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Climate Change and Development: Interlinked Challenges and Opportunities

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Climate Change and Development – Interlinked Challenges and Opportunities

Introduction

Climate change is increasingly regarded not only as an environmental or intergenerational sustainability issue but also as a development concern. Climate change and development are closely linked. Responding to climate change is required for inclusive economic growth, poverty reduction, and development over the long run. The effects of climate change are not homogenous: they will affect the poorest more quickly and more deeply. Promoting development is also necessary to meet the climate change mitigation and adaptation needs that require significant resources and capacity.

In a very deep sense, the climate change agenda is the United Nations agenda. It is a global agenda to ensure the integrity of our planet, to mitigate further accentuation in global inequality and poverty, and to reduce the sources of conflict that may emerge around climate-induced forced migration, water scarcity, or competition for land and resources.

This paper maps some of the linkages between climate change and development, both from the point of view of the challenges associated with each other as well as the opportunities that emerge from having a more integrated perspective. The paper contains three interrelated sections. First, the paper reviews recent findings of climate science since the publication of last Intergovernmental Panel on Climate Change (IPCC) report. The new evidence on sea level rise, land and ocean surface temperature increases, suggests that climate is changing faster than what the latest IPCC indicated would be the more likely path.

Second, the paper maps various links between climate and development. This shows that climate change and development are integrated, so that, for example, national development strategies and official development assistance have to be climate-proofed. The climate mitigation and adaptation needs of developing countries have to be supported by the right type of incentives and also by new, additional and adequate resources channeled from richer countries.

The third part of the paper explores ways of combining the development and climate agendas by addressing questions such as: What are some estimates of the mitigation potential from new and low-carbon technologies? Is the current global economic and financial crisis actually creating an opportunity for a green stimulus? Finally where is the money coming from? Along with many others, the paper argues that new, additional and significant public funding from developed countries is definitely needed, but nurturing and expanding carbon markets, at national, regional and global levels, will be equally important considering the huge funding potential the private channel could generate for developing countries' climate activities. Pricing carbon is critical to unleash these financial flows and to set in motion the type of incentives that drive investments for meaningful climate change mitigation.

1. Recent Evidence on the Pace of Climate Change

Global efforts to mitigate climate change have been guided by updated climate change evidence. IPCC (2007) reports numerous observed long-term changes in climate. These include changes in arctic temperatures and ice, widespread changes in precipitation amounts, ocean salinity, wind patterns and extreme weather events including droughts, heavy precipitation, heat waves and intense tropical cyclones. Unequivocal warming of the climate system is evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level.

Since the publication of the latest report by IPCC (2007), new evidence from physical climate science has emerged to indicate some climate indicators are changing near the upper bound of the IPCC (2007) projection range. Some aspects of climate change are progressing faster than was previously thought. This section reviews some of the latest evidence.

For example, Richardson et al. (2009) show sea level rises at greater rates than indicated by IPCC (2007). Figure 1 shows change in sea level from 1970 to 2008 relative to the sea level in 1990. The rate of sea-level rise has increased in the period from 1993 to the present, rising near the upper bound of the IPCC (2007) projections. Pfeffer et al. (2008) predict a best guess of about 0.8 meters sea level rise by 2100. Grinsted et al. (2009) use a moderate climate change scenario (IPCC's A1B emission scenario) to project a range of 0.9 to 1.3 meters of sea level rise in 2090 to 2100 (see Figure 2). Dahl-Jensen et al. (2009) use the new observation data of the increasing loss of mass from glaciers, ice caps and the Greenland and Antarctic ice sheets to conclude an alarming prediction of global mean sea level rise of 1 meter by the end of 21st century (2090-2099) compared to the end of 20th century (1980-1999), which almost doubles the IPCC projection made in 2007 (at a range of 0.18 to 0.59 meter rise for the 120-year period).

Domingues et al. (2008) and Church et al. (2009) report updated trends in ocean heat content and surface ocean temperature¹. Both studies find the ocean has warmed significantly in recent years. Domingues et al. (2008) plot a linear trend of global ocean heat content over the period of 1961-2003 based on updated global ocean heat content data. The new linear trend is 50 percent steeper than the linear trend previously reported by IPCC (2007) which implies a higher rate of multi-decadal warming (see Figure 3).

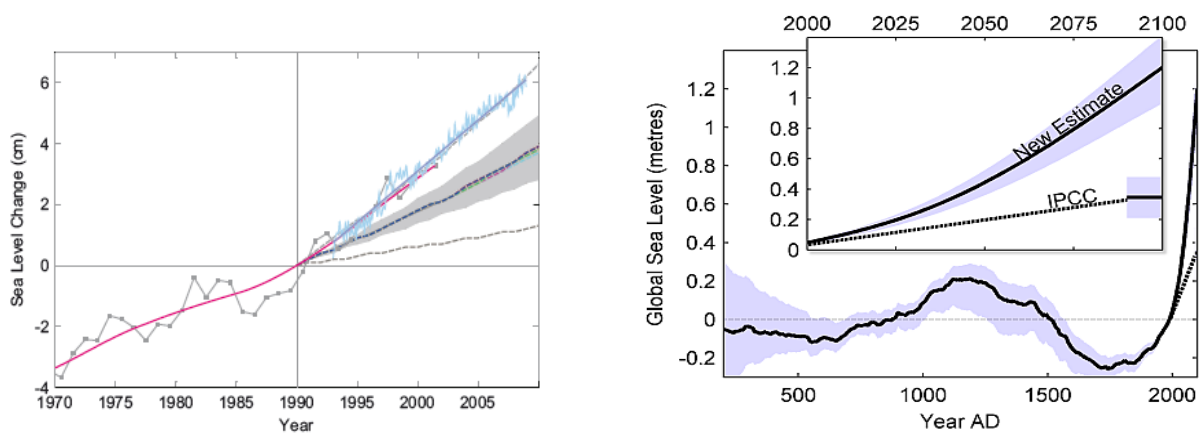
Sokolov et al. (2009) report new projections of surface temperature based on the MIT Integrated Global System Model. Compared to their year 2003 projection of 2.4 degrees Celsius warming, the new study projects a median probability of surface warming of 5.2 degrees Celsius in 2091 to 2100, with a 90 percent probability range of 3.5 to 7.4 degrees. Their stronger warming result is quite robust. Several factors contribute to the stronger warming projection, among which is an updated economic model of GDP growth projection that eliminate many low emission scenarios used in the earlier study.

¹ This is important as the climate is largely related to the flows of heat coming in and out of the planet and the storage of heat in ocean, land, atmosphere, and etc. The largest amount of heat has been stored in the ocean, and thus a change in ocean temperature will probably be a better indicator of climate change than a change in air temperature.

IPCC (2007) projects that a further warming of about 0.1 degrees Celsius per decade would be expected even if the concentrations of all GHGs had been kept constant at year 2000 levels. Continued greenhouse gas emissions at or above current rates would cause further warming and induce many changes in the global climate system. Plattner (2009) and Solomon et al. (2009) find some daunting evidence that climate change may be irreversible for long time. Their studies suggest that even we cut greenhouse gas emissions to zero today it will take more than 1000 years for the global average surface temperature to drop.

In 1996 the European Union set the goal of limiting warming to 2 degrees Celsius (3.6 Fahrenheit) above pre-industrial levels. In the latest La Quilla G8 summit, world leaders also agreed a goal of limiting global warming to 2 degrees Celsius. Drawing on the latest scientific, economic and social evidence on climate change, Richardson et al. (2009) emphasizes a warming beyond 2 degrees is dangerous and are likely to cause major societal and environmental disruptions through the rest of the century and beyond.

Figure 1 Change in Sea Level from 1970 to 2008, Figure 2 Projected Sea Level Rise (200-2100 AD) relative to the sea level at 1990

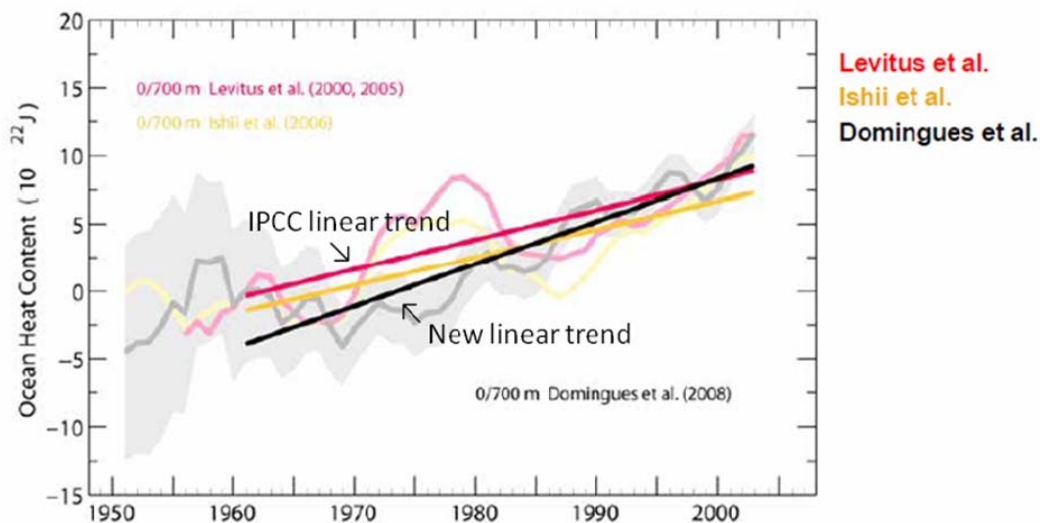


Source: Richardson et al. (2009), p. 8, fig. 1.
 Note: The solid lines are based on smoothed observations (light lines connect data points). The envelope of IPCC projections is shown for comparison.

Source: Grinsted et al. (2009), fig. 7.
 Note: Projections are based on IPCC A1B emission scenario and Moberg et al. (2005) temperature reconstruction data.

Harry, Lowe and Hanson (2009), however, warn that even with the most and stringent emission reduction action to achieve peak emissions in 2015, it is still likely to overshoot our current temperature targets of 2 degrees Celsius. If global emissions climb until 2025, the authors' projected peak median temperature will rise to 2.5 degrees Celsius; if global emissions peak in 2035, the projected median temperature will be as high as 3 degrees Celsius. For adaptation purpose, the authors recommend to prepare for a warming scenario of 4 degrees Celsius or higher.

Figure 3 Global Ocean Heat Content



Source: Domingues et al. (2008).

Note: Levitus et al. (2005) and Ishii et al. (2006) are two studies used in IPCC (2007) on long-term ocean heat content.

It is also worthy to mention that the long-term nature of climate change, coupled with the complexity of climate systems, implies that while we know that climate is changing, we do not know how fast and how far the implications from this change will be with certainty. Even with much progress made on climate science in the past decade, there still exists a wide range of uncertainties on the future course of climate change, which includes uncertainties on baseline emission projections, how emissions accumulate via the carbon cycle into atmospheric concentrations, how and when atmospheric concentrations translate into global mean temperature changes, and how global mean temperature changes decompose into regional temperature and climate changes, among others..

But the catastrophic effects of climate change that could threaten the whole of humanity even may not happen immediately but are definitely possible. The updated climate evidence reveals 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 climate warming—if ever, in some cases—could be reversed. This justifies taking action now as insurance against possible catastrophic effects that would affect everybody. The greater are uncertainties, the greater is the risk of waiting. As Quiggin (2008) concludes that “the more uncertain we are about the outcomes, the more certain we should be about the need to take action that reduces the rate of climate change.”

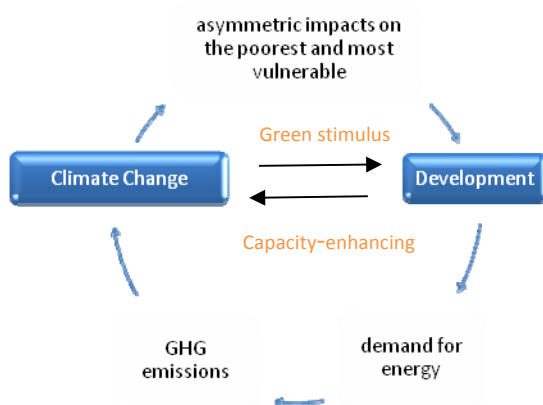
2. Climate and Development: Mapping the Linkages

Avoiding an uncertain yet possible future climate catastrophe is one reason to tackle climate change. Another important reason is that we now know with certainty that climate change will have a more immediate impact on many of the poorest people in the world. “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 on development and help those affected to mitigate and adapt to climate change” (Dervis 2008). If no mitigation and adaptation action is taken, climate change may not only threaten to unwind the development progress hardly made so far but also impact development today and development prospects tomorrow.

Climate and development are closely related (Figure 4). Historically, industrialization and accompanied economic growth is linked to fast demand for energy, especially fossil fuels, and an increase in greenhouse gas (GHG) emissions. GHG emissions, especially energy-related CO₂ emissions and the resulting progressive rise in atmospheric concentrations of GHGs is the major cause of climate warming (IPCC 2007). Climate and development is also related because impacts of climate change will be heterogeneous across countries with developing countries suffering most rapidly. Moving forward, developmental efforts have to be made consistent with concerns about climate change mitigation and adaptation.

Climate change and development are not only interlinked challenges. There is also interlinked opportunity (Figure 4). For example, a green stimulus that address climate change challenges may also help create jobs and economic gains that can help poor countries reduce poverty and embark on a more sustainable development path. And a sustainable development, feeding back, will also make mitigation and adaptation easier as a sustainable economy is able to enhance its mitigation and adaptation capacity (IPCC 2007).

Figure 4 Mapping the Linkages between Climate and Development



Source: Own elaboration.

2.1. Growth-Induced Emissions and Climate Change

IPCC (2007) cites strong evidence showing that most of the observed increase in global average temperatures since the mid-20th century is very likely due to observed increase in anthropogenic greenhouse gas concentrations.² Global atmospheric concentrations of GHGs have increased rapidly since the beginning of industrialization and now far exceed pre-industrial values as a result of human activities. Carbon dioxide (CO₂) is the most important GHGs. The global increases in CO₂ concentration are due primarily to fossil fuel use and land use change.

Developed countries emitted most of the historical GHG emissions. Annex 1 countries accounted for 75 percent of total energy-related CO₂ emissions for the period of 1850 to 2005.³ Today's richest countries have the overwhelming responsibility for the accumulated stocks of GHGs in the atmosphere. Even if we look at today's emissions—that is, flows rather than stocks—rich countries remain important emitters.

But it is also true that most of the growth in GHG emissions over the last four decades took place in developing and transition economies (UNCTAD 2009). For example, global CO₂ emissions increased by 51 percent from 1980 to 2005, Annex 1 countries CO₂ emissions grew by 6 percent while Non-Annex 1 countries' CO₂ emissions grew more than 170 percent.

2.2. Climate Change-Induced Development Challenges

The impacts of climate change vary depending on where one lives. Climate change imposes asymmetric impacts not only on economic development but also on human development (Figure 4). If we exclude extreme consequences of warming, such as the catastrophic events that are likely to leave every country and virtually every person worse off, climate change affects different regions and different groups of people differently.

Some impacts could be beneficial in some locations for some time with a few degrees of warming, but most impacts are expected to be adverse (UNDP 2007). Poor developing countries are particularly vulnerable to the adverse impacts of climate change because many of these economies depend on sectors that are susceptible to climate fluctuations, such as agriculture, fisheries, forestry and tourism. Poorer countries are also less capable of adapting to the adverse impacts of climate change. The poorest countries and people are suffering the most in terms of the effects of climate change, and this pattern is likely to persist in the future. If this pattern does persist, climate change will hurt economic growth, drive income divergence and deepen global inequalities.

The exposure of the poor to extreme weather risks is heavily skewed towards developing countries. The studies show that 1 in 1,500 people were estimated to be affected annually by climate disasters in OECD countries between 2000 and 2004, but in developing countries as many as 1 in 17 people were affected (Anthoff and others 2006, Dasgupta and others 2007, and UNDP 2007).

² Discernible human influences now extend to other aspects of climate, including ocean warming, continental-average temperatures, temperature extremes and wind patterns (IPCC 2007).

³ It is calculated based on Climate Analysis Indicators Tool (CAIT) Version 6.0. (Washington, DC: World Resources Institute, 2009).

There exists a large empirical literature studying the direct relationship between climatic shocks and economic growth. For example, the IMF (2003) finds that large-scale natural disasters have occurred on average once every 20 years in least developed countries (LDCs) over the 1977-2001 period, with an average impact on GDP ranging from -2.7 percent to -5.8 percent in the most recent (1997-2001) period. Since climate change may increase the frequency and severity of natural disasters, the IMF study suggests that climate change could strongly affect growth in developing countries, in the absence of mitigation or adaptation policies.

Dell, Jones and Olken (2008) compare individual country's historical temperature and precipitation data with historical growth data from 1950 to 2003 and find higher temperature substantially reduce economic growth in poor countries but have little effect in rich countries. In poorer countries, they estimate that a 1 degree Celsius rise in temperature in a given year reduces economic growth in that year by about 1.1 percentage points. In a follow up study, Dell, Jones and Olken (2009) use 12-country municipal data to find a negative within-country relationship between income and temperature, with a 1 degree Celsius rise in temperature associated with a 1.2-1.9 percent decline in municipal per-capita income.

The climate-development relationship is complex. Climate change could be a 'threat multiplier' that makes existing development challenges more complex and intractable (Brown and Crawford 2009). There have been research linking climate change to agriculture (Cline 2007), to food security (Batissi and Naylor 2009, Nellemann et al. 2009), to water scarcity (Böhner and Lehmkuhl 2005, Thompson and others 2002), to health (IPCC 2007), and to conflict (Brown and Crawford 2009), all of which have direct and indirect effects on economic activity.

Cline (2007) predicts that developing countries will suffer an average 10–25 percent decline in agricultural productivity by the 2080s, assuming 'business as usual', and ignoring carbon fertilization. Declines in agriculture productivity 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.

Batissi and Naylor (2009) exhibit that it is very likely (greater than 90 percent in probability) that the tropics and subtropics will experience unprecedented seasonal (summer) heat by the end of the century. Thus many developing countries in the regions could experience significant losses of agriculture productivity. Using historical data⁴ on seasonal heat and crop yields, the authors illustrates the damage extreme seasonal heat may cause to regional and global food security.

Nellemann et al. (2009) warn that up to 25 percent of the world food production may be "lost", under a business-as-usual scenario, during the 21st century as a result of climate change, water scarcity and land degradation. Therefore it is very likely to have an even more volatile and escalating food prices and threaten the food security in many climate-vulnerable developing countries.

⁴For example, severe heat in the summer of 2003 resulted in a drop in maize yields by 36 percent in Italy and by 30 percent in France; a prolonged hot summer of 1972 caused a 13 percent decline in grain production in the former USSR.

IFPRI (2009) estimates that in some developing countries some crop yields in 2050 could be only half of their 2000 levels due to the effects of climate change, and under a business-as-usual scenario. Irrigation may not help as climate change is likely to hit irrigated systems harder. South Asia, the world's most heavily populated region, looks more vulnerable: IFPRI forecasts a possible 50 percent fall in its wheat yield by 2050 with no CO₂ fertilization effect (higher CO₂ concentrations in the atmosphere could help "fertilize" plant growth and increase crop yields) compared to 1990.

The negative effects of climate change on crop production are especially significant in Sub-Saharan Africa and South Asia between 2000 and 2050. In South Asia, climate change is projected to result in a 14-percent decline in rice production relative to the no-climate-change scenario, a 44- to 49-percent decline in wheat production, and a 9- to 19-percent fall in maize production (with no CO₂ fertilization effect). In Sub-Saharan Africa, the rice, wheat, and maize production declines with climate change are 15 percent, 34 percent, and 10 percent (with no CO₂ fertilization effect), respectively (IFPRI 2009). These estimates are all under a business as usual scenario.

IFPRI (2009) forecasts that between 2000 and 2050 climate change could result in additional price increases for agricultural crops: 32 to 37 percent for rice, 52 to 55 percent for maize, 94 to 111 percent for wheat, and 11 to 14 percent for soybeans (with no CO₂ fertilization effect).

There is also the likely impact of climate change on health. The IPCC (2007) projects 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. IFPRI (2009) finds that calorie availability throughout the developing world in 2050 is forecasted to be lower not only than in the no-climate-change scenario but also compared to 2000 levels (under a business as usual scenario). For the average consumer in a developing country, the decline is 7 percent relative to 2000 (with no CO₂ fertilization) if no action is taken to mitigate climate change. By 2050, the decline in calorie availability will increase child malnutrition by 20 percent (with no CO₂ fertilization effect) relative to a world with no climate change.

Climate change will hit some countries harder than others. ADB (2009) finds global warming under a business as usual scenario is likely to cause rice yield potential to decline by up to 50 percent on average by 2100 compared to 1990 in Indonesia, Philippines, Thailand, and Vietnam. For these four countries, the potential economic cost of inaction each year could equal a loss of 6.7 percent of their combined gross domestic product by 2100, more than twice the world average loss. Global warming could increase the number of deaths from heat-related cardiovascular and respiratory diseases relative to the estimated number of deaths from these diseases without climate change by as much as 2.9 percent and 12.4 percent by 2050 and 9.2 percent and 20.4 percent by 2100 in the four countries.

The economic development in some poor Asian and African countries is also threatened by increasingly severe water scarcity which is associated with the retreat of glaciers. Thompson et al. (2002) report tropical glaciers in Africa have decreased by 60 to 70 percent since the early 1900s. According to Böhner and Lehmkühl (2005), up to 80 percent of the glaciated area in Central and High Asia may be lost within this century with rising temperatures.

Climate-induced conflicts may also emerge through several channels (Brown and Crawford 2009). For example, deteriorating water scarcity may lead to increasing competition between different sectors, different communities and different countries. Increasingly unpredictable weather patterns could result in reductions in crop yields which will push food prices higher and fuel social tensions. Sea level rise, increased natural disasters and the shrinking viable agricultural land may cause large-scale and destabilizing forced migration. Combined with poor governance and existing ethnic division, the above stresses may tip fragile states towards socioeconomic and political collapse.

3. Integrating the Climate and Development Agendas

The climate and development agendas are to be integrated. The United Nations Secretary General suggests capturing an unprecedented opportunity to map out a more sustainable economic future in the coming Copenhagen climate negotiations. As developing countries are the most vulnerable to climate change which they bear the least historical responsibility, advanced economies are expected to lead the way in cutting their emissions and channel resources to help developing countries undertake mitigation and adaptation and embark on a sustainable low-carbon growth pattern. Developing countries will integrate addressing climate change into their development planning process to better tackle the two daunting challenges.

In this section, we first look at the mitigation potential from adopting energy efficient and low carbon technologies. Then we will argue a low-carbon growth path that integrates mitigation and development is the one needed for a sustainable global economic growth. In response to the current financial and current crisis, many countries have announced big fiscal stimulus including extensive spending on “greening” technologies and energy efficiencies. We therefore will take a look at economic crisis and green stimulus. The last part focuses on financing for an integrated development and climate change agenda, analyzing the potential financing needs and financial mechanisms to meet the needs.

3.1 Bottom-Up and Top-Down Approaches

Technology is essential to climate mitigations. To estimate the mitigation potential of different energy efficiency and low carbon technologies, it is possible to follow either a bottom-up approach, which focuses on different sectoral technologies and their contribution to energy efficiency and emission reduction, or a top-down approach, which focuses on the economy as a whole and studies the interactions among energy, environment and economy at the macro level. IPCC (2007) uses both approaches and finds that at the global level the two approaches yield very similar results in estimating total emission mitigation potential (see Table 1 and Table 2).

Despite recent rapid technological developments, focusing on energy efficiency and low carbon technology alone may not be enough to achieve the goal of limiting global warming to 2 degrees Celsius above pre-industrial levels. In our opinion, it is also important and necessary to consider revamping the old model of economic growth, reexamining the western consumption habits of energy, creating policy interventions that could help create incentives for more climate-conscious household and firm behaviors.

McKinsey (2009), one of the latest reports adopting the bottom-up approach to estimate the global emission mitigation potential, look at mitigation potential across 10 sectors (power, petroleum and gas, cement, iron and steel, chemicals, other industry, transport, buildings, waste, forestry, and agriculture). Identifying all the technical mitigation measures costing less than €60 per tonne of CO₂ equivalent (see

Figure 5), McKinsey (2009) finds a global mitigation potential of 38 Gt CO₂ equivalent in 2030, which will bring global emissions to 32 Gt CO₂ equivalent. This is a 55 percent cut compared with the business-as-usual (BAU) scenario in 2030 (70 Gt CO₂ equivalent), 30 percent emission cut from 2005 global emission levels (46 Gt CO₂ equivalent), and 11 percent emission cut from 1990 levels (36 Gt CO₂ equivalent).

Table 1 Global Mitigation Potential in 2030 Estimated from Bottom-Up Studies

Carbon price (US\$/tCO ₂ -eq)	Economic potential (GtCO ₂ -eq/yr)	Reduction relative to SRES A1 B (68 GtCO ₂ -eq/yr) (%)	Reduction relative to SRES B2 (49 GtCO ₂ -eq/yr) (%)
0	5-7	7-10	10-14
20	9-17	14-25	19-35
50	13-26	20-38	27-52
100	16-31	23-46	32-63

Source: IPCC (2007), Summary for Policymakers, p. 9, table SPM.1.

Table 2 Global Mitigation Potential in 2030 Estimated from Top-Down Studies

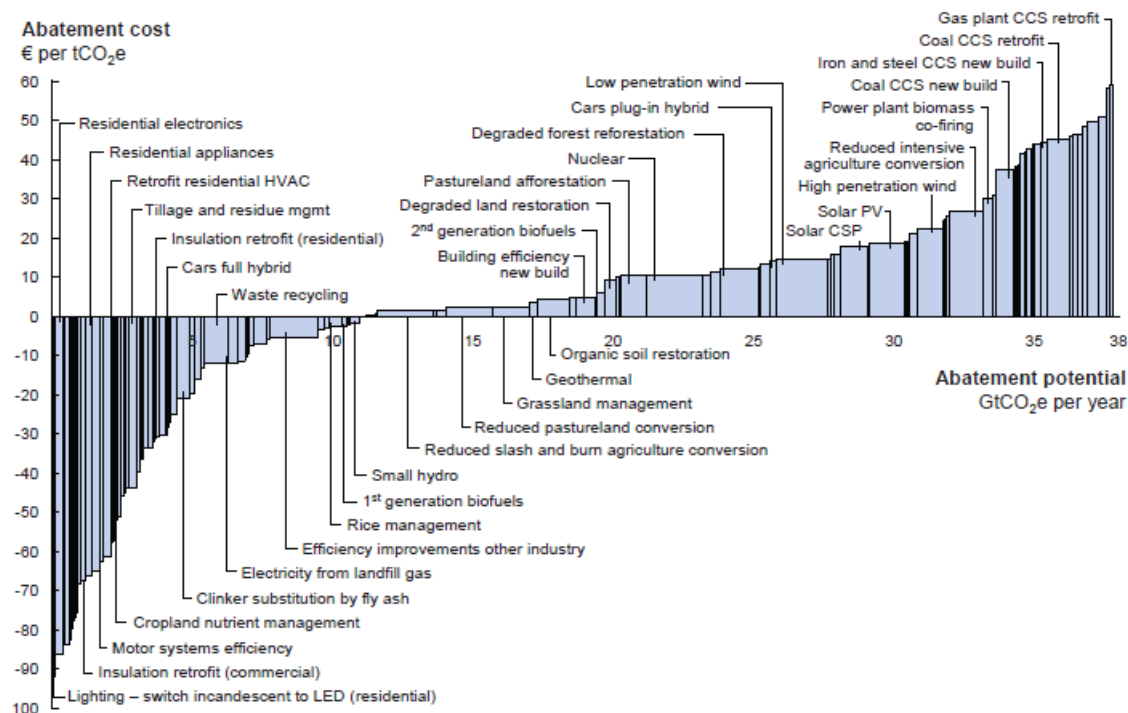
Carbon price (US\$/tCO ₂ -eq)	Economic potential (GtCO ₂ -eq/yr)	Reduction relative to SRES A1 B (68 GtCO ₂ -eq/yr) (%)	Reduction relative to SRES B2 (49 GtCO ₂ -eq/yr) (%)
20	9-18	13-27	18-37
50	14-23	21-34	29-47
100	17-26	25-38	35-53

Source: IPCC (2007), Summary for Policymakers, p. 9, table SPM.2.

The McKinsey estimate on global mitigation potential by 2030 is comparable to the IPCC (2007) bottom-up estimate for the high carbon price case (\$100 per tonne of CO₂ equivalent). Energy efficiency and low carbon technology has been developing rapidly over the last two years, but meanwhile there had been an upward revision on global economic growth, especially on

developing countries' growth projections. These two factors have opposite effect on the estimate of global mitigation potential.

Figure 5 Global GHG Mitigation Cost Curve



Source: McKinsey (2009), p. 7, Exhibit 1.

According to McKinsey (2009), adopting technical mitigation measures to cut global emissions to 32 Gt CO₂ equivalent by 2030 is consistent with the long term 450 parts per million (ppm) concentration path peaking at 510 ppm. To limit global warming to 2 degrees Celsius above pre-industrial levels, a deeper emission cut is needed. Another 9 Gt CO₂ equivalent emissions cut are required from more expensive technical measures and behaviour changes so that global emissions can be brought down to 23 Gt CO₂ equivalent a year by 2030, which is consistent with the long term 400 ppm concentration path peaking at 480 ppm. The 400 ppm atmospheric concentration pathway, according to McKinsey (2009), is likely to limit global warming to 2 degrees Celsius. This 50 percent global emission reduction by 2030 compared to 2005 levels (47 Gt CO₂ equivalent compared to BAU) will be a very challenging target.

It is worthy to note that the McKinsey mitigation potential estimate of 38 Gt CO₂ equivalent, however, has already been based on very aggressive assumptions⁵ made by McKinsey (2009) in terms of strong and wide implementation of energy efficiency and low-carbon technologies across sectors and across regions. In other words, this mitigation potential represents a very optimistic

⁵ Strong assumptions include, for example, in Transport sector, McKinsey (2009) assumes 40 percent of new car sales by 2030 are hybrid vehicles; in Power sector, low-carbon generated power is assumed to contribute to 70 percent of global electricity by 2030, and etc.

emission reduction the world can realize if all the affordable energy efficiency and low-carbon technology opportunities are captured fully. Therefore the emission cut of 47 Gt CO₂ equivalent needed to limit global warming to 2 degrees Celsius will be even harder to achieve.

3.2. Mitigation and Development: Low-Carbon Growth Paths

Climate mitigation and adaptation agenda can be integrated with development agenda.⁶ Development planning and strategies could become more effective when taking climate mitigation and adaptation into consideration.

Climate adaptation and development are widely considered integrated and hard to distinguish⁷. It is a consensus that adaptation needs to help countries adapt to the full range of development problem (UNDP 2007). McGray et al. (2007) summarizes three main reasons why adaptation and development are overlapping both methodologically and in practice. First, the objectives of two efforts almost always overlap. For example, training farmers in water conservation practices is a climate adaptation activity but also protects development. Building small irrigation projects will help pull people out of poverty (a development activity) but is an adaptation to climate change as well. Secondly, methodologically, many strategies to help reduce climate vulnerabilities are also used to address non-climate vulnerabilities. As McGray et al. (2007) put it, “rarely do adaptation efforts entail activities not found in the development toolbox.” Third, as it is difficult to disentangle anthropogenic climate change from normal climate variability, the efforts made to better deal with normal climate variability and keep people from falling into poverty will very likely help adaptation to uncertain anthropogenic climate change in the future.

But the relationship between climate mitigation and development is less clear. Some argue that mitigation and development cannot co-exist, and mitigation is not as urgent as development for developing countries. It is true that emission paths into the future will have important implications on economic growth and income distribution. The losses of income that are predicted if mitigation is taken up will fall on some countries and people more than others. For example, strong mitigation measures may hurt economies that are heavily dependent on fossil fuels. Within countries, many people that work in or are dependent on emission-intensive activities may be economically displaced.

On the other hand, others argue that if no strong and immediate mitigations are taken, not only the whole world may be subject to catastrophic climate risks but also development progress made by poor countries can be completely erased by climate disasters (UNDP 2007). In this section we will argue that mitigation and development can be integrated. A low carbon development path is in the interest of both developing and developed countries.

Environmental Kuznets Curves (EKC) have been used by some developing countries to argue their on-going economic growth will automatically erase environmental degradation so that they

⁶ See IPCC (2007), Robinson *et al.* (2006), UN (2009) and etc.

⁷ The distinction between adaptation and development are mainly for funding purposes as developing countries require adaptation financing to be new and additional to the traditional ODA.

can choose to grow first and clean up later. But the EKC's have been proved largely a myth, and especially there is no clear-cut existing evidence to support the EKC's for carbon emissions in non-OECD countries (Stern 2004; Marzio, Alessandro and Francesco 2006). Instead, some experts have argued that setting a strong mitigation target and adopting a low carbon economic growth model is the only sustainable development path for developing countries (Stern 2009).

Going low-carbon is costly in the short-term, but the potential benefits could be huge in the long run. For example, developing renewable energy requires significant fixed investment but could reduce a country's dependence on imported fossil fuels. Energy efficiency imposes an upfront expense but can help consumers and business saving energy costs for the long term. Low-carbon technologies are expensive to develop and put to use but will create new jobs and new sources of growth. The power, transport, building and industrial sectors, in particular, have been identified to have significant potential to benefit from low carbon technology and for emission cuts (Tomlinson 2009). For some developing countries, going low carbon will even give them some comparative advantages because of their ample sources of renewable energy.

The global market for low carbon technology goods and services has been growing rapidly due to the increasing demand for low carbon and energy efficiency goods and services. Innovas (2009) estimates that the global low carbon and environmental goods and services (LCEGS) market⁸ is worth about \$4.65 trillion for 2007/2008, growing by 4 percent and projected to continue to grow. Traditional environmental activities account for 22 percent of the total LCEGS, renewable energy for 31 percent and the emerging low carbon for almost half of the global LCEGS market. The largest LCEGS by market value include alternative fuels, 19 percent (emerging low carbon sector), building technologies, 13 percent (emerging low carbon sector), wind power, 12 percent (renewable energy sector) and alternative fuels for vehicles, 11 percent (emerging low carbon sector). For the year 2007/2008, the renewable energy sector grows slightly faster than the other two sectors.

Geographically, Asia occupies 38 percent, Europe 27 percent, and the Americas 30 percent of the global LCEGS market in 2007/2008. Table 3 lists the 7 largest country players in the global low carbon LCEGS market. Among which are two fast growing developing economies China and India, accounting for 13.5 and 6.3 percent of the global market share.

⁸ According to Innovas' definition, LCEGS include traditional environmental activities (environmental consultancy, air pollution control, environmental monitoring, pollution control, waste management, recovery and recycling, and environmental management support service.), as well as activities in the renewable energy (wind, wave and tidal, biomass, geothermal, hydro and photovoltaic energy generation and support services, and renewable consultancy) and emerging low carbon market (alternative fuels, carbon capture and storage, building technologies, energy management and carbon finance).

Table 3 Major Country Share of Global Low Carbon EGS Market, 2007/2008

Country	Percentage of Global Low Carbon EGS
United States	20.6
China	13.5
Japan	6.3
India	6.3
Germany	4.2
United Kingdom	3.5
France	3.0

Source: Innovas (2009).

The \$4.65 trillion global LCEGS market will create new demand for technologies, goods and services that will allow countries across the world to make the transition to a low carbon economy. New jobs will be created, and new business and profit opportunities will also emerge for well-positioned business and companies. The Carbon Trust (2008) reports that a company that is well-positioned and pro-active could increase its value by up to 80 percent by making the transition to low carbon based activities and markets.

Innovas (2009) estimates in the UK today, there are about 881,000 jobs in the LCEGS sector and nearly half of them are in the emerging low carbon sector. It projects this number will grow as UK take further actions to transit its economy to a low carbon one. According to Renner, Sweeney and Kubit (2008), the renewable energy sector of China is valued at nearly US\$17 billion and employs almost 1 million workers in 2007, including 600,000 in solar thermal, 266,000 in biomass generation, 55,000 in solar photovoltaics (PV) and 22,200 in wind power.

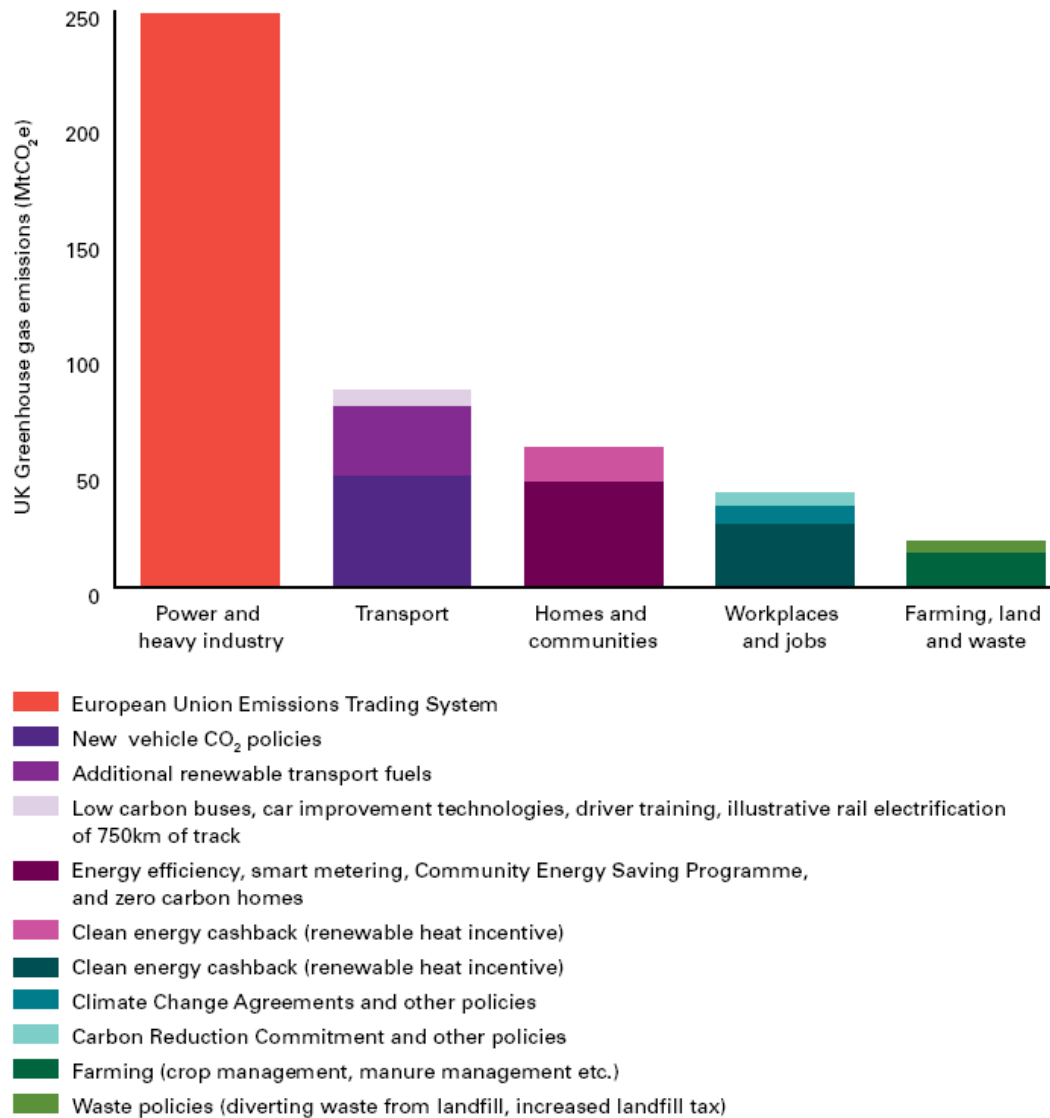
However, we cannot just wait for businesses and households to become ready and economically motivated enough to adopt low carbon production and consumption patterns. The public policy that guides, supports and creates incentives, therefore, appears to be critical as of now. A low carbon growth model is new for both developing and developed countries. The developing world is looking at developed countries. Ironically, there have not been many developed-country role models exhibiting the low-carbon economic growth path is not only feasible but also efficient and desirable. Major developed economies only start to take actions and transit their economies to low carbon ones.

In July 2009, the UK government announced a detailed low carbon transition plan in aim to cut its emissions by 34 percent by 2020 (relative to its 1990 level). “The 2009 UK Low Carbon Transition Plan: National Strategy for Climate and Energy” elaborates the details for UK to meet the 2020 emission reduction target, including taking specific steps to transform its power sector, homes and communities, transport sector, farming and manage its land uses and waste more sustainably.

The UK plan will cut emissions by 459 million tonnes in the third carbon budget (2018-2022). Figure 6 shows where the cuts will take place. About 250 million tonnes emission cut will be made

in the power and heavy industry through the EU Emissions Trading System. Other main policies that contribute to emission reductions include energy efficiency policies and increased use of renewable energy for heat and transport.

Figure 6 UK's Main Emission Cut Driving Policies



Source: The UK Low Carbon Transition Plan: National Strategy for Climate and Energy (2009), p. 44, chart 4.

3.3. Economic Crisis and Green Stimulus

Fighting against climate change is argued as “the biggest stimulus package of all” for those two billion people without access to clean energy (Steiner 2009). Investments to be made on climate mitigation and adaptation, estimated at the scale of hundreds of billions a year, will also boost the

global economy and stimulate the demand and markets for low carbon and environmental goods and services.

Faced with the current global economic and financial crisis, many countries have announced and implemented aggressive stimulus packages to sustain the demand and rescue their economies. It has been argued and some countries have responded accordingly that the economic crisis we experience today provides a unique opportunity for both developed and developing countries to find a driver of long-term sustainable economic growth. UNEP, for example, has launched a Green Economy Initiative and proposed a global green new deal to promote green stimulus and green recovery programs around the world.

Both country-specific and sector-specific studies show a stimulus program incorporating low-carbon and energy efficiency will not only help reduce emissions but also help create employment and pull the economy out of recession.

Pollin et al. (2008) suggest that a \$100 billion green economic recovery program in the US could create 2 million jobs through investments in retrofitting buildings to improve energy efficiency, expanding mass transit and freight rail, constructing “smart” electrical grids, and stimulating wind and solar power, as well as next-generation biofuels. Wheeler (2008) also argues a green revolution in the US will strengthen American security and create new opportunities for economic growth.

Barbier (2009) conducts a comprehensive study on the economic and employment implications of greening the energy sector. He finds that for US’ green energy initiatives, every \$1 billion government invested have the potential to save \$450 million per year on energy costs and consumption, create 30,000 job-years⁹ (a 20 per cent increase in job creation over more traditional fiscal stimulus measures) and reduce annual US greenhouse gas (GHG) emissions by almost 600,000 tons between 2012 and 2020. Barbier (2009) estimates that for the EU an immediate and large-scale programme to expand energy conservation and renewable energy supply could create 1 to 2 million new, full-time jobs.

Developing countries also respond positively to the call for green stimulus and green recovery program. For example, South Korea has announced a Green New Deal plan which is estimated to cost around \$36 billion, more than 3 per cent of its 2007 GDP, over 2009 to 2012 in aim to create 960,000 jobs (Barbier 2009). The low-carbon projects include developing high-speed railroads and urban mass transit, fuel efficient vehicles and clean fuels, energy conservation and environmentally friendly buildings. About 149,000 jobs are expected to be created in 2009 alone, mainly in construction.

There are also some examples from low income countries that try to integrate development with climate change when responding to the crisis. For example, the Republic of Rwanda is investing in one of the biggest solar project in Africa while committing the economy to a low-carbon path including energy efficiency improvements in agriculture, the sector which employs over 50 per cent of its population (Steiner 2009).

⁹ Job-years refer to the number of full-time equivalent jobs lasting one year.

Sector-wise, according to Barbier (2009), more than 3.8 million jobs could be created globally at low-carbon transport sector through producing high-fuel efficiency and hybrid vehicles, alternative fuel use and low emission technologies. Additional 19 million ancillary jobs worldwide could be added in fuel refining and distribution, sales, repairs and services. In biofuel production, he estimates another 10 million jobs, adding to 1.2 million biofuel jobs existing today, can be generated through global expansion of next generation feedstocks. Public mass transit investment has a multiplier of 2.5 to 4.1 for every direct job created; based on which, Barbier (2009) estimates that in US, a 10-year federal investment programme in high-speed railway systems could potentially create 250,000 new jobs; in South Korea, a \$7 billion investment in mass transit and railways over the next three years is expected to create 138,000 jobs.

3.4 Financing for Development and Climate Change

Historically and stock-wise, developing countries, especially the least developed countries, contributed much less than rich countries to the GHGs stocks in the atmosphere. But the least developed countries and poorest people tend to be the most exposed and vulnerable to the impacts of climate change. This is one reason why the principle of common but differentiated responsibility enshrined in the United Nations Framework Convention on Climate Change—UNFCCC – is so important.

To help developing countries address climate change and at the same time reduce poverty and achieving MDGs, new, additional and predictable finance from developed countries is critical. Any global climate deal has to be a development deal as well.

There have been various studies to estimate the financing needed by developing countries for mitigation and adaption¹⁰. UNFCCC (2007) estimates that additional mitigation investment and financial flows needed to cut global emission by more than 30 Gt CO₂ equivalent is \$200 to \$210 billion per year by 2030, and over half of the additional global investment and financial flows in mitigation would be needed in developing countries. The estimates have been suggested to be revised up because of higher projected capital costs in the energy sector (UNFCCC 2008).

McKinsey (2009) estimates that the global mitigation cost would be around €200 to €350 billion annually by 2030 based on its most optimistic set of assumptions (“the most economically rational abatement opportunities are pursued to their full potential”). The total upfront investment in abatement measures needed would be €530 billion in 2020 per year or €810 billion per year in 2030 – incremental to business-as-usual (BAU) investments. McKinsey (2009) estimates that close to 60 percent of the total investments will be needed in developing countries, which is about €320 billion per year in 2020 and €490 billion per year in 2030.

¹⁰ For example, see IEA (2008), McKinsey (2009), UNFCCC (2007, 2008) and etc. It is important to note that comparing mitigation/adaptation costs across studies is not so straightforward because of different assumptions used in the studies.

The estimate for adaptation financing is subject to high uncertainty and varies from study to study. UNDP (2007) estimates the new and additional finance needed for adaptation in developing countries to protect the poor and MDG results is around \$86 billion a year by 2015, representing about 0.2 percent of developed countries' GDP in 2015. World Bank (2006) estimate an amount of \$10-40 billion a year by 2020 is needed to finance adaptation in developing countries. Stern et al. (2007) estimate an amount of \$4-37 billion a year for climate proof investment on all adaptation-related activities in developing countries. Oxfam International (2007) estimated that adaptation will cost more than \$50 billion annually in developing countries, and this amount has to be financed by additional and new sources. UNFCCC (2008) estimates the investment and capital flows needed for adaptation activities in developing countries in 2030 is about \$28-58 billion a year.

Developing countries also speak out how much financing they need from developed countries. For example, the current G-77 and China proposal requests Annex I Parties contribute 0.5 to 1 percent of their Gross National Product (GNP), in addition to their existing ODA commitments, to mitigation, adaptation, technology transfer and capacity development activities, which could amount to some amount between \$200 billion and \$400 billion a year.

As the financial needs to address climate change are large, global, and urgent, the challenge of responding to climate change presents itself as a unique opportunity for developing countries. Fairness and capacity concerns will argue for that the financing needs should be met primarily by developed countries. There are two main channels to deliver these needed mitigation and adaptation finance to developing countries: public channel (publicly funded programmes) and private channel (carbon markets).

3.4.1 Climate Financing - Public Channel

Public funding for mitigation and adaptation in developing countries includes official development assistance (ODA) and the public funding provided under the Convention's financial mechanism, which is additional to the traditional ODA funding.

In 2008, total net ODA from OECD's Development Assistance Committee (DAC) members is amounted to \$114 billion (in 2007 prices) and at the highest level ever. Levina (2007), in a rough analysis on the categories of ODA-funded activities by OECD DAC countries from 2000 to 2005, suggests that about 30-40 percent of ODA is sensitive to climate risks and around 60 percent of overall ODA could be relevant to adaptive capacity and adaptation.

Under the Convention's financial system, there are four public finance sources of funds that can facilitate adaptation, mitigation and technology cooperation activities in developing countries. These financial mechanisms include the Global Environment Facility (GEF) Trust Fund, the Special Climate Change Fund (SCCF), the Least Developed Countries Fund (LDCF) and the Adaptation Fund. The first three are operated by the GEF, and rely on voluntary contributions from developed countries. The Adaptation Fund is operated by its own Board and is funded by a 2 percent levy on the CDM.

Both developing countries and transition economies are eligible to access the GEF Trust Fund, but only developing countries are eligible for the SCCF, and only LDCs are eligible for the LDCF. Eligible countries cannot access resources directly. Instead, they have to propose projects for financing through one of currently 10 agencies¹¹, which assist governments and NGOs in the development, implementation and management of GEF-funded projects.

The majority of currently available funds under the Convention are accessible through the GEF. The GEF Trust Fund provides public financing for general climate projects, including mitigation, adaptation and technology transfer activities. Since 1991, GEF has provided \$8.6 billion in grants and leveraging \$36.1 billion in co-financing for over 2,400 projects in more than 165 countries. GEF funds are contributed by donor countries. In 2002, 32 donor countries pledged \$3 billion to fund operations through 2006. At the Fourth GEF Assembly in 2006, an additional \$3.13 billion was committed¹².

The SCCF and LDCF, however, mainly support adaptation projects. As of October 2008, 13 donors had pledged about \$91 million to SCCF. There are 15 approved SCCF adaptation projects totaling \$67.5 million and 14 projects in the pipeline that are expected to request approximately USD \$46 million¹³. As of October 2008, 19 donors had pledged \$172.8 million to LDCF, among which \$9.4 million had been allocated to preparation of NAPAs and \$77 million was committed to NAPA implementation projects.

The adaptation funding provided by SCCF and LDCF are rather limited. At present, most international adaptation funding, with the exception of the conventional ODA, will be provided through the Kyoto Protocol's Adaptation Fund.

The Adaptation Fund was recently established to finance concrete adaptation projects and programmes in developing countries. The Adaptation Fund is financed with 2 percent of the Certified Emission Reduction (CERs) issued for projects of the Clean Development Mechanism (CDM) and with funds from other sources. So far, two sales of CERs have been conducted to finance the Adaptation Fund, 600,000 tons of CERs sold at an average price of €12.17 per ton in May 2009 and 500,000 tons of CERs sold at an average price of €11.46 per ton June 2009 respectively, by the World Bank as Trustee for the Adaptation Fund¹⁴.

There are also other mechanisms that channel public financing to developing countries beyond the Convention. The largest so far is the \$6.1 billion pledged in 2008 by 10 developed countries to the World Bank's Climate Investment Funds (CIFs)¹⁵.

¹¹ The 10 agencies are African Development Bank, Asian Development Bank, European Bank for Reconstruction and Development, Food and Agriculture Organization of the United Nations, Inter-American Development Bank, International Fund for Agricultural Development, UNDP, the United Nations Environment Programme, United Nations Industrial Development Organization, and the World Bank. Source: UNFCCC (2008).

¹² Source: http://www.gefweb.org/interior_right.aspx?id=50

¹³ Source: http://unfccc.int/adaptation/implementing_adaptation/adaptation_funding_interface/items/4565.php, and http://unfccc.int/adaptation/implementing_adaptation/adaptation_funding_interface/items/4564.php.

¹⁴ Source: <http://www.adaptation-fund.org/pressreleases.html>.

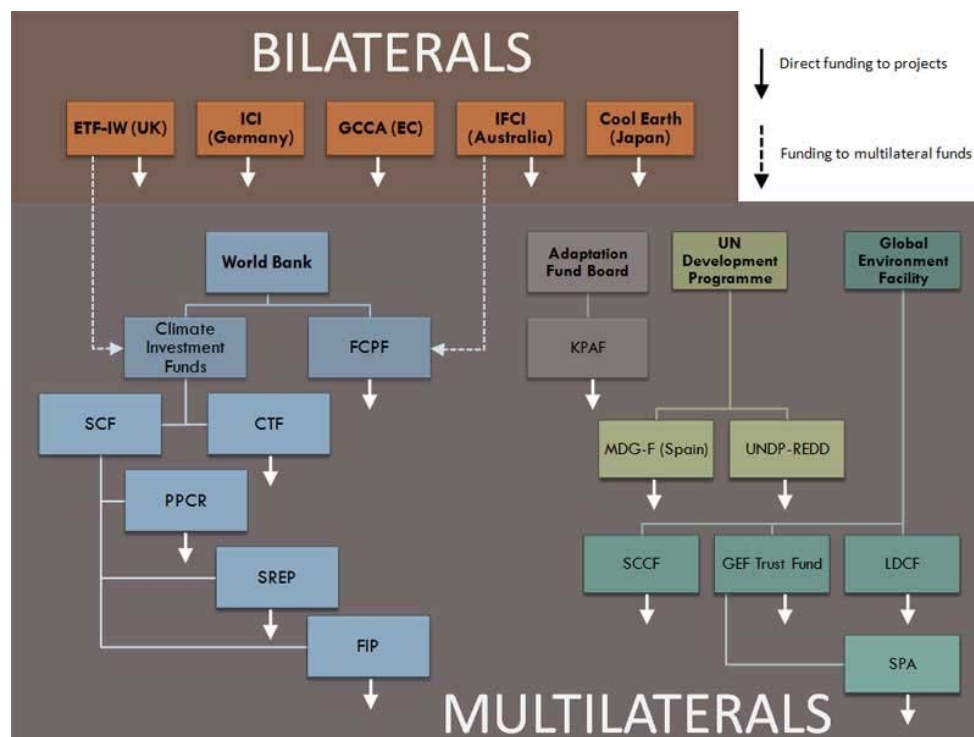
¹⁵ Some developing countries do not accept these funding as public as they are not funded under the Convention.

The Climate Investment Funds (CIF) are comprised of two trust funds: the Clean Technology Fund (CTF); and the Strategic Climate Fund (SCF). Each fund has a specific scope and objective as well as a specific governance and administrative structure. The Clean Technology Fund (CTF) will promote investments in clean technologies and the Strategic Climate Fund (SCF) will serve as an overarching fund to support targeted programs and finance new approaches with potential for scaled-up, transformational action. Under the SCF, there are three sub-programs: the Pilot Program for Climate Resilience (PPCR), which aims to integrate climate risk and resilience into core development planning in developing countries; the Forest Investment Program (FIP); and the Program for Scaling-Up Renewable Energy in Low Income Countries (SREP), which focuses on creating new economic low-carbon opportunities in the energy sector and increasing energy access through the use of renewable energy¹⁶.

As the Copenhagen conference on climate change is approaching, more climate funds have been set up to expedite the efforts to finance mitigation and adaptation activities in developing countries. Figure 7 summarizes 18 bilateral and multilateral climate funds established so far to help developing countries to tackle their climate change challenges.

¹⁶ Details about the World Banks' CIFs are available at <http://go.worldbank.org/58OVAGT860>.

Figure 7 18 Bilateral and Multilateral Climate Funds



Source: Overseas Development Institute, <http://www.climatefundsupdate.org/listing/architecture>.

Note: ETF-IW (Environmental Transformation Fund – International Window), ICI (International Climate Initiative), GCCA (Global Climate Change Alliance), IFCI (International Forest Carbon Initiative), KPAF (Kyoto Protocol’s Adaptation Fund), FCPF (Forest Carbon Partnership Facility), SCF (Strategic Climate Fund), CTF (Clean Technology Fund), PPCR (Pilot Program for Climate Resilience), SREP (Scaling-Up Renewable Energy Program for Low Income Countries), FIP (Forest Investment Program), MDG-F (MDG Achievement Fund – Environmental and Climate Change thematic window), UNDP-REDD (UNDP - Reduced Emissions from Deforestation and Land Degradation), SCCF (Special Climate Change Fund), LDCF (Least Developed Countries Fund), SPA (Strategic Priority on Adaptation).

The 18 climate funds listed above, most of which are new, will provide bilateral and multilateral funding for climate mitigation and adaptation. According to UNFCCC (2008), most of the new bilateral and multilateral climate funds will focus on mitigation activities and could provide significant annual funding for mitigation in developing countries. The adaptation funding available from current source and new initiatives is less than \$500 million per year, most of which will be provided through the Adaptation Fund.

In June 2009, the UK government releases ‘The Road to Copenhagen’, a manifesto for a global climate deal. It proposes to raise around \$100 billion per annum by 2020 (available from 2013) from a combination of the carbon market, new and additional sources of predictable finance and a limited amount of ODA. It encourages the leading developing countries to propose ambitious and

concrete climate actions eligible for this \$100 billion source. It also proposes a substantial portion of the public finance to be earmarked for adaptation for the poorest and most vulnerable countries.

Other UK recommendations include linking emissions trading systems in developed countries by 2015 to create a global, liquid market in emissions reductions, proposing a new international partnership on public finance for climate change, requiring all ODA to be climate-proofed but subject to a ceiling of 10 percent of ODA going to finance projects meeting both poverty reduction and mitigation or adaptation objectives, supporting an international mechanism for auctioning a small percentage of national emission allowances or some comparable domestic legislation to provide predictable and adequate climate finance, raising finance from aviation and maritime emissions, proposing for public support to leverage private sector investment through guarantees and insurance schemes, forestry credits and forest-backed bonds.

3.4.2 Climate Financing – Private Channel

According to UNFCCC (2008), current funding available for mitigation under the Conventions is less than \$1 billion per year. The newly proposed bilateral and multilateral climate initiatives will provide significantly more funding for mitigation. But current and planned public funding resources, adding together, are still insufficient to meet the identified mitigation needs, which are estimated up to hundreds of billions of dollars a year.

The carbon market, on the other hand, has mobilized substantial private funding from developed countries to developing countries. Under the Kyoto Protocol, there are three main market-based flexible mechanisms, which complement the public finance sources under the Convention's financial architecture. They are Clean Development Mechanism (CDM), Joint Implementation (JI), and International Emissions Trading (IET)¹⁷ which came to life in 2008.

The market mechanisms under the Kyoto Protocol allow Annex-1 countries to finance emission-reduction projects in developing and transition countries to earn certified emission reduction (CER) credits/emission reduction unit (ERU) credits for emission reductions that are “additional” to the emissions reductions that would have occurred without the project. Each unit carbon credit is equivalent to one tonne of CO₂. CDM is used to finance projects in developing countries with no targets, and JI is to support projects in transition countries which have emission targets as well. CDM and JI are designed to provide a win-win solution to global emission reductions.

Take CDM for example, developing countries attract capital flows through the CDM. CDM also could transfer clean and low-carbon technology to developing countries and help them move onto a sustainable path of development. CDM helps lower the annual compliance costs for Annex-1 countries which are allowed to use CER credits acquired from financing emission reduction

¹⁷ IET is still in its early stage of development. It issues Assigned Amount Units (AAUs) for emission reductions. By early 2009, announced AAU transactions amount to 100 MtCO₂e for a value of US\$1.2 billion (Capoor and Ambrosi 2009). The new IET transactions mainly take place in some East European countries. This paper will focus the discussion on CDM and JI.

projects abroad to meet their own emission reduction targets under the Protocol. For example, EU companies will be allowed to convert credits from CDM projects for use towards meeting their commitments¹⁸. Unused carbon credits from CDM projects are also linked with the emissions trading system and thus can be traded and sold within the EU ETS.

Table 4 Carbon Market in 2007 and 2008

	2007		2008	
	Volume (MtCO ₂ e)	Value (MUS\$)	Volume (MtCO ₂ e)	Value (MUS\$)
Project-based Transactions				
Primary CDM	552	7,433	389	6,519
JI	41	499	20	294
Voluntary market	43	263	54	397
Sub total	636	8,195	463	7,210
Secondary CDM				
Sub total	240	5,451	1,072	26,277
Allowances Markets				
EU ETS	2,060	49,065	3,093	91,910
New South Wales	25	224	31	183
Chicago Climate Exchange	23	72	69	309
RGGI	na	na	65	246
AAUs	na	na	18	211
Sub total	2,108	49,361	3,276	92,859
TOTAL	2,984	63,007	4,811	126,345

Source: Capoor and Ambrosi (2009), p. 1, table 1.

Capoor and Ambrosi (2009) report that the overall carbon market reached a total value of about \$126 billion in 2008, double its 2007 value (see Table 4). The largest segment of the carbon market is the EU ETS which is valued at \$92 billion in 2008. More than \$8 billion and \$7 billion of private funding have been generated in 2007 and

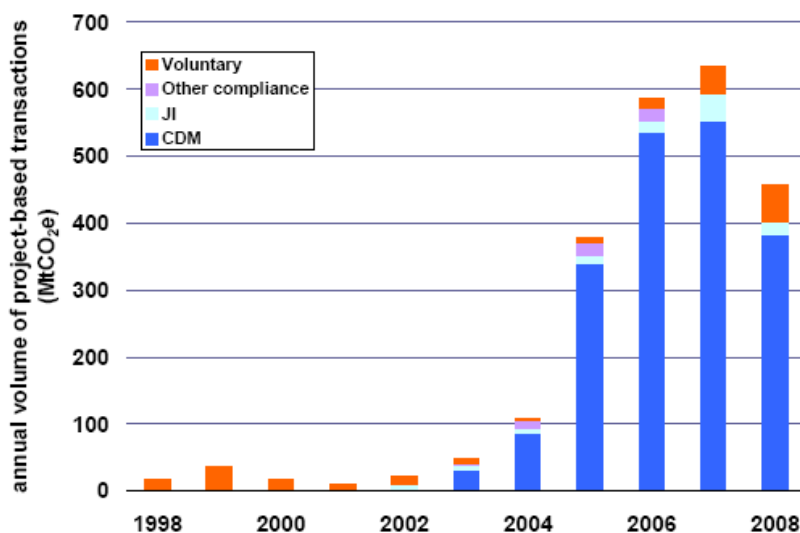
¹⁸ The volume of CER and ERU credits that can be used to meet emission reduction targets is usually limited by an Annex-1 country to ensure efforts made to reduce emissions at home. For example, in the EU, this limit is on average about 10 percent of allowance allocations. Source: http://ec.europa.eu/environment/climat/emission/linking_en.htm.

2008, mainly through the CDM and JI, to finance mitigation projections in developing countries and transition economies¹⁹.

Outside of Kyoto compliant mechanisms, there are also voluntary carbon markets where actions taken to reduce greenhouse gas emissions are being verified and traded in the global over-the-counter market for greenhouse gas emissions. For example, although there is no national mandated carbon offset program in the United States, various state and regional programs are being developed for the voluntary reduction of greenhouse gases such as the Chicago Climate Exchange and the California Climate Action Registry.

Figure 8 shows the volume of carbon traded in the project-based markets, which mainly reflects the size of the carbon offset market that channel private financing to fund carbon emission cut in developing countries and transition economies by developed countries through CDM and JI.

Figure 8 Annual Volumes (MtCO₂e) of Project-Based Emission Reductions Transactions (vintage up to 2012)



Source: Capoor and Ambrosi (2009), p. 32, fig. 2.

But unfortunately the regulatory delays, associated high transaction costs as well as the uncertainty caused by the post-Kyoto policy vacuum have limited the growth of the CDM and JI market. Compared to 2007, confirmed transactions for primary CERs (pCERs) declined 30 percent, and the corresponding transactions value dropped 12 percent to around \$6.5 billion in 2008 from \$7.4 billion in 2007. The JI market also declined about 40 percent in value in 2008. The voluntary market continued to grow in 2008 but grew at a slower pace than previous years.

¹⁹ Only the primary CDM market transactions represent the carbon market transactions that channel private funding to developing countries. The secondary market for CERs (sCERs) grows very fast in 2008 and become the second largest segment of the carbon market. But these trades do not directly give rise to emission reductions as transactions in the primary market, and these trades do not generate additional capital flows to developing countries either.

The size of carbon offset market continues to be constrained in 2009. By August 2009, around 1,800 CDM projects have been registered with about 320 million CERs issued. The annual CDM volume may surpass the one in 2008 but probably will still fall short compared to the volume of 552 million CERs issued in 2007. UNFCCC projects that by 2012, it is expected there will be another 1.6 billion CERs to issue from registered projects²⁰.

It is widely agreed that the current CDM will neither be able to meet the demand for emissions reduction credits from Annex 1 countries nor be able to channel sufficient private funding to developing countries. On the supply side, the current CDM is criticized to constrain the supply of carbon credits because of regulatory delays and high transaction costs.

On the demand side, there is growing potential demand for Kyoto Mechanism units as major developed countries commit to stronger emission reduction targets (see Table 5). For example, the European Parliament adopted the Climate and Energy Package to set a target of 20 percent GHG reduction of 1990 levels by 2020.²¹ EU is also willing to set a more aggressive target of 30 percent emission reduction by 2020 if other developed countries make similar commitment. The 30 percent carbon emission reduction of 1990 levels will help create an additional demand of about 300 Mt CO₂ equivalent per year over 2013-2020 (Capoor and Ambrosi 2009).

Table 5 Proposed Emission Reduction Targets by Major Developed Countries

Country or region	2020 target	2020 target (ref: 1990 emissions)	2020 target (ref: 2005 emissions)
EU	20% below 1990 levels, scaling up to 30% if international agreement	-20% to -30%	-14% to -25%
Australia	5% below 1990 levels, scaling up to 15%, possibly 25%, if international agreement	+13% to +1%, possibly -11%	-11% to -21%, possibly -30%
Canada	20 % below 2006 levels	-3%	-22%
US	17% below 2005 levels	-4%	-17%
Overall ambition		-10% to -15%	-16% to -21%

Source: Capoor and Ambrosi (2009), p.61, table 7.

The American Clean Energy and Security (ACES) Act recently passed by the House of Representatives calls for the following US GHG emission reduction targets: US GHG emissions

²⁰ The data reflects information up to August 25th 2009. Source: <http://cdm.unfccc.int/index.html>.

²¹ Other targets include to increase the share of renewable energy sources to 20 percent by 2020 and to improve energy efficiency by 20 percent by 2020.

not to exceed 97 percent of 2005 level in 2012; not to exceed 83 percent of 2005 level in 2020; not to exceed 58 percent of 2005 level in 2030; and not to exceed 17 percent of 2005 level in 2050.

The ACES Act, which does not automatically accept all CDM-certified credits, however provides generous allowable limits of two billion tons annually from domestic and international offsets, and international allowance trading. Half of an entity's offsets can come from domestic sources and half from international sources. In US, according to the ACES Act, in 2012, approximately 30% of an entity's allowance obligation can be satisfied with offsets; this percentage increases to 67% by 2050. EPA can increase the allowable percentage for international offsets (up to 1.5 billion). Starting in 2018, international offsets are discounted at a 1.25 ratio (i.e. 1.25 offsets equal 1 emission allowance).

The potential demand from the US and EU combined, 1.8 billion CERs, provides an opportunity for developing countries to scale-up their supply of emission reduction credits. As the current form of CDM will fail to meet the challenge, there have been proposals to scale up CDM and expand the supply of carbon offsets.

Capoor and Ambrosi (2009) summarize 4 important elements to stimulate the supply of carbon offset credits by attracting the participation of developing countries and meanwhile encouraging more ambitious targets from developed countries. These elements are: a sufficient carbon price signal, a wide range of eligible offset types, sufficient lead time for project development and an efficient offset approval process, and an expanding scope and scale of offsets and credits can be used to offset (e.g. international mitigation activities in agriculture).

The European Commission (EC) has proposed that the project-based mechanism to be limited to LDCs in the future, and that major emerging economies need to adopt a sectoral offset approach to transact credits generated from additional reductions from specific sectors e.g., steel, cement and power. US proposes a four-prong approach to developing international offsets: (1) project by-project (determined by EPA); (2) sectoral offsets; (3) credits from an international body (e.g. UNFCCC); and (4) avoided deforestation offsets.

Several new financing proposals also emerge in aim to scale up the climate financing to developing countries. For example, to drive a more aggressive offset market to channel climate financing to poor developing countries, developed countries are suggested to set a more ambitious emission reduction target, allow a higher proportion of domestic emission reductions to be offset by CDM credit purchase, or leverage the offsetting mechanism by linking one tone of emission reduction to several CDM credits purchased from developing countries. More climate financing may also be generated by raising the levy on the sale proceeds of CDM credits, auctioning domestic emission permits, taxing bunker fuels used in international aviation and maritime transport or the production and consumption of oil directly (Pendleton and Retallack, 2009).

3.4.4 Pricing Carbon

To discourage carbon emissions, a high enough price has to be placed on carbon emissions²². This section will discuss the importance of pricing carbon from the perspective of nurturing private investments and encouraging the growth of carbon markets to scale up private financial flows to developing countries.

Both public and private channels are important to help finance mitigation and adaptation activities in developing countries. But the scale of public finance is much smaller than that of private finance. It is expected that over time the private sector will take on a progressively larger role as the financing need grows much faster than what developed countries' public funding could support. Although what is the better market mechanism to price carbon remains the focus of a heated debate, there is consensus that pricing carbon is necessary to ensure the long-term effectiveness and profitability of climate change mitigating investments. In practice, a combination of Kyoto mechanism, emission trading systems, some forms of carbon taxation, along with interventions such as energy efficiency standards and subsidies for low carbon technologies²³, may be used together.

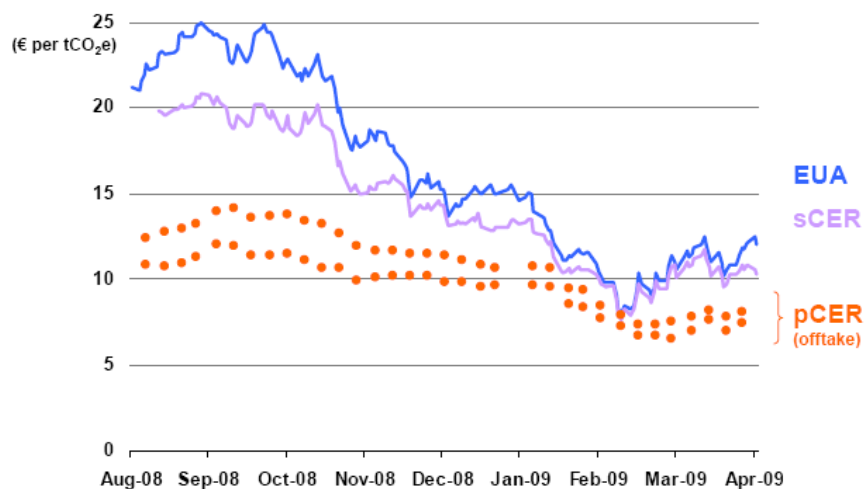
Several market mechanisms can work to determine a carbon price (currently there also exist more than one carbon prices in the carbon market). First, the market-based mechanisms under the Kyoto Protocol generate standardized certified emission reduction credits. The price on these carbon credits (e.g. CERs, ERUs) gives a price for carbon in such carbon offsetting arrangement. Second, a cap-and-trade emission trading system yields a carbon price for emission permits traded in the system (e.g. the price for EUA in the EU ETS). Third, carbon taxation is another market-based approach to pricing carbon. How carbon taxation works depending on how it is designed. But generally, it will raise the price of carbon-based energy production and consumption. In this way the carbon emitters will have direct incentives to reduce their carbon emissions until the cost of doing so is greater than the carbon tax. Part of the carbon taxation revenue generated in rich countries could and should be earmarked for transfers to developing countries.

Prices in the carbon market started to decline and became extremely volatile since the world economy dramatically slowed down in 2007. For example spot EUA prices (currently trading at around €10-15 per tonne) declined nearly 75 percent in less than a year, from a record-high of €28.73 in July 2008 to as low as €7.96 in February 2009 (See Figure 9). Primary CER price also declined more than 50 percent over the same period. Similar declines occurred in prices of futures contracts for EUAs and secondary CERs as well.

²² See Hepburn and Stern (2008) as an illustration of the consensus view that addressing climate change requires carbon pricing.

²³ See Derviş (2008), and the references therein, for a summary discussion on the advantages and shortcomings of these different approaches to pricing carbon.

Figure 9 Carbon Prices Responding to the Economic Shocks



Source: Capoor and Ambrosi (2009), p.6, fig. 1.

The volatile carbon prices could make investing in carbon markets look more risky and less attractive to investors and thus creates uncertainty on the volume and value of carbon finance flows from developed countries to developing countries. Establishing a price floor for carbon has been proposed to reduce price volatility in the carbon market²⁴ (a variable carbon tax or a hybrid carbon tax-and-trade scheme could be an instrument to achieve it). For example, the ACES Act proposed a reserve price of \$10 (in 2009 dollars) per ton of CO₂ in 2012.

Pricing carbon is also a sensitive issue because of its potential distribution effects²⁵. Historically, developing countries are responsible for far less of the accumulated stock of greenhouse gases than developed countries. Their current per capita emissions are still modest. But developing countries need to have access to affordable energy for their developmental needs. Therefore a global agreement to price carbon has to ensure that developing countries can meet their energy needs, without endangering their economic growth and poverty reduction efforts²⁶.

²⁴ For example, see comments made by Adair Turner, Michael Grubb, and et al. Source: <http://www.carbon-financeonline.com/index.cfm?section=lead&action=view&id=11903>.

²⁵ A price on carbon could be regressive (Grainger and Kolstad 2009; Hassett, Mathur, and Metcalf 2009; Metcalf 1999; Parry 2004). Thus policy interventions are needed to compensate the adverse distribution effects of a carbon price.

²⁶ For more on the emissions of developing countries and their needs for expanded access to energy see Derviş (2008) and UNDP (2007).

Conclusion

In this paper, we argued that with the adequate support (financial, technical and capacity-building) provided by the richer countries strong and immediate mitigation and adaptation efforts are needed from both developed and developing countries to prevent a possible climate catastrophe for the whole of humanity and to protect the poorest and most vulnerable populations exposed to climate risks. The argument is based on new and stronger scientific evidence on climate change, logical linkages between climate change and development, and a forward-looking assessment on how to two agendas can be integrated to embark all countries on a sustainable low carbon growth path.

IPCC (2007) already revealed stunned scientific evidence on fast-changing climate and the contribution of human activities to it. The updated climate evidence since then suggested that climate might have been changing at a faster speed than what IPCC (2007) reported. These worrisome scientific climate change evidence also places more pressure on world leaders to reach binding emission reduction targets in Copenhagen as the time left to prevent the dangerous 2 Celsius degrees climate warming above the pre-industrial level is rather limited and a medium-term emission reduction target is extremely crucial. If we miss the opportunity in Copenhagen, not only the world is exposed to possible catastrophic climate events but also the cost of mitigation and adaptation will become much higher when actions are to be taken later.

Climate change and development are closely linked. Development creates an increase in demand for energy. Burning of fossil fuels for energy leads to the rise in accumulated atmospheric CO₂ concentrations in the air, which is likely to have caused the global warming. Climate risks and uncertainties, on the other hand, levy a biased burden on developing countries, especially the poorest and most vulnerable. Simply put, high-carbon development may induce climate change, and climate change may exaggerate development challenges. A straightforward implication will be that development and climate change have to be tackled jointly.

As of how these two agendas can be integrated, political resolve, strategic planning, appropriate policy interventions, a new type of economic growth model, capturing the opportunity of a global economic crisis for a green stimulus are all needed. But comparing the financing needed for climate mitigation and adaptation globally and in developing countries, we have a clear message for what is needed most to push the agenda forward. New, additional and significant public funding channeling from developed world to developing countries is needed but not enough. The majority of the huge climate financing needs will probably be met in private carbon markets. This paper also highlights the importance of pricing carbon to nurture the growth of carbon markets and scale up private financial flows to developing countries.

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