equivalent concentration. The overall framework of the 2007/2008 HDR is to keep the average global temperature increase less than 2°C above pre-industrial levels, whereby concentrations in the atmosphere would probably have to be stabilized at around 450 ppm of CO_2 equivalent by 2050. 'Probably' because we are not dealing with certain outcomes. Taking the different models that have been used by various scientists and planners, if concentrations are stabilized at 450 ppm by 2050 there is about a 50 per cent chance of keeping the temperature rise below 2°C (Figure 1). If stabilized at 550 ppm then the probability of exceeding the 2°C goal goes up to around 80 per cent.

The argument set forth below is not critically dependent on these exact numbers. Some experts could say that their model suggests something different, and that the world should stabilize at 500 ppm rather than 450 ppm to remain below the 2°C limit. Somebody else might say that 2°C is too ambitious and that 2.5°C is probably a more reasonable target. We are not going to argue about that; the range is acceptable. However, it is clear that 4°C or 5°C as limits are not acceptable because they would almost certainly lead to catastrophic changes within decades.

FIGURE 1
PROBABILITY OF TEMPERATURE INCREASES WITH DIFFERENT STABILIZATION LEVELS

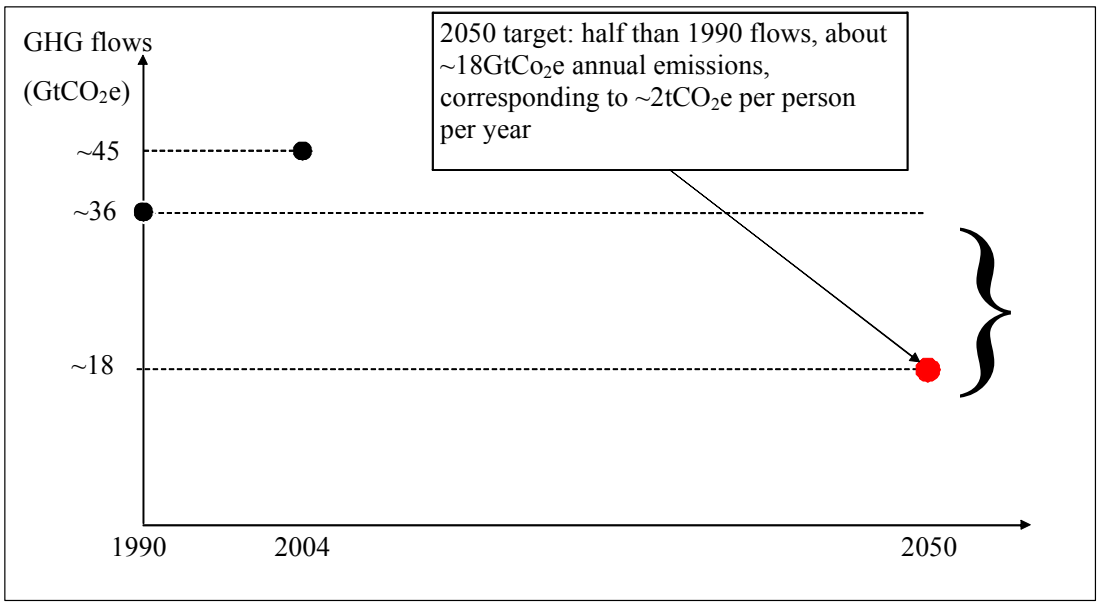


Note: Data refer to the highest, lowest, and midpoint estimate resulting from several different climate models.

Source: UNDP (2007) based on Meinshausen (2007).

If we do take 2°C as the limit for temperature increases and accept the fifty–fifty probability of not exceeding this limit that comes with stabilizing concentrations by 2050 at 450 ppm, what does this imply in terms of emissions? The emissions target consistent with stabilization at 450 ppm requires, roughly, that by 2050 we cut average emissions worldwide to around 18 gigatonnes (Gt) of CO_2 equivalent (Figure 2). In 1990, the overall emissions were 36 Gt of CO_2 equivalent globally, so by the year 2050 emissions will have to be cut in half relative to the 1990 level. In 2004 the world stood at about 45 Gt of CO_2 equivalent (IEA 2006: III.6). Thus, the reduction needed is much steeper: around 27 Gt (as compared with 18 Gt if 1990 is taken as the reference). If the world population is projected to reach around nine billion people by 2050 this means that, on average, the world has to emit at most two tonnes of CO_2 equivalent per capita.

FIGURE 2
TARGET FOR GLOBAL EMISSIONS CONSISTENT WITH STABILIZATION OF GREENHOUSE GASES (GHG)



Note: $GtCO_2e$= gigatonnes of carbon dioxide equivalent.

Source: Based on UNDP (2007) and IEA (2006).

What are the kinds of emission paths that may take us to this global reduction in emissions? In 1990, developed countries were emitting roughly half of CO_2 equivalent and developing countries the other half, including land use change (about 20–25 per cent of total emissions) which is very concentrated in some developing countries. This corresponds to flows, not to the contribution to stocks of greenhouse gases. If a target of 80 per cent reduction is adopted for developed countries, then arithmetically this means that developing countries will have to cut by 20 per cent over 1990 levels by 2050.

The 80 per cent cut by developed countries is ambitious, because the reduction is from 1990 levels and, overall, these countries have increased their emissions since then. Still, the more that developed countries reduce, the less that developing countries will have to contribute, and vice versa. If developed countries make a 90 per cent reduction, then developing countries can do 10 per cent, to arithmetically arrive to the 2050 target. Importantly, as stated in the HDR, the 20 per cent is of course an average for all developing countries—it does not mean at all that any particular country should adopt 20 per cent as a target.

3.2 Differences in Emissions across Countries

It is of course important to look beyond these broad averages at some country groupings. Considering CO_2 emissions (as opposed to CO_2 equivalent) from fossil fuels, gas flaring, and cement production, in 2004 high income OECD countries were emitting about 12,255 megatonnes of CO_2, roughly the same as middle income

countries (Table 1). Low income countries have very low emissions, as do high income oil producers (although the latter have quite significant emissions in per capita terms).

In per capita terms, the average high income OECD countries stand at 13 tonnes of CO_2, excluding land use change, and middle income countries at 4 tonnes of CO_2 per capita. The poorer countries emit very little in per capita terms. On average, taking just the emissions from fossil fuels, we have a situation where the OECD countries still emit more than three times that of middle income countries in per capita terms.

TABLE 1
CO_2 EMISSIONS ACROSS GROUPS OF COUNTRIES, 2004

	CO_2 emissions (megatonnes of CO_2)		CO_2 emissions per capita (tonnes of CO_2)	
	From fossil fuels, gas flaring, and cement production	Including changes in forest biomass	From fossil fuels, gas flaring, and cement production	Including changes in forest biomass
High income OECD	12,255	11,296	13.1	12.1
High income oil producers	610	609	20.3	20.2
Middle income	12,125	15,448	4.0	5.1
Low income	2,003	3,128	0.9	1.4

Note: Data refers to CO_2 emissions only. Total greenhouse gas emissions can be between 10 and 40 per cent higher. Emissions from changes in forest biomass are volatile. Calculations assume that emissions from deforestation in 2004 were equal to the mean yearly emissions for 1990–2005. High income oil producers correspond to high income OPEC members.

Source: UNDP (2007).

Looking at the figures for some of the individual countries (Table 2), the United States emits more than the EU-15, both in absolute and in per capita terms. The US stands close to 21 tonnes of CO_2 per capita without changes in forest biomass. Elsewhere, China emits 3.9 tonnes of CO_2 per capita, the Russian Federation about 10 or 11 tonnes of CO_2 per capita, and India is still only at 1.2 tonnes of CO_2 per capita. Brazil emits 1.8 tonnes of CO_2 per capita from fossil fuels, as does Indonesia. However, if changes in forest biomass are included, these countries become important players as they have vast forests. There are different points of view on this issue. Some people worry that Brazil and Indonesia are contributing significant emissions from their deforestation. Others argue that there are countries that cut down their forests earlier in the process of development, so it would be unfair to focus on Brazil and Indonesia just because they happen to have large forest resources.

TABLE 2
CO_2 EMISSIONS ACROSS SELECTED COUNTRIES, 2004

	CO_2 emissions (megatonnes of CO_2)		CO_2 emissions per capita (tonnes of CO_2)	
	From fossil fuels, gas flaring, and cement production	Including changes in forest biomass	From fossil fuels, gas flaring, and cement production	Including changes in forest biomass
United States	6,046	5,546	20.6	18.9
EU-15	3,242	2,968	8.4	7.7
Japan	1,257	1,139	9.8	8.9
Russian Federation	1,524	1,596	10.6	11.1
China	5,007	4,672	3.9	3.6
India	1,342	1,301	1.2	1.2
Brazil	332	1,443	1.8	7.8
Indonesia	378	2,650	1.7	12.2

Note: Data refers to CO_2 emissions only. Total greenhouse gas emissions can be between 10 and 40 per cent higher. Emissions from changes in forest biomass are volatile. Calculations assume that emissions from deforestation in 2004 were equal to the mean yearly emissions for 1990–2005.

Source: UNDP (2007).

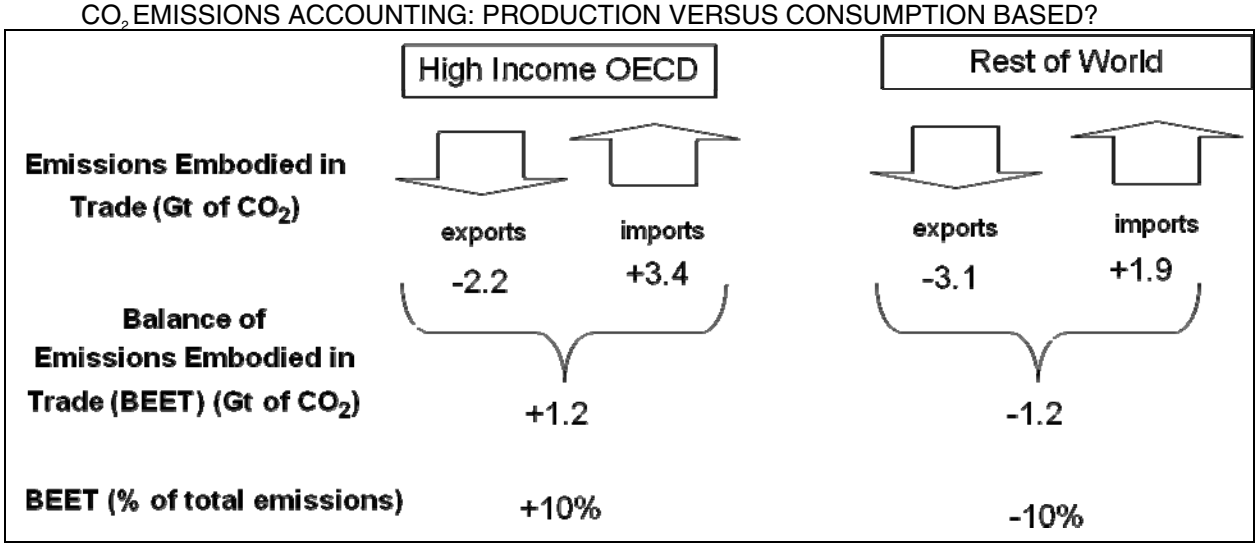
3.3 Emissions Accounting: Production or Consumption Based?

An interesting point to keep in mind in the debate on emissions is how they are accounted for. What is a fair way of measuring emissions? Basically, where production linked to emissions takes place (within country borders) or where consumption of the goods produced occurs (taking into account traded goods)? If China exports a large amount of manufactured goods that are actually consumed in other countries, should we 'allocate' the emissions to China, where the goods were produced, or to wherever they end up being consumed? Which is the right country to assign the emissions to? Is it the country that consumes these products or the one that produces them?

This is obviously an important debate and there are some studies on the topic. Addressing the issue is not easy because one has to rely on input–output tables. Let us consider a car: one would have to trace who produced the steel or the leather, and because the energy that was used at every step matters, to have a comprehensive picture, one has to trace the whole process, which is obviously not so easy. Still, there are some studies that attempt to capture the difference it would make if emissions were based on consumption, rather than production. Some estimates show that the high income OECD countries as a whole would be emitting 10 per cent more if emissions were measured based on consumption, while in the case of non-OECD countries they would emit 10 per cent less. Consumption based measures favour developing countries whereas production based measures favour richer countries (Figure 3).

FIGURE 3

CO_2 EMISSIONS ACCOUNTING: PRODUCTION VERSUS CONSUMPTION BASED?



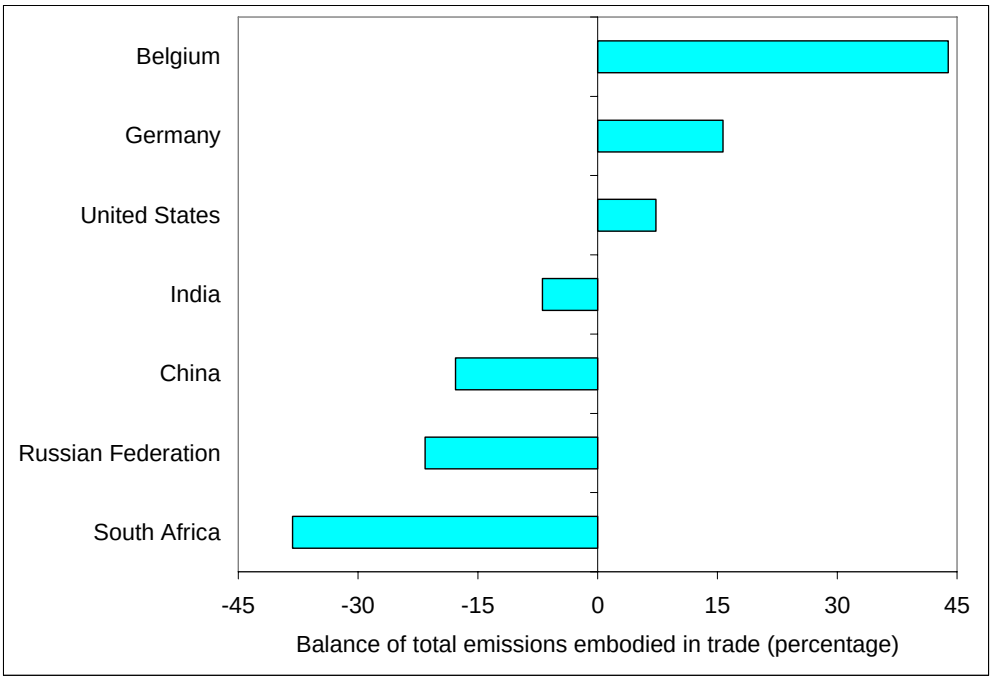
Note: Data for 2001. Emissions exclude land use changes. Gt = gigatonnes.

Source: Peters and Hertwich (2008).

For individual countries, the choice of emissions accounting is very important, particularly for those with large extractive industries (Figure 4).

FIGURE 4

BALANCE OF EMISSIONS EMBODIED BY TRADE, SELECTED COUNTRIES



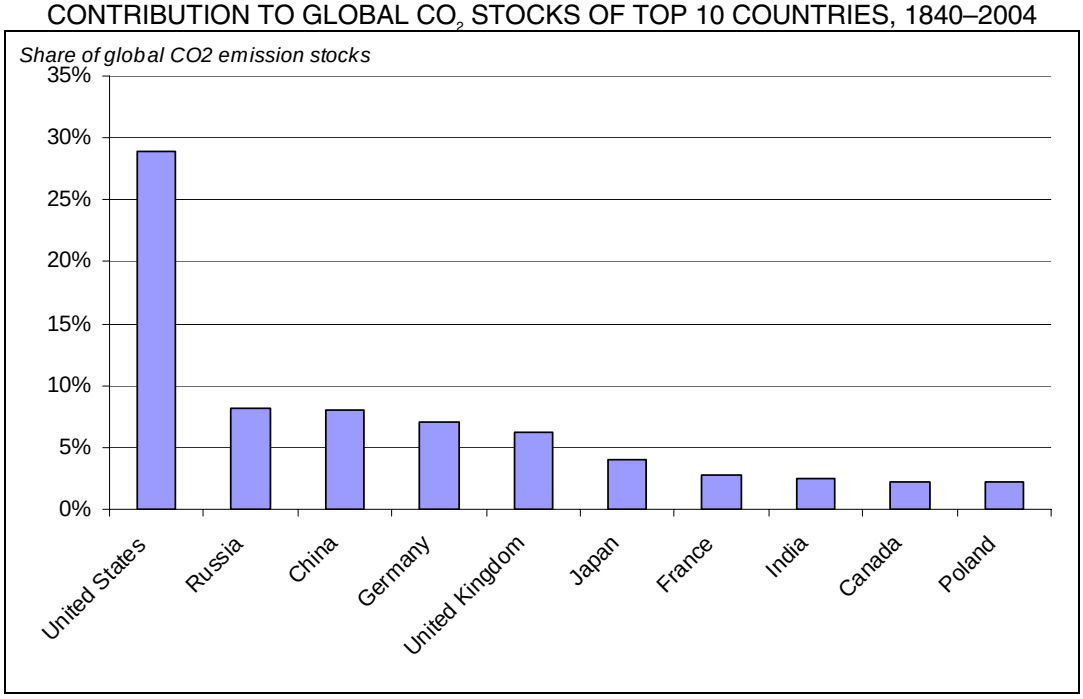
Note: Data for 2001. Emissions exclude land use changes.

Source: Peters and Hertwich (2008).

For example, South Africa, having large extractive related industries (including mining and primary metal manufacturing) that represent a large share of their exports, would be greatly penalized with emissions accounting based on production, *vis-à-vis* accounting based on consumption. For some of the small, highly consumer European countries, such as Belgium with a large trade sector, it would be the opposite. They would have a bigger burden if emissions are based on consumption rather than on production. Do we deal with production based limits or do we deal with consumption based limits? Consumption based limits seem fairer in my view, although they are more complicated to compute.

We have to keep in mind that the greenhouse gas figures presented so far are in terms of flows. However, the stocks are also an important part of the fairness debate. Roughly two-thirds of the stocks of the heat trapping gases in the atmosphere originated from the rich countries (Figure 5). Some people argue that the stocks should provide the key to the formula for the burden sharing of the mitigation effort. People do take into account past accumulation because it is the stock that causes the problem and not the flow as such. While developing countries are now very important players in terms of current flows, they have not been such important players in terms of stocks.

FIGURE 5
CONTRIBUTION TO GLOBAL CO_2 STOCKS OF TOP 10 COUNTRIES, 1840–2004



Note: Data refers to total CO_2 emissions from the use of fossil fuels.

Source: CDIAC (2007).

In conclusion, the broad outline of what is required to avoid dangerous climate change is the stabilization of the concentration of greenhouse gases in the atmosphere at a level that is consistent with keeping global average temperature increases below about 2°C compared to pre-industrial levels. A range of models suggest that a stable concentration at around 450 ppm by 2050 would give the world about a fifty–fifty chance that this limit in temperature increase would not be breached. There is no certainty about these being the precise limits for temperature increases and concentration, but they do give us 'point estimates' that can be used to guide the mitigation effort that, broadly, the world will be required to undertake.

Using these limits as guidance, the world as a whole will have to cut emissions of greenhouse gases by about half by 2050 compared to 1990 levels, and by more than that if we use the current levels of emissions, which have increased since 1990.

As in 1990, developed and developing countries emitted each (as a group) half of total emissions; implying that the degree of reductions by developed countries determines arithmetically how much would be required of developing countries. With reductions from 1990 levels expressed in percentage terms, developing countries will have to reduce the difference from 100 of the reduction by developed countries. So a reduction of 80 per cent by developed countries, as proposed in the HDR, would imply a reduction of 20 per cent by developing countries.

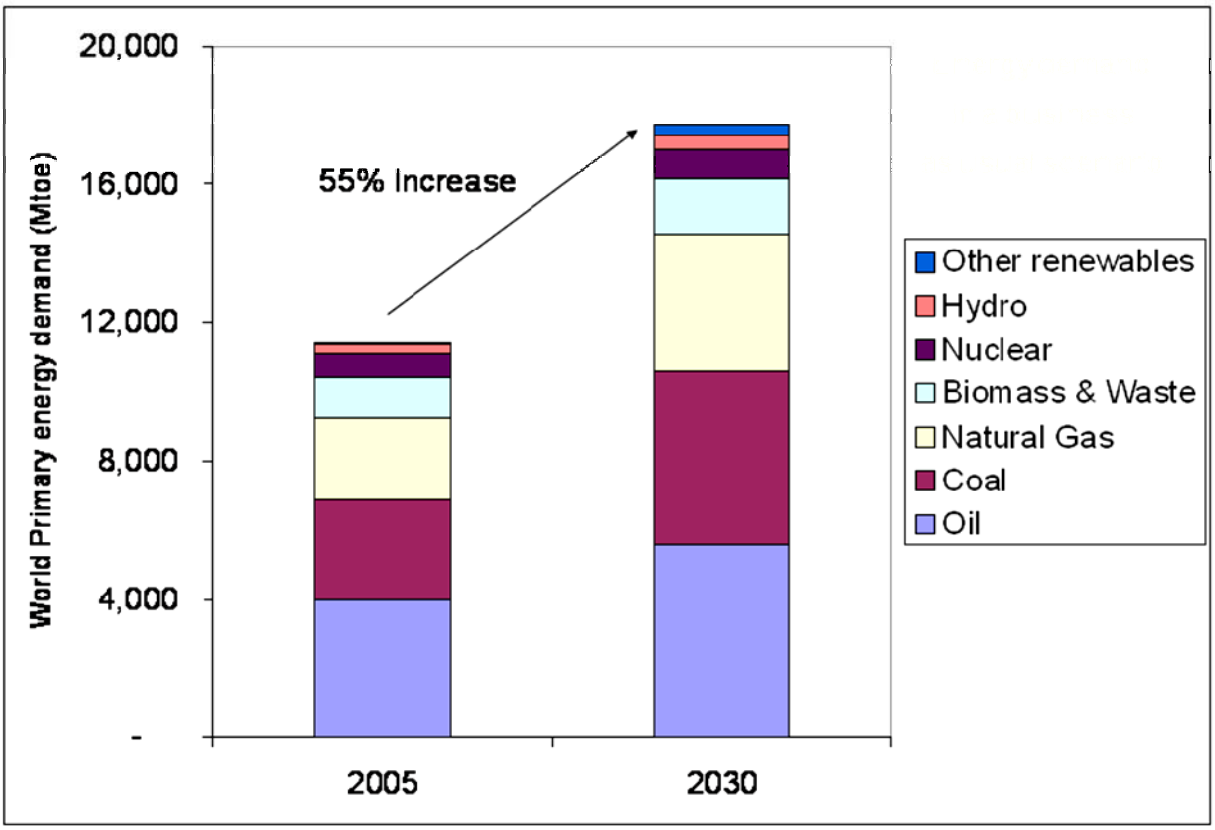
These aggregate reduction targets do not imply that each and every country needs to reduce emissions by the same relative amount. There are large differences across countries in current emissions. And even the way in which emissions are accounted for matters. And, of course, historical emissions that have contributed to today's concentrations are markedly different across countries as well. The message, therefore, is that while we do have the broad outline of what the world as whole will need to achieve, the implementation will have to attend to the specific circumstances of groups of countries, as well as individual countries. One of the key elements to take into consideration, as explored in the next section, is to balance the mitigation effort against the need for expanding access to energy for development.

4 MITIGATION WHILE EXPANDING ACCESS TO ENERGY

An important dimension of the climate change debate is related to access to energy, which is key to development. The energy sector is the biggest player in terms of generating CO_2 gases with approximately 85 per cent of CO_2 emissions generated from fossil fuels (IEA 2006). Agriculture and land use change are two other important factors. We cannot consider climate change and its appropriate policies without thinking of energy and energy policies.

The demand for energy is increasing rapidly as the world economy expands, driven by the fast growing middle income developing countries. Within the energy sector, fossil fuels like coal, oil, and natural gas are still overwhelmingly important (Figure 6). The growth in energy use is increasingly being driven by non-OECD countries. China alone will account for a one-third share of global increase in a business-as-usual scenario (Table 3). The transition economies are not playing a very important role because they are very energy intensive. India is of course coming up as another major player, together with other developing countries.

FIGURE 6
WORLD PRIMARY ENERGY DEMAND PROJECTIONS UNDER BUSINESS AS USUAL, 2005–2030



Note: Data includes power generation, other energy sectors, and total final consumption. Mtoe = Million tonnes of oil equivalent.

Source: IEA (2007: 74).

TABLE 3
WORLD PRIMARY ENERGY DEMAND BY REGION

Regions	2005	2030	Increase 2005–2030	Share of the global increase (%)
China	1,742	3,819	2,077	33
India	537	1,299	762	12
OECD	5,542	6,800	1,258	20
Transition economies	1,080	1,434	354	6
Rest of the world	2,528	4,369	1,841	29
Total (Mtoe)	11,429	17,721	6,292	100

Note: Mtoe = Million tonnes of oil equivalent.

Source: IEA (2007: annex A).

The world faces a big problem. On the one hand we have the challenge of climate change, which requires us to stabilize greenhouse gas emissions. On the other hand we have a rapidly accelerating world economy accompanied with growing demand for energy. Developing countries rightly underline that they need access to energy to grow and that their use is tiny compared to the use of energy in the rich countries. They have the right to development and the right to use that energy. The United States consumes almost 8,000 kg of oil equivalent per capita compared to the fraction consumed by small African countries or a large country like India. China's energy use is higher but is still a fraction of that in rich countries (Table 4). Approximately 412 million Indians—out of a population of 1.1 billion—have no access to electricity, and more than 90 per cent of people without access to electricity live in rural areas. Moreover, around 668 million Indians still rely on fuel wood, dung, and agricultural residues for cooking (IEA 2007: 573).

TABLE 4
ENERGY USE, 2004

Country	Kg of oil equivalent per capita
Benin	303
India	531
Angola	613
Brazil	1,114
China	1,242
Japan	4,173
Germany	4,218
Russian Federation	4,460
United States	7,920
Iceland	11,976

Note: Energy use refers to use of primary energy before transformation to other end-use fuels.

Source: Word Development Indicators online.

TABLE 5
PROJECTED INVESTMENTS IN ENERGY-SUPPLY INFRASTRUCTURE
IN A BUSINESS AS USUAL SCENARIO, 2006–2030

	Total investments 2006–2030 (US$ bn)	Annualized investments (US$ bn)
OECD	8,082	337
Developing countries	11,338	472
Transition economies	2,148	90
World	21,936	914

Note: Figures in 2006 US$. World includes interregional transport (totalling US$369 bn).

Source: IEA (2007: 95).

Thus, it is a legitimate point made by developing countries that they need to increase energy use and fuel their development. The world cannot stop their development and demand of energy. Projections for total investments in energy infrastructure are very large (Table 5).

Over the period 2006–2030, developing country investments in energy infrastructure are more important than in OECD countries. If old technologies are used producing large amounts of heat-trapping gases, then these investments will lead to a situation where developing countries will become the major emitters of greenhouse gases, based on existing technologies and existing processes.

We obviously need to change our energy use patterns. There are approximately 800 million vehicles in the world today; 73 million new cars were added in 2007 (Heywood 2006; OICA 2008). And old style cars will add to carbon emissions. The same argument goes, of course, for the power sector. But how do we achieve a less carbon intense economy? There are various ways to reduce CO_2 emissions. One is replacing carbon intensive fossil fuels with cleaner alternatives like nuclear energy. Or opting, when possible, for less harmful fossil fuels, like natural gas, which does produce heat-trapping gases, but less so than oil or coal. Energy efficiency and energy improvements are a huge avenue to save carbon. Carbon capture and storage technology, reforestation, land use, and sustainable management of forests can also play an important role.

There is of course a big debate about nuclear energy. It is a cleaner technology, and, if deployed on a larger scale can contribute significantly to the reduction of carbon emissions. However nuclear energy poses other challenges, such as risks from potential accidents, as well as nuclear proliferation; an increasingly important issue. Mohamed ElBaradei, the head of the International Atomic Energy Agency (IAEA), has said that, in his estimate, there are now close to 30 countries that have the capacity to produce nuclear weapons within two years.[10] There is also the issue that

[10] http://www.iaea.org/NewsCenter/Statements/2006/ebsp2006n018.html

we have not yet found a really safe and good way to dispose of the most radioactive waste from nuclear power plants. The nuclear energy debate remains an open issue. Clearly, although it has the potential to help fight climate change, there are dangers associated with it.

5 THE POSSIBLE CONTOURS OF A GLOBAL APPROACH

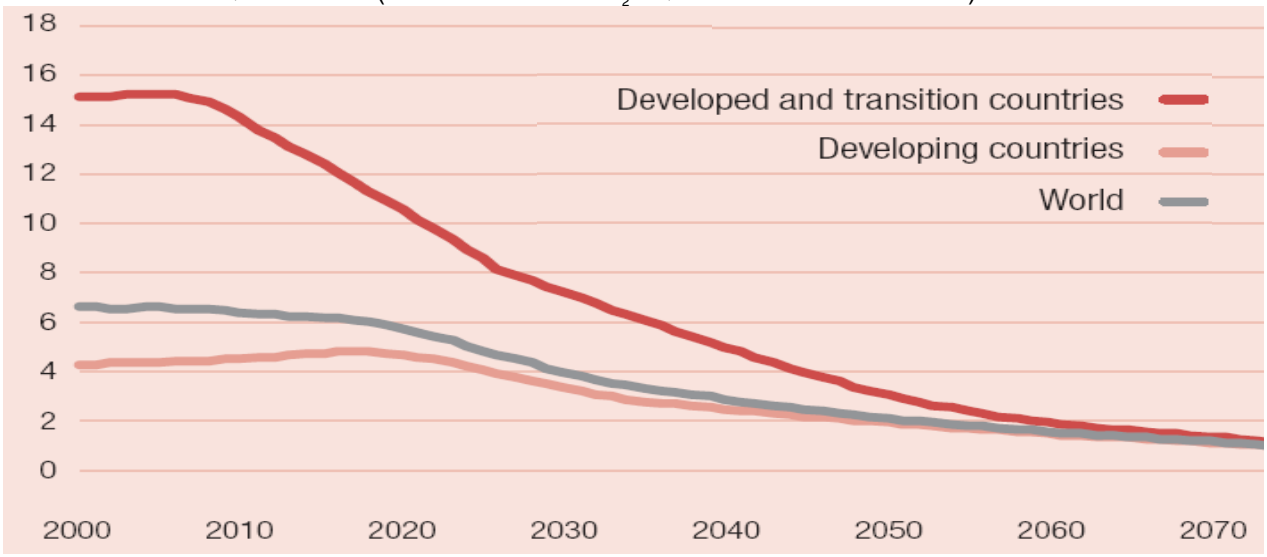
Addressing climate change requires that we design a process that takes the world to a stable and safe concentration level of greenhouse gas emissions, while at the same time achieving the proper balance across countries and over time in terms of the relative contributions to emissions reductions, and the need to expand access to energy, which is critical for development and poverty reduction. In my view, the process has to be based on the framework enshrined in the UNFCCC of common but differentiated responsibility, and allow for long term flexibility in implementation.

In this section, I first elaborate on what I mean by these two principles of differentiated responsibility and long term flexibility. Second, I place the discussion of mitigation and adaptation to climate change under the broader analytical framework of the provision of global public goods and development assistance for poverty reduction. This framework is helpful when thinking about the type of policy options to address climate change, and to generate broader insights into other types of challenges that the international community faces which bear some analytical resemblance to climate change. Finally, I discuss a key element of any global approach to address climate change, which will have to, in some way, include the implementation of market based approaches (mainly cap-and-trade and carbon taxes) to mitigate climate change.

5.1 Differentiated Responsibility and Long Term Flexibility

As outlined earlier, the goal in terms of overall emissions is to take the world, gradually, to about two tonnes of CO_2 equivalent per capita on average. We are currently very far from having an equal average for developed and developing countries (Figure 7). Aiming at an emission target of roughly two tonnes of CO_2 equivalent per capita globally seems to be prudent and perhaps a fair and acceptable policy. As mentioned, if the rich countries take the very ambitious goal of reducing their emissions by 80 per cent from 1990 levels, then arithmetically this leads to a 20 per cent reduction by the poor countries.

FIGURE 7
EMISSIONS PER CAPITA FOR STABILIZING CONCENTRATIONS AT 450 PPM CO_2 EQUIVALENT (IN TONNES OF CO_2 EQUIVALENT PER CAPITA)



Source: UNDP (2007) based on Meinshausen (2007).

For developing countries a 20 per cent reduction is actually a very ambitious policy goal as well, since they have to cut emissions from a much higher level than they were in the 1990s. But arithmetically it is hard to arrive at another solution because it is difficult for the rich countries to go beyond cuts of more than 80 per cent. Importantly, this is an average for developing countries: it does not imply that every developing country has to cut emissions by 20 per cent. There will be a need for country differentiation, namely taking into consideration some of the elements that have been discussed.

These reduction targets mean that per capita emissions are eventually equalized. The HDR scenario of 80 per cent reduction for rich countries and 20 per cent reduction for poor countries will actually lead to a world wherein 2060 emissions are equalized on a per capita basis. This kind of target might also be acceptable to developing countries. India's official position at Bali was: 'We will never emit more than the rich countries'. In a sense India is saying: 'Let us go for an equal per capita type of policy'. In the short term that is impossible as one cannot expect the US to reduce emissions per capita drastically. The two tonnes of CO_2 equivalent per capita target is more of a mid-century goal that would seem both possible and fair.

However, some flexibility has to be retained: this cannot be a mechanical goal. In general, the whole approach to climate change has to recognize the differentiated responsibility of countries and the long term flexibility that is required. Differentiated responsibility, because countries have different income levels and different historical contributions to the problem.[11] There are also differences in

[11] For a discussion on climate justice see, for example, Roberts and Parks (2007).

terms of countries' resources and how they can tackle these issues. Moreover, developing countries have huge energy needs that need to be met. There are also differences due to geographical circumstances. For example, countries have very different exposure to high and low temperatures. It would seem somewhat unfair to ask countries exposed to extreme cold (Iceland, for example) or extreme heat (Saudi Arabia, for instance) to reduce emissions by more than countries in more temperate climates (such as those bordering the Mediterranean).

So one cannot be an extremist when targeting equal per capita emissions. Some adjustments due to geographical circumstances are going to be needed. It is a broad guideline for the kind of targets and framework we are heading for; it cannot be taken that every person in the world will have to agree to emit the same amount of CO_2. And differences in natural resource endowments have to be taken into account, particularly if emissions are measured based on production. As mentioned earlier, if a country has big extractive industries exporting their products, then a production based carbon measure will always mean that that country will emit more. A consumption based approach might correct that problem.

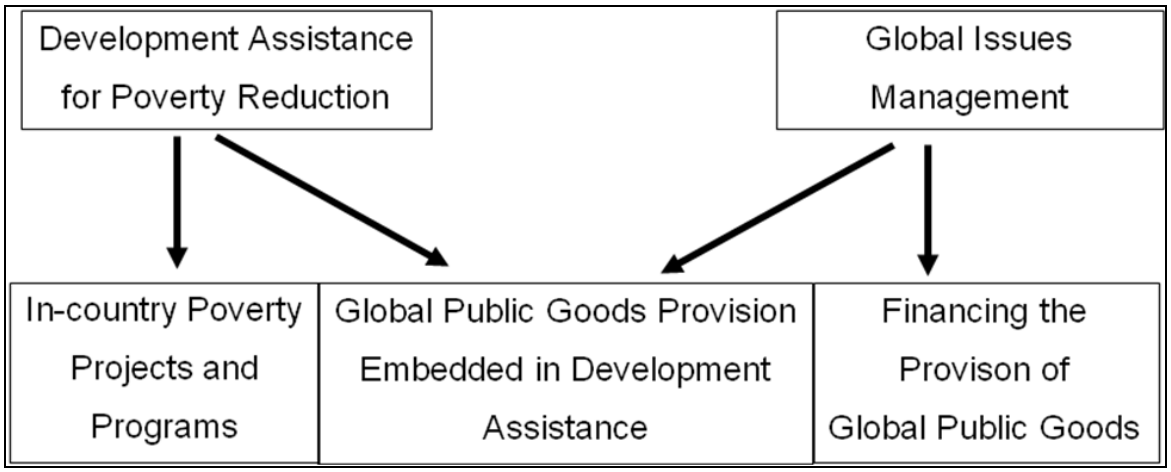
5.2 Poverty Reduction and the Provision of Global Public Goods

The debate on climate change offers a good illustration of the two kinds of activities that the international community and the UN are involved in and that are sometimes confused (Figure 8). One dimension relates to 'development assistance for poverty reduction'. Basically resources are generated by the international community to fight poverty. There is an ethical/distributional foundation to it: the objective is to help the poor based on an ethical/political belief that one should not leave people in extreme poverty. There are some indirect global benefits from that assistance, but the primary objective is to help poor people. That is one major objective of 'development assistance', and this leads to poverty projects and programmes in developing countries.

The other dimension relates to 'global issues management' or the provision of global public goods.[12] By mitigating climate change, a global public good is provided from which everybody will benefit. By reducing the risks of nuclear 'accidents' or nuclear terrorism, a global or at least a regional public good is provided. By preventing the avian influenza virus from mutating from animals to people, everyone benefits without distinction of location and country. The resources spent on global public goods conceptually have a different objective than the resources that are spent on poverty reduction.

[12] For more on global public goods see, for example Kaul et al. (1999); Kaul et al. (2003); Sandler (1997; 2004); and International Task Force on Global Public Goods (2006).

FIGURE 8
TWO POLICY OBJECTIVES:
POVERTY REDUCTION AND PROVISION OF GLOBAL PUBLIC GOODS



Source: Adapted from UNDP (2006).

Often these two dimensions are both present: as illustrated in the middle part rectangle in Figure 8; there are many global public goods that are embedded in development and poverty reduction programmes. Two examples will help clarify (Table 6).

The first example uses the illustration of climate change. If the developed world gives assistance for climate-proofing and adapting poverty reduction to climate change, this will help the poor. This includes, for example, protecting people against floods in Bangladesh. This is a climate- and adaptation-related expenditure that directly helps these poor people, but does not necessarily have the direct immediate feedback effects that are characteristic of a global public good, which would bring direct benefits to people living in Helsinki or in New York. On the other hand, if the developed world generates a new clean technology (for example carbon capture for coal plants), then by inventing the new technology we are protecting the atmosphere by not adding to greenhouse gas emissions. The production of that technology in itself is a true global public good because everybody can benefit from it. So the expenditure of developing that technology would be part of providing a global public good. In the middle, if India is helped to finance new energy plants with more recent technology that reduces the actual greenhouse gas emissions coming from these plants, then two things are done at once. One, India is helped to tackle its energy needs, helping the people in India to have greater access to energy. But second, the overall climate impact, through providing a global public good, is also mitigated.

TABLE 6
ILLUSTRATIONS OF THE TWO POLICY OBJECTIVES:
ADDRESSING CLIMATE CHANGE AND AVIAN INFLUENZA

Development assistance for poverty reduction	Global public goods provision embedded in development assistance	Financing the provision of global public goods
Assistance for climate proofing and adapting poverty reduction to the effects of climate change	Financing energy efficiency and renewables in poor countries	Development in new clean technologies
Compensation to the poor for the culling of birds	Reduction of the probability of virus mutations that could pose a global threat	Production of vaccine against avian influenza

Source: Adapted from UNDP (2006).

The second example is related to avian flu. If peasants who cull their birds in Indonesia and Vietnam are compensated, they are helped in terms of poverty reduction. These are poor people, and the birds were their livelihood, so compensating them is a poverty reduction activity. If on the other hand, we produce a vaccine against the avian influenza virus to immunize people around the world, then that is similar to the carbon capture technology mentioned above: it is really a global public good. If we support programmes in Indonesia and Vietnam, including the culling of birds, which actually reduce the potential for the virus from mutating from animal to human then we are both helping the poor people of these countries but at the same time we are also producing a global public good as we are preventing the avian influenza virus from mutating.

This conceptual distinction is important to keep in mind, particularly with regard to the debate about development assistance and the Millennium Development Goals (MDGs). Now that we know that climate change is a growing threat to all of humanity, and a more immediate threat to the poor, then looking at expenditures for mitigation and adaptation, we have to keep in mind these two dimensions. On the one hand, we have to increase development assistance and adaptation assistance to help fight poverty because the poor are more exposed than we thought and more vulnerable than we thought 10 years ago *vis-à-vis* floods, extreme weather events, loss of agricultural productivity, and other effects of climate change. At the same time (on the other hand), there is the global public good of climate stability, which requires stabilizing concentration levels of greenhouse gases in the atmosphere. So by helping India to produce energy in a cleaner way, the whole world is helped and we are contributing to a global public good.

The kind of approach that would seem to make more sense is to have resource channels considering these two dimensions. First, there has to be development assistance for the poorest countries and the poorest people, as there is already. But we actually need to increase development assistance because the needs for

adaptation and the effects of climate change make the fight against poverty even more difficult than before. Second, and this is an issue at the forefront of the agenda, there is the need to provide concessional grant-like resources to many middle income countries to help them choose the energy path that will help mitigate climate change and provide a global public good.

In fact, over the last few decades there has been an increasing movement to provide official development assistance (ODA) to the poorest countries, forgive their debts, and provide them with grants. The International Development Association (IDA) resources of the World Bank have become even more grant-like. For middle income countries, the argument was that they should take care of their own poor people. I do not agree with this argument because I believe that these poor people also deserve some international solidarity. But beyond solidarity, there is also a global public good-like argument for actually channelling concessional resources to middle income countries. Suppose that some middle income country is going to build a power plant that will cost US$500 million. If it does so with old technology, which will lead to significant carbon emissions, it will cost US$500 million. If it uses new clean technology to capture the carbon it might cost US$550 million rather than US$500 million. The extra US$50 million for that programme of investment should be paid out of a resource that funds global public goods. It would be unfair to ask the middle income country, emitting much less per capita than rich countries, to pay for that extra public good that everybody will benefit from. So the US$500 million should be financed by the middle income country, by its national private or public sectors, or by foreign investors coming in with commercial terms for building that infrastructure. There is no public good argument for financing the plant itself with concessional terms. But the incremental cost for making that plant a clean investment (and thereby mitigate and provide the public good to the whole of humanity) should be provided by the international community. In that sense we must find mechanisms of concessional financing for development projects in middle income countries that have important global public good characteristics. That is why it does make sense to have concessional funds at the UN or at the World Bank not just for the poorest countries, but also for middle income countries, in the interests of the citizens of rich countries. This is something that is becoming much clearer; we must now find the financial engineering and mechanisms that will allow this to take place. Since Kyoto this mechanism has basically been the cap-and-trade system.[13]

[13] In fact, this is the logic of funding under the Global Environmental Facility (GEF).

5.3 Market-based Approaches to Mitigate Climate Change

It is worthwhile ending this section by summarizing the two major market-based approaches for mitigating climate change: cap-and-trade and carbon taxes. These two approaches, in isolation or combined in some fashion, will certainly be a key element in moving forward with a global approach to mitigate climate change.[14]

Cap-and-trade means that an emitting entity is given an emission target (a cap) that is legally binding, but there is flexibility in how this cap is met. That is, trade is allowed, with those that stay below the cap being able to sell the 'excess permit' given their actual emissions, and those that emit above the cap needing to buy permits to cover their emissions. The reason why trade is beneficial from a global economic point of view is that it is much more efficient to reduce carbon emissions where these reductions can be achieved at lowest cost. So by allowing emissions permit trading, two objectives are achieved: (1) emissions are kept at a desired level because the caps ensure an upper limit to the overall level of emissions; and (2) the emissions limit is achieved in the cheapest possible way.

So cap-and-trade is an effective and efficient mechanism, and gathers a lot of support for being a major part of the overall mitigation strategy. It has other advantages. It builds on existing practice. People are beginning to understand it, and therefore having a global agreement that has an important cap-and-trade component will be a logical extension of what was achieved during Kyoto. The other main advantage is that it allows resource transfers across the private sector. In other words if a Norwegian, Finnish, German, or American firm invests in a carbon reduction project in Brazil, India, or in Benin, the resource transfer happens directly from the private firm to the investor in the developing country. It does not need to travel through the public budget. For many political and practical reasons this is a big advantage because having all the resource transfers through public budgets is going to be very difficult and probably politically unfeasible. Having some of these resource transfers occur through market mechanisms and directly from the private sector is the major advantage of a cap-and-trade system.

But cap-and-trade also has its disadvantages: it can lead to price volatility. Whenever there are quantity restrictions, prices are typically more volatile because adjustment in changes in supply and demand will have to take place through prices, given that quantities are fixed. This may be particularly problematic given that the prices that are likely to be volatile are linked to fossil fuels and other sources of energy which are critical across the economy (Shapiro 2007). There are also disadvantages in terms of measurement and administration, particularly if trading requires the measurement of the actual reduction in emissions rather than just the

[14] There is extensive literature on this subject; only some aspects of these instruments will be covered in this section. For further reading, refer to Cooper (2000); Mansur (2007); McKibbin and Wilcoxen (2002); Nordhaus (2007); and Weitzman (1974), amongst others.

emissions themselves as is the case in the current Clean Development Mechanism (CDM), because there are as yet no caps for developing countries. Some of these measurement problems can lead to strategic behaviour and gaming. For example, some projects in developing countries could be projected in the worst possible way, and then the agreement not to pursue this worst possible investment could be presented as a carbon reduction project: maybe the developing country never intended to building that particular power plant but by presenting it as such and asking for a resource transfer in order not to build it, they gain the resource. There is serious criticism of the CDM mechanism based on this type of strategic behaviour. The problem would be reduced if there were binding caps on all, because the basis of trade and compensation would not be on a reduction of emissions compared to a hypothetical baseline, but on the emissions themselves, however generated. Nonetheless, a proper and efficient carbon trade or cap-and-trade mechanism would require a strong administrative structure that measures emissions in a reasonable way.[15]

The other market based approach to mitigation that many economists favour is carbon taxation. Carbon taxes raise the price of carbon based energy directly, imposing the costs on those firms and economies that produce emissions. In this way these carbon emitters have direct incentives to reduce their energy use or substitute cleaner alternative energy, until the cost of doing so is greater than the tax. Carbon taxes are administratively simpler. Carbon taxes would not allow the kind of strategic behaviour that the cap-and-trade might lead to. Many economists make the comparison of cap-and-trade and carbon taxes to quotas and tariffs. Carbon taxes lead to much leaner administrative mechanisms. They can indirectly control emissions because quantities are not directly targeted but rather via prices. Prices can then be adjusted if the targeted amounts of emission reductions are not being achieved. The revenues of carbon taxes would naturally accrue to the public sector. That can be considered both an advantage and a disadvantage. It may be an advantage in terms of transparency, or some finance ministers might think it is a good thing as they get higher revenues. Alternatively it is politically a disadvantage because taxes are unpopular and the resource transfer to developing countries is not direct as in the cap-and-trade mechanism. With carbon taxes, these public revenues have to be ear-marked or given to the developing countries, leading to political problems linked to that transfer. Developed countries would have to pass budgets in parliaments, allowing quite large transfers to developing countries. These transfers are in the tens of billions of dollars, maybe even the hundreds of billions of dollars.[16] It is a substantial amount of money, but the political process of budgets may be difficult.

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15 Shapiro (2007) also points out that cap-and-trade additionally creates a serious potential for private financial manipulation as the national and international trading of billions of dollars of permits will attract large financial institutions eager to create new financial instruments based on the permits.

16 See UNFCCC (2007).

With carbon taxes there is also the issue of determining the base line in terms of international comparisons. For example, if the US and EU agree tomorrow to a carbon tax of US$50 per tonne, would an equal tax be fair? Some people would agree: US$50 for the US and US$50 for the EU. But others would disagree and argue that in the US the tax should be higher as it has much lower taxes on gasoline and many other energy products than Europe does. Europe, by presently taxing some of these energy products at a high level already has, in a sense, an indirect carbon tax. So where is the baseline against which you compare the US$50 carbon tax? Some would argue, given the high price of energy in Europe, the carbon tax should be US$20 or US$30 and the tax in the US should be, say, US$70. These examples show that it is not so easy to agree on the comparability of carbon taxes.

As noted, carbon taxes would not allow the kind of strategic behaviour that cap-and-trade might lead to in some cases; and in that sense it would be fairer, as everyone would face the same kind of costs. The same costs within the same country but not across countries. Carbon taxes across countries would not start from the same level, they would have to gradually equalize over time. Otherwise the burden put on developing countries would be too large. These are some of the advantages and disadvantages of the two different approaches being debated.

In the end, the same underlying principles of flexibility and differentiation that should provide the foundation for an overall global approach to mitigating climate change will have to apply to the choice between the use of these two market based approaches. Perhaps the wisest way forward is to use both in combination, based on feasibility and effectiveness considerations.

6 CONCLUSION

To conclude, I would like to emphasize the following. First, I think we need strong ambition. Climate change is a serious problem and it is growing. At this point there is a lot of talk, but there is still not much action. Given the very large risks ahead of us, and given the huge development implications for the poorest people, we must have strong ambition in terms of climate change policy. Strong ambition means strong policy, but also timely action. We cannot delay the response any longer.

At the same time, we must firmly accept that there are common but differentiated responsibilities. All countries have a common problem: it is a problem for humanity and for the whole world. The responsibilities of this problem in terms of past actions, as well as the ability to respond, vary amongst countries. One cannot ask the same from all countries: there will be differences in commitments. The kind of firm targets that are needed and are feasible in rich countries cannot be brought along with the same timetable in the developing countries. Europe has acted quite courageously: the most recent proposal by the European Commission is quite ambitious. In the US there is going to be a lot of change and a lot more proactive climate policy will emerge. The same also applies to Japan.

In developing countries it will take more time because they need to be convinced that they can grow and develop to meet the needs of their people and at the same time do it in a climate responsible way. Developing countries need to have the financing mechanisms not just in theory but in practice. Promises are not enough. The developed world has to generate these mechanisms before they can ask developing countries to accept the tough responsibilities that they also eventually will have to accept. There will also be a differentiation in terms of timing. Rich countries and the international community have to show in very concrete terms what they can do for developing countries before a deal can be reached where they are full participants. There needs to be flexibility in terms of the targets, in the way they are formulated, and we also need to think about consumption and production measures. We need to think increasingly in per capita terms, but we have to be careful not to make this into a mechanical target. Adjustments have to be made worldwide for specific historical or geographic circumstances just as the European Union countries have done.

We will need multiple instruments: there is no silver bullet. Both carbon taxes and the cap-and-trade mechanism are needed, together with energy efficiency, energy standards, and the various financing mechanisms, including those that will be required to address emissions related to deforestation and land use change. We need to have more of both public and market based transfers. Some adaptation needs of the poor and developing countries will have to go to the public budget as official development assistance. But a lot of the shared mitigation costs will have to go through market mechanisms, using the private sector. The public sector alone

cannot achieve the magnitudes required. The financial engineering, the market regulation, and market building that go with this will require a lot of attention. And administratively, we have to do this as efficiently as possible.

Finally, I will say that we do need a global framework. If some countries opt out now, others will eventually opt out, leading to an unravelling of a common approach. There are some people that argue that the big actors should get together and negotiate and reach a deal among themselves. I am not arguing that all the debates and all the negotiations should take place in a big room with 190 countries present. A lot of the action may have to take place between the big actors, the EU, US, Japan, Russia, and China. They have to get together and find ways and areas around which they can reach compromises. But there is always going to be the question of who is not included? Do we include India in the big actors' negotiation? While some would agree because of India's size and importance in the world economy, and in terms of its emissions, there is also an argument not to include India because it is not as developed as China, and in per capita terms it has much lower carbon emissions. But if we do include India, there will be other countries. Should we include the Republic of Korea? And Brazil should probably be included because of the forest issue. Indonesia also is important. So, there is no easy way of ring-fencing the set of 'important players'. We need parallel approaches. On the one hand we need a global framework that should be under the auspices of the United Nations, as it has been. But on the other hand we need to have the flexibility and the space for some actors to get together to work on compromise solutions, even some bilateral talks may be useful. We need this two-track approach: we need the global framework, the UN framework, the universal participation; but we also need the dynamics that a small number of players could create to move us forward.

These are my perspectives on this very complicated topic. I must confess to you again that I am a relative neophyte on this topic and I did not work on it much until about two years ago. As a macroeconomist and development planner I was focusing on other issues, as many other economists did. But I think we now have a situation where when we think of development, when we think of growth, when we think of global public goods, we cannot ignore climate change. Climate change has become a central issue that we have to tackle; it is a central issue for this century.

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