A Framework Proposal for a post-2012 Copenhagen Protocol – How to Reach 80% Reductions by 2062

Convergence towards 3% Reductions per Annum by all Countries in 2062

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1. Negotiating a Contingent post-2012 Climate Change Treaty

The UNFCCC and its Kyoto Protocol (KP) have set a significant precedent as a means of solving a long-term international environmental problem. The Kyoto Protocol’s most notable achievements are the stimulation of an array of national policies, the creation of an international carbon market and the establishment of new institutional mechanisms (such as the CDM and JI). Yet, these are only the first steps towards implementation of an international response strategy to combat climate change.

The effectiveness of the Kyoto Protocol is currently constrained by modest emission reduction objectives and will therefore have a limited effect on atmospheric GHG concentrations. The good intentions set out by the Kyoto Protocol during the first commitment period will need to be followed-up by measures to achieve deeper reductions to effectively stop climate change in the future.

In December 2009, the world’s leaders will gather in Copenhagen to negotiate a successor agreement to the Kyoto Protocol, where the engagement of the major emitters in the world – notably the United States and China – will be key to its success. The members of the Copenhagen Conference of the Parties (COP) should seize the unique opportunity to negotiate a post-2012 agreement that shows that lessons from the first commitment period (from 2008-2012) have been learnt. The challenge will be to find a new technologically feasible and politically acceptable solution to drastically cut carbon emissions over the next 50 years. In addition, the regulatory structure of existing KP mechanisms will need to be improved for its overall success.

1.1 Aligning the Positions of the World’s Major Emitters

The efforts of China and the United States in the next few years will determine the worldwide efforts in slowing climate change to a large extent. Yet, the United States and China, as the world’s two largest emitters, will likely need to cooperate in order to meet the goals of the post-2012 agreement. The United States has already committed to reducing its emissions by 17% below 2005 levels by 2020, and China has pledged to peak its emissions by 2030. However, the challenge lies in ensuring that these commitments are met, and that other countries also contribute to the global effort.

ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>AAU</td>
<td>Assigned Allowance Units</td>
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<td>CDM</td>
<td>Clean Development Mechanism</td>
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<td>CDMPlus</td>
<td>Clean Development Mechanism Plus</td>
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<td>CER</td>
<td>Certified Emission Reduction</td>
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<td>CERPlus</td>
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<td>COP</td>
<td>Conference of the Parties</td>
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<td>CO₂</td>
<td>Carbon dioxide</td>
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<td>EGT1</td>
<td>Expert Group on Technology Transfer</td>
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<td>EU</td>
<td>European Union</td>
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<td>EU-ETS</td>
<td>European Union Emission Trading System</td>
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<td>ETS</td>
<td>Emission Trading System</td>
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<td>GHG</td>
<td>Green House Gas</td>
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<td>GEF</td>
<td>Global Environment Facility</td>
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<td>IPCC</td>
<td>International Panel on Climate Change</td>
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<td>JI</td>
<td>Joint Implementation Mechanism</td>
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<td>KP</td>
<td>Kyoto Protocol</td>
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<td>UNFCCC</td>
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extent. In the past, China and India along with other developing countries were exempted from taking on commitments to reduce emissions on the grounds that the industrialized countries bore the heaviest responsibility for global warming. Given the extraordinary growth in these countries over the past ten years, that argument seems no longer sustainable (UNFCCC, 2007 a,b). As the bulk of the growing energy demand in the world occurs in developing countries, the CO₂ emission growth accordingly will be dominated by developing countries. Therefore, finding a way to include China, as well as the other developing countries will be crucial.

Getting developing countries – termed Non-Annex I countries under the Convention – to adopt aggressive climate change policies will be much easier if the United States as well as Australia and Canada are on board. For the past eight years, the Bush Administration has refused to join the Protocol, saying that it is flawed because it fails to hold developing nations such as China and India to the same mandatory greenhouse gas emissions caps as the industrial nations. Since the inauguration of President Obama in January 2009, the tone in the White House towards the international efforts to combat global warming has changed. President Obama has signaled a new era for science in United States policy towards climate change and stressed that he would make decisions “on fact and science rather than ideology,” an explicit rejection of the administration of President George W. Bush, who has been widely criticized for doing the opposite (Dickinson, 2008). Under Obama’s presidency, the House of Congress has approved a bill, the American Clean Energy and Security Act, which includes the heat-trapping gases scientists have linked to climate change. The final bill has a goal of reducing greenhouse gases in the United States to 17 percent below 2005 levels by 2020, and 83 percent by mid-century. These first signs of sea-change can be expected to induce a change in the administration’s attitude towards the next climate negotiations. Yet, the U.S. position that any international treaty to reduce emissions that contribute to global warming must include legally-binding commitments from developing countries such as India and China, should be taken seriously.

Developing countries on the other side argue that it seems unfair to expect impoverished people to cut back on energy consumption, which is not even sufficient to meet their basic living conditions. As a block, developing countries have thus far taken the position that industrialized countries would need to strongly reduce their CO₂ emissions first before they would be ready and willing to adopt quantitative emission reduction targets thereby relying on the UNFCCC principle of “common but differentiated responsibilities” (UNFCCC, Article 5, Principles, 1992). The position of developing countries is not as uncompromising as it seems at first sight. Most developing countries have signaled in Bali a willingness to contribute to GHG emission reductions contingent on developed countries’ financial and technological support in building a low-carbon intensive energy infrastructure (Santarius T., et al, 2008).

China is signaling its recognition of the increasing importance of climate change issues. In 2007, China released the National Climate Change Program (on June 4, 2007) that is the first national program of this kind in developing countries that requires to cut the country’s greenhouse gas emissions by 950 MtCO₂ equivalent per year by 2010 (Zhang, 2008). In March 2009, the Chinese Prime Minister, Wen Jiabao, announced to increase spending on clean technology as part of a plan to cut carbon emissions. Its willingness to cut its soiling CO₂ emissions is contingent on a global deal with the United States and the rest of the developed world. According to the founding dean, Professor Kiang, of the College of Environmental Science at the University of Beijing, China would join a post-2012 climate change treaty and seek to reduce their emissions to a definite figure, as long as this was part of a global agreement that involved all countries acting together – including the United States – and transferred modern energy technology to China (McCarthy, 2007). Under the same contingencies, other developing countries would (most likely) sign a post-2012 climate treaty as well.

As for the European Union (EU), it does not seem to take much to get the Europeans to commit to significant post-2012 emissions reductions. By proposing to unilaterally reduce CO₂ emissions by 20% (below 1990 levels) in 2020, the EU has set positive precedent. The EU is willing to extend this target to a ~30% target if other industrialized countries also adopt significant reduction targets (European Commission, 2008).

These observations sketch a rough outline of how a post-2012 climate change treaty would need to look like to satisfy the interests of all parties, i.e. China, the U.S., the developing countries and Annex-I countries. In this negotiation, no one party will commit to act if commitments from all other parties are missing – except for the EU. On the other hand, all countries are dedicated to contribute to climate change mitigation if all other countries also intend to act. This is a typical prisoner’s dilemma situation where the world, and the entire atmosphere, could be better off if only a significant number of countries committed themselves to action. At the moment, however, due to a lack of trust and missing enforcement institutions not many countries – apart from the EU – are willing to undertake action without credibly being assured that the others will follow up on what they initially promised to do. Since countries are sovereign states, there is no supranational government to rely on for enforcing commitments. In such an environment, it is important to work with self-enforcing mechanisms in international treaties. What is needed is a mechanism that ensures that those countries who commit themselves to act first are in the end not culminated, otherwise they won’t start to act.

In addition to setting incentives for all countries to sign a new climate treaty with concrete, targeted responsibilities towards reducing GHG emission, the new climate agreement requires a built-in, self-enforcing mechanism that ensures that global GHG emissions are being reduced with high certainty over the life-time of the treaty. The contribution of this paper is to introduce such a mechanism that aligns the interests of different parties with respect to a Kyoto successor agreement, so that in the end the world can move rapidly forward with climate change mitigation. The mechanism that is being proposed builds on the idea of “making action of developing countries contingent on action by industrialized countries,” and therefore falls in the category of contingent-based commitments. Before deriving the fundamentals behind the commitment mechanism in Chapter 2, the objectives to be accomplished with a post-2012 climate change agreement are being summarized in the following. Lastly, Chapter 3 presents the details to be discussed in Copenhagen with respect to implementing a new framework proposal.

1.2 Objectives for a Copenhagen Treaty

1.2.1 Primary Objective – Agreeing on a Stabilization Level

The ultimate objective of the United Nations Framework Convention on Climate Change (UNFCCC) is to stabilize atmospheric concentrations of greenhouse gases at a level that will prevent dangerous anthropogenic interference with the climate system. Findings of the IPCC Working Group III
show that without additional policies, global GHG emissions are projected to increase 25-90% by 2030 relative to 2000 (UNFCCC, 2008b). Fossil fuel dominance is expected to continue to 2030 and beyond if the world does not take any action. To better understand how the GHG concentration in the atmosphere would be changing throughout the 21st century the Intergovernmental Panel on Climate Change (IPCC) uses insights from climate change modeling that relate different emission growth scenarios to concentration levels. Furthermore, these GHG changes are related to changes in the mean temperature from which possible consequences for our livelihoods, economies and ecosystems are predicted.

A 450 ppm (parts per million) stabilization scenario may limit global warming to 1.2 to 2.3°C by 2100, provided that CO₂ emissions peak around 2010, and fall to about 40 per cent below present by 2050 and about 70 per cent below present by 2100 (UNFCCC, 2008b). Carbon dioxide amount is already 385 ppm and rising by about 2 ppm per year. An increase in CO₂ concentration to 550 ppm is projected to lead to an average temperature increase of ~6°C. From a scientific point of view what follows is that deep emission cuts are needed immediately in order to avoid significant increases in mean temperature.

Defining what is dangerous anthropogenic interference with the climate system and, consequently, the limits to be set for policy purposes are complex tasks that can only be partially based on science, as such definitions inherently involve normative judgments. Therefore, a stabilization level is not quantified by the UNFCCC. Discussions on future actions on climate change in Copenhagen need to involve the question at what level stabilization should be sought, and what constitutes “dangerous.”

The primary objective in Copenhagen should be to use these and other scientific findings (such as Hansen J. et al., 2008) to agree on a concrete stabilization level. The EU, for instance, made staying below the 450 ppm concentration level an official policy objective as this was the consensus among member countries that this was the level needed to help avoid irreversible damage to the global climate and its ecosystems (European Commission, 2005; Watanabe R. et al., 2008). With the scientific evidence available about climate change and its consequences for the environment, achieving a GHG concentration at 450 ppm by 2050 might also become the general consensus among the participants in Copenhagen. If in the future, further scientific research produces new insights, which justify a re-consideration of this assessment, the political debate about what is the appropriate GHG stabilization level can be picked up. For the moment what matters is that a decision is being made, otherwise any discussion about how best to reach this level becomes irrelevant.

1.2.2 Subordinate Objectives

Engagement of All Countries

According to the UNFCCC, mitigation efforts over the next two to three decades will determine to a large extent the long-term global mean temperature increase and the corresponding climate change impacts (UNFCCC, 2008c).

In industrialized countries, overall CO₂ emissions have been reduced by 4.7%, a trend that was strongly influenced by the emission reductions caused by the disintegration of the formerly centrally planned economies in Central and Eastern Europe and the resulting phase-out of inefficient energy and industrial production techniques. However, recent data presented by the UNFCCC Secretariat shows that CO₂ emissions in the groups of industrialized countries have grown again by 2.3% since the year 2000. Based on historic responsibility and current economic capabilities, industrialized countries must continue to take the lead in combating climate change (which is in accordance with Article 3, paragraph 1, of the Convention), and first of all get their own emission paths under control.

As laid out in the Bali Action Plan, attaining the GHG emission reductions that are needed to achieve the ultimate objective of the Convention requires a comprehensive response by all countries. Developing countries’ efforts to eradicate poverty and enhance economic growth are set to require vast amounts of energy and huge investments in energy-related infrastructure. At the same time, the greatest greenhouse gas mitigation potential – around 70% of what is possible worldwide – is precisely in these parts of the world (UNFCCC, 2008c). Therefore, the future climate change regime requires further engagement of developing countries, in particular those whose emissions already, or will in the near future, significantly contribute to atmospheric concentrations. However, developing countries may need special incentives to assume reduction responsibilities – such as technology transfers – that are in line with safeguarding their economic development.

Create Incentives for True Technology Transfer to Developing Countries

The energy sector is responsible for the largest share of global CO₂ emissions. Alerting are therefore the facts that energy demand in developing as well as in industrialized countries is steadily growing. In the period up to 2030, the energy supply infrastructure worldwide will require a total investment of $22 trillion, with about half of that in developing countries. Many developing countries experiencing rapid growth are making huge investments worth billions of dollars in capital stock, such as infrastructure and power generation, that will be used for thirty years or more. Without massive investments in green technologies in developing countries emissions will be growing up by 50%, instead of down by 50% as science says they should (UNFCCC, 2008d). Due to the long-lived nature of most energy infrastructure (lock-in effect), it is critical that action begins now to promote the development and use of low-carbon technologies.

A strengthened international post-2012 climate change regime needs to encompass and foster international technology cooperation and innovation. Effective and efficient mitigation of climate change depends on the rate of global diffusion and transfer of technologies. Too often, however, the debate over GHG emission reductions pits near-term action against long-term action of investment in technology, when both are necessary and are much more effective when undertaken together. A new climate change treaty will need to help overcome this problem so that the future energy demand of developing countries is met in a climate-friendly manner.

In the near term, it is essential to take advantage of existing technologies and while making substantial investment in the technologies of the future. Technology cooperation between developed and developing countries, and increasingly between developing countries, will be needed on an unprecedented scale. The Copenhagen treaty should provide incentives for developing countries to be able to leapfrog the carbon-intensive development stage that industrialized countries underwent. At best, the new mechanism decouples economic development from emission growth.
Reforming the CDM

The use of flexible mechanisms set out in the Kyoto Protocol led to the establishment of a market for carbon offsets. Notably, the Clean Development Mechanism (CDM) has created a large project pipeline – about 250 million carbon offset credits are expected by 2012 – and mobilized substantial financial resources. On the other hand, the CDM has faced methodological challenges regarding the determination of baselines and additionality which currently hinders the widespread extension of carbon emission projects in Non-Annex I countries (World Bank, 2008a). If designed appropriately, the CDM could prove to be a win-win mechanism. First, the CDM could provide an opportunity for developing countries to get increased access to more advanced energy efficiency and could thus help to accelerate economic development along a more sustainable path. Second, it will help industrialized countries in meeting their emission commitments at a lower overall cost than would otherwise have been the case.

As pointed out in the previous section, the CDM did not live up to achieving the level of infrastructure investment that is required to help developing countries leap-frog a carbon-intensive stage of development. The CDM could have contributed greatly to infrastructure investments (in energy), but instead the existing, complex CDM monitoring methodology for large-scale projects has proven itself a barrier (World Bank, 2008b). The mystery of the low penetration rate of energy related projects – even in countries undergoing power emergencies and rampant blackouts, as 35 countries in Africa are currently experiencing – can be explained by the high upfront costs such programs require. The investment horizon that is being set out by the KP (through its commitment phases) has proven to be too short for those projects to become profitable. In addition, the numerous HFC-23 projects that led to a vast supply of CERs on the market for carbon offsets (in phase 1) reduced the incentives for investments in alternative carbon projects, especially if those required time until the first carbon offsets could be earned. Also, the positive incentives for economic development that were expected from carbon finance projects remain to be demonstrated.

In order to expand the potential of the CDM, policy makers will need to critically review the current process of registering CDM projects and the accreditation of carbon offset credits. To review, improve and extend existing climate change policies, negotiators should rely more on scientific evidence and make use of existing best practices for technology transfer. This approach implies that existing regulatory laws – for CDM/JI – need to be revised. Especially market incentives that might have been neglected unintentionally need to be taken into account in order to make the CDM work. To do so, it would be advisable to have experts from different scientific backgrounds, such as business, economists and engineering, advise politicians and policy makers.

Creation of a Global Carbon Market

Similar short-comings exist with the mechanism of emission trading. Despite the fact that the protocol has stimulated the development (and implementation) of emissions trading systems, a fully global emissions trading system is far from being realized. Currently, emission allowances issued, for instance under the European Union Emission Trading System (ETS), are not fungible with other ETSs due to vast differences in regulatory structures. At the moment, a European company wishing to purchase a European Union Allowance (EUA) has to pay the price that it costs another European company to reduce its emissions, i.e. by implementing a less-carbon intensive production technology.

By linking emission trading systems from several countries with each other, someone needing to buy an allowance is now faced with a broader spectrum of companies selling allowances. Since countries vary in their technological levels, a broader pool of companies also means that more opportunities within the system exist for reducing emissions. Thus, the potential for reducing CO2 at a lower cost is higher among a more heterogeneous group of companies (Jotzo et al., 2008). The price for an emission allowance is therefore going to be cheaper in a system with a larger pool of sellers. Therefore, a global carbon market would contribute to the goal of having carbon emissions reduced at the lowest costs possible.

If governments aimed for the establishment of a truly global ETS, policy makers would need to find ways of linking their trading systems with each other. For the creation of global carbon market, the set-up of national emission trading systems needs to be reviewed in order to align its fundamentals so that linking becomes an option (Haites, 2009). As for the revision of the CDM, an expert group with researchers and practitioners from different backgrounds – among them private sector participants – should be in charge of providing innovative solutions on how to link the already existing emission trading systems with each other.

For the future, climate change regulation under political debate should always be analyzed by specialists before it is implemented in order to avoid some of the above-mentioned slip-ups. By considering ex-ante the economic incentives, spill-over effects or externalities that might be created through new climate policy, unintended consequences for market participants can be avoided. The time for a trial-and-error period, i.e. time to figure out what works and doesn't, has run out and we need to undertake more efforts to guarantee that new laws and regulations end up achieving what politicians and negotiators had intended initially. To establish scientific co-operation across different sciences a permanent expert group should be established within the existing UNFCCC framework.

To sum up, agreeing on stabilizing GHG emissions at a sustainable level should be the main focus for the upcoming climate negotiations. For achieving a specific GHG stabilization level, technological innovation and the rapid, widespread transfer and implementation of low-carbon technologies in developing countries, including know-how for mitigation of greenhouse gas emissions, is required and needs to be supported. For the purpose of enhancing implementation on the ground, the existing regulatory structure of the flexible mechanism (CDM/JI) needs to be revised. Without improving the registration and accreditation process of the CDM/JI, it will be difficult to expand the coverage of the flexible mechanisms and many carbon abatement opportunities in the world might pass by. How these objectives translate into concrete policy will be described in chapter 3. In the following chapter, the foundation for the contingent commitment mechanism through which a specified GHG concentration level can be achieved is explained.

2. Implementation of the Primary Objective

With an agreed upon concentration level, different ways of achieving it exist. For instance, in order to reach 450 ppm by 2055, Moomaw (2008) suggests that we would need to reduce our carbon emissions by 80 percent by 2055 in order to turn the tide on climate change. The proposal by Moomaw (2008), namely the "9% Solution" to climate change envisages that all countries reduce their GHG emissions gradually by three percent per annum (with respect to the previous year). This would imply
that in 23 years the world will have reduced its emissions by 50 percent, and by 75 percent in 47 years. Starting today, we could attain our 80 percent reduction after 53 years.

2.1 Revised Version of the "3% Solution to Climate Change"

Instead of all countries continuously reducing their emissions by three percent (relative to the previous year), one could imagine that some countries reduce their emission by more than three percent to make up for other countries. What matters at the end of a year in order to achieve the "3% Solution" is that total world emissions have gone down by three, and not so much by whom these GHG emissions have been reduced. Theoretically speaking, it would be possible that a small group of countries took the responsibility to reduce emissions each year by an amount that equals a three percent reduction of global emissions.

Agreeing on national emission reduction targets without having a rule or basis for deciding who should reduce how much opens up a bargaining-game. In 1997 at the COP in Kyoto, the various degrees of reduction commitments were rather the result of a political give-and-take and not motivated by a joint consensus about historic contributions to climate change, or the economic capabilities to mitigate. Without an objective criterion determining each country's emission reductions, the struggle could be even greater this time as developed and developing countries are involved likewise. Given the lack of such a burden-sharing formula, it seems easier to keep the number of countries in charge of reducing the world's carbon emissions low.

Two Stage Negotiation Approach

One way of avoiding a North-South debate at Copenhagen would be to break with the previous negotiation approach from Kyoto and introduce instead a two-stage negotiation process. In the first stage, all members of the COP select a group of countries in charge of taking on the task of reducing global emissions by three percent according to some objective criterion. In the second stage, only those countries that belong to the selected group negotiate on how best to split the burden (see section 2.2).

Clearly, charging one group of countries with the mitigation responsibility of the entire world should not be a permanent solution and it would not be politically feasible either. Concentrating action on a few will help to ensure that the action needed to reach a set concentration level can start immediately. In addition, administrating and monitoring a few countries in their reduction efforts will also be easier. The idea is that the selected group undertakes all necessary mitigating efforts and over time will be relieved by other countries that join and take over some of the reduction responsibilities from the selected group. Let me call the group of countries responsible for reducing the world's emissions the "First-mover" group, and the group to which all other countries belong the "Second-mover" group. What is needed is a condition or formula that determines when countries from the second-mover group need to become active, and the extent of GHG reductions for which these countries become responsible (see section 3.2).

"Reaching a common goal at differentiated speed"

At the time when the Convention was negotiated, developing countries did not make commitments to reduce or limit greenhouse gas emissions as the principle of "common but differentiated responsi-
bilities" was applied. In Copenhagen, in order to agree to post-2012 climate treaty, we should move forward and refine this principle to "reaching a common goal at differentiated speed." This implies that member countries should first agree on a specific concentration level of CO₂ and a date at which this should be reached (see section 3.2). Second, they should also agree on a method on how to ensure that this concentration level will be reached. For example, countries might agree on reaching the common goal of stabilizing GHG emission at 450 ppm over the next fifty years by reducing total world GHG emissions by three percent each year. Alternative formulations where the date or the concentration level varies can be thought of as well, and should be the outcome of a political debate among member countries. The refined principle differs from the initial one by specifying a measurable objective, setting a deadline and agreeing on a method for implementation. It embraces the original version as it still grants countries flexibility in splitting the responsibilities amongst each other.

Over the agreed time period, countries may make progress towards the revised "3%-Solution" at differentiated speed, i.e. some countries may be reducing less or more in the interim period. Ideally, at the end of the commitment phase all countries should be reducing 3 percent of their GHG emissions (compared to the previous year). According to this principle, if developing countries continue to emit CO₂ (instead of immediately starting to mitigate) then industrialized countries would need to assume additional responsibilities and reduce more than 3 percent per annum.

The question that remains is what criterion to use for deciding which countries should belong to the first-mover group. Developing countries have in the past proposed to use per capita GHG emissions, since in general poorer countries tend to have lower per capita GHG emissions. On the basis of this criterion all industrialized countries would belong to the first-mover group. Industrialized countries would favor an alternative measure that uses the metric of GHG emissions per unit of economic output (i.e. GHG emissions per USD of GDP). In general, developed countries display lower GHG intensities per unit of economic production process than developing countries. Yet, this criterion would violate the principle of "common but differentiated responsibilities." In addition, finding consensus amongst the North and South for one of the two metrics would be difficult. What is needed is a "fair" criterion which takes not only historic responsibilities into account, but considers future contributions to GHGs and is grounded on verifiable, scientific insights.

2.2 Criteria for Selecting First-Mover Countries

Developing countries and industrialized countries do not only differ by income, and their historic and future contributions to global warming, they also differ in their short- and long-term potential to mitigate emissions. The concept of "mitigation potential" has been developed by IPCC (2007a,b,c) and is defined as the scale of GHG reductions that could be made, relative to emission baselines, for a given level of carbon price. Some countries possess a huge mitigation potential starting as of today, while other countries' mitigation potential will be at its peak in the future. Differences over time and across countries in mitigation potential could be exploited to determine which countries should belong to the first- and second mover group.

From an economic point of view it would be advisable to require a country to reduce emissions when its potential to do so is vast (since economic costs will be low). The benefit of "mitigation potential" as an objective criterion is that it is future-oriented (compared to the alternative metrics presented
above), i.e. one’s obligation to mitigate is conditioned on one’s capabilities (either today or in the future), while it safeguards the principle to act based on historic responsibilities for the climate change problem. In order to determine which countries should be asked to start mitigating, the mitigation potential across countries today and in the future needs to be analyzed more closely.

Exploiting Differences in Long- and Short-term Emission Savings Potential across Countries

Using mitigation potential to determine when a country has to act makes it possible to exploit the varying degrees of (asymmetrically distributed) technological opportunities for reducing GHG emissions around the world. In general, the mitigation potential varies by sector and the available mitigation technologies (McKinsey & Company, 2009). Analyzing the contribution to global emission (in relative terms) from different sectors shows that there are already big differences. By 2004, CO₂ emissions from power generation represented over 27% of the total anthropogenic CO₂ emissions and the power sector was by far its most important source. About 26% of GHG emissions were derived from energy supply (electricity and heat generation), about 19% from industry, 14% from agriculture, 17% from land use and land-use change, 13% from transport, 8% from the residential, commercial, and service sectors and 3% from waste (UNFCCC, 2007a). Given that differences in the stage of economic development are closely related to specific compositions of industries and technologies, the mitigation potential will also vary across countries. In general, developed countries tend to be more industry heavy which implies that emissions from power generation and energy supply play a greater role in their mitigation portfolio, while in the economies of many developing countries the largest contributions are from the agricultural sector. As the latter develop, the contribution of emissions from the agricultural sector decreases (in relative terms to the country’s overall emissions) while emissions from other sectors, such as the energy sector, become relatively more important in the country’s emission portfolio (FAO, 2008).

Energy-intensive industrialized countries such as the United States possess in the near future a vast potential to reduce GHG emissions without sacrificing their living standards (Moomaw, 2008). Some of the cheapest options for reducing emissions in developed countries involve electricity and energy savings in buildings, fuel savings in vehicles, and providing public awareness on the efficient utilization of energy (McKinsey & Company, 2009). In the United States, energy efficiency improvements throughout the energy system (especially at the end use side), can play a significant role in preparing the economy for its low-carbon future. Lifestyle changes can reduce GHG emissions too. Changes in consumption patterns that emphasize resource conservation contribute to developing a low-carbon economy. Measures related to personal energy consumption behavior can be implemented at a very low cost as all what they require is a re-thinking of one’s lifestyle. Yet, in the aggregate benefits from lifestyle changes make up a large contribution to mitigating emissions (Few Centers, 2008).

For paving the way for a low-carbon economy in industrialized countries, significant improvements in the efficiencies of energy production, distribution, and end-use technologies, as well as the use of lower carbon fuels and energy carriers such as hydrogen will be required. The transition has other benefits as well, such as increasing energy security, improving public health, and promoting economic development as this was the case in Germany in the solar and wind power industry. Compared to German standards, the distribution of solar, wind, geothermal heating and biomass for electricity generation is in many other industrialized countries still in its infancy. Some of these industries require public support, while others are more mature and need only market incentives for their deployment and diffusion (IPCC, 2007c).

Next, growth rates which determine future emissions vary also by sector. Since 1970, GHG emissions from the energy supply sector have grown by over 145%, while those from the transport sector have grown by over 120%; as such, these two sectors show the largest growth in GHG emissions. The industry sector’s emissions have grown by close to 65%, LULUCF (land use, land-use change and forestry) by 40% while the agriculture sector (27%) and residential/commercial sector (26%) have experienced the slowest growth between 1970 and 2004. Taking the large growth rates of emissions in the energy sector together with the increasing importance of energy in developing countries shows that in developing countries the future mitigation potential in this sector will be huge. There will be a vast potential for energy savings in the long-term (compared to the business as usual).

Critical for unleashing these future savings potential in developing countries is that the right investment decisions to meet their growing energy demand are being made today (see section 1.2.2). The need for energy in developing countries can be addressed through a combination of mature renewable energy technologies, such as solar, wind, and hydro power. China’s wind potential, for instance, is among the largest in the world. Wind power capacity is currently on track for nearly 400 percent growth by 2013 (from 24GW to 117GW) and the Chinese government has recently announced the intention to support an even more aggressive growth trajectory. Furthermore, China is already the world leader in solar thermal energy for hot water, with 60 percent of installed systems. Similar investments in green infrastructure are needed in other developing countries. The largest mitigation potential from the industrial sector is, however, available at the moment in energy intensive industries, i.e. in developed countries. On the other hand, the largest mitigation potential – that can be realized immediately as investments in infrastructure are not required – in developing countries is in agriculture, more precisely in the conservation of forests (Nelson G., 2009). At the current rates of deforestation developing countries contribute to more than 20% of human-caused greenhouse gas emissions, making deforestation across the globe a significant contributor to human-induced climate change.

To sum up, industrialized countries possess a high mitigation potential already today, which might decrease over time without innovation. Even if countries like the United States managed over the next couple of years to use energy more efficiently, without new technological innovations a level of GHG reductions might be reached at which it becomes difficult and costly to continue reducing more than three percent at home. The mitigation potential in developing countries is huge in the short-run only in certain sectors (agriculture), while an even greater mitigation potential exists in the future (in the energy supply and power generation sector). To tap into the future mitigation potential of developing countries, steps towards the implementation of a new, low-carbon infrastructure will need to be taken today, while industrialized countries will need to upgrade their energy infrastructure to access its own potential in this sector. In this respect the current global economic downturn may actually be providing the impetus needed to move to a low-carbon economy. Historically, periods of depressed economic conditions have provided an opportunity for investment in infrastructure and new technologies at lower cost than at other times. In responding to the current financial crisis, there has been widespread recognition of a need for substantial investment by governments to restore confidence. Government fiscal stimulus packages are intended to reinvigorate depressed economic conditions.
Many political leaders are making investment in clean energy and energy efficiency a central tenet of their economic recovery efforts. Using insights about mitigation potential, it makes sense to have industrialized countries take the lead with emission savings (first-mover group) and to complement these efforts in the future with emission savings from developing countries (second-mover group).

3. Implementation of the Subordinate Objectives

The negotiations in Copenhagen in December 2009 should lead to an agreement on the architecture of a post-Kyoto Protocol with the figures to be filled in during the years thereafter, the latest by 2012. As for the primary objective, the first challenge in Copenhagen will be to agree on a GHG concentration level to be reached at a set point in time. Based on the concentration level scientific need to determine how much of the total world GHG emissions need to be reduced every year given current emission growth rates. Next, delegates will need to find an approach which guarantees that the concentration level will be reached with high certainty by the end of the new commitment phase. In section 2.1, we proposed a revised version of the "3.3% Solution" to climate change. Others alternatives, such as a sectoral approach to GHG mitigation (Meckling J. et al., 2009), exist as well. For the implementation of the primary objective, we proposed to use objective criteria, such as mitigation potential (see section 3.1), in order to select a group of countries which becomes in charge of meeting the objective – at least in the near future. Specific binding emission targets will need to be negotiated by first-mover countries. As before, those countries may assume different responsibilities as long as the total amount of GHG emission reduced by them is equal to 3% of total world emissions. In the following, concrete policy proposals are made in order to create incentives for true technology transfer, to reform the existing CDM regulatory structure and to pave the way for the creation of a global carbon market.

3.1 Creation of an Advisory Think Tank Group

Scientific insights from climate change science, physics, and chemistry contributed to our current understanding of the global warming problem. The natural sciences first of all discovered the global warming phenomenon and then continuously fostered our understanding of emission growth, CO2 concentrations in the atmosphere, and the corresponding temperature increases. Regular assessment reports are being published by the International Panel for Climate Change (IPCC, 2004). As for other sciences, individuals such as Nicholas Stern (Stem, 2006) or Bill McKibben also contributed through their publications and presentations to our understanding of the policy responses available to climate change. With their insights about economic efficiency of different climate change regulatory tools – carbon tax, quantitative emission restrictions, and regulations – economists contributed to the development and implementation of cap-and-trade systems such as the European Emission Trading System (EU-ETS). Apart from the IPCC whose focus is on climate change science, no other international institution exists that pools the academic findings related to combating climate change and makes them available to politicians and negotiators. Given the obvious need for expert advice on international responses to climate change (see section 1.2) the input from other scientific disciplines could be greatly improved within the existing institutional structures of the UNFCCC.

As was pointed out in section 1.2, policy makers' intention with respect to enhancing technology transfer through the CDM has not been fully realized as there are a number of barriers to the wider uptake of CDM projects. These range from legal, regulatory, institutional, financial, and lack of technical capacity to the need for investment in infrastructure necessary for new energy technologies. A wide range of innovative public policy approaches and capacity building will be needed to overcome these barriers. Yet, the CDM underperformed mainly because the market incentives, which set signals for stakeholders in carbon finance, were not anticipated, or fully thought through by delegates. Various studies confirmed the fact that investors undertake carbon offset projects based on risk and the returns associated with the project. Looking at emerging market private equity investments, we know that risk varies greatly by country. In order to undertake an emission abatement project in a politically unstable environment or in a country with uncertain administrative bodies, an investor demands a higher return. Yet, the price for one certified emission reduction (CER) unit, i.e. one abated ton of carbon equivalent, is the same for all CERs no matter from which country they are. Therefore, it is not surprising that Africa hosts only a few CDM projects at the moment given that the risk of undertaking investments in some African countries is far higher than, for instance, in Asia or Latin America. To avoid these constructional weaknesses of the CDM in the future and in order to improve the existing regulatory structure, politicians and delegates at the climate negotiations will need to rely more on science-based expert advice.

Similar to the IPCC which gathers scientific evidence and information about the advancement of climate change and its consequences, a think tank group comprising the best researchers from different scientific fields – economics, business, finance, and engineering – is needed to foster cooperation on climate policy issues across sciences. For this purpose, the UNFCCC's institutional structure should be amended by creating a Think Tank Group for enhancing scientific understanding among climate change policy makers. At the moment, within the UNFCCC the Expert Group on Technology Transfer (EGTT) is tasked to identify ways to advance technology transfer activities under the Convention. In addition, the Global Environment Facility (GEP) is in charge of allocating and disbursing about US$ 250 million per year in grants for enhancing the development of markets related to climate change and for technology transfer projects, including support for energy efficiency, renewable energies and sustainable transportation. The knowledge of existing sources should be integrated in the Think Tank Group.

The task of such of the Think Tank Group would be similar to the IPCC's experts should support policy-makers and delegates in understanding market mechanisms behind the CDM/JI and emission trading systems. To do so, the think tank should publish regular reports on the latest insights on how to reform the CDM, and how to link emission trading systems with each other. Furthermore, it should make best-practice cases of CDM projects available to a wide audience and keep the world informed about technological progress (or lack thereof) in developing countries. At the end, the experts from the Think Tank Group should be in a position to inform policy makers about what projects are technically feasible, constitute a good choice in a given country, and what are their benefits for sustainable economic development, and under what conditions will investors finance them.

3.2 Details for Implementing the 3% Convergence Mechanism

Freedom of Geographical Destination

Bundling the responsibilities to achieve the "3% Solution" (see section 2.1) would not imply that the selected group needs to reduce the required quantity of emissions within their domestic territories
only. At one point, such a rigid constraint might require that those countries would need to shut down entire carbon-intensive industries, which would affect the economic activities of these countries dramatically. In addition, such a restriction creates an unwanted problem, namely carbon leakage. If the first-mover countries chose to establish an ETS in order to meet its international mitigation commitments, companies that are regulated under the ETS may decide to re-locate to second-mover countries to avoid paying for the CO₂ emissions. To avoid carbon leakage and to allow first-mover countries to achieve their mitigation commitments at the most cost-efficient way, they need to be granted the flexibility to reduce their emissions at home or abroad by carrying out a project-based mechanism, such as the CDM. As long as the freedom to choose whether to reduce GHG emissions themselves, i.e. within their domestic territory, or to purchase the equivalent carbon credits or emission allowances (from other first-mover countries) is acknowledged by all members to the Convention, the selected countries are ensured that any additional unit of emissions can be mitigated at the lowest economic costs possible.

**Continuation of a flexible Mechanism**

The government of a first-mover country faces many options on how to achieve its Copenhagen commitments either through CDM/JI or by creating an ETS. As before, governments may purchase Assigned Allowance Units (AAUs) from other governments from the first-mover group. Given that reduction commitments will be substantially higher under the Copenhagen agreement, the likelihood that other governments are selling their AAUs is however small.

In practice, the corresponding quantities of GHG allowances that each country of the first-mover group is still allowed to emit will be handed out taking into account the different, individual reduction commitments. As pointed out in section 2.2, countries belonging to the first-mover group will need to negotiate on how to split the burden of reducing, for instance, the 3 percent of total world emissions. If not stated otherwise, the existing UNFCCC structure in charge of monitoring and administering compliance should also be in charge of implementing the Copenhagen outcome. By the end of a year, a first-mover country will need to demonstrate its compliance with the UNFCCC, i.e. demonstrate that it emitted only the amount of GHG emissions that it was granted. When implementing, for instance the revised "3% Solution," the initial amount of allowances handed out in the first year will need to be reduced every year, i.e. each first-mover country has to return the corresponding amount of allowances to the UNFCCC. To achieve their reduction commitments, governments can invest in carbon funds, such as the ones from the World Bank Group, which will deliver in return, emission reduction units from CDM. Alternatively, governments may decide to fund carbon offset projects in second-mover countries through their domestic development banks, which yields the benefit of job creation at home. Lastly, as under the KP, governments can forward their compliance to the private sector and create a cap-and-trade system. Under an emission trading system, the government decides which agents — companies, private households, public entities — to regulate and ask those agents to reduce their emission by granting them a small amount of emission allowances, which can either be distributed via an auction or through grandfathering. It has now become the obligation of the regulated industries, or households, to ensure that they can meet their emission reduction targets by the end of the year.

**Creation of a New CDM Unit**

In order to foster technology transfer through the CDM, the existing mechanism needs to be upgraded. CDM projects that actually transfer low-carbon intensive energy technologies and contribute to the creation of an environmentally sustainable infrastructure in developing countries need to be distinguishable from traditional CDM projects which often only harvest the low-hanging fruits, i.e. do not contribute to the building of a low-carbon infrastructure (Umweltbundesamt, 2006). Let me call CDM projects that actually lead to technology-transfer and building of climate-friendly infrastructure CDMPlus projects. The carbon offsets harvested from these projects shall be called CERPlus credits, instead of certified emission reductions (CER) which are issued from the traditional CDM projects. By creating a second, separate CDM unit, a new financial asset is born which means that prices of traditional CERs should differ from prices of CERPlus credits. More importantly, the new asset class of the CDM can be used to create the missing incentives for technology transfer to developing countries. To do so, existing mitigation technologies need to be screened in terms of whether they lead to the building of a green energy infrastructure need. The executive board of the CDM at the UNFCCC should work together closely with experts from the newly created Think Tank to determine which abatement technologies can be categorized as leading to infrastructure investments and technology transfer in developing countries. Only carbon offset projects that use these mitigation technologies will be eligible for the CDMPlus. By distinguishing the efforts to invest in a long-term infrastructure projects from the traditional CDM projects, incentives to invest in true technology transfer are created. To entice carbon offset investors, who have so far shied away for undertaking long-term carbon offset projects (for reasons explained in section 1.2), a premium needs to be added so that their exist a benefit to invest in the new asset class. CDMPlus projects will at a future date lead to the pay-out of additional carbon allowances from the UNFCCC, i.e. everyone who invests in these abatement projects will not only receive the traditional carbon credit, but gets a second allowance for free for having undertaken the necessary investments in climate-friendly technologies that are needed to help developing countries leap-frog the carbon-intensive stage of development. Under what conditions the pay-out of the second allowance takes place and the occurrence of the event will be explained below.

**Criterion Determining when Second-Movers Have to Start Mitigating**

As the number of CDMPlus projects increases over time in developing countries, their level of low-carbon energy infrastructure increases. Thus, the quantity of CDMPlus projects is an indicator of the technological maturity of a host country. In order to use the new CDM unit as an indicator, the absolute number of CDMPlus projects has to be interpreted relative to the initial situation in the host country and the future energy demand of the country. Therefore, country-specific factors such as population, population growth rates, initial GDP, initial infrastructure and power generation need to be considered. For finding an appropriate indicator that determines a country’s technological maturity, delegates of the climate negotiations should work together with experts from the Think Tank Group. The outcome of this undertaking should be a formula, based on the number of CDMPlus projects and the individual characteristics of host countries, which can be used to assess a host country’s progress towards a sustainable green infrastructure.
The point at which a developing country has to assume GHG reduction responsibilities should ideally be linked to its stage of technological maturity. Technological maturity relates to the country's ability to satisfy its energy needs in a climate-friendly manner, and it is also linked to its mitigation potential (see section 2.2). If developing countries have reached a point where they possess capacities to save GHG emissions without sacrificing their economic well-being, they should be required to support the ongoing efforts of first-mover countries. The above-mentioned formula can also be used as an objective measure to determine a tipping point, i.e. a point in time from which developing countries can be expected to contribute to mitigation efforts. Again, the UNFCCC monitoring unit would also be in charge of making public each country's progress towards reaching the tipping point. Once a second-mover country has matured, passed the tipping point, it will need to start mitigating emissions after a grace-period. Since industrialized countries have reached this point, they have started achieving the 3% Solution, mitigation action by second-mover countries would constitute additional abatement efforts. Instead, for having received CDMPlus projects that fostered a low-carbon development, second-mover countries will gradually need to take over the reduction commitments of first-mover countries until they are mitigating 3 percent of their emissions relative to the previous year. That is, at the moment of reaching one's technological maturity, the second-mover country receives from the UNFCCC monitoring unit as many AAUs as the country's total GHG emission at the time of reaching the tipping point. This implies that the second-mover country will now need to undertake and implement policy measures which ensure that its GHG emissions in the following year won't exceed its assigned allowances.

Given that the UNFCCC keeps track of the progress all second-mover countries make in reaching its tipping point, governments are alerted and have sufficient preparation time to implement the necessary institutions and policies required to handle the next phase. After a short grace period during which developing countries neither have to reduce emissions nor are allowed to increase their own, matured second-mover countries will need to start mitigating, i.e. emit less than the level of the GHG emission in the tipping point year. Since the CDMPlus asset is attributed additional benefits for the project developers in first-mover countries — an additional allowance at an unspecified time in the future — negotiations about the quantitative restrictions for developing countries upon reaching the tipping point can be avoided. The number of CDMPlus projects, where one unit equals one ton of carbon dioxide equivalents, determines automatically the commitment reductions for second-mover countries.

As pointed out, the idea is that project developers and investors of CDMPlus projects are awarded additional units of emission rights from the UNFCCC once the country in which the carbon offset project was carried out has reached its tipping point. Thus, to facilitate implementation and registration with the UNFCCC, the CERPlus units need to be issued including detailed information about the mitigation methodology, the host country and the economic agent holding the CERPlus title. Each time the CERPlus unit is sold to another agent, the information about the sale will need to be tracked by the UNFCCC in order to enable the pay-out. Once the pay-off allowance for having undertaken a CERPlus project has been issued to the agent possessing it, the UNFCCC simultaneously will need to collect an AAU from the host-country in order for the global capped emissions to remain constant. If the second-mover country has established an ETS, the government will need to issue the emission allowances in the ETS. The mechanism behind CDMPlus ensures that first-mover countries have an incentive to invest in pro-climate infrastructure today, as this will be rewarded in the future. Under the Copenhagen agreement, first-mover countries have total control over how much abatement activity they are willing to carry out in second-mover countries and how much domestic emission reductions they want to undertake. By investing in CDMPlus projects, first-mover countries are ensuring a guarantee that the future part of their reduction commitments are being taken over by developing countries. The latter, on the other hand, receive the technology and energy infrastructure needed to leap-frog a carbon-intensive stage of development and are only required to reduce emissions once they are in a position to do so.

3.3 Summary

The two-stage approach to solving the 21st century climate change problem is built around a contingent agreement – no matter to which group (first or second-mover) a country belongs – it will always be required to act at some point, while always receiving benefits at another point in time. First-mover countries must act immediately under the proposal (since their mitigation potential is high) and receive their benefits later; in second-mover countries, infrastructure investment and the greening of technologies happens first (for unleashing their future mitigation potential), while the obligation to contribute to solving the 21st century global warming problem comes at a later point.

The proposal creates a mechanism that requires action by developing countries only after the developed countries have fulfilled their part. GHG reductions in developing countries are contingent on having reached technological maturity. As for the political feasibility, industrialized countries, like the U.S. should favor the mechanism since developing countries are part of the new climate change treaty and will need to subsequently adopt GHG reductions commitments in the future; in fact the speed and the magnitude at which developing countries will need to start mitigating lies in the power of industrialized countries.

The proposed mechanism encourages technology transfer because only those projects that actually lead to long-term infrastructure development and technology transfer qualify for receiving an additional allowance in the future. The so-called "long hanging fruits" projects will still happen – as the demand for carbon offsets from first-mover countries will be large at the beginning, given that the long-term projects will take a few years to deliver offsets. A notion of equity and fairness among countries in sharing the present and future responsibilities for our atmosphere is re-established since richer countries, who are responsible for the current GHG concentrations have to act immediately, while poorer countries, who will be responsible for GHG concentrations in the future (unless their policy change), need to act when their time has come. First-mover countries will need to start reducing at home immediately once the total assumed responsibility of reducing 3% p.a. of total world emissions implies that the demand for carbon offsets from the CDM market may not be able to deliver that many credits – at least in the short-term – to enable the rich to buy their way out. This side-effect should please environmental non-governmental organizations in industrialized countries that have been pushing for action at home. Most importantly, the contingent-based mechanism ensures that developing countries receive technology transfer. A major push in research and development (R&D) for new energy-saving technologies is required to foster the future mitigation potential in industrialized countries. Investments in R&D, either by governments or the private sector, are more likely to happen if the Copenhagen Protocol encompasses a long-term horizon and when pressure to innovate is high today.
References


World Watch Institute, (2005), China Calls on the U.S. to Join Kyoto Protocol, by Yingling Liu on December 1, 2005; http://www.worldwatch.org/node/144.


Notes

1 The United States signed the Kyoto climate accord to reduce greenhouse gases a decade ago but, unlike 177 other countries, the U.S. never ratified the treaty. The pact expires in 2012. A detailed overview of the history of climate change negotiation is provided by Wyzze van der Gaast (2008).

2 China which currently ranks second in the world's CO₂ emissions is projected to pass the United States sometime between 2025 and 2030 as the largest emitter of carbon dioxide. 

3 The International Energy Agency warned in its 2008 World Energy Outlook that 97 percent of projected growth in emissions of carbon dioxide from energy use through 2030 (without aggressive action) will come in developing countries, with three-fourths of that growth in China, India and the Middle East. By 2025, China could account for one-quarter of global CO₂ emissions according to China Environment Forum, Woodrow Wilson International Center for Scholars http://wilsoncenter.org/?index.cfm

4 Chris Flavin, the president of Worldwatch, said that "Without their (developing countries) participation the next round of emissions limits will hardly be meaningful." (World Watch, 2005).

5 Republican Jim Sensenbrenner, who attended seven talks from Dec. 1-12, 2008, a top Republican on the House select committee on energy independent and global warming wrote in a letter to President Barack Obama that "...any treaty that does not include legally binding and verifiable greenhouse gas emissions reductions from developing countries will not be ratified by the U.S. Senate because it will not accomplish the fundamental goal of reducing global emissions." (Marrero, 2008).

6 In particular, the Chinese Government plans to increase spending on science and technology by over 25% on 2008 levels with extra funding assigned to wind, solar, nuclear, and clean coal technologies. China's $586bn fiscal stimulus package has secured praise for assigning more than 30 percent of spending to low-carbon projects and programs to clean up pollution (UNEP, 2009).

7 The main body to govern the development of an international climate policy regime is the UNFCCC, which is an intergovernmental organization without supranational powers.

8 According to Article 2 of the Convention, such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner (UNFCCC, 1992).

9 Two thirds to three quarters of this increase is projected to come from developing countries, though their average per capita CO₂ emissions will remain substantially lower than those in developed countries regions. (UNFCCC, 2008b).

10 These and other stabilization scenarios are described in IPPC (2001a, b).

11 The Bali Action Plan stresses that developing countries will need support in responding to this challenge, following the principle of common but differentiated responsibilities.

12 According to the IEA (2008), global energy demand will grow by 55% by 2030.

13 Levels of foreign direct investment (FDI), commercial lending, and equity investment all increased greatly in recent years. These are the dominant means by which the private sector makes technology-based investments in developing countries and economies in transition. However, private sector investment in the form of FDI in developing countries has favored East and South East Asia, and Latin America (UNFCCC, 2008a).

14 It is estimated that the CDM for renewable energy and energy efficiency projects (which were registered during 2007) resulted in 5.7 billion USD in capital investment. This is about triple the amount of official development assistance for energy and renewable energy projects in the same countries (World Bank 2008b).

15 Additionality is defined in the so-called Marrakesh Accords as follows "a CDM project activity is additional if anthropogenic emissions of Greenhouse Gases by sources are reduced below those that would have occurred in the absence of the registered CDM Project activity."

16 Joint fulfillment is one of the four Kyoto flexible mechanisms and lead to the creation of the EU bubble during the commitment phase 2008-2012. The EU committed to cut its emissions by 8 percent with member states taking on different responsibilities.

17 Developed countries hold a 20% share in the world population but account for 46.4% of global GHG emissions. In contrast, the 80% of the world population living in developing countries (non-Annex I countries) account for 53.6% of GHG emissions. Based on the metric of GHG emission per unit of economic output, Annex I countries generally display lower GHG intensities per unit of economic production process than non-Annex I countries (UNFCCC, 2007c).

18 The unit of measurement for "mitigation potential" is expressed in cost per unit of carbon dioxide equivalent emissions avoided or reduced.

19 Singh and Fehrs (2001) found that wind and solar photovoltaics create 40% more jobs per dollar than coal.

20 Growth of solar and wind energy is often the result of comprehensive energy policy frameworks at national levels instituted through legislation. To increase the uptake of solar and wind power the Government in Germany adopted "fees-in tariffs" in 1990. Those provisions allow eligible generators to receive a fixed and transparent premium price for their renewable electricity sale. The term "feed-in tariff" is used both for a minimum guaranteed per unit of produced renewable electricity to be paid to the producer, as well as for a premium that is added to market electricity prices for supplied renewable energy. As a result, Germany transformed itself from a country with sparse renewable resources 1990 into an international renewable energy powerhouse.

21 A recent study done by Deutsche Bank (2009) counted more than 250 climate change related policy developments between July 2008 and February 2009 by governments around the world.

22 Bill McKibben is author of numerous environmental books dealing with climate change, such as his book "Fighting Global Warming - Now."

23 No other environmental regulatory tool can reduce GHG Emissions with 100% certainty and at the lowest costs possible than emission trading (Sten, 2006).