CLIMATE CHANGE IN LATIN AMERICA AND THE CARIBBEAN

A REVIEW OF THE BONN AND MARRAKECH DECISIONS AND THEIR EFFECT ON THE CLEAN DEVELOPMENT MECHANISM OF THE KYOTO PROTOCOL

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WORKING PAPER

This working paper is being published with the sole objective of contributing to the debate on a topic of importance to the region and to elicit comments and suggestions from interested parties. The paper has not gone through the Department's peer review process or undergone consideration by the SDS Management Team. As such, it does not represent the official position of the Inter-American Development Bank. Please direct your comments to Gil Nolet, Environment Division, 1300 New York Avenue W0500, Washington, D.C., 20577, gilbertn@iadb.org.

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The views and opinions expressed herein are those of the author and do not necessarily reflect the official position of the Inter-American Development Bank or the other organizations mentioned in this report.

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Glossary of abbreviations

AAUs	*Assigned Amount Units*
AERs	*Additional Emission Reductions*
AIJ	*Activities Implemented Jointly*
AfDB	*African Development Bank*
AsDB	*Asian Development Bank*
BAU	*Business as Usual*
CAF	*Coorporación Andina de Fomento*
CDM	*Clean Development Mechanism*
CERs	*Certified Emission Reductions*
CERUPT	*Certified Emission Reduction Unit Procurement Tender*
CH_4	*Methane*
CO_2	*Carbon dioxide*
CO_2	*Carbon dioxide equivalent*
COP	*Conference of the Parties*
CPR	*Commitment Period Reserve*
EB	*Executive Body*
EBRD	*European Bank for Reconstruction and Development*
ERPA	*Emission Reduction Purchase Agreement*
ERUs	*Emission Reduction Units*
ERUPT	*Emission Reduction Unit Procurement Tender*
FAO	*Food and Agricultural Organization*
GEF	*Global Environment Facility*
GHG	*Greenhouse Gases*
IDB	*Inter-American Development Bank*
IFAD	*International Fund for Agricultural Development*
IFC	*International Financial Corporation*
IPCC	*Intergovernmental Panel on Climate Change*
IET	*International Emissions Trading*
JI	*Joint Implementation*
N_2O	*Nitrous Oxide*
NSS	*National Strategy Study*
ODA	*Official Development Assistance*
PCF	*Prototype Carbon Fund of the World Bank*
PCN	*Project Concept Note*
PIN	*Project Idea Note*
RMUs	*Removal Units*
UNFCCC	*United Nations Framework Convention on Climate Change*

UNEP	*United Nations Environmental Program*
UNIDO	*United Nations Industrial Development Organization*
VERs	*Verified Emission Reductions*
VROM	*Dutch Ministry of the Environment*

Executive Summary

This document presents a literature overview of recent climate change developments, in particular with regards to carbon markets under the Clean Development Mechanism (CDM).

To assist Annex I countries achieve compliance in a cost-effectively manner, the Kyoto Protocol allows the use of different market-based instruments of which the Clean Development Mechanism (CDM) is the only mechanism that involves developing countries. It allows Annex I countries to invest in projects that reduce GHG emissions in developing countries, and use the CERs accruing from such projects to contribute to compliance with their emissions target.

Parties to the United Nations Framework Convention on Climate Change (UNFCCC) attained a political agreement in Bonn during COP6bis in July 2001. Subsequently, the Marrakech Accord (COP7) formalized the political agreements made in Bonn, defining the operational rules and modalities for the implementation of the Kyoto Protocol. These operational rules and modalities include: no-supplementarity condition, eligibility criteria to participate in the flexible mechanisms, sinks and the creation of a new Removal Unit (RMU), banking of credits, creation of three new funds to assist developing countries, the operating rules for the flexible Mechanisms (IET, JI, and CDM), and the compliance regime which started defining its shape, although the legal status is still pending until after the ratification of Kyoto.

With regard to the Clean Development Mechanism, Parties in Bonn and Marrakech agreed on several issues including that: "investment additionality" will not be considered as a necessary condition for CDM projects; Annex I Parties must refrain from using CERs generated from nuclear power; sinks are accepted under the CDM, but limited to afforestation and reforestation; and CDM projects are to be validated, and reductions verified and certified by designated operational entities, to be design by the EB (EB members where recently elected during COP7).

The Kyoto Protocol is expected to enter into force by the end of 2002 due to the agreements reached in Bonn and Marrakech during COP6bis and COP7, respectively. Although there is no formal market for carbon credit, several transactions have taken place. In these cases, the price of carbon credits has been determined by the vintage,

location of reductions, and the likelihood that the reductions will earn future recognition. The most comprehensive record of GHG emissions transactions has been assembled in a report prepared by Natsource for the Prototype Carbon Fund Plus. Market data indicates that the prevailing price in the market is in the range of US$14-44.4/tonC for government-issued permits, while the price for CERs is only in the range of US$6.5-11.1/tonC for CERs.

In addition, there are several theoretical studies that try to estimate the size of the carbon credit market and the price of the credits under different assumptions and scenarios. In the case of theoretical studies, carbon credits are considered absolutely fungible regardless of their origin (CERs, ERUs, or AAUs), therefore for each scenario and set of assumptions the estimated price of carbon credit is only one. Results differ substantially based on the assumptions and scenarios used in each model such as projection on population, economic growth, carbon-intensity of energy consumption and production, technology level, and assumptions regarding economies of scale of alternative energy sources.

In general, the theoretical models could be divided into two groups. The first group corresponds to earlier studies done prior to any of the most recent events which are expected to have a great impact on the carbon market i.e., the withdrawal of the USA and the agreements reached in Bonn and Marrakech. Under a trading scenario, prices would fluctuate between US$9.6 to US$215/tC. Among this group of studies, only some of them specifically examine the size of the CDM. According to this sub-group of studies, carbon credits from CDM will satisfy between 10 and 55 percent of the total market (including domestic action), which equals to between 144 and 723 MtC. Carbon prices will be in the range of US$9.6-36.7 t/C, and the total market value of CDM credits will be US$2.8-21 billion.

The second group corresponds to more recent studies that include some of the aforementioned events into their models i.e., USA withdrawal and the agreements reached in Bonn and Marrakech. This group of theoretical studies provides several new estimates of the future price of carbon credits, although less analysis of the effects on the CDM market. According to a study by Gruetter (2002) (the only study in this group that estimates the potential size of the CDM market), the US withdrawal reduces the CDM market size from previous estimates of US$2.8-21 billion to a range from zero to US$0.8 billion. The same

study shows that the carbon credit price would range from zero to US$7/tC when the US is absent from trading (Gruetter 2002).

Under the present scenario, developing countries are not expected to play a major role in the carbon credit market unless: (a) "hot air" suppliers (Russia and Ukraine) and/or China (the largest and cheapest seller of CERs) form a cartel; (b) Russia and Ukraine become ineligible for participating in the trading system; and (c) demand for hot air is less than expected.

Introduction

The objective of this document is to present an overview of recent climate change developments, in particular with regards to carbon markets under the Clean Development Mechanism (CDM). The document is divided into three sections. The first section describes the history of the climate change negotiations. Section two presents an overview of the recent decisions adopted at the last international meetings (Bonn Agreements and Marrakech Accord), which have improved the odds of ratification of the Kyoto Protocol by 2002. The third section analyzes the carbon credit market. The first part of this section briefly presents the available information regarding real carbon credit transactions, while the second section focuses on the literature review of several theoretical models and presents the theoretical estimates of the price and size of the carbon market.

I. Description of Kyoto Protocol, CDM, and other UNFCCC related and relevant agreements

One of the main results of the 1992 Rio de Janeiro Earth Summit was the adoption of the United Nations Framework Convention on Climate Change (UNFCC), which provides the overall policy framework for addressing climate change. The UNFCCC entered into force in 1994 and was designed to address the concerns expressed by the Intergovernmental Panel on Climate Change (IPCC)[1] regarding a rapidly rising global temperature, as the result of increased accumulation of carbon dioxide equivalent greenhouse gases (GHG) in the atmosphere caused by excessive human-induced emissions. The above normal, and uncertain, rise in temperature could produce serious consequences on land and water systems threatening human life.

Parties to the convention agreed to a set of commitments and established an ongoing framework for reviewing progress and updating their obligations through regular meetings of the Conference of the Parties (COP).

In 1997, during the third Conference of the Parties (COP3), more than 150 countries adopted the Kyoto Protocol to the UNFCCC. Kyoto strengthens the commitments of industrialized countries and countries with economies in transition (Annex I countries[2]) to reduce human-induced carbon emissions by specifying their (CO_2equivalent or CO_2e)[3] quantified emission limitations relative to their 1990 emission levels to be accomplished during the first commitment period (2008-2012)[4]. The overall emission reduction targets a 5% average reduction compared to 1990's levels. Compared to business as usual projections,

[1] The IPCC was established in 1988 by the World Meteorological Organization (WMO) and the United Nations Environmental Program (UNEP). Its purpose is to assess scientific, technical and socioeconomic information relevant to understanding the risks associated with human-induced climate change. Its current structure includes three working groups and a Task Force on National GHG Inventories: Working Group I addresses the scientific aspects of the climate system and climate change; Working Group II addresses the scientific, technical, environmental, economic and social aspects of the vulnerability to climate change, and the impacts for ecological systems, socioeconomic sectors and human health, with an emphasis on regional sectoral and cross-sectoral issues; Working Group III assesses scientific, technical, environmental, economic and social aspects of the mitigation of climate change.

[2] Refers to Annex I of the UNFCCC which includes developed, former Soviet Union and Eastern European countries.

[3] Kyoto include six GHGs: Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs), and Sulphur hexafluoride (SF6). The IPCC has defined, for all of these gases, an equivalent conversion to CO_2 depending on their Global Warming Potential.

however, the targets are even more challenging, and therefore could stimulate demand for cost-efficient emission reductions in a wide variety of sectors such as power generation, waste management, and transportation.

With the objective to assist Annex I countries achieve compliance in a cost-effectively manner, Kyoto allows the use of market-based instruments. It introduces a framework for International Emissions Trading (IET) of assigned amount units (AAUs)[5], and two additional flexible mechanisms: (1) purchase of ERUs (emission reduction units) obtained through JI (joint implementation) projects within Annex I countries; and (2) purchase of CERs (Certified Emission Reductions) from developing countries through the CDM. The basic idea of JI and CDM refers to the possibility of producing abroad and/or importing the emission reductions needed, in addition to local reductions, to comply with Kyoto. JI refers to international projects aimed at reducing greenhouse gas emissions in Annex I countries, whereas international emission-reduction projects under the CDM are hosted by developing countries.

The CDM is the only mechanism that involves developing countries. Its purpose is to assist developing countries to achieve sustainable development, while being a cost effective means to help Annex I countries achieve Kyoto's target. It allows Annex I countries to invest in projects that reduce GHG emissions in developing countries, and use the CERs accruing from such projects to contribute to compliance with their emissions target. CDM projects must create real, measurable, and long-term benefits related to the mitigation of climate change, and emission reduction should be "additional" to any that would have occurred in the absence of the certified project activity.

Four different types of additionalities have been identified -- environmental, financial, investment, and technological -- but, in fact, only the first two (environmental and financial) are relevant for current CDM discussions. "Environmental" additionality refers to emission reductions being additional to business as usual emission reductions (baseline scenario), while "financial" additionality refers to CDM funding being additional to Official Development Assistance (ODA).

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[4] Quantified emission limitations and reduction commitments of Annex I countries are inscribed in Annex B of the Kyoto Protocol, which is the reason why the literature also refers to Annex B countries. Annex B, however, does not include Turkey and Belarus.

[5] AAUs refer to the level of GHG emissions each Annex I country is allowed to emit according to Annex B of the Kyoto Protocol.

In addition to the CDM, the Kyoto Protocol will also indirectly affect developing countries as a consequence of change in relative prices of energy and high-emission outputs[6]. Annex B GHG emissions restriction is projected to have significant impacts on industry output in developing countries[7]. Developing countries are expected to increase carbon emissions as a result from carbon leakage related to the drop in price of fossil fuels and are also expected to experience changes in the growth of real GDP.[8]

The Protocol has yet to enter into force and continues to have unresolved issues. Yet, it provides a framework for future discussion and negotiations. Kyoto requires the ratification of at least 55 Parties to the Convention, including Annex I Parties, which account in total for at least 55% of total CO_2e emissions for 1990 from that group to enter into force. Despite the withdrawal of the U.S. from negotiations (March 2001) -- the U.S. represents 25% of 1990 emissions from Annex I countries --, Kyoto is expected to enter into force by 2002.

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[6] According to Polidano et. al. (2000) the net impact on any developing country will depend on its particular production and trade structure. They estimated the indirect economic impacts on developing countries of the Protocol's GHG restrictions on Annex B countries. Negative effects include lower fossil fuel export earnings (included in the group of affected countries are Colombia and Venezuela) resulting from lower world prices and lower export volumes to Annex B countries, and higher import prices for energy intensive goods. Positive effects include increases in the export competitiveness of non-Annex B producers of energy goods (including Brazil) and associated increases in investment levels.

[7] These effects can be broadly grouped into impacts on energy intensive products, fossil fuels and agriculture. The largest production impacts on energy intensive sectors are projected to be on iron and steel and nonferrous metals because these commodities are the most energy intensive and are widely exported to Annex B countries; Brazil production would increase between 2 and 7 per cent relative to the reference case. Among fossil fuels, coal production in developing countries is projected to be the most affected followed by oil production; gas production is projected to increase in countries that use most of their production domestically, such as Mexico, while it is projected to fall in regions that export a relatively large share of production to Annex B countries.

[8] See Hagem and Holtsmark, 2001 and Jakeman et al., (2001). The shift of production and emissions from developed to developing countries illustrates the leakage effect, which is projected to be 14% in 2010 in a no-trading scenario, and 8% in an emissions trading scenario. Under a scenario that also considered the CDM, leakage rates are projected to be around 6.5% in 2015 for non-Annex B countries. In general, indirect effects are much bigger under a no-trade scenario. Real GNP (in 2010) relative to the reference case (no Kyoto) should increase for developing countries as a whole, but should have the opposite effect on Annex B countries. Among Latin American countries the worst real GNP impacts would be faced by Venezuela and Colombia, which rely heavily on fossil fuel exports; Argentina and Mexico would face both positive and negative impacts, but on the whole their real GNP impact would be relatively small; while Brazil, which relies more heavily on energy intensive exports to Annex B countries would face a relative increase in real GNP.

The U.S. administration under President Bush has recently (February 2002) announced an alternative approach to the Kyoto Protocol, which relies on voluntary participation to slow, but not halt the growth of emissions of GHG. The administration has proposed a "carbon intensity target" by which the USA will cut GHG intensity (emissions for every dollar of GDP) by 18% over the next 10 years.

II. The Bonn Agreement and the Marrakech Accord

Parties to the UNFCCC attained a political agreement in Bonn during COP6bis in July 2001 that could facilitate the ratification of the Kyoto Protocol. Subsequently, the Marrakech Accord (COP7) formalized the political agreements made in Bonn, defining the operational rules and modalities for the implementation of the Kyoto Protocol. These operational rules and modalities include:

- ✓ *No-Supplementarity condition*: countries are not obliged to attain a minimum emission reduction with local abatement measures. Instead, they can achieve their Kyoto targets by simply buying all the emission reduction requirements in the market, increasing the demand for credits. Furthermore the fungibility of AAUs, ERUs, and CERs was accepted.
- ✓ *Eligibility criteria to participate in the flexible mechanisms*. Annex I countries will be eligible to participate in the flexible mechanisms depending on several conditions as the acceptance to abide by the compliance regime of the Protocol, and to annually report on sink activities[9]. Although Russia and Ukraine may have strong incentives to ratify the Protocol, it is still uncertain whether these two countries will fulfill the conditions to be eligible to participate in international trading, therefore to sell their "hot-air".
- ✓ *Operating rules for the flexible Mechanisms (IET, JI, and CDM)*:
- ▪ *International Emissions Trading (IET)*: Parties will be allowed to trade only if they:
  - Maintain in its national registry a list of legal entities authorized to trade.

[9] The eligibility criteria also require Annex I countries to be a Party to the Kyoto Protocol; to have established its assigned amount; to have a national system for estimation of emissions and removals; to have a national registry; to have submitted the most recent required annual inventory for emissions and removals; and to submit and required supplementary information on assigned amount.

- Keep a Commitment Period Reserve (CPR) equal to the lowest between 90% of a Party's assigned amount or 5 times its most recent inventory. CPR calculations must include ERUs, CERs, AAUs and RMUs[10].

- *Joint Implementation:* Only credits generated after 2008 will be eligible ERUs under JI projects. Annex I Parties are to refrain from using ERUs generated from nuclear power, and Host Party government has prerogative to decide if a JI project achieves sustainable development. Standards and procedures for activities such as accreditation, criteria for baselines, additionality, monitoring, and verification are in general similar to those for the CDM. Other JI rules and modalities include:
  - Creation of a "two-track system" depending whether the host country has fulfilled the eligibility criteria[11].
  - Establishment of a Supervisory Committee to supervise, inter alias, the verification of ERUs.
  - The Supervisor Committee must accredit independent entities responsible for activities such as project validation, monitoring, verification of reductions and removals.
- *The Clean Development Mechanism:* During COP7 Parties selected the CDM Executive Board (EB), which will be responsible for defining the procedures and rules, as well as solving the many uncertainties surrounding the CDM[12]. Other important rules are:
  - The Bonn Agreement does not include "investment additionality" as a condition for CDM projects. Such an additionality requirement would have limited the CDM to marginal projects, i.e. those that only become financially viable with the addition of carbon credit sales. Several sources had indicated that such a restriction would impede the development of the CDM mechanism[13].

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[10] Removal Units (RMUs). Explained in the main text further below.

[11] Track 1 will apply when the host party meets the eligibility requirements to use the mechanisms and may then verify reductions/removals as being additional and issue emission reduction units. Track 2 will apply when a host party does not meet eligibility requirements. In this case, verification will be through the Article 6 verification committee.

[12] As for examples guidance for baseline determination and forestry projects, and selection of Operational Entities (responsible for validation, verification, and certifications of CERs).

[13] According to the opinion of experts from the PCF, NGOs and Private Funds, the benefit of carbon sales at current prices would generally have a positive effect of 100 to 200 basis points increase on the internal rate of return (IRR) of a project. According to a case study done by British Petroleum, the effect on the IRR was almost negligible for most of the projects (10-40 basis point increase) with the exception of a couple of new power generation projects in China and Brazil (in the case of Brazil subject to the baseline) which showed an

- Host Party government has the prerogative to decide whether a CDM project achieves sustainable development.
- Annex I Parties are to refrain from using CERs generated from nuclear power.
- Sinks are accepted under the CDM, but limited to afforestation and reforestation. In addition, for the first commitment period, Annex I countries are not allowed to acquire CDM sink credits equivalent to more than 1% of their 1990 emissions, times five.
- CDM projects that started in any period from 2000 until prior to the Marrakech accord will be eligible for credits if submitted for registration before December 31st, 2005. Any other CDM projects will be eligible for credits only after the date of project registration.
- A non-Annex I Party can participate in the CDM only if it is a Party to the Protocol.
- Parties using the CDM are to designate a national authority for this purpose.
- CDM projects are to be validated, and reductions verified and certified by designated operational entities, to be design by the EB.
- CERs are to be issued by the CDM registry administrator working under the authority of the EB.
- CERs are transferable between national registries (fungibility).

✓ *Sinks under articles 3.3 & 3.4 of the Protocol and the creation of a new Removal Unit (RMU).*

- The Bonn agreements allocated additional credits generated from domestic forestry[14] and cropland management activities for Annex I countries for the first commitment period under article 3.4 of Kyoto[15], which allowed for the future

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increase of 120 to 380 basis point as a function of the price per ton of CO_2 which ranged from 5-20US$ ($18.5-74/tC). In this last case, the lower effect (120 basis point) should even be considered as a cap given that the current market price for CERs goes below 5US$/t CO_2 ($18.5/tC). Some more examples are available in the document by Goldemberg et al.(1999).

[14] Kyoto had already assigned credits from certain forestry activities to Annex I countries. According to article 3.3 of Kyoto, changes in GHG emissions resulting from human-induced changes in deforestation, reforestation, and afforestaton- undertaken since 1990, should be considered by Annex I countries in the calculations of their GHG emission targets.

[15] Additions to and subtractions from the assigned amount units of an Annex I Party resulting from forest and cropland management under article 3.4 and article 6 (JI), shall not exceed the values inscribed in Annex Z of the Bonn Agreement.

inclusion of GHG removals by sinks from the agricultural soil, and additional land-use change and forestry categories.

- Land use and land use change and forestry activities of Parties shall not exceed the value inscribed in Appendix Z to the Bonn Agreement[16].
- Russia's cap on sinks activities under additional forestry activities (article 3.4 of Kyoto) increased to almost twice the amount allocated in Bonn (from 17.63 to 33 million tons of carbon annually).
- Creation of a new "Removal Unit" (RMUs) to represent all sinks credits generated in Annex I countries, including those obtained from JI projects.
- RMUs are part of a Party's assigned amount and can be traded or used to comply with a Party's commitment.

✓ *Banking of credits.* Carbon credits can be carried-over to future commitment periods under the following conditions:

- A Party can carry over valid ERUs held in its national registry (which have not been converted from RMUs) up to a maximum of 2.5% of its assigned amount.
- A Party can carry over valid CERs held in its national registry up to a maximum of 2.5% of its assigned amount.
- A Party can carry over valid AAUs held in its national registry.
- RMUs cannot be carried over to the subsequent commitment period.

Banking will play a major role in the carbon market because it could avoid a price collapse by restricting supply. The extent of banking will be determined by forced-banking (in the case on non-eligibility); expectation of future prices during future commitment periods[17]; and price manipulations by a cartel.

✓ *Funding issues*: All countries recognized the need of new contributions for the implementation of the Convention and agreed on a special climate change fund under the UNFCCC (to boost existing financing available under the Global Environment

[16] Credits from re-vegetation, and cropland and grazing land management are provided through a menu approach, allowing parties to select the activities to be included. These activities are to be accounted for as total emissions and removals in the commitment period less five times the total emissions and removals in the base year. Up to 8.2 million tones of carbon can be claimed to offset any debit under Article 3.3, and each party can claim further credits from forest management under JI and Article 3.4 up to the cap specified in the Appendix Z of the Bonn Agreement.

[17] Future prices will depend on new global emission reduction targets, and the potential participation of the USA and developing countries in international emissions trading in a second commitment period.

Facility – GEF – climate change focal areas as well as other bilateral and multilateral activities), and indicated that new sources of funding shall be made available to developing countries. A Least Developed Countries Fund (from voluntary contributions) will be established to develop National Adaptation Programs of Action (NAPA). Finally, there will be a specific Kyoto Protocol "Adaptation Fund" to help developing countries finance adaptation (to climate change) projects – which will be partly funded by a levy on CDM projects of 2% of the CERs generated.

- ✓ *The Compliance Regime* started defining its shape, although the legal status is still pending until after the ratification of Kyoto. Countries not fulfilling their commitment shall restore carbon tons at a rate of 1.3 to 1; will be suspended from the market; and will need to develop a compliance action plan.

It is interesting to note that the negotiating power and role that each group of countries played during the last COP meetings. Three different geographical groups could be distinguished at Bonn and Marrakech:

(i) The Umbrella group -Australia, Japan, Russia, and Canada- indicated that they would oppose a treaty that did not include the United States. Based on its bargaining power –no ratification of Kyoto would be possible without any member- they demanded further concessions than the ones granted by Bonn, such as the doubling of Russia's sink credits.

(ii) The European Union took the lead in foreign policy, and made an effort to keep the Kyoto process going on. The EU was the group that argued to limit the number of carbon credits accrued from CDM projects in sinks to 1% of base-year emission times five, as well as to exclude conservation from CDM forestry projects.

(iii) The G-77/China pushed in favor of the creation of new funds to aid developing countries, as well as to limit on banking of CERs and RMUs

III. The Carbon Credit Market[18]

Although there is no formal market for carbon credit, several transactions have taken place. In these cases the price of carbon credits has been determined by the vintage, location of reductions, and the likelihood that the reductions will earn future recognition. In addition, there are several theoretical studies that try to estimate the size of the carbon credit market and the price of the credits under different assumptions and scenarios. In the case of theoretical studies, carbon credits are considered absolutely fungible regardless of their origin (CERs, ERUs, or AAUs), therefore for each scenario and set of assumptions the estimated price of carbon credit is only one.

The first part of this section briefly presents the available information regarding real carbon credit transactions, while the second sections focuses on the literature review of several theoretical models and presents the theoretical estimates of the price and size of the carbon market. Both sub-sections also present specific information on the CDM. At the end of the document there are a group of tables that summarize the numbers presented in this section. Table 1 presents a summary of the GHG transactions; table 2 presents several estimates of the emission reduction required by Annex I countries; table 3 present the market size and price estimates of several theoretical models; table 4 presents the theoretical estimates of the CDM market; and table 5 present the most recent theoretical estimates of the carbon market after considering the withdrawal of the US and some of the decisions taken at Bonn and Marrakech.

III.1 Current Transactions:

The carbon credit market is just emerging so the number of transactions is still very restricted and not much information is available. The most comprehensive record of GHG emissions transactions has been assembled in a report prepared by Natsource for the Prototype Carbon Fund Plus of which only the executive summary is available. The GHG market data summary is presented in table 1. No detailed information regarding CERs that would allow us to identify the type of projects and host countries was available in the report's executive summary.

[18] Note: the unit used for presentation is ton of Carbon which is equivalent to approximately 3,7 tons of CO_2.

Market data indicates that the prevailing price in the market is in the range of US$14-44.4/tonC for government-issued permits, while the price for CERs is only in the range of US$6.5-11.1/tonC for CERs.[19]

III.2 Literature Review on Future Carbon Credit Market:

There is a broad theoretical literature addressing issues related to the future market of carbon credits, such as average estimations of the future price of carbon credits, size of the future carbon emissions reduction market (both in market value and market size), size of the flexible mechanisms including the CDM, and the economic impacts of the Protocol (GDP growth, trade, output of energy-intensive industries, etc.).

Results differ substantially based on the assumptions and scenarios used in each model (see Annex 1 for a general description of models used in the literature). A key factor in these models is the determination of the emissions reduction requirement of Annex I countries[20], which is a function of several economic and institutional variables such as projection on population, economic growth, carbon-intensity of energy consumption and production, technology level, and assumptions regarding economies of scale of alternative energy sources[21]. Table 2 presents a survey of several estimates of required emission reductions for different groups of countries.

Furthermore, these theoretical models could be divided into two groups. The first group corresponds to earlier studies done prior to any of the most recent events which are expected to have a great impact on the carbon market i.e., the withdrawal of the USA and

[19] A recent study of the University of St. Gallen presents a revised GHG price expectation by surveying existing theoretical price forecast and considering additional sources of information that may shed light on the accuracy of these forecast such as real price data from the emerging GHG market and lessons learned from previous attempts to model emission market behavior (SO_2 market in the US). This study based their results according to current market conditions, basically the development of the UK and EU trading systems in the first place and the Kyoto protocol in the second place. According to their results during the period 2000-4 the voluntary nature of the UK trading system is likely to keep the price of government-issued permits at or below current market valuations of approximately US$26/tonC; the EU-wide trading program, its voluntary nature, and additional supply from abroad, if international trading rules are agreed on, might determine a price below US$37/tonC for the period 2005-7; the absence of the US during the first commitment period 2008-12 will likely determine that the price for this period will remain at the same levels that the previous period.

[20] Estimation of the emissions reduction needed by Annex B countries during the first commitment period is between 600 and 1300 MtC for all GHG. These estimates depend on the projection of the Business as Usual (BAU) scenario, which refers to the scenario of projected emissions if the Kyoto Protocol would not be implemented, of each one of these countries.

[21] Other variables include: labor productivity, employment level, income effects, capital substitution, fluctuation in exchange rates, diffusion of technological innovation, inclusion of various carbon-based gases, timeframe or forecast periods, and economic behavior.

the agreements reached in Bonn and Marrakech into the calculation in their models. The second group corresponds to more recent studies that include some of these aforementioned events into their models. Many of these recent studies also address other unknowns, such as the possibility of monopolistic behavior of the Former Soviet Union and Eastern Europe with "hot air"[22], or of China with CERs.

Table 3 provides a summary of several market estimations for the group of studies prior to the withdrawal of the US and the Bonn/Marrakech agreements. Under a trading scenario prices would fluctuate between US$9.6 to US$215/tC. This range of results depends on the different assumptions made in each model (e.g., baseline calculations, participant, and sectors included).

Among this first group of studies, only some of them specifically examine the size of the CDM. According to this sub-group of studies, carbon credits from CDM will satisfy between 10 and 55 percent of the total market (including domestic action), which equals to between 144 and 723 MtC[23]. Carbon prices will be in the range of US$9.6-36.7 t/C, and the total market value of CDM credits will be US$2.8-21 billion[24]. Table 4 presents a summary of the results[25]. A more realistic number for the size of the CDM market could also be the number of CDM projects contained in the Activities Implemented Jointly (AIJ) program of

[22] Annex B of the Kyoto Protocol, assigns Russia an emission reduction target for the first commitment period that is higher than any of the business as usual projection of emission for 2010. As a result of this, Russia will achieve compliance without any effort and sell the additional AAUs (hot air). There is no clarity regarding the quantity of credits that Russia will sell during the first commitment period.

[23] Vrolijk (1999) also proposes an alternative and simple analysis to estimate the size of the CDM market. Based on the Dutch's CDM budget decision, and the share of emissions of the Netherlands relative to the total emissions of industrialized countries, indicated that the potential market value of the CDM could be about US$2.5 billion per year.

[24] Most of these models simply assume that CDM projects take the price of carbon credits as given, and from that assumption they derive the size of the market. Therefore, they do not take into account the actual dynamics of the market. One model that attempted to capture the dynamics of the market was done by the US Administration study of the impacts of the Kyoto Protocol on the US Economy. Vrolijk (1999) based on this findings, also calculated that CDM investments were estimated to range between 6.86 to 4.14 US$ billion (it is worth noting here that the size of the CDM is given for only one country; the investment of only the US in CDM).

[25] It is interesting to note in table 4 the relevance of the baseline (BAU) estimates. Zhang calculates the CDM market value for the two official EU baseline estimates. When net emissions reduction required by the EU in 2010 rise from 27.9 MtC (low official EU baseline projection) to 234 MtC (high projection), the marginal abatement cost within the EU increases to US$249.9/tC from $9.1/tC (Zhang, 2000). This sharp increase in emissions reduction required by the EU drives up total Annex I countries' demand for CERs. As a result the size of the CDM market increases almost a half from 292 to 421 MtC, and the value of the CDM, increases twice the value from 2.8 to 6.7 billion dollars.

the UNFCCC. By February 2002[26], 70 AIJ projects[27] could eventually lead to investments under the CDM. These projects amount to a total 102 MtC estimated GHG emission reduction or sequestered during the lifetime of the projects[28], more than a third coming from the forestry sector[29]. Annex 2 presents a table of AIJ projects in Latin America.

Given that all three flexible mechanisms can be used, indistinctly, to meet emissions reduction requirements, market forces will mostly determine the share of each one. The main advantage of CERs in this respect is that they can be accrued from 2000 onwards; meanwhile the other mechanisms can only account for credits as from 2008. On the other hand, the fees charged under CDM projects for administrative costs and the adaptation fund will make the CDM less attractive. Still unclear, and quite important for estimating the size of the CDM market, is the extent to which the sustainable development criteria will be applied.

The second group of theoretical studies provides several new estimates of the future price of carbon credits, although less analysis of the effects on the CDM market. According to a study by Gruetter (2002) (the only study in this group that estimates the potential size of the CDM market), the US withdrawal reduces the CDM market size from previous estimates of US$2.8-21 billion (table 2) to a range from zero to US$0.8 billion[30]. The same study shows that the carbon credit price would range from zero to US$7/tC when the US is absent from trading (Gruetter 2002). Table 5 presents a summary of these studies (and their assumptions). It also presents the price and market size estimates of several other studies under different scenarios (e.g., banking of credits, sinks from Annex Z and restricted sale of hot air).

Under the present scenario, developing countries are not expected to play a major role in the carbon credit market unless: (a) "hot air" suppliers (Russia and Ukraine) and/or China (the largest and cheapest seller of CERs) form a cartel; (b) Russia and Ukraine become

[26] Source: AIJ Program, http://www.unfccc.int.
[27] This number includes projects that have been accepted, approved or endorsed by the designated national authorities for AIJ of the Parties concerned.
[28] Lifetime of a project does not necessarily match with the period in which CERs will be eligible under the rules of the Kyoto Protocol. See the section on CDM rules and modalities defined by the Bonn/Marrakech agreement.
[29] According to the rules of sinks under CDM, most of these projects will not generate CERs given that are categorized as forest protection or conservation.
[30] In a review of the most recently literature on carbon markets, Buchner et.al., (2001) indicate that the price of carbon permit could drop between 13.5 up to even 100 per cent compared to previous studies as a consequence of the US withdrawal.

ineligible for participating in the trading system; and (c) demand for hot air[31] is less than expected. According to Gruetter (2002), a 75% restriction of hot air and a 25% restriction of CERs from China would increase the market price to approximately US$ 12/tC and the CDM market size to US$ 1.3 billion. According to a study of Point Carbon, if Russia and Ukraine are not eligible for trading, the market price could increase up to US$ 33.3/tC.

The prospects of voluntary participation of US firms (or even the eventual re-entry of the US in the Kyoto process) have an influence on market prices as well. According to Grüetter (2002), a partial US participation combined with a fairly probable cartelistic situation, could result in a price of carbon credit in the order of US$16/tC. Benefits in terms of export revenues for non-Annex B countries would be in the order of US$3.1 billion[32]. Clearly, market price and the potential benefit of the CDM are now much more sensitive to the scenarios and the assumptions made about the key issues recently negotiated in Bonn/Marrakech, the predictions of monopolistic behavior, and the potential participation of the US.

An innovative approach is provided by Buchner et al. (2001), who examine the technology innovation and knowledge spillover impacts of the US withdrawal. In the presence of endogenous and induced technical change, the US withdrawal would result in higher global emissions from other Annex B countries, which in turn will result in higher demands for credits from these Annex B countries. Therefore, the change in carbon credit price as a consequence of the US withdrawal, would be much smaller than projected by other studies[33].

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[31] According to the PCF, Russia will probably not be able to sell hot air because it has not developed the necessary institutions and because the demand of hot air will be affected by the international opinion. It is well known that hot air does not represent any real reduction of emissions, therefore, the international community will have a better opinion of countries that avoid buying hot air to achieve their commitments.

[32] This scenario assumes that the US reduces emissions by 50% of BAU-Assigned Amounts according to the Kyoto Protocol; Cartel: 50% reduction of volume of "hot air" and 50% implementation rate of China compared with perfect competition.

[33] The role of endogenous technical changes can be seen in several ways. In first place a lower permit price constitutes a smaller incentive to undertake environmental-friendly R&D in all Annex B countries. This would increase domestic emissions and therefore would make it more difficult to meet the Kyoto targets. As a consequence the demand for permits would increase, and the supply from Russia would decrease. Seller countries, and Russia in particular, could react to the US decision not to ratify the Protocol by reducing their Research and Development (R&D) efforts on energy-saving technologies and practices. A second effect goes through the behavior of investments; the lower the total emission abatement induced by the US defection reduces output below its optimal level, therefore the remaining Annex B countries must increase investments to increase output, leading to greater emission in these countries.

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TABLES

Table 1: GHG Emission Transactions

Commodity Type	Vintage Year	Price per ton C (US$)
VERs (verified Emission reduction, no government approval)		
Annex B VERs	1991-2007	2.22-5.55
Annex B VERs	2008-2012	6.1-11.1
CDM VERs	2000-2001	6.5-11.1
Compliance Tools (government approval)		
Dutch ERUs	2008-2012	16.3-29.6
Danish allowances-Mid market bid-offer	Average 2001-2003	14
European ERUs –Indicative Bids	2008-2012	25.9-44.4
Australian Early Action AAUs- Indicative Offers	2008-2012	22.2-44.4
UK permits –Mid market bid-offer	2003	31.3
BP internal allowances – Pilot Phase	1999	37-92.5
BP internal allowances – Full-scale internal trading	2000-2001	1.85-92.5

Data updated on July 1 2001

Prices were originally presented in the report per ton of Carbon dioxide equivalent. Prices presented in this table were approximated (by multiplying by 3.7) to price per ton of carbon.

Table 2: Estimates of Emissions Reduction Required by Annex I Countries in MtC in 2010*

	OECD	USA	Japan	EU	OOE	EET	FSU	Annex B	Annex I
Vrolijk [a]	580-1160						-100/-300	440-830	669
EPPA		666	111	388	122	20	-28		1306
RIIA		461	71	60	58	17	-76		666
Haites									1000
G-Cubed									1102
GREEN									1298
SGM									1053
GTEM		679	79	150	116	-18	-275		1023
Zhang		424	71	28	60	16	-79		621
Cicero (Hagem and Holtsmark) [b]	3.7-12.8 (% from BAU)								

Sources: Kolshus et.al., (2001); Hagem and Holtsmark (2001); Zhang; Grüetter (2001)
OOE: Other OECD countries; EEY: Eastern Europe; FSU: Former Soviet Union.
*Given the differences in the model structures and the baseline emissions paths, the estimates of the total emissions required will differ. The study by Zhang is based on compilation of national communications and is lower than those from economic modeling studies.
a: various sources including: International Energy Outlook 1998, EIA 1998; World Energy Outlook, IEA 1996; European Energy to 2020: A Scenario Approach, EC 1996; National Communications as compiled by Grubb and Vrolijk, EEP Climate Change Briefing, No.11.
b: Emissions reductions required range from 3.7% from BAU in the scenario of emissions trading with the USA to 12.8% from BAU in an scenario without the USA. Emissions for industrialized countries as a whole are expected to increase by 9% from 1990 to the first commitment period (2008-12) under the BAU scenario. The model estimate that global emission reductions during the first commitment period will be about 5.5% 0.9% relative to BAU with and without the USA participation, respectively.

Table 3: Earlier Carbon Market Estimates

	Scenarios	Price ($/tC)[a]	Market size ($billion)	LDCs or CDM market size *
ABARE (in 2010) [j]	Annex B trading	214.6 (US1995)	595 (MtC)	
MIT-EPPA	No trade	See results per region on Annex 1		
	Annex B trading	127		
	Global trading including DCs (US$85)	24		17.4 ($bn/y in 2010) 723 (MtC in 2010)
RICE-98[b]	No Trading	570 (US$1990)		
	Global unrestricted trade	78 (US$1990)		
Manne and Richels (1999), MERGE model [c]	No trading	240 in the US		
	Annex I + CDM	100		
	Global trading including DCs	70		
Mckibben et al. (1999), G-Cubed model (in US$1995)[d]	No trading (average)	170 (US$1995)		
	Global trading including DCs	23 (in 2010 MTC) 27 (in 2020 MTC)	20.4 (in 2010) 52.7 (in 2020)	11.5 ($bn/y) in 2010 (China has 61%) 41.4 ($bn/y) in 2020 (China has 59%)
DNR (1998)[e]	Trade + CDM	55.5		
ACT [f]	Annex II trading	112.5 (in 2010)	16.432 (in 2010)	
	Global trading	80 (in 2010)	17.654 (in 2010)	
White House study [g]	Trading	14-23		
Kurosawa et al. (1999), GRAPE [h]	Annex I trading		26.6 (in 2010) 18 (in 2020) 9.6 (in 2030)	
Zhang (1999) (US$1998)	Annex I trading + CDM	9.6 (in 2010)	5.96 (in 2010) 620 (MtC in 2010)	2.8($bn/y in 2010) 292.1 (MtC in 2010)
Grüetter (2001b)[k] (US$2000)	Full trade	30	24.4	20 (US$bn/y)
	Annex I trading only	148.5	59.8	
	Monopolistic supply	150	60.9	
Grüetter (2001a) [l] (US$2000 in 2010)	"Pronk scenario	17	8.16	3.5
	Free market	21	15.8	9.5
	Restricted buyer market	10	3.3	2.3
	Restricted seller market	171	61.6	11
	"Pronk" scenario/no hot air	30	14.4	8.9
	No US with perfect competition	0-14	0-7	0-5.2
	No US assuming monopoly	0-110	100-300	0-16
Morozova and Stuart (2001) [i], (US$1998)	Domestic Abatement	285	92.4	
	Annex I/JI trading	137	44.5	
	Annex I + CDM	111	18	China: 8 (US$bn/y) India: 2.1 (US$bn) LAC and Africa: 3.4 (US$bn)
	Global Trading (assumes 30% domestic abatement and 70% international trading)	96.5	31.2	China: 9.85 (US$bn) India: 2.62 (US$bn) LAC and Africa: 3.9 (US$bn)
	Diversified Market (50% abatement occurs domestically)	194	63	

Source: Morozova and Stuart (2001); Polidano et.al., (2000); Grüetter (2001a, 2001b); Zhang (1999)

MTC: metric tons (a little bit less than 1 ton)

MtC: million tons of carbon

*The value provided will correspond to CDM market size if CDM is explicitly included in the scenarios column. Otherwise it will correspond to the market size corresponding to the active (trading) participation of developing countries in the global market.

a: All values are expressed in tons of carbon. Calculations were done for values obtained in tons of carbon dioxide (approximately 1 ton Carbon = 3,7tons CO_2).
b: The Regional Integrated Model of Climate and the Economy is an updated version of several Nordhaus' models who was the pioneer on work on the dynamic integrated climate-economy model.
c: MERGE is a market equilibrium model that can combine, for example, the dynamics of the energy supply sector and ancillary domestic economy considerations that could influence demand and prices in an emission reduction market over time, i.e. the value of a region's human and natural capital, labour, and its share of carbon emissions right.
d: G-Cubed is a multi-sector intertemporal general equilibrium model of the world economy. The model consists of a set of 8 regional general equilibrium models linked by international flows of products and assets. The model only accounts for emissions of carbon dioxide. Because the USA has the lowest abatement cost in this model, under certain circumstances, it would be beneficial for the USA to be a carbon permit seller.
e: Dutch National Research Program on Global Air Pollution and Climate Change did a study on flexibility instruments under the Kyoto Protocol. DNR's study assumes optimal trade without market imperfections. The average permit price from a range of estimates is actually US$40/tC.
f: Achieving Commitments by Trading of the Center for International Climate and Environmental Research in Oslo (CICERO). Annex II, differs from Annex I countries, by not including economies in transition and countries added to Annex I amendment pursuant to decision 4/CP.3 adopted at COP3. ACT includes all gases listed in the Kyoto Protocol. Assumptions about BAU emissions in 2010 are based on emission scenarios presented in national communications when it is possible. Starting point for the model is June 1998.. The model assumes that there is not hot air from Eastern European emissions, and the amount of Russian hot air is equal to 167 million tons.
g: The White Hose study uses the Stanford Energy Modelling Forum's results and Battelle's Second generation Model. According to this study the CDM would cut costs by 20-25%.
h: GRAPE is an example of a model that relies foremost on modelling the energy sector while taking a more aggregate approach while representing the rest of the economy. For more details see Kurosawa et. al., Energy Journal 1999.
i: Estimates from over a dozen studies were averaged, controlling for differing assumptions about factors in the BAU estimations. Nearly half the capital flows to China ($9.85 billions), FSU ($5.47bn), and India ($2.62). The value on the third column for the scenario of Annex I+CDM assumes 50% of total share of global trade at 15% per ton average fee.
Several of theses and other studies contribute to the issue of constrained flexible mechanisms, but these results are not presented given that supplementarity is not an issue anymore according to Bonn/Marrakech agreement.
j: Annex 1 provides a summary of the ABARE-GTEM model.
k: Grüetter consulting developed the CERT model, which is not a general equilibrium model but a "meta-model" with uses inputs (BAU, Marginal abatement Cost curves) from other models. These results were obtained by using CERT version 1.1. and are the average values between GTEM all GHG and EPPA CO_2 only. The full trade scenario includes all countries. Values in each category vary as a result of different BAU and marginal cost curves utilized.
l: Grüetter consulting developed the CERT model, which is not a general equilibrium model but a "meta-model" with uses inputs (BAU, Marginal abatement Cost curves) from other models. These results were obtained by using CERT version 1.1. and are the average values between GTEM all GHG and EPPA CO_2 only. ***"****Pronk" scenario*: includes 50% supplementarity, 120 MtC 0-cost sinks, 2% adaptation fund, 1% convention fund, 70% commitment period reserve, 3 US$ transaction costs, no monopoly. *Free market*: 100% hot air sold, 100% implementation CERs, 120 MtC 0-cost sinks, no supplementarity, 3US$ transaction costs, no convention fund, no adaptation fund, no commitment period reserve, no monopoly. *Restricted buyer marker*: No sale of hot air, 100% implementation of CERs, 70% domestic reduction, 3US$ transaction cost, no 0-cost sinks, 2% adaptation fund, 1% convention fund, 70% commitment period reserve, no monopoly. *Restricted seller market*: full trading of hot air, 30% implementaion of CERs, no supplementarity, 3US$ transaction cost, no 0-cost sinks, no adapatation fund, no convention fund, no commitment period reserve, monopoly. *No US perfect competition*: no participation of the US, 2% CERs into the adaptation Fund, 0-cost sinks according to Appendix Z of Bonn, no supplementarity, full "hot air" trading, no impact of commitment period reserve, 0 transaction cost, 100% implementation rate of CDM, convention fund financed not through GHG market. *No US with assuming monopoly*: identical to previous scenario but assuming monopolistic behavior of sellers. Values in each category vary as a result of different BAU and marginal cost curves utilized.

Table 4: Previous Estimates of the CDM Market in 2010[34]

Model	Market Share (%)	Market Size (MtC)	Market price (US$/tC)	Market Value (US$ bn)
OECD	33	397	19	7.5
ABARE [f]		117-351	181-203.5	2.6-7.1
G-Cubed*	38	400	13	5.2
Second Gener.M	48	503	26	13
EPPA*	55	723	24	17.4
Green*	31	397		
SGM*	43	454		
Zhang [a]	47	292-421	9.6	2.8-6.7
Morozava and Stuart [b]			111	18
US Administration [c]	19-46	144-344	24-42	6-8.3
Austin et al.	33-55	397-723	13-26	5.2-17.4
Vrolijk [d]	10-21	67-141		2.77-2.99
Haites [e]	27-57	266-575	36.7	9.8-21

Source: Morozova and Stuart (2001); Zhang (1999); Austin (1999); Vrolijk (1999); Kolshus et. al. (2001).

a: This result is obtained from a no-supplementarity scenario. The lowest range estimates are based on the low EU official baseline projection and the highest value is based on the high EU official baseline projection. The price of US$9,6 presented on the fourth column, corresponds to the low EU official baseline projection. If countries subtract their own abatement cost, the net market size would yield US$1.6-3.8bn., where China would account for 59.9% of the market followed by India (15.5%). Market size and value range is determined by the low (27.9 MtC) and high (234 MtC) official EU baseline projections.

b: Estimates from over a dozen studies were averaged, controlling for differing assumptions on factors in the BAU estimations. A 15% service fee is taken into consideration in these estimations.

c: The US Administration studied the impact of Protocol on the US economy.

d: Vrolijk and Dr. Michael Grubb developed an emission trading model (ITEA) that creates marginal abatement cost curves for each Annex B country. ITEA quantifies the impact of Kyoto mechanism, but only referring to relative costs (results presented are calculated reference to the domestic only action scenario; compliance cost domestic action=100). Ranges vary for scenarios where CDM potential is equal to half the total non-Annex B CO_2 emissions in 2010 and scenario where CDM potential equals the projected 2010 emissions and marginal abatement cost are halved for the CDM. If there is no trade in hot air, CDM market size would range from 101-210 MtC and US$6.16-6.62 billions for market value.

e: The estimated size of the CDM market in 2010 ranges from 266 MtC in a supplementarity scenario (trade should not exceed 50% of reductions from BAU) to 575 MtC under no limit scenario; it assumes a fixed quota price.

f: Values are expressed in US$1995. The CDM estimates are based on the specific analysis of energy efficiency improvements in the thermal electricity sector. Two rates of energy efficiency improvement in thermal electricity power generation are examined, 2.5% and 7.5%. The lowest rate is associated with the highest price and lowest carbon market size. Under this illustrative CDM example of energy efficiency, the majority of CERs are generated in China and India.

* Austin and Faeth (2000) analyzed the results of these economic models. These models ignore the high transaction costs that may arise from the CDM, and the administrative and adaptation fees.

[34] Austin et. al., (1999) argue that global modeling exercise tend to overestimate the CDM flows because, in practice, political institutions and transactions costs will probably keep CDM activity at a much lower level of estimates.

Table 5: New Estimates of the Carbon Credit Market

	Scenarios	Price (US$/tC)	Market size (US$billion)	Market Size (MtC)	LDC or CDM market value (US$bn/y)
Grüetter [f] (US$2000 in 2010)	No US with perfect competition	~0-7	~300-400	~0-2.8	~0-.8
	25% hot air reduction	~3	~300	~0.9	~0.2
	50% hot air reduction	~4	~400	~1.6	~0.5
	75% hot air reduction	~7	~400	~2.8	~1
	25% hot air reduction + 75% China's CERs	~4	~300	~1.2	~0.3
	50% hot air reduction + 50% China's CERs	~6	~300	~1.8	~0.5
	75% hot air reduction + 25% China's CERs	~12	~300	~3.6	~1.3
	Full participation of the US and perfect competition	~18	~700	~12.6	~5.6
	Partial participation of the US and perfect competition	~8	~500	~4	~1.1
	Full participation of the US and Cartel	~34	~700	~23.8	~11.1
	Partial participation of the US and cartel	~16	~500	~8	~3.1
Point Carbon [a] (in 2010)	Russia and Ukraine non-eligible	33.3			
	EIT cartel and no second commitment period	29.6			
	Banking range 1080-3240 tC	Low: 18.5 Medium: 40.7 High: 59.2			
CAEMA [b] (in 2010)	Original Kyoto with the US	21			
	Without the US	6.1			
	Without US + sinks	5.3			
	Without US + sinks + hot air (% sold of hot air)	10%: 5.3 50%: 4 75%: 3.8 100%: 3.6			
Cicero [c]	Kyoto with the USA	55.5 (MTC)			
	Kyoto without the USA	18.5 (MTC)			
ABARE [d]	Trading without USA and Canada; Russia and Ukraine monopolistic behaviour; CDM	177.6 (in 2010; US$2001)		352.2 (from 2001 until 2015; 44.8 correspond to South America)	
Buchner et.al., [e] (in 2010, US$1990))	Trading among all Annex I countries	23.2-43.8			
	Without the US	15.1-40.3			
	Without the US and Russia	67.6-96.1			

Source: Point Carbon (2001); CAEMA (2001); Hagem and Holtsmark (2001);Jakeman et.al., (2001); Buchner et.al (2001); Grüetter (2002)

All values are expressed in tons of carbon. Calculations were done for values obtained in tons of carbon dioxide (approximately 1 ton Carbon = 3,7tons CO_2).
MTC: metric tons (a little bit less than 1 ton)
MtC: million tons of carbon
a: Point Carbon was founded in May 2000 by a group of Norwegian researchers (http://www.pointcarbon.com). They assume no participation of the US. The second scenario results in 2160 tC not sold.
b Results were obtained from the scenario 11 of the CERT model, using marginal abatement costs and 1990 emissions from GTEM model (Annex 1), including all GHG and sinks from Annex I countries; Kyoto targets based on Royal Institute of International Affairs; Business as Usual based on GTEM. Scenario with sinks refers to new allowances made in Bonn under article 3.4, According to CAEMA these amount to approximately 470 million additional credits, but the additional number of credits established in Annex Z of the Bonn Agreement is lower than this amount.
c: Hagem and Holtsmark applied a static partial equilibrium model developed at Cicero that emphasizes the links between the fossil fuel markets and a market for emissions permits under the Kyoto Protocol. The CDM is not incorporated into the model calculations. All markets are assumed to be competitive except for the oil market. The BAU scenario is based on the Conventional Wisdom scenario developed by the EC, 1996. Total growth of emissions from 1990 to 2010 in USA, Annex B excluding USA, and in the rest of the World are set to 24%, 8%, and 50%, respectively.
d: This analysis extends over the first four commitment periods until 2027. It includes sinks, CDM, emissions trading and the commitment period reserve. It is assumed that the USA and Canada do not participate in the emissions trading scheme and do not undertake emissions abatement other than the changes in emissions intensity already included in the reference case. Parties' targets for the second and subsequent commitment periods are assumed to be 5.2% below their targets for the first commitment period. Other assumptions include: *Banking*: Parties are assumed to bank emission credits in order to maximize their net present value (a 7% discount rate is used). All parties are assumed to have no emission credits banked at the end of the fourth commitment period; *Market behaviour*: Russia and Ukraine are assumed to have and use their monopoly power to restrict the sale of hot air. It is calculated that the emissions credit level sale that maximize their revenues is 135 MtC per year. All other parties are assumed to behave competitively; *CDM*: The analysis present an illustrative example of CDM projects in forestry and technology transfer in thermal electricity generation (1.2% efficiency improvement). It is assumed that the net revenue from the sale of CERs is shared equally between the hosts and the Annex B investor. Non-Annex B countries are able to generate CERs equal to les than an additional 10% of carbon sequestration by reference case planting of commercial forests.
e: The high price was determined in an scenario that incorporated technology transfer and knowledge spillover effects, and the low price value was obtained from a scenario that considered technology transfer, but not the effects of knowledge spillover. All of these results would be enhanced when banking and imperfect competition in the permit market are taken into account. They use a modified version of RICE model, in which technical change is endogenous and responds to environmental policies to quantify the changes in R&D, investments, abatement effort and demand for permits. The analysis focuses on CO_2 only. All countries, which adhere to the Protocol, are assumed to meet the Kyoto constraints from 2010 onwards (so-called "Kyoto forever" hypothesis).
f: Grüetter (2002) estimates were developed based upon CERT version 1.2. This version includes new BAU estimates based upon recent publications of the US Department of Energy and GTEM-ABARE, and the marginal cost curves are from EPPA and GTEM. Values in each category vary as a result of different BAU and marginal cost curves utilized. Scenarios include perfect competition, restriction of FSU's hot air, and restriction of FSU's hot air and reduction of China's offer of CERs. The last four scenarios incorporate the full or partial participation of the US (the US reduces emissions by 50% of BAU-Assigned Amount according to Kyoto) and the possibility of the creation of a cartel (50% reduction of volume of hot air and 50% reduction of China's offer of CERs compared with perfect competition).

Annex 1

General description of models

Models can be broadly divided in two groups: top-down economic models and bottom-up engineering models. The former allow abatement cost to be calculated in terms of welfare loss for various reduction levels. By contrast, the engineering approaches plot the potential emissions reduction for different marginal cost levels or use energy system optimization models, which derive the marginal costs from imposing and emissions constraint.

Some Key Characteristics of Models

Features	NEMS	EPPA	MERGE	SGM	OECD-GREEN	G-Cubed	IIAM	GTEM
Production	Energy Technology Vintage Detail	Energy Technology Vintage Detail	Aggregate Production/ Cost Functions	Energy Technology Vintage Detail	Energy Technology General Production Function	Energy Technology General Production Function	Energy Technology General Production Function	Energy Technology General Production Function
Number of sectors	14	10	11	9	4	12	6	16
Number of fuels	8	7	8	7	8	5	4	4
Regions	1	12	9	12	12	8	5	9
Foresight	No	None	Perfect	Limited	None	Limited	Perfect	Limited
International Capital Flows and Financial Effects	No	No	No	No	No	Yes	No	No

Source: Edmonds and Scott (1999)

On the supply side, all the studies employ a "bottom-up" approach for the energy system. The models include detailed technical description of energy technologies (e.g., availability dates, heat rates, carbon coefficients). Energy technologies include existing sources and new options that are likely to become available. Cost and performance constraints vary by region and also improve with time (assumed technological change). For the balance of the economy, a more "top-down" perspective is taken, with macroeconomic production functions that provide a substitution between capital, labor, and energy inputs. All of the models except for NEWS, which solves for each year, solve for every 5 years. Full employment is assumed in the other models.

There are also significant structural differences between the models that account for some of the differences in estimated costs of particular policies. Some of these differences include:

- The resources an technologies available and the marginal costs of those resources and technologies;
- The sensitivity of energy demand to changes in prices of fuels;
- The degree of foresight that decision-makers are assumed to have (in particular, their ability to react to expected price changes);
- The ability of regional economies to shift into industries of greater or less energy intensity as energy prices change;
- The degree and speed of substitution between factors of production (i.e., labor, capital. Materials, energy) when relative prices change;
- The representation of technology, especially energy equipment.

For example, NEWS, EPPA, MERGE, SGM, and OECD GREEN all have detailed representations of energy technology wherein energy equipment is tracked by vintage and only retired as the economics of operating it dictate. IIAM and GTEM have more general production functions. The models vary considerably in the number of industries (4 industries in OECD GREEN, 16 in GTEM) and the number of fuels. Population dynamics vary in complexity from OECD GREEN, which simply uses United Nations demographic projections, to GTEM, which has a highly detailed demographic structure that responds to economic incentives. Foresight ranges from perfect foresight (knowledge of future prices and available technologies) (MERGE) to contemporaneous and backward-looking only (GREEN EPPA). In general, those models with a high degree of technological detail and foresight can adjust more quickly to carbon price increases, as can those that are relatively optimistic about technological change in general.

The various models also differ from each other in how they define regions and in the base cases used for analysis. For example, the EPPA model breaks the OECD into the US, Japan, European Economic Community, and "other" OECD regions (which include Canada, Australia, and New Zealand) while SGM shows Canada, Australia and Westerns Europe separately, but not European Economic Community. NEWS has only one economic region (the US), while EPPA, OECD GREEN and SGM have 12 regions, G-Cubed has 8,

GTEM has 19, and IIAM uses 5 geopolitical regions which it disaggregates into 87 individual countries.

Morozova and Stuart (2001) examined several models that appeared prior to November 1999, and found three main approaches among economic models:

- *General equilibrium* (GE) models attempt to capture the effects of the interaction of demand and supply aggregated to sectoral levels in a perfect competitive market. GE models allow for inter-industry interactions and international trade in non-energy goods. Within the framework of GE models, energy prices are driven by changes in the relative production costs of different types of energy (coal, gas, oil). These cost ultimately influence consumption of the quantity demanded and type of energy goods relative to the prices in non-energy sectors and budget constraints. Among the most well known models based on this approach are MIT Emissions Prediction and Policy Assessment model (EPPA).
- *Macroeconomic* models account for the interaction between supply, demand, price, and macroeconomic variables such as international capital flows. Unlike GE, these models allow for some market imperfection produced as for instance by information asymmetry, and more importantly, macro econometric forecasts carefully consider monetary policy reactions to economic shocks, resulting from the introduction of the Kyoto Protocol. The primary example of this approach is the Oxford's Global Macroeconomic and Energy Model (for details about this model see Cooper et al., 1999).
- *Aggregate Production/Cost Function (APCF)* models are based upon optimal economic growth theory. These models aggregate all industries within the state borders, while GDP is determined by an aggregate production function, where capital, labor and carbon are the key inputs into the economy. Models based on this approach tend to control for the effects of capital utilization and employment and focus on the costs of reducing carbon emission from unconstrained baselines via an aggregate cost function within each economy. Though this approach generally omits all inter-industry interactions, it includes trade in carbon and carbon emissions rights (but not in other goods and services). The best example of this approach is the Regional Integrated model of climate and the Economy (RICE) used at Yale University.

Some of the most and more recent referred work on forecasts of trading and CDM markets is based on two well-known models, MIT 's Emissions Predictions and Policy Assessment (EPPA) and Australia's GTEM (ABARE). GTEM is the only to consider sinks between the two models.

MIT-EPPA model:

EPPA provides estimates of the costs of carbon emission reductions at different levels throughout the economy using a general equilibrium model of global economic activity, energy use and carbon emissions.

The current version of the model covers the period 1985 to 2100 in five-year steps. The world is divided into 12 regions (Table 1), which are linked by bilateral trade. The economic structure in each region consists of eight production sectors and four consumption sectors (Table 2) plus one government and one investment sector. In addition to these production sectors, there are two future energy supply or "backstop" sectors that produce perfect substitutes for refined oil and electricity (Table 2).

Table 1: Regions

USA	United States
JPN	Japan
EEC	European Community
OOE[a]	Other OECD
EET[b]	Central and Eastern Europe
FSU	The Former Soviet Union
EEX[c]	Energy-exporting LDCs
CHN	China
IND	India
DAE[d]	Dynamic Asian Economies
BRA	Brazil
ROW	Rest of the World

a: Australia, Canada, New Zealand, EFTA (excluding Switzerland and Iceland), and Turkey
b: Bulgaria, Czechoslovakia, Hungary, Poland, Romania, and Yugoslavia.
c: OPEC countries as well as other oil-exporting, gas-exporting, and coal-exporting countries.
d: Hong Kong, Philippines, Singapore, South Korea, Taiwan, and Thailand.

MIT forecasts are modeled by calculating Marginal Abatement Curves (MACs) for each region under consideration. To illustrate full global trading, EPPA study relies on global aggregate supply and demand curves for emission permits (not abatement curves). The curves indicate the total quantities of permits that would be supplied or demanded at various price levels in a given market.

Table 2: Production and Consumption sectors

Production sectors		**Consumption sectors**	**Primary Factors of Production**
Non-Energy	Agriculture	Food and beverages	Labor
	Energy-intensive industries	Fuel and power	Capital (by vintage)
	Auto, truck and air transport	Transport and communication	Sector-specific fixed factors for each fuel
Energy	Crude oil	Other goods and services	Land in Agriculture
	Natural Gas		
	Refined Oil		
	Coal		
	Electricity, gas and water		
Future Supply Technology	Carbon liquids backstop[a]		
	Carbon-free electric backstop[b]		

a: Liquid fuel derived from shale
b: Carbon-free electricity derived from advanced nuclear, solar power or wind.

The base-level emissions are set for 1985and the emissions in subsequent periods are related to changing levels of energy and non-energy activities using various energy substitution elasticity factors. Emissions from deforestation are exogenously determined, and are added to the emissions driven by the activity levels generated by the EPPA model. In the results shown below, these emissions are assumed constant at estimated 1985 values from 1985 to 2000, and thereafter to decline linearly to zero by 2050.

Price ($/tC in US$98) for different scenarios

	No trade	Annex I Trading [a]	World Trading [b]
JPN	584		
EEC	273		
OOE	233		
USA	186		
EET	116		
Clearing Price		127	24
Total Cost ($bn/year)	120	54	11

Source: MIT, Global Change Joint Program Report No. 41, 1998.
a: About a third of the permit exports consist of "hot air" with a cost of zero; total gains from emission trading are US$66 billion, split between FSU (US$34bn) and for US$32 billion for OECD plus EET; Japan and the EEC are the two regions that benefit the most because their autarkic marginal cost where the highest. They import 66% and 35% of their reduction requirements.
b: Three countries account for the bulk of exports: China (47%), FSU (23%) and India (11%); FSU gains decrease to US$4 billion because of the participation of developing countries; Imports of reductions requirements account for Japan (92%), EEC (76%), USA (68%), OOE (66%), and EET (56%).

The MIT model also examines what would happen to the global carbon trading system when projected rate of economic growth is 10% higher and 10% lower than in the

reference EPPA projections for all regions. The variation in economic growth has a large effect on demand, but not much on supply since most of the supply comes from unconstrained regions, the FSU or the developing countries. Higher growth rates reduce supply, and conversely for lower growth rates.

Volume and price changes with a rate of economic growth 10% higher and 10% lower than in the reference case (business as usual)

	Volume traded (MtC)	Price ($/tC in $98)
Annex I	12	40
Global trading	120	6

The MIT study also examines the case of an inefficient supply or carbon credits. In this respect, it views the CDM as a constraint on the global trading of carbon emission permits. Specifically, it views the CDM as an increase in transaction costs, which would result in a wedge between the price paid by consumers and that received by producers. In this case the single biggest beneficiary is the FSU, as it benefits from the increase of the market price and the increase of its exports. The results for different levels of surcharge are show below.

Prices, Flows and Gains with CDM Surcharge

Level of CDM Surcharge	None	25%	50%
Market Price (US$ 1985)	23.8	27.4	30.6
Profit to DCs from CDM (US$billion)	10.2	8.9	7.9
CDM Exports (MtonC)	723	687	354
World cost (US$ billion)	11.2	15	18.2

ABARE-GTEM:

GTEM is a dynamic global general equilibrium model. It contains detail coverage of 45 regions and 55 sectors, particularly energy markets. Combustion and non-combustion carbon dioxide and methane and nitrous oxide emissions are represented in GTEM (these gases account for 99% of global anthropogenic GHG emissions, IPCC 1996). In addition, a simplified representation of the economic effects of carbon sequestration in Kyoto forests in Annex B countries is included.

In GTEM, climate change policy analysis is based on a reference case scenario, which does not include current or planned policy responses to climate change, and policy scenarios that represent implementation of the Kyoto Protocol. The latest GTEM Annex B

reference case includes estimates of carbon sequestration under Articles 3.3 and 3.4 of the Kyoto Protocol (August 2000 submission to the IPCC, and estimates of article 3.4 forest management according to the Bonn agreement). Global emissions of three principal GHG are projected to rise from 28 million tonnes of carbon dioxide equivalent in 1990 to 45 billion tonnes in 2015 in the GTEM reference case, with the major part of this increase coming from developing countries.

In GTEM, least cost modelling of independent emissions abatement involves imposing a carbon equivalent penalty on the greenhouse gas emissions of each Annex B country. The penalty represents the broad class of least cost economic instruments that could be used by governments to reduce emissions. The aggregate economic impacts are reflected in changes in GNP relative to the reference case. Emission reductions are available from reduction in combustion related carbon dioxide emissions through energy efficiency improvements and fuel switching, and from reductions in non-combustion sources trough adoption of new technologies and management practices.

Emissions for Annex B countries are obtained from the 1998 official national inventory or from the most recent inventory data.

Annex 2

Approved AIJ projects in Latin America

Country	Approved projects
Argentina	• Capex, SA Electric Generation Project • Landfill Gas Management in Greater Buenos Aires (fugitive gas capture) • Rio Bermejo carbon Sequestration in East Kalimantan (forest preservation)
Belize	• Rio Bravo Carbon Sequestration Pilot Project (forest preservation) • BEL/Maya Biomass Power Generation Project
Bolivia	• Noel Kempff Mercado Climate Action Project (forest preservation) • Rural Solar Electrification: Pilot Phase • Taquesi River Hydroelectric Power Project
Chile	• Wind Energy Project in Northern Chile • SIF Carbon Sequestration Project (Aforestation) • Rio Condor Carbon Sequestration Project (forest preservation) • Natural Gas project with Australia (fugitive gas capture)
Costa Rica	• Aeroenergia SA Wind Facility • Dona Julia Hydroelectric Project • ECOLAND: Piedras Blancas National Park (forest preservation) • Klinki Forestry Project (reforestation) • Plantas Eolicas SRL Wind Facility • Territorial and Financial Consolidation of Costa Rican National parks and Biological Reserves (forest preservation) • Tierras Morenas Windfarm Project • Reforestation and Forest Conservation Project with Norway • Methane Emission Reduction at wastewater Treatment Plant in Coffee Mills
Ecuador	• Bilsa Biological Reserve (forest preservation)
El Salvador	• CESSA Energy Efficiency CO_2 Reduction
Guatemala	• Matanza Hydroelectric Project • Santa Teresa Hydroelectric Project • The Rio Hondo Hydroelectric Project
Honduras	• Bio-Gen Biomass Power Genration Project, Phase I

	• Bio-Gen Biomass Power Genration Project, Phase II • Solar-Based Rural Electrification
Mexico	• APS/CFE Renewable Energy Mini Grid Project • Community Silviculture in the Sierra Norte of Oaxaca • Project Salicornia: Halophyte Cultivation in Sonora • Scolel Te: Carbon sequestration and Sustainable Management in Chiapas (reforestation) • ILUMEX: High Efficiency Lighting
Nicaragua	• El Hoyo-Monte Galan Geothermal Project
Panama	• Commercial reforestation in the Chiriqui Province
Peru	• The Central Selva Climate Action Project

Source: http://www.unfccc.int (AIJ Program).

Annex 3

Climate Change Activities of Selected International Financial Institutions and Government Agencies

World Bank Group

The World Bank has been involved in several activities related to climate change and has developed the Global Climate Change Program which includes the following different initiatives (in addition to the Prototype Carbon Fund explained below):

- ***National Strategy Studies Program***: This program is a collaborative effort, initially launched in 1997 as a joint effort from the Government of Switzerland and the World Bank. Its objective is to provide capacity building assistance to the JI/CDM host countries regarding the application of the Kyoto Protocol flexible mechanisms. The program has expanded to include other donor countries (Germany, Australia, Finland, and Canada) and targets nearly 30 Bank client countries for promotion of the integration of global climate change issues into national sustainable development.

  The objective of each study is to provide the relevant national authorities and other stakeholders with an opportunity to better understand the issues and opportunities presented by potential international markets and other financing opportunities for greenhouse gas (GHG) offsets and to develop and analyze options (see Annex 5 for more details about NSS studies, and Annex 6 for detail about the current status of NSS studies).

  The World Bank has already completed 9 NSS and has another 17 in the stage of progress or preparation. Three of the completed studies are in Latin American countries (Argentina, Colombia and Bolivia), with additional studies in preparation in Chile, Brazil, Guatemala, Peru and El Salvador.

  The publications of the completed studies are available online.

- ***Energy-Environment Strategy***: The World Bank is adopting a broad range of policies that target the principal sources of pollution across sectors. Its objectives include accelerating the substitution of traditional fuels; promoting new energy technologies by removing barriers to the development of their markets; and strengthening monitoring

and enforcement capabilities for mitigating the environmental impact of energy production and use.

- ***Carbon Backcasting Study***: The World Bank is considering strategies that encourage investments in low and no-carbon energy alternatives such as including a carbon shadow price in its analysis of project benefits and costs. The objectives of the shadow price study are to determine whether the shadow price could adversely affect the economic analysis of energy loans, and to analyze whether the shadow price would encourage investments in low-carbon alternatives.

- ***Global Overlays for Climate Change***: The World Bank's Global Environment Division has begun applying a new analytical tool called a Global Overlay to integrate Global Environment Externalities into the World Bank's economic and sector work. Climate change global overlays are applied in sectors such as energy, transport, forestry and agriculture. Similar to a graphic overlay, which attaches a new layer to an already existing surface, the global overlay concept adds a global dimension to the sector studies that the Bank undertakes on a regular basis for its client countries

  A climate change overlay consists of two parts:

  1. It uses an existing sector development strategy for sectors with significant greenhouse gas (GHG) emissions, and calculates the associated emissions.
  2. It outlines cost-effective GHG mitigation options available to the country if it seeks to limit its GHG emissions in a sector

  Global overlays provide at least three critical improvements:

  - *Economies of Scale and Scope.* Adding a global component to regular sector work offers the prospect of capturing analytical economies of scale and scope.
    Scale economies arise from extensive data collection in sector reviews. For example, GHG emissions linked to energy use are fairly easy to calculate from the data collected for regular energy sector studies. Global overlays also capture economies of *scope*. For example, they bring World Bank sector economists and operational staff in

contact with GHG abatement studies undertaken by developing countries as part of FCCC reporting requirements.

- *Integration into Sector Work*. Integrating global concerns into regular Bank sector work is bound to have a long-range impact on regular Bank work, as sector economists become familiar with available mitigation options and unexploited "win-win" opportunities offering considerable domestic benefits while reducing GHG emissions.

- *Identifying GEF Projects.* Global overlays are also an important screening tool for identifying cost-effective GEF investment projects. The overlays' sectoral focus allows more in-depth analysis of mitigation options than country-level studies, and a closer identification of cost-effective investment opportunities for GHG reduction. Client country participants in sector work also show their awareness of these opportunities, making the GEF project selection process as transparent as possible from a host country perspective[35].

- ***Activities Implemented Jointly***: The AIJ program at the World Bank is a collaborative effort launched in 1996 between the government of Norway and the World Bank on a pilot basis to demonstrate the potential mechanism for reducing greenhouse gas emissions and contributing to sustainable development in the Bank's client countries. Pilot projects include Burkina Faso, India, Poland and Mexico (see Annex 4 for more detail about these projects).

  The AIJ program provided important input into the development of the Bank's overall strategy on Climate Change, with a strong emphasis on the use of market mechanisms. The AIJ Program contributed to the development of the Prototype Carbon Fund (PCF).

[35] As an example, a prototype of a global overlay for the energy sector in Ukraine recently completed included a baseline analysis, the identification of mitigation alternatives as well as the cost effectiveness of each alternative identifying them as potential “regular development loans” or GEF financed activities.

Clean Development Mechanism Assist has evolved as a spin-off the AIJ Program to enhance capacity building initiative in Africa. The Program has received donor interests from Sweden, Canada and France.

In addition, the World Bank is also evaluating the possibility to launch a National Adaptation Strategy Program.

The Bank, through the Prototype Carbon Fund, is in the process of negotiation with the Dutch Ministry of the Environment (VROM) for the acquisition of CERs on their behalf. The IFC has reached a similar agreement with VROM (see below).

Prototype Carbon Fund (PCF)

The Executive Board of the World Bank established the PCF on July 20th, 1999. Its objective is to gather, analyze, learn and disseminate knowledge from project-based emissions transactions gained from a “learn-by-doing” approach. As a pilot activity, the PCF does not endeavor to compete in the emission reductions market; it is restricted to US$180 million, it is expected to place all its funds by mid-2004, and is scheduled to terminate in 2012.

The PCF funds projects that produce high quality greenhouse gas emission reductions, which could be registered with the UNFCCC. For this purpose, it has developed an entire methodology to assess projects according to their sector of origin and risks involved, among other factors. Its portfolio target is between 20-30 US$/ton C. Currently, it is the most highly recognized institution actively participating in the acquisition of carbon credits from JI and CDM projects.

The PCF is financed with resources provided by both the public and private sectors. Contributors, or "Participants," in the PCF receive a pro rata share of the emission reductions, verified and certified in accordance with carbon purchase agreements reached with the respective countries "hosting" the projects.

The PCF has indicated that approximately half of the PCF investments will be made in Economies-in-Transition (JI), and half will be made in developing countries (CDM). The major emphasis will be placed on renewable energy and energy efficiency projects, which have a great potential for replication and for reducing climate change at a reasonable cost. Until now, the PCF has completed the preparation and successfully negotiated three Emission Reduction Purchase Agreements with Latvia (solid waste management project),

Uganda (small hydro project), and Chile (small hydro project). It is also close to sign two additional Emission Reduction Purchase Agreements with Costa Rica (small hydro and wind power projects) and Brazil (switch from mineral carbon to vegetal carbon project). Additionally, it has a broad variety of projects in its pipeline, including several projects in Latin America with an emphasis in Central America (see Annex 7 for a list of projects in LAC region and their status).

The PCF has expressed a willingness to support the purchase of emissions reductions from projects in the Central American region. Since the PCF already has a project under preparation in Costa Rica, investments now focus on Belize, El Salvador, Guatemala, Honduras, Nicaragua, and Panama. In order to meet the objectives described above, the PCF will commit up to $10 million of its resources for the purchase of high quality emissions reductions from eligible projects in the above Central American countries.

The recent Bonn and Marrakech decisions have motivated the PCF to launch new vehicles that will allow it to participate and gain experience in activities that have not been part of their portfolio until now. These include: Prototype Sequestration Fund (March 2003), and Small Country/Small Project Fund (end of 2002).

International Finance Corporation (IFC)

The International Finance Corporation (IFC) is the World Bank Group's private sector window, and, as such, also implements projects for the Global Environment Facility and the Montreal Protocol. IFC helps the private sector develop projects that promote the objectives of the climate change and biodiversity conventions.

The IFC's climate change activities are managed by the environmental market group. Their participation is limited to promoting private sector projects that could be financed by the IFC. They do not play a role in capacity building, adaptation or mitigation.

The IFC has recently signed an agreement with the Dutch Ministry of the Environment (VROM) for buying CERs on their behalf. The contract is for US$40 million with a duration of three years time during which the IFC is expected to buy approximately 10 million tons of CO_2.

Corporación Andina de Fomento (CAF)

With the support of the Center for Sustainable Development in the Americas (CSDA), CAF established in May 1999 the Latin American Carbon Program (PLAC) with the objective to support their member participation in the new emerging carbon market. Its goal is to contribute to the development of the carbon market, the definition of financial instruments and mechanisms, and to encourage the participation of private business in this market.

PLAC operates through technical assistance[36], technical exchanges[37], regional workshops and special meetings[38], publication and outreach material[39], and project development support[40].

European Bank for Reconstruction and Development (EBRD)

The EBRD is at the initial stage of developing an active -project focused- role in JI and CDM[41]. They are preparing the second presentation to their Board of Directors, which will finally define their role in climate change.

Until now, EBRD's role in CDM and JI projects has been one of a facilitator. In order to minimize the EBRD's risk exposure, the Bank has not acted as a broker nor as credit buyer. The EBRD has been relatively pro-active in terms of projects in the region but had limited involvement in capacity building due to a lack of donor funds. The EBRD has also developed a GHG methodology to assess the Bank's loans' carbon impact.

The EBRD assisted Romania in developing an energy conservation project under the Activities Implemented Jointly pilot phase. This project is currently under implementation and the donor country is negotiating with the Romanian government to obtain the carbon

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36 Support member countries in the development of informed positions; support the public and private sectors with project design and implementation and contribute in the financial input and options for the design of the CDM.

37 Support the exchange of experiences on the CDM negotiations; national instruments and mechanisms for the quantification, certification, and verification of carbon offsets; financial models, instruments and mechanisms; and the identification, preparation and implementation of eligible investment projects.

38 Promote regional dialogue and the exchange of information and experiences among member countries; and support meetings where market options, financial instruments, project development and implementation and other relevant issues are discussed.

39 Includes proposals for the CDM prepared by member country organizations; public awareness and education materials; and other contributions that assist the establishment of the carbon market.

40 For projects that: are profitable; use methodologies acceptable under the Kyoto Protocol; and generate verifiable carbon reductions.

credits. The EBRD played the role of facilitator between private clients and the ERUPT program of the Netherlands and intend to continue doing the same with the CERUPT program also[42]. The EBRD is also involved in the Rumania's small hydro-power project that won one of the contracts under the first tender of ERUPT in 2001. The EBRD is currently preparing other projects in the sectors of energy-efficiency, power generation, waste management, transportation (energy-efficiency). The EBRD has not been involved in any forestry projects yet. According to EBRD staff[43], it is estimated that 20% of the EBRD's project pipeline has a climate change potential.

The EBRD has not developed accounting procedures for carbon credits, but has expressed interest in exploring this with other IFIs, together with several other issues (e.g., bankruptcy of carbon credit projects).

The Asian Development Bank (AsDB)

The AsDB has launched a regional project for the Promotion of Renewable Energy, Energy Efficiency and Greenhouse Gas Abatement (PREGA). The three-year PREGA project, co-financed by the Netherlands and AsDB on a grant basis, promotes investments in technologies that will increase the poor's access to energy services as well as help to reduce greenhouse gas emissions. In addition the AsDB is having preliminary discussions with the Dutch Ministry Environment on a possible establishment of a CDM mechanism.

The AsDB has developed two projects in China with the GEF: a wind power development project through the UNDP and a project on efficient utilization of agricultural wastes through the World Bank.

Global Environment Facility (GEF)

Climate change is one of the four focal areas of the GEF[44]. It accounts for approximately 40% of its budget ($1.1 billion in 275 projects). As the financial mechanism

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41 Seven of their member countries classify under the CDM category (e.g., Caucasus, Georgia, Uzbekistan, and Kazakhstan), some of which have already ratified the Kyoto Protocol.

42 The ERUPT (Emission Reduction Unit Procurement Tender) program was designed by the Dutch government to buy ERUs from JI projects, while the CERUPT (Certified Emission Reduction Unit Procurement Tender) was developed to buy CERs from CDM projects. For more information see http://www.senter.nl.

43 Personal communication with Karen McClellan (Senior Banker Energy Efficiency) and Nathalie Roth (Project Preparation Committee Officer, Power and Energy Utilities, Banking Department).

44 In addition to biodiversity, international waters and Ozone depletion. Indirectly they have also play a key role in combating land degradation.

for the UNFCCC, GEF receives guidance from the COP on policy, program priorities, and eligibility criteria related to the Convention.

Its objective is to design projects to reduce the risks of global climate change while providing energy for sustainable development. The GEF approach is to support private sector initiatives in order to promote long-term sustainable models to be replicated. GEF grants should contribute barriers removal and accelerate market's creation, while the projects need to be self-sufficient in the long run. GEF climate change projects are organized into four areas[45]: 1) removing barriers to energy efficiency and energy conservation; 2) promoting the adoption of renewable energy by removing barriers and reducing implementation costs; 3) reducing the long-term costs of low greenhouse gas emitting energy technologies; and 4) supporting the development of sustainable transport.

The GEF implements projects through either its three Implementing Agencies (UNDP, UNEP, and the World Bank[46]) or the Executing Agencies operating under the Expanded Opportunities Policy. This latter group includes the four largest Regional Development Banks (AsDB, AfDB, EBRD, and IDB) as well as specialized UN Agencies (IFAD, FAO and UNIDO).

The Dutch Ministry of the Environment (VROM)

Several governments are actively involved in climate change activities, particularly with regards to the creation of national trading systems (UK, Denmark, and the European Union). The Netherlands has developed an active role in another front by actively promoting the use of the other two flexible mechanisms, JI and CDM.

The Government of the Netherlands has decided to achieve 50% of their Kyoto obligations through the use of flexible mechanisms. CDM and JI together are expected to cover in total 125 Megatons of CO_2, most of which should come from CDM projects.

The Dutch Ministry of the Environment (VROM) is the organization responsible for the execution of CDM projects and purchase of CERs (JI projects belong to the responsibility of the Ministry of Economic Affairs). Due to EU procurement rules, VROM

[45] GEF projects are also categorized by the country or region in which a project is underway and the implementing agency responsible. A detail list of projects can be downloaded from http://www.gefweb.org/Projects/projects-Projects/PROGLIST.pdf

[46] The World Bank is responsible for the implementation of approximately 50% of climate change GEF project portfolio.

cannot buy CERs directly in the market and instead is seeking cooperation with International Financial Institutions (who are exempted from these rules). VROM has already signed a contract with the IFC (see above). In addition, VROM has also launched international Certified Emission Reduction Unit Procurement under the responsibility of the Dutch Agency Senter. CERUPT has already closed its first tender and it is in the process of selection of projects. 33% of the projects presented were from Central America and 12% from South America. The average price per ton of CO_2 is expected in the EUR3-5 range (EUR 11-18/tonC). Senter has also launched ERUPT process which objective is the acquisition of ERUs from JI projects.

Annex 4

Projects under the AIJ program

Country	Project	Details
Mexico	ILUMEX	Replacement of more than 2 million incandescent light bulbs with compact fluorescent light bulbs in the cities of Monterrey and Guadalajara.
Poland	Conversion from coal to gas fired boilers.	The project has three main components: - Conversion of coal to gas involving investments in about 30 non-industrial small to medium-sized heat plants (boilers) for their conversion from coal to natural gas - Insulation of installations and installation of energy efficient equipment in new residential areas. - Technical assistance.
India	Integrated Agricultural Electricity Demand Side Management	The project combine four technical measures in an integrated approach to generate electricity savings and GHG reductions: - Improvements of the distribution system efficiency by converting from low voltage (LV) feeders to high voltage (HV) feeders. - Reduction in system demand and line losses - Provision of customer meters to provide information on energy consumption - Improvements in end use efficiency
Burkina Faso	Sustainable Biomass Energy Management	The project components are: - Community based forest management - Carbonization technologies - Solar PV systems - Improved Kerosene cooking stoves

Annex 5

National Strategy Studies (NSS)

NSS studies are carried out by teams of national consultants with targeted support from foreign consultants that often have experience through previous Strategy Studies or similar work. The effort is coordinated by a national Project Coordinator who assumes overall responsibility for the study on a day-to-day basis.

The study is generally consisted of the following six tasks:
Review of previous relevant studies and develop improved understanding of the

- AIJ/JI/CDM
- GHG emission reduction potential and costs
- GHG emission reduction market opportunities
- Domestic prerequisites
- JI/CDM options for a country
- GHG projects

A NSS study must:

- Quantify the potential for GHG offsets and assess the related costs
- Analyze the country-specific choices in addressing climate change
- Highlight the opportunities created by a possible market for GHG offsets and other financing opportunities (e.g. the Global Environment Facility) for GHG abatement projects.
- Assess potential for technology transfer and identify areas to its implementation, establishing with CDM countries the link to sustainable development targets.
- Identify possible issues and concerns with GHG offsets trading and possible trading mechanisms and develop policy options and strategies, and
- Develop a pilot pipeline of possible projects for different financing opportunities and available to all interested sponsors.

Annex 6

Current Status of NSS Studies

Country	Source of Funding	Status	Estimated Starting / Completion Date
Completed Studies			
Czech Republic	Switzerland	Publication available	
Slovak Republic	Switzerland	Publication available	
Russian Federation	Switzerland / Finland	Publication available	
Uzbekistan	Switzerland	Publication available	
Argentina	Canada / (under a bilateral cooperation with the World Bank)	Publication available	
Zimbabwe	Switzerland	Publication available	
Colombia	Switzerland	Publication available	
Bolivia	Switzerland	Soon	
South Africa	Switzerland	Soon	
Studies in Progress / Preparation			
Ukraine	Switzerland	In progress	February 2001 / March 2002
Hungary	Austria	On hold	
Kazakhstan	Austria	In progress	Early 2001
Romania	Switzerland	Under discussion	2001 / 2002
Africa			
Egypt	Switzerland	In progress	October 2000 / October 2001
Asia			
Indonesia	Germany	In progress	January 200 / March 2001
Thailand	Australia	In progress	September 2000 / September 2001
Papua New Guinea	Australia	In progress	October 2000 / September 2001
Vietnam	Australia	In progress	February 2000 / March 2002
China	Switzerland / Germany	In preparation	August 2001 / December 2002
India	Switzerland / Australia	In preparation	August 2001 / September 2002
Sri Lanka	Australia	In preparation	October 2001 / December 2002
South America			
Chile	Germany	In progress	December 2000 / November 2001
Brazil	Switzerland	In preparation	Summer 2001 / December 2002
Guatemala	Switzerland	In preparation	Summer 2001
Peru	Switzerland	In preparation	Summer 2001
El Salvador	Finland	In preparation	Fall 2001

Annex 7

PCF Project's Pipeline in Latin America

Institution PCF	Project	Country	Status
	Fund for Renewable Energy	Costa Rica	Soon to become ERPA**
	Fuel Switching/Renewable Energy	Brazil	Soon to become ERPA**
	Renewable Energy/Small Hydro	Guatemala	Approved PIN/GE
	Renewable Energy/Biomass	El Salvador	Approved PIN/GE
	Renewable Energy/Waste rice husk	Nicaragua	Approved PIN/GE
	Energy self-sufficiency with biogas (biomethanation)	Nicaragua	Approved PIN/GE
	Power Generation/ Peanut Shell	Nicaragua	Approved PIN/GE
	Renewable Energy/Wind	Honduras	PIN
	Renewable Energy/Geothermal	Guatemala	PIN
	Landfill Gas	Costa Rica	PIN
	Renewable Energy/Wind	Costa Rica	PIN
	Renewable Energy/Hydroelectric	Costa Rica	
	Renewable Energy/Wind	Costa Rica	
	Renewable Energy/Hydroelectric	Costa Rica	
	Renewable Energy/Small Hydro	Costa Rica	PIN

PIN: project sponsor has presented a Project Idea Note. If approved the PIN needs to become a PCN (project consideration note)
Sources: http://www.prototypecarbonfund.org
GE: these projects have obtained government endorsement
***: Emission Reduction Purchase Agreement.*