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State of the Carbon Market: How the future market can encourage developing country participation

Background Paper

Peter Wooders and Jean Nolet

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IISD acknowledges the generous support of Environment Canada.

Published by the International Institute for Sustainable Development

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Preface

The International Institute for Sustainable Development (IISD) has prepared three papers to explore how major developing economies might become effectively engaged in a post-2012 global climate change regime. The goal of this second background paper, *The Carbon Market: How the future market can encourage developing participation* is to examine the impact the carbon market could have on funding mitigation and adaptation in developing countries.

The information in this background paper provides input to the analysis of the main report of the series, *Encouraging Developing Country Participation in a Future Climate Change Regime;* and should be read in conjunction with that report. The first background paper in the series is, *Financing Mitigation and Adaptation in Developing Countries: New options and mechanisms*.

Abbreviations and Acronyms

AAU	Assigned Amount Unit
AFOLU	agriculture, forestry and other land use
AOSIS	Alliance of Small Island States
APP	Asia-Pacific Partnership on Clean Development and Climate
A/R	afforestation/reforestation
AWG-KP	Ad Hoc Working Group on Further Commitments for Annex I Parties under the Kyoto Protocol
AWG-LCA	Ad Hoc Working Group on Long-term Cooperative Action under the Convention
CCGT	combined cycle gas turbine
CCS	carbon capture and storage
CCX	Chicago Climate Exchange
CDM	Clean Development Mechanism
CER	Certified Emission Reduction
CH_4	methane
CMP	Conference of the Parties serving as the Meeting of the Parties
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
COP	Conference of the Parties
DCSC	developing country sectoral commitments
DRE	decentralized renewable energy
EC	European Commission
EE	energy efficiency
ERU	Emissions Reduction Unit
EU	European Union
EUA	European Union Allowance
EU-ETS	European Union Emission Trading System
FAO	Food and Agriculture Organization
FCPF	Forest Carbon Partnership Facility
Gt	Gigatonne (billions of tonnes)
GDP	gross domestic product
GHG	greenhouse gas
HFC	hydroflourocarbon
IEA	International Energy Agency
IET	International Emissions Trading
IETA	International Emissions Trading Association
IISD	International Institute for Sustainable Development
JI	Joint Implementation
LDC	least developed country
LULUCF	land use, land-use change and forestry
MMSD	market mechanism for sustainable development
MOP	Meeting of the Parties

MRV	measurable, reportable and verifiable
Mt	megatonne (millions of tonnes)
N_2O	nitrous oxide
NAMA	nationally appropriate mitigation actions
OCGT	open-cycled gas turbine
OECD	Organisation for Economic Co-operation and Development
OTC	over-the-counter
ppmv	parts per million per volume
R&D	research and development
REDD	Reducing Emissions from Deforestation and Forest Degradation
SBI	Subsidiary Body for Implementation
SBSTA	Subsidiary Body for Scientific and Technological Advice
SCM	sectoral crediting mechanism
SD-PAM	sustainable development policies and measures
TOA	technology-orientated agreement
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
U.S.	United States of America
URC	UNEP-Risoe Centre
VCS	Voluntary Carbon Standard
VER	Verified Emission Reduction

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1.0 Background

1.1 Overview

This is the second background paper to the IISD report, *Encouraging Developing Country Participation in a Future Climate Change Regime*. This paper focuses on the potential impact of the carbon market on funding mitigation and adaptation in developing countries.

The main report and first background paper emphasize that mitigation and adaptation will require major finance and investment with estimates of hundreds of billions of dollars per year.[1] Despite being relatively young and immature, the value of the world carbon market is already over US$50 billion per year. Carbon markets could generate at least a significant proportion of the finance and investment required, but to do so will require that markets expand their coverage, both geographically and within the sectors and activities of the economy.

Market instruments are extremely flexible since they can be designed to cover projects, sectors, policies and measures. Different instruments have different applications; a full coverage of developing country actions by the carbon market is likely to require several options, applied in combination.

To be successful, there must be a recognition that market instruments would lead to real reductions in greenhouse gas (GHG) emissions and be acceptable to both the buyer and the seller. This background paper presents the options available and discusses their advantages, disadvantages, and where and to what they could be applied. It is informed by considerations of supply and demand and by how the options would fit into the framework of the United Nations Framework Convention on Climate Change (UNFCCC).

Using part of the revenues generated by carbon markets could also make a major contribution to financing and investing in the necessary actions to reduce climate change impacts. An example is the 2 per cent levy on Certified Emission Reductions (CERs) generated by Clean Development Mechanism (CDM) project for the Adaptation Fund. This paper assesses how such schemes could be developed, what levels of finance they might raise and their impacts on both the market itself and the UNFCCC negotiations.

This background paper does not assess whether markets are a better solution than other options for mitigation across all or parts of the economy. Rather, it seeks to assess what markets could potentially achieve in developing countries and the conditions needed to support them.

[1] The UNFCCC (2008c) reports figures of the order of US$200 billion per year for mitigation and tens, possibly hundreds, of billions of dollars per year for adaptation.

1.2 How Carbon Markets support GHG Mitigation

1.2.1 Direct Support

Carbon markets increase mitigation by providing a financial incentive to eligible entities to reduce their carbon emissions.[2] The size of this financial incentive is the net value (market price[3] minus costs of investing in abatement) of the tradable financial instrument. These tradable financial instruments fit into two categories:

- allowances to emit GHGs; and
- credits (or offsets) from activities recognized as leading to reductions in GHG emissions.

Any number of futures and derivative markets can be set up, but all these are related to the primary trading of the two instrument types.

The size of the carbon market is principally driven by the difference between expected or business-as-usual (BAU) emissions and the caps placed on emissions for the activities covered.[4] This difference creates demand for allowances and, if they are eligible, for credits from activities outside those covered by caps. More stringent caps (a larger reduction below BAU emissions) and increasing the number of activities covered will result in higher demand.

The impact of carbon markets on mitigation in developing countries is clearly a function of demand. This demand can come from two sources:

- domestic caps; and
- access to foreign markets for credits.

At present, there are no domestic caps in developing countries.[5] Sale of CERs generated in developing countries through CDM projects to developed country markets is the only incentive that carbon markets give to increase mitigation in developing countries at the moment. By far the largest flow of credits, and thus finance, is the sale of CERs into the European Union Emissions Trading Scheme (EU-ETS).

Any discussion of markets must take into account the quality of credits. Credits are generally calculated as reductions from a counterfactual of BAU emissions, but there is always uncertainty and debate over the setting of this counterfactual. There is also the need to demonstrate that a project

[2] Implementing projects and activities to reduce GHG emissions generally requires "up-front" investment and leads to changes in operating costs (which can be either positive or negative). Carbon markets have the potential to deliver financial flows, which improve the investment case. In general, such financial flows will arise over a number of years and more closely resemble a reduction in operating costs rather than an up-front investment. However, the net impact of the carbon market is to encourage investment.

[3] Reducing emissions will often require an investment that will then be paid back over several years. The incentive is thus the market prices over a number of years, and investors must take a view on how they see the market price developing (and indeed whether they think the carbon market will continue to exist or evolve).

[4] Note that caps may be absolute in nature or can be set as indices, for example, carbon dioxide (CO_2) per tonne of production.

[5] Note that South Korea has launched a voluntary emissions trading scheme.

would not have happened anyway, that it is "additional." Demonstrating additionality requires an assessment against an agreed protocol, which is based on several assumptions. There is significant concern in many quarters that credits from schemes such as the CDM do not demonstrate sufficient additionality to allow their widespread use as offsets against emission reductions from activities covered by caps. [6] The way this issue is resolved will be a key determinant of the future impact of the carbon market in developing countries. Credit providers favour schemes which are simple and cheap to administer; policy-makers in countries with caps wish to see concrete demonstration of the additionality of credits.

1.2.2 Indirect Support

A levy of two per cent on each CER issued under the CDM is already in place, generating funding for adaptation in developing countries. A similar levy on International Emissions Trading (IET) and Joint Implementation (JI), the other principal flexible mechanisms under the Kyoto Protocol, were proposed but not adopted during COP 14 in Poznan, Poland in December 2008. Another proposal from the Norwegian government suggests auctioning a small share (two per cent) of Assigned Amount Units (AAUs) to finance adaptation (UNFCCC, 2008e). Taxes and levies could be applied when allowances are first granted or when they are traded. Applying them during trading would likely have a more distortionary impact on the market.

A larger revenue source is potentially from part or all of the proceeds from the auctioning of emission allowances. Suggestions to date have focused on the EU-ETS, by far the largest current market for emission allowances and credits. The issue of "hypothecating" revenue generated in this way to mitigation and/or adaptation activities, particularly if such revenue is to go abroad, has been a major source of debate and contention and will need to be resolved if indirect support is to be a significant source of finance going forward. Indirect support is analyzed in further detail in Section 2.3.

1.3 Development of the Carbon Market to Date

Trading in carbon tentatively started as the Kyoto Protocol moved toward ratification and is now one the world's fastest growing markets. The market was worth US$64 billion in 2007 with 70 per cent within the EU-ETS (Capoor and Ambrosi, 2008). The bulk of the remainder of the market was for CERs generated under the CDM, but markets for voluntary offsets and trading of AAUs under the Kyoto Protocol's IET facility are both currently growing strongly. Annex A includes a review of market development and trading to date, by instrument type.

[6] For example, see Schneider, 2007. Schneider, a member of the CDM Methodologies Panel, estimates that additionality is unlikely or questionable for 40 per cent of projects registered so far.

2.0 How could the Carbon Market Develop – Demand and Developing World Revenue

2.1 Overview of Carbon Market Demand

The scale of global commitments agreed to post-2012 will define the demand for emission allowances and for emission reduction credits. The level of this demand defines the maximum role the carbon market can play. If the scale of global commitments is limited, then this will reduce the role that the market can play in incentivizing mitigation in both developed and developing countries. A secondary effect is that low levels of demand tend to lead to lower market prices, thus further reducing incentives for countries to reduce their emissions.

Estimating the level of future demand is clearly subject to major uncertainty: two UNFCCC discussion tracks (under the Kyoto Protocol and Convention respectively) are ongoing,[7] and a huge number of potential post-2012 regimes have been proposed.[8] A range of commentators have stated that the most efficient solution to global GHG emission reductions would be a world-wide price for carbon.[9] This is generally linked to the vision of a future global cap-and-trade system. Such a scheme is normally considered to be 20 to 40 years away, and different countries will be ready to move into such a system at different times. A smooth progression to global cap-and-trade, using the architecture of the Kyoto Protocol, is only one of many possibilities of how the carbon market could develop. These possibilities—or "scenarios"—can be characterized using the following characteristics:

- whether the Kyoto architecture is continued or abandoned;
- how many other multi-national, national and regional schemes develop and what their characteristics are (absolute or intensity caps, share of economy covered, GHGs included, sectoral approach, among others) –one of the most important developments is how U.S. schemes will develop, since these would both cover a large share of the world's GHG emissions and would set an example of the level of effort the U.S. is willing to make.)
- whether and how these schemes are linked together;
- whether the schemes will allow credits from emission reduction schemes outside their borders to be used as offsets (either through linking trading schemes or through credits); and
- whether the Major Developing Economies (MDEs) take on commitments or not.

Varying these characteristics could radically alter the quantity of demand for carbon in the markets. This in turn could lead to a wide range of prices for carbon.

For their part, developing countries could participate fully in one or more schemes, could sell credits from GHG emission reduction projects widely or could choose to limit their activities. Developing

[7] Two discussion tracks were opened under the Montreal Action Plan of COP-11/MOP-1 within the UN formal negotiations: under Article 3.9 of the Kyoto Protocol, a discussion on future commitments beyond 2012; and under the UNFCCC to undertake a non-binding dialogue for long-term cooperative action to address climate change.

[8] See, for example, Cosbey *et al.,* 2007.

[9] See, for example, Stern, 2007.

countries have some influence on the total level of demand because their taking of caps increases demand and by engaging in the process they will engender trust and commitment from the developed world, encouraging them to take on more stringent caps.

2.2 Estimating the Potential Range of Demand and Developing Country Revenue

As noted, estimating the level of demand is subject to great uncertainty. Estimating developing world revenue adds more uncertainty since it requires assessments to be made including:

- the expected market price for carbon;
- if, and when, some or all developing countries take on commitments; and
- if they do not take on commitments, the level of access that would be granted to credits from emissions mitigation in developing countries in developed country markets.

Given the scale and number of uncertainties, developing scenarios which aim to precisely define the size of the carbon market in the future is considered to be impossible. An estimate can be made of the range within which demand must lie, and by imposing a range of market prices and market access assumptions on this, an estimate also can be made of a range for possible developing country revenue.

2.2.1 Maximum Demand: Required Reductions in GHG Emissions

The companion paper, *Encouraging Developing Country Participation in a Future Climate Change Regime,* gives indicative estimates of the GHG emission reductions required for the world to stabilize at 450 ppmv, 550 ppmv and 650 ppmv respectively (reproduced in Table 1 below). Whether reductions occur in the developed or developing world regions, and the contribution of specific countries, is immaterial to the level of reductions required and is not considered within this estimate of the range of possibilities. Depending on the desired stabilization concentration, required reductions are:

- 2-9 $GtCO_2e$ in 2020 (a 4-18 per cent reduction in emissions below BAU levels); or
- 16-33 $GtCO_2e$ in 2050 (a 23-46 per cent reduction in emissions below BAU levels).

These required reductions set maximum carbon market demands—demand cannot be higher than the total reductions required. Where the reductions are made will depend on how markets develop. In the ideal case, reductions will be made where the costs of reduction are lowest—the panacea of a single global market.

Table 1: Indicative Reductions required for Stabilization at 450, 550 and 650 ppmv CO_2e

Stabilization Concentration	Required Reductions (below BAU)			
	2020		2050	
	%	GtCO2	%	GtCO2
450 ppmv CO2e	18	9	46	33
550 ppmv CO2e	13	7	33	23
650 ppmv CO2e	4	2	23	16

2.2.2 Demand and Revenue – without Developing Country Commitments

The IPCC (2007) noted that reductions required from developed countries alone would be about 25-40 per cent in 2020 and 50-80 per cent in 2050. Combining these with the three stabilization concentrations presented above gives estimated developed country demand of 2-6 $GtCO_2$ in 2020 and 11-18 $GtCO_2$ in 2050. How far this could support developing country mitigation actions depends on the share of demand developing countries could meet. This in turn depends on both the costs of developing country reductions relative to those in developed countries and on what access developing countries would be given to carbon markets in developed countries.

Current and expected quantities of CERs to 2012 are estimated to be about 600 $MtCO_2$/year (0.6 $GtCO_2$/year)–see Section B2.3 for details. CER prices have been in the range of US$0-25/$tCO_2$ to date. This gives developing world revenue of US$0-15 billion per year. It should be noted that developing countries would need to subtract the costs of investing in CDM projects from this to arrive at their net benefit.

Assuming that developing countries could supply 50 per cent of developed country demand, [10] developing world revenue would be as shown in Table 2. With 2020 demand ranging from 1-3 $GtCO_2$, revenue of US$10-30 billion would result if the carbon price were US$10/$tCO_2$. Such a price is very likely to be at the lower end of the range–a carbon price of UD$100/$tCO_2$ would increase developing country revenue to $100-300 billion. With world gross domestic product (GDP) in 2020 projected to be about $100 trillion (IEA, 2008), developing world revenue would represent 0.01-0.3 per cent of world GDP.

Again, assuming developing countries could supply 50 per cent of developed country demand, 2050 demand ranges for credits range from 5.5-9 $GtCO_2$. If the price were US$10/$tCO_2$, developing world revenue would range from US$55-90 billion; with carbon prices of US$100/$tCO_2$, this would increase to US$550-900 billion. While these figures appear much larger than the 2020 revenue, GDP is projected to almost treble between 2020 and 2050, meaning that the revenue remains in the range 0.01-0.3 per cent of world GDP (IEA, 2008). This conclusion is clearly based on the assumption that carbon prices in 2050 would be in the range US$10-100/$tCO_2$. It is difficult to make any projections so far into the future, but there is a possibility that the carbon price could be considerably higher.

[10] The limits expressed in the EU-ETS for Phase 2 and Phase 3 show a limit of CERs of approximately 50 per cent of demand.

Table 2: Developing World Revenue with 50 per cent of Developed Country Demand met by Developing Country Credits

		2020		2050	
Carbon Price ($/tCO2)	Stabilization Concentration	Demand Transfer (GtCO2)	($ billion)	Demand Transfer (GtCO2)	($ billion)
10	450 ppmv CO2e	3	30	9	90
10	550 ppmv CO2e	2	20	6.5	65
10	650 ppmv CO2e	1	10	5.5	55
100	450 ppmv CO2e	3	300	9	900
100	550 ppmv CO2e	2	200	6.5	650
100	650 ppmv CO2e	1	100	5.5	550

2.2.3 Demand and Revenue – with Developing Country Commitments

There is no consensus as yet whether and when some or all developing countries would take on commitments. Such commitments could significantly increase the overall demand for GHG reductions from developed countries alone, perhaps by 50-100 per cent.

Adding developing country commitments would have the effect of increasing the carbon price, since options higher up the marginal abatement curve would need to be implemented. However, the ability of developing countries to sell to the developed world will be decreased by the need to use domestic reductions to meet developing country commitments. Developing world revenue would thus tend to be increased by higher carbon prices, but decreased by lower sales. The net effect could be either positive or negative, but could be considered to leave revenue at the same order of magnitude as a very rough, first order estimate.

Developing world revenue is not the main focus of this paper. What we are considering is the incentive that the carbon market can provide to developing countries to undertake mitigation actions. Here, the inclusion of developing country commitments is unequivocally positive; higher carbon prices give more incentive to developing countries to invest in abatement measures.

2.3 Revenue from Indirect Support: Taxes and auctioning of allowances

2.3.1 Overview

The carbon market has been identified as a vehicle that can generate significant funds by applying a tax or by the auctioning of allowances. A 2 per cent levy on CERs issued has already been implemented in the period to 2012 to fund adaptation in developing countries; and several proposals have been made around the wider application of measures (for example, the Norwegian proposals for auctioning AAUs, EU discussions about the auctioning of EUAs and the potential uses of auctioned revenues).

Potentially, such measures could provide a larger amount of funding to developing countries than the carbon market. All allowances could in principle be auctioned whereas the demand in a carbon market is only that proportion of allowances between BAU emissions and the cap. In practice, several issues are likely to reduce the funding which could be generated including:

- Developed country producers cite competitiveness concerns if they are subject to carbon prices while their competitors in developed countries are not. Developed country policy-makers are concerned both about this loss of competitiveness and the leakage of emission reductions (in simple terms, reductions in developed countries being fully or partially offset by increased emissions in developing countries).
- Finance ministries are generally against hypothecation (they prefer revenue to go into the general public purse rather than to be allocated specifically for a particular purpose).
- There is likely to be considerable resistance to the transfer abroad of revenue raised. Other than the loss of domestic revenue, concerns that money transferred abroad would not be spent effectively and that transfers abroad would add to the competitive disadvantage suffered by domestic producers subject to carbon prices are often cited as reasons against major fund transfers.
- The sudden provision of large amounts of funding may overwhelm the absorptive capacity of developing countries.
- Markets for carbon and trade could be affected. Economic theory suggests that whether allowances are auctioned or given out free should not affect how much abatement is taken up or where. This assumption relies on the allocation method being perfect with respect to new entrants and plant closures and on all organisations having perfect information over the long term. Such conditions do not tend to be fully met in practice, where auctioning of allowances is likely to be treated as an extra cost requiring a change in investment and production strategies. Taxes and levies make the reductions they are applied to more expensive for the buyer. If the same tax or levy was applied to all abatement options in all countries then there should be no impact on what options are taken up. In practice, taxes and levies are likely to apply to only part of the abatement options (for example, at present they apply only to CERs). If the tax or levy is significant, this distortion will be higher.

2.3.2 A Key Precedent: Auctioning under the EU Emission Trading System

A key precedent, illustrative of many of the points above and one which may provide a good indication of how indirect support may develop going forward, is the recent European development of policy. The EU-ETS saw limits (up to 5 per cent and 10 per cent respectively) on the amount of allowances which could be auctioned in Phase 1 (2005-07) and Phase 2 (2008-12). Member States generally auctioned little or none of their allowances, focusing on specific elements (for example, the auctioning of the new entrant reserve surplus in the United Kingdom in Phase 2). Revenues from auctioning were not transferred abroad.

EU-ETS plans for Phase 3 were much more ambitious. Originally it was proposed that 100 per cent of electricity generation allowances would be auctioned from 2013 Auctioning for industrial sectors

would be covered by the ETS being phased in with 100 per cent auctioning by 2020. The European Commission stated that 20 per cent of auctioning revenue would be available for transfer abroad, provided that the actions financed would be monitorable, reportable and verifiable (MRV). The Commission was firmly against any transfer of funds into developing country general budgets. The final agreement within the EU's Energy and Climate Change Package of December 12, 2008 was watered down (Council of the European Union, 2008). The auctioning of electricity generation allowances would start at 30 per cent in 2013 and be 100 per cent no later than 2020. However, the auctioning of allowances to industry was essentially cancelled–only those sectors considered to be at no risk of competitiveness impacts would see auctioning, phased in over the period 2013-2027. Furthermore, only about 10 per cent of industry was classified as being at "no risk". While fewer allowances would be auctioned, the Commission did recommend that "at least 50%" of the revenues raised from auctioning should be used in the fight against, and adaptation to, climate change and that, "part of this amount will be used to enable and finance actions to mitigate and adapt to climate change in developing countries that will have ratified this [international] agreement, in particular in least developed countries" (European Council, 2008).[11]

The exact reasons why the EU scaled down its auctioning plans have not been made fully clear. Contributory factors include competitiveness concerns, the possible impacts of the financial crisis on jobs and companies' prospects and the energy security of supply implications of increasing the relative costs of coal-fired electricity generation in Poland and other parts of Eastern Europe. Old arguments about whether cap-and-trade is the best way forward for European industry and what share of the national burden they should take on were also played out again.

2.3.3 Possible Developing World Revenue

Referring back to Table 1, demand from developed countries for credits in 2020 was estimated to be 1-3 $GtCO_2$. Developed country BAU emissions at the same time were 18 $GtCO_2$. Therefore, if all developed country allowances were auctioned and all revenues transferred to developing countries, revenue would be at least six times what the carbon market could provide.

If taxes or auctioning of allowances was introduced for all developed country emission allowances, all the revenue raised was transferred to the developing world and there was the absorptive capacity to effectively spend these large inflows, then the carbon market could be sufficient to bring about the large emission reductions that are required from developing countries. All three parts of this hypothetical scenario have significant issues. The experience of the EU to date has been to scale down on its auctioning plans within the EU-ETS and not to make an equivocal proposal regarding the share of revenues to be transferred abroad. Furthermore, such transfers would be conditional on strict MRV requirements. While something of a leap, we can tentatively conclude that indirect support from taxes and auctioning will not be able to raise more finance than the direct access of developing countries to carbon markets.

[11] Note that conclusion 5 refers to the "points contained in 17215/08," (Council of the European Union, 2008, Brussels, December 12, 2008. Energy and climate change – Elements of the final compromise. 17215/08. POLGEN 142 ENER 472 ENV 1010, December 11-12, 2008.

Either taxing or auctioning allowances clearly offers the potential for very large financial flows to developing countries. Whether such flows could be implemented in practice is far from certain.

2.3.4 Taxes and Auctioning with Developing Country Commitments

While not a focus of current negotiations or proposals, there is no reason why developing countries could not tax or auction the allowances within their own commitments. With developing country emissions projected to be responsible for an increasing share of world emissions, this represents an increasing potential source of finance for incentivizing developing country participation. Financing raised from this source would be under the control of developing countries and would thus not have to meet developed country requirements regarding MRV and sustainable development criteria, among others.

Taxing or auctioning of developing country commitments could be a major source of financing for developing country mitigation. While their future use is uncertain; it seems much more likely that they will not be used in the immediate future.

3.0 Opportunities for Developing Country Participation

Section 2 discussed the potential carbon market demand for emission reductions from developing countries. Without developing country commitments, this demand was estimated to be up to 1-3 $GtCO_2$/year in 2020 and 5.5-9 $GtCO_2$/year in 2050. These demand figures are substantially in excess of projected flows from the CDM[12] of 0.6 $GtCO_2$/year to 2012. With developing country commitments[13], demand could possibly increase by a further 50-100 per cent.

To meet demand on this scale, increases in emission mitigation from developing countries are required across the board in terms of the:

- countries which participate in generating emission reductions;
- sectors which participate; and
- number of enterprises and activities within these sectors which participate.

Emission reductions can be made from across the economy, from single projects in oil and gas exploration, to programs on efficient lighting in homes, to the reduction of emissions from soils. These various reduction types often require different market mechanisms. Some reduction types are already eligible and used under the CDM, others are eligible but largely not used and some are ineligible. Finally, markets themselves could be inside or outside the UNFCCC process with consequent implications for how they are designed and governed.

[12] Noting that the voluntary market also generates credits, but at a far lower rate than the CDM in terms of both volume and value (see Section 2 for more details).

[13] This Appendix does not attempt to analyze if or when some or all developing countries may take on commitments. It simply shows what impact the carbon market could have with and without these commitments.

This Section discusses the options available for accessing the developing world's potential supply of emission reductions and issues around their implementation. Market incentives to developing countries to mitigate emissions are maximized when the largest possible share of their emission reduction possibilities are eligible; such widespread eligibility is likely to require a range of market mechanisms. The scope of the mechanisms differs with some bringing significant amounts of new emission reductions into the market and others having a more marginal effect, perhaps focused only on one sector of the economy.

3.1 GHG Emissions from Developing Countries: Occurrence and mitigation

3.1.1 Where Emissions Occur

Developing countries will generally be able to deliver most emissions mitigation in the sectors where their GHG emissions are highest. Table 3 shows emissions for the year 2000 by sector and by gas for the largest non-Annex I countries and for the rest of non-Annex I. CO_2 represents the majority of the total emissions, but methane and nitrous oxide emissions, notably from agriculture, are significant. Of note also are the high net emissions from the forestry sector where emissions largely occur outside the MDE group of countries.

Detailed analysis on where emissions occur is given in Annex B. Key conclusions from this are:

- The MDEs (Brazil, India, Indonesia, China, Mexico, South Africa and South Korea) accounted for over 60 per cent of non-Annex I CO_2 emissions in 2006. China itself represented 43 per cent of non-Annex I CO_2 emissions and India a further 10 per cent;
- CO_2 emissions are dominated by electricity generation (41 per cent in 2006) and industry (26 per cent). These figures are higher than for Annex I countries (where electricity generation and industry account for 50 per cent of the total);
- Significant cuts in emissions from the electricity generation sector will require action on coal (and, in some countries, on oil). There is some potential for emission reductions at existing coal plants, but larger cuts will require new plants be built to as high an efficiency as possible at a minimum, or preferably with another fuel source or with carbon capture and storage (CCS);
- Industrial emissions are dominated by one subsector–Iron and Steel–which accounted for over a quarter of emissions in 2006. A further two subsectors, Non-Metallic Minerals and Chemical and Petrochemical, accounted for a quarter of the emissions. While there are significant differences between the shares of emissions of subsectors to the economy in different countries, it is clear that including these three subsectors in carbon markets is essential if industry's potential contribution is to be fully accessed.

Table 4: GHG Emissions in 2000 from non-Annex I Countries by Sector and by Gas

Country		Brazil				China				India				South Africa				Mexico				Other non-Annex I			
Type of GHG		CO_2	CH_4	N_2O	Oth	CO_2	CH_4	N_2O	Oth	CO_2	CH_4	N_2O	Oth	CO_2	CH_4	N_2O	Oth	CO_2	CH_4	N_2O	Oth	CO_2	CH_4	N_2O	Oth
Total (Mt CO_2)		1,701	366	241	6.3	3,288	788	645	50	980	498	67	6.9	305	53	22	5.4	481	161	25	4.4	10,357	1,609	600	35
Energy	Electricity and Heat	50	N/A	N/A	N/A	1,480	N/A	N/A	N/A	557	N/A	N/A	N/A	190	N/A	N/A	N/A	154	N/A	N/A	N/A	1,411	N/A	N/A	N/A
	Manufacturing and Construction	94	N/A	N/A	N/A	965	N/A	N/A	N/A	222	N/A	N/A	N/A	62	N/A	N/A	N/A	68	N/A	N/A	N/A	790	N/A	N/A	N/A
	Transportation	126	N/A	N/A	N/A	218	N/A	N/A	N/A	92	N/A	N/A	N/A	36	N/A	N/A	N/A	103	N/A	N/A	N/A	805	N/A	N/A	N/A
	Other Fuel Combustion	35	6.4	2.7	N/A	375	49	23	N/A	98	37	4.0	N/A	12	2.6	1.7	N/A	33	2.5	3.2	N/A	N/A	69	32	N/A
Industrial Processes		20	0.1	5.0	6.3	298	0	30	50	47	0	3.0	6.9	4	0	2.3	5.4	17	0.1	0.9	4.4	178	0.8	11	35
Waste		N/A	36	4.0	N/A	N/A	149	19	N/A	N/A	112	2.4	N/A	N/A	20	0.9	N/A	N/A	43	1.6	N/A	N/A	287	21	N/A
Agriculture Forestry and Other Land Use (A FOLU)	Ag.	N/A	320	230	N/A	N/A	468	572	N/A	N/A	317	58	N/A	N/A	23	17	N/A	N/A	53	18.8	N/A	N/A	871	N/A	N/A
	FOLU	1,372	N/A	N/A	N/A	-47	N/A	N/A	N/A	-40	N/A	N/A	N/A	1.7	N/A	N/A	N/A	97	N/A	N/A	N/A	6504	N/A	N/A	N/A

Source: based on data found in Climate Analysis Indicators Tool (CAIT) Version 6.0. World Resources Institute, 2009 (data from 2000).

It is clear that a significant reduction in emissions from the developing world will require inclusion of:

- MDE countries, notably their Electricity and Heat Generation, and Manufacturing and Construction sectors;
- the forestry sector, which would be very valuable in Brazil and Indonesia, but particularly outside the MDE group; and
- expanded efforts to include agriculture, especially for countries outside the MDE group.

3.1.2 Where Emissions have been Mitigated – Experience from the CDM

CDM in the Energy Sector

Assessing the impact of current CDM projects and hypothesizing how they could develop in the future requires a mapping of CDM project types onto developing country emissions and abatement potentials. Figures for 2007 showed that:

- The share of CERs generated from industrial gas projects has declined rapidly (URC, 2009).
- China's share was 73 per cent of the projects March 2009, well in excess of its share of emissions (China was responsible for 43 per cent of non-Annex I CO_2 emissions in 2006) (URC, 2009). Primary CDM volumes transacted were of the order of 500 $MtCO_2$. Non-Annex I CO_2 emissions in 2006 were 12,865 $MtCO_2$, with the CDM representing around 4 per cent of these emissions (IEA. 2009).

A detailed analysis of the CDM pipeline to date reveals that it is electricity generation where the majority of the CER volume has been undertaken. Table 4 summarizes the analysis, based on all projects registered to date. The top 10 categories account for 91 per cent of all CERs; total expected CERs from all projects are almost 600 $MtCO_2$ annually.

Table 4: CDM Projects by Type

Category	Type	Projects	1000 CERs	Share of Total (%)	
Power Generation - Renewables	Hydro	1,150	118,015	20	
Power Generation - Renewables	Wind	621	53,412	9	35
Power Generation - Renewables	Biomass energy	660	39,996	7	
Power Generation - Energy efficiency	EE own generation	395	60,337	10	13
Power Generation - Energy efficiency	EE supply side	49	14,591	2	
Power or Flaring - Methane recovery	Landfill gas	321	49,407	8	13
Power or Flaring - Methane recovery	Coal bed/mine methane	63	28,199	5	
Fuel Switching - Power generation/others	Fossil fuel switch	139	44,226	7	7
Industrial Gases	HFCs	23	83,066	14	22
Industrial Gases	N_2O	66	48,559	8	
Others	Others	1,489	56,665	9	9
TOTAL		**4,364**	**596,473**		

Source : UNEP-Risoe Centre, 2009, CDM Pipeline, January, 2009.

The biggest category (35 per cent of the total) is renewable electricity generation. Hydro plants and wind parks are dominant in this sector, in the range 10-50 megawatts and a very large proportion are located in China. Chinese schemes are particularly favoured as it is argued that the baseline would be coal-fired electricity generation, and thus high credit levels would occur for each unit of electricity generated. A further 13 per cent of CERs come from methane recovery. Most of the methane recovered from coal beds or mines is used to generate power with some landfill gas also used in this way.

The two top 10 energy efficiency categories account for another 13 per cent of CERs and are also focused on power generation. "EE own generation" is predominantly the use of waste heat and waste gases to generate electricity. "EE supply side" is mainly technology change rather than making existing processes more efficient. The mainstays are the conversion of open-cycled gas turbines (OCGT) to combined cycle (CCGT) co-generation schemes and some ultra-supercritical coal plants, particularly in China. Finally, the fuel switching category includes a large proportion of CCGT schemes coupled with oil and coal switches to gas within boiler and industrial processes.

Therefore, approximately 60 per cent of the CERs from registered projects to date are based in some way on electricity generation. A further 22 per cent of the CERs are from industrial gases, leaving a remainder of under 10 per cent, which includes energy efficiency in industrial processes and the residential, transport and commercial sectors. The CDM has made little progress in these sectors. The data also reveal that:

- Options to date are dominated by China, in part because of the high avoided coal emissions factor of Chinese electricity generation.
- Projects to date represent "low hanging fruit." Options such as waste heat and waste gas recovery can be rolled out across industry, but are then exhausted. They are already common practice in many developed countries. Similarly, there are only so many OCGT plants available for conversion to CCGT. The combined share of hydro and wind in Chinese electricity generation in 2030 is projected by the IEA (2008) in their Reference Scenario to remain at the 2006 value of 15 per cent with coal still of the order of 80 per cent.
- Many of the projects are within bulk electricity supply and intensive industry and their main sustainable development benefit is reducing coal use.

There is thus major doubt that growth in the current range and location of CDM projects would be sufficient to move developing countries onto a path where GHG emissions were significantly lower than business-as-usual projections.

CDM in the Agriculture, Forestry and Other Land-Use Sectors

The Food and Agriculture Organization (FAO, 2008a) reported that of the thousand CDM projects registered by the UNFCCC in 2008, over one-third were either undertaken in agriculture and forestry sectors directly, or focused on renewable energy processes in agro-industry. There were 339 projects in June 2008 that were expected to generate 16.2 million CERs annually. This represents eight per cent of the CERs that are and will be generated annually by all CDM projects by 2012.

The FAO (2008) noteed that only 41 of the 339 CDM projects were related to the forestry sector; and 40 projects implemented renewable energy activities from wood biomass. Only one project focused on afforestation/reforestation (A/R) activities. For such projects, A/R credits are capped for use by Annex I parties at one per cent of base-year emissions or five per cent of emissions during the entire five-year commitment period from 2008 to 2012. Avoided deforestation activities are excluded as a means to meet emission targets in the first commitment period. It is also important to note that the EU-ETS rules currently exclude forestry CDM credits.

In June 2008, there were 298 CDM agricultural projects, (88 per cent of the total agricultural and forest CDM projects), which were expected to generate about 75 per cent of total CERs from agriculture and forestry (FAO, 2008). Agriculture CDM projects focus largely on two activities– methane capture in improved animal manure management systems and bio-energy production from agricultural biomass waste.

Land use, land-use change and forestry (LULUCF) projects are perceived by some to be complex, which could be a significant limiting factor on the quantity of projects going forward.

3.2 Overview of Market Mechanisms

There is considerable uncertainty over what a post-2012 regime will look like and what instruments and mechanisms could be employed within this. Options for market mechanisms—that will generate instruments that can be traded on the carbon market—to involve developing countries could be similar to the CDM or radically different. Again, this is not the only way that mitigation can be incentivized, but it is the only one considered in this paper.

A key plank of the CDM was that it should result in sustainable development benefits in developing countries. The sustainable development benefits vary according to project type. Pure trading and the destruction of non-CO_2 industrial gases have little sustainable development benefits beyond reducing global warming. Community-based investments in renewable energy in LDCs are likely to have much higher benefits.

3.3 Options Considered for Developing Countries

Discussions to date have largely concentrated on the supply of credits from developing countries, taking the CDM as a starting point and seeing how this could be expanded and/or whether new market mechanisms would be required. This concentration is driven by the needs to focus negotiations on the next commitment period; it is recognized that developing country commitments will be required if atmospheric GHG concentrations are to be stabilized at a reasonable level. The analysis presented in Section 2 firmly illustrated this view.

Capoor and Ambrosi (2008) believe that the experience of the CDM has demonstrated its power as a tool to engage developing countries to contribute meaningfully to climate change mitigation. They note that the CDM represents only the tip of the iceberg of the potential of market mechanisms and other approaches to mitigating and adapting to climate change. They add that as the CDM has

expanded, so also has scrutiny from a wide variety of quarters, including questions about sustainable development benefits, additionality and project performance/delivery.

Developing country participation can be increased by either deepening existing markets and/or developing them into new areas. Such developments will, in many cases, require supporting measures. Several studies identify and describe the large number of possible mechanisms. A 2007 IISD study analyzed 43 potential post-2012 climate regimes and discussed how the CDM and other Market Mechanisms for Sustainable Development (MMSDs) could be applied within them (Cosbey *et al.*, 2007). From the literature, the following options have been identified:

1. current CDM;
2. broadened CDM;
3. expansion of scope;
4. programmatic CDM;
5. sectoral CDM (often referred to as a Sectoral Crediting Mechanism or SCM);
6. other MMSDs;
7. crediting on the basis of technology-oriented agreements (TOA);
8. allocation-based MMSDs: crediting on the basis of policies, legal requirements or measures (including sustainable development policies and measures or sustainable development policies and measures (SD-PAMs), nationally appropriate mitigation actions or nationally appropriate mitigation actions (NAMAs) and a Reducing Emissions from Deforestation and Forest Degradation (REDD) mechanism for forestry emissions);[14]
9. developing country sectoral commitments (DCSC);
10. intensity targets with "no-lose" conditions, applied to one or more sectors'
11. intensity targets, applied to one or more sectors;
12. absolute targets, applied to one or more sectors;
13. developing country commitments applied to the economy as a whole; and
14. taxation and/or auctioning of allowances, to raise funds disbursed domestically or abroad.

The list of options progresses from the current situation toward an absolute cap with revenue raised from the issuing of allowances. Such a progression would be consistent with the "Phased Approach to a Safe Climate" detailed in a *Encouraging Developing Country Participation in a Future Climate Change Regime* (Table 9, pp.52-53 of the main paper).

[14] Note that such policies, legal requirements or measures could be applied to programs or sectors.

3.4 Potential Application of the Options – Without Developing Country Commitments

An analysis has been conducted to establish how a broadened CDM and other MMSDs could be applied and what their potential impact could be. The analysis is presented in generic form (applied to all countries equally). In practice, there are differences in the abilities of various countries to access the current CDM and differences are expected for other options applied. However, many of the issues facing increasing mitigation by sectors are common across countries; it is the make-up of their economy and their electricity generation mix that are the key differentiators. The result of the analysis, which was conducted by sector and by option, is summarized in Table 5 and Figure 1:

- Table 5 shows the share of GHG emissions in the non-Annex I countries and the current impact of the CDM. Entries in bold represent the sectors where the options could have the highest impact.
- Figure 1 is a schematic attempt show the share of GHG emissions in non-Annex I countries that are currently covered by the CDM and that could be covered by the application of each of the five options considered. The larger the shaded area, the larger the share of GHG emissions covered.

These conclusions can be drawn:

- There is significant potential from broadening the CDM. Programmatic CDM could allow mitigation opportunities to be accessed in the Residential, Commercial & Public and Other, and Agriculture and Forestry sectors. However, the potential of this mechanism, the emissions covered by these sectors and the extra opportunities for incentivising developing country mitigation all remain limited. sectoral CDM appears to have the highest potential, with the potential to significantly increase mitigation in the key industry and electricity generation sectors. Expanding the scope of the CDM such that it included nuclear and/or CCS also offers extra mitigation potential compared to the current CDM. TOAs have not to date been associated with market mechanisms. Nevertheless, there is no fundamental reason why a market mechanism could not be adopted that resulted in a payment if a certain technology were employed. Such a mechanism could have enormous scope across the economy. Minimum requirements on domestic and commercial appliances, the requirement that any new coal-fired power plant have at least a minimum efficiency or the insistence on best available technologies within the industrial sector could all result in large emission reductions and, potentially, large fund transfers.

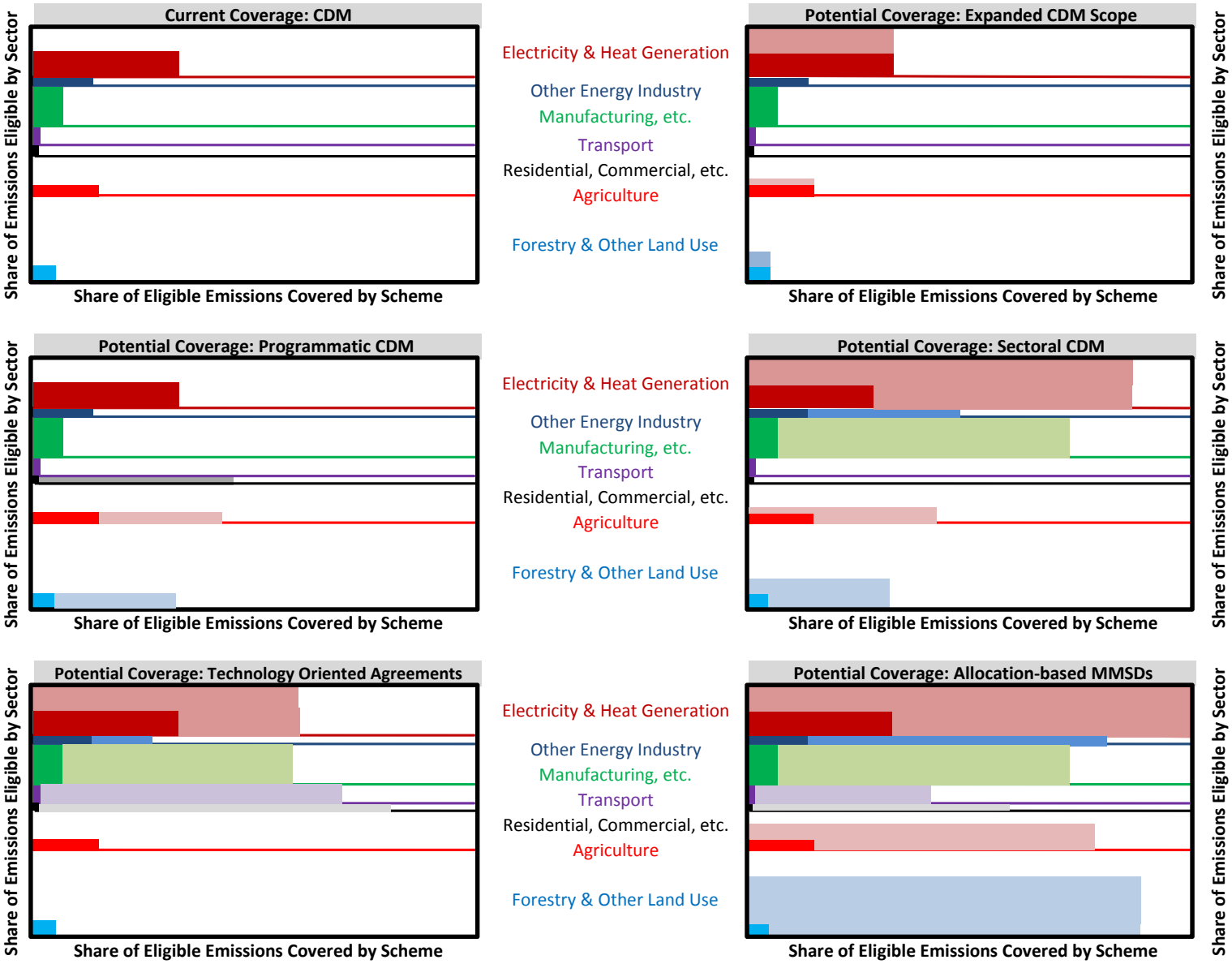
  In the energy sectors, allocation-based MMSDs could relate to the use of policies, legal requirements and measures to demonstrate that developing countries are undertaking mitigation actions. Registering such policies, in the form of NAMAs, SD-PAMs or otherwise, looks likely to be part of the future world response to combating climate change. Taking the next step to credit such actions, either through a market mechanism or alternative method, would be a major but not inconceivable way forward. By their nature, policies and measures could be applied across the economy and their potential as MMSDs is thus very large. Within the agriculture and forestry sectors, REDD and sustainable land-based

Table 5: MMSD Options for Developing Country Mitigation

Sector	Share of non-Annex I GHG Emissions (%)	Impact of Current CDM	Expanded CDM Scope (extra areas eligible)	Programmatic CDM (bundling of many projects)	Sectoral CDM ("project" is a sector)	(TOAs (standards and labelling, among others)	Allocation-based MMSDs (policies, legal requirements, measures)
Electricity & Heat Generation	22	Has been main impact. Must move beyond 'low hanging fruit'	**Could allow inclusion of CCS and Nuclear**	*Most projects large enough already. Useful for future micro-generation*	**Depends on specific design. Major potential if industry-wide baseline applied**	**Theoretically could lead to significant GHG emission reductions. But how incentivized?**	**Could have major impact. Depends on demand for credits generated—would be considered additional?**
Other Energy Industry	2	Some coverage, notably gas flare recovery	*No particular constraints at present*	*Application appears limited – projects large enough to cope with transaction costs*	**May be some promise to scale-up mitigation.**	**May be some promise to scale-up mitigation.**	**Certain policies could lead to very high mitigation reductions (for example, cessation of gas flaring)**
Manufacturing, Construction, Industrial Proc. and Waste	15	Industry low. Landfill gas and industrial gas destruction	*No particular constraints at present*	*Application appears limited – projects large enough to cope with transaction costs*	**Very promising to scale-up mitigation, using a common baseline**	**Theoretically could lead to significant GHG emission reductions. But how incentivized?**	**Likely to be similar to Technology agreements – easier to administer, harder to quantify impact**
Transport		Very low	*No particular constraints at present*	*Could have some use for pooling small projects*	*Potential in marine and aviation sectors; other projects too diverse*	**Key way to regulate performance. Demand for credits generated?**	**Probably best option to include the transport sector in an agreement**
Residential, Commercial, & Public Sector, Others	4	Very low	*No particular constraints at present*	**Key focus: lowers transaction costs for small projects**	*Activities and projects too diverse to fit into a homogenous sector*	**Key way to regulate performance. Demand for credits generated?**	**Considerable promise. Larger potential scope than Programmatic CDM**
AFOLU	50 (15 Agriculture, 35 Forestry and Other Land Use)	Low	*Could allow agriculture sequestration activities and forest management activities*	**Would facilitate aggregation of projects to overcome the transaction and monitoring costs barriers**	**Would facilitate aggregation of projects to overcome trans. & monitoring costs and barriers and would encourage sequestration activities**	*Difficult to see how it could be applied*	**Great potential for REDD and agricultural carbon sequestration activities and sustainable land-based management practices**

GHG emission data based on year 2000 data from the Climate Analysis Indicators Tool (CAIT) Version 6.0, World Resources Institute, 2009.

Figure 1: Options to Expand Developing Country Mitigation without Developing Country Commitments



Key: The horizontal lines within each of the six diagrams show sectoral shares of 2000 GHG emissions within non-Annex I countries (for example, Electricity & Heat Generation was 22 per cent of emissions). The height of the blocks shows what emission shares are eligible under each option; the width of the block indicates what share of eligible emissions could be implemented under the scheme. The darker blocks represent the current CDM. Pastel shades then show extensions above and beyond the current CDM. Finally, the total shaded area shows how much of non-Annex I GHG emissions could be covered by the option.

Source: Author's estimates. The figures are largely schematic in nature.

management practices could both bring significant sources of GHG emissions into market mechanisms.

The analysis presented represents an estimate of the potential. How this estimate was developed and issues around each option's implementation are discussed in Section 3.5.

3.5 Potential and Implementation of Broadened CDM and other MMSDs

This Section discusses the options which could be taken without developing countries taking on commitments. For a discussion of the options if one or more countries took on commitments covering some or all of their economy, see Section 3.6.

3.5.1 Allocation-Based MMSDs

Most mitigation actions in developing countries are taken without the benefit of international recognition under the current climate regime. Some of these measures directly aim at mitigating GHG emissions, whereas most of them aim at other objectives, such as energy efficiency, which have a co-benefit of reducing climate change. Many developing countries want a mechanism through which such measures would be recognized as part of their climate change international efforts. For example, the Republic South Korea (2009) has suggested the creation of a registry through which developing country NAMAs would be listed, such as SD-PAMs, REDD activities, sector-wide technology standards, laws and regulations, standards (energy efficiency standards), carbon tax and gas-mileage of motor vehicles. Most post-2012 regime proposals of this type do not entail binding commitments from developing countries, but do involve commitments of support from developed countries (for example, technology incentives and funding). They can be applied to sectors or to programs and a market mechanism to cover these could have similarities to sectoral or programmatic CDM.

As agreed in paragraph 1(b) (ii) of the Bali Action Plan, developing countries are expected to take, "nationally appropriate mitigation actions in the context of sustainable development, supported and enabled by technology, financing and capacity building, in a measurable, reportable and verifiable manner." Since NAMAs are required to embrace sustainable development considerations, they are likely to be very similar to SD-PAMs. NAMAs, SD-PAMs and a wide range of other policies, legal requirements and measures [15] can all be grouped within the category of "allocation-based MMSDs." These would operate by first granting an "allocation," which could include the impacts of expected reductions, to a sector. [16] Any reductions beyond this allocation, measured in tonnes of carbon, would be eligible for sale through the carbon market. These allocations could be set out in NAMA plans and agreed to by the COP, and the allowances would be subject to MRV requirements. The intent of a broader MMSD is to move away from credits for project-based GHG emissions and the need to demonstrate additionality–an issue that has proven controversial over the life of the CDM.

[15] Note that, *inter alia*, the South-North Dialogue and Dual Track approaches for post-2012 climate regimes both propose that developing countries make voluntary pledges to implement sustainable development policies and measures to reduce GHG emissions.

[16] In effect, any option which is not project based could be included as an allocation-based MMSD.

Allocation MMSDs include a range of options whereby countries will receive credits if their emissions from a sector are below an "allocated" value.

Through a reporting system, which could take the form of a registry, allocation-based MMSDs could be rewarded with carbon credits, as proposed by the Republic of South Korea and India. According to the Republic of South Korea (2009), only those that are not supported with financing and technology transfer by developed countries should be eligible for credit. Crediting should act as an incentive to take action to mitigate climate change in areas that would have not have seen action because of a lack of financial support. As such, activities that could be implemented without relying on revenues from the sale of credits would not be credited. Crediting would be in a manner very similar to that proposed for policy-based CDM. Allocation-based MMSDs could play a positive role in a new international climate regime, by encouraging Annex I Parties to commit to more stringent targets in anticipation of a stream of carbon credit supplied through allocation-based MMSDs.

A key question will be the determination of the allocation for a sector or activity. While there are issues around the setting of appropriate baselines for CDM projects, there are at least firm protocols and methodologies covering setting boundaries, measuring emissions and accounting for leakage. There is also generally experience from the implementation of a range of similar projects.

For policies, legal requirements or measures, there are two further issues–the policy may not have GHG emissions as its primary target and what is measurable will often not be directly related to emissions. Therefore, it may be possible to measure the amount of money spent on a program or the number of energy efficient appliances purchased in the marketplace. To estimate the GHG impacts of these indicators needs both a counterfactual of what would have happened without the policy and an assessment of what part of the change in behaviour was due to the policy. Baumert and Goldberg (2006) have explored the possibility of Action Targets, where payments are made as a function of the percentage reduction developing countries make in their GHG emissions below an agreed baseline. Previous experience in other countries could be used to define what policies and measures should (and should not) be considered additional and to guide the estimation of the scale of the GHG emission reduction.

The considerable uncertainty in the assessment of GHG emission reduction impacts on allocation-based MMSDs is not unique. Countries that put in place policies and measures to reduce GHG emissions want to understand their efficacy. If market mechanisms are to be built around policies and measures, it is essential that buyers have sufficient confidence that the abatement claimed is sufficiently robust to warrant them paying for the actions. If confidence is not high, the likely result is buyers limiting the share of allocation-based MMSDs in their overall abatement portfolios.

REDD – Reducing Emissions from Deforestation and Forest Degradation

Allocation-based MMSDs (NAMAs or SD-PAMs) could help to realize forestry mitigation potential in developing countries. Given the magnitude of deforestation emissions and predicted low abatement costs compared to other forestry measures and other mitigation measures, there is general agreement that emissions from deforestation and degradation in developing countries should be

addressed immediately. Reduction of emissions and the enhancement of sinks are cost-effective options that could take effect relatively quickly (Nabuurs, *et al.,* 2007; and Stern, 2007).

Two prominent proposals on REDD view financing in different ways. Brazil's 2006 proposal indicates that REDD support should be through a fund that is based on grant contributions from developed countries, rather than a market mechanism. The 2005 Papua New Guinea and Costa Rica proposal suggested crediting REDD activities, thus allowing developing countries access to the carbon market. The second proposal is based on "compensated reduction" and suggests establishing national baseline rates for deforestation. Any difference below the baseline compared to participating Parties' deforestation rates would be granted credits. Myers (2007) outlines the main feature of the proposal:

- ex-post emission reduction verification;
- baseline based on historic deforestation rates during a given period;
- voluntary participation, but deforestation rates must be maintained or equivalent credits must be purchased; and
- permanent credits.

Several researchers have put forward similar proposals explaining how a REDD market mechanism could work, [17] and the World Bank launched the US$250 million Forest Carbon Partnership Facility (FCPF) in December 2007 aimed at building capacity for REDD in developing countries with the objective that the market will then further fund these activities. Credits generated by FCPF projects cannot be used for compliance while REDD activities are not eligible under the CDM, but FCPF projects are expected to generate credits that would be traded on the voluntary market.

Gullison *et al.,* (2007) explain that there are uncertainties regarding the magnitude of forestry and other land-use emissions, and there are still outstanding monitoring, permanence, baselines and leakage questions. These issues have contributed to the decision not to include CERs from A/R CDM activities in the EU-ETS; and some other developed countries, such as Canada, have indicated they will not allow the use of CERs from forestry activities in their emissions trading systems. Recent efforts, such as the IPCC 2006 Guidelines on the AFOLU sector, and the protocol work of the Voluntary Carbon Standard (VCS) and the Canadian province of Alberta indicate that monitoring and permanence barriers can be overcome.[18]

In 2009, negotiations on REDD will take on increased intensity with considerable expectation that a REDD mechanism (either fund or market based) will be part of a post-2012 agreement. A consideration in the discussion of allowing the sale of credits from REDD on the carbon market is the risk of flooding the market. One of the key benefits of expanding market mechanisms under the

[17] See, for example, the proposals by the European Commission Joint Research Centre (Trines, *et al*., 2006) and Pedroni, and Streck, 2007.

[18] The VCS (2008) has developed the *Tool for AFOLU Non-Permanence Risk Analysis and Risk Determination* that includes a project risk assessment to determine the number of non-tradable buffer credits to be held in reserve to cover unforeseen losses from carbon. The Alberta government has developed an afforestation protocol–see: http://www.carbonoffsetsolutions.ca/offsetprotocols/finalAB.html.

new post-2012 agreement is a larger quantity of GHG reductions, but the question is whether the resulting flow of credits from developing countries would find buyers or how low would the carbon price fall. A clear implication for a post-2012 regime that includes credits for deforestation is the need for ambitious targets for developed countries that will fuel demand for these CERs, and agreement in developed countries to purchase CERs from projects in the land-use sectors. "Swamping" of the market could be reduced by including restrictions on the share of REDD credits to be used for Annex I compliance, indirect links between separate markets (a price link only) and financing REDD through auctions or other indirect support mechanisms. [19]

3.5.2 Sectoral CDM

Sectoral approaches have been widely advocated and discussed over the past few years. Discussions are conducted on sectoral CDM under the two Ad Hoc Working Groups of the Bali Road Map– Ad Hoc Working Group on Further Commitments for Annex I Parties under the Kyoto Protocol (AWG-KP) and Ad Hoc Working Group on Long-term Cooperative Action under the Convention (AWG-LCA)–although no sector has been targeted specifically. Sectoral approaches cover a range of different options, from TOAs to transnational sector schemes where a single sector effectively takes on a target covering many countries and trades internally to meet this. Many of these options could still be developed and applied in the long term, but it is sectoral CDM that has received attention in the current round of negotiations. Sectoral CDM refers to specific sectors within a country and should not be confused with transnational targets applying to a sector as a whole.

In common with programmatic CDM, sectoral CDM seeks to reduce transaction and monitoring costs and to package together what would otherwise be several separate projects. Such considerations are particularly acute for the AFOLU sector, where costs and fragmentation are most acutely felt. However, sectoral CDM has also been proposed as a way to include energy intensive industrial and electricity generation sectors, and it is within these sectors that the biggest potential reductions are likely to be found.

Currently, there are two definitions of sectoral CDM: policy-based CDM and clustered CDM. Policy-based CDM would promote national or local policy initiatives by rewarding the government with CERs (Schneider, 2007). This would provide a real incentive for developing countries to enact policies that make the AFOLU sector (among others) less carbon intensive (Samaniego and Figueres, 2002), "thus successfully mainstreaming climate considerations into the economic growth model" (Figueres, 2006).

Schneider (2007) notes that clustered CDM is a mechanism through which private actors would implement local projects that, "would be clustered along the lines of a specific sector." An example of clustered CDM would be to define baselines for activities in the AFOLU sector. Investments that contribute to staying below the baseline level could then receive the difference between the baseline level and the achieved level in the form of CERs (Schneider, 2007).

For sectoral CDM, emission credits would be based on the actual emission trends observed in the sector against the baseline. Sectoral CDM partly avoids the counter-factual and hypothetical

[19] For a description of the wide range of proposals, see Parker, *et al.,* 2008.

assessment of the motivation of private entities to demonstrate additionality; the main challenge is the uncertainty of the emission projection (Schneider, 2007).

Sectoral CDM could be a way to include activities which have beneficial development aspects but are not as cost effective as others. This could be achieved by implementing a project with both low and high abatement costs, "so that the overall price of the CERs would be competitive" (Sterk and Wittneben, 2005). Sectoral CDM that includes policy-based projects would also solve the problem of governments being reluctant to implement climate protection policies and measures for fear of making future CDM projects non-additional; and would instead reward them for their efforts to mitigate climate change.

Sectoral CDM is most commonly associated with energy-intensive industry. The cement, iron and steel, and aluminum sectors have advocated the use of sectoral approaches of various kinds, of which sectoral crediting mechanisms are a key option. Implementing sectoral CDM illustrates some of the key issues that developing countries must face if they are to control their emissions directly (rather than indirectly through policy), including:

- a boundary must be drawn around what a sector is and which emissions are included;
- robust data must be collected from all plants within the sector over a period of time;
- MRV is an essential requirement;
- a baseline must be drawn which encourages the sector to reduce its emissions, in line with an equitable share of what the country as a whole needs to achieve; and
- account must be taken for the differences between individual plants' emissions and their opportunities to abate their emissions.

These are significant issues and have largely stopped the momentum toward the adoption of sectoral approaches. However, significant potential remains for emission mitigation from sectoral CDM, and the activities to set up CDM institutions in a developing country are essential experiences required for managing a reduction commitment at a later date.

While the focus to date of sectoral approaches has largely been on energy-intensive industry, sectors that are either less energy intensive or do not produce goods that are traded competitively may be some of the best candidates for sectoral CDM. The electricity generation, aviation, international marine and transport sectors have been associated with sectoral CDM. Sectoral CDM may also have a large role in regard to agriculture activities, such as soil carbon sequestration.

3.5.3 Programmatic CDM

Programmatic CDM allows the bundling of many similar projects into one single project. As such, it is attractive for smaller projects, where the transaction costs associated with understanding CDM rules, developing a project and then taking it through the CDM stages can be prohibitive. [20] Another difficulty is that small projects in many sectors are also often fragmented over large geographical

[20] Efforts are ongoing to "professionalize" the CDM institutional structure, including making it less bureaucratic.

areas. These difficulties contribute to the lack of projects within the Residential, Commercial & Public and Other, Transport, Agriculture and Forestry sectors to date. Aggregation of many players and regions would allow the generation of emission reductions that are large enough to ensure project viability and attractiveness to compliance buyers (FAO, 2008a).

Officially, policies and standards cannot currently be considered for crediting under the CDM.[21] Some pressure to include them can be found in the considerations to include avoided deforestation (see the discussion on REDD in Section 3.5.1). In practice, policy CDM that includes implementation (for example, of an energy efficiency standard) bears many similarities to programmatic CDM and it may be impossible to make a distinction between programmatic and policy CDM.

Projects in the Electricity Generation, Other Energy and Industry sectors tend to be relatively large and it is difficult to see where programmatic CDM would increase uptake significantly. There may be some potential to pool small transport projects under programmatic CDM, but it is within the Residential, Commercial & Public and Other sector (4 per cent of non-Annex I GHG emissions in 2006) and Agriculture and Forestry sectors where there is the most potential for programmatic CDM. The potential for credit generation may be large. Mollet (2005) calculates that standards and labelling of just four key products (including refrigerators and air conditioners) could reduce 2020 emissions by 500 $MtCO_2$.

Capoor and Ambrosi (2008, p. 37) regard the move toward programmatic CDM as an extremely positive development and they commend the CDM Executive Board for progress in this regard. They add that it has the potential to help scale up transformative initiatives, while also reducing transaction costs, which is of particular importance for smaller countries that may have several smaller dispersed opportunities in important sectors. The decision at COP 11/MOP 1 to allow for programmatic CDM was followed by guidance on modalities from the CDM Executive Board.[22] In June 2007, programmatic CDM was introduced, opening the possibility to register an unlimited number of CDM project activities under a single CDM program of activities. Although it was expected that many projects would be registered, uptake to date has been very limited. Total expected first period reductions for programs of activities were only 94,000 tCO_2/year in the UNEP Risoe pipeline on January 16, 2009.

It is argued that procedural and methodological barriers impede the development of programmatic CDM. As an example, Figueres (2008) indicates that designating a coordinating entity is often an issue. Since it should bear responsibility for the effective long-term implementation of the project, institutional capacity and operational continuity during the project lifetime are required. Moreover, for these projects, CERs are often the only cash income. As a result, there is a high financial risk that few financial institutions are willing to bear. On the other hand, as noted by Figueres (2008), they are often the "most" additional CDM projects as they depend exclusively on the CER income to be implemented and would not be otherwise implemented.

[21] See Decision 7/CMP.1, paragraphs 20 and 21 (EB Guidance from COP/MOP-1, 2005).
[22] See UNFCCC, 2005 and the EB-28 Meeting Report, Annex 15.

Programmatic CDM may make some impact, but a realistic view would be that this is far from a given and needs to be proven in practice. Within the transport sector, there may be some benefits from bundling, but the impact is almost certainly lower than what would be expected from other sectors. Perhaps the key benefit of programmatic CDM is that it reaches out to the smaller and least developed countries, which may engage them more fully in the negotiations and allow more progress to be made.

3.5.4 Expanded CDM

The CDM does not contain many explicit exclusions. Nevertheless, the scope of projects developed to date has been relatively narrow. Within the energy sector, nuclear and CCS are two potential CDM projects. Both are important as they have the potential to reduce emissions from electricity generation, the largest single emitter in the non-Annex I countries and particularly for China and India. Within the land-use sector, the scope of current mitigation activities is quite narrow and could be significantly expanded. Issues around these three key potential expansions are presented below.

Carbon Capture and Storage

CCS has no benefit other than GHG emission reduction and thus a long-term value for avoided GHG emissions is essential for its widespread implementation. To this end, regulatory and legal issues needing resolution have been proposed and discussed at length.[23] The incorporation of CCS into the CDM has been discussed at several COPs, including the meeting in Poznan in December 2008. There are concrete proposals on the table that have informed the negotiations.[24] It is probably fair to say that the current impasse on CCS is not an issue to do with the technicalities of the regulations required or a framework necessary for long-term monitoring of sequestered CO_2; rather, the potential scale of reductions from CCS has led to discussions around it becoming a proxy for the design of the system as a whole.

Whether carbon market credits from the CDM would be sufficient in scale and whether their value could be guaranteed over a sufficiently long period to incentivize CCS is uncertain and will depend on the size of demand within carbon markets, which will be driven by the stringency of the caps countries agree to in the future. Carbon markets are one source of finance for the very significant investments that fitting CCS technology to electricity generation and other industrial processes would entail. The other alternative for governments would be to mandate the use of CCS for at least some applications (for example, coal-fired electricity plants). This would radically increase the costs of these options, but may not be cost-effective. The abatement costs of CCS could be higher than other options that are not mandated by government. It is difficult at this stage to see governments in developing countries mandating CCS unless there was some source of external finance. The carbon market could potentially provide at least part of this.

Current needs for CCS are to incentivize demonstration plants before the year 2020, when CCS is expected to move into the deployment phase. The carbon market is most suited as an instrument to technologies in the deployment phase and would not provide sufficient incentive for financing

[23] See, for example, the CO_2 Capture Project (http://www.co2captureproject.org).
[24] See, for example, the submission of the International Emissions Trading Association (IETA, 2008) to the UNFCCC.

demonstration plants.[25] The inclusion of CCS in the CDM from 2020 is, therefore, where an expanded CDM could have the most impact.

Nuclear

In common with CCS, nuclear would also benefit from a long-term value for carbon, but there are many other issues regarding its use in developing countries. Long-term waste storage and disposal, the possibility of accidents with potentially severe impacts and insuring against them, potential links between civil and military programs, the contribution of supply to energy security, and the very low emissions of acidic gases and GHGs across its lifecycle are some of the pros and cons of nuclear deployment. The debate to date has not led to nuclear coming close to being an accepted technology under the CDM. Whether this continues to be the case is somewhat a moot point: it is difficult to see any major growth in nuclear capacity in non-Annex I countries outside China and India, both of which already have nuclear programs without any contribution from carbon markets or any other internalization of the value of avoided carbon emissions. In conclusion, it appears the highly-charged nuclear debate can be largely avoided—carbon pricing is unlikely to make any significant difference to uptake of nuclear in the developing world, at least within the medium term.

Land-use Projects – Agriculture and Forestry

Many activities with the greatest value to rural communities in poorer developing countries were excluded from the CDM in the first commitment period with sinks activities restricted to A/R. These projects have not been widely taken up under the CDM. As of February 1, 2009, there was only one registered small-scale CDM project in the A/R sector (with 34 projects in the CDM pipeline). The slow uptake of A/R projects may hold lessons for including market-based mechanisms for broader land-use projects in a post-2012 agreement. REDD is being discussed as a separate mechanism/activity for the post-2012 period (see section 4.5.6 below), and there are strong arguments for expanding the CDM to include sustainable forest management, agricultural soils and other sustainable land management practices.

Some barriers to the CDM market have to be removed to better include the land-use sector in the CDM. FAO and IFAD found that land-based climate change mitigation project activities, especially in rural areas, face several barriers to entering the carbon market, such as high start-up and transaction costs, expensive entry fees, insufficient knowledge about project registration cycles, small project scale and fragmentation (FAO and IFAD, 2008). Such barriers may be attenuated by the creation of different forms of CDM (programmatic, policy-based or clustered CDM).

Perhaps the largest concern is the temporary nature of credits from A/R projects (and other land-use projects that could be included under the CDM), whereby the credits expire after a predefined period. The issue of non-permanence of the carbon sequestered through A/R projects has been addressed through temporary CERs (tCERs) and long-term CERs (lCERs). tCERs expire at the end of the commitment period following the one during which they were issued, while lCERs expire at

[25] See, for example, the United Kingdom's CCS Competition, which advocates capital and operational support– *Competition for a Carbon Dioxide Capture and Storage Demonstration Project, PROJECT INFORMATION MEMORANDUM, UK BERR*, November 19, 2007. See: http://www.berr.gov.uk/files/file42478.pdf.

the end of the project's crediting period, which can be 20 years (renewable up to two times) or 30 years without a renewal option. Once these tCERs and lCERs expire, the holder of the credit must replace them with new ones or achieve an equivalent amount of emission reductions elsewhere. The expiring nature of these credits means that A/R projects are regarded as a less attractive investment option than other types of CDM projects. The temporary nature of credits under forestry CDM projects is a major barrier preventing funds and companies from purchasing these CERs (Ecosecurities, 2006), and it influenced the decision of the EU-ETS to exclude forestry CDM credits. As well, there is a current cap on A/R project activities under the CDM (as noted, A/R CDM activities are limited to one per cent of a country's total emissions in 1990 multiplied by five).

CDM projects are not equally distributed over the different continents and among non-Annex I countries. Trines *et al.* (2006) indicate that expanding land-use activities under the CDM is likely to improve this distribution. Many developing countries are concerned about access to the carbon market and having a market mechanism that includes more land-use activities. For example, the African Bio-Carbon Initiative calls for a post-2012 agreement that encourages sustainable agriculture in Africa, including crediting and financial mechanisms that reward improved agriculture and forest management practices that will also help the poor adapt to climate change (Common Market for Eastern and Southern Africa, 2008). It should be noted that not all developing countries support expanding the CDM in this manner. Tuvalu (2008) for the Alliance of Small Island States (AOSIS) is not in favour of the expansion of the land-use and forestry sectors in the CDM.

Mitigation potential in the agriculture and other land-use sectors in developing countries is significant. Bellarby *et al.* (2008) note that soil carbon sequestration (including cropland and grazing land management and restoration of organic soils) is a prominent option for mitigation in the agricultural sector with a mitigation potential of up to 5.34 Gt CO_2e per year. The UNFCCC (2008b) estimates that 70 per cent of the reduction potential in agriculture is in developing countries, meaning that the inclusion of expanded land-use activities, particularly sequestration of carbon in agricultural soils, is where a broadened CDM could have the most impact.

3.5.5 Technology Oriented Agreements

TOAs refer to multinational agreements on technology. They can include minimum standards, labelling or prescriptions as to what is the "best available technology" and which technologies should no longer be used. In theory, TOAs could mandate only the best possible technologies and/or preclude others. As noted in section 3.4, TOAs have not generally been associated with market mechanisms to date, but there is no fundamental reason why a market mechanism could not be used to provide payments for the use of specified technologies.

An often-referenced example of a TOA is the Asia-Pacific Partnership on Clean Development and Climate (APP).[26] A wide range of activities are planned or under operation within the APP, including technology agreements in energy-intensive sectors. These have been mainly led by Japan and seek to make the use of existing technologies as efficient as possible and to ensure that new technologies are as climate friendly as possible. APP programs have included information exchange and best practice discussions. No mention has been made as yet of using market mechanisms to incentivize such

[26] See: http://www.asiapacificpartnership.org/.

actions. Japanese commentators have also floated the idea of developed countries receiving credits for the transfer of energy-saving technologies to developing countries.

Perhaps TOAs should best be seen as a component part of other options (for example, as an indicator of the success of a NAMA).

3.6 Options for Developing Country Commitments

The international negotiations include a highly contentious discussion of possible graduation of some non-Annex I Parties to a state of target- or action-based commitments. The CDM would likely be more oriented to sustainable development than mitigation, serving the needs of less-developed nations.

Under the Convention, several Parties to the AWG-LCA have suggested that developing countries could commit to sectoral targets. Switzerland, for example, proposed that developing country actions should represent intensity targets, either binding or no-lose (Switzerland, 2008). In this case, targets could also be established for the agriculture and forestry sectors.

Other Parties [Sri Lanka, Uzbekistan, Canada, and the European Community (EC) and its member States, Australia, Japan, Australia and Norway] proposed that developing country mitigation actions can include sectoral approaches (UNFCCC, 2008a). The EC and its member States (2008) have put forward sectoral trading systems as a national policy tool for mitigation, and the EC and its member States (2008) and South Africa (2008) have proposed no-lose sectoral crediting baselines.

Some other Parties proposed the implementation of sectoral approaches for different groups of developing countries. For example, Australia (2008) suggested that economy-wide targets should be set for advanced economies and include cooperative sectoral approaches. Japan (2008) proposed that major developing countries implement sector-wide emission reduction activities and sectoral intensity targets.

Developing countries are concerned that the economic costs of agreeing to commitments would be significant and would constrain their growth. The adoption of per unit output ("intensity" or "dynamic") caps in the first instance would break the potential constraint on output. Such commitments have a lower potential downside than caps on absolute emissions and thus there can be limits on the quantity of net allowances that can be transferred from sectors with per unit caps to those with absolute caps.[27] The whole potential downside can be eliminated if "no-lose" or "no-regret" features are added.[28] Schemes of this type see targets set somewhere below BAU emissions with credits then being gained if this target is exceeded. If the target is not met, there is no downside. Between BAU emissions and the target, there is an area where the sector is subject to abatement costs without generating any revenue credits. It is only when the sector exceeds the target by a certain amount that revenue can be gained through sale of credits. It would be preferable if the

[27] See for example the United Kingdom Climate Change Levy market "Gateway" concept where net sales from per unit to absolute sectors were not permitted

[28] See Schmidt, et al, 2006. Sector-based Approach to the Post-2012 Climate Change. Washington, D.C.: Centre for Clean Air Policy.

net revenue function could be made continuous (for example, by allowing an increasing share of reductions to be sold as total mitigation increases). Finalization of no-lose designs requires this issue be addressed.

Developing countries could take on commitments either for only discrete sectors within their economies or for the economy as a whole. A graduated approach would see developing countries progressively building up commitments. For example:

- start with "no-lose" intensity targets for one or a limited number of sectors;
- increase the number of sectors and make the intensity targets two-way (with the possibility of a downside); and
- introduce absolute targets for several sectors and then for the economy as a whole.

This approach would allow developing countries to build up their experience and capacity as they become wealthier and as developed countries meet their internationally-agreed commitments. The first sectors to agree to targets would be those that are the highest emitters of GHGs per unit of GDP, have relatively few sites, are easiest to categorize and collect data for, have the financial and managerial capacity to invest in abatement options, and are the most prominent within the debate on competitiveness and leakage. These sectors are well known: iron and steel, non-ferrous metals, non-metallic minerals (cement and glass, among others.), pulp and paper, basic chemicals and refinery products. Due to its major contribution to GHG emissions and its importance as an input cost to industries such as metal smelting, the electricity generation sector can be added to this list.

Developing countries no-lose commitments will only be successful as a market mechanism if there is a market for the credits they generate by emitting less than their targets. This will require countries in the developed world to be open to becoming net purchasers from these schemes. This may prove problematic. One of the original formulations of sectoral approaches was the idea of a transnational sector, whereby a single sectoral cap would cover emissions across several countries. This concept was resisted by some on the grounds that it would have led to a "carve out" of the sector from within a country's commitment. If the sector in a particular country became a net purchaser of allowances under the sectoral scheme, the country would have to make good this deficit by additional purchases and/or abatement. While this is not part of the current suite of options that are considered to be strong possibilities for inclusion within a post-2012 deal, in the long term, transnational carve outs, or at least the guarantee of market access for sectors from developing countries whose caps might be less stringent than those in developed countries, is a prerequisite of success.

3.7 How could Developing Country Participation in the Carbon Market Develop?

3.7.1 Phased Approach to a Safe Climate

Section 3.3 showed a list of options, from the current situation to an absolute cap with revenue raised from the issuing of allowances. A progression using some or all of these steps would be

consistent with the "Phased Approach to a Safe Climate" detailed in *Encouraging Developing Country Participation in a Future Climate Change Regime* (Table 9, pp. 52-53 of the main paper).

A system based on the carbon market would involve progression using some or all of the steps summarized below. Therefore, one country could include other MMSDs and then take on sectoral commitments, all the while retaining the current CDM for some sectors; while another country progressed through all six steps: [29]

1. current CDM;
2. broadened CDM;
3. other MMSDs;
4. DCSCs;
5. developing country commitments applied to the economy as a whole; and
6. taxation and/or auctioning of allowances, to raise funds disbursed domestically or abroad.

The graduation of some non-Annex I Parties to a state of target- or action-based commitments is highly contentious. What is more certain is that developing countries will not take on commitments unless developed countries meet increasingly stringent commitments themselves. Each step of the progression would be dependent on developed countries meeting their internationally-agreed commitments.

Section 2 concluded that reductions solely from developed country commitments would not be sufficient to stabilize atmospheric emissions at levels that are considered to have a relatively low risk of major damage from climate change. It added that the indirect support of revenues raised from taxing or auctioning developed country allowances would be similarly unlikely to yield sufficient revenues to reduce developing country GHG emissions enough.

These considerations are somewhat academic in that they apply mostly to the medium and long term. The concern at present is that the negotiations to be concluded at or shortly after the Copenhagen meeting should put the world on the path to stabilizing emissions at a level of acceptable risk. This does not require developing countries to commit to any targets, but could be helped by a broadening of the CDM and the application of other MMSDs, (steps 1 and 2 from the graduated list above). The extension of crediting measures would help build essential capacity in developing countries (allow them and their potential trading partners to better understand where emissions arise and how they can be measured and mitigated). To this end, options which cover sectors and/or policies, legal requirements and measures (allocation-based MMSDs) appear to offer the best coverage of GHG emissions in non-Annex I countries.

[29] It should be noted that the carbon market is not necessarily the best option for all sectors in all countries. The experience of the developed world has pointed to carbon markets being best employed in the electricity generation, other energy and intensive industry sectors. There is no reason to assume that developing countries would apply cap-and-trade to a different set of sectors.

3.7.2 Incorporating Agriculture, Forestry and Other Land-use Measures

Agriculture and forestry sectors could be treated within their own schemes or could become part of an economy-wide scheme. Programmatic CDM, REDD and sectoral targets could all be used to efficiently incentivize GHG emissions minimization actions in developing countries—where there is substantial mitigation potential in regard to sinks (both forest and agricultural soils). The current approach is one of experimentation with a need to establish whether market mechanisms should be part of the solution and, if so, what are the best options.

The forestry and agriculture sectors, with their large mitigation potential, offer considerable opportunity for developing countries to access the carbon market, although some barriers need to be overcome (such as permanence and methodological uncertainties). Options range from making these activities eligible under the CDM to the imposition of caps on these sectors.

Broadened CDM

It has been proposed that more agricultural and forestry activities should be eligible under the CDM, such as soil carbon sequestration activities and sustainable land management practices. REDD could potentially be under the CDM or addressed in some other manner. If REDD and agricultural soils were to become eligible activities under the CDM, this could result in lowered prices of CERs because of the potential large number of credits from these sectors (unless some countries restrict the access of forestry- and agriculture-based CERs to their emission trading systems, as is the case for the EU-ETS at the present time). Programmatic and sectoral CDM hold more promise for these sectors because of their ability to bring together large numbers of small projects, helping to alleviate monitoring and transaction costs.

Other MMSDs

Credits from allocation-based MMSDs are likely to be a good means to encourage developing country access to market-based mechanisms in the forestry and agriculture sectors. Such an option does not compel developing countries to report their emissions with as much stringency as if a cap was imposed on their emissions. Indeed, difficulties in reporting emissions is often used as an argument against the imposition of caps on non-Annex I countries, as most do not have the required experience or data.

Conclusion

The AFOLU has often been treated in this paper as one sector for clarity concerns. There is the possibility that Parties could adopt decisions specifically on one sector, either agriculture or forestry. It is foreseeable that Parties will reach a separate agreement on REDD that could lead to the inclusion of REDD activities in the carbon market. There is also the possibility that Parties will expand the CDM to include soil carbon sequestration activities, such as reduced tillage or no-till practices. If sectoral agreements are elected as a means to achieve mitigation, Parties could reach a separate sectoral agreement on agriculture. Of course, such decisions would not achieve a complete integration of the AFOLU sector in a post-2012 market-based mechanism if compared with the option of imposing caps on the AFOLU sector as a whole in Annex I Parties and of crediting NAMAs in non-Annex I Parties.

While there are clearly sector-specific issues and a phased approach may proceed at different speeds for AFOLU, as compared to other GHG-emitting sectors, there does not appear to be any fundamental reason why the AFOLU sector could not be brought into the phased approach shown in Section 3.7.1.

3.7.3 Incorporating Adaptation

The carbon market is not suitable to directly deliver adaptation, but it can contribute to in two indirect ways:

- within integrated mitigation and adaptation activities; and
- using the revenues from taxes on carbon trades or the auction of emission allowances (this option is discussed in Appendix 1).

Mitigating GHG emissions from any project clearly reduces the need for adaptation. Currently, there is no instrument that converts adaptation services into a GHG reduction equivalent. However, the carbon market could deliver adaptation benefits to developing countries:

- Many GHG mitigation projects have an adaptation component, and the market could encourage investments in these sectors. A key example is decentralized renewable energy (DRE), where the provision of new energy services and the benefits they bring increase the capacity of the community to deal with climate change impacts. Sustainable land-use projects (for example, forestry and agriculture) can also deliver mitigation and adaptation benefits.
- The provisions of the CDM include the need to explicitly include the contribution the project will make to sustainable development; adaptation is clearly included within this.

The links between mitigation and adaptation should not be overstated. Although there are cases when certain projects have similarly-sized mitigation and adaptation benefits, in general mitigation projects will have significantly lower adaptation benefits than mitigation benefits. Adaptation projects will show the same pattern, but in reverse.

Linking mitigation and adaptation is a new area, but a tentative conclusion is that the carbon market will probably deliver relatively low adaptation benefits. Similarly, specific adaptation projects such as DRE will produce GHG reductions which are minor relative to that from specific mitigation projects. One potential option is to include a financial or labelling premium for mitigation projects with a high adaptation benefit, such as agriculture or forestry.[30]

3.7.4 Including Premium Carbon Credits

There are several examples of "premium" carbon credits in the market (for example, the Gold Standard for CDM projects). [31] According to the FAO and IFAD, a regulated market for premium carbon credits for AFOLU should also be created. In this case, premium carbon credits would be credited to land-use roject activities that not only sequester carbon, but also enhance adaptation

[30] A key precedent is for "Gold Standard" CDM, where a market with a significant price premium has built up (see, for example, Capoor and Ambrosi, 2008, p. 36).
[31] See: http://www.cdmgoldstandard.org/.

capacity through improved ecosystem resilience. Such activities might include forest management, agroforestry, agricultural "good practices" (including conservation and organic agriculture) that conserve or restore soil and water resources, and properly scaled bio-energy projects for rural communities. A regulated market could be created under the post-2012 climate regime by requiring compliance buyers to include a fixed percentage of such credits in their portfolio. This is likely to result in higher prices for those credits if compared to standard credits and it may have the advantage of increasing direct financial flows to project participants in rural communities (FAO and IFAD, 2008).

Markets are most efficient when the product is homogenous. This homogeneity allows liquidity to be maximized (for example, by easing the creation of futures and derivatives markets). The differentiation of credits, however good the reasons for this are, acts against the formation of a common market. Decisions around premium credits should thus carefully weigh the sustainable development "pros" of the investments encouraged against the "cons" (the impacts on the market's ability to most efficiently allocate resources).

3.7.5 Concerns of Developing and Developed Countries

The analysis presented thus far in this background paper has been apolitical. It is of course vital that the key concerns of developing and developed countries are met for a successful negotiation to be concluded. Certain of these concerns are common to all countries; others to developing or developed countries only.

Concerns Common to all Countries

All countries are concerned that the cost of meeting carbon commitments would impose large costs on their economies. Modelling studies tend to show that economic costs are likely to be in the range 0.1-1.0 per cent loss in GDP per year (see, for example, Stern, 2007), but these are simulations. There is very little empirical evidence of what the impacts of carbon commitments will be. The phased approach would help; it would allow the leading countries to demonstrate the costs. It has been suggested that developed countries show that commitments can be met without significant economic costs. While desirable, this is too constraining. If developed countries show the opposite, does this then mean that commitments should be abandoned? Rather than aiming for insignificant economic costs, equity considerations would suggest that the costs to developed countries should always be higher than those to developing countries. Again the phased approach, with countries remaining a fixed number of steps ahead or behind each other, would address this issue.

Many countries are actively attempting to maximize their share of any future clean technology market. While there might be economic costs to the economy in meeting commitments, this could be partially or fully offset if the country became a major supplier of technologies such as wind turbines. It is instructive to assess agreements using this lens–it shows one reason why certain countries seek to limit the import of offsets into their markets and why they may favour certain options over others.

All countries wish to see administrative simplicity**.** Developed countries additionally wish to see

offset schemes such as the CDM being reformed such that they become more attractive to investors.

Developing Country Concerns

Concerning market design, developing countries want access to carbon markets.

There is a trade-off between the costs and benefits of developing countries constraining their GHG emissions. Developing countries fear that constraining their GHG emissions will result in a loss of economic output, by either imposing extra costs and/or through a loss of international competitiveness. They consider it is fundamentally the responsibility of developed countries to combat climate change. There are, however, a set of advantages to developing countries taking on capped commitments, including:

- indirect environmental benefits – for example, reducing emissions of other pollutants;
- development – economic growth, modernization of equipment, infrastructure development are all assisted by enabling domestic investment and foreign direct investment;
- industrial competitiveness – ensuring production costs are minimized;
- energy security of supply;
- balance of trade – including the limits on hard currency availability;
- reducing energy subsidies; and
- other sustainable development benefits.

These interests largely define the manoeuvring room developing countries have in agreeing to mitigate their GHG emissions. In times of high energy prices and where a country is a net energy importer (for example, China at the moment), energy efficiency (and hence GHG mitigation) becomes attractive for its reduction in production costs and increase in energy security of supply. Conversely, a country that is not so worried about its energy security of supply may not see such a strong case for limiting its energy use.

Developing countries also wish to preserve their net income from the sale of credits in the CDM and other markets, both in the short- and long-term. Here it appears that the principle that developed countries should pay more than developing countries to combat climate change should take precedence over ensuring that developing countries always receive a minimum net payment: again this is facilitated by maintaining a fixed number of "steps" between different countries. During the early stages of development, when financial and technology transfers are most important, bridging mechanisms can be set up to counteract losses in credit incomes. Such bridging mechanisms need to fulfill two purposes:

- As a guarantee of continuing income to investors in existing CDM projects, either if the host country graduates to commitments, if the project in question is no longer eligible within new CDM modalities, or if the CDM as a mechanism is not renewed post-2012. Here a bridging

mechanism could ensure that there is a market for the credits generated post-2012, [32] that a minimum price is guaranteed for all CERs for a certain period, or that rules could be incorporated into the new mechanism(s) to ensure the eligibility of existing CDM projects (for example, converting CDM projects into JI projects).

- As compensation for the loss in expected revenues from future CDM projects. A possibility here is to agree to caps that are in excess of BAU emissions, thus allowing revenues to accrue to developing countries while retaining the incentive of the carbon price to reduce emissions.

Food security is a concern in regard to mitigation options in the agricultural sector. One concern is that bio-energy projects might divert edible crops from food markets, leading to higher food prices and worsening food security. A second concern is that food production needs to keep pace with rising populations and improvements in standards of living. Some mitigation efforts, such as sequestering carbon through biochar and returning it to agricultural land, can increase and maintain soil fertility. But, as noted in the UNFCCC (2008b) report on agriculture, "there are limitations to emission reductions in the agriculture sector particularly because of the role of this sector in providing food for a growing global population" and that "it would be reasonable to expect emission reductions in terms of improvements in efficiency rather than in absolute reductions in GHG emissions." If Quantified Emission Limitation and Reduction Objectives are established for the AFOLU sector, the question of the form of the target is likely to arise. Generally, intensity-based targets in the agricultural sector are more attractive to developing countries and are a better means of ensuring food security than absolute targets (UNFCCC, 2008c and FAO, 2008).

4.0 Conclusions

4.1 Background

- The switch to a low carbon economy will require major investment, with estimates that mitigation and adaptation will require hundreds of billions of dollars per year.
- Despite being relatively young, the value of the world carbon market is already over US$60 billion per year and is growing strongly.
- Market instruments are extremely flexible: they can be designed to cover projects, sectors, policies and measures.
- Different instruments have different applications; a full coverage of developing country actions by the carbon market is likely to require several options, applied in combination.
- Using part of the revenues generated by carbon markets could also make a major contribution to financing and investing needs.

[32] For example, the World Bank has agreed to buy CERs until 2014 (World Bank, 2007).

4.2 Development of the Carbon Market to Date

- The size of the carbon market is principally driven by the difference between expected BAU emissions and the caps placed on emissions, for the activities covered.
- The impact of carbon markets on mitigation in developing countries is clearly a function of this demand. This demand can arise from domestic caps and access to foreign markets for developing country credits.
- At present, there are no domestic caps in developing countries. Access to developed country markets to sell credits is the sole current incentive that carbon markets give to mitigation in developing countries.
- By far the largest flow of credits, and thus revenue, is the sale of CERs to the EU-ETS and to funds run by governments and international financial institutions.
- Taxes and levies, or auctioning, could be applied when allowances are first granted. This represents a potentially very large revenue source.
- The carbon market value in 2007 was US$64 billion with approximately three-quarters made up of trade in EUAs under the EU-ETS.

4.3 How could the Carbon Market Develop? Demand and Developing Country Revenue

- The scale of global commitments agreed to post-2012 will define the demand for emission allowances and for emission reduction credits. The level of this demand defines the maximum role the carbon market can play.
- Developing countries themselves have some influence on the total level of demand since their taking of caps increases demand and by engaging in the process they will engender trust and commitment from the developed world, thus encouraging them to take on more stringent caps.
- Estimating the level of demand is subject to great uncertainty. Estimating developing country revenue adds further uncertainty since: it requires an assessment to be made of the expected price of carbon; if, and when, some or all developing countries take on commitments; and if they do not take on commitments, the level of access to developed country markets granted to credits developing countries.
- Given the scale and number of uncertainties, developing scenarios that precisely define the size of the future carbon market is considered to be impossible. What we can do is to estimate the range of demand within a range of market prices and market access assumptions, and estimate a range of possible developing world revenue.
- Stabilizing atmospheric concentration of CO_2e at 450 to 650 ppmv would require reductions in world emissions of the order of 2-9 $GtCO_2$ (4-18 per cent of BAU emissions) in 2020 and

16-33 $GtCO_2$ (23-46 per cent of BAU emissions) in 2050. These required reductions set maximum carbon market demands.

- Assuming developing countries could supply 50 per cent of developed country demand and market prices would be in the range US$10-100/$tCO_2$, developing country revenue would range from US$10-300 billion in 2020 (0.01-0.3 per cent of world GDP). In 2050, with the same market prices, revenue would be US $55-900 billion, again in the range 0.01-0.3 per cent of world GDP.
- If some or all developing countries took on commitments, demand could increase by 50-100 per cent. Market prices would also increase, increasing the incentive for mitigation in developing countries. The volume transferred to developed countries would decrease, but the impact on the size of developing world revenue is uncertain.
- In theory, auctioning all developed country allowances could lead to developing country revenue several times in excess of that which the carbon market could provide directly.
- In practice, there are likely to be major constraints on the amount of funding which can be transferred in this way. The EU proposed an indicative limit on transfers abroad of 20 per cent of auctioned revenues; it has recently significantly decreased the number of its allowances it proposed to auction.

4.4 Opportunities for Developing Country Participation

- The CDM is expected to generate 0.6 $GtCO_2$/year of credits to 2012.
- Meeting potential demand of 1-3 $GtCO_2$ in 2020 and 5.5-9 $GtCO_2$ in 2050 will require increases in mitigation across the board (there is a need for expansion in terms of the countries, sectors and enterprises that currently generate credits).
- Based on an analysis of where GHG emissions from developing countries occur, a significant reduction would require: the inclusion of the MDEs, notably their Electricity & Heat Generation and Manufacturing & Construction sectors; including the forestry sector would be very valuable, particularly in countries outside the MDE group; and efforts would be significantly extended if agriculture sector was included.
- Experience from the CDM indicates that 60 per cent of reductions are based in some way on electricity generation. A further 22 per cent is from the destruction of industrial gases with the remainder mostly from agriculture. China is projected to receive 73 per cent of the credits from projects in the pipeline to date.
- There is considerable uncertainty as to what a post-2012 regime will look like and what instruments and mechanisms could be employed within this. A range of different MMSDs will be required if developing country GHG emissions from all sectors are to be included in the carbon market.

- A list of options progressing from the current situation toward an absolute cap with revenues raised from the issuing of allowances has been considered:
    1. current CDM;
    2. broadened CDM;
    3. other MMSDs;
    4. DCSCs;
    5. developing country commitments applied to the economy as a whole; and
    6. taxation and/or auctioning of allowances to raise funds disbursed domestically or abroad.
- An analysis has been conducted to establish how the options could be applied and what their potential impact could be. The analysis is generic; the issues faced by sectors tend to be similar whatever country they are found in and include:
    - Allocation-based MMSDs offer the largest potential to bring large parts of developing country GHG emissions within market measures. They could contain any policy, legal requirement or measure, and would work by granting credits for sale into the market when performance exceeds the allocation for the activity covered. REDD is a key example for the forestry sector; the discussions around crediting NAMAs and SD-PAMs illustrate the debate for other sectors.
    - There is significant potential from broadening the CDM, notably from moving to sectoral CDM. Expanding the scope of the CDM would only have a significant impact in the agriculture and forestry sectors, although it could also allow CCS and nuclear, increasing the mitigation options available to the electricity sector. Programmatic CDM would not likely increase mitigation significantly; it would mostly be useful in the residential and transport sectors, whose share of GHG emissions are relatively low and where CDM uptake has been very low to date.
    - TOAs could, in theory, be used to generate credits for sale into the market and would have a large reach across sectors and emissions. In practice, developing MMSDs would be problematic.
- Commitments for some or all sectors in some or all developing countries are highly contentious. A graduated approach would see developing countries progressively building up commitments:
    - start with "no-lose" intensity targets for one or a limited number of sectors;
    - increase the number of sectors and make the intensity targets two-way (with the possibility of a downside); and
    - introduce absolute targets for several sectors and then for the economy as a whole.

- Such a graduated approach would allow developing countries to build up their experience and capacity as they became wealthier and as developed countries meet their internationally-agreed commitments.
- The first sectors to agree to targets would be energy-intensive industry and electricity generation, as in developed countries. These sectors are high emitters of GHGs per unit of GDP, have relatively few sites, are the easiest to categorize and collect data for, have the financial and managerial capacity to invest in abatement options, and are most prominent in the competitiveness and leakage debate.
- A phased approach could be applied to the development of the carbon market as a tool for mitigating developing country GHG emissions. Countries would move up a step when other countries have proven they've met their commitments (a fixed number of steps would be maintained between countries).
- There is little chance of developing countries agreeing to commitments in the short term. An expanded CDM (notably making it sectoral) and allocation-based MMSDs could support significant mitigation in the developing world.
- The agriculture and forestry sectors could follow the same phased approach as other sectors, although probably more slowly. Targets in these sectors would require developing countries to improve their understanding and monitoring of GHG emissions from these sectors.
- It would not be straightforward to include adaptation within a market mechanism. Premium carbon credits for certain activities would similarly add complexities. Before differentiated credits are agreed to, an assessment of the benefits from encouraging certain investments against losses in market liquidity needs to be made.

4.5 Political Considerations

- The conclusions presented to date have been largely made on an apolitical basis. It is of course vital that the key concerns of developing and developed countries are met for a successful negotiation to be concluded.
- All countries are concerned about the economic costs of meeting carbon commitments. It is considered preferable to use the principle that costs to developed countries should always be higher than those to developing countries, than to attach the potentially limiting condition that economic costs must be proven to be insignificant.
- All countries are seeking to maximize their share of the future clean energy technology market. If countries become over protective, the efficiency gains from using the market will be diluted.
- All countries wish to see administrative simplicity. Developing countries want access to carbon markets for any surpluses they have. Developed countries want there to be investor-friendly conditions for offset schemes such as the CDM.

- There is a trade-off to be made, between the costs and benefits to developing countries, when agreeing to commitments. Benefits include local environmental improvement, increased security of supply, increased penetration of clean technologies and reducing energy subsidy payments.
- Developing countries wish to preserve their current and potential future income from credits, notably the CDM. The principle that developed countries should always pay more than developing countries is considered to be more workable than one which guarantees developing countries net income in perpetuity.
- A move to a broadened CDM and/or allocation-based MMSDs can include the provision that registered CDM projects will continue to receive income for a guaranteed period, either within the new MMSDs or independently. In the long term, allocating over-generous caps to developing countries could be used as a compensation payment while maintaining the carbon price signal.

4.6 Overall Conclusions

- Carbon markets could be a major part of encouraging developing country GHG emissions mitigation, whether or not developing countries take on commitments.
- A wide range of options could be applied. Sectoral CDM and allocation-based MMSDs offer the largest potential scope, but the CDM could be retained in its current form to continue to support sustainable development in less developed countries.
- The long term aim of significant GHG emission reductions across the world are best served by a phased approach. This could be applied to all countries and all sectors, including the agriculture and forestry sectors, which are largely outside emission regulations at the current time.
- This paper has not considered options other than those that the carbon market could deliver. It is recognized that certain sectors in certain countries may be better served by some other method for regulating emissions. Similarly, the carbon market is most applicable when technologies and techniques are already commercialized rather than when they are under development. Nevertheless, carbon markets may well be the best option we have. Other mechanisms may not be really well suited to either the wide suite of responses which are required [33] (policy, behavioural change and demand reduction, among others) or to the sheer scale of the finance required. It is worth asking if options other than the carbon market could arrive at a full solution, noting that the inclusion of the private sector is a key requirement in delivering scale and innovation.
- Expanding the reach of markets requires that several key issues be addressed:
    - details on how the new allocation-based MMSDs will generate credits;

[33] This is important–actions are needed across the whole economy and will require different, sector-specific policies and incentives. It is easier to see carbon markets supporting a good number of these, rather than something like China's demand for developed countries to commit one per cent of GDP to developing countries for green technology.

  - the agreement of the developed world to buy the credits produced, without prejudice;
  - acceptance of the need for a phased approach to meet long-term targets and assistance to meet this need (for example, by developed countries agreeing to buy credits as a support to capacity building in developing countries, even if their additionality is not fully robust);
  - all countries meeting their commitments with the leadership of the developed world essential; and
  - negotiations must address the concerns of all countries.
- Action is needed in developing countries as soon as possible to avoid the locking-in of carbon-intensive systems and practices.

4.7 Further Work

This background paper has scoped out the issues and proposed a framework. Further analysis should be directed toward:

1. operationalizing sectoral CDM and allocation-based MMSDs;
2. expanding the analysis to assess how the instruments proposed would work for market players–would they allow competition on cost and result in markets that are sufficiently liquid to drive change?
3. overlaying the analysis onto the short-term negotiations, including how a range of emission trading schemes could be linked together and receive developing country credits.

Annex A: Development of the Carbon Market to Date

Trading in carbon, tentatively started as the Kyoto Protocol, moved toward ratification and is now one the world's fastest growing markets. This section provides an overview of how the carbon market–including the EU-ETS, CDM and voluntary markets–has developed to date in terms of volume, value, and distribution of market share among countries and sectors.

Under the Kyoto Protocol, 38 developed countries committed to reduce their collective GHG emissions by 5.2 per cent below 1990 levels over the period 2008-2012. They can meet their targets through national measures or by way of three market-based mechanisms: IET, CDM and JI.

Many countries have used emissions trading, individually or cooperatively, as part of their climate change initiatives (or are planning to do so), creating different regulatory carbon markets formally outside the Kyoto Protocol. In parallel, another type of carbon market, the voluntary carbon market, has emerged. This market includes all transactions of carbon offsets that are not required by regulation. It is basically conducted by non-regulated individuals who or companies that compensate for their GHG emissions. The principal aims for such companies are to receive less stringent targets in the future and/or improve their image. Ethical considerations can inform companies' decisions to varying extents; there is also an element of pure speculation in the voluntary market.

A 1. The Market as a Whole

The global carbon market has continuously expanded over the past few years. Capoor and Ambrosi (2008) report that the total volume traded increased from 1.7 billion tonnes of CO_2e in 2006 to nearly 3 Giga tonnes (Gt) in 2007–a growth rate of 71 per cent. Since 2005, the value of the global carbon market has increased even faster with growth rates estimated to be 288 per cent and 105 per cent in 2006 and 2007 respectively (see Table 6).

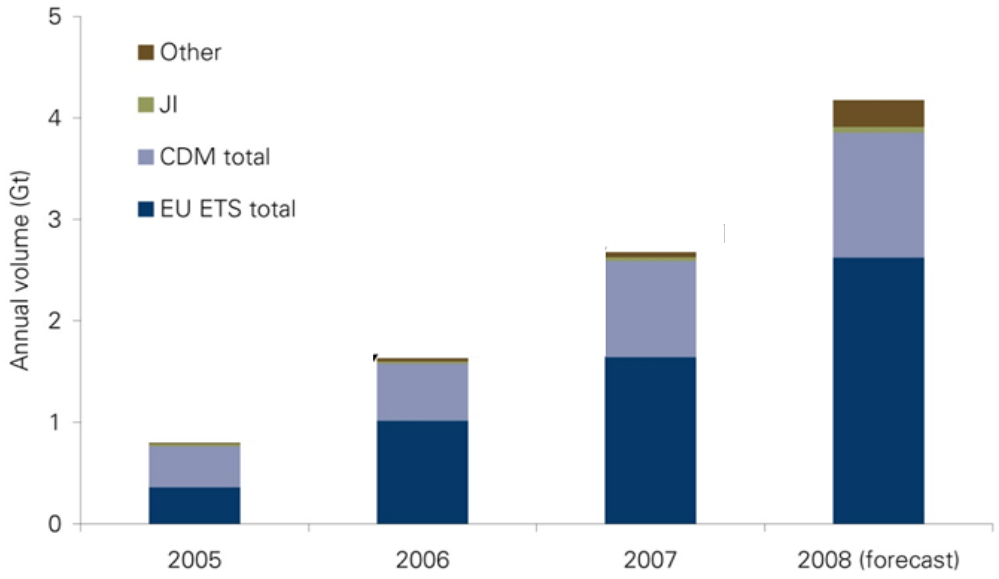
Table 6: Volumes Exchanged and Corresponding Values on the Global Carbon Market, 2004-2007

	2004	2005	2006	2007
Estimated Volume (Million tCO_2e)	126	710	1,745	2,983
Growth		435 %	146 %	71 %
Estimated Value (Million US$)	N/A.	10,864	31,235	64,035
Growth		-	288 %	105 %

Source: Capoor and Ambrosi (2006), p.13, 23; Capoor and Ambrosi (2007), p.3; and Capoor and Ambrosi (2008), p.1.

The CDM market was the largest segment of the global carbon market in terms of volume in 2004-2005, but since 2006 the EU-ETS has come first (see Figure 2). In 2007, the EU-ETS represented 62 per cent of the market share volume and 70 per cent of the value.[34] The global carbon market is now almost entirely dominated by those two markets.

Figure 2: Reported and Estimated Contracts 2005-7, Forecast 2008 ($GtCO_2e$)



Source: Point Carbon (2008), Figure 3.1, p.23.

It is important to note that although the value of the carbon market is often used to illustrate market size, it remains an indirect and inexact measure. Market value is calculated as the quantity of allowances traded multiplied by their price. Market value can vary significantly for a constant demand since some allowances can be traded many times over. If enterprises tend to invest in their own abatement options, we will see lower trading than if abatement investments were concentrated within fewer enterprises. It is also essential to note that the value of an allowance is only the revenue side of the equation—the costs of emission abatement must be subtracted from this to give the net cost to the investor. The correct measure of cost effectiveness is to measure total system cost in meeting the overall cap.[35] These system costs are the sum of all investments in abatement and changes in operating costs, plus any transaction costs associated with monitoring and trading allowances, among others. Within this definition, the value of trade is simply a transfer payment from one enterprise to another and, therefore, does not affect system cost.[36] Finally, measuring system cost is much more difficult than calculating the value of the market.

[34] The high prices in EU-ETS compared to other market segments explain the higher share of the value of the EU-ETS compared to the volume.
[35] Where the total cap is the sum of the caps for each enterprise covered.
[36] But trading can have very significant effects on the distribution of costs–(which enterprises are "winners" or "losers").

A 2. Markets using the Kyoto Mechanisms

A 2.1 IET – International Emissions Trading

The Kyoto Protocol allows countries with commitments (Annex B Parties) to buy and sell allowed emissions as Assigned Amount Units (AAUs). Although the market has a large potential–in the order of several billion tonnes of CO_2e (Røine *et al.*, 2008, p. 37)–traditionally there has been very little trading to date of the Kyoto Protocol's AAUs between countries. The non-ratification of the United States, many other countries likely (or looking) to significantly miss their caps and concerns over "hot air" have been contributing factors.[37]

The market is now picking up and several trades have been reported in the last quarter of 2008 and the first of 2009, including:

- The Czech Republic sold 40 million AAUs to Japan in March 2009 (Point Carbon, 2009c).
- Ukraine announced that it had agreed to sell 15 million AAUs to Japan in 2009 and a further 15 million in 2010, all at a price of $\$10/tCO_2e$ with estimates that their total sales of AAUs could be 100-200 million AAUs (noting they have a surplus of around 2.5 billion AAUs) (Point Carbon, 2009b).
- Slovakia announced that it had sold emissions rights worth US$66.3 million to a private investor on December 11, 2008 (Point Carbon, 2008).
- Hungary has sold emission units to Spain, Belgium and Japan.
- Latvia was finalising the small print on selling AAUs to Austria, Netherlands and Japan in 2008 (Point Carbon, 2008).

The exact reasons for these sales are not clear–mostly they are thought to be compliance sales, but they could also be some form of hedging, purchases made for reputational reasons or for some other purpose. A very large market in AAUs must still be considered unlikely, but is not impossible. If the market did become large, it could act as competition to developing country credits. There is concern that some of the AAUs sold to date are hot air and thus should be excluded from the market (Point Carbon, 2009b).

A 2.2 Joint Implementation

Joint Implementation is a project-based mechanism that allows developed countries to earn credits from a project implemented in another developed country. JI emission reduction projects earn Emission Reduction Units (ERUs), each equivalent to one tonne of CO_2e. JI is by far a less significant segment of the global carbon market than the CDM, but JI experienced a 156 per cent growth in traded volumes in 2007–almost a tripling of transactions (see Table 7). Despite large

[37] Large emissions reductions (decreases of an average 35 per cent in 2005 from 1990 levels) occurred in Russia and Eastern European countries in the 1990s because of the economic collapse that followed the fall of the Soviet Union. The large amount of tradable emissions available from these countries is referred to as "hot air" because they resulted from an unintentional deviation from business as usual emission patterns, rather than new investment in clean energy.

recent growth, market value remains small in comparison to the EU-ETS and trading of CERs under the CDM.

Table 7: Volumes Exchanged and Corresponding Values on the JI Market, 2005-2007

	2005	2006	2007
Estimated Volume ($MtCO_2e$)	11	16	41
Growth	-	45%	156%
Estimated Value (MUS$)	68	141	499
Growth	-	107%	254%

Source: Capoor and Ambrosi (2007), p.20; and Capoor and Ambrosi (2008), p.19.

A 2.3 CDM – Clean Development Mechanism

The CDM is currently the only means to engage developing countries in the formal carbon market. It is now a significant instrument, although concerns remain as to its environmental integrity. From a carbon market basis, CERs have been sold into the EU-ETS and have been bought by a range of governments as offsets against their Kyoto Protocol targets.

The annual volume of CER transactions has been growing strongly since 2002, although the growth rate of volumes transacted slowed to an estimated three per cent in 2007 (see Table 8). As of January 1st 2009, the CDM Pipeline contained 4,364 projects, with 1,300 registered, 344 in the registration process and 441 with CERs issued (UNEP-Risoe Centre, 2009). The fact that the total CDM value grew at a higher rate than its total volume is an indication of the strong competition and activity in this market Capoor and Ambrosi, 2008: 19). The project stage, project type and counterparty also influence the price of primary CERs (Røine *et al.*, 2008, p. 37).

The market for secondary trading of CERs, a segment "derived" from the primary market, grew significantly in 2007 (see Table 8). Its total volume went from an estimated 25 $MtCO_2e$ in 2006 to 240 $MtCO_2e$ in 2007–an 860 per cent growth. Most of this exponential growth is related to European Union Allocation (EUA)-CER swaps (Røine *et al.*, iii). [38]

China has dominated the number of CERs issued to date (41.5 per cent) and has a much larger share of the volume expected from registered projects (73 per cent). The majority of CERs have been derived from electricity generation in one form or another with the destruction of industrial process gases also having a significant share. The volume of CERs from afforestation/reforestation projects has been relatively low, at less than 10 per cent of the total. Further analysis of the types of projects and the host countries which have made major contributions to the generation of CERs is given in Section 3.1 and Annex B.

[38] EUAs are tradable emission credits from the EU-ETS. Each allowance carries the right to emit one tonne of CO_2.

Table 8: Volumes Exchanged and Corresponding Values on CDM Market, 2005-2007

		2005	2006	2007
New projects in the CDM pipeline		473	840	1429
Number of projects with CERs issued		285	103	13
Primary CERs	Estimated volume ($MtCO_2e$)	341	537	551
	Growth	-	57%	3%
	Estimated value (MUS$)	2,417	5,804	7,426
	Growth	-	140%	28%
Secondary CERs	Estimated volume ($MtCO_2e$)	10	25	240
	Growth	-	150%	860%
	Estimated value (MUS$)	221	445	5,451
	Growth	-	101%	1125%

Source: Capoor and Ambrosi (2006), p.13, 23; Capoor and Ambrosi (2007), p.3; Capoor and Ambrosi (2008), p.1; and UNEP Risoe CDM/JI Pipeline Analysis and Database, January 1, 2009.

A 3. Markets for Other GHG Instruments

A range of emission trading schemes have been/are being set up, either as part of countries' responses to the commitments of the Kyoto Protocol or as voluntary initiatives.

A 3.1 EU-ETS – European Union Emission Trading Scheme

The EU-ETS was launched on January 1, 2005 as a crucial cornerstone of European climate change policy. In its first phase, which extended from 2005 to 2007, the EU-ETS covered over 11,500 energy-intensive installations across the EU, including combustion plants, oil refineries, coke ovens, iron and steel plants, and factories making cement, glass, lime, brick, ceramics, and pulp and paper. Its second phase runs from 2008 to 2012.

As stated in Section A1, the EU-ETS is the major segment of the global carbon market, and is, "the engine, perhaps even the laboratory, of the global carbon market" (Capoor and Ambrosi, 2008, p. 7). In 2007, the EU-ETS saw a traded volume of more than two billion EUAs for a market value of around US$50 billion. This represents nearly a doubling of both volume and value transacted compared to 2006 and more than six times the volume and value transacted in 2005 (see Table 9).

Table 9: Volumes Exchanges and Corresponding Values on the EU-ETS, 2004-2007

	2004	2005	2006	2007
Estimated volume ($MtCO_2e$)	8	321	1,104	2,061
Growth	-	320%	244%	87%
Estimated value (MUS$)	N/A	7,908	24,436	50,097
Growth	-	-	209%	105%

Source: Capoor and Ambrosi (2006), p.13; Capoor and Ambrosi (2007), p.11; and Capoor and Ambrosi (2008), p.19.

To meet their compliance requirements, installations can use CDM and JI. In Phase 2, installations would be allowed to use a total of around 280 $MtCO_2e$ of CDM/JI credits per year (see Capoor and Ambrosi 2008, Table 4, p.10).

A 3.2 Other Regulatory Schemes

Other cap-and-trade schemes have either been set up or are in the process of being set up; they are currently significantly smaller in scale that the EU-ETS or CDM markets. The schemes are generally national or regional in nature and have a range of design specifics and commitments. Examples in the U.S. include the Regional Greenhouse Gas Initiative (RGGI) and Western Climate Initiative (WCI). Meanwhile, Australia has the New South Wales (NSW) market, Japan is finalizing its scheme, New Zealand's scheme is under review and President Obama has request Congress to develop a cap-and-trade system for the United States. Among a range of other regulatory schemes, Alberta has an Energy Environment Technology Fund. [39]

Within the developing world there has also been some limited progress. The South Korean scheme, a voluntary emissions trading system, had seen 133 projects with 11.6 million tonnes of CO_2 equivalent registered by August 2008 (Park, 2008).

A3.3 Voluntary Markets

Several voluntary markets have developed, principally focused on the supply of offsets (with varying criteria on baselines and environmental integrity, among others) and/or on companies developing their baselines and agreeing to voluntary reduction targets.[40] The voluntary market can be divided into two segments: the Chicago Climate Exchange (CCX), a voluntary cap-and-trade scheme; and the "over-the-counter" (OTC) market, a broader, non-binding market.

[39] See: http://environment.alberta.ca/2264.html

[40] See, for example, the California and Chicago Registries. One of the key aims of such schemes has been for companies to demonstrate the extent of their "early action" reductions, enabling them to argue for less stringent caps if these are based on reductions from a more recent date.

In common with the other segments of the global carbon market, the voluntary carbon market has been growing over the past few years. In 2007, a confirmed volume of 42 million tonnes of CO_2e was transacted on the OTC voluntary market (see Table 10).[41] Combined with the CCX, the total volumes transacted during 2007 amounts to more than 65 Mt CO_2e, about two per cent of the total market share. In terms of value, the voluntary segment accounted for about 0.5 per cent of the global carbon market.

Table 10: Volumes Exchanged and Corresponding Values on the Voluntary Carbon Market, 2004-2007

		2004	2005	2006	2007
CCX	Total Volume ($MtCO_2e$)	2	1	10	23
	Growth	-	- 100%	900%	130%
	Total value (MUS$)	3	3	38	72
	Growth	-	0%	1167%	89%
OTC	Confirmed volume ($MtCO_2e$)	8	9	14	42
	Growth	-	13%	56%	200%
	Confirmed value (MUS$)	34	38	58	258
	Growth	-	12%	53%	345%

Source of data: Hamilton, *et al.*, (2008), p. 24-25.

The supply of offsets in the voluntary markets is very diverse. In the OTC market in 2007, a significant share was held by renewable energy (31 per cent), energy efficiency (18 per cent), methane destruction (16 per cent) and forestry projects (18 per cent) (Hamilton *et al.*, 2008, p. 7). A decrease of industrial gas projects was observed from 2006, reflecting buyers concerns with sustainable development attributes (Hamilton *et al.*, 2008, p. 7).

With respect to project location, Asia and North America dominated the OTC voluntary market in 2007, with 39 per cent and 27 per cent of market share respectively. Asia, Europe and Australia have increased their share of the market in 2007 while North America, Latin America and Africa's share have decreased. In some cases, those changes are an indication of a move in 2007 to originate Verified Emission Reductions (VERs) from projects awaiting for CDM approval (Hamilton *et al.*, 2008, p. 7).

Concerns have been levelled as to the ability of the voluntary market to deliver credible emissions reduction (see, for example, Trexler, 2006). The most serious of these relate to additionality, double counting and sustainable development. In comparison, the CDM can be thought of as a premium product.

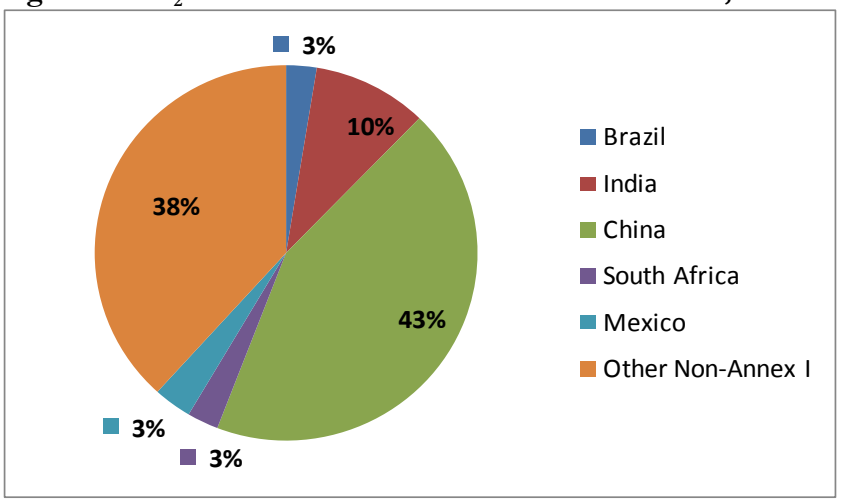
[41] Since data collected by Ecosystem Marketplace and New Carbon Finance are based only on completed and confirmed transactions, the actual credit volume transacted in the voluntary market is certainly higher than this amount.

Annex B: Developing Country Emissions and Abatement Potential

B1. Where do Developing Country GHG Emissions Arise?

A relatively small number of developing countries are responsible for the majority of GHG emissions from the non-Annex I group. Figure 3 shows that five MDEs accounted for over 60 per cent of CO_2 emissions from fuel combustion in 2006. Even within this group, emissions are highly concentrated with China responsible for 43 per cent of the total and India a further 10 per cent. Clearly a carbon market within which China is active can be expected to show much different traded volumes and prices than one within which it is not active.

Figure 3: CO_2 Emissions from non-Annex I Countries, 2006



Source; IEA, 2009.

AFOLU activities in non-Annex I countries can play a significant role in achieving GHG emission reductions. It is predicted that in the order of 20 per cent of current annual global emissions or some 10,000 $MtCO_2$ of annual reductions can be achieved through forestry-based activities in developing countries (Metz *et al.*, 2007). With a similar perspective for the agriculture sector, these considerable emission reduction potentials could provide great opportunities to gain tradable credits issued from agriculture and forestry projects in developing countries.

AFOLU activities also have the potential to help non-Annex I countries to achieve sustainable development, especially in least developed countries, since some AFOLU mitigation activities, such as carbon sequestration, may achieve sustainable development objectives (for example, poverty reduction) (Baalman and Schlamadinger, 2008).

However, the current international climate change regime limits these opportunities to afforestation/reforestation (A/R) CDM projects. Moreover, relating CDM methodologies are very restrictive. As a result, agriculture and forestry credits are mainly traded on the voluntary market

where forestry-based activities make up some 30 per cent to 40 per cent of all voluntary offset projects (Kollmuss, *et al.*, 2008).

The diversity of the emissions covered by the agriculture and forest sectors, with the scale of the GHG abatement opportunities in those sectors, makes future perspectives promising for developing countries' participation through AFOLU credits trading.

B1.1 Current and Future Emissions of the Agriculture and Forest Sectors and Scale of the GHG Abatement Opportunities in those Sectors

Agriculture

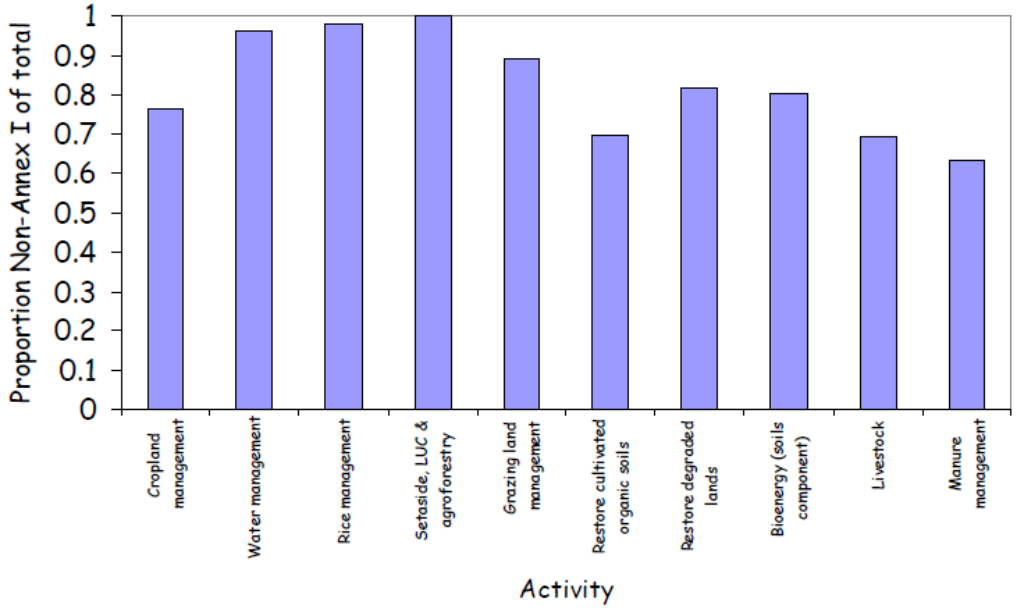
On a global scale, the main sources of non-CO_2 GHG emissions from agriculture are soils (nitrous oxide - N_2O emissions), enteric fermentation (methane - CH_4 emissions), manure management (CH_4 and N_2O emissions) and rice cultivation (CH_4 emissions). CO_2 sources include soils (especially when reduced tillage or fallow are implemented) and fuel emissions from agricultural machines and utilities.

The UNFCCC reports that taken as a whole, agricultural activities contribute between 10 and 12 per cent of the total global anthropogenic GHG emissions or about 5.1-6.2 Gt of CO_2e per year. Between 1990 and 2005, emissions from the sector increased by about 18 per cent, the average annual growth being about 60 Mt CO_2e. Agricultural GHG emissions growth mainly occurs in developing countries where most of the world agricultural production takes place. Between 1990 and 2005 agricultural GHG emissions in developing countries increased by 32 per cent, making those countries responsible for about 75 per cent of total agricultural emissions in 2005 (UNFCCC, 2008b).

Agriculture is a major GHG emitter in developing countries, and offers a large array of emission mitigation opportunities. Smith, *et al.* (2007), report that on a global scale, mitigation measures in the agricultural sector could contribute to substantial GHG emission reductions up to 2030 with potential ranges from 5 to 20 per cent of total CO_2 emissions and with a global technical mitigation potential (excluding fossil fuel offsets from biomass) ranging from 5.5 to 6 $GtCO_2e$ per year by 2030.

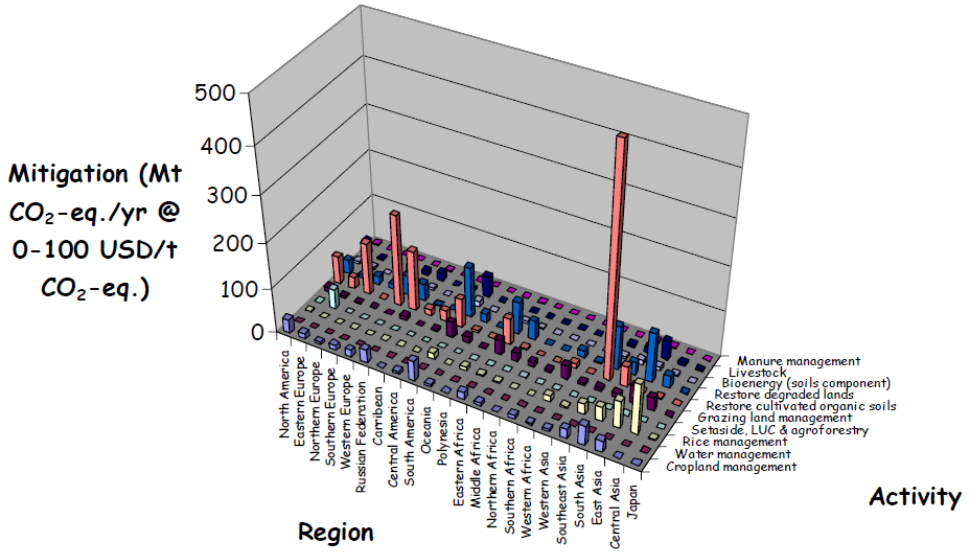
According to the UNFCCC (2008b), about 30 per cent of this potential can be achieved in developed countries and 70 per cent in developing countries. According to non-UNFCCC sources, a large proportion of agriculture mitigation potential is located in non-Annex I countries or economies in transition. Trines *et al.* (2006) report that 80 per cent of the global total agricultural mitigation potential is found in non-Annex I countries. Figure 4, taken from Trines *et al.* (2006), shows mitigation potentials found in non-Annex I countries as a proportion of the global total for each agricultural mitigation activity whereas Figure 5, also taken from Trines *et al.* (2006), shows the difference between mitigation potential at \$US 0-100/tCO_2e for each agricultural mitigation practice depending on where it is implemented in the world. This allows a distinction between mitigation potentials in developing countries and developed countries.

Figure 4: Mitigation Potential found in Non-Annex I Countries as a Proportion of the Global Total for each Agricultural Mitigation Activity



Source: Trines, *et al.*, 2006.

Figure 5: Mitigation Potential at US$0-100t CO_2e-1 of each Agricultural Mitigation Practice in each of the FAO/*International Institute for Applied Systems Analysis* Agro Ecological Zones Global Regions (2000)



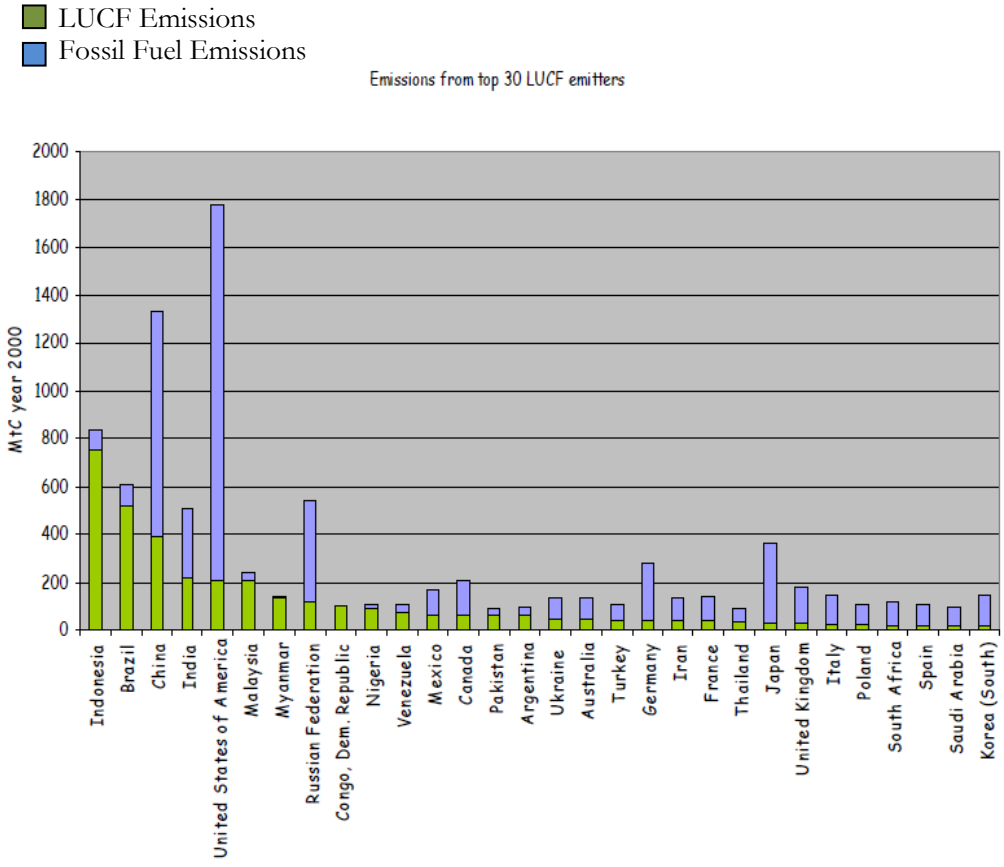
Source: Trines, *et al.*, 2006.

Forestry

Land-use change GHG emissions, that include emissions from deforestation and emissions from some agricultural activities, exceed emissions from all other agricultural sources. (Figure 6 shows top 30 emitting nations' LUCF emissions in 2000). The forestry sector is an important emitter mainly because of deforestation and forest degradation, which can trigger the release of a considerable amount of GHG emissions. CO_2 emissions from land-use change, including deforestation, are, in most cases, associated with agricultural activities, which provide incentives to deforestation and forest degradation (FAO, 2008). Nevertheless, the forestry sector has huge potentials for carbon sequestration.

Options with the highest potential in forestry can be found in tropical regions (including Central and South America, Africa and Asia) especially with the implementation of REDD activities (Trines, *et al.*, 2006). The IPCC reports that REDD would have the largest and most immediate carbon stock impact in the short term per hectare and year globally (Nabuurs, *et al.*, 2007).

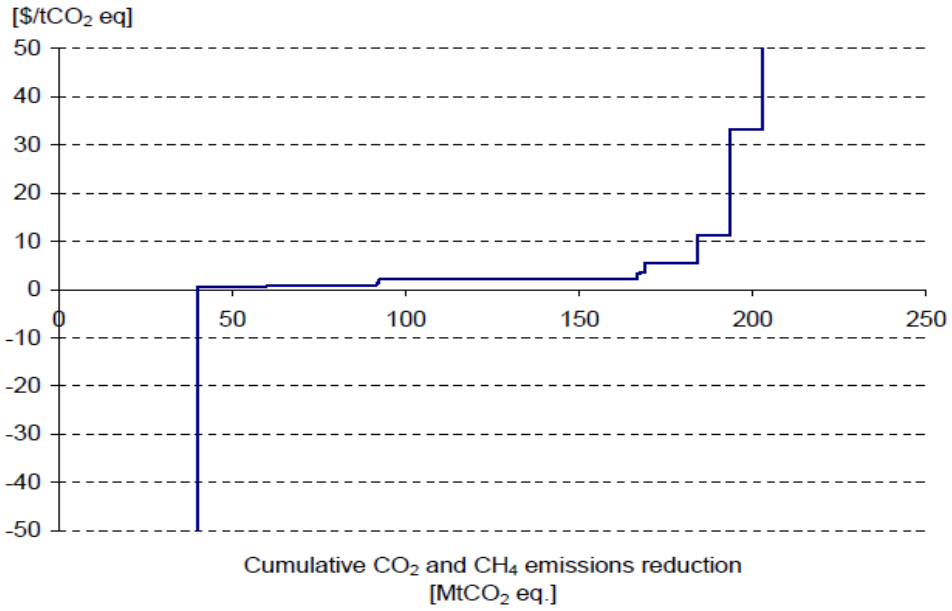
Figure 6: Top 30 Emitting Nations, 2000, Ranked according to LUCF Emissions



Source: Trines, *et al.,* 2006.

Mitigation potentials in the agricultural and forestry sectors in developing countries are considerable. As various low-cost mitigation options could be found in both sectors, economic mitigation potentials are very significant; with slightly higher potentials in agriculture. Nevertheless, the largest single potential can be found in forestry through REDD activities (Trines, *et al.*, 2006). A Marginal Abatement Costs curve for the agricultural and forestry sectors in the whole is presented in Figure 7.

Figure 7: Extrapolated Marginal Abatement Costs curve for the Agricultural and Forestry Sectors in Non-Annex I Countries

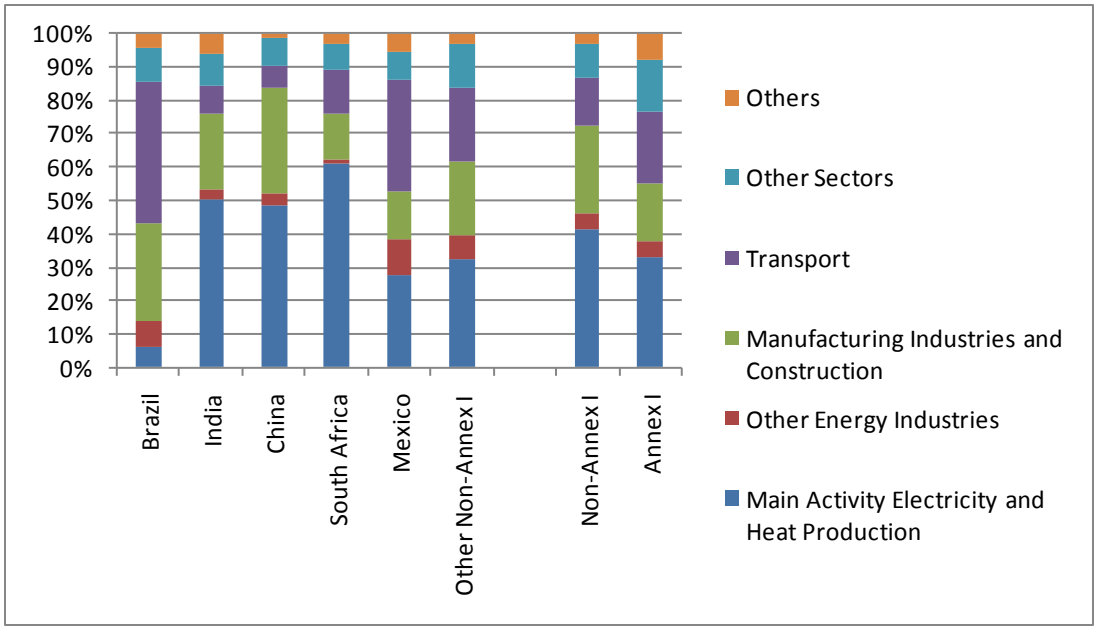


Source: Wetzelaer, *et al.,* 2007

A deep, liquid market requires the participation of the key countries and of the key emission sources within these. Figure 8 shows that the electricity generation and industry sectors account for over 50 per cent of emissions in all countries except Brazil (whose electricity generation is almost all from hydroelectric plants).

Non-Annex I countries as a whole show a larger proportion of emissions from electricity generation and industry than do Annex I countries. For non-Annex I countries, the proportions are 41 per cent and 26 per cent respectively, or 67 per cent of the total. For Annex I countries, electricity generation causes 33 per cent of CO_2 emissions and industry 18 per cent, giving a combined figure of 51 per cent. The difference is partially explained by the reliance of non-Annex I countries (notably China and India) on coal as a key energy source, but also reflects the much higher per capita emissions for transport and within the residential and commercial sectors within Annex I countries. As non-Annex I countries develop economically, we can expect their economies to become less intensive. At present electricity generation and industry account for two-thirds of non-Annex I emissions. The participation of these two sectors in the carbon market is clearly a key driver of its volume and prices.

Figure 8: Split of CO_2 Emissions by Country and Group 2006



Source: IEA, 2009

Within electricity generation, emission reductions are firstly a question of reducing emissions from fossil fuels with coal the key fuel to address. Ideally we would see a switch from coal to renewable generation, but such a switch is often limited by the availability of renewable resources at an acceptable price and would, in all cases, take a significant period of time.[42] CCS is similarly constrained by when it may become available as an option—various studies indicate that it may be commercially available sometime between 2020 and 2030. Furthermore, only a portion of coal plants would be close enough to storage sites and/or carbon pipelines to make the option economically feasible.

In the shorter term, GHG mitigation from the coal sector will rely on:

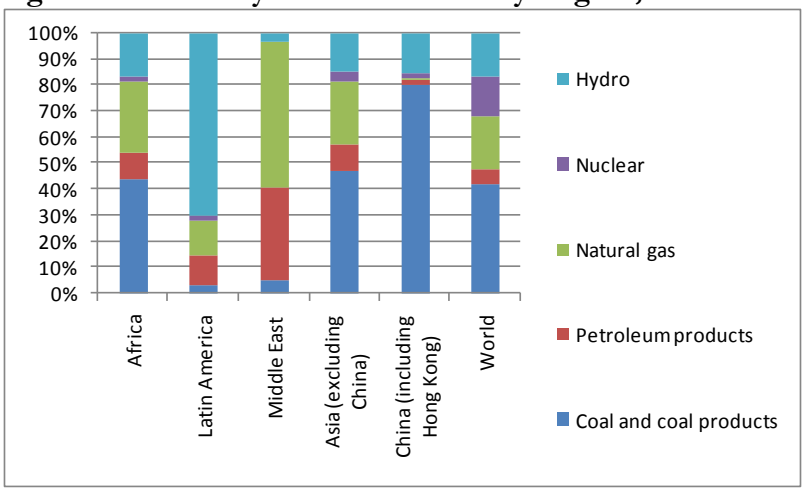
1. increasing efficiency at existing plants – options are limited with relatively expensive refurbishment of the key plant components necessary for any significant improvements in plant efficiency;
2. switching to natural gas as far as is possible – by choosing gas as the fuel for new plants, by using existing gas plants at the highest load factor possible and by converting coal plants to "dual fuel," plants that can also use gas); and
3. ensuring that new coal plants use the most efficient "best available technology."

[42] Once an electricity generating plant is built, its investment costs have been "sunk" and thus we must pay only operating costs going forward. Closing down such a plant before the end of its lifetime (typically in the order of 40 years for fossil fuel and nuclear plants) is an expensive option—hence we become locked in to the current plant. Countries' targets for moving to a de-carbonized electricity sector tend to use 2050 as their target year.

The debate around which coal abatement options should be supported is contentious. One school of thought argues that any support for coal generation ties the world into coal going forward, and should thus be ineligible. The alternative viewpoint is that coal is plentiful and cheap in many countries and will be used so we should encourage its use to be as clean as possible.[43]

Figure 9 shows the electricity generation mix in 2006 for regions of developing countries and for the world. Latin American generation is dominated by hydro and thus offers little potential for reduction from the existing mix.[44] No other developing country region has a hydro share greater than 20 per cent, and nuclear's share is in the range 0-4 per cent in all regions. Oil generation uses heavy fuel oil with many similar issues as those regarding coal (relatively low efficiency, and relatively high emissions of sulphur oxides and other gaseous pollutants). In Africa, Asia and particularly in China, reducing emissions from coal is a major opportunity. In the Middle East, there is significant potential for moving out of oil into gas.

Figure 9: Electricity Generation Mix by Region, 2006



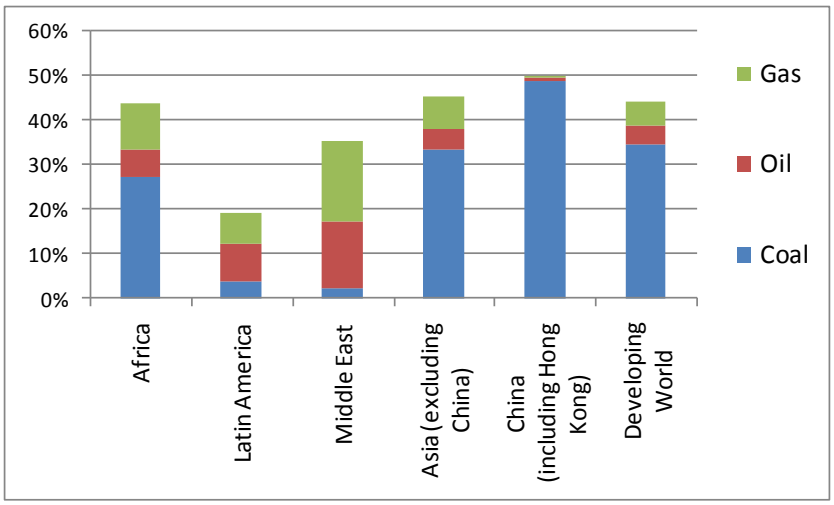
Source: IEA, 2008.

Figure 8 showed that the importance of emissions from the electricity sector within a country's overall emissions when fuel combustion is high. Figure 10 illustrates the issue by fuel. The Chinese electricity sector contributed half of China's emissions in 2006, almost entirely from coal; coal contributes 25-35 per cent of overall emissions in the rest of Asia and in Africa. Latin American and Middle Eastern emissions from coal-fired electricity generation are less than 5 per cent. Therefore, reducing emissions from oil and gas use in electricity generation is the key action.

[43] There are many understandings of what is meant by "clean" coal. In this case, we are simply stating that the efficiency of generation is as high as is possible. The most efficient new coal plant may approach 50 per cent efficiency in the near future, compared to efficiencies of 30-40 per cent for the vast majority of existing plants. The potential for reductions by efficiency improvement is thus in the range 20-40 per cent of emissions, if all existing coal plants were refurbished to the standards of the best available technology and all new plants were built using best available technology. Even in this case, CO_2 emissions per unit of electricity generation would still be around 50 per cent higher than those from natural gas Combined Cycle Gas Turbine (CCGT) plants.

[44] Many countries are finding it difficult to maintain their hydro shares as they expand the capacity of their electricity systems. In this case, the mix of new plants built represents an opportunity to reduce emissions.

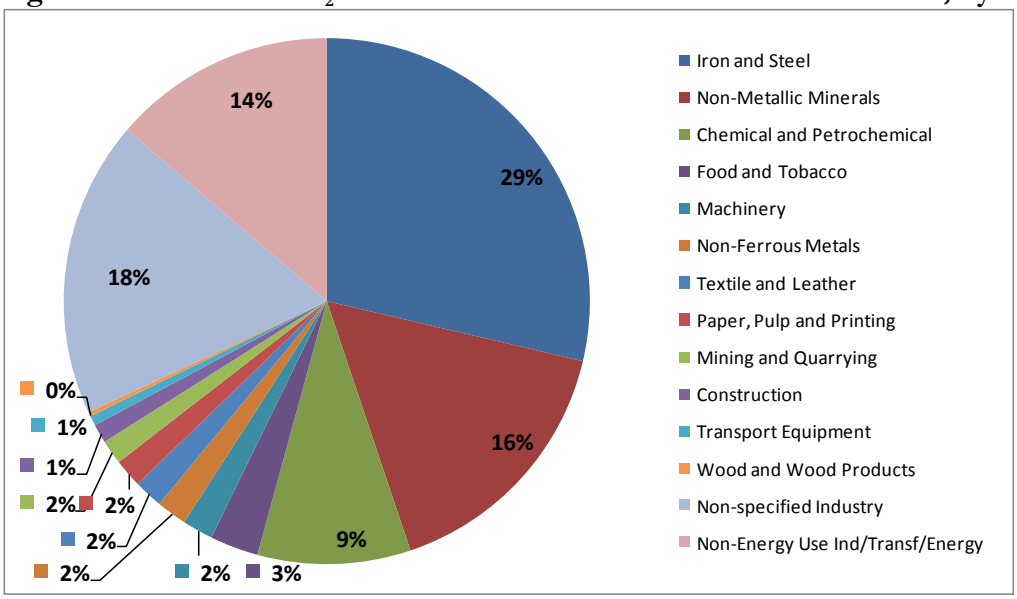
Figure 10: Electricity Share of CO_2 Emissions from Fuel Combustion by Region, 2006



Source: IEA, 2008.

Industrial CO_2 emissions by industrial sector were shown to be 26 per cent of the non-Annex I total in Figure 8. Figure 11 shows that one subsector—iron and steel—accounted for over a quarter of emissions in 2006 and a further two subsectors—non-metallic minerals and chemical and petrochemical—a further quarter of emissions. While there are significant differences between the shares of subsectors to the economy in different countries, it is clear that including these three subsectors in carbon markets is essential if industry's potential contribution is to be fully accessed.

Figure 11: Industrial CO_2 Emissions from non-Annex I Countries 2006, by Subsector



Source: IEA, 2008.

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