How cost-effective are carbon emission reductions under the Prototype Carbon Fund?

Hiromi Nagai

MSc Environmental Change and Management

Dissertation

University of Oxford

2 September 2005

Supervisor: Cameron Hepburn

14,601 Words

(excluding Tables and Figures; including abstract and footnotes)

Acknowledgement

I am grateful to Carbon Finance Business team of the World Bank for giving me the opportunity and support to work on this research, by allowing me to access Project Appraisal Documents which are not available on the website, stimulating my interest in the carbon emission reduction projects, and providing various comments during my twice visits to their office in Washington DC and through e-mails. In particular, I owe Yoshitaka Hagiwara, Senior Operations Officer in the Carbon Finance Business of the World Bank, a huge thank you for spending so much time to discuss the direction and contents of this research. His insights and comments have inspired me to pursue this research and have helped me to achieve the in-depth understanding of a carbon transaction. I would like to thank Jusen Asuka, a researcher in Tohoku University, who encourages me on selecting this topic at the first stage of this project. To Rachael Mallis and Wilhelm Mohn, I am grateful for proof readings. Finally, I am so much indebted to my supervisor, Cameron Hepburn, for his supervision, which is far beyond the call of duty. His ideas, insights, logic, wisdom, linguistic advices and great encouragement: without any single factor he has given to me during this project, I might not have been able to write up my dissertation.

Except where otherwise stated and acknowledged, I certify that this Dissertation is my sole and unaided work.

Hiromi Nagai
2 September, 2005
Environmental Change Institute
Linacre College
University of Oxford
Oxford, OX1 3JA
United Kingdom

Contents

Lists of Figures and Tables

Figures

Tables

List of Abbreviations

CFB	Carbon Finance Business
CDM	Clean Development Mechanism
CDM EB	Clean Development Mechanism Executive Board
CER	Certified Emission Reduction
CERUPT	Certified Emission Reduction Units Purchase Tender
CMM	Coal Mine Methane
CO2	Carbon Dioxide
ERPA	Emission Reduction Purchasing Agreement
ERU	Emission Reduction Unit
EU ETS	European Union Emission Trading Scheme
EUA	European Union Allowance
IERC	Implicit Emission Reduction Cost
IGES	Institute of Global Environmental Strategies
INR	International Rivers Network
GEF	Global Environment Facility
NPV	Net Present Value
OECD DAC	Organisation for Economic Co-operation and Development, Development Assistant Committee
PAD	Project Appraisal Document
PDD	Project Design Document
PCF	Prototype Carbon Fund
SSP	Small Scale Project
SSN	South-South-North
UN	United Nations
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
WB	World Bank
WACC	Weighted Average Capital Cost
WWF	World Wildlife Fund

(unit)

MW	Mega Watt
GWh eq.	giga watt hour equivalent
tCO2e	ton per carbon dioxide equivalent

Evaluated Projects

Projects technologies order	Project Abbreviation in this thesis	Carbon credits Amounts		Periods		Remarks Credit Breakdown
Colombia Jepirachi Carbon Offset Project (19.5MW Wind)	Colombia Wind project	1,168,251	tCO2e	21	yrs.	
Costa Rica Cortega Wind Power Subproject (8.4MW Wind)	Costa Rica Cortega Wind subproject	302,800	tCO2e	21	yrs.	
Cost Rica Vera Blanca Wind Power Subproject (9.6MW Wind)	Costa Rica Vera Blanca Wind subproject	329,100	tCO2e	21	yrs.	
Chile Chacabuquito Hydro Power Project (26MW Hydro)	Chile Hydro project	2,800,000	tCO2e	21	yrs.	
Costa Rica Cote Hydroelectric Subproject (6.3MW Hydro)	Costa Rica Hydro subproject	180,600	tCO2e	21	yrs.	
China Xiaogushan Hydropower Project (98MW Hydro)	China Hydro project	2,640,109	tCO2e	10	yrs.	
China Jicheng Coal Mine Methane Project (120MW CH4 recovery)*1	China CMM project	22,546,000	tCO2e	10	yrs.	*1: Credit Breakdown Captured CH4 (90%); Fuel Switch (10%)
Mexico Waste Management Guadalajara Subproject (4.5MW CH4 recovery)*2	Mexico Guadalajara Waste project	1,582,300	tCO2e	10	yrs.	*2: Credit Breakdown Captured CH4 (66%), Fuel Switch (34%)
Mexico Waste Management Monterrey II Subproject (4MW CH4 recovery)*3	Mexico Monterrey II Waste project	1,216,900	tCO2e	10	yrs.	*3: Credit Breakdown Captured CH4 (64%), Fuel Switch (36%)
Mexico Waste Management Leon Subproject (CH4 recovery)	Mexico Leon Waste project	200,700	tCO2e	10	yrs.	
India Municipal Solid Waste Treatment Project (5.6MW CH4 recovery)	India Waste project	1,018,479	tCO2e	10	yrs.	
Brazil Minas Garais Plantar Project (Fuel Switch)*4	Brazil Plantar project	12,885,984	tCO2e	28	yrs.	*4: Credit Breakdown Fuel Switch (56%: 1st-21st); Sequestration (31%: 1st-21st); Reduced CH4 (13%: 8th-28th)
Moldova Soil Conservation Project (Sequestration)	Moldova Sequestration project	1,812,178	tCO2e	21	yrs.	

Abstract

The Clean Development Mechanism (CDM) aims both to mitigate greenhouse gases cost-efficiently and to contribute to sustainable development in developing countries. In order to catalyze CDM projects, the World Bank established the Prototype Carbon Fund (PCF) in 1999. This thesis aims to assess cost-effectiveness of projects managed by the PCF, as well as to understand the relationship between cost-efficiency and sustainable development. This is achieved using data acquired from the World Bank Project Appraisal Documents and Project Design Documents covering thirteen PCF projects. In particular, Implicit Emission Reduction Costs (IERCs) are calculated for each project, and then compared with various carbon prices. Unlike the carbon credits prices determined by the negotiation in the market, IERCs represent the real costs of generating carbon emission reductions, and permit cost benefit tests over the different technologies. It is found that IERCs for the thirteen projects vary from -\$9/tCO2e to \$13/tCO2e, dividing the projects' cost benefit analysis result into two groups: cost-efficient projects and cost-inefficient projects. Interestingly, however, some of the cost-efficient projects appear to be problematic projects, often condemned by the civil society as failing to contribute to sustainable development. This finding leads some support to the idea of providing a separate incentive to support the achievement of sustainable development objectives.

Chapter 1: Introduction

1.1 Clean Development Mechanism and Carbon Fund

This thesis addresses the Clean Development Mechanism (CDM), one of the three flexible mechanisms within the Kyoto Protocol. While the other two mechanisms, emission trading and Joint Implementation (JI), function within the Annex I countries (developed countries and countries in transition economies) who have quantified carbon emission limits in the first commitment period in 2008-2012, the CDM works between Annex I countries and non-Annex I countries (developing countries) who do not have such a limit. The CDM creates project-based carbon transactions, where Annex 1 countries assist non-Annex I in implementing a carbon emission reduction project and acquire the credits to be issued on emission reduction (or removals by sinks) achieved by the concerned project with the project contributing to sustainable development in non-Annex I countries (UN 2000; Barrett, 1998; IGES, 2005; Victor, 2001).

In order to facilitate project-based carbon transactions, many carbon funds have been established, including some created by Governments. Their aggregated capitalization grew from $275 million in January 2004 to $950 million in April 2005 (Lecocq and Capoor, 2005). The Prototype Carbon Fund (PCF) managed by the World Bank (WB) is one of the frontier carbon funds, aiming at demonstrating the profitability of project-based carbon transactions, disseminating knowledge and supporting public-private partnerships (WB, 2005a).

This thesis will evaluate thirteen projects under the PCF, using project data obtained from the WB. A central part of the evaluation of the thirteen projects involves defining the Implicit Emission Reduction Cost (IERC) of Carbon. Considering the sheer number of carbon funds, many stimulated by the PCF (Asuka 2004), assessing the social profitability of those projects is an important exercise.

1.2 Aim and scope

This thesis aims to:

1) determine the IERC for the thirteen projects under the PCF managed by the WB;

2) demonstrate how IERC can be utilized in emission reduction project appraisal;

3) assess cost efficiency for the thirteen projects;

4) investigate whether there is a trade-off between cost-efficiencies and sustainable developments.

Although many practitioners assess the revenue impact of carbon credits generated by emission reduction (WB PAD 2005a; 2005b; 2004a; 2004c; 2002b; 2002c; 2001), revealing the cost of carbon credits has been less drawn attention. This thesis shed the light on the cost rather than price.

It is worthwhile emphasizing the difference between *cost* and *price*, since they are sometimes confused. Cost means production cost of emission reduction within each project. That is, the value each project has potentially in reducing carbon emission. Price, on the other hand, is determined by outside factors such as markets.

The scope of this thesis is limited to the assessment of cost-efficiency. Although Chapter 5 discusses the issue of contribution of sustainable development, the assessment on sustainable development by each project is beyond the scope of this thesis. Several methodologies have evolved for defining sustainable development criteria for CDM projects. These include Multi-Attributive Assessment of CDM invented by Sutter (2004), the Gold Standard invented by WWF, a world prominent environmental NGO (WWF, 2005a; 2005b; 2003; 2002), and the South-South-North (SSN) sustainable development tool invented by SSN, an environmental NGO (Sutter, 2004; Asuka, 2004). In order to utilize those methodologies, however, the stakeholders' preference for sustainable development indicators in economic, social and environmental aspects, such as employment generation, water quality etc., is critical. It is difficult to obtain the necessary information to conduct this analysis for the thirteen projects, which vary across countries and technologies for emission reduction.

1.3 Outline

This thesis is comprised of five parts. Chapter 2 explains the background to the CDM, Chapter 3 elaborates the methodology and data for calculating and evaluating IERCs, Chapter 4 presents the result of the analysis, Chapter 5 contains a discussion and an implication, and Chapter 6 concludes this thesis.

Chapter 2: Background to the Clean Development Mechanism

2.1 Overview of carbon projects and the Prototype Carbon Fund

The PCF was established in 1999 with $180 million contributed from Governments (Canada; Finland; Norway; Sweden; Netherlands; Japan Bank of International Cooperation) and public sectors such as electricity companies, banks, trading companies (WB, 2005b). As of September 30, 2004, it has reviewed over 400 potential CDM project proposals, of which 10 projects had signed an Emission Reduction Purchase Agreement (ERPA) and 15 projects are under negotiation for the ERPA (WB, 2005c).

The carbon transaction is added on a usual project structure. Figure 1 explains the typical project structure in the case of power generation types of carbon emission reduction projects such as wind power projects. The bottom left-hand dotted line shows a carbon contract. The finance provided by the PCF relates to this carbon contract.

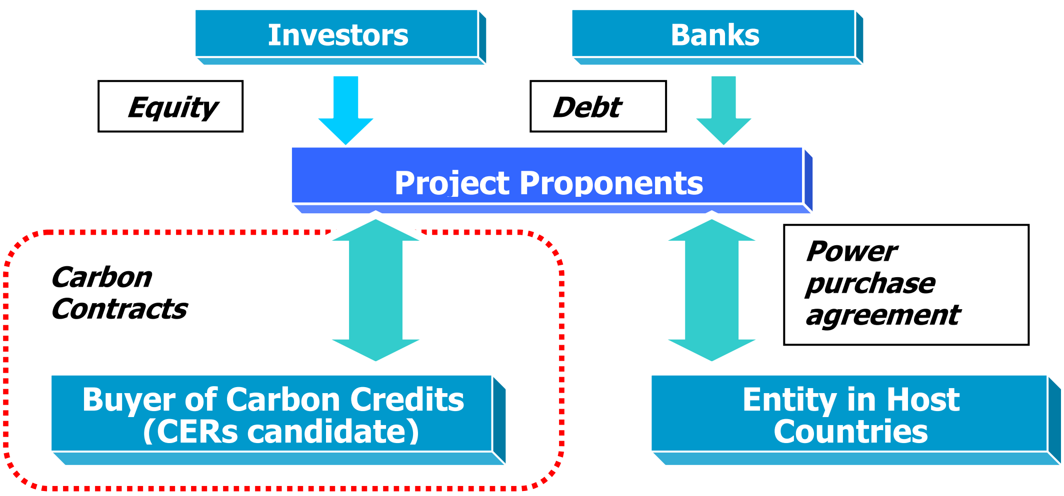


Figure 1: Project Scheme of the Carbon Emission Reduction Project

<Source adopted by WB (2002a)>

A long and complex process must be navigated before the carbon credits can be rubber stamped as Certified Emission Reduction (CER) (UNEP 2005; WB 2002b). Figure 2 provides an illustration of the certification process.

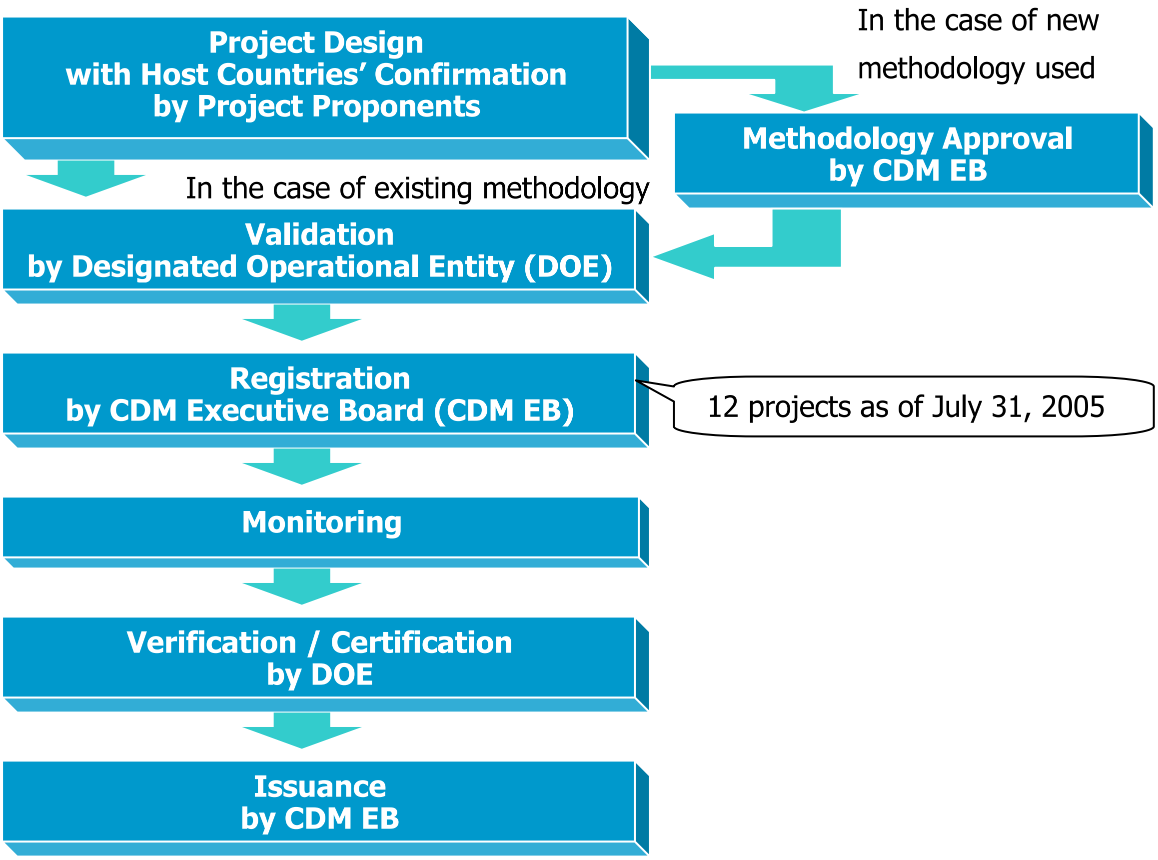


Figure 2: Clean Development Project Cycle

<Source: adopted from UNFCCC website, 2005a>

As of July 31, 2005, no CERs have been issued by the CDM Executive Board (CDM EB). Thus, all CERs currently traded in the market are "candidate" CERs, which inherently contain some delivery risks. All projects have the potential for not generating CERs as contracted, either by not being accepted by the CDM EB (a registration risk), or by not generating the promised emission reduction during operation. The most front runners are just entering monitoring (Point Carbon 2005a) and only 12 projects have completed registration (UNFCCC, 2005b). For validation which is done by

Designated Operational Entities (DOE), a third party inspection agency for the CDM project, 24 projects are posted on the UNFCCC website on July 31st 2005 for public comments, while 158 projects are stored in archives (UNFCCC, 2005c).

It is only recently that some projects go directly through from project design to validation stage. Still, many projects should go through methodology approval stage, since they use new methodology. Since CERs accrue as the difference between actual verified emission and "hypothetical" emission, which would have occurred without the CDM project, the project proponents should elaborate how to estimate the "hypothetical" emission i.e. baseline (WB 2002c; IGES 2004). This is known as preparing a methodology, which must be approved by the CDM EB. As of July 31, 2005, 23 methodologies and 4 consolidated methodologies have been approved (UNFCCC, 2005d). For Small Scale Projects (SSP), defined as the following projects: renewable energy projects up to 15 mega watt (MW); energy efficiency with reductions of 15 giga watt hour equivalent (GWh eq.) per year; other projects of less than 15,000 ton per carbon dioxide equivalent (t/CO2e) per year (UNFCCC, 2002, Decision 17/CP.7), 11 methodologies are approved (UNFCCC, 2005e), with no approved methodology for afforestation and reforestation (UNFCCC, 2005f).

None of the thirteen projects analysed in this thesis has been registered. They are either under validation, seeking for methodology approval or preparing project design including host countries' approval. Thus, all thirteen projects possess delivery risk.

2.2 Two Rationales: Cost-effectiveness and Sustainable Development

The CDM has dual purposes. The first objection is to reduce carbon emission cost-effectively. The second object is to contribute to sustainable development in non-Annex I countries (developing countries) (UNFCCC, 1997; UNEP, 2005; UN, 2000; IGES, 2004; Sutter, 2004).

The former objective – cost effectively reducing carbon emissions – is likely to be satisfied by CDM projects, because abatement costs in developing countries should be lower than those in developed countries (WB, 2004). As carbon dioxide (CO2) and other greenhouse gases mix rapidly in the atmosphere (Ueta and Hayashi, 2000; Sutter, 2004), it does not matter where the emission reduction takes place. The latter objective – sustainable development – is critical for the political acceptance of the CDM by the G77, a coalition of developing countries seeking to harmonize the negotiating positions of its 132 developing country members (Sutter, 2004).

Confirmation that the project contributes the sustainable development is "the host party's prerogative" (UNFCCCC, 2002, decision 17/CP.7). This is why the CDM project must acquire the host country's approval during the preparation of the project design. The Gold Standard, mentioned above, is one of the tools that may be used to assess sustainable development, declares that it is not seeking "to interfere with the host government's sovereign right to define sustainable development" but to offer "a framework for assessing this" (WWF, 2005). Concerns about sustainable development are addressed and discussed in Chapter 5.

One might hypothesise that there is a trade-off between the two objectives of the CDM.

Although case studies by the World Resource Institute and the Energy and Resources Institute in India conclude that there is a high degree of overlap between these two aims in potential projects in India (Sutter, 2004), Sutter (2004) argues that the selection of case studies and the chosen assessment methodology considerably influence the result of such studies. In contrast, Sutter (2004) argues that there is a trade-off whose magnitude depends on projects' distribution in terms of abatement costs and contribution to sustainable development. This argument accelerates "race to the bottom" concerns. There are many concerns that host countries may compete for weaker criteria of sustainable development contribution in order to attract CDM investment (Cosbey *et al*, 2005; Sutter, 2004; Asuka, 2004). These concerns stem from the current low level of CER prices and the existence of hot air, "a surplus of emission entitlements in economies in transition countries, especially in Russia and Ukraine, that may not be exhausted by economic growth" by 2010 (Barrett, 1998). This leaves most developing countries with less market power and may weaken the sovereign right to judge sustainable development contribution. If a trade-off exists between cost-effectiveness and high sustainable development contribution, sustainable development considerations may be ignored by investors and project proponents, who have an incentive to choose cost-effective projects.

2.3 Additionality Considerations

As the CERs account for the difference between actual emission and hypothetical baseline, the additionality is the central concept differentiating a business-as-usual project and the CDM project

(UNEP 2005; UN, 2000; Sutter, 2004; Asuka, 2004). Additionality is defined as Article 12.5 of the Kyoto Protocol stating that emission reductions shall be "additional to any that would occur in the absence of the certified project activity" (UNFCCC 1997). However, the interpretation of this statement has been extremely unclear.

Various additionalities have been discussed so far both in practitioners and literatures. Sutter (2004) discerns "environmental additionality" and "project additionality". This difference is the most important since the dispute over additionality explained below of this section has been environmental additionality only versus environmental plus other additionality. Environmental additionality is that a carbon emission reduction project should result in greenhouse gases mitigation compared with a hypothetical baseline (Sutter, 2004; Asukia, 2004; DTI 2005). Project additionality contains factors without which the concerned carbon emission reduction *project* would not have happened (Sutter, 2004). It ranges very widely and any additionality, including environmental additionality, discussed in this section can be considered as "project additionality".

Such project additionality, besides environmental additionality, may contain "investment additionality", "financial additionality" and/or "technical additionality". First, "Investment additionality" is that the project investors would not have invested the project without the CDM (Michaelowa and Greiner, 2003; Asuka 2004; DTI 2005). If a certain project is already attractive in investment profitability without the revenue generated by the CERs, this project would be most probably judged as having no investment additionality. Thus, the CDM EB may possibly reject to register carbon credits generated by such a project as CERs. This is the main issue within project additionality and creates controversy. Some argues that "investment additinality" must be necessary for eligibility of the CDM project (Michaelowa and Greiner, 2003; Asuka and Takeuchi, 2004), while others argue not (Jepma, 2003; Cosbey *et al*, 2005; UNEP, 2005). Second, "Financial additinality" is that the concerned carbon emission reduction project should not be diverted from Overseas Development Assistance (Asuka, 2004; Dutschke and Michaelowa, 2003; DTI, 2005). The Marrakech Accords clarifies this as the public funding for the CDM projects should not "result in the diversion of official development assistance", which is a financial obligation of developed countries for solving development issues (UNFCCC, 2002). This is endorsed by the Organisation for Economic Co-operation and Development, Development Assistant Committee (OECD DAC), explicitly ruling out the use of official development aid for the investment on CERs portion, while not mentioning other investment on underling finance (OECD, 2004). Finally, "Technical additionality" is that the technologies employed in the project should be the best available technology for the host nation (DTI, 2005; CGER, 2005).

The road leading to a decision by the CDM EB, the decision maker for approving methodology, has been long and winding (Sutter, 2004). The first draft of the Project Design Document (PDD) issued by CDM EB in 2002 endorses project additionality. After a backlash from business groups and Annex I countries, the final version of PDD changes the interpretation considerably towards "environmental additionality only". However, their decision in June 2003 swung back again for supporting environmental plus project additionality. The CDM EB rejected all baseline methodologies submitted by the project under the Certified Emission Reduction Units Purchase Tender (CERUPT), the world's first tender for soliciting CDM projects dealt by the Dutch Government. The reason for this was due to the lack of or too lax an additionality test (Sutter, 2004; Asuka, 2004). Further, the CDM EB released the "Tool for the demonstration and assessment of additionality", which consists of 5 steps: identification of an alternative, investment analysis, barrier analysis, common practice, and impact of CDM registration (UNFCCC, 2004). This tool leans further for requiring project additionality, however, it is criticized. Some concerns about over-conservatism on defining "additionality", which may impede foreign direct investment flow (Eco Securities, 2005; UNEP 2005). Further, this tool is criticized because it does not clarify the baseline scenario, critical for defining the CDM project and so just burdens a project proponent additional task for the CDM procedure (Matsuo, 2005). A clear consensus how to assess additionality seems to be slow and unlikely to appear in the near future.

Chapter 3: Methodology and Data

This chapter explains the methodology and data. Section 3.1 elaborates the methodology, introducing the concept of an IERC of carbon, providing an overview of the most important different carbon prices appearing in the literature, and explaining the variables for sensitivity analysis. Section 3.2 addresses data and documents the sources, and explains the selection criteria of the data.

3.1 Methodology

3.1.1 IERC Calculation

The IERC is a break-even value which brings the Net Present Value (NPV) to zero. By explaining why and how NPV is calculated, this section reveals why and how IERCs are calculated.

The NPV approach is widely used for inter-temporal project appraisal (Lumby and Jones, 1999; Currey and Weiss, 1993). It enables one to restate a future net cash flow as an equivalent current one (Kolstad, 2000; Tietenberg, 2003), allowing several projects to be compared and evaluated on the present value basis.

The NPV is calculated in four steps: first by deciding an appropriate time horizon for project appraisal; secondly by calculating net cash flow in each year during a determined time horizon; thirdly by discounting future net cash flow in each year and restating them in a present term; fourthly by aggregating discounted net cash flow (Lumby and Jones, 1999). This requires data on project-related-periods, cost and revenue, and discount rate. The data employed for this analysis will be described in 3.2.2.

Within the four steps, especially discounting the future value, “time value of money” is the central concept in calculating NPV (Lumby and Jones, 1999). It is done by a discount factor which weighs the future cash flow. The discount factor is computed by the equation:

$$D(t) = \frac{1}{(1+r)^t} \quad \text{---------(1)}$$

where, D is the discount factor, t is the time horizon, and r is the discount rate.

Since the discount rate (r) is exponential with time (t), selecting a discount rate and time horizon has a significant impact on NPV (Turner *et al*, 1994; Pearce *et al*, 2003).

Although it is not the only determinant, the NPV is one of the decision making tools used to decide whether the investors make an investment on the specific project (Lumby and Jones, 1999; Curry and Weiss, 1993). An investor may compare between two projects to determine which one should be invested in or compare an investment with an immediate consumption. The latter brings the principal norm that the NPV should be at least over zero (Lumby and Jones, 1999; Currey and Weiss, 1993), since, if a project does not generate any NPV, then the rational person should consume money now (Pearce *et al*, 2003). In this manner, the discount rate reflects the opportunity cost of capital (Curry and Weiss, 1993).

NPV, however, does not directly reveal the cost of carbon emission reduction under a certain project, since each project has different amounts of carbon emission reduction. The evaluators, who can be any participants: investors, project proponents, project sponsors, fund managers, a host countries' government, and participants from the developed countries, should have the emission reduction cost per ton carbon dioxide equivalent (tCO_2e) in order to compare projects' cost-efficiency in emission reduction. The Implicit Emission Reduction *Cost* (IERC) is the value per ton CO_2e, which brings NPV to zero and represents project's potential in carbon emission reduction cost-efficiency. It is a production cost for producing one unit of carbon credit.

From the investor's perspective, one can consider that IERCs should be the least carbon *price* acceptable for the investors, taking into account that the NPV should be at least over zero. In another word, the investor implicitly wishes to have project proponents to *sell* carbon credits, i.e. candidate CERs in a CDM project at IERC's level in order to avoid the negative NPV.

Some academics have used the same concept as the IERC for assessing the carbon emission reduction project's cost-efficiency. Motta *et al* (2002) conducted an economic analysis of Brazilian forestry and energy CDM projects by using "the minimum carbon price level" which ensures a zero NPV under a discount rate of 12%. This is the price level which a certain project option needs to obtain at the CDM market, although it is one of several indices for investment appraisal. Oxera (preliminary before publication 2005), a prominent UK-based policy research institute, is exploring benefits net of cost per tonne of carbon saved, in order to assess the variety of cost-efficiency resulting from different policy approaches (taxation, voluntary agreement with car manufactures, subsidies, building standards, etc.) in various sectors (household, business, agriculture, transport, etc.).

Asuka (2004) critically introduces the concept of carbon credit value necessary for achieving an investor's expecting profitability (not NPV zero but some profit) as the production *cost* of carbon emission reductions. His critique is based on the arbitrariness in determining "expected profitability". Thus, if we fix "expected profitability" as the level of NPV to zero, his critique may not be appropriate. Furthermore, the lack of data availability often makes other means for calculating production cost of carbon emission reductions difficult. The "incremental cost" approach, adopted by Global Environmental Facility (GEF), a trust fund providing grants for carbon emission reduction projects under the UNFCCC, calculates the unit carbon emission reduction cost by dividing the project cost difference between a business-as-usual case (eg. coal-fired plant) and an environmentally-friendly case (eg. wind-power plant) with thee estimated carbon reduction (GEF 2005; GEF 1996). This approach requires project cost data for the business-as-usual case, which is, however, often not available. On the other hand, the IERC can be used as a production cost of carbon emission reduction under a certain project without knowing the business-as-usual project cost. Moreover, understanding and calculating the incremental cost is complicated and knowledge accumulation required (GEF, 2002). The implementing agencies of the GEF have made great efforts to educate recipient countries (GEF, 2002). Considered the current burden carried by the project proponents, such as baseline development and the proof of additionaliy, the simpler way of estimating "cost" without a substantial additional effort seems desirable. Thus, the IERC is rational on estimating "production cost" of one carbon credit.

In this thesis, an IERC for the thirteen projects is calculated in three steps: first by inputting carbon credit amounts; secondly by choosing the carbon inflator; thirdly by using the goal seek function of Excel which calculates the break-even carbon price. The data employed for this analysis will be described in 3.2.3.

3.1.2 Carbon Prices

The calculated IERC will be compared with different carbon prices: a Social Cost of Carbon (SCC), European Union Allowance (EUA) prices and CER prices. The comparison works as a cost benefit test as depicted in Figure 3. IERCs are the cost of one unit (1tCO2e) emission reduction, while price signals represent benefit of avoiding one unit (1tCO2e) emission reduction. If benefit is greater than cost, such a project passes the cost benefit test and vice versa. Thus, this comparison gives the answer whether the sample projects financed by PCF are cost-efficient or not.

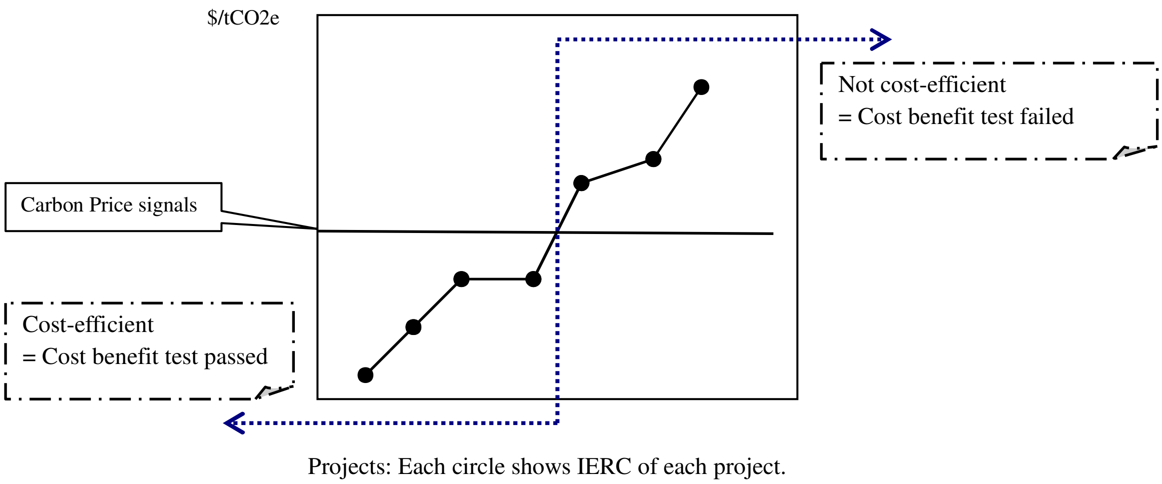


Figure 3: Cost Benefit Test by IERCs versus Various Carbon Prices

Carbon Price (1) the Social Cost of Carbon

The SCC expresses the present value of the marginal benefit to avoid the extra damage by one unit (1tCO2e) emission reduction. That is the value brought to the society by curbing one unit of greenhouse gases. If the investment for reducing greenhouse gases should ensure the most efficient level (the optimal allocation) as economics have argued (Kolstad, 2000; Tietemburg 2003), then SCCs will express a justifiable level to which the society should make an effort for decreasing greenhouse gases. That is, it is not the optimal allocation of the wealth if the society invests money in excess of the value such an investment brings about. Supported by this demand, many academics have estimated SCCs for emission in this decade by monetizing the projected damage caused by climate change throughout the far future, such as hundred year time frames, and discounting them to present values (Pearce, 2003a; Tol, 2003; Clarkson and Deyes, 2002; Nordhause and Boyer, 2000; Cline, 2004). Thus, SCC can examine whether a certain investment for an emission reduction project lies within the optimal allocation of social wealth or not.

The estimate of SCCs, however, varies widely due to different assumption parameters, scope and value judgement (Pearce, 2003a; Tol, 2005; Clarkson and Deyes, 2002; Ceronsky 2004; Kolstad and Toman, 2001). Tol (2005) gathered 103 estimates of SCCs from 28 published studies and found a wide range of estimates: the mode at $0.5/tCO2e; the median at $3.8/tCO2e; the average of $25.3/tCO2e; the upper bound as $95.4/tCO2e[1] (Tol, 2005). However, after a better understanding of how each assumption parameter affects estimates causes the range of estimates to converge to some extent. In the same survey, Tol (2005) further discerns with a meta-analysis the estimates depending

[1] The original paper uses the unit as “tC” (ton carbon). The author converted those figures with an equation as X”tC”/3.67=Y”tCO2e” (ton carbon dioxide equivalent).

on one of the most influential parameters, discounting: in particular, a pure rate of time preference which is one of factors comprising social discount rate (Tol, 2005; Pearce 2003a; Clarkson and Deyes, 2002; Ceronsky 2004; Cline, 2004). This analysis concluded the average of $4.4/tCO2e and the upper bound as $16.9/tCO2e in the case of a pure rate of time preference of 3% and the average of $13.5/tCO2e in the case of a pure rate of time of 1%. It is finally suggested that the range of SCC is $2.7-$5.5/tCO2e, with an upper limit of $13.6/tCO2e (Tol, 2005).

Considering Tol's finding, the author adopted the upper bound of Pearce's estimate (2003a), $9.1/tCO2e (US$1990) as a carbon price signal for this thesis appraisal, since it contains a declining discount rate with a reasonable pure rate of time preference and equity weighing. This SCC is estimated on the base studies of Nordhaus and Boyer (2000) and Tol and Downing (2000), selected after peer-review of 13 studies (Pearce 2003a). It uses a pure rate of time preference of 3%, a corresponding social discount rate 4-5%, which can be argued as "close to what most western governments use for most long term investments" (Tol 2005). Also, it adopts a declining discount rate, which can be a countermeasure to cope with the "tyrannical fashion" of the exponential discount rate especially for avoided damage in the far future (Hepburn 2004; Weiztman, 2001). For example, the present value of $100 in 100 years is only $5.2 with a 3% flat discount rate ($\$100/(1.03)^{100} = \$5.2$). A declining discount rate has started to be adopted for avoiding the drawback of the flat discount rate (Ceronsky, 2004). It also considers equity weighing, which incorporates the utility difference depending on income level. One dollar for the poor brings greater utility than for the rich (Anthoff, 2004; Tol 2003). This is important, as the impact by climate change covers globally, where both poor and wealthy countries exist. Pearce SCC incorporates those critical parameters.

However, a caution should be drawn on scope and judge value for avoided damage in the Pearce estimates, although its discussion is out of the scope of this thesis. First, the Pearce estimates include adaptations, such as inventing a hot weather resistant crop, which usually decrease avoided damage. Secondly, it does not include damage by catastrophe, such as thermohaline collapse, which increases marginal avoided damage by emission in this decade. Thirdly, it does not include socially contingent damage, such as the additional cost by migration due to climate change which may increase marginal avoided damage (Pearce, 2003a). Furthermore, ancillary benefit, which happens concurrently with greenhouse gas emission reduction projects, is not considered (Pearce, 2003a). For instance, if a coal-fired thermal power plant changes to a wind farm for curbing greenhouse gases, such a project also reduces sulphur oxide emission which should be beneficiary to local people's health. The last benefit is linked to the notion of contribution to sustainable development, one of two rationales of the CDM project.

Carbon Price (2) European Union Allowance Prices

The emission trading scheme theoretically realizes the cost-effective solution for reducing greenhouse gases (Tietenberg, 2003; Kolstad, 2000). While imposing the allowance limit for emitting greenhouse gases in each installation, the emission trading scheme allows participant installations to trade their allowances among each other. Each installation reduces emission until their marginal abatement cost of carbon emission equalizes allowance price. One installation having a lower marginal abatement cost reduces more greenhouse gases and could trade the surplus allowances to the others having a higher marginal abatement cost. Thus, equimarginal cost-effectiveness in the society can be realized.

The European Union Emission Trading Scheme (EU ETS) is the single largest market for greenhouse gases emission allowances, which started operation in January 1, 2005 (EC, 2005; Lecocq and Capoor, 2005; Asuka, 2004). It sets the first phase (2005-2007) for CO2 only and the second phase (2008-2012) for possible expansion to other greenhouse gases specified in the Kyoto Protocol such as methane. The banking over annual transaction and over phases are also permitted. It covers more than 12,000 installations, representing about 45% of the 25 EU countries' total CO2 emissions. Thus, the allowances price in EU ETS (EUAs: European Union Allowance) should represent equimarginal abatement cost for those installations.

The so-called "Linking Directive" (European Directive 2004/101/EC) governs the relationships between the ETS and the Kyoto Protocol. It recognizes that the credit value produced by the CDM and the JI projects is equivalent to the credit value of EU allowances, by allowing the import of CERs produced by the CDM project and Emission Reduction Unit (ERUs) produced by the JI project into the ETS except credits produced by nuclear facilities or sequestration (EC, 2005; Lecocq and Capoor, 2005). Thus, the investor for the CDM projects should consider the EUAs price as a potential benchmark, according to which they could trade their carbon credit.

The EUAs prices, however, have fluctuated widely. The price was €7-9 ($8.8-$11.3) in 2004, and has increased steadily and gradually up to approximately €20 ($25.0) until the beginning of June, 2005 after formal inception of EU ETS (Lecocq and Capoor, 2005). Then, EUAs prices started a steep increase in the middle of June, and recorded the highest level of over €29 ($36.3) on July 11, 2005. They decreased suddenly down to €18 ($22.5) in July 22, 2005. At time of writing (the end of July), EUAs were traded at about €20 ($25) (Point Carbon, 2005c). Thus, this assessment uses those three levels: a low level in 2004, a current level and a record level.

It is noteworthy that Lecocq and Capoor (2005) suggest that the current EUAs price may not represent the long-term supply-demand equilibrium during 2005-2007 and might decrease its price in the long-term. This is because the current price may be sustained by cold weather, high oil prices and less participation from Eastern European member States where potential supply sources of carbon emission reduction are abundant.

Carbon Price (3) Certified Emission Reduction Prices

The current prices traded as CERs are settled mainly between the buyer and the original credit supplier, while financing institutions appear to simply start seeking for an opportunity in the secondary market for purchasing credits at a lower price and selling them at a higher price (Point Carbon, 2005b). Although the price is just one of many contractual factors, the CDM project investor may consider this price as a benchmark for their investment appraisal. The most influential benchmark should be the WB PCF reference price as $3-5/tCO2e (WB, 2002; Asuka, 2004) and thus will be used for this assessment. Nevertheless, this section explores briefly the CER price for envisaging the market outlook.

The CER prices show great variety, since each contract possesses different terms, risk and characteristics (Lecocq and Capoor, 2005; Asuka, 2004). One way of understanding CERs price is by the registration risk. When a seller takes little or no risk for registration, remaining a dominant contractual style, credit price is lower, while it is higher when a seller takes risk (Point Carbon 2005a). A wide range of risk hedges are considered in either case: i.e. payment stops if the contracted carbon credits are not issued as CERs; incurred liquidated damages if CERs are not delivered; simple cancellation if CERs not delivered; no cancellation even if CERs not issued A recent survey reports $3.60-$5.00 for the former (buyer takes a registration risk) with a weighted average of $4.23, and $3.00-$7.15 for the latter (seller takes a registration risk) with a weighted average of $5.63, in the period between January 2004 to April 2005, indicating approximately $1.4 premium for registration risk (Lecocq and Capoor, 2005). A recent report quotes €4.5-7.5 ($5.6-$9.4) for the former and an average of €9 ($11.3) for the latter, with the upper limit approximately €11 ($13.8) (Point Carbon, 2005a). Thus, as Table 1 shows, one can say that the market judges the registration risk fee in the range of $1.4-$4.

Table 1: Certified Emission Reduction Prices Difference depending on Registration Risk

	Buyer's Risk	Seller's Risk	Registered CERs	Differential
Lecocq and Capoor (2005)	$3.60 - $5.00	$3.00 - $7.15		
for Jan. 2004 - Apr. 2005	Ave. $ 4.23	Ave. $5.63		$1.4
Point Carbon (2005a)	€4.5 - €7.5	Ave. €9	not over €11	approximate
for "recent market" Jul. 26	($5.6-$9.4)	(Ave. $11.3)	(not over $13.8)	$4

<source: from Lecocq and Capoor (2005); Point Carbon (2005a)>

Another method for understanding various CERs price is difference in technology. CERUPT specified the target prices depending on technologies in its Terms of Reference (Asuka, 2004). Although it does not disclose whether these prices are actually used for the contracts, this reveals implicitly the market perception on the value difference in technologies. Similarly, a paper in 2003 reports the difference in price levels of carbon contracts depending on technologies (Cogen *et al*, 2003). Table 2 shows the difference in prices by technologies.

Table 2: Certified Emission Reduction Prices Difference depending on Technologies

CERUPT max. price on Terms of Reference		Cogen *et al* (2003) mainly from PCF & CERUPT			
Renewable Energy (not biomass)	€ 5.50	Wind (RE)	$3.43	-	$7.92
		Geothermal (RE)	$3.02	-	$5.99
		Hydro (RE)	$3.00	-	$5.99
		Unspecified (RE)	$3.83		
Clean biomass (not waste)	€ 4.40	Biomass (RE)	$3.15	-	$7.92
Energy Efficiency	€ 4.40	Energy Efficiency	$2.46	-	$5.18
Fuel Switch, Methane Recovery	€ 3.30	Fuel Switch	$3.50		
		Process Change	$2.00	-	$4.00
		Landfill Gas	$0.65	-	$6.79
		Cogeneration	$8.00		
		Flare vent receovery	$3.00	-	$5.00
		Afforestation	$3.63		
		Unspecified	$2.50	-	$6.00

<Source: Asuka (2004); Cogen *et al* (2003)>

One interesting phenomena emerging in the market currently is a premium for "development-friendly" CERs (Ellis *et al*, 2004; WB, 2004). A survey by questionnaires for 60 Japanese and 22 European private companies, aiming at quantifying premium and discerning its factor, concludes that a premium for CERs highly contributing to sustainable development does exist, in spite of its relatively small ratio within premium factors (Asuka, 2004). The Government of Germany declares to purchase CERs endorsed by the Gold Standard at €10, which is higher than prices specified in CERUPT (Asuka 2004). Although a higher contribution to sustainable development is just one factor for achieving the Gold Standard approval (WWF, 2005b), this may prove the recent trend favouring development friendly projects.

Since EU ETS allows the import of CER as described above, the prices of EUAs and candidate CERs should converge theoretically as arbitrageurs would purchase cheaper CERs and sell them at EU ETS with a higher price, which does not happen thus far (Lecocq and Capoor, 2005). Lecocq and Capoor (2005) points out three possible reasons: 1) riskier contracts in CERs than EUAs; 2) time delivery challenge for 2005-2007 vintage CERs; and 3) remaining regulative uncertainty for importing CERs into EU ETS. However, they also concluded that time will resolve these issues on the ground that regulative uncertainty is rather a technical issue which can likely be resolved, and that a larger portfolio of CERs in the future may facilitate aggressive contracts in which the seller takes more risks. Furthermore, the more a secondary market develops, mainly by a financing institute, the less discriminative price difference would occur between EUAs and CERs, and even within candidate CERs (Point Carbon 2005b). However, when such convergence will happen is still questionable (Lecocq and Capoor, 2005).

3.1.3 Variables for Sensitivity Analysis

After the cost benefit test with the above three carbon prices, the sensitivity analysis with five variables was conducted. The first two are 1) discount rate and 2) carbon inflator. Products' sales price such as electricity prices, often chosen as a variable for a sensitivity analysis, are not selected in this thesis, since they are assumed in the original data and it is not an aim of this thesis to challenge the original assumption. The other three are issues unique to the CDM projects, widely discussed both among academics and practitioners: 3) the post-2012 issue; 4) credit delivery risk; and 5) transaction cost. These three variables are selected because other CDM-related issues do not directly affect IERCs. However, one should note that these sensitivity analyses aim mainly at demonstrating the potential use of IERCs and not at assessing these issues themselves and hence some caution might be appropriate. If one would like to assess them, a holistic approach including political, institutional and other economical analyses should be undertaken.

Discount Rate

As elaborated in Section 3.1.1, since the discount rate influences drastically on NPV, the selection of discount rate for assessing projects is important (Kolstad, 2000; Tietenburg, 2003). While a private sector cost benefit analysis often uses Weighted Average Capital Cost (WACC), the weighted average interest rate of several finance sources required for a specific project (Lumby and Jones, 1999), a public sector cost benefit analysis, assessing social profitability, adopts social rate of time preference as discount rate, which is estimated by the equation (Turner *et al*, 1994):

$$s = \rho + \mu g \quad \text{--------} \ (2)$$

where, s is social rate of time preference (social/consumption discount rate), ρ is pure rate of time preference (utility discount rate), μ is aversion to inequality, and g is consumption growth rate.

This represents the opportunity cost of capital for a society.

Carbon Inflator

The carbon inflator is the annual increasing percentage carbon *value* per tCO2e. The damage caused by 1 CO2te emission gets worse year by year, since such damages have a positive function to accumulated greenhouse gases (Clarkson and Deyes, 2002), while greenhouse gases will stay in the atmosphere ranging from days to millennia (Houghton, 2004). An emission in 10 years would damage more than today's emission. Thus, carbon value for 1 tCO2e should increase year by year.

Factors Post-2012

Because of political and institutional uncertainty beyond 2012, an interest in CERs generated after 2012 is very limited and prices are low (UNEP, 2005). The fact that the CERs can be generated up to 21 years (7 years times 3 periods) under the Kyoto Protocol rule implies that policy makers originally intended that the CERs generated after 2012 should keep value (Lecocq and Capoor, 2005). Lecocq and Capoor (2005) suggest the UNFCCC Parties to indicate that the CERs generated after 2012 "will be valid", which may help in diluting investor's concern for the post-2012 vintage CERs. However, no one knows the market making function follows the UNFCCC Parties indication. Rather, a steep fall in CERs price may be possible even though such CERs are still "valid". There is still huge uncertainty for post-2012 (UNEP, 2005; Haites, 2004). Due to this connection, sensitivity analysis was conducted with these 13 projects by omitting carbon credits to be generated after 2012.

Credit Delivery (Registration Risk)

The CERs will be issued only after the long process as described in Chapter 2. Although there are 10 projects registered (as of July 20, 2005), the registration is the relatively early stage of the procedures. The fastest runner is proceeding through the monitoring phase at time of writing, where over - and/or under- estimation issues have only just started to be discussed. For example, the Korean Ulsan HFC23 Reduction Project has monitored only 30% of originally estimated CERs, while Indian Rajasthan Biopower Project achieved 96% of the original estimates (Point Carbon, 2005a). Thus, there are continuous credit delivery risks as the procedure continues especially for pioneering projects.

Even within the first step of the procedure, namely Validation and Registration, some projects take a weaving course. This may be the reason that CERs prices are often categorized with and without registration risk as discussed in the former section. Out of the 13 projects evaluated, the Brazil Plantar project has a huge discrepancy between the credit amount (12,885,984 tCO2e) in the Project Appraisal Document (PAD) and Project Design Document (PDD) originally issued by the WB and the amount (1,704,111 tCO2e) in the PDD recently submitted to the CDM EB. While the former counts the carbon credit achieved by forest sequestration, fuel switch and methane recovery, the latter only counts the carbon credits achieved by methane recovery. This difference resulted from that this project is one of the first frontier carbon sequestration project as a CDM project and there was no clear methodology at that time on estimating carbon credits from sequestration (Dopazo, 2005, personal communication). The civil society, including NGOs, has been fiercely against this project particularly for carbon credits earned by sequestration in mono-culture plantation (CDM Watch, 2005e; Wysham, 2005). Considering these situations, the author assumes that the project proponents may possibly need to reduce the credit amounts. This can be an example of credit registration risk, although the Brazil Plantar project has not yet been registered. Therefore, sensitivity analysis with this example was conducted in order to demonstrate how registration risk will affect IERC estimates. Similarly, China CMM Project has a discrepancy, although it is rather small, in carbon credit amount between the PAD and the PDD recently submitted to the CDM EB. Thus, this project will also be analyzed.

Transaction Costs

The transaction cost is believed to be one of the biggest impediments to foster the CDM projects (Barrett, 1998; UNEP, 2005; Asuka 2004; Ellis *et al*, 2004; Michaelowa *et al*, 2003). In particular, the projects earning smaller amounts of carbon credit are more disadvantageous than those earning larger amounts of carbon credit (Michaelowa *et al,* 2003; Asuka, 2004; Fitcher 2003). Michaelowa *et al* (2003) argue that the CDM project with annual emission reduction less than 50,000 tCO2e is unlikely to be viable due to transaction cost.

The transaction cost unique to the CDM projects is incurred at the "pre-implementation" and the "implementation" stages (Michaelowa *et al*, 2003). The former includes search costs, negotiation costs, including one associated to the preparation of the PDD to be paid to consultancy, baseline determination cost to be paid to consultancy, approval costs, validation cost to be paid to DOEs, review costs for validation, and registration costs to be paid to the CDM EB. The latter includes monitoring costs, verification costs and review costs to be paid to the DOEs, and certification costs to be paid to the

CDM EB.

The transaction cost varies depending upon the project type and size, often falling in the \$50,000-\$250,000 range for pre-implementation (UNEP, 2005). Asuka (2004) summarized 5 papers' stating transaction costs with a caveat. That is, they are the figures from a few years ago and may possibly have increased recently, ranging from \$53,000-\$200,000 for pre-implementation and \$9,000-\$250,000 for implementation. The Chile Hydro project, one of the evaluated 13 projects, estimates transaction costs as \$200,000 for pre-implementation and \$350,000 for implementation (WB PAD, 2001)

Sensitivity analysis of the transaction costs for four projects (the Chile Hydro project; Mexico Waste Guadalajara subproject; Mexico Waste Leon subproject; and the Mexico Waste Monterrey II subproject), where information on transaction costs can be found in their PADs, will be conducted. Additionally, the analysis is also conducted with the hypothetical transaction costs, \$250,000 for pre-implementation, in order to demonstrate how pre-implementation transaction costs are affected assuming the same transaction cost for all thirteen projects.

3.2 Data

3.2.1 Project Selection and Sources

The availability of data determined the selection of the thirteen projects. The WB has posted 25 CDM projects on the Website (WB 2005c) for which Emissions Reductions Purchase Agreements

(ERPAs) signed or under development with PCF. Of them, thirteen projects (including subprojects) have the necessary data available for calculating an IERC such as cost and revenue data, and can be analyzed tangibly.

For collecting the required data, primarily five sources are used:

1) the WB web-site information available on June 1, 2005 (WB 2005d);
2) the Project Appraisal Document (PAD) downloaded from the WB web-site on June 1, 2005 (WB PAD 2002a; 2001) or acquired from the WB CFB Helpdesk by personal communication on June 6, 2005 (WB PAD 2005a; 2005b; 2004a; 2004b; 2004c; 2002b; 2002c; 2001);
3) the Project Design Document originally made by the WB (WB PDD) was downloaded from the WB web-site on June 1, 2005 (WB PDD 2003a; 2003b; 2002a; 2002b; 2001) or acquired from the WB CFB Helpdesk by personal communication on June 6, 2005 (WB PDD 2004);
4) the Project Design Document posted on the United Nations Framework Convention on Climate Change (UNFCCC PDD) as of June 25, 2005 (UNFCCC PDD 2004a; 2004b; 2004c; 2003);
5) the web-site information by CDM Watch as of June 25, 2005 (CDM Watch, 2005d-m), which is one of the active NGOs for monitoring the CDM project.

Refer to Table 3 showing available data sources.

Table 3: Evaluated 13 Projects with Data Sources (order by technologies)

Project Name	Technology for Emissionn Reductions	PAD date	PAD	WB PDD	UNFCCC PDD	CDM Watch
Colombia Wind project	Wind farm	14-Nov-02	XX	X	NA	X
Costa Rica Cortega Wind subproject	Wind farm	30-Oct-02	XX	NA	NA	X
Costa Rica Vera Blanca Wind subproject	Wind farm	30-Oct-02	XX	NA	NA	X
Chile Hydro project	Hydroelectricc (run-of-river hydro)	5-Dec-02	X	X	X	X
Costa Rica Hydro subproject	Hydroelectric (Small hydro)	30-Oct-02	XX	NA	NA	X
China Hydro project	Hydroelectric (Run-of-river hydro)	30-Jun-04	XX	XX	NA	X
China CMM project	Methane recovery from Coal Mine Methane, Fuel switch	1-Jul-04	XX	NA	X	X
Mexico Guadalajara Waste project	Landfill gas management (reduced methane), Fuel switch	2-Feb-05	XX	NA	NA	NA
Mexico Monterrey II Waste project	Landfill gas management (reduced methane), Fuel switch	2-Feb-05	XX	NA	NA	NA
Mexico Leon Waste project	Landfill gas management (reduced methane), Fuel switch	2-Feb-05	XX	NA	NA	NA
India Waste project	Landfill gas management (reduced methane), Fuel switch	10-Nov-04	XX	X	X	X
Brazil Plantar project	Forest sequestration, Carbonization methane (reduced methane) , Resource switch (coal to biomass)	1-Apr-02	X	X	X	X
Moldova Sequestration project	Forest sequestration	10-Sep-03	XX	X	NA	NA

X: data available on the websites
XX: data acquired by the personal communication with the WB on June 6, 2005
NO: The projects for which PADs are not yet developed at the moment of June 6, 2005.

The PAD is an appraisal document made by the WB for investment judgment. Typically, a regional base department in the WB (eg. Latin America and Caribbean Region) cooperates with a specialized department (eg. Finance, Private Sector and Infrastructure Department; Environmental and Social Sustainable Development), and both are responsible for writing PADs. The PAD should contain the necessary data for calculating an IERC since it provides a project description and project analysis, including financial and economic analysis, while other documents than PADs lack such financial data. Thus, all evaluated 13 projects have the PAD. Note that some PADs do not contain tangible cost and revenue data, and just provide the result of financial analysis, such as Brazil Atals Monguiana Bagasse Cogeneration project. Those projects are also excluded from this thesis evaluation.

The PDD is the standard formatted document which the CDM project participants (mostly the project developer) should prepare in the very first stage and submit to the DOE for “validation” and thus eventually to the CDM EB for “registration” (UNFCCC 2005b; IGES, 2004). The WB PDDs are available for 6 projects. The UNFCCC PDDs posted on the UNFCCC Website either during methodology, validation and registration approval are for 4 projects.

The CDM Watch is a Non Governmental Organization based in Bali, Indonesia, who monitors the CDM projects, in particular whether the CDM project assures additionality and contributes to sustainable development without harming environment (CDM Watch, 2005a). It provides the information, including carbon credit amounts and crediting period of PCF projects on the website, which is available for 10 projects out of 13 projects in this thesis.

The data obtained from those sources are project-related periods, cost and revenue, discount rate and carbon credit amounts. There are sometimes discrepancies or lack of complete data within and among the documents. In such cases, the author made appropriate assumptions. In order to clarify, Appendix 1 is provided, which elaborates in particular the difference between the original data statement including their assumptions and the author’s assumptions for the above four data. Further, in Appendix 2, the IERC calculation sheet for all projects, show the actual numbers used for the analysis. These two documents enable the reader to check in detail how the data were collected.

The interviews were also conducted either by e-mail or face-to-face with the personnel in charge of Carbon Finance Business in the WB. The latter was conducted either on May 15, 2005 when the author made a presentation to persons of the Carbon Finance Business in Washington DC, USA, or on August 12, 2005 when the author visited Washington DC. This is not structured-style interview but open-style discussion.

3.2.2 Data for NPV Calculation

As described in the former section, data regarding project-related-periods, cost and revenue, and discount rate are necessary for calculating the NPV. The case of the Chile Hydro project is exemplified, since its PAD is accessible on the WB website (WB PAD, 2001). Table 4 and Table 5, Excel sheets of the Chile Hydro project, may help the readers in understanding how the NPV was calculated. Refer to Appendix 2 for other projects.

Table 4: Calculating NPV, Chile Hydro Project in Project Lifetime

C value inflator	
Discount rate	10%

Discount rate

Cost and Revenue

Project lifetime = Evaluated period

Crediting period

w/o Carbon Revenue :

Cost & Revenue information: PAD p17-18 for 2001-16; PAD p25 for 2017-2041

		mil $	tCO2e		$	mil $	-	mil$	Cap. Exp.	Op. Cost	Ope. Cost	Revenue	Revenue	Revenue
	Year	Net Cash Flow	Carbon Credit	Year	Carbon Value	Carbon Benefit	Discount Factor	Present Value	Investment	O&M	Toll	Spot Energy	Contract Energy	Capacity
2001	0	-17.000				0.000	1.000000	-17.000	-17.000					
2002	1	-18.937		1		0.000	0.909091	-17.215	-20.000	-0.150		0.148	1.065	
2003	2	3.820		2		0.000	0.826446	3.157		-0.320	-0.150	1.110	2.264	0.916
2004	3	3.820		3		0.000	0.751315	2.870		-0.320	-0.150	1.110	2.264	0.916
2005	4	3.820		4		0.000	0.683013	2.609		-0.320	-0.150	1.110	2.264	0.916
2006	5	3.820		5		0.000	0.620921	2.372		-0.320	-0.150	1.110	2.264	0.916
2007	6	3.820		6		0.000	0.564474	2.156		-0.320	-0.150	1.110	2.264	0.916
2008	7	3.820		7		0.000	0.513158	1.960		-0.320	-0.150	1.110	2.264	0.916
2009	8	3.820		8		0.000	0.466507	1.782		-0.320	-0.150	1.110	2.264	0.916
2010	9	3.820		9		0.000	0.424098	1.620		-0.320	-0.150	1.110	2.264	0.916
2011	10	3.820		10		0.000	0.385543	1.473		-0.320	-0.150	1.110	2.264	0.916
2012	11	[illegible]		11		0.000	0.350494	1.339		-0.320	-0.150	1.110	2.264	0.916
2013	12	3.820		12		0.000	0.318631	1.217		-0.320	-0.150	1.110	2.264	0.916
2014	13	3.820		13		0.000	0.289664	1.107		-0.320	-0.150	1.110	2.264	0.916
2015	14	3.820		14		0.000	0.263331	1.006		-0.320	-0.150	1.110	2.264	0.916
2016	15	3.820		15		0.000	0.239392	0.914		-0.320	-0.150	1.110	2.264	0.916
2017	16	3.820		16		0.000	0.217629	0.831		-0.320	-0.150	1.110	2.264	0.916
2018	17	3.820		17		0.000	0.197845	0.756		-0.320	-0.150	1.110	2.264	0.916
2019	18	3.820		18		0.000	0.179859	0.687		-0.320	-0.150	1.110	2.264	0.916
2020	19	3.820		19		0.000	0.163508	0.625		-0.320	-0.150	1.110	2.264	0.916
2021	20	3.820		20		0.000	0.148644	0.568		-0.320	-0.150	1.110	2.264	0.916
2022	21	3.820		21		0.000	0.135131	0.516		-0.320	-0.150	1.110	2.264	0.916
2023	22	3.820				0.000	0.122846	0.469		-0.320	-0.150	1.110	2.264	0.916
2024	23	3.820				0.000	0.111678	0.427		-0.320	-0.150	1.110	2.264	0.916
2025	24	3.820				0.000	0.101526	0.388		-0.320	-0.150	1.110	2.264	0.916
2026	25	3.820				0.000	0.092296	0.353		-0.320	-0.150	1.110	2.264	0.916
2027	26	-8.180				0.000	0.083905	-0.686		-8.180				
2028	27	3.820				0.000	0.076278	0.291		-0.320	-0.150	1.110	2.264	0.916
2029	28	3.820				0.000	0.069343	0.265		-0.320	-0.150	1.110	2.264	0.916
2030	29	3.820				0.000	0.063039	0.241		-0.320	-0.150	1.110	2.264	0.916
2031	30	3.820				0.000	0.057309	0.219		-0.320	-0.150	1.110	2.264	0.916
2032	31	3.820				0.000	0.052099	0.199		-0.320	-0.150	1.110	2.264	0.916
2033	32	3.820				0.000	0.047362	0.181		-0.320	-0.150	1.110	2.264	0.916
2034	33	3.820				0.000	0.043057	0.164		-0.320	-0.150	1.110	2.264	0.916
2035	34	3.820				0.000	0.039143	0.150		-0.320	-0.150	1.110	2.264	0.916
2036	35	3.820				0.000	0.035584	0.136		-0.320	-0.150	1.110	2.264	0.916
2037	36	3.820				0.000	0.032349	0.124		-0.320	-0.150	1.110	2.264	0.916
2038	37	3.820				0.000	0.029408	0.112		-0.320	-0.150	1.110	2.264	0.916
2039	38	3.820				0.000	0.026735	0.102		-0.320	-0.150	1.110	2.264	0.916
2040	39	3.820				0.000	0.024304	0.093		-0.320	-0.150	1.110	2.264	0.916
2041	40	3.820				0.000	0.022095	0.084		-0.320	-0.150	1.110	2.264	0.916
	Sum		0					-1.339	-37.000	-20.490	-5.700	42.328	87.097	34.808

Table 5: Calculating NPV, Chile Hydro Project in Crediting Period

C value inflator	
Discount rate	10%

Discount rate · Cost and Revenue · Evaluated period · Crediting period

w/o Carbon Revenue : — Cost & Revenue information: PAD p17-18 for 2001-16; PAD p25 for 2017-2041

		mil $	tCO2e		$	mil $	-	mil$						
	Year	Net Cash Flow	Carbon Credit	Year	Carbon Value	Carbon Benefit	Discount Factor	Present Value	Cap. Exp. Investment	Op. Cost O&M	Ope. Cost Toll	Revenue Spot Energy	Revenue Contract Energy	Revenue Capacity
2001	0	-17.000				0.000	1.000000	-17.000	-17.000					
2002	1	-18.937		1		0.000	0.909091	-17.215	-20.000	-0.150		0.148	1.065	
2003	2	3.820		2		0.000	0.826446	3.157		-0.320	-0.150	1.110	2.264	0.916
2004	3	3.820		3		0.000	0.751315	2.870		-0.320	-0.150	1.110	2.264	0.916
2005	4	3.820		4		0.000	0.683013	2.609		-0.320	-0.150	1.110	2.264	0.916
2006	5	3.820		5		0.000	0.620921	2.372		-0.320	-0.150	1.110	2.264	0.916
2007	6	3.820		6		0.000	0.564474	2.156		-0.320	-0.150	1.110	2.264	0.916
2008	7	3.820		7		0.000	0.513158	1.960		-0.320	-0.150	1.110	2.264	0.916
2009	8	3.820		8		0.000	0.466507	1.782		-0.320	-0.150	1.110	2.264	0.916
2010	9	3.820		9		0.000	0.424098	1.620		-0.320	-0.150	1.110	2.264	0.916
2011	10	3.820		10		0.000	0.385543	1.473		-0.320	-0.150	1.110	2.264	0.916
2012	11	3.820		11		0.000	0.350494	1.339		-0.320	-0.150	1.110	2.264	0.916
2013	12	3.820		12		0.000	0.318631	1.217		-0.320	-0.150	1.110	2.264	0.916
2014	13	3.820		13		0.000	0.289664	1.107		-0.320	-0.150	1.110	2.264	0.916
2015	14	3.820		14		0.000	0.263331	1.006		-0.320	-0.150	1.110	2.264	0.916
2016	15	3.820		15		0.000	0.239392	0.914		-0.320	-0.150	1.110	2.264	0.916
2017	16	3.820		16		0.000	0.217629	0.831		-0.320	-0.150	1.110	2.264	0.916
2018	17	3.820		17		0.000	0.197845	0.756		-0.320	-0.150	1.110	2.264	0.916
2019	18	3.820		18		0.000	0.179859	0.687		-0.320	-0.150	1.110	2.264	0.916
2020	19	3.820		19		0.000	0.163508	0.625		-0.320	-0.150	1.110	2.264	0.916
2021	20	3.820		20		0.000	0.148644	0.568		-0.320	-0.150	1.110	2.264	0.916
2022	21	3.820		21		0.000	0.135131	0.516		-0.320	-0.150	1.110	2.264	0.916
	Sum		0					-4.650	-37.000	-6.550	-3.000	22.348	46.345	18.320

Project-related Periods

Although the project appraisal is usually done for the project lifetime, this thesis will examine two time horizons: project life time and crediting period.

All projects except three (Chile Hydro project: lifetime 40 years versus a period conducted for financial analysis 51 years; China Coal Mine Methane (CMM) project: 20 years versus 28 years; Moldova Sequestration project: 15 years versus 30 years) use lifetime for their own financial analysis. The project lifetime is usually determined by the main equipment lifetime and thus depends on the technology in general. For example, the PAD for the China CMM project sets up the project lifetime (20 years) "as is common for an internal combustion engine", which is the piece of main equipments (WB PAD, 2004a). The project lifetime of each project is retrieved from either the PAD or the PDD.

In addition to the lifetime, the "crediting period", while issuance of CERs is to be admitted

(UNFCCC, 2003), is essential for the CDM project. The crediting period should be either for 10 years or 7 years times 3 periods according to the rule of the CDM (IGES, 2004). Thus, the period from when the capital expenditure cost is generated (0^{th} year) until the end of the crediting period is also used in appraising. Please note that some projects like the China CMM project does not generate candidate CERs until the third year and thus the whole analyzed period may be different per each project even though the crediting periods are the same. The crediting period of each project is obtained from either the PADs or PDDs.

Cost and Revenue

Cost data, consisting of capital expenditure and operational cost, and revenue were obtained from PADs with the following principles:

Upon collecting the data, two rules were adopted in accordance with Lumby and Jones, 1999 (p149). First, depreciation should be ignored since depreciation is non cash flow and so does not enter into the NPV cash flow analysis so long as such depreciation is the same covered by capital expenditure. For example, in case of the Brazil Plantar project, the amount under depreciation and exhaustion is not covered by investment (capital expenditure) and thus counted into capital expenditure (WB PAD, 2002a). Secondly, all finance cash flows such as interest charges, loan repayments, dividends, etc. and their tax effects should be ignored since these are implicitly taken into account through discounting.

The income tax and any tax relief on capital expenditure, usually considered in the investment appraisal decision (Lumby and Jones, 1999), are excluded, because of the following reasons. First, the tax is redistributed into the society. As this analysis aims at revealing the social cost of carbon emission reduction, the expenses coming back to the society should not be counted as cost. In the case of a private cost benefit analysis, tax impacts would be considered, which is not the consideration of this thesis. Secondly, the 13 evaluated projects are in eight countries which have very different tax systems. One of main purposes of this assessment is to compare the 13 projects in terms of project cost profile, and thus requires to have the same basis for factors other than project cost and revenue.

The currency is shown in US dollars since most of the projects except the two Chinese projects and Indian Waste project, use US dollars. Chinese Yuan or Indian Rupee are converted to US dollars with an exchange rate in their PADs. Thus, currency risk is *not* considered in this analysis.

All costs and revenues are analysed in real terms using constant prices as of the 0^{th} year for each project. Some projects implicitly (eg. Brazil Plantar project; Chile Hydro project) or explicitly (eg. China Hydro project) use real terms, while other projects implicitly (eg. Costa Rica Vara Blanca Wind subproject) or explicitly (eg. Costa Rica Hydro subproject) assume nominal terms with inflation. All values were converted to real terms before the analysis was conducted.

Transaction costs for the CDM project, are excluded. Since this assessment aims to investigate the project's potential in carbon emission reduction cost efficiency, transaction costs unique to the CDM should be separately considered. Transaction costs is considered in the sensitivity analysis as stated in Section 3.1.3.

The insurance cost is included if the project counts it as cost, since some projects may require insurance and others not. Similarly, the working capital requirement is also included if the project requests (ADB, 2001). It is stocks of material and spares such as coal stock in the case of the coal-fired power plant which facilitates smooth project operation. It is counted either in capital expenditure, operational cost, or nowhere if the project does not require it, depending on the project type. Even in the case that the residual value is not released (i.e. Brazil Plantar project), which should not be done in accordance with the cost benefit analysis rule (ADB, 2001), the author follows the original documents. Moreover, the contingency cost is included in case that the project counts it as cost. This is because the more risky projects tend to include contingency, which should be part of the project's attributes.

Based on the above principles, the necessary data were obtained. It should be noted, however, that data for all projects were not always complete. While some projects have a complete data set over the lifetime (eg. Brazil Plantar project), others do not. The latter can be divided into two types: ones which lack data in a part of the time horizon (eg. Chile Hydro Power project: while the data in 2001-2016 is available, the data in 2017-2022 is not.); others that have only capital expenditure data and annual operational cost and revenue data (eg. India Waste project). The author assumes that the operational cost and revenue in the last available year should constantly continue as in the case of the former, and the annual operational cost and revenue should incur in the 1st year afterwards over the project lifetime or project crediting period in the case of the latter.

In order to achieve data accuracy, the capital expenditure amount, having the largest impact on the NPV, was checked with the financing plan explaining the project cost. All projects' capital expenditures are compatible with their own financing plan. Refer to Appendix 1 for more details.

Discount Rate

Discount rate in this thesis is considered to be 10%, with a sensitivity analysis of 5% and the discount rate was used for each project's financial analysis. In their financial analysis in PADs, 7 projects (Colombia Wind project; Costa Rica Cortega Wind subproject; Costa Rica Vera Blanca Wind subproject; Costa Rica Hydro subproject; China Hydro project; China CMM project; India Waste project) use WACC, varying from 4.66% to 10%, 3 projects (Chile Hydro project; Brazil Plantar project; Moldova Sequestration project) use assumed discount rate 10%, and 3 projects do not reveal discount rate (Mexico Guadalajara Waste subprojects; Mexico Monterrey II Waste subproject; Mexico Leon Waste subproject).

The assumption of a 10% discount rate can be justified in order to have the same basis for factors other than project cost and revenue. Furthermore, out of 10 projects having discount rate data available, 4 projects use the 10% discount rate. Finally, the developing countries tend to have a higher discount rate and 10% seems a plausible rate. For example, Motta et al (2002) use a discount rate of 12% for assessing Brazilian projects, as 10-12% "can be seen as the common reference for opportunity cost of capital in Brazil".

3.2.3 Data for IERC Calculation

As described in the former section, IERC calculation requires the data input of carbon credit amounts and carbon inflator. Table 6 and Table 7 are again the examples of Excel sheets of Chile Hydro Power project.

Table 6: Calculating IERC, Chile Hydro Project in Project Lifetime

C value inflator	10%
Discount rate	10%

w/ Carbon Revenue :

		mil $	tCO2e		$	mil $	-	mil$	Cost & Revenue information: PAD p17-18 for 2001-16; PAD p25 for 2017-2041					
	Year	Net Cash Flow	Carbon Credit	Year	Carbon Value	Carbon Benefit	Discount Factor	Present Value	Cap. Exp. Investment	Op. Cost O&M	Ope. Cost Toll	Revenue Spot Energy	Revenue Contract Energy	Revenue Capacity
2001	0	-17.000			0.48	0.000	1.000000	-17.000	-17.000					
2002	1	-18.937	60000	1	0.53	0.032	0.909091	-17.187	-20.000	-0.150		0.148	1.065	
2003	2	3.820	137600	2	0.58	0.080	0.826446	3.223		-0.320	-0.150	1.110	2.264	0.916
2004	3	3.820	137600	3	0.64	0.088	0.751315	2.936		-0.320	-0.150	1.110	2.264	0.916
2005	4	3.820	137600	4	0.70	0.096	0.683013	2.675		-0.320	-0.150	1.110	2.264	0.916
2006	5	3.820	137600	5	0.77	0.106	0.620921	2.438		-0.320	-0.150	1.110	2.264	0.916
2007	6	3.820	137600	6	0.85	0.117	0.564474	2.222		-0.320	-0.150	1.110	2.264	0.916
2008	7	3.820	137600	7	0.93	0.128	0.513158	2.026		-0.320	-0.150	1.110	2.264	0.916
2009	8	3.820	137600	8	1.03	0.141	0.466507	1.848		-0.320	-0.150	1.110	2.264	0.916
2010	9	3.820	137600	9	1.13	0.155	0.424098	1.686		-0.320	-0.150	1.110	2.264	0.916
2011	10	3.820	137600	10	1.24	0.171	0.385543	1.539		-0.320	-0.150	1.110	2.264	0.916
2012	11	3.820	137600	11	1.36	0.188	0.350494	1.405		-0.320	-0.150	1.110	2.264	0.916
2013	12	3.820	137600	12	1.50	0.207	0.318631	1.283		-0.320	-0.150	1.110	2.264	0.916
2014	13	3.820	137600	13	1.65	0.227	0.289664	1.172		-0.320	-0.150	1.110	2.264	0.916
2015	14	3.820	137600	14	1.82	0.250	0.263331	1.072		-0.320	-0.150	1.110	2.264	0.916
2016	15	3.820	137600	15	2.00	0.275	0.239392	0.980		-0.320	-0.150	1.110	2.264	0.916
2017	16	3.820	135600	16	2.20	0.298	0.217629	0.896		-0.320	-0.150	1.110	2.264	0.916
2018	17	3.820	135600	17	2.42	0.328	0.197845	0.821		-0.320	-0.150	1.110	2.264	0.916
2019	18	3.820	135600	18	2.66	0.361	0.179859	0.752		-0.320	-0.150	1.110	2.264	0.916
2020	19	3.820	135600	19	2.92	0.397	0.163508	0.689		-0.320	-0.150	1.110	2.264	0.916
2021	20	3.820	135600	20	3.22	0.436	0.148644	0.633		-0.320	-0.150	1.110	2.264	0.916
2022	21	3.820	135600	21	3.54	0.480	0.135131	0.581		-0.320	-0.150	1.110	2.264	0.916
2023	22	3.820				0.000	0.122846	0.469		-0.320	-0.150	1.110	2.264	0.916
2024	23	3.820				0.000	0.111678	0.427		-0.320	-0.150	1.110	2.264	0.916
2025	24	3.820				0.000	0.101526	0.388		-0.320	-0.150	1.110	2.264	0.916
2026	25	3.820				0.000	0.092296	0.353		-0.320	-0.150	1.110	2.264	0.916
2027	26	-8.180				0.000	0.083905	-0.686		-8.180				
2028	27	3.820				0.000	0.076278	0.291		-0.320	-0.150	1.110	2.264	0.916
2029	28	3.820				0.000	0.069343	0.265		-0.320	-0.150	1.110	2.264	0.916
2030	29	3.820				0.000	0.063039	0.241		-0.320	-0.150	1.110	2.264	0.916
2031	30	3.820				0.000	0.057309	0.219		-0.320	-0.150	1.110	2.264	0.916
2032	31	3.820				0.000	0.052099	0.199		-0.320	-0.150	1.110	2.264	0.916
2033	32	3.820				0.000	0.047362	0.181		-0.320	-0.150	1.110	2.264	0.916
2034	33	3.820				0.000	0.043057	0.164		-0.320	-0.150	1.110	2.264	0.916
2035	34	3.820				0.000	0.039143	0.150		-0.320	-0.150	1.110	2.264	0.916
2036	35	3.820				0.000	0.035584	0.136		-0.320	-0.150	1.110	2.264	0.916
2037	36	3.820				0.000	0.032349	0.124		-0.320	-0.150	1.110	2.264	0.916
2038	37	3.820				0.000	0.029408	0.112		-0.320	-0.150	1.110	2.264	0.916
2039	38	3.820				0.000	0.026735	0.102		-0.320	-0.150	1.110	2.264	0.916
2040	39	3.820				0.000	0.024304	0.093		-0.320	-0.150	1.110	2.264	0.916
2041	40	3.820				0.000	0.022095	0.084		-0.320	-0.150	1.110	2.264	0.916
	Sum		2800000					0.000	-37.000	-20.490	-5.700	42.328	87.097	34.808

Carbon Credit Amount

Carbon Value Inflator

NPV Zero by Goal Seek with changing Carbon Value

Table 7: Calculating IERC, Chile Hydro Project in Crediting Periods

C value inflator	10%
Discount rate	10%

Carbon Credit Amount

Carbon Value Inflator

w/ Carbon Revenue :

Cost & Revenue information: PAD p17-18 for 2001-16; PAD p25 for 2017-2041

	Year	Net Cash Flow (mil $)	Carbon Credit (tCO2e)	Year	Carbon Value ($)	Carbon Benefit (mil $)	Discount Factor (-)	Present Value (mil$)	Cap. Exp. Investment	Op. Cost O&M	Ope. Cost Toll	Revenue Spot Energy	Revenue Contract Energy	Revenue Capacity
2001	0	-17.000			1.66	0.000	1.000000	-17.000	-17.000					
2002	1	-18.937	60000	1	1.83	0.110	0.909091	-17.116	-20.000	-0.150		0.148	1.065	
2003	2	3.820	137600	2	2.01	0.277	0.826446	3.386		-0.320	-0.150	1.110	2.264	0.916
2004	3	3.820	137600	3	2.21	0.304	0.751315	3.099		-0.320	-0.150	1.110	2.264	0.916
2005	4	3.820	137600	4	2.43	0.335	0.683013	2.838		-0.320	-0.150	1.110	2.264	0.916
2006	5	3.820	137600	5	2.67	0.368	0.620921	2.600		-0.320	-0.150	1.110	2.264	0.916
2007	6	3.820	137600	6	2.94	0.405	0.564474	2.385		-0.320	-0.150	1.110	2.264	0.916
2008	7	3.820	137600	7	3.24	0.445	0.513158	2.189		-0.320	-0.150	1.110	2.264	0.916
2009	8	3.820	137600	8	3.56	0.490	0.466507	2.011		-0.320	-0.150	1.110	2.264	0.916
2010	9	3.820	137600	9	3.92	0.539	0.424098	1.849		-0.320	-0.150	1.110	2.264	0.916
2011	10	3.820	137600	10	4.31	0.593	0.385543	1.701		-0.320	-0.150	1.110	2.264	0.916
2012	11	3.820	137600	11	4.74	0.652	0.350494	1.567		-0.320	-0.150	1.110	2.264	0.916
2013	12	3.820	137600	12	5.21	0.717	0.318631	1.446		-0.320	-0.150	1.110	2.264	0.916
2014	13	3.820	137600	13	5.73	0.789	0.289664	1.335		-0.320	-0.150	1.110	2.264	0.916
2015	14	3.820	137600	14	6.31	0.868	0.263331	1.234		-0.320	-0.150	1.110	2.264	0.916
2016	15	3.820	137600	15	6.94	0.955	0.239392	1.143		-0.320	-0.150	1.110	2.264	0.916
2017	16	3.820	135600	16	7.63	1.035	0.217629	1.057		-0.320	-0.150	1.110	2.264	0.916
2018	17	3.820	135600	17	8.39	1.138	0.197845	0.981		-0.320	-0.150	1.110	2.264	0.916
2019	18	3.820	135600	18	9.23	1.252	0.179859	0.912		-0.320	-0.150	1.110	2.264	0.916
2020	19	3.820	135600	19	10.16	1.377	0.163508	0.850		-0.320	-0.150	1.110	2.264	0.916
2021	20	3.820	135600	20	11.17	1.515	0.148644	0.793		-0.320	-0.150	1.110	2.264	0.916
2022	21	3.820	135600	21	12.29	1.667	0.135131	0.741		-0.320	-0.150	1.110	2.264	0.916
	Sum		2800000					0.000	-37.000	-6.550	-3.000	22.348	46.345	18.320

NPV Zero by Goal Seek with changing Carbon Value

Carbon Benefit – Carbon Credit Amount

The carbon credit amount means here how much CERs the project will earn, which is the central concept of the CDM projects. All four data sources described in 3.2.1 are investigated, while PADs' data is the most respected, since PADs are the most influential documents for an investment decision. Whenever discrepancy was found between sources, which it was most cases except Colombia Wind project, the author assumed that the data either in PADs, WB PDDs or UNFCCC PDDs was accurate, subject to that those amounts were permissibly close to the data on the CDM Watch website for comparison. The only exception of this basic rule is for the China Hydro project where CDM Watch shows further larger carbon credit amounts than those shown on PAD, WB PDD and even the WB website. The author assumed the PAD should be more plausible in this case, while ignoring CDM Watch data. Refer to Appendix 1 and 2 for the detail.

The time profile of carbon credit will be retrieved either from the PAD or the PDD, if available. Table 8 summarizes four patterns of data availability. First, some projects have complete time profile data. Second, some projects have it partially and thus the author accordingly allocates evenly the difference between total carbon credits and aggregated annual credits when the time profile is known. Third, some projects have a time profile in the manner of carbon credit income in their financial analysis with their assumed unit of carbon price. In such cases, the author estimated annual carbon credits by dividing their expected carbon income with their assumed unit price. Lastly, some projects have a combination of the above second and third patterns with a partial time profile available in dollars. Estimation is done in the above in a combined manner.

Table 8: Summary of Available Carbon Credit Time Profile

What is available?	Projects	
Completed time profile	Brazil/Fuel Switch	
	China/CMM	
	China/Hydro	
	Colombia/Wind	
	India/Waste	
Partial time profile	Chile/Hydro (15 years)	Time profile for 5 years assumed.
	Mexico/Guadalajara/Waste (7 years)	Time profile for 3 years assumed.
	Mexico/Leon/Waste (7 years)	Time profile for 3 years assumed.
	Mexico/Monterrey II/Waste (7 years)	Time profile for 3 years assumed.
Completed time profile in dollar amount	Costa Rica/Cortega/Wind	Time profile calculated with their assuming unit carbon price.
	Costa Rica/Hydro	Time profile calculated with their assuming unit carbon price.
	Costa Rica/Vera Blanca/Wind	Time profile calculated with their assuming unit carbon price.
Partial time profile in dollar amount	Moldova/Sequestration (6 years)	Time profile for 15 years assumed.

Carbon Inflator

Since there is no such data available in any document, the author assumes a carbon inflator of 10%. Because of that, the sensitive analysis with 0% and 5% cases are carried out.

Chapter 4: Results

Section 4.1 presents the result with a base case, 10% discount rate and 10% carbon inflator. Section 4.2 reports comparison with carbon prices. Section 4.3 addresses the result of the sensitivity analysis.

4.1 Central Result with a Base Case

Table 9 addresses the calculated IERC for lifetime period and crediting period.

Table 9: IERCs for Project Lifetime and Crediting Period

	Lifetime			Credit		
India/Waste	-$9	30	yrs.	$3	10	yrs.
Mexico/Monterrey II/Waste	-$0.1	21	yrs.	$0.8	10	yrs.
Mexico/Guadalajara/Waste	$0.2	21	yrs.	$1	10	yrs.
Chile/Hydro	$0.5	40	yrs.	$2	21	yrs.
Brazil/Plantar	$2	28	yrs.	$2	28	yrs.
China/CMM	$2	20	yrs.	$3	10	yrs.
China/Hydro	$3	30	yrs.	$11	10	yrs.
Mexico/Leon/Waste	$3	21	yrs.	$3	10	yrs.
Colombia/Wind	$5	21	yrs.	$5	21	yrs.
Costa Rica/Cortega/Wind	$7	25	yrs.	$9	21	yrs.
Moldova/Sequestration	$9	15	yrs.	$6	21	yrs.
Costa Rica/Hydro	$10	40	yrs.	$16	21	yrs.
Costa Rica/Vera Blanca/Wind	$13	25	yrs.	$16	21	yrs.

*1: China/CMM: Captured CH4 (90%); Fuel Switch (10%)
*2: Mexico/Guadalajara: Captured CH4 (66%), Fuel Switch (34%)
*3: Mexico/Monterrey II: Captured CH4 (64%), Fuel Switch (36%)
*4: Brazil/Plantar: Fuel Switch (56%); Sink (31%); Reduced CH4 (13%)

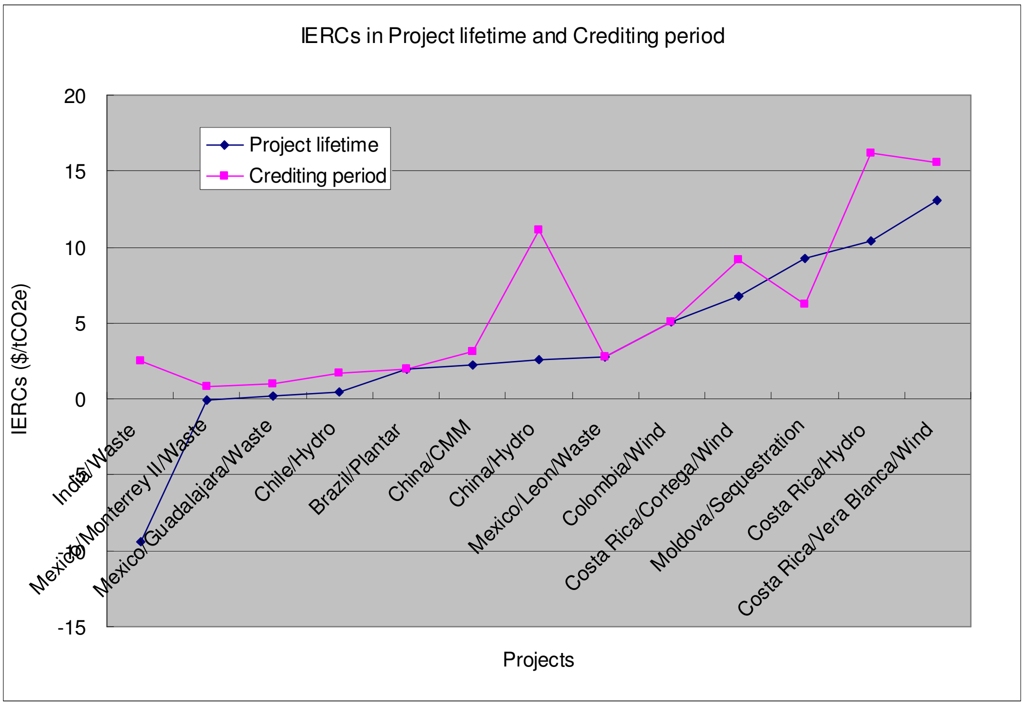
The calculated IERC varies from -$9/tCO2e to $13/tCO2e for lifetime period under the assumed discount rate 10% and carbon inflator 10%, while from $0.8/tCO2e to $16/tCO2e for the crediting period. The negative value shows that the projects concerned (Mexico Monterry II Waste Subproject; India Waste project) are profitable even without carbon revenue. Every project except

Mexico Leon Waste subproject and Moldova Sequestration project calculates less IERC for the lifetime period than for the crediting period, if the project lifetime is longer than the crediting period. This result is plausible, since the longer the period evaluation, the more profit is usually generated. Thus, more economical emission reduction becomes envisaged. If the project lifetime equals the crediting period such as in the case of the Brazil Plantar project and Colombia Wind project, IERCs are of course same. The Brazil Plantar project has 28 years as crediting period, which looks unusual since the crediting period admitted under the UNFCCC is either 10 years or 7 years times 3 periods (21 years). This is because that project has three sources of emission reductions: fuel switch; carbon sequestration and reduced methane, which start to generate carbon credits in different times, i.e. in 2009, 2002 and 2002. Thus, the total crediting period for those projects is 28 years (WB PAD, 2002a)

The exception in the Mexico Leon Waste subproject and in the Moldova Sequestration project can be explained. The result of the Mexico Leon Waste subproject, which has the same IERC for both a project lifetime and crediting period in spite of different length (project lifetime: 21 years and crediting period: 10 years), is caused by the author's assumption. This project has revenue only from CERs sale, and no revenue will incur after the crediting period. Thus, the IERC for this project is estimated for recovering the aggregated project cost. If one assumes that this facility would be operated even without revenue, only the cost will be incurred which may have resulted in the higher IERC. Since the author assumes that the project sponsor should stop operating the facility in spite of a facility lifetime due to no revenue, the aggregated cost is the same both for project lifetime and crediting time, which results in the same IERC. The Moldova Project has a higher IERC because the lifetime project is shorter (15 years) than crediting period (21 years), which appears odd, but is specified in the original document (WB PDD 2002a, p6; p8).

Figure 4 illustrates the results shown in Table 9 for project lifetime and crediting period.

Figure 4: IERCs in Project Lifetime and in Crediting Period



It seems that methane recovery projects, such as waste management (5 projects), tend to result in lower IERCs while wind power projects (3 projects) result in higher IERCs. Hydro projects (3 projects) tend to show a relatively larger discrepancy in IERCs between project lifetime and crediting period. This may be because project lifetime of hydro projects is longer than those of other projects. As the project sample has only one representative for fuel switch project, and the same for a sequestration project, it is difficult to say anything here about them.

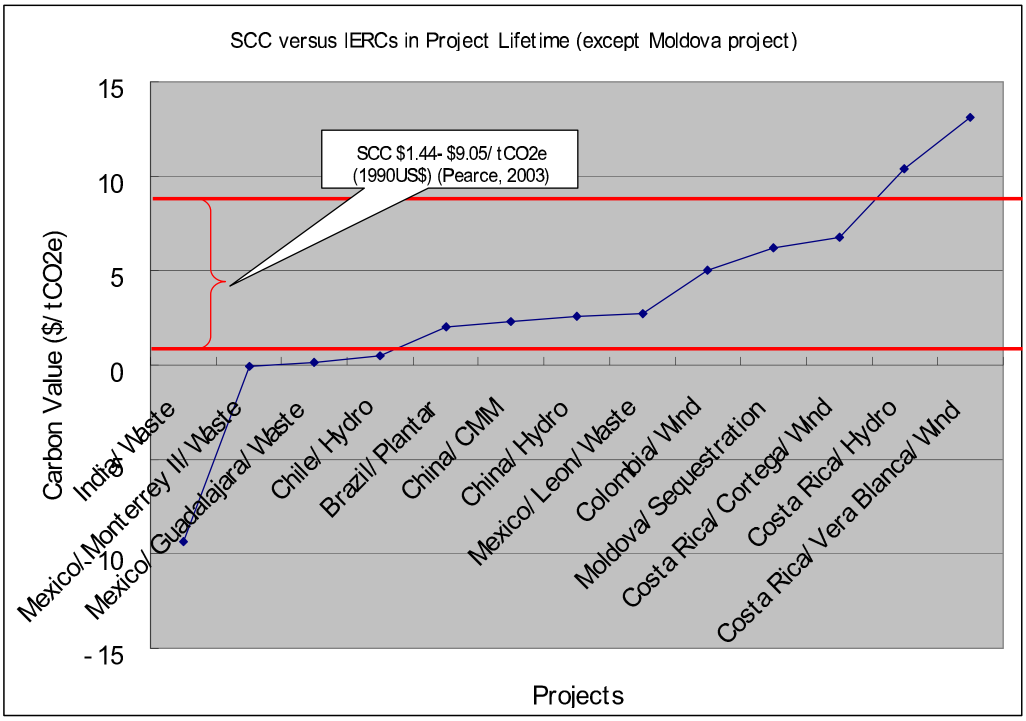
4.2 Comparison with Carbon Prices

Section 4.2 compares the IERCs addressed in Section 4.1 with the carbon prices: SCCs; EUAs; CERs as elaborated in Section 3.1.2. Since the difference between project lifetime and crediting period has already been examined, the following section will use IERCs only for project lifetime. Note that credit period is used for the Moldova Sequestration project, since it has a shorter project lifetime than crediting period which appears unusual.

4.2.1 Comparison with Social Cost of Carbon

Figure 5 illustrates the comparison between SCC estimated by Pearce (2003a) and IERCs under a base case, a 10% discount rate and a 10% carbon inflator.

Figure 5: Social Cost of Carbon versus IERCs



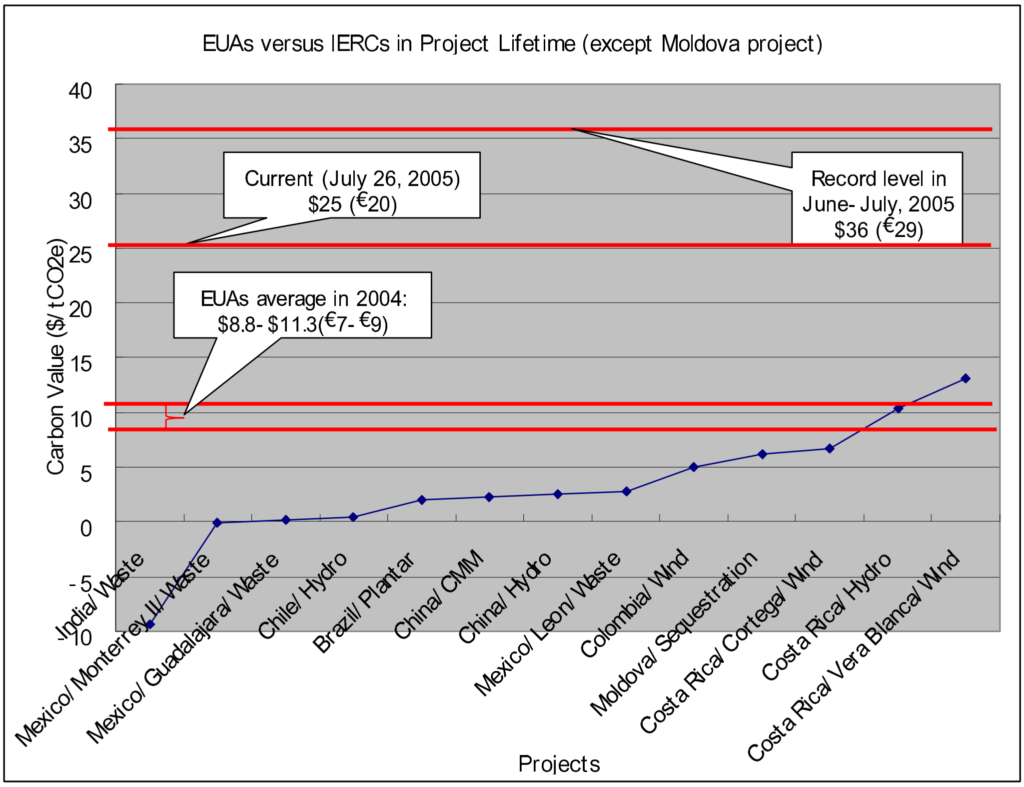
Comparing with Pearce's upper limit of SCC, 2 projects (Costa Rica Hydro project; Costa

Rica Vera Blanca project) fail cost benefit test in the base case scenario. 4 projects (India Waste project; Mexico Monterrey II Waste project; Mexico Guadalajara Waste project; Chile Hydro project) pass the cost benefit test even with Pearce's lower limit of SCC.

4.2.2 Comparison with European Union Allowances Prices

Figure 6 illustrates the comparison between EUAs in various timing and IERCs under a base case with a 10% discount rate and a 10% carbon inflator.

Figure 6: European Allowance Units' Prices versus IERCs

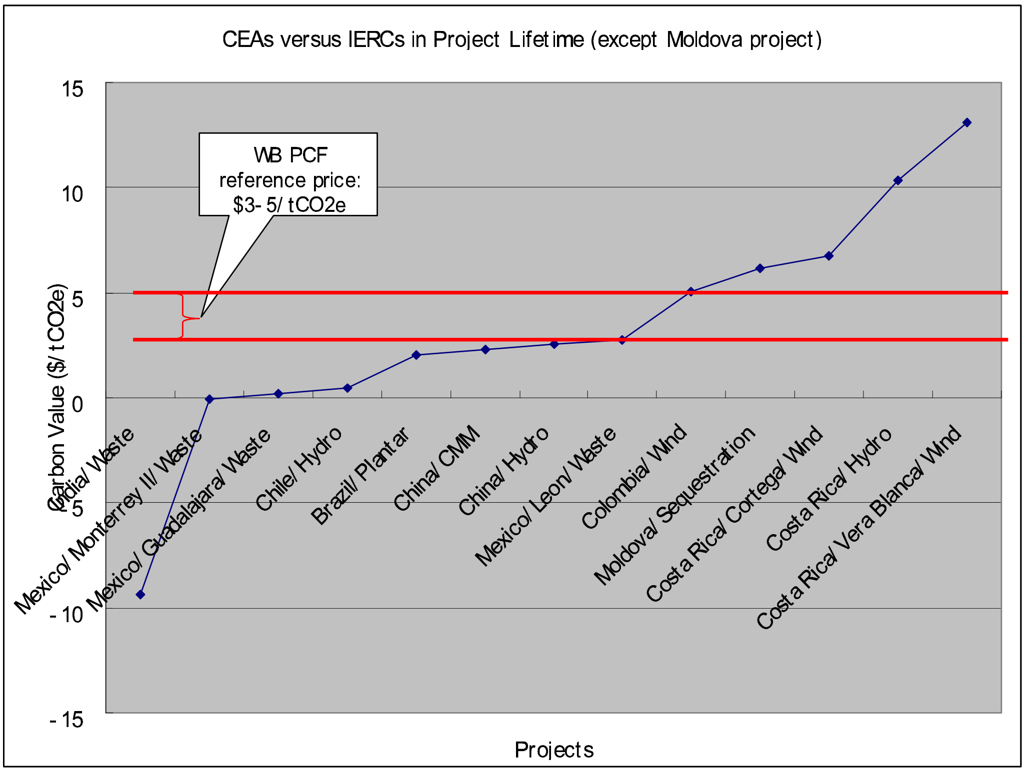


If one adopts the average price in 2004, the output is very similar to the comparison with Pearce estimate SCC as described in Section 4.2.1. If one considers the current level as €20 to be the relatively stabilized price, the result changes. All projects pass the cost benefit test.

4.2.3 Comparison with Certified Emission Reduction Prices

Figure 7 illustrates the comparison between CERs, in particular the referenced prices specified by the WB CFB, and IERCs under a base case with a 10% discount rate and a 10% carbon inflator. The reason why the WB CFB's reference price $3-5/tCO2e is emphasized is that evaluated thirteen projects are under PCF and had contracted a part of carbon credits with PCF within that price range.

Figure 7: Certified Emission Reduction Prices versus IERCs



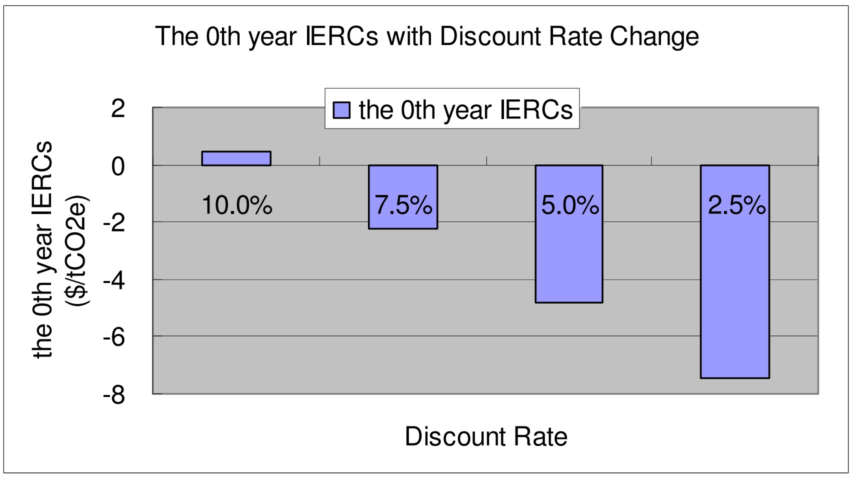
Comparing with the WB upper limit of referenced price, 5 projects (Colombia Wind project; Costa Rica Cortega Wind project; Moldova Sequestration project; Costa Rica Hydro project; Cossta Rica Vera Blanka Wind project) fail the cost benefit test under the base case scenario. On the other hand, the rest of 8 projects (India Waste project; Mexico Monterrey II Waste project; Mexico Guadalajara Waste project; Chile Hydro project; Brazil Plantar project; China CMM project; China Hydro project; Mexico Leon Waste project) pass the cost benefit test even with the lower limit referenced price.

4.3 Sensitivity Analysis

4.3.1 Discount Rate

Figure 8 illustrates how discount rate change affects carbon value in case of project lifetime, holding carbon inflator at 10%, by using an example from the Chile Hydro project because of data accessibility on the website.

Figure 8: The 0th Year IERC Change with Discount Rate Change in Project Lifetime Case



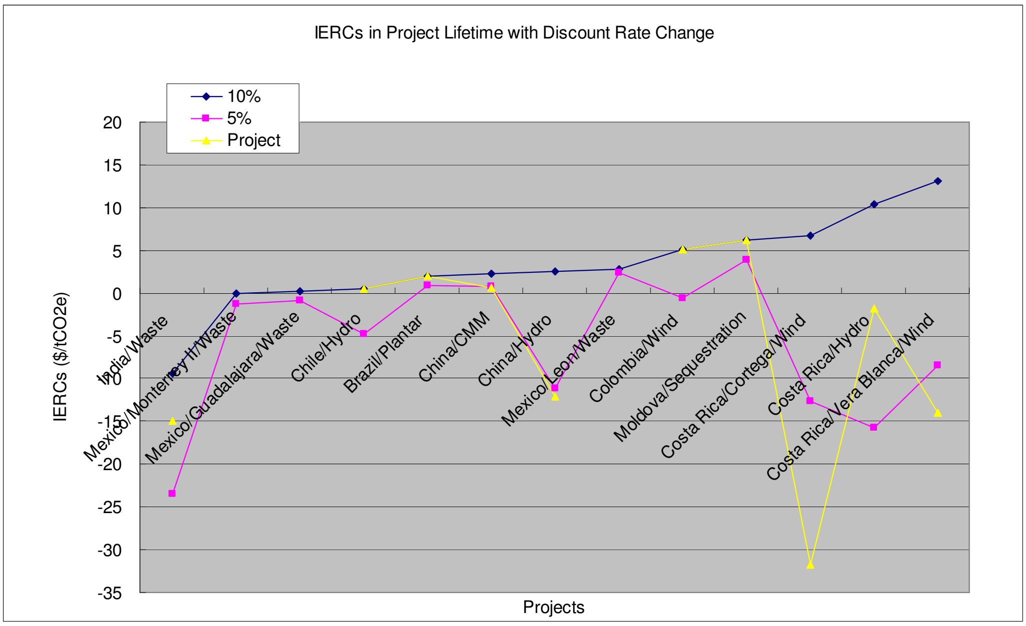
As depicted in Figure 8, the smaller discount rate results in less IERC at 0th year.

Table 10 and Figure 9 display IERCs in 0th year of project lifetime (except for the Moldova project as explained in Section 4.2) for discount rates 10%, 5% and the discount rate used for each project's original financial analysis, holding carbon inflator at the assumed 10%.

Table 10: IERCs with Discount Rate Change (Project lifetime except Moldova project)

	Project Lifetime				
Discount Rate	10.0%	5.0%	Project DR		
India/Waste	-$9.4	-$24	-$15	7.8%	WACC
Mexico/Monterrey II/Waste	-$0.1	-$1.3		?	
Mexico/Guadalajara/Waste	$0.2	-$0.9		?	
Chile/Hydro	$0.5	-$4.8	$0.5	10.0%	DR
Brazil/Plantar	$2.0	$0.9	$2.0	10.0%	DR
China/CMM	$2.3	$0.7	$0.7	5.0%	WACC
China/Hydro	$2.6	-$11	-$12	4.7%	WACC
Mexico/Leon/Waste	$2.7	$2.3		?	
Colombia/Wind	$5.0	-$0.7	$5.0	10.0%	WACC
Costa Rica/Cortega/Wind	$6.7	-$13	-$32	5.4%	WACC
Moldova/Sequestration	$6.2	$3.8	$6.2	10.0%	DR
Costa Rica/Hydro	$10	-$16	-$1.9	7.7%	WACC
Costa Rica/Vera Blanca/Wind	$13	-$8.5	-$14	4.9%	WACC
*1: China/CMM: Captured CH4 (90%); Fuel Switch (10%)					
*2: Mexico/Guadalajara: Captured CH4 (66%), Fuel Switch (34%)					
*3: Mexico/Monterrey II: Captured CH4 (64%), Fuel Switch (36%)					
*4: Brazil/Plantar: Fuel Switch (56%); Sink (31%); Reduced CH4 (13%)					

Figure 9: IERCs in Project Lifetime with Discount Rate Change



As observed in the Chile Hydro project example above, all projects have higher IERCs as the assumed discount rate increases. Although Figure 9 and Table 10 depict only for the case of project lifetime, the result in the case of crediting period is the same. Note that there is no constant change pattern for discount rate changes. Some projects such as the Costa Rica Cortega Wind project and the Chile Hydro project show a large decrease in IERC upon discount rate decreasing to 5%, while other projects, such as the Mexico Monterrey II Waste, do not. The change in the IERC following the change in discount rate seems more dependent on project profile, for instance, what marginal profit the project has without carbon revenue.

The discount rate variation changes the result of some cost benefit tests. For example, while the cost benefit test with the upper limit the WB CFB referenced CERs price ($5/tCO2e) in case of a 10% discount rate fails with five projects in the right-hand side of Figure 9 as addressed in Section 4.2.3, the same projects have passed the cost benefit test in the case of 5% discount rate.

4.3.2 Carbon Inflator

The higher the assumed carbon inflator, the lower the calculated IERC at 0th year, for somewhat trivial mathematical reasons. Recall that the IERC is the carbon price which yields a zero NPV. With a higher inflation rate of the carbon price, the 0th year's IERC must be smaller in order to ensure that the NPV remains zero. Figure 10 illustrates all projects having a positive IERCs value in a 10% carbon inflator increase their carbon value as carbon inflator lessens.

Figure 10: IERCs in Project Lifetime with Carbon Inflator Change

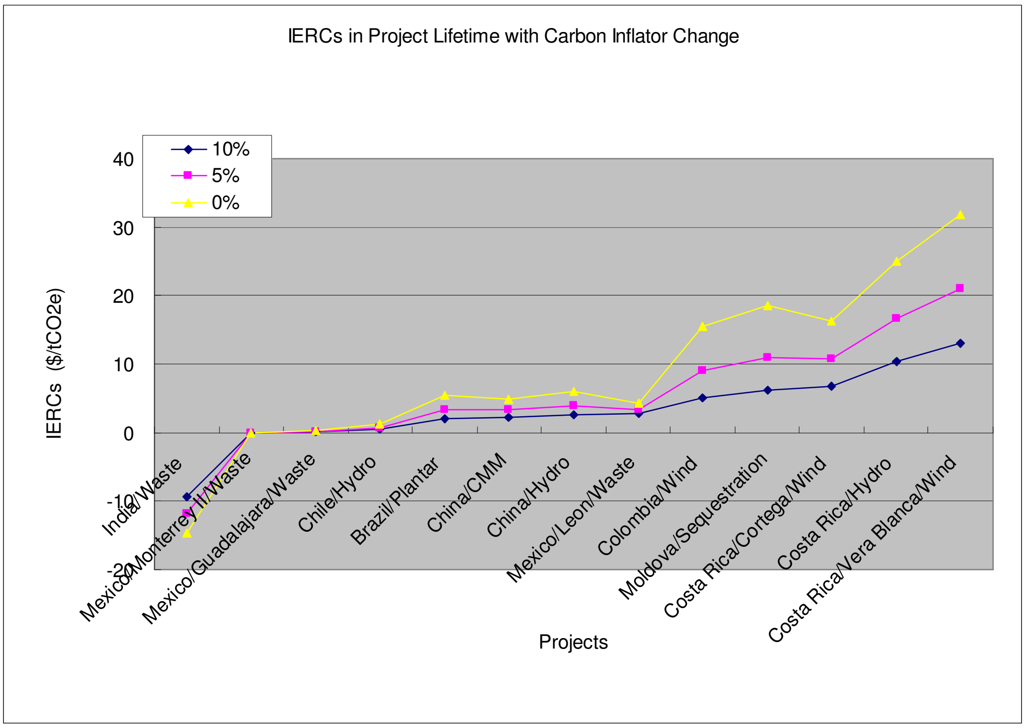


Figure 10 also shows that higher IERCs tend to vary larger on carbon inflator fluctuation. In other words, the higher the IERCs, the more volatile to carbon value changes the project becomes. Thus, a relatively lower IERCs project has a better predictability for carbon value fluctuation.

The decrease in carbon inflator changes the result of some cost benefit tests. For example, three projects (Costa Rica Cortega project; Moldova Sequestration project; Colombia Wind project), having passed the cost benefit test with the upper limit of Pearce's (2003) estimating SCC ($9/tCO2e), fail the cost benefit test when the carbon inflator assumed is 0%. Further, the Costa Rica Vera Blanca Wind project sees its cost benefit test result change with EUA current level prices, €20 ($25), from pass with 10% carbon inflator to failure with 0% carbon inflator.

4.3.3 Factors Post-2012

Table 11 addresses how IERCs are affected if carbon credit to be delivered after 2012 becomes void due to post-2012 issues in case of a base case, a 10% discount rate and a 10% carbon inflator.

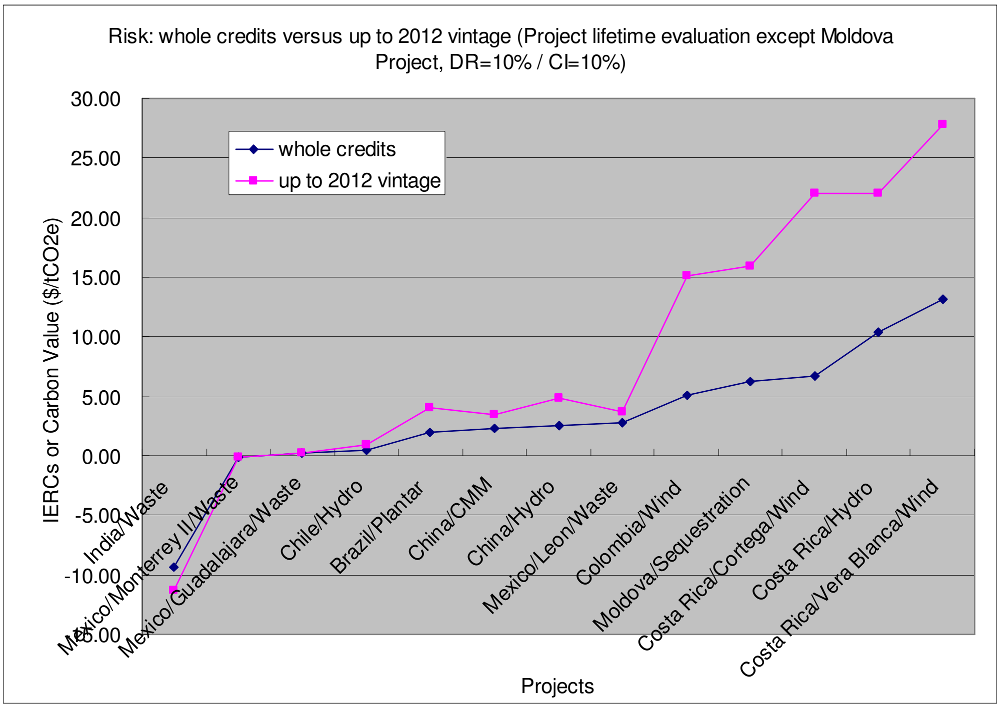
Table 11: Impact on IERCs by Factors of Post-2012

DR=10%, CI=10%	All Credits					Up to 2010-vintage					Difference
Project lietime except Moldova	IERCs	Periods		Credits (000 tCO2e)		IERCs	Periods		Credits (000 tCO2e)		in IERCs
India/Waste	-$9	10	yrs	1,018	100%	-$11	8	yrs.	842	83%	-$2
Mexico/Monterrey II/Waste	-$0.1	10	yrs	1,217	100%	-$0.1	7	yrs.	910	75%	-$0.03
Mexico/Guadalajara/Waste	$0.2	10	yrs	1,582	100%	$0.2	7	yrs.	1,183	75%	$0.1
Chile/Hydro	$0.5	21	yrs	2,800	100%	$1	11	yrs.	1,436	51%	$0.5
Mexico/Leon/Waste	$3	10	yrs	201	100%	$4	7	yrs.	150	75%	$1
China/CMM	$2	10	yrs	22,546	100%	$4	7	yrs.	14,600	65%	$1
Brazil/Plantar	$2	28	yrs	12,886	100%	$4	11	yrs.	6,323	49%	$2
China/Hydro	$3	10	yrs	2,640	100%	$5	6	yrs.	1,416	54%	$2
Moldova/Sequestration	$6	21	yrs	1,812	100%	$16	8	yrs.	702	39%	$10
Colombia/Wind	$5	21	yrs	1,168	100%	$15	9	yrs.	390	33%	$10
Costa Rica/Hydro	$10	21	yrs	181	100%	$22	10	yrs.	85	47%	$12
Costa Rica/Vera Blanca/Wind	$13	21	yrs	329	100%	$28	10	yrs.	155	47%	$15
Costa Rica/Cortega/Wind	$7	21	yrs	303	100%	$22	10	yrs.	143	47%	$15

The post-2012 issue affects on IERCs in the range of -$2 to $15. The negative figures are calculated in case the original IERCs are negative.

There seem to be two groups: one with the 2012 issues having a large impact, one with the impact being relatively smaller. The former has relatively higher IERCs originally, while the latter lower. Figure 11 serves to demonstrate this difference more clearly.

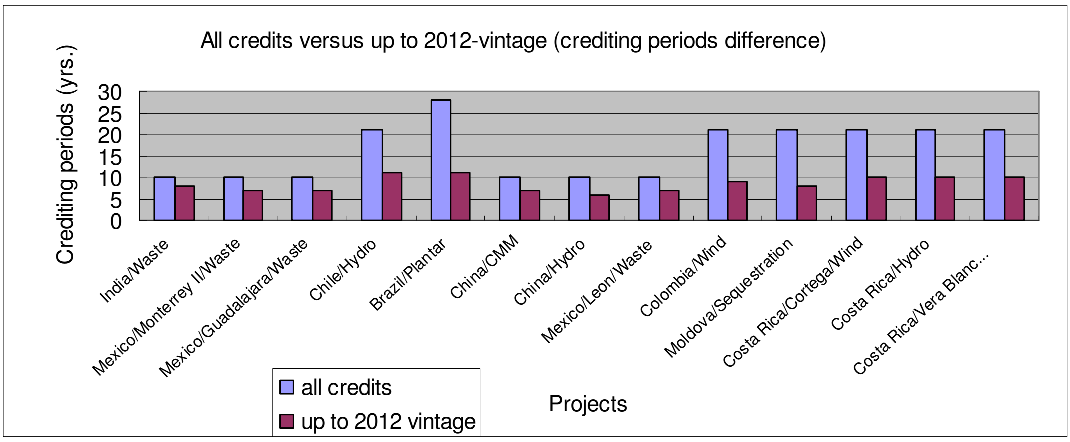
Figure 11: IERCs in the case of All Credits versus up to 2012-vintage Credits



The 5 projects (Colombia Wind project; Costa Rica Cortega Wind project; Moldova Sequestration project; Costa Ricca Hydro project; Costa Rica Vera Blanca Wind project) all see a larger impact, where changes in the cost benefit test result in failure with the upper limit of Pearce's (2003a) SCC. Like the carbon inflator decrease case, the Costa Rica Vera Blanca Wind project fails the cost benefit test even with current EUA price level (€20 = $25) due to the post-2012 issue.

There are two possible reasons for dividing the two groups. The first is length of crediting period. A larger impact group are mostly with longer crediting period such as 21 years while a relatively smaller impact group with shorter period like 10 years. Thus, the former is obliged to have longer dead crediting period if the post-2012 vintage carbon credits become no value in the market. Figure 12 shows the whole crediting period and crediting periods up to 2012 for each project.

Figure 12: Crediting Period Differences between all credits versus 2012-vintage



All of the greater impacted 5 projects have originally 21 years crediting period, while most of the low impact group are 10 years. The exceptions of the Brazil Plantar project and the Chile Hydro project seem to originate from the low IERCs figures. Those two projects have relatively lower IERCs incorporating all credits, \$2/tCO2e for Brazil and \$0.5/tCO2e for Chile, while the other 5 projects have over \$5/tCO2e. The impact of no admission for post-2012 vintage credit is relatively smaller in the case of the relatively lower IERCs' projects.

4.3.4 Credits Registration Risk

Table 12 demonstrates how the discrepancy in carbon credits amount specified both in the WB PDD and in the UNFCCC PDD influence IERCs.

Table 12: Impact on IERCs by Registration Risk

		Credits Amounts		IERCs for Project lifetime	
		000 tCO2e	%	DR=10% CI=10%	DR=10% CI=0%
Brazil/Plantar	WB PDD	12,886	100%	\$2	\$5
	UNFCCC PDD	1,704	13%	\$15	\$47
China/CMM	WB PDD	22,546	100%	\$2	\$5
	UNFCCC PDD	19,700	87%	\$3	\$5

Apparently, the huge discrepancy in the Brazil Plantar project (100% versus 13%) shows a tremendous impact on IERCs, making them approximately 8 times larger in the case of carbon inflator 10% and 9 times larger in the case of carbon inflator 0%, under discount rate 10%. This impact of change in the whole cost and benefit test, as was done in the former section, implies how credit delivery issues are critical. However, when discrepancy is relatively small (100% versus 87%) as in the China case, the impact appears relatively small. This contrast can be compared, since both have very similar IERCs in the original crediting period.

4.3.5 Transaction Costs

Table 13 demonstrates how transaction cost specified in the WB PAD influence IERCs.

Table 13: Impact on IERCs by Transaction Costs

		Transaction cost data	W or W/O	DR=10% CI=10%	DR=10% CI=0%
Chile/Hydro		(preparation) $200,000 (verification) $350,000	W/O Transaction Cost	$0.6	$1.4
2,800,000	tCO2e	(TOTAL) $550,000	W/ Transaction Cost	$0.6	$1.5
21	Years	(PAD p18)	*Difference*	*$0.03*	*$0.08*
Mexico/Gualajara/Waste		(initial) $186,000 (verification, etc.) $159,000	W/O Transaction Cost	$0.2	$0.3
1,582,300	tCO2e	(TOTAL) $345,000	W/ Transaction Cost	$0.3	$0.5
10	Years	(PAD p32*1)	*Difference*	*$0.2*	*$0.2*
Mexico/Leon/Waste		(initial) $ 26,000 (verification, etc.) $ 22,000	W/O Transaction Cost	$2.7	$4.3
200,700	tCO2e	(TOTAL) $ 48,000	W/ Transaction Cost	$2.9	$4.5
10	Years	(PAD p32*1)	*Difference*	*$0.2*	*$0.3*
Mexico/Monterrey II/Waste		(initial) $138,000 (verification, etc.) $118,000	W/O Transaction Cost	-$0.1	-$0.1
1,216,900	tCO2e	(TOTAL) $256,000	W/ Transaction Cost	$0.1	$0.1
10	Years	(PAD p32*1)	*Difference*	*$0.2*	*$0.2*

<source: WB PAD for Chile/Hydro Project; WB PAD for Mexico/Waste Project>

*1: Transaction cost for Mexico/Waste Project are posted commonly for those 3 projects as follows

$350,000 for initial verification, $300,000 for further verification and WB supervision.

The author assumingly allocates these transaction cost into three projects according to carbon

The transaction cost impacted IERCs with (+) $0.03-0.2/tCO2e in the case of discount rate 10% and carbon inflator 10%. However, it seems too premature to draw any conclusion, especially considering that three projects in Mexico are under one umbrella project and thus transaction cost may be less than a usual project due to repeated effects. Therefore, this thesis simply presents the calculation output on the transaction cost matter.

The sensitivity analysis with hypothetical transaction cost for all projects are shown in Table 14.

Table 14: Impact on IERCs by Hypothetical Transaction Costs

Projects	All Credits		Annual Credits	With Hypothetical Transaction	Without Transaction	Difference
	000 tCO2e	yrs.	000 tCO2e	$	$	$
China/CMM	22,546	10	2,255	2.3	2.3	0.01
Brazil/Plantar	12,886	28	460	2.0	2.0	0.02
Chile/Hydro	2,800	21	133	0.6	0.5	0.1
China/Hydro	2,640	10	264	2.7	2.6	0.1
Moldova/Sequestration	1,812	21	86	6.3	6.2	0.1
Mexico/Guadalajara/Waste	1,582	10	158	0.3	0.2	0.2
Mexico/Monterrey II/Waste	1,217	10	122	0.1	-0.1	0.2
Colombia/Wind	1,168	21	56	5.3	5.0	0.2
India/Waste	1,018	10	102	-9.1	-9.4	0.2
Costa Rica/Vera Blanca/Wind	329	21	16	14	13	0.8
Costa Rica/Cortega/Wind	303	21	14	7.6	6.7	0.8
Mexico/Leon/Waste	201	10	20	4.0	2.7	1.2
Costa Rica/Hydro	181	21	9	12	10	1.4

The impacts vary from (+) $0.01 to (+) $1.4, where projects with smaller annual carbon credits appear to tend towards a larger impact and vice versa. This is compatible with the arguments that projects with smaller carbon credits have disadvantages as elaborated in Section 3.1.3.

Chapter 5: Discussion

How Differently an Implicit Emission Reduction Cost can be Utilized

In order to demonstrate how carbon credits influence each project's revenue stream, the WB Carbon Finance Business (WB CFB) often uses two ways: 1) how much the carbon credits increase revenue per unit electricity or unit of the goods (i.e. \$/kWh: dollar per kilo watt hour; \$/tcm CH_4: dollar per ton cubic meter of methane) with the assumption of the fixed carbon *price* (i.e. \$3/tCO_2e), and 2) how much the carbon credits boosts the project's Internal Rate of Return (IRR) and improves its NPV with the assumption of the fixed carbon *price* (WB, 2002b; WB, 2005e) Internal Rate of Return (IRR) is the discount rate at which investment has zero net present value and used widely as one of indices in appraising projects (Lumby and Jones, 1999). If the IRR is greater than discount rate or WACC to be used for the concerned project, such a project is acceptable since such a project reflects the more profitable use of the capital involved (Lumby and Jones, 1999). Although these ways represent the impact of carbon revenue, they seem to have two drawbacks.

The first drawback is the difficulty in comparing projects with different technologies. For instance, please imagine the case in which one needs to compare a wind power project, like the Colombia Wind project, representing an emission reduction credits' impact as \$/kWh and a methane capture project, like the Mexico Leon Waste project, representing it as \$/tcm. If the latter uses methane for a generation, it can be converted into \$/kWh. However, like the Mexico Leon Waste project, there is a project which carries out only methane capture. Thus, the check of revenue increase by carbon credits per unit does not sometimes function, while the IRR boosting rate has no this kind of drawback. IERCs can also compare projects throughout the different technologies as Chapter 4 demonstrates.

However, the IRR boosting rate cannot overcome the second drawback. That is, the difficulty in examining the potential profitability of emission reduction that the specific project has, i.e. the profitability of carbon credits generation. This drawback is rooted in considering only the carbon *price*. It is plausible if those indices aim to estimate a carbon *revenue* impact. Indeed, they may not aim at assessing project potential in emission reduction profitability. However, if one would like to assess the profitability of carbon credit, the *cost* should be examined. The *price* is determined by the market, i.e. a negotiation. In the case of CERs dealt by the PCF, the referenced price ranging $3-5/tCO2e affects the price negotiation. All of the thirteen projects were also agreed with the fixed price of the above range with the PCF. These are *prices* determined through negotiations, never *costs* which each specific project potentially is endowed with, and thus no "production cost" for generating one CER. The IERC or incremental cost, a *production cost* of reducing emission, can overcome this difficulty. As IERCs seem more desirable than the incremental approach, as discussed in Section 3.1.2, the IERC is the candidate for solving this difficulty.

Of course, the IERC also contains a drawback. As examined in Chapter 4, it varies depending on appraisal time horizon choice, discount rate and carbon inflator. The first two are common issues which the NPV approach carries in usual project appraisal, and which the incremental cost approach should also face. The carbon inflator is an issue which only IERCs have. However, this critique can be mitigated by verifying the impact through the sensitivity analysis, as done in Section 4.3.2. Furthermore, the incremental cost approach likely imposes an additional burden on the project proponents, such as estimating another “hypothetical” business-as-usual project cost (eg. coal-fired plant). When one considers the concerns about the complexity of the CDM projects (UNEP, 2005), and the complicated and knowledge-required estimation of the incremental cost (GEF, 2002), more complicated data may not be welcome. Thus, IERCs should be preferable.

IERCs can also detect the impacts unique to the CDM project conducted in Section 4.3.3, 4.3.4 and 4.3.5. This feature is not exclusive to IERCs, since the incremental cost estimation and revenue impacts indices can also demonstrate them. However, the demonstration in this thesis proves at least that IERCs can work as indices for addressing the impacts by the CDM projects. Moreover, IERCs can be one of the indices for assessing investment additionality, if the international policy community has determined to keep requiring investment additionality as a prerequisite. If the IERC is negative, it means that the concerned project can yield the positive NPV despite of carbon revenue. Thus, it can show investment additionality in terms of financial issue. Of course, the private sector may have constraints to reveal such data. However, compared with a rather complicated additionality tool (Matsuo, 2004), IERCs may be much simpler.

Cost-Efficiency Assessment for Thirteen Projects

As revealed by Section 4.2, all projects pass cost-benefit test if compared with the recorded EUAs price, €29. However, it is too risky to use this recorded price as a price parameter. First, this level kept only about 1 week (July 4-13, 2005) (Point Carbon, 2005c). Secondly, there is a suggestion that even the current EUA price level around €20 would not realize the long-term equilibrium price and thus would have a risk to fall as discussed in Section 3.3.2 (Lecocq and Capoor, 2005). Thus, it seems rational to use at least the current price level, €20, as a price parameter whilst all the time being aware of the latter concern. In such a case, the questionable project is only the Cost Rica Vera Blanca Wind project. Similarly, there are two questionable projects with SCC comparison: Costa Rica Vera Blanca Wind projects and Costa Rica Hydro projects.

If the referenced CERs prices of the WB CFB are referred as a carbon price, 8 projects (India Waste project; Mexico Monterrey II Waste subproject; Mexico Guadalajara Waste subproject; Chile Hydro project; Mexico Leon Waste project; China CMM project; China Hydro project; Brazil Plantar project) pass a cost benefit test. They consist of 5 methane recovery projects, 2 hydro-electric power projects and 1 fuel switch projects. These 8 projects appear stable, without changing the cost benefit test result with sensitivity analysis of discount rate, carbon inflator and post-2012 issues.

This finding corresponds to the recent prevailing knowledge that higher Global Warming Potential (GWP) gases abatement projects possess more cost efficiency (Ellise *et al*, 2003; WB, 2005e). Methane possesses 21 times GWP as large as CO2, which means 1 tonne methane emission equals to 21

tCO_2e emission. Thus, emission reduction cost per tCO_2e tends to lower in the case of methane emission reduction projects than CO_2 emission reduction projects. The result endorses this argument.

However, if higher GWP projects yield lower IERCs which means they are more cost efficient, this also endorses the fear that the Hydrofluorocarbons (HFCs) destruction projects will be predominant in the CERs market (Ellis *et al*, 2004; CAN 2004; Kiko Network, 2004). The HFCs have GWP from 12 to 12,000 times as large as CO_2 (Houghton, 2004) and actually HFCs destruction projects have dominated about 30% of the whole WB Carbon Finance Business traded from 2003 to May 2004 (Streck, 2005). The HFCs destruction projects are good in terms of cost efficiency but questionable in terms of a counter-incentive to the aim of Montreal Protocol and the contribution to sustainable development. The former concern arises because HFCs is a by-product of HCFC22, prohibited from manufacturing for developed countries by 2020 and developing countries by 2040 under the Montreal Protocol. It is solved by the Conference of Party (COP 10) decision held in December, 2004, that only the existing facilities manufacturing HCFC22 can be eligible as the HFCs destruction CDM projects (UNFCCC Decision 12/CP.10, 2004). The latter concerns arise because a potentially abundant supply for the HFCs projects may crowd out the possible CERs by projects which contribute more to sustainable development, such as renewable energy projects (Ellis *et al*, 2004). The civil society has tried to form the consensus that HFCs projects tend not to contribute to sustainable development, which can be witnessed in the Gold Standard promoted by the WWF, that sets eligibility only for renewable energy projects and end-use energy efficiency projects, but not for HFCs projects

(WWF, 2005b; 2005c). However, before any formal international policy is formulated for controlling this issue, one could consider the cost efficiency of HFCs projects in emission reduction, which is one of the rationales for the CDM projects. One can also promote HFCs instead of other projects.

Moreover, two hydro-projects, within those which passed the cost benefit test seem problematic in terms of sustainable development. These projects are sometimes considered as relatively "large" hydroelectric projects, 98MW for the China Hydro project and 26MW for the Chile Hydro project. International Rivers Network (IRN) and the CDM Watch, both of which are NGOs for monitoring the CDM project, argue that "small hydro" considered as environmentally friendly hydro-electric projects should be under 10MW and have condemned the PCF hydro-electric projects over 10MW (IRN & CDM Watch, 2004). They justify their argument on the grounds that the EU ETS requires hydro projects above 20MW to respect the guidelines and standards designated by the World Commission on Dams (WOD). These are widely acknowledged principles but not incorporated in the WB PDDs (IRN & CDM Watch, 2004). The Gold Standard defines small low-impact hydro with a size limit of 15MW, complying with the WCD guidelines (WWF, 2005c). Although it is not the scope of this thesis to assess whether the China Hydro and the Chile Hydro projects are "small", the fact remains that these are considered by the civil society as "large" hydro projects.

Furthermore, the Brazil Plantar project has also been criticized by the civil society on the grounds of emission reduction generated from mono-culture plantations, which are considered environmentally unfriendly (Wysham, 2005; CDM Watch 2005). This may be the reason for the large decrease of carbon credits stated in the UNFCCC PDD issued on July 1, 2004, from 100% stated in the WB PDD into approximate 13% (WB PDD, 2002b; UNFCCC PDD, 2004b) as discussed in Section 3.1.3.

On the other hand, 5 projects (Colombia Wind project; Moldova Sequestration project; Costa Rica Cortega Wind project; Costa Rica Hydro project; Costa Rica Vera Blanca Wind project) can be judged as questionable or marginal in cost-efficiency. As mentioned above, they failed the cost benefit test with the referenced CERs prices by the WB CFB. Further, although 5% discount rate sensitivity analysis changes all 5 projects cost benefit test result with the upper limit of the WB CFB CERs referenced prices ($5/tCO2e) into pass, the sensitivity analysis with carbon inflator decrease down to 0% changes those 5 projects cost benefit test with Pearce (2003a)'s upper limit SCC price (approximately $9/tCO2e) into failure. Moreover, the sensitivity analysis by post-2012 issues demonstrates that those 5 projects would incur a relatively larger negative impact, making the tests fail.

Interestingly, these 5 projects all contain non-disputable renewable energy (3 wind projects and 1 hydro project with 6.3MW), except the Moldova sequestration. To the extent of the author's knowledge, no civil society has complained about those projects nor wind power electricity projects and small-hydro projects below 10 MW. Thus, this appears to imply that non-disputable renewable energy projects tend to posses higher IERCs, which means lower cost-efficiency. Thus, this finding may endorse the argument that cost-efficiency and contribution of sustainable development could be a trade-off relationship as discussed in Section 2.2.

As discussed thus far, the results suggest a trade-off between cost-efficiency and sustainable development. This would raise a concern about "race to the bottom" because of the "prerogative" right to the developing countries (Cosbey *et al*, 2005; Sutter, 2004; Asuka, 2004). Thus, the international policy community should think about the criteria for sustainable development, in order to avoid a rush to the "low hanging" CERs. As introduced in Section 2.2, META-CDM promoted by Sutter (2004) can be a tool for reaching a consensus on such criteria. It consists of a set of critical environmental thresholds and weights by stakeholder's preference on each sustainable development indicator, by ideally surveying more than 20 people involved in such a project (Sutter, 2004). Although this methodology still has several issues, such as difficulty in comparing different areas' projects or every time survey required for capturing stakeholders' preferences, these issues are common for any quantified methodology for sustainable development criteria. META-CDM is much superior to others in terms of accuracy (Asuka, 2004). Therefore, the establishment of sustainable development criteria should proceed as soon as possible.

The argument of the trade-off between cost-efficiency and contribution to sustainable development comes from the vivid difference between the 8 projects and the 5 projects, both in terms of IERCs and discussions among NGOs. The cost-efficient 8 projects have IERCs ranging from -\$9/tCO2e to \$3/tCO2e, while relatively cost-inefficient 5 projects from \$5/tCO2e to \$13/tCO2. Given the trade-off and concern about "race to bottom", the international community should consider any mean to stimulate projects with higher sustainable development contribution. One of the means to doing so is to raise the price of carbon credits. Actually, the WB provides the premium *price*, (+) \$0.5/tCO2e, for the projects contributing more to sustainable development (Pacdan, 2004; Hiratake, personal communication, 2005). However, the range of IERCs, -\$9/tCO2e to \$13/tCO2e, implies \$0.5/tCO2e *price* addition is not enough as an impetus.

The investigation how the carbon credits price can be differentiated for stimulating higher sustainable development contribution projects should be explored in the future research. This thesis points it out here simply the following issues to be overcome. First, which kind of projects should be prioritized with how higher prices should be determined. The META-CDM discussed above can be utilized for defining higher carbon prices deserved projects. Second, higher pricing should require careful consideration on the issue of crowding out the private trust fund managing companies. They have increased the concern about the competition against the WB CFB (Carbon Finance, 2005; Hagiwara, personal communication, 2005). Any kind of transparent rule for providing higher pricing may be required. Finally, acquiring fund trustors' approval for higher pricing may be difficult. Since the current WB CERs reference price range, \$3-\$5/tCO2e, is determined by willingness to pay by the fund trustors (Dopazo, personal communication, 2005), increasing prices should be challenging given that the private sectors seek maximum profitability. This would become even more difficult if the arbitrage in market mechanism occurs and equalise carbon credit prices in the EU ETS market, which would be enable to lose the value of premium CERs generated by "development-friendly" projects discussed in Section 3.1.2.

Chapter 6: Conclusions and areas for future research

The CERs trade and the CDM projects have increased year by year. In such a situation, it is important to assess the cost-efficiency of such projects, which is one of the rationales of the CDM projects. This thesis suggests utilizing IERCs and appraises the cost efficiency of thirteen projects managed by the WB PFC by using IERCs.

IERCs have been demonstrated to compare the projects over different technologies. They can also assess the impact in terms of $/tCO2e for various risks widely discussed in the CDM arena, namely, post-2012 issues, delivery risk and transaction cost. The ability to assess these phenomena presents a broad potential to utilize the IERCs as a tool of assessing the CDM projects.

The IERCs estimation result in varying -$9/tCO2e to $13/tCO2e under the assumed discount rate 10% and carbon inflator 10%. This proves that production cost of emission reduction varies depending upon the project profile. Looking at them in detail, the results reveal that most of the lower IERCs include the methane recovery projects and the relatively large hydro projects. Accordingly, cost benefit tests, using SCC estimated by academics, EUAs prices formally incepted from January, 2005 onwards and CERs prices traded in the market, result in favour of lower IERCs and against higher IERCs.

A problem, however, is created in terms of contribution to sustainable development, as the results suggests that there seems to be a trade-off between lower IERCs and higher contributions to sustainable development. This issue may be propagated by the fact that host countries have the sole right to interpret what a sustainable development contribution is, i.e. increases the "race-to-bottom" concern. Thus, international policy participants should consider any remedy for mitigating this trade-off. One possible way to achieve this is making transparent sustainable development criteria such as META-CDM. Possible future studies should pursue how to establish sustainable development criteria among different technologies and various countries. Furthermore, higher pricing on more sustainable development projects is also one possible means as an impetus for fostering such a project. The difference in IERCs ranging from -\$9/tCO2e to \$13/tCO2e implies the current WB sustainable development premium price, (+) \$0.5/tCO2e, would be too small to stimulate such projects.

The CDM is the world's first trial for introducing an incentive market mechanism in the climate change policy arena among developed countries and developing countries, which possess dual aims and complicated procedures. This thesis suggests that IERCs can take an important role for assessing these issues. In the future, the assessment can contribute to the renewal of the framework of the CDM scheme.

Appendix 1: Project Data Set and Assumptions

Chile: Chacabuquito Hydroelectric Power Project
Documents from which the data is collected:

i. (the WB website) the WB website, PCF Projects available at http://carbonfinance.org/pcf/router.cfm?Page=Projects in June 1, 2005

ii. (PAD) "Project Appraisal Document on a Proposed Purchase of Emissions Reductions from the Prototype Carbon Fund (PCF) in the Amount of US$ 3.5 Million from the Hidroelectrica Guardia Vieja, S.A. (Republic of Chile) for the Chacabuquito Hydroelectric Power Project, December 5, 2001" downloaded on June 1, 2005 from the WB website at http://carbonfinance.org/pcf/router.cfm?Page=Projects&ProjectID=3107

iii. (Annex) "Chile: PCF Chacabuquito Hydroelectric Power Project ANNEX 1-6" downloaded on June 1, 2005 from the WB website at http://carbonfinance.org/pcf/router.cfm?Page=Projects&ProjectID=3107

iv. (WB PDD) "Prototype Carbon Fund, Chile: Chacabuquito 26 MW Run of River Hydropower Project, Project Design Document, Final Draft October 1, 2001" downloaded on June 1, 2005 from the WB website at http://carbonfinance.org/pcf/router.cfm?Page=Projects&ProjectID=3107

v. CDM Watch website on PCF project explanation available on June 27, 2005 at http://cdmwatch.org/project_details.php?ID=13

vi. (UNFCCC PDD) "Clean Development Mechanism Project Design Document Form (CDM-PDD) Version 02 – in effect as of: 1 July 2004" downloaded on June 27, 2005 from the UNFCCC website, http://cdm.unfccc.int/UserManagement/FileStorage/FS_790768463

0. General

➢ Project Components:
The project includes constructing a 25MW a run-of-the-river power plant (PAD p6). Greenhouse gas emission reduction result from switching power generation resource from fossil fuel to renewable hydro power (UNFCCC PDD p7-8).

➢ Base Case:
The base case is coal-fired thermal electricity generation plants in high-case and natural gas-fired thermal electricity generation plants in low-case (PAD p8), which will be determined by the CDM EB. In this analysis, a high-case will be used.

1. Project-related-period

➢ Original Data
  - ✓ The "useful life" of this project is 40 years (PAD p16).
  - ✓ The "operational lifetime of run-of-river hydropower plant is estimated as 30 years" (UNFCCC PDD p18).
  - ✓ The ER crediting period is 21 years, consisting of three renewable 7-years baselines (PAD p8) (PAD p8).
  - ✓ The cost starts generating in 2001 (Table 6, PAD p17).
  - ✓ The financial analysis is done with 51 years for both without and with carbon benefit (PAD p18-19; Annex p5-8).

➢ Author's Assumption:
  - ✓ There is a discrepancy of project lifetime between PAD and UNFCCC PDD. The author assumes that PAD (40 years) should be correct since their financial analysis use life time 50 years, even longer than 40 years.

2. Cost and Revenues

- Key Data Location
  - ✓ The 2001-2016 Cash Flow (Table 6) is in page 17-18 (PAD).
  - ✓ The 0^{th}-50^{th} year Cash Flow (Table 5.B) is in page 25 (PAD).

- Data Quality

➢ Original Data Statements
  - ✓ The original data is in US dollars without showing an exchange rate.
  - ✓ The original financial analysis starts from 2001 (PAD p17-19).

➢ Author's Assumption: no author's assumption

- Capital Expenditure, Operating Cost and Revenue
  The author picks up the following for 2001-2016:
  (1) capital expenditure not from "Depreciation" [2] but from "Investment",
  (2) revenue from "Income" consisting of "Spot energy", "Contract Energy" and "Capacity", and
  (3) operational cost from "Cost" consisting of "Operation and maintenance" and "Toll", specified in Table 6 (PAD p17-19).
  For 2017-2041, the author picks up the net cash flow from Table 5.B (p25).

➢ Original Data Statements
  - ✓ The original data states that the project will cost approximately $37 million for constructing a hydro-electronic power plant system including contingencies excluding financing charges, shown in "investment" in the Table 6 (PAD p16). It consists of $32 million associated to the run-of-river hydro plant and $5 million to the expansion of transmission lines for a new power plant (PAD p16).
  - ✓ The investment cost does not include finance charges (PAD p16).
  - ✓ Financing plan shows same amount $37 million in Table 4.A (PAD p14) (*and so the above looks plausible*).
  - ✓ Table 6 also shows "depreciation" with annual $1.524 million for calculating "operational revenue".
  - ✓ The original writer's financial projection of the cash flow, shown in Table 6 and Table 5.B, includes the following: 1) revenues from sale of energy and capacity payment; 2) investment; 3) operation, maintenance and administrative expenses of the hydro plant (PAD p17).
  - ✓ The Project Sponsor expects to contract out 85GWh/year (approximately 53% of electricity to be generated) at the node price at approximately US$26.6 MWh. It also expects to receive capacity payment[3] of at US$58.31/kW/year, which are consistent both official and market forecasts (p17). Further it expects to sell remaining electricity around 75 GWh per year at the market at the spot price, projected at US$14.8 GWh, which is historical average of the October-March period (p17).

➢ Author's Assumption other than "tax"
  - ✓ The author does not choose "depreciation" but take "investment" instead since the author assumes that both covers same asset (a hydro power plant system) and "depreciation" is non-cash flow as stated in the thesis.
  - ✓ The author assumes that the 0th-15th year in Table 5.B (Annex p25) is compatible to 2001-2016 in Table 6 (p17-18), since annual net cash flow in 0th-15th year in Table 5.B is same as those in 2001-2016 in Table 6.
  - ✓ The author assumes that the negative cash flow in the 26th year in Table 5.B (-$8.18 million) should be due to major maintenance.

3. Discount Rate

➢ Original Statement
  - ✓ Discount rate used for their Financial Analysis is 10%, which is Chilean power sector legal discount rate (p19).
  - ✓ Sensitive analysis includes with 8% and 12% discount rate (p18, Annex p25).

➢ Author's Assumption: please refer to the page the Section 3.2 in this thesis.

4. Carbon Credit Amount

---

[2] Refer to Section 3.2.2 for excluding "depreciation".

[3] "Capacity payment" means a component of the Pool Purchase Price which is designed to provide an incentive for generating capacity to be made available (www.nordpool.no/information/glossary.html). "Pool Purchase Price" means the time waited average pool purchase, which the basis of payments by distributors for purchases of electricity from the base-load generators through the pool.

- Original Statement
  - ✓ 2,752,000 tCO2e — the WB website

2,752,000 tCO2e		the WB website
1,986,400 tCO2e	2002-16	PAD p8
1,812,000 tCO2e	2002-22	WB PDD p3
2,812,000 tCO2e	21 years	CDM Watch
2,800,000 tCO2e[4]	21 years	UNFCCC PDD p8

  - ✓ The annual time profile in 2002-2016 is shown (PAD p8)
- Author's Assumption
  - ✓ The author assumes the UNFCCC PDD as total credit amount since it is closer to CDM Watch, while using PAD time profile for first 15 years.
  - ✓ For the last 6 years time profile in 2017-2022, the author divides the difference between UNFCCC PDD (2,800,000 tCO2e) and PAD (1,986,400) evenly.

[4] Refer to Section 3.1.3 in this thesis for the huge discrepancy between UNFCCC and others.

Brazil: Minas Gerais Plantar Project
Documents from which the data is collected:

ii. (the WB website) the WB website, PCF Projects
available on June 1, 2005 at http://carbonfinance.org/pcf/router.cfm?Page=Projects

iii. (PAD) "Project Appraisal Document on a Proposed Purchase of Emissions Reductions from the Prototype Carbon Fund in the Amount of US$ 5.3 Million to the Republic of Brazil for the PCF Minas Gerais Plantar Project, April 1, 2002"
downloaded on June 1, 2005 from the WB website,
http://carbonfinance.org/pcf/router.cfm?Page=Projects&ProjectID=3109

iv. (PAD Annex) Annex 1 to 6 of the above 2.
downloaded on Jun 1, 2005 from the WB website,
http://carbonfinance.org/pcf/router.cfm?Page=Projects&ProjectID=3109

v. (WB PDD) "Prototype Carbon Fund Brazil: Sustainable Fuelwood and Charcoal Production for the Pig Iron Industry in Minas Gerais, The "Plantar" Project Design Document, Submitted with Documents for Validation, 17 October, 2001, Updated and resubmitted for Validation March 2002" downloaded on June 1, 2005 from the WB website,
http://carbonfinance.org/pcf/Router.cfm?Page=Projects&ProjectID=3109

vi. (CDM Watch) CDM Watch website on PCF project explanation available on June 27, 2005 at
http://cdmwatch.org/project_details.php?ID=12

vii. (UNFCCC PDD) "Clean Development Mechanism Project Design Document Form (CDM-PDD) Version 02 – in effect as of: 1 July 2004" downloaded on June 27, 2005 from the UNFCCC website, http://cdm.unfccc.int/UserManagement/FileStorage/FS_258955548

0. General

- Project components:
The project includes the followings: creating plantations (23,100 hectare of high yielding provenances of Eucalyptus and 47.3 hectare of cerrado) in 2001-2009 for resource of sustainable charcoal as pig-iron reduction agent; improving kiln technology for reducing methane leakage during carbonization in pig-iron production (PAD p9-10; WB PDD p3-4; p6-7). The project sponsor is Plantar S.A, a family-owned Brazilian company. Greenhouse gas emissions reduction result from 1) carbon sequestration by afforestation, 2) reduction in methane on producing pig-iron by improving a kiln i.e. "carbonization" (PAD p17), and 3) fuel switch prevention from charcoal to coke produced by coal.
- Base case:
The base case is an ongoing shift to the use of coke with imported coal. Although the project sponsor, Planter S.A., uses now the charcoal as a reduction agent for pig-iron production, it faces a supply bottleneck because of financially unfeasible plantations. This may likely make the small-scale charcoal-based independent pig-iron producers such as Plantar S.A. abandon production, which result in propagation of coke-based pig-iron production (PAD p8; WB PDD p5-6).

1. Project-related-periods

- Original Data Statement
  - ✓ Project life is 28 years (PAD p10; WB PDD p3),
  - ✓ The ERs crediting period is 21 years from three sources: 1) forest sequestration; 2) improved kiln technology; 3) resource switch from coal-based coke to plantation-based charcoal (PAD p10), starting in 2002, 2002 and 2009 (PAD p17-8).
  - ✓ The cost starts generated in 2002 (Annex 6).
  - ✓ The financial analysis is done with 21 years for the case without carbon revenue and 28 years for the case with carbon revenue (PAD p19; Annex 6)
- Author's Assumption: no author's assumption

2. Cost and Revenue

- Key Data Location
  - ✓ The 2002-2029 Annual Cash Flow Table is located in Annex 6, which contains data for capital expenditure, operational cost and revenues.

- Data Quality

- Original Data Statements
  - ✓ The original data is in US dollars. The original writer assumes that the exchange rate between the US dollars and the Brazilian Real, which is required for about 23% of the operating costs (purchasing iron ore and export shipping charge) and 20-50% of the revenue (exporting pig-iron), is *as of* January 1, 2001 (Annex 6).
  - ✓ The all costs and revenue are based on three year averages ending on December 31, 2000 (Annex 6).
- Author's Assumption: no author's assumption

- Capital Expenditure, Operating Costs and Revenues
  The author picks up the following for 2002-2029:
  (1) capital expenditure from "Investment" consisting of "Land plus infrastructure", "Plantation" and "Methane flaring", "Working capital"[5], and "Depreciation and exhaustion",
  (2) operating cost and revenue from "Activity net benefit", while not from "Income tax"[6], specified in the Table (Annex 6).
- Original Data Statements
  - ✓ Investment consists of "Land plus infrastructure", "Plantation" and "Methane flaring", shown in the 2002-2029 Cash Flow Table in Annex 6, which is aggregated $35,570,000.-, without salvage value in 2029 (PAD Annex 6).
  - ✓ Financial plan in p5, p10 and p19 shows aggregated $38.8 million (*and so the above looks plausible*).
  - ✓ "Working capital" in the 2002-2029 Cash Flow Table in Annex 6 is generated throughout years.
  - ✓ Besides the above Investment, there is "Depreciation and exhaustion" in the Table, generated with annual average approximate $2.6 million in 2009 afterwards as same timing as "Activity net benefit".
  - ✓ This project does not generate any revenues before the first wood harvest occurred in 2009 afterwards (PAD p20).
  - ✓ Beginning in the 2009, the project will require the full use of the assets of the pig-iron production subsidiary, Plantar Siderugica (PAD Annex 6).
  - ✓ Annex 6 states that the pig iron mill and its auxiliary assets necessary for reducing methane will be rented to the project at a cost of $500,000 annually represented as the assets value (Annex does not have any page designation).
  - ✓ "Activity net benefit" in the Table generates in 2009 afterwards with annual average approximate $3.9 million which gradually increase from $2.5 million in 2009 to $5.5 in 2029.
  - ✓ The revenue of this project other than carbon revenue is only "sale of pig iron produced with charcoal and moving from 50% to 100% own charcoal production" (WB PDD, p4)
  - ✓ The major inputs to the production of plantation-based pig-iron are charcoal (including the cost of the wood from which it is produced), iron ore, labour electricity, and shipping and handling for exports (PAD Annex 6).
  - ✓ "Income tax" is shown in the Table in 2009 afterwards.
- Author's Assumption: explaining the author's picking up the data;
  1) "Land plus infrastructure", "Plantation", "Methane flaring" – see above
  2) "Working capital"[7], excluding "Income tax"[8] – see page the Section 3.2 in the thesis
  3) "Depreciation and exhaustion", "Activity net benefit" – see below
  - ✓ Author assumes that "Depreciation and exhaustion" in the Table should be for an existing facility to produce pig-iron and thus should be incorporated in this thesis's analysis. Author judges because of the followings: 1) this project generates revenue (pig-iron sale) only after 2009, when "Depreciation and exhaustion" cost is first incurred, (and so this cost should be related to pig-iron production facility); 2) the asset value is usually represented in "Depreciation and exhaustion" if not included in capital expenditure; 3) the relatively large chunk (approximately annual US2.6 million).
  - ✓ Author assumes "Activity net benefit" should include operational cost and revenues generated

---

[5] Refer to Section 3.2.2 in this thesis for picking up "working capital".
[6] Refer to Section 3.2.2 in this thesis for excluding "income tax".
[7] Refer to Section 3.2.2 in this thesis for picking up "working capital".
[8] Refer to Section 3.2.2 in this thesis for excluding "income tax".

from sale of pig-iron manufactured by this project plantation-based charcoal, judging from the original data statement.

3. Discount Rate
- Original Statement
  - ✓ Discount rate used for their Financial Analysis is assumed as 10% (p19).
- Author's Assumption: please refer to the page the Section 3.2 in this thesis.

4. Carbon Credit Amount
- Original Data Statement
  - ✓ 10,251,564 tCO2e the WB website
    12,885,984 tCO2e 21 years PAD p17-18
    12,885,984 tCO2e 21 years WB PDD p12-13
    13,789,656 tCO2e 21 years CDM Watch
    1,794,111 tCO2e[9] 21 years UNFCCC PDD p8; Section E.4.
  - ✓ The annual time profile in the whole crediting time is shown (PAD p17-18; WB PDD p17-18; UNFCCC PDD Section E.4.)
- Author's Assumption
  - ✓ The author assumes that the PAD should be more plausible.
  - ✓ The author demonstrates the comparison analysis for carbon credit amounts both in the PAD and the UNFCCC PDD. Please see page the Section 3.2 in the thesis.

[9] Please refer page the Section 3.2 in this thesis for the huge discrepancy between UNFCCC and others.

China: Coal Mine Methane Project
Documents from which the data is collected:

i. (the WB website) the WB website, PCF Projects
available at http://carbonfinance.org/pcf/router.cfm?Page=Projects in June 1, 2005

ii. (PAD) "Project Appraisal Document on a Prototype Carbon Fund in the Amount of US$10 Million to the People's Republic of China for a Jincheng Coal mine Methane Project, July 1, 2004"
acquired from Steele in the WB Carbon Finance Business on June 6, 2005 by personal communication

iii. (CDM Watch) CDM Watch website on PCF project explanation available on June 27, 2005 at http://cdmwatch.org/project_details.php?ID=374

iv. (UNFCCC PDD) "Clean Development Mechanism, Project Design Document Form (CDM-PDD), Version 02 - in effect as of: 1 July 2004)" downloaded on June 27, 2005 from the UNFCCC website, http://cdm.unfccc.int/UserManagement/FileStorage/FS_993853453

0. General

- ➢ Project Components:
The project includes capturing of methane from coal mine, constructing a 120MW gas-fired plant with the captured methane for replacing grid electricity generated by coal-fired power plants with the power transmission lines (PAD p3), and capacity building and consulting services. Greenhouse gas emissions reduction result from 1) reduction in methane on digging coal mine and 2) thermal electricity generation fuel switch from coal to fugitive coal mine methane (UNFCCC PDD p6-7).
- ➢ Base case:
The base case is coal-fired thermal electricity generation plants.

1. Periods related to the Project

➢ Original Data

- Original Data Statement
  - ✓ The operational lifetime for the project activity is 20 years "as is common for internal combustion engines" (UNFCCC PDD p17).
  - ✓ The ERs crediting period is 10 years (UNFCCC PDD p8).
  - ✓ The plant operation is expected from 2006 (PAD p33).
  - ✓ The cost starts generated in 2003 (Table p3).
  - ✓ The financial analysis is done with 28 years (PAD p31).

➢ Author's Assumption: no author's assumption

2. Cost and Revenue

- Key Data Location
  - ✓ The 2003-2030 Cash Flow Table 5.3 is located in page 36-37 (PAD).

- Data Quality

➢ Original Data Statement
  - ✓ The original data in PAD p36-37 are in Chinese Yuan.
  - ✓ The exchange rate the original writer use is US$1=CY8.28[10] (p0=just after the title page).

➢ Author's Assumption
  - ✓ The author coverts the original data in PAD p36-37 to US dollars with using the exchange rate specified in PAD (US$1=CY8.28).

- Capital Expenditure, Operating Costs and Revenues
The author picks up the following for 2003-2025:
(1) capital expenditure *not* from "Depreciation" [11] but from "Capital Expenditure",
(2) revenue from "Sales Revenue" consisting of "Gross sales" by coal mine methane production

[10] Since China adopted a fixed exchange rate system, the exchange rate in any case should no be fluctuated.
[11] Refer to Section 3.2.2 for excluding "depreciation".

and "Gross sales" by electricity generation,
(3) operational cost from "Cost of Goods Sold (coal mine methane production)" consisting of "Fixed O&M cost" and "Variable O&M cost", and "Cost of Goods Sold (electricity generation)" consisting of "Fixed O&M cost", "Variable O&M Cost" and "fuel cost", and
(3) operational cost *not* from "City Construction & Education tax"[12] and "Income tax"[13], stated in Table 5.3 (PAD p36-37).

- Original Data Statement
  - ✓ "Capital expenditure" stated in Table 5.3 are aggregated as approximate CY 1,106 million (approximate $134 million): CY 148 million (approximate $18 million) for capturing coal mine methane and CY 958 million (approxi8mate $116 million) for construing the power plant (PAD p36-37).
  - ✓ Project cost estimates shows $136.69 million (*and so the above looks plausible*) including the followings: Underground CMM[14] Recovery and Drainage; CMM Fired Power Plant and Transmission Lines; Resettlement; Consulting Services; Staff Training; Institutional Strengthening; Contingency; Interest During Construction (PAD p4). "Interest During Construction" costs $11.21 million.
  - ✓ The period of depreciation is set as 20 years and the aggregated depreciation shown in the Table 5.3 is exactly same amount as "capital expenditure". (*Thus, it is plausible to take only "capital expenditure" and not both.*)
  - ✓ "Fixed O&M cost" and "Variable O&M cost" for electricity generation in Table 5.3 are assumed CNY 20-24/1000kWh for fixed O&M and CNY 49/1000kW for variable O&M (PAD p32-33).
  - ✓ "Gross sales" by coal mine methane is expectedly based on CNY 0.2 /m3 and the expected selling amount is assumed relatively small in the first 2006-2007 and constant from 2008. "Gross sales" by electricity generation is based on CNY 0.2 /kWh guaranteed in the agreed power purchase contract and the expected selling amount assumingly starts first at 40% of the installed capacity in 2006-7 and will increase from 2008 in line with the new engine installation (PAD p32-33).
- Author's Assumption: no author's assumption except excluding "taxes". Please refer to page the Section 3.2 in the thesis for the tax.

3. Discount Rate
   - Original Data Statement
     - ✓ Discount rate used for their Financial Analysis is WACC 4.96% (PAD p10).
   - Author's Assumption: please refer to the page the Section 3.2 in this thesis.

4. Carbon Credit Amount

- Original Data Statement
  - ✓

49,046,000 tCO2e		the WB website
22,550,000 tCO2e	2002-16	PAD p36-37
19,745,382 tCO2e	21 years	CDM Watch
19,700,000 tCO2e[15]	21 years	UNFCCC PDD p8

  - ✓ The annual time profile in 2002-20222 is shown (PAD p36-37)
- Author's Assumption
  - ✓ The author assumes the PAD should be plausible since PAD is the most influential document for investment decision.
  - ✓ However, because the UNFCCC PDD is closer to CDM Watch, the author demonstrates sensitive analysis with UNFCCC PDD's carbon credit.

---

[12] Refer to Section 3.2.2 for excluding "tax".
[13] Refer to Section 3.2.2 for excluding "tax".
[14] CMM = Coal Mine Methane
[15] Refer to Section 3.1.3 in this thesis for the huge discrepancy between UNFCCC and others.

Colombia: Jepirachi Carbon Off Set Project
Documents from which the data is collected:

i. (the WB website) the WB website, PCF Projects
available at http://carbonfinance.org/pcf/router.cfm?Page=Projects in June 1, 2005
ii. (PAD) "Project Appraisal Document on a Prototype Carbon Fund in the Amount of US$3.2 Million for Empresas Publiccas de Medellin (EEPPM) for the Jepirachi Carbon Off Set Project, October 30, 2002"
acquired from Steele in the WB Carbon Finance Business on June 6, 2005 by personal communication
iii. (WB PDD) "Clean Development Mechanism Project Design Document (CDM-PDD) Prototype Carbon Fund Colombia: Jepirachi Wind Power Project, September 8, 2003" downloaded on June 27, 2005 from the WB website,
http://carbonfinance.org/pcf/Router.cfm?Page=Projects&ProjectID=3119
iv. CDM Watch website on PCF project explanation available on June 27, 2005 at
http://cdmwatch.org/project_details.php?ID=14
v. (UNFCCC PDD) "Clean Development Mechanism Project Design Documents (CDM-PDD) Prototype Carbon Fund Colombia: Jepirachi Wind Power Project September 8, 2003 / April 7, 2004 as amended on November 28, 2003 in response to the draft recommendations of the Methodology Panel to the CDM Executive Board contained in F-CDM-NMmp ver 03 – NM0024, as revised on April 7 and 12, 2004 in response to Methodology Panel recommendations as approved by the CDM Executive Board contained in F-CDM-NMmp ver 3 – NM0024 resubmitted for reconsideration by the Methodology Panel and the CDM Executive Board" downloaded on June 27, 2005 from the UNFCCC website,
http://cdm.unfccc.int/UserManagement/FileStorage/FS_837711305

0. General

➢ Project components:
The project includes constructing on-grid wind power generation and a social program (PAD p14-5).
➢ Base case:
The base case is the mixture of gas-fired plants and coal-fired plants (PAD p14-5). That is, a mix of coal & gas based power plant is base case in 2005-2009 and a gas based power plant after 2010 (PAD p28).

1. Project-related-periods

➢ Original Data
• Original Data Statement
  ✓ Project life is 21 years (PAD p30; WB PDD p14).
  ✓ The ERs crediting period is 21 years, starting in 2004 (PAD p30).
  ✓ The cost starts generated in 2002 (Table 2 PAD p49).
  ✓ The plant starts commissioning at the end of 2003 (PAD p30, p48).
  ✓ The financial analysis is done with 21 years (PAD p30).
➢ Author's Assumption: no author's assumption

2. Cost and Revenue

• Key Data Location
  ✓ The 2002-2012 Cash Flow is located in Table 2 (PAD p49) and the 2002-2012 Income Statement Proforma in Table 5 (PAD p50) while assumptions for those tables are summarized in Table 1 (p48).

• Data Quality
➢ Original Data Statements
  ✓ The original data available in 2002-2012 are with 3 % annual increase "for the purpose of financial analysis" (PAD p30, p49).
  ✓ The Tables above only show the 10 first year of project life even though the (original their financial) analysis reflects 21 years (PAD p30).
  ✓ The original data is shown in US dollars, while it states that the exchange rate of Colombian

Pesos is on US$=COP 2340.50 (PAD p0)

- Author's Assumptions
  - ✓ The author assumes that the original writer should provide 3% annual increase due to inflation, since there is no physical reason to increase operational cost and revenue except unexpected market price upset. Since this analysis is done in the real terms, this 3% increase should be ignored.
  - ✓ The author assumes the operational cost and revenue in 2013-2024 as same as 2002-2012. It should be plausible since the original financial analysis also assumes the constant 3% annual increase for the project lifetime (21 years).
  - ✓ The author ignores the exchange rate and deals the data as if in a 0^{th} year's real term US dollars.

- Capital Expenditure, Operating Costs and Revenues

  The author picks up the following for 2003-2012:

  (1) capital expenditure *not* from "Depreciation" [16] but from "Investment and Working Capital Requirement",

  (2) revenue from "Revenue" consisting of "Electricity Sales",

  (3) operational cost from "O&M" and "Land's Rent for social program"[17], and

  (3) operational cost *not* from "income tax"[18],

  stated in Table 2 and Table 5 (PAD p49; p50).

- Original Statements
  - ✓ "Investment and WCR" costs US$20,598,852 and there are no further capital expenditure expected in the life of the project (PAD p30).
  - ✓ Annex 3 (PAD p47) and Table 6 (PAD p16) shows project cost and finance plan of $21 million for Wind Facility ($20.2 million) and Social Program ($0.8 million) (*and thus, the above looks plausible*).
  - ✓ "Energy Sales" is based on that electricity quantity to be sold is approximately 68GWh per year, 40% of Plant Factor, and 2.6 cents per kWh, which is "very conservative" estimate (PAD p30).
- Author's Assumption
  - ✓ The author assumes that "Depreciation" in Table 2 should cover same fixed assets to be constructed by "Investment", since there is no critical facility involved in this project other than wind power plant.
  - ✓ For the operational cost and revenue in 2013-2024, please refer to "data quality" above.

3. Discount Rate

- Original Data Statement
  - ✓ Discount rate used for their Financial Analysis is WACC 10% (PAD p30).
  - ✓ Sensitive analysis includes with 5%, 6%, 7% and 11% discount rate (PAD p31).
- Author's Assumption: please refer to the page the Section 3.2 in this thesis.

4. Carbon Credit Amount

- Original Statement
  - ✓

1,168,000 tCO2e		the WB website
1,168,249 tCO2e	21 years	PAD p29
1,680,000 tCO2e	21 years	WB PDD p6; p26
1,680,000 tCO2e	21 years	CDM Watch
1,680,000 tCO2e	21 years	UNFCCC PDD p6

  - ✓ The annual time profile in the whole crediting period is shown (PAD p29)
- Author's Assumption
  - ✓ The author assumes the PAD as total credit amount since the difference is negligible and time profile is also available.

---

16 Refer to Section 3.2.2 for excluding "depreciation".

17 Those are shown in Table 5 (p50), which is compatible the difference between "Operational cost" and "Depreciation" in Table 3 (p49).

18 Refer to Section 3.2.2 for excluding "tax".

Costa Rica: Chorotega Wind Firm project
Documents from which the data is collected:

i. the WB website, PCF Projects
available at http://carbonfinance.org/pcf/router.cfm?Page=Projects in June 1, 2005

ii. (PAD) "Project Appraisal Document on a Prototype Carbon Fund in the Amount of US$10 Million to the Republic of Costa Rica for the Umbrella Project for Renewable Energy Sources, October 30, 2002"
acquired from Steele in the WB Carbon Finance Business on June 6, 2005 by personal communication

iii. CDM Watch website on PCF project explanation available on June 27, 2005 at http://cdmwatch.org/project_details.php?ID=131

0. General

➢ Project Components:
The project includes constructing on-grid wind power generation and 3km transmission line (PAD p9).

➢ Base Case:
The base case is the thermal plant electricity generation (PAD p17-8).

1. Project-related-periods

➢ Original Data

- Original Data Statement
  - ✓ The life time is 25 years after the plant commission date in 2003 (PAD p40; p109).
  - ✓ The ERs crediting period is 21 years after 2003 (PAD p19).
  - ✓ The cost starts generated in 2002 (p110).
  - ✓ The financial analysis is done with project life time, 25 years (Annex B1 p109; Annex B2 p110).

➢ Author's Assumption: no author's assumption

2. Cost and Revenue

- Key Data Location

✓ The 2002-2027 Cash Flow is located in Annex B2 (PAD p110) and the 2003-2010 Financial Statements Proforma in Annex B5a (PAD p113) while assumptions for those tables are summarized in Annex B1 (PAD p109).

- Data Quality

➢ Original Data Statement
  - ✓ The original data is shown in US dollars, while it states that the exchange rate of Colones is on US$1=331.87LC (PAD p0).
  - ✓ The original data in Annex B5b for 2003-2010 are with 2% annual increase without giving a reason.
  - ✓ The "Revenue" shown in Annex B2 for 2003-2027 are with 2% annual increase without giving a reason.

➢ Author's Assumption
  - ✓ The author assumes that the original writer should provide 2% annual increase due to inflation, since there is no physical reason to increase operational cost and revenue except unexpected market price upset. Since this analysis is done in the real terms, this 2% increase should be ignored.
  - ✓ The author assumes the operational cost and revenue in 2011-2027 as same as 2010. It seems plausible since the revenues shown in Annex B2 are constantly 2% increasing until 2027 and the operational costs deducting depreciation are also same.
  - ✓ The author assumingly ignores the exchange rate and deals the data as if in a 0^{th} year's real term US dollars.

- Capital Expenditures, Operating Costs and Revenues

The author picks up the following for 2003-2012:

(1) capital expenditure *not* from "Depreciation" [19] in Annex B5a but from "Investment" in Annex B1;
(2) revenue from "Total Revenue" consisting of "Electricity Sales" and "Other Revenue" in the year 2003;
(3) operational cost from "Total Operational Costs", in particular "O&M", "Administration" and "Insurance" in Annex B5a;
(3) operational cost *not* from "Total Operational Costs", in particular "Financial Costs" [20], "Municipal Taxes" and "Depreciation and Amortization" in Annex B5a,
stated either in Annex B5a or Annex B1 (PAD p113; p109).

- Original Data Statements
  - ✓ Forecasted investment costs are $17,334,890. There are no further capital expenditures expected in the life of the subproject. (PAD p40).
  - ✓ Annex 3 states that the required financing for Chorotega Subproject is $ 17.3 million (PAD p36) (*and so the above is plausible*).
  - ✓ Working Capital requirements, valued at $50,000, is provided initially by the original investment.
  - ✓ "Insurance" costs in Annex B5a become about one third in 2008 (PAD p113)
  - ✓ "Electricity Sales" is based on that electricity quantity to be sold is approximately 21.2 GWh per year, 29% of Plant Factor, and 9 cents per kWh(PAD p19; p40; p109)
  - ✓ "Revenue" in 2003 in Annex B2 ($1,957,140) is compatible to "Total Revenue" in Annex B5a.
  - ✓ "Operational costs" in 2003 in Annex B2 ($118,320) is compatible the aggregated amount in 2003 of the followings in Annex B5a: "O&M"; "Administration"; "Insurance"; "Financial Costs"; "Municipal Taxed"; "Depreciation and Amortization".
  - ✓ "Revenues" in Annex B2 remain unchanged until 2027 except 2% annual increase.
  - ✓ "Operational costs" in Annex B2 remain unchanged until 2027 except 2% annual increase and slight decrease in 2008 afterwards.
- Author's Assumption
  - ✓ The author assumes that "Depreciation and Amortization" in Annex B5a should cover same fixed assets to be constructed by "Investment", since there is no critical facility involved in this project other than wind power plant.
  - ✓ The author assumes that "Insurance" should become one third in 2008 afterwards in line with the change of "Insurance" in 2008 afterwards in Table B5a.
  - ✓ The author assumes the operational cost and revenue in 2011-2027 as same as 2010. It is plausible because of the following reasons: "Revenues" shown in Annex B2 remain unchanged; "Revenues" in Annex B2 is compatible to "Total revenues" in Annex B5a; "Operational costs" in Annex B2 remain unchanged except slight decrease in 2008, which may be due to insurance cost decrease; "Operational costs" in Annex B2 is compatible to the aggregated amount of "O&M"; "Administration"; "Insurance"; "Financial Costs"; "Municipal Taxed"; "Depreciation and Amortization".

3. Discount Rate

- Original Statement
  - ✓ Discount rate used for their Financial Analysis is WACC 5.41% (p19; p41; p109).
  - ✓ Sensitive analysis includes with 8%, 9%, 10% and 11% discount rate (p19; p109; p111).
- Author's Assumption: please refer to the page the Section 3.2 in this thesis.

4. Carbon Credit Amount

- Original Data Statement
  - ✓ 323,850 tCO2e the WB website
    300,000 tCO2e 21 years CDM Watch
  - ✓ The Discount Cash Flow Analysis in 2002-2027 (PAD p110) shows annual income with and without carbon credit, provided that the former is estimated on unit carbon revenue $3.0/tCO2e (PAD p109) for 21 years in 2003-2023.
  - ✓ The annual time profile in the whole crediting time is shown in the above Cash Flow Analysis

[19] Please refer to page the Section 3.2 in this thesis for excluding "depreciation".
[20] Please refer to page the Section 3.2 in this thesis for excluding "financial charge".

in dollars amount (PAD p110).

- Author's Assumption
  - ✓ The author assumes carbon credit amount in the Discount Cash Flow Analysis (PAD p110) as 329,100 tCO_2e as follows;

    (1) by calculating annual carbon revenue:

    net cash flow with carbon revenue (-) without carbon revenue

    (2) by dividing (1) with$3/$tCO_2e$

    (3) by aggregating (2) for the whole 21 years crediting period

    For readers' understanding, the following equation is aggregated each factor;

    $63,596,182 (-) $62,687,782 (=) $908,400 (/) $3/$tCO_2e$ (=) 302,800 tCO_2.

    <with> <without> <carbon revenue> <unit> <credit amount>

    This is close enough to CDM Watch (300,000 tCO_2e).
  - ✓ The author uses time profile is used shown in this Discount Cash Flow Analysis.

Costa Rica: Cote Hydroelectric Subproject
(under Umbrella Project for Renewable Energy Sources)
Documents from which the data is collected:
the WB website, PCF Projects
available at http://carbonfinance.org/pcf/router.cfm?Page=Projects in June 1, 2005
(PAD) "Project Appraisal Document on a Prototype Carbon Fund in the Amount of US$10 Million to the Republic of Costa Rica for the Umbrella Project for Renewable Energy Sources, October 30, 2002"
acquired from Steele in the WB Carbon Finance Business on June 6, 2005 by personal communication
CDM Watch website on PCF project explanation available on June 27, 2005 at
http://cdmwatch.org/project_details.php?ID=132

0. General
- Project Components:
The project includes constructing a 6.3 MW Hydroelectric power generation using water from the Cote Lake (PAD p8). It includes a cap on the dam to increase its height by 1m, an open canal, an additional tunnel, a pressure pipe, a powerhouse containing a 6.3 MW Francis turbine, a substation and sluice (PAD p8-9), while the existing water intake structure, tunnel and dam will be diverted for this project (PAD p8).
- Base Case:
The base case is the thermal plant electricity generation (PAD p17-18).

1. Project-related-periods
- Original Data
- Original Data Statement
The life time is 40 years after the plant commission date in 2003 (PAD p38; p117).
  - ✓ The ERs crediting period is 21 years after 2003 (PAD p18; p38).
  - ✓ The cost starts generated in 2002 (p118).
  - ✓ The financial analysis is done with project life time, 40 years (Annex A1 p117; Annex A2 p118)
- Author's Assumption: no author's assumption

2. Cost and Revenue
- Key Data Location
  - ✓ The 2002-2042 Cash Flow is located in Annex A2 (PAD p118) and the 2003-2010 Income Statements Proforma in Annex A5 (PAD p120) while assumptions for those tables are summarized in Annex A1 (PAD p117).

- Data Quality
- Original Data Statement
  - ✓ The original data is shown in US dollars, while it states that the exchange rate of Colones is on US$1=331.87LC (PAD p0).
  - ✓ The original data in Annex A5 for 2003-2010 are with 2% annual increase without giving a reason.
  - ✓ The "Revenue" and "Operational Costs" shown in Annex A2 for 2003-2042 are with 2% annual increase without giving a reason.
- Author's Assumption
  - ✓ The author assumes that the original writer should provide 2% annual increase due to inflation, since there is no physical reason to increase operational cost and revenue except unexpected market price upset. Since this analysis is done in the real terms, this 2% increase should be ignored.
  - ✓ The author assumingly ignores the exchange rate and deals the data as if in a 0^{th} year's real term US dollars.

- Capital Expenditures, Operating Costs and Revenues
The author picks up the followings for 2003-2010:

(1) capital expenditure *not* from "Depreciation"[21] in Annex A5 but from "Investment" in Annex A1;
(2) revenue from "Total Revenue" which is "Electricity Sales" in the year 2003;
(3) operational cost from "Total Operating Costs", in particular "O&M", "Administration", "Insurance" and "Canon" in Annex A5,
stated either in Annex A5 or Annex A1 (PAD p120; p117).
For 2011-2042, the author assumes to continue operational cost and revenue in 2010 afterwards, checked by Cash Flow in 2011-2042 stated in Annex A2 (p118).

- ➢ Original Data Statements
  - ✓ Forecasted investment costs are $10,920,220. There are no further capital expenditures expected in the life of the subproject (PAD p38).
  - ✓ Annex 3 states that the required financing for Cote Hydro Subproject is $10.5 million (PAD p36) (*and so the above is plausible*).
  - ✓ Working Capital requirements are negligible (PAD p37).
  - ✓ "Electricity Sales" is assumingly based on that electricity quantity to be sold is approximately 13.2 GWh per year, 24% of Plant Factor, and 7.9 cents per kWh(PAD p18; p37; p117)
  - ✓ "Operational costs" in 2003 in Annex A2 ($118,320) is compatible the aggregated amount in 2003 of the followings in Annex A5: "O&M"; "Administration"; "Insurance"; "Canon".
  - ✓ "Revenue" in 2003 in Annex A2 ($10421,360) is compatible with "Total Revenue" in Annex A5.
  - ✓ "Operational costs" and "Revenues in Annex A2 remain unchanged until 2042 except 2% annual increase.
- ➢ Author's Assumption
  - ✓ The author assumes that "Depreciation and Amortization" in Annex B5a should cover same fixed assets to be constructed by "Investment", since there is no critical facility involved in this project other than hydro power plant.
  - ✓ The author assumes the operational cost and revenue in 2011-2042 as same as 2010. It is plausible because of the following reasons: "Operational cost" and "Revenues" shown in Annex A2 remain unchanged; "Revenues" in Annex A2 is compatible to "Total revenues" in Annex A5; "Operational costs" in Annex A2 is compatible to the aggregated amount of "O&M", "Administration", "Insurance" and "Canon".

3. Discount Rate

- ➢ Original Statement
  - ✓ Discount rate used for their Financial Analysis is WACC 7.74% (p19; p38; p117).
  - ✓ Sensitive analysis includes with 8%, 9%, 10% and 11% discount rate (p117; p119).
- ➢ Author's Assumption: please refer to the page the Section 3.2 in this thesis.

4. Carbon Credit Amount

- ➢ Original Data Statement
  - ✓ 215,138 tCO2e the WB website
    204,000 tCO2e 21 years CDM Watch
  - ✓ The Cash Flow Analysis in 2002-2042 (PAD p118) shows expected annual income by carbon credit calculated on $3.0/tCO2e (PAD p117) for 21 years in 2003-2023.
  - ✓ The annual time profile in the whole crediting time is shown in the above Cash Flow Analysis in dollars amount (PAD p118).
- ➢ Author's Assumption
  - ✓ The author assumes carbon credit amount in the Cash Flow Analysis (PAD p110) as 180,600 tCO2e, calculating as follows;
    $541,800 (/) $3/tCO2e (=) 180,600 tCO2.
    This is close enough to CDM Watch (204,000 tCO2e).
  - ✓ The author uses time profile is used shown in this Cash Flow Analysis.

[21] Refer to Section 3.2.2 in this thesis for excluding "depreciation".

Costa Rica: Vara Blanca Wind Power
Documents from which the data is collected:

i. the WB website, PCF Projects
available at http://carbonfinance.org/pcf/router.cfm?Page=Projects in June 1, 2005

ii. (PAD) "Project Appraisal Document on a Prototype Carbon Fund in the Amount of US$10 Million to the Republic of Costa Rica for the Umbrella Project for Renewable Energy Sources, October 30, 2002"
acquired from Steele in the WB Carbon Finance Business on June 6, 2005 by personal communication

iii. CDM Watch website on PCF project explanation available on June 27, 2005 at http://cdmwatch.org/project_details.php?ID=130

0. General

➢ Project Components:
The project includes constructing a 9.6 MW wind farm with 15 aerial generators of Turbo winds technology (PAD p9).

➢ Base Case
The base case is the thermal plant electricity generation (PAD p17-8).

1. Project-related-periods

➢ Original Data

- Original Data Statement
  - ✓ The life time is 25 years after the plant commission date in 2003 (PAD p43; p102).
  - ✓ The ERs credit period is 21 years after 2003 (PAD p43).
  - ✓ The cost starts generated in 2002 (p103).
  - ✓ The financial analysis is done with project life time, 40 years (AnnexC1 p102; Annex C2 p103)

➢ Author's Assumption: no author's assumption

3. Cost and Revenue

- Key Data Location

✓ The 2002-2027 Cash Flow is located in Annex C2 (PAD p103) and the 2003-2010 Financial Statements Proforma in Annex C5a (PAD p105) while assumptions for those tables are summarized in Annex C1 (PAD p102).

- Data Quality

➢ Original Data Statement
  - ✓ The original data is shown in US dollars, while it states that the exchange rate of Colones is on US$1=331.87LC (PAD p0).
  - ✓ The original data in Annex C5b for 2003-2010 are with 2% annual increase without giving a reason.
  - ✓ The "Revenue" shown in Annex C2 for 2003-2027 are with 2% annual increase without giving a reason.

➢ Author's Assumption
  - ✓ The author assumes that the original writer should provide 2% annual increase due to inflation, since there is no physical reason to increase operational cost and revenue except unexpected market price upset. Since this analysis is done in the real terms, this 2% increase should be ignored.
  - ✓ The author assumes the operational cost and revenue in 2011-2027 as same as 2010. It seems plausible since the revenues shown in Annex C2 remain unchanged except constantly annual 2% increase until 2027 and the operational costs deducting depreciation are also same.
  - ✓ The author assumingly ignores the exchange rate and deals the data as if in a 0^{th} year's real term US dollars.

- Capital Expenditures, Operating Costs and Revenues

The author picks up the followings for 2003-2010:

(1) capital expenditure *not* from "Depreciation and Amortization" [22] in Annex C5a but from "Investment" in Annex C1;
(2) revenue from "Total Revenue", which is "Electricity Sales" in Annex C5a;
(3) operational cost from "Total Operational Costs", in particular "O&M", "Administration" and "Insurance" in Annex C5a;
(3) operational cost *not* from "Total Operational Costs", in particular "Financial Costs" [23], "Municipal Taxes" and "Depreciation and Amortization" in Annex C5a,
stated either in Annex C5a or Annex C1 (PAD p105; p102).

- Original Data Statements
  - ✓ Forecasted investment costs are $20,368,023. There are no further capital expenditures expected in the life of the subproject. (PAD p43).
  - ✓ Annex 3 states that the required financing for Vera Blanca Subproject is $ 18.7 million (PAD p36) (*and so the above is plausible*).
  - ✓ Working Capital requirements, valued at $50,000, is provided initially by the original investment.
  - ✓ "Insurance" costs in Annex C5a become about one third in 2008 (PAD p105)
  - ✓ "Electricity Sales" is assumingly based on that electricity quantity to be sold is approximately 22.9 GWh per year, 27% of Plant Factor, and 9 cents per kWh(PAD p21; p43; p102)
  - ✓ "Revenue" in 2003 in Annex C2 ($2,058,210) is compatible to "Total Revenue" in Annex C5a in 2003.
  - ✓ "Operational costs" in 2003 in Annex C2 ($1,599,450) is compatible the aggregated amount in 2003 of the followings in Annex C5a: "O&M"; "Administration"; "Insurance"; "Financial Costs"; "Municipal Taxed"; "Depreciation and Amortization".
  - ✓ "Revenues" in Annex C2 remain unchanged until 2027 except 2% annual increase.
  - ✓ "Operational costs" in Annex C2 remain unchanged until 2027 except 2% annual increase and slight decrease in 2008 afterwards.
- Author's Assumption
  - ✓ The author assumes that "Depreciation and Amortization" in Annex C5a should cover same fixed assets to be constructed by "Investment", since there is no critical facility involved in this project other than wind power plant.
  - ✓ The author assumes that "Insurance" should become one third in 2008 afterwards in line with the change of "Insurance" in 2008 afterwards in Table C5a.
  - ✓ The author assumes the operational cost and revenue in 2011-2027 as same as 2010. It seems plausible because of the following reason: "Revenues" shown in Annex C2 remain unchanged; "Revenues" in Annex C2 is compatible to "Total revenues" in Annex C5; "Operational costs" in Annex C2 remain unchanged except slight decrease in 2008, which may be due to insurance cost decrease; "Operational costs" in Annex C2 is compatible to the aggregated amount of "O&M"; "Administration"; "Insurance"; "Financial Costs"; "Municipal Taxed"; "Depreciation and Amortization".

3. Discount Rate

- Original Statement
  - ✓ Discount rate used for their Financial Analysis is WACC 4.85% (p21; p44; p102).
  - ✓ Sensitive analysis includes with 8%, 9%, 10% and 11% discount rate (p21; p102; p104).
- Author's Assumption: please refer to the page the Section 3.2 in this thesis.

4. Carbon Credit Amount

- Original Data Statement
  - ✓ 355,825 tCO2e the WB website
    327,000 tCO2e 21 years CDM Watch
  - ✓ The Discount Cash Flow Analysis in 2002-2027 (PAD p103) shows annual income with and without carbon credit, provided that the former is estimated on unit carbon revenue $3.0/tCO2e (PAD p102) for 21 years in 2003-2023.
  - ✓ The annual time profile in the whole crediting time is shown in the above Cash Flow Analysis

[22] Refer to Section 3.2.2 in this thesis for excluding "depreciation".
[23] Refer to Section 3.2.2 in this thesis for excluding "financial charge".

in dollars amount (PAD p103).

- Author's Assumption
  - ✓ The author assumes carbon credit amount in the Discount Cash Flow Analysis (PAD p103) as 329,100 tCO_2 as follows;
    (1) by calculating annual carbon revenue:
    net cash flow with carbon revenue (-) without carbon revenue
    (2) by dividing (1) with\$3/tCO_2e
    (3) by aggregating (2) for the whole 21 years crediting period
    For readers' understanding, the following equation is aggregated each factor;
    \$66,912,384 (-) \$65,925,084 (=) \$987,300 (/) \$3/tCO_2e (=) 329,100 tCO_2.
    <with> <without> <carbon revenue> <unit> <credit amount>
    This is close enough to CDM Watch (327,000 tCO_2e).

✓ The author uses time profile is used shown in this Discount Cash Flow Analysis.

China: Xiaogushan Hydropower Project
Documents from which the data is collected:

i. the WB website, PCF Projects
available at http://carbonfinance.org/pcf/router.cfm?Page=Projects in June 1, 2005

ii. (PAD) "Project Appraisal Document on a Proposed Purchase of Emissions Reductions in the Amount of US$ 8 Million Minimum to the Ministry of Finance People's Republic of China for CN-PCF-Xiaogushan hydropower Project June 30, 2004"
acquired from Steele in the WB Carbon Finance Business on June 6, 2005 by personal communication

iii. (WB PDD) "Annex 15: Project Design Document for Xiaogushan Hydropower Project"
acquired from Steele in the WB Carbon Finance Business on June 6, 2005 by personal communication

iv. CDM Watch website on PCF project explanation available on June 27, 2005 at http://cdmwatch.org/project_details.php?ID=286

0. General

- Project Components:
  The project includes constructing a 98-megawatt, run-of-river hydropower plant, facilitating rural electrification and furthering institutional strengthening (PAD p4).
- Base Case:
  The base case is coal-fired thermal electricity generation plants (PAD p4)

1. Project-related-periods

- Original Data
- Original Data Statement
  - ✓ The credit period submitted is 10 years (PDD p21), expected in 2007-2016 in Table A9.5 (PAD, p48).
  - ✓ The operational lifetime is explained as 30 years as common for hydropower plants (PDD, 21), expected in 2006-2035 in Table A9.1 (PAD p41-42).
  - ✓ The cost starts generated in 2003 (Table A9.5, p48; Table A9.1, p41-42)
- Author's Assumption: no author's assumption

2. Cost and Revenue

- Key Data Location
  - ✓ The 2003-2027 NPV calculation is located in Table A9.5 (PAD p48).

- Data Quality
- Original Data Statement
  - ✓ The original data in PAD p48 are in Chinese Yuan.
  - ✓ The exchange rate the original writer use is US$1=CY8.28[24] (PAD p0).
  - ✓ All costs and revenues are expressed in real terms using constant prices as of January 2003" (PAD p44)
- Author's Assumption
  - ✓ The author coverts the original data in PAD p48 to US dollars with using the exchange rate specified in PAD (US$1=CY8.28).

- Capital Expenditure, Operating Costs and Revenues
  The author picks up the followings for 2003-2027:
  (1) capital expenditure *not* from "Depreciation" [25] but from "Capital Expenditure" and "Working Capital Reserve";
  (2) revenue from "Sales Revenue" which is "Gross sales" by energy sales;
  (3) operational cost from "Cost of Goods Sold" which is "O&M Cost";

[24] Since China adopt a fixed exchange rate system, the exchange rate in any case should no be fluctuated.
[25] Refer to Section 3.2.2 for excluding "depreciation".

(3') operational cost *not* from "VAT tax"[26], "Adjusted tax"[27],
stated in the Table A9.5 (PAD p48).
For 2028-2035, the author assumes the data with checking the Table 9.1 Cash Flow Table with opportunity cost (PAD p41).

- Original Data Statement
  - ✓ "Capital expenditure" stated in Table A9.5 are aggregated as approximate CY 754 million (approximate $91 million for construing the hydro power plant (PAD p48; p43).
  - ✓ Annex 5 project cost estimates shows $87 million (*and so the above looks plausible*) including the followings: hydropower plant; rural electrification; institutional strengthening; contingencies; interest during construction (PAD p30). "Interest during construction" costs $9.07 million.
  - ✓ The period of depreciation is set as 31 years and the aggregated depreciation shown in the Table A9.5 is almost same as "capital expenditure" (CY 731 million). (*Thus, it is plausible to take only "capital expenditure" and not both.*)
  - ✓ "Gross sales" by energy sales is expectedly based on CY 0.29 /kWh which has been already contracted between the project sponsor and the Gansu Electricity Grid Company with an approval by the provincial price bureau (PAD p44). The annual electricity generation is 358 GWh, starting in 2006 with 50% operation and 100% operation in 2007 afterward (PAD p44; p48).
  - ✓ Operation & Maintenance expenses include salary, material expense, administrative expense, reservoir maintenance, Insurance fee and plant maintenance expense (PAD p45).
  - ✓ "O&M cost" and "Energy supply benefit" in Table A9.1, a cash flow analysis with opportunity cost in 2002-2035, remain unchanged throughout 2007-2035 (PAD p41-42).
  - ✓ "O&M cost" and "Gross sales" by energy sales in Table A9.5 remain unchanged throughout 2007-2027 (PAD p48).
- Author's Assumptions
  - ✓ The author assumes that the operational cost and revenue in 2028-2034 remain unchanged those in 2027 because of the following reasons: "O&M cost" and "Energy supply benefit" in Table A9.1 with economic analysis remain unchanged throughout 2007-2035 (PAD p41-42); "O&M cost" and "Gross sales" by energy sales in Table A9.5 with financial analysis remain unchanged throughout 2007-2027 (PAD p48).

3. Discount Rate

- Original Statement
  - ✓ Discount rate used for their Financial Analysis is WACC 4.66% (p13; p45-46; p48).
- Author's Assumption: please refer to the page the Section 3.2 in this thesis.

4. Carbon Credit Amount

- Original Statement
  - ✓

2,932,600 tCO2e		the WB website
2,640,109 tCO2e	2007-2016	PAD p48
2,649,119 tCO2e	10 years	WB PDD p8
3,706,600 tCO2e	10 years	CDM Watch

  - ✓ The annual time profile in the whole crediting period is shown (PAD p48)
- Author's Assumption
  - ✓ The author assumes the PAD as correct one, in spite that that (2,640,109 tCO2e) is apart from CDM Watch (3,706,600 tCO2e) because of the following reasons: 1) CDM Watch is even higher than that on the WB website, which tends to post larger amount of carbon credit; 2) WB PDD is closer to PAD; 3) PAD has time profile.

[26] Refer to Section 3.2.2 for excluding "tax".
[27] Refer to Section 3.2.2 for excluding "tax".

Mexico: Waste Management and Carbon Offset Project – Guadalajara subproject
Documents from which the data is collected:

i. the WB website, PCF Projects
available at http://carbonfinance.org/pcf/router.cfm?Page=Projects in June 1, 2005

ii. (PAD) "Project Appraisal Document on a Proposed Purchase of Emissions Reductions by the Prototype Carbon Fund in the Amount of US$ 8.4 Million to Sistemas De Energia Internacional S.A. De C.V. (SEISA) for the Mexico: Waste Management and Carbon Offset Project February 15, 2005"
acquired from Steele in the WB Carbon Finance Business on June 6, 2005 by personal communication

0. General

➢ Project Explanation:
Guadalajara landfill gas management is one of three projects under Mexico Umbrella Waste Management project, which the above document ii covers. Although the WB website explains "21 megawatt capacity 6 bundled waste-to-energy project", there are only 3 projects for which the author acquired the PADs: Guadalajara subproject, Monterrey II subproject; Leon subproject. Thus, this paper analyses only those three projects.

➢ Project Components:
The Guadalajara project includes the facility to capture landfill gas with which a 4.45 MW power will be generated (p6; p22-25).

➢ Base Case:
The base case is methane release without landfill gas capture system plus displaced CO_2 by power generation with utilizing landfill gas (p12-13).

1. Project-related-periods

➢ Original Data Statement
- ✓ The project lifetime is 21 years after commissioning landfill gas capture system (p31).
- ✓ The "0th year" corresponds to 2005 (p33).
- ✓ The facility is expected to be in operation 2006 (p6).
- ✓ There is no clear mention on the crediting period, except that PCF carbon emission reduction contractual period is 7 years with an option extending up to 10 years (p1; p6; p31).

➢ Author's Assumption
- ✓ The author assumes that the crediting period may be 10 years, judging that PCF has an option to extend the credit purchase period up to 10 years.
- ✓ The author assumes that cost should start generated in 2005, judging that "0th year corresponds to 2005" (p33) and "[Guadalajara, Monterrey II and Leon facility is] expected to be in operation by 2006" (p6).

2. Cost and Revenue

- Key Data location
  - ✓ The project cost is explained in Annex 4 (PAD p31).
  - ✓ The annual revenue and operational and maintenance costs are estimated in Annex 4 (PAD p32).
  - ✓ The Profit & Losses Statement Table in 1st-11th year is in Annex 4 (PAD p36).

- Data Quality

➢ Original Data Statements
- ✓ The original data is shown in US dollars, while it states that the exchange rate of Mexican Pesos on US$1=MXN 11.17 (PAD p0).
- ✓ The original data in the Table in Annex 4 for 1st-11th year are with 3% annual increase (PAD p36), while Annex 4 states both revenues from energy sales and costs are projected to increase 3% due to inflation (PAD p31).
- ✓ 0th year corresponds to 2005 (PAD p33).
- ✓ The facility is expected to be in operation 2006 (PAD p6).
- ✓ The "Revenue" from "Generation-Contract" in the 1st year on the Table is $2,000,700 and that in the 2nd year is $2,050,700 (PAD p36), while Annex 4 states annual revenue from generation

contract is $2,050,893 (PAD p32)

- ✓ The aggregation of "Operating Costs" excluding "Depreciation" plus "Royalties" in the 1st year on the Table is $1,496,700 and that in the 2nd year is $1,608,500 (PAD p36), while Annex 4 states annual compatible operational cost is $$1,608,460 (PAD p32).

➢ Author's Assumption

- ✓ The author assumes that the 1st year specified in the Table in PAD p36 should be the year 2005, in spite of the statement that "0th year corresponds to 2005". It seems plausible since dollars amount in the 2nd year of both revenue and operational costs in the Table is compatible to dollars amount explained in Annex 4 texts which the original writer projects to incur in 2006.
- ✓ The author assumingly ignores 3% annual increase since this analysis is done in real terms.
- ✓ The author assumingly ignores the exchange rate and deals the data as if in a real term US dollars.

- Capital Expenditure, Operating Costs and Revenues

The author picks up the following for 2005 and 2006:
(1) capital expenditure *not* from "Depreciation" [28] in the Table (PAD p36) but from "Project costs and financing" stated in Annex 4 (PAD p31) for the year 2005;
(2) revenue from "Electricity Sales" explained in "Annual Revenues" in Annex 4 (p31-32);
(3) operational cost from "Operational and Maintenance Costs" after deducting "Transaction costs" explained in "Operational Costs" in Annex 4 (p32).
In 2007 afterwards, the author assumes by checking text in Annex 4 and Table (p31-33; p36).

➢ Original Data Statements

- ✓ Project cost for Guadalajar projects is $4,550,000, consisting of the followings: "Engine Cost"; "Transformer"; "Civil Work"; "Gas Booster"; "Gas Extraction System"; "Electrical Connection" (PAD p31).
- ✓ Electricity Sales, projected incur in 2006, counts $2,050,893 (PAD p32).
- ✓ The energy sales is assumingly based on that electricity quantity to be sold is approximately 35.1 GWh per year and 5.84 cents per kWh (PAD p31-32), which is conservative price (PAD p8). This sale is under the self-generation scheme but the buyer is also a shareholder of the special purpose company in this project (PAD p31).
- ✓ Operational Costs, projected incur in 2006, counts $1,608,460 consisting of the followings; $382,604 for "Royalties"; $947,220 for "Operational and Maintenance" which is a variable cost of 2.70 cents per kWh generated for engine maintenance; $71,245 for "Gas System Maintenance"; $44,528 for "Insurance"; $7,930 for "Miscellaneous"; $53,973 for "Environmental & Social Program"; $20,000 for "Land Rental & Annual Verification Cost"; $80,960 "Project Administration Fee" (PAD p32).
- ✓ "Operational Costs" described above includes "transaction cost" which is a special cost incurred for accomplishing the CDM project. Transaction costs for 3 projects together estimates $350,000 and $300,000. The former covers cost of the WB appraisal, the preparation and validation of the CDM, and the initial verification, recovered in five equal instalments of $70,000. The latter covers cost for annual verifications and the WB supervision for the contract term, recovered in annually in the 7 years contract term (PAD p32).
- ✓ Operational cost for "Environmental and Social Program" is incurred only for the 7 years contract term as far as carbon credit revenue from the PCF exists (PAD p7; p36). If carbon credit contract with the PCF is extended, this Program is also extended and so cost is incurred accordingly.

➢ Author's Assumption

- ✓ The author assumes that "Depreciation" in Table should cover same fixed assets to be constructed by "Project Costs", since the aggregation of "Depreciation" in the Table in the 1st-10th year becomes $4,550,000 (PAD p36), a same amount of "Project Costs" in Annex 4 (PAD P31).
- ✓ The author assumingly allocates "transaction cost" for the CDM project into 3 projects in a weighted manner according to their carbon credit amounts and extracts it from "operational cost", since "operational cost" includes "transaction cost".

---

[28] Refer to Section 3.2.2 for excluding "depreciation".

- ✓ The author assumes to extend operational cost for "Environmental and social program" up to 10 years, since this analysis conduct with 10 years crediting period as explained above 1.
- ✓ For the operational cost and revenue in 2007 afterwards, the author assumes to remain unchanged as 2006 except "transaction cost" and operational cost for "environmental and social program", since this analysis is conducted in real terms.

3. Discount Rate

- ➢ Original Statement
  - ✓ Discount rate used for their Financial Analysis is not stated in any document.
- ➢ Author's Assumption: please refer to the page the Section 3.2 in this thesis.

4. Carbon Credit Amount

- ➢ Original Statement
  - ✓ 3,000,000 tCO_2e (for 3 projects) 2006-2015 PAD p1; p6; p12; p14; p31
  - ✓ 2,006,800 tCO_2e (for 3 projects) 2006-2012 PAD p12
    - 1,050,000 tCO_2e (for Guadalajara) 2006-2012
    - 780,500 tCO_2e (for Monterrey II) 2006-2012
    - 150,000 tCO_2e (for Leon) 2006-2012
    - 26,270 tCO_2e (for displaced CO_2) 2006-2012

    Annual Time Profile is available.
  - ✓ 2,243,952 tCO_2e (for 3 projects) 2006-2012 PAD p31
    - 1,050,000 tCO_2e (CH_4 for Guadalajara) 2006-2012
    - 780,500 tCO_2e (CH_4 for Monterrey II) 2006-2012
    - 150,769 tCO_2e (CH_4 for Leon) 2006-2012
    - 133,240 tCO_2e (CO_2 for Guadalajara) 2006-2012
    - 129,444 tCO_2e (CO_2 for Monterrey II) 2006-2012
  - ✓ The carbon credit amount for 3 projects can increase from "*2 million tCO2*" to 3 million tCO_2e by extension of crediting period up to 2015 (p6; p31).
  - ✓ The carbon credit amount for 3 projects can increase from "*2.2 million tCO2*" to 3 million tCO_2e by extension of crediting period up to 2015 (p8).
  - ✓ The CO_2 reduction is calculated based on 0.584 tCO_2e/MWh (p14).
  - ✓ Electricity generation is as follows (p32):

    35,100 MWh for Guadalajara

    31,422 MWh for Monterry II
  - ✓ The CO_2 reduction will occur only in Guadalajara and Monterrey II subproject, involved in power generation, while Leon subproject contains only capturing methane.
- ➢ Author's Assumption
  - ✓ There is a discrepancy of carbon credit in 2006-2012: 2 million tCO_2e versus 2.2 million tCO_2e, coming from the difference in CO_2 emission reduction by landfill power generation: 26,270 tCO_2e versus 262,684 tCO_2e (133,240 tCO_2e + 129,444 tCO_2e). The author assumes the latter, 2.2 million tCO_2e, should be more plausible, since the calculated CO_2 reduction based on a given equation (0.584tCO_2e/MWh) is much closer to the latter CO_2 emission reduction. The followings are calculations:

    0.584tCO_2e/MWh x 35,100 MWh x 7 years = 143,489 tCO_2e ←→ 133,240 tCO_2e

    0.584tCO_2e/MWh x 31,422 MWh x 7 years = 128,453 tCO_2e ←→ 129,444 tCO_2e
  - ✓ For the last 3 years time profile and subproject profile in 2013-2015, the author assumingly divides the difference between 2.2 million tCO_2e and 3 million tCO_2e as follows:

    (1) in a weighted manner with carbon credit amounts in 2006-2012 into 3 projects (Guadalajara; Monterrey II; Leon);

    (2) and further evenly into 3 years (2013-2015) within each subproject.

Mexico: Waste Management and Carbon Offset Project – Monterrey II subproject
Documents from which the data is collected: Same as Guadalajara above.

0. General

- Project Explanation:
  Monterrey II landfill gas management is one of three projects under Mexico Umbrella Waste Management project. Please refer to Guadalajara subproject's explanation.
- Project Components:
  The Monterrey II project includes capturing landfill gas with which a 3.99 MW power generation will be facilitated (p6; p22-25).
- Base Case:
  The base case is methane release without landfill gas capture system plus displaced CO2 by power generation with utilizing landfill gas (p12-13).

1. Project-related-periods: same as Guadalajara subproject.

2. Cost and Revenues

- Data Quality
- Original Data Statements
  - ✓ The original data is shown in US dollars, while it states that the exchange rate of Mexican Pesos on US$1=MXN 11.17 (PAD p0).
  - ✓ The original data in the Table in Annex 4 for 1st-11th year are with 3% annual increase (PAD p35), while Annex 4 states both revenues from energy sales and costs are projected to increase 3% due to inflation (PAD p31).
  - ✓ 0th year corresponds to 2005 (PAD p33).
  - ✓ The facility is expected to be in operation 2006 (PAD p6).
  - ✓ The "Revenue" from "Generation-Contract" in the 1st year on the Table is $1,791,100 and that in the 2nd year is $1,835,900 (PAD p35), while Annex 4 states annual revenue from generation contract is $1,835,858 (PAD p32)
  - ✓ The aggregation of "Operating Costs" excluding "Depreciation" plus "Royalties" in the 1st year on the Table is $1,327,300 and that in the 2nd year is $1,433,400 (PAD p35), while Annex 4 states annual compatible operational cost is $1,433,400 (PAD p32).
- Author's Assumption
  - ✓ The author assumes that the 1st year specified in the Table in PAD p36 should be the year 2005, in spite of the statement that "0th year corresponds to 2005". It seems plausible since dollars amount in the 2nd year of both revenue and operational costs in the Table is compatible to dollars amount explained in Annex 4 texts which the original writer projects to incur in 2006.
  - ✓ The author ignores 3% annual increase since this analysis is done in real terms.
  - ✓ The author ignores the exchange rate and deals the data as if in a real term US dollars.

- Capital Expenditure, Operating Costs and Revenues
  The author picks up the following for 2005 and 2006:
  (1) capital expenditure *not* from "Depreciation" [29] in the Table (PAD p35) but from "Project costs and financing" stated in Annex 4 (PAD p31) for the year 2005;
  (2) revenue from "Electricity Sales" explained in "Annual Revenues" in Annex 4 (p31-32);
  (3) operational cost from "Operational and Maintenance Costs" after deducting "Transaction costs" explained in "Operational Costs" in Annex 4 (p32).
  In 2007 afterwards, the author assumes by checking text in Annex 4 and Table (p31-33; p36).
- Original Data Statements
  - ✓ Project cost for Monterrey II projects is $3,690,000, consisting of the followings: "Engine Cost"; "Transformer"; "Civil Work"; "Gas Booster"; "Gas Extraction System"; "Electrical Connection" (PAD p31).
  - ✓ Electricity Sales, projected incur in 2006, counts $1,835,858 (PAD p32).
  - ✓ The energy sales is based on that electricity quantity to be sold is approximately 31.4 GWh per year and 5.84 cents per kWh (PAD p31-32), which is conservative price (PAD p8). This

[29] Refer to Section 3.2.2 for excluding "depreciation".

sale is under the self-generation scheme but the buyer is also a shareholder of the special purpose company in this project (PAD p31).

- ✓ Operational Costs, projected incur in 2006, counts $1,433,400 consisting of the followings; $335,379 for "Royalties"; $833,402 for "Operational and Maintenance" which is a variable cost of 2.70 cents per kWh generated for engine maintenance; $70,019 for "Gas System Maintenance"; $35,010 for "Insurance"; $6,977 for "Miscellaneous"; $53,045 for "Environmental & Social Program"; $20,000 for "Land Rental & Annual Verification Cost"; $79,568 "Project Administration Fee" (PAD p32).
- ✓ "Operational Costs" described above includes "transaction cost" which is a special cost incurred for accomplishing the CDM project. Transaction costs for 3 projects together estimates $350,000 and $300,000. The former covers cost of the WB appraisal, the preparation and validation of the CDM, and the initial verification, recovered in five equal instalments of $70,000. The latter covers cost for annual verifications and the WB supervision for the contract term, recovered in annually in the 7 years contract term (PAD p32).
- ✓ Operational cost for "Environmental and Social Program" is incurred only for the 7 years contract term as far as carbon credit revenue from the PCF exists (PAD p7; p35). If carbon credit contract with the PCF is extended, this Program is also extended and so cost is incurred accordingly.

- ➢ Author's Assumption
- ➢ The author assumes that "Depreciation" in Table should cover same fixed assets to be constructed by "Project Costs", since the aggregation of "Depreciation" in the Table in the 1st-10th year becomes $3,690,000 (PAD p35), a same amount of "Project Costs" in Annex 4 (PAD P31).
- ➢ The author allocates "transaction cost" for the CDM project into 3 projects in a weighted manner according to their carbon credit amounts and extracts it from "operational cost", since "operational cost" includes "transaction cost".
- ➢ The author assumes to extend operational cost for "Environmental and social program" up to 10 years, since this analysis conduct with 10 years crediting period as explained above 1.
  - ✓ For the operational cost and revenue in 2007 afterwards, the author assumes to remain unchanged as 2006 except "transaction cost" and operational cost for "environmental and social program", since this analysis is conducted in real terms.

3. Discount Rate: same as Guadalajara subproject.

4. Carbon Credit Amount: same as Guadalajara subproject

Mexico: Waste Management and Carbon Offset Project – Leon
Documents from which the data is collected: Same as Guadalajara above.

0. General
- Project Explanation:
  Leon Waste Management project, which the above document ii covers. Although the WB website explains "21 megawatt capacity 6 bundled waste-to-energy project", there are no documents available for the other 3 projects and thus this paper analyze only 3 landfill gas management projects in Guadalajara, Monterrey II and Leon.
- Project Components:
  The Guadalajara project includes capturing landfill gas which will be flared (p6; p22-25).
- Base Case:
  The base case is methane release without landfill gas capture system (p12-13).

1. Project-related-periods: same as Guadalajara subproject.

2. Cost and Revenues
- Data Quality
- Original Data Statements
  - ✓ The original data is shown in US dollars, while it states that the exchange rate of Mexican Pesos on US$1=MXN 11.17 (PAD p0).
  - ✓ The original data in the Table in Annex 4 for 1st-11th year are with 3% annual increase (PAD p34), while Annex 4 states that operational costs are projected to increase 3% due to inflation (PAD p31).
  - ✓ 0th year corresponds to 2005 (PAD p33).
  - ✓ The facility is expected to be in operation 2006 (PAD p6).
  - ✓ The aggregation of "Operating Costs" excluding "Depreciation" plus "Royalties" in the 1st year on the Table is $35,600 and that in the 2nd year is $36,100 (PAD p34), while Annex 4 states annual compatible operational cost is $36,120 (PAD p32).
- Author's Assumption
  - ✓ The author assumes that the 1st year specified in the Table in PAD p34 should be the year 2005, in spite of the statement that "0th year corresponds to 2005". It seems plausible since dollars amount in the 2nd year of operational costs in the Table is compatible to dollars amount explained in Annex 4 texts which the original writer projects to incur in 2006.
  - ✓ The author assumingly ignores 3% annual increase since this analysis is done in real terms.
  - ✓ The author assumingly ignores the exchange rate and deals the data as if in a real term US dollars.

- Capital Expenditure, Operating Costs and Revenues
  The author picks up the followings for 2005 and 2006:
  (1) capital expenditure *not* from "Depreciation" [30] in the Table (PAD p34) but from "Project costs and financing" stated in Annex 4 (PAD p31) for the year 2005;
  (2) operational cost from "Operational and Maintenance Costs" after deducting "Transaction costs" explained in "Operational Costs" in Annex 4 (p32).
  In 2007 afterwards, the author assumes by checking text in Annex 4 and Table (p31-33; p34).
- Original Data Statements
  - ✓ Project cost for Leon projects is $362,500, consisting of the followings: "Civil Work"; "Gas Booster"; "Gas Extraction System" (PAD p31).
  - ✓ This project generates no sales other than carbon credit revenue (PAD p13; P32)
  - ✓ Operational Costs, projected incur in 2006, counts $36,112 consisting of the followings; $10,000 for "Royalties"; $16,112 for "Environmental & Social Program"; $10,000 for "Land Rental & Annual Verification Cost" (PAD p32).
  - ✓ "Operational Costs" described above includes "transaction cost" which is a special cost incurred for accomplishing the CDM project. Transaction costs for 3 projects together

[30] Refer to Section 3.2.2 for excluding "depreciation".

estimates $350,000 and $300,000. The former covers cost of the WB appraisal, the preparation and validation of the CDM, and the initial verification, recovered in five equal instalments of $70,000. The latter covers cost for annual verifications and the WB supervision for the contract term, recovered in annually in the 7 years contract term (PAD p32).

  - ✓ Operational cost for "Environmental and Social Program" is incurred only for the 7 years contract term as far as carbon credit revenue from the PCF exists (PAD p7; p34). If carbon credit contract with the PCF is extended, this Program is also extended and so cost is incurred accordingly.

- ➢ Author's Assumption
- ✓ The author assumes that "Depreciation" in Table should cover same fixed assets to be constructed by "Project Costs", since the aggregation of "Depreciation" in the Table in the 1st-10th year becomes $363,000 (PAD p34), a close amount of "Project Costs" in Annex 4 (PAD P31).
- ✓ The author allocates "transaction cost" for the CDM project into 3 projects in a weighted manner according to their carbon credit amounts and extracts it from "operational cost", since "operational cost" includes "transaction cost".
- ✓ The author extends the operational cost for "Environmental and social program" up to 10 years, since this analysis conduct with 10 years crediting period as explained above 1.
- ✓ For the operational cost and revenue in 2007 afterwards, the author assumes to remain unchanged until 2015 while carbon credit revenues generated. However the author assumes that this operation will be stopped once the project ceases to generate revenue provided that a rational private company should not operate the facility generating no revenue.

3. Discount Rate: same as Guadalajara subproject.

4. Carbon Credit Amount: same as Guadalajara subproject.

India: Municipal Solid Waste Treatment cum Energy Generation Project
Documents from which the data is collected:

i. the WB website, PCF Projects
available at http://carbonfinance.org/pcf/router.cfm?Page=Projects in June 1, 2005

ii. (PAD) "Project Appraisal Document on a Proposed Purchase of Emissions Reductions by the Prototype Carbon Fund in the Amount of US$ 4.25 Million from the Asia Boioenergy India Ltd. (India) for the ABIL Solid Waste management Project in the City of Lucknow November 10, 2004"
acquired from Steele in the WB Carbon Finance Business on June 6, 2005 by personal communication

iii. (WB PDD) Clean Development Mechanism Project Design Document (CDM-PDD) Municipal Solid Waste Treatment cum Energy Generation Project, Lucknow, India Submitted to Prototype Carbon Fund (PCF) September 2003 by Infrastructure Development Finance Company limited ITC Centre, 3rd Floor 760, Anna Salai, Chennai – 600 002
downloaded from the WB website at
http://carbonfinance.org/pcf/Router.cfm?Page=Projects&ProjectID=3125 in June 1, 2005

iv. (CDM Watch) CDM Watch website on PCF project explanation available on June 27, 2005 at http://cdmwatch.org/project_details.php?ID=203

v. (UNFCCC PDD: Same documents as above WB PDD)
Clean Development Mechanism Project Design Document (CDM-PDD) Municipal Solid Waste Treatment cum Energy Generation Project, Lucknow, India Submitted to Prototype Carbon Fund (PCF) September 2003 by Infrastructure Development Finance Company limited ITC Centre, 3rd Floor 760, Anna Salai, Chennai – 600 002
downloaded from the UNFCCC website at
http://cdm.unfccc.int/UserManagement/FileStorage/FS_415553625

0. General

- Project Explanation:
The project establishes a Municipal Solid Waste processing facility which utilize methane generated from a the treatment of the Municipal Solid Waste for power generation. The facility brings a 5.6 MW power generation by 300 tonnes per day of Municipal Solid Wastes and a 75 tonnes per day of organic manure. Greenhouse gas emissions reduction results from 1) the capture and utilization of methane, 2) power generation, 3) use of organic fertiliser to replace chemical fertiliser. (PDD p1; PAD p11)
- Project Components:
The project includes a Municipal Solid Waste processing facility, which has a biogas production part and a power generation part. The former part produces biogas from wastes, which also separates and processes organic manure from wastes. The latter part generates a gross 5.6 MW power by 300 tonnes per day of wastes. (PDD p2; PAD p11-12)
- Base Case:
The base case is methane release without landfill gas capture system. Since Municipal Solid Waste Rule 2000 is enforced in December, 2003 which controls the landfill facility, the base case should be with a certain level of methane release constraints. It is considered as "the gradual improvement of waste management practices using acceptable technical options expected to occur over a period of time to comply with the Municipal Solid Waste Rule 2000" (PAD p19; PDD p7-10). The compliance rate is taken into account from the actual report by the Central Pollution Control Board who is responsible for monitoring compliance of the Municipal Solid Waste Rule 2000.

1. Project-related-periods

- Original Data Statement
  - ✓ The project lifetime is 30 years after commissioning landfill gas capture system (PAD p12; PDD p10).
  - ✓ The crediting period is 10 years (PAD p6; UNFCCC PDD p11).
  - ✓ The project implantation period is 2004-2014 (PAD p6).
  - ✓ The capital expenditure has already been incurred at November 10, 2004, which is slightly over budget (PAD p35-36).
- Author's Assumptions

- ✓ The author assumes that 2004 should be 0^{th} year, judging that capital expenditure run slightly over the budget (PAD p35-36) which reveals that the project has already generate cost in 2004.

2. Cost and Revenue

- Key Data Location
  - ✓ Table 5 for capital cost of the project is stated in Indian Rupee (PAD p56).
  - ✓ Table 6 for operating cost per month is stated in Indian Rupee (PAD p57).
  - ✓ The operational cost explanation sheet is shown in text (PAD p37).
  - ✓ The 1^{st}-10^{th} year Cash Flow Analysis is located in the text (PAD p38).

- Data quality

➢ Original Data Statements
  - ✓ The original data showing capital cost, operating cost per months and revenues are stated in Indian Rupees (PAD p56; p57), while it states that the exchange rate of Indian Ruppes on US$1=Rs 45.00 (PAD p2).
  - ✓ The original data in Cash Flow Table for 1^{st}-10^{th} year are with 6% annual increase (PAD p38), while mentioning that both revenues and costs are projected to increase 6% due to inflation (PAD p36).

➢ Author's Assumption
  - ✓ The author assumingly 6% annual increase since this analysis is done in real terms.
  - ✓ The author coverts the original data to US dollars with using the exchange rate specified in PAD (US$1=Rs. 45.00).

- Capital Expenditures, Operating Cost and Revenues

  The author picks up the following for 2004 and 2005:

  (1) capital expenditure from "Capital Cost of the project" stated Table 5(PAD p56) for the year 2004.

  The author estimates the following for 2005:

  (2) revenue from "Total Revenues" in the Cash Flow Table (PAD p38) for 2005-2014;

  (3) operational cost from the explanation sheet (PAD p37) and "Operating cost per month" in Table 6 (PAD p57) for 2005.

  In 2006 afterwards, the author assumes remain unchanged 2005 afterwards.

➢ Original Data Statements / Capital s Expenditure
  - ✓ Capital cost of the project estimates Rs. 830 million ($18.444 million) consisting of the followings: Rs. 150.948 million ($3.354 million) for "Civil Works"; Rs.148.379 million ($3.297 million) for "Mechanical, Electrical & Piping"; Rs. 50.157 million ($ 1.115 million) for "Sorting Plant Equipment"; Rs. 243.16 million ($ 5.404 million) for "Digester related equipments & Other services"; Rs. 77.163 million ($ 1.715 million) for "Power Plant"; Rs. 84.359 million ($ 1.875 million) for "Interest during construction"; Rs. 67.7 million ($ 1.504 million) for "Pre-operative and other expenses"; Rs. 8.134 million ($ 8.134 million) for "Contingencies" (PAD p56).
  - ✓ Actual capital expenditure is Rs. 786.9 million ($ 17.5 million) as of November, 2004, (*and thus, the above seems plausible*).

➢ Author's Assumption: no author's assumption

➢ Original Data Statements / Revenues
  - ✓ Revenue consists of sale electricity and sale compost besides carbon credit revenue (PAD p13-14).
  - ✓ "Total revenues" in the Cash Flow Table includes sales electricity, sale compost and revenue from PCF through carbon credits in 2004-2015 (PAD p38)
  - ✓ The revenues ratio is approximately 11% from credit carbon revenue, 21% from compost sales and 68% from electricity sales (PAD p13)
  - ✓ Carbon credit revenue from PCF is calculated on $3.5 per tCO2e[31] times 100,000 tCO2e in

[31] The ERs contract price with PCF is $4.25/tCO2e (p6; p13). However, PCF provide a special payment scheme in which PCF will pay $3.50/tCO2e to the project sponsor and $0.75/tCO2e to the buyer (Uttar Pradesh Power Corporation Limited) with whom the project sponsor will sell electricity (p13-14). This is because the financial health of electricity buyer is poor and PCF and the project

2004-2015 ((PAD p6; p37)

- ✓ Compost sales are calculated at Rs. 1500/tonne ($33/tonne), much higher than the price of conventional manure but lower than the price of the high-quality organic manure with a recently signed contract with a regional wholesaler (PAD, p36-37). The sale volume is projected at 50% quantity in the 1st year, 70% in the 2nd year and 90% in the 3rd year afterwards (PAD p36), and net organic manure will be produced at 71 tonnes per day (PAD p31)
- ✓ Tariff used for estimating energy sales starts Rs. 3.49/kWh with annual 5% escalation in accordance with the Power Purchase Agreement while a Rs. 4.5/kWh cap existing (PAD p14; PAD p36-37). It is more expensive than the averaged tariff which the buyer has made contracts. However, the PAD concluded that the direct impact of this project with higher tariff on the buyer's financial sustainability is negligible considering that this Power Purchase Agreement is a very small fraction (0.2%) of the buyer's purchase (PAD p14).

➢ Author's Assumption

- ✓ The author estimates revenue for sale electricity and sale compost by discerning them from "total revenues" in a following manner.

  a) The author converts "Total revenues" shown in 2005-2014 in Indian Rupee to US dollars with US$1=Rs45.

  b) The author deducts credit carbon revenue ($3.5/tCO2e x 100,000 tCO2e) from "total revenues" in each year. This assumption is plausible since the average percentage of annual credit carbon revenue to total revenue counts about 9%, corresponding to credit carbon revenue ratio (11%) stated in the PAD.

  c) The author deducts 6% inflation from b), which represents revenue from sale electricity and sale compost. This assumption seems plausible since the average percentage of those revenues against total revenue counts about 91%, which almost corresponds to compost and electricity sales ratio (89%) stated in the PAD.

  d) The author estimates compost sales quantity per year and convert it to US dollars (Rs. 1500/tonne ($33/tonne) x 71TPD x 360 days x 50% in 1st year/70% in 2nd year/90% in 3rd year afterwards). The average percentage of those estimated compost revenue counts about 18%, almost corresponding to the compost sales ratio (21%).

  f) The author considers revenue left after deducting credit carbon revenue and estimated compost revenue as electricity sales revenue. The author back-checks how much power generation the assumed electricity sales revenue should bring, by dividing with tariff (Rs. 3.49/kWh in 1st year; Rs. 3.66 in the 2nd year; Rs. 3.85/kWh in the 3rd year; Rs. 4.04/kWh in the 4th year; Rs.4.24/kWh in the 5th year; Rs.4.45/kWh in the 6th year; Rs.4.5/kWh in the 7th year afterward). The averaged electricity power is 32GWh per year, which seems plausible for a 5.6 MW thermal gas power plant.
- ✓ The author assumes the revenue in 2015-2034 remain unchanged as that in 2014.

➢ Original Data Statements / Operating Costs

- ✓ The original writer estimates operating costs of Rs.2,950,000/month ($65,556/month) consisting of the followings: Rs. 800,000 for "Salary for staff"; Rs.150,000 for "Unskilled manpower; Rs. 150,000 for "Fuel for wheel loaders, forklift, compost machine"; Rs.100,000 for "Lubricants"; Rs.300,000 for "Spares for engines (on an average)"; Rs.100,000 for "Spares for other equipment"; Rs.200,000 for "Maintenance for plant and machinery"; Rs.250,000 for "O&M contract for Gas Engine"; Rs. 200,000 for "Marketing expenses"; Rs.300,000 for "Insurance expenses; Rs.400,000 for "Administrative expenses" (PAD p57).
- ✓ The text explains the operating costs as the following Table (PAD p37);

No.	CONTENTS	EXPLANATION
h)	Royalty Charges to municipal government	1% of revenues generated from power sales
i)	Engine Operating Costs	Rs.1.3 crores for full year
j)	Operations & Maintenance	2% of Capital Expenditure
k)	Repairs and Maintenance Costs	0.5% of equipment costs
l)	Spares and Consumables	2.5% of revenues

sponsor tries to decrease the risk of payment default (p14).

m)	Grit Removal Costs	0.20 crores
n)	Contingency operating Costs	5% of (engine operating costs+O & M costs+ R & M costs + spares + grit removal costs)

- Author's Assumption:
  - ✓ The author calculates operating cost based on per month data;
    $65,556/month x 12 months = approximately $ 0.79 million
  - ✓ The author estimates the operating cost as approximately US$ 0.90 million, calculated in accordance with Table (PAD p37) in the following manners:
    h) The averaged annual electricity sales revenues estimated above f), US$ 3.01 million (*) 1% (=) $ 0.03 million
    i) Rs. 1.3 crores (*) 10 (/) Rs 45 = $ 0.29 million
    j) Rs 786.9 million (PAD p35) (*) 2% (/) Rs 45 = $ 0.35 million
    k) Equipment-related costs shown in "Capital cost of the project" including "Mechanical, Electrical & Piping", "Sorting Plant Equipments", "Digester related equipments & Other services" and "Power Plant", which aggregates Rs. 441.696 million (PAD p56) (*) 0.5% (/) Rs. 45 = $ 0.05 million
    l) The averaged annual sales revenue estimated above c), US$ 3.96 million (*) 2.5% (=) $ 0.10 million
    m) 0.20 crores (*) 10 (/) Rs 45 (=) US$ 0.04 million
    n) Above (i) (+) j) (+) k) (+) l) (+) m)) (*) 5% (=) $ 0.04 million
  - ✓ The author picks the more conservative estimation $ 0.90 million on the basis that the Table 6 does not include the aggregated $ 0.11 million consisting of h) "Royalty", m) Grit Removal Costs and m) Contingency in PAD p37 Table.

3. Discount Rate

- Original Data Statement
  - ✓ Discount rate used for their Financial Analysis is WACC 7.75% (p20).
- Author's Assumption: please refer to the page the Section 3.2 in this thesis.

4. Carbon Credit Amount

- Original Statement
  - ✓ 1,898,649 tCO2e — the WB website
    1,084,777 tCO2e — 10 years — PAD p19
    1,084,777 tCO2e — 10 years — CDM Watch
    1,084,777 tCO2e — 10 years — UNFCCC PDD p18
  - ✓ The annual time profile in the whole crediting period is shown (PAD p19; UNFCCC PDD p18)
  - ✓ Although this project has 3 separate emission reduction: reduction in methane by "biomethanation" of municipal solid waste; fossil fuel displacement; chemical fertiliser displacement, the above PAD and UNFCCC PDD covers only for biomethanation resulting in methane reduction (UNFCCC PDD p1; PAD p19). UNFCCC PDD mentions that the separate PDD should be prepared for other two emission reduction (UNFCCC PDD p1).
- Author's Assumption
  - ✓ The author assumes PAD (for methane reduction only) with sensitive analysis of the WB website (for whole 3 emission reduction sources).
  - ✓ For the case of all 3 emission reduction resource, the author assumingly divides the difference between the WB website (1,898,649 tCO2e) and PAD (1,018,477 tCO2e) evenly in the whole crediting period, 2005-2014.

Moldva Soil Conservation Project

Documents from which the data is collected:

i. the WB website, PCF Projects
available at http://carbonfinance.org/pcf/router.cfm?Page=Projects in June 1, 2005

ii. (PAD) "Project Appraisal Document on a proposed in the amount of US$ to the for Soil Conservation Project " (no date) acquired from Steele in the WB Carbon Finance Business on June 6, 2005 by personal communication

iii. (WB PDD) Clean Development Mechanism Project Design Document (CDM PDD Version 01 (in effect as of: 29 August 2002) downloaded on June 1, 2005 from the WB website at http://carbonfinance.org/pcf/Router.cfm?Page=Projects&ProjectID=3133

iv. (CDM Watch) CDM Watch website on PCF project explanation available on June 27, 2005 at http://cdmwatch.org/project_details.php?ID=196

0. General

➢ Project Components:
The project includes afforesting 14,500 hectares of degraded agricultural land on 1,891 plots distributed throughout the country (PAD p5).

➢ Base Case:
The base case is no afforestation/reforestation activity due to financial constraints backed up by the data for the period 1994-2000 (WB PDD p6).

1. Project-related-periods

➢ Original Data Statement
The project lifetime is 15 years (WB PDD p6).
The crediting period submitted to the CDM EB is 7 years with twice renewable (WB PDD p8).
The financial analysis is conducted based on 30 years without salvage value and 100 years with salvage value (PAD p10), where carbon revenue is taken account for 21 years (PAD p33).
The cost starts generated in 2002 (PAD p28).

➢ Author's Assumption: no author's assumption

2. Cost and Revenue

• Key Data location
  ✓ Afforestation Costs and Financing is estimated in Table 1 for 2002-2010 (PAD p28).

• Data Quality

➢ Original Data Statements
  ✓ The original data is shown in US dollars without mentioning any exchange rate information.
  ✓ All cost and revenues are calculated in constant prices (PAD p34).

➢ Author's Assumption: no author's assumption

• Capital Expenditure, Operating Costs and Revenues
The author picks up the followings for 2002-2010:
(1) capital expenditure and operational cost from "Annual costs needed for aforestation";
(2) revenue from "Annual income from timber + non-timber products",
stated in Table 1 (PAD p28).
In 2011 afterwards until 2025, the author assumes the data by checking text (PAD p33-36).

➢ Original Data Statements
  ✓ "Annual costs needed for afforestations", including both capital expenditure and operational costs is estimated the aggregated $13.5 million in 2002-2010 with gradually decreasing from approximately $2 million in 2002 into $0.3 million in 2010 (PAD p28). It includes machinery, labour, seedlings, fencing and forest management (PAD p28).
  ✓ "Annual income from timber + non-timber products" is estimated the aggregated US$477,607 in 2002-2010 (PAD p28). The revenue from non-timber products includes sales of Rosa canina plants (dried and fresh), revenues from granting hunting leases, revenues from leasing forests for bee keeping, and revenues from leasing forests for grazing livestock (PAD p11; p33). The last one can be done only after the forest is more than 15 years old (PAD p11; p33), which is after 2017.

- Author's Assumption
  - ✓ For 2011-2025, the author assumes that operational cost and revenue in 2010 remain unchanged. Since this revenue does not include one from forests rented out for grazing to cows which can be generated only after the forest is more than 15 years old (PAD p11; p33), the actual revenue may have more than this assumption. Thus, this assumption should be conservative.

3. Discount Rate

- Original Statement

  Discount rate used for their Financial Analysis is 10% (PAD p10).
- Author's Assumption: please refer to the page the Section 3.2 in this thesis

4. Carbon Credit Amount

- Original Statement
  - ✓ 3,215,296 tCO2e — the WB website

3,215,296 tCO2e		the WB website
1,812,178 tCO2e	21 years	PAD p10; p31
1,812,178 tCO2e	15 years	WB PDD p14-15
1,935,223 tCO2e	21 years	CDM Watch
  - ✓ There is no time profile available.
- Author's Assumption
  - ✓ The author assumes the PAD should be more plausible, since PAD (1,812,178 tCO2e in 21 years) is closer to CDM Watch (1,935,223 tCO2e in 21 years).
  - ✓ For the time profile, the author divides 1,812,178 tCO2e into 21 years.

Appendix 2: IERC Calculation Excel Sheets (a base case)

Chile Hydro project

Country Project	Chile / Chacabuquito Hydro Power Project									
Project Contents	Mid size run-of river hydropwer plant (25MW; 175GWh gross (160GWh net))									
Base case	Coal-fired thermal power generation (high case), Gas-fired thermal power generation (low case)									
Project Implementation	15	years		2002-16		PAD p0				
Lifetime	40	years		2002-2041		PAD p16 (Discrepancy: UNFCCC PDD p18 says 30 years.)				
PCF	1000000	tCO2e	2002-10/16	by	$4.06	million	with	$3.50	/tCO2e	HP table; PAD p0,8; Annex 1 p18 (assumed unit price)
ER TOTAL	2752000	tCO2e			HP table					
	1986400	tCO2e	2002-16 (15 yrs.)		PAD p8					
	1812000	tCO2e	2002-22 (21 yrs.)		WB PDD p3					
	2812000	tCO2e	21 yrs		CDM Watch "A report on whether the projeect meets the validation requests of the CDM issued 31 Oct. 2001"					
	2800000	tCO2e	2002.07- (21 yrs.)		UNFCCC PDD p8 >> Methodology review under #NW0076-rev.					
Cost	$37.0	w/o financing charges;				PAD p16, PAD Annex 6 p14				
		$34.0	the cost associated with the hydro electric plnat and related equiment							
		$3.0	the expansion of the current 110KV transmission lines connectingn Los Quilos and Aconcagua plants							
Finaniclal Analysis	PAD p18-19, Annex p5-8			51 years ?			51 years ?			*Not only for Chacabuquito Project but also whole company
	EIRR			w/o	9.80%		w/	10.30%		*DR 10% is Chilean power sector leagal discount rate.
	NPV	DR	10%	w/o	-$0.75	million	w/	$0.95	million	*Sensitivity analysis with DR 8%/12% available.
Technology	a run-of-river hydro									
C value inflator	**10%**									
Discount rate	**10%**									

UNIT		mil $	tCO2e		$	mil $	-	mil$	Cost & Revenue information: PAD p17-18 for 2001-16; PAD p25 for 2017-2041					
w/ Carbon Revenue :									Cap. Exp.	Op. Cost	Ope. Cost	Revenue	Revenue	Revenue
	Year	**Net CF**	**C credit**	**Year**	**C value**	**C benefit**	**DF**	**PV**	Investment	O&M	Toll	Spot Energy	:ontract Energ	Capacity
2001	0	-17.000	0		0.48	0.000	1.000000	-17.000	-17.000					
2002	1	-18.937	60000	1	0.53	0.032	0.909091	-17.187	-20.000	-0.150		0.148	1.065	
2003	2	3.820	137600	2	0.58	0.080	0.826446	3.223		-0.320	-0.150	1.110	2.264	0.916
2004	3	3.820	137600	3	0.64	0.088	0.751315	2.936		-0.320	-0.150	1.110	2.264	0.916
2005	4	3.820	137600	4	0.70	0.096	0.683013	2.675		-0.320	-0.150	1.110	2.264	0.916
2006	5	3.820	137600	5	0.77	0.106	0.620921	2.438		-0.320	-0.150	1.110	2.264	0.916
2007	6	3.820	137600	6	0.85	0.117	0.564474	2.222		-0.320	-0.150	1.110	2.264	0.916
2008	7	3.820	137600	7	0.93	0.128	0.513158	2.026		-0.320	-0.150	1.110	2.264	0.916
2009	8	3.820	137600	8	1.03	0.141	0.466507	1.848		-0.320	-0.150	1.110	2.264	0.916
2010	9	3.820	137600	9	1.13	0.155	0.424098	1.686		-0.320	-0.150	1.110	2.264	0.916
2011	10	3.820	137600	10	1.24	0.171	0.385543	1.539		-0.320	-0.150	1.110	2.264	0.916
2012	11	3.820	137600	11	1.36	0.188	0.350494	1.405		-0.320	-0.150	1.110	2.264	0.916
2013	12	3.820	137600	12	1.50	0.207	0.318631	1.283		-0.320	-0.150	1.110	2.264	0.916
2014	13	3.820	137600	13	1.65	0.227	0.289664	1.172		-0.320	-0.150	1.110	2.264	0.916
2015	14	3.820	137600	14	1.82	0.250	0.263331	1.072		-0.320	-0.150	1.110	2.264	0.916
2016	15	3.820	137600	15	2.00	0.275	0.239392	0.980		-0.320	-0.150	1.110	2.264	0.916
2017	16	3.820	135600	16	2.20	0.298	0.217629	0.896		-0.320	-0.150	1.110	2.264	0.916
2018	17	3.820	135600	17	2.42	0.328	0.197845	0.821		-0.320	-0.150	1.110	2.264	0.916
2019	18	3.820	135600	18	2.66	0.361	0.179859	0.752		-0.320	-0.150	1.110	2.264	0.916
2020	19	3.820	135600	19	2.92	0.397	0.163508	0.689		-0.320	-0.150	1.110	2.264	0.916
2021	20	3.820	135600	20	3.22	0.436	0.148644	0.633		-0.320	-0.150	1.110	2.264	0.916
2022	21	3.820	135600	21	3.54	0.480	0.135131	0.581		-0.320	-0.150	1.110	2.264	0.916
2023	22	3.820			3.89	0.000	0.122846	0.469		-0.320	-0.150	1.110	2.264	0.916
2024	23	3.820			4.28	0.000	0.111678	0.427		-0.320	-0.150	1.110	2.264	0.916
2025	24	3.820			4.71	0.000	0.101526	0.388		-0.320	-0.150	1.110	2.264	0.916
2026	25	3.820			5.18	0.000	0.092296	0.353		-0.320	-0.150	1.110	2.264	0.916
2027	26	-8.180			5.70	0.000	0.083905	-0.686		-8.180				
2028	27	3.820			6.27	0.000	0.076278	0.291		-0.320	-0.150	1.110	2.264	0.916
2029	28	3.820			6.90	0.000	0.069343	0.265		-0.320	-0.150	1.110	2.264	0.916
2030	29	3.820			7.59	0.000	0.063039	0.241		-0.320	-0.150	1.110	2.264	0.916
2031	30	3.820			8.35	0.000	0.057309	0.219		-0.320	-0.150	1.110	2.264	0.916
2032	31	3.820			9.18	0.000	0.052099	0.199		-0.320	-0.150	1.110	2.264	0.916
2033	32	3.820			10.10	0.000	0.047362	0.181		-0.320	-0.150	1.110	2.264	0.916
2034	33	3.820			11.11	0.000	0.043057	0.164		-0.320	-0.150	1.110	2.264	0.916
2035	34	3.820			12.22	0.000	0.039143	0.150		-0.320	-0.150	1.110	2.264	0.916
2036	35	3.820			13.44	0.000	0.035584	0.136		-0.320	-0.150	1.110	2.264	0.916
2037	36	3.820			14.78	0.000	0.032349	0.124		-0.320	-0.150	1.110	2.264	0.916
2038	37	3.820			16.26	0.000	0.029408	0.112		-0.320	-0.150	1.110	2.264	0.916
2039	38	3.820			17.89	0.000	0.026735	0.102		-0.320	-0.150	1.110	2.264	0.916
2040	39	3.820			19.68	0.000	0.024304	0.093		-0.320	-0.150	1.110	2.264	0.916
2041	40	3.820			21.64	0.000	0.022095	0.084		-0.320	-0.150	1.110	2.264	0.916
	Sum		**2800000**					**0.000**	-37.000	-20.490	-5.700	42.328	87.097	34.808

Country / Project			Brazil / Minas Garais Plantar Project												
Project Contents			Plantations (23,100 ha Eucalyptus + 47.3 ha cerrado) for sustainable charcoal resource and improved kiln technology, for a pig-iron production												
Base case			An ongoing shift to the use of coke from imported coal from charcoal for pig iron production												
Project Implementation			28	years		2002-22	PAD p5, p10				only from the plantations & the carbonizationn of methane				
Life time			28	years		2002-22	PAD p5, p10								
PCF			1514286	tCO2e	2002-8	for	$5.3	million	with	$3.50	/tCO2e	HP table, PAD p10 (period) *p19 says 2004-8			
ER TOTAL			total	10251564	tCO2e		HP table		Status "pre-validation reported 31 June 2002" (CDM Watch)						
				12885984	tCO2e	21 yrs	PAD p17-18		4,545,398 for Sink; 7,903,262 for fuel switch; 437,325 for reduced CH4						
				12885984	tCO2e	21 yrs	WB PDD p12-13		4,545,398 for Sink; 7,903,262 for fuel switch; 437,325 for reduced CH4						
			"opposed"	13789656	tCO2e	21 yrs	CDM Watch		4,299,951 for Sink; 7,741,405 for fuel switch; 1,781,300 for reduced CH4						
				1704111	tCO2e	21 yrs	UNFCCC PDD p8; Section E.2 >> Mehodology review under #NW0110 only for reduced CH4								
Project Cost & Finance			$38.8	million		PAD p5, 10, 19									
				$3.2	million	from Plantar S.A. equity,									
				$30.7	million	from Plantar S.A., internal cash generation									
				$4.9	million	from Co financiers (debt financing)									
Financial Analysis			PAD p19, Annex 6			21 years			28 years			*2000$US			
			IRR			w/o	4.0%		w/	10.9%		*Exchange rate on June 1, 2001			
			NPV	DR	10%	w/o	-$11.4	million	w/	$1.7	million	*DR 10% is just assumed.			
Technology			Forest sequestration (2002-22), Reduced methane (Carbonization methane) (2002-22), Resource switch from coal-based coke to plantation-based charcoal (2009-29)												
	C value inflator		**10%**												
	Discount rate		**10%**												
UNIT		mil $	tCO2e		$/tCO2e	mil $	-	mil$		Cost & Benefit Information: PAD Annex 6					
w/ Carbon Revenue :										Cap. Exp.	Cap. Exp.	Cap. Exp.	Cap. Exp.	Working Cap.	Op. Cost & Rev.
	Year	**Net CF**	**C credit**	**Year**	**C value**	**C revenue**	**DF**	**PV**		Land+infra	plantation	CH4 flaring	charcoal facility		Activity net benefit
2002	0	-5.016	17289	1	2.01	0.035	1.000000	-4.982		-1.624	-2.821	-0.100		-0.472	0.000
2003	1	-5.334	587	2	2.21	0.001	0.909091	-4.848		-1.624	-3.497	-0.100		-0.113	0.000
2004	2	-5.450	27511	3	2.43	0.067	0.826446	-4.449		-1.624	-3.497			-0.329	0.000
2005	3	-5.535	98894	4	2.67	0.264	0.751315	-3.960		-1.624	-3.497			-0.414	0.000
2006	4	-5.648	521229	5	2.94	1.531	0.683013	-2.812		-1.624	-3.497			-0.526	0.000
2007	5	-5.760	1600667	6	3.23	5.172	0.620921	-0.365		-1.624	-3.497			-0.639	0.000
2008	6	-6.073	2245108	7	3.55	7.980	0.564474	1.076		-1.624	-3.497	-0.200		-0.752	0.000
2009	7	-2.850	625771	8	3.91	2.447	0.513158	-0.207					-3.329	-2.038	2.517
2010	8	-0.792	395246	9	4.30	1.700	0.466507	0.423					-3.329	0.138	2.399
2011	9	-0.292	395248	10	4.73	1.870	0.424098	0.669					-3.329	-0.043	3.081
2012	10	0.511	395249	11	5.20	2.057	0.385543	0.990					-2.729	0.072	3.169
2013	11	0.948	395250	12	5.72	2.262	0.350494	1.125					-2.696	-0.072	3.715
2014	12	0.646	395306	13	6.30	2.489	0.318631	0.999					-2.662	0.072	3.236
2015	13	1.016	392535	14	6.93	2.719	0.289664	1.082					-2.662	-0.072	3.749
2016	14	1.112	392472	15	7.62	2.990	0.263331	1.080					-2.429	0.072	3.469
2017	15	1.482	392459	16	8.38	3.289	0.239392	1.142					-2.429	-0.072	3.982
2018	16	1.112	392450	17	9.22	3.618	0.217629	1.029					-2.429	0.072	3.469
2019	17	1.482	392444	18	10.14	3.980	0.197845	1.080					-2.429	-0.072	3.982
2020	18	1.112	392440	19	11.15	4.378	0.179859	0.987					-2.429	0.072	3.469
2021	19	1.482	392438	20	12.27	4.815	0.163508	1.030					-2.429	-0.072	3.982
2022	20	1.112	390969	21	13.50	5.277	0.148644	0.950					-2.429	0.072	3.469
2023	21	2.276	376346	22	14.85	5.588	0.135131	1.063					-2.360	0.022	4.615
2024	22	2.142	376346	23	16.33	6.146	0.122846	1.018					-2.360	0.119	4.384
2025	23	2.596	376346	24	17.96	6.761	0.111678	1.045					-2.360	-0.053	5.009
2026	24	2.340	376346	25	19.76	7.437	0.101526	0.993					-2.360	0.091	4.610
2027	25	2.822	376346	26	21.74	8.181	0.092296	1.015					-2.360	-0.053	5.235
2028	26	2.565	376346	27	23.91	8.999	0.083905	0.970					-2.360	0.091	4.835
2029	27	14.413	376346	28	26.30	9.899	0.076278	1.854		11.365			-2.360	-0.053	5.461
	Sum		**12885984**					**0.000**		0.000	-23.805	-0.400	-54.261	-4.955	81.839

Country			China / Jincheng Coal Mine Methane Project													
Project			Capture of coal mine methane associated with coal mining operation and utilization of coal mine methane for 120MW power generation													
Base case			Methane recovery from Coal Mine, CO_2 reduction by coal-fired or gas-fired power plants' generation electricity													
Project Implementation			?	years												
Life time			20	years		UNFCCC PDD p17										
PCF			4000000	tCO2e		by	$17.00	million	with	$4.25	/tCO2e	HP table				
ER TOTAL			49046000	tCO2e			HP table									
			22546000	tCO2e	2006-15 (10 yrs.)		PAD p36-7									
			not available				WB PDD				↓ "seeking approval for baseline & monitoring methodology"					
			19745382	tCO2e	10 yrs.		CDM Watch		1,927,660tCO2e for Fuel Switch, 17,817,722tCO2e for gas capture							
			19700000	tCO2e	2006.01- (10 yrs.)		UNFCCC PDD p8 >> Methodology review under #NW0102									
Cost			$138.7			PAD p4 (cost); PAD p32 (finance)										
				$14.2	million	CMM recovery				$82.0	million	Asian Development Bank				
				$97.6	million	120MW CMM fired power plant				$22.0	million	Local Commercial Bank				
				$26.9	million	Other (contingentcy, interst, etc.)				$24.7	million	Equity				
Finaniclal Analysis			PAD p10-11, p26-35			28 years			28 years							
			FIRR			w/o	5.30%		w/	14.80%						
			NPV	WACC	4.96%	w/o	$0.37	million	w/	$25.52	million					
Technology			Methane recovery from Coal Mine, Power generation used with Coal Mine Methane													
	C value inflator		**10%**													
	Discount rate		**10%**													
UNIT		mil $	tCO2e		$	mil $	-	mil$		Cost & Benefit information: PAD p36&37 until year 2030						
w/ Carbon Revenue :										Cap. Exp.	Cap. Exp.	Op. Cost	Op. Cost	Revenue	Revenue	
	Year	**Net CF**	**C credit**	**Year**	**C value**	**C revenu**	**DF**	**PV**		CMM	120MW	Vari. O&M	Fix O&M	Methane	Electricity	
2003	0	-7.711	0		2.27	0.000	1.000000	-7.711		-3.89	-3.82					
2004	1	-49.235	0		2.50	0.000	0.909091	-44.759		-4.35	-44.89					
2005	2	-11.088	0		2.75	0.000	0.826446	-9.164		-3.11	-6.75	-0.84	-0.39			
2006	3	-38.288	670000	1	3.02	2.025	0.751315	-27.245		-2.59	-39.78	-6.45	-1.77	2.19	10.12	
2007	4	-19.176	1660000	2	3.32	5.519	0.683013	-9.328		-2.59	-20.18	-6.80	-1.91	2.19	10.12	
2008	5	8.235	2000000	3	3.66	7.314	0.620921	9.655		-1.30		-12.04	-3.04	4.37	20.24	
2009	6	9.474	2320000	4	4.02	9.333	0.564474	10.616				-12.04	-3.10	4.37	20.24	
2010	7	9.474	2650000	5	4.43	11.727	0.513158	10.879				-12.04	-3.10	4.37	20.24	
2011	8	9.474	2650000	6	4.87	12.899	0.466507	10.437				-12.04	-3.10	4.37	20.24	
2012	9	9.474	2650000	7	5.35	14.189	0.424098	10.035				-12.04	-3.10	4.37	20.24	
2013	10	9.474	2650000	8	5.89	15.608	0.385543	9.670				-12.04	-3.10	4.37	20.24	
2014	11	9.474	2650000	9	6.48	17.169	0.350494	9.338				-12.04	-3.10	4.37	20.24	
2015	12	9.474	2646000	10	7.13	18.857	0.318631	9.027				-12.04	-3.10	4.37	20.24	
2016	13	9.474			7.84	0.000	0.289664	2.744				-12.04	-3.10	4.37	20.24	
2017	14	9.474			8.62	0.000	0.263331	2.495				-12.04	-3.10	4.37	20.24	
2018	15	9.474			9.49	0.000	0.239392	2.268				-12.04	-3.10	4.37	20.24	
2019	16	9.474			10.43	0.000	0.217629	2.062				-12.04	-3.10	4.37	20.24	
2020	17	9.474			11.48	0.000	0.197845	1.874				-12.04	-3.10	4.37	20.24	
2021	18	9.474			12.63	0.000	0.179859	1.704				-12.04	-3.10	4.37	20.24	
2022	19	9.474			13.89	0.000	0.163508	1.549				-12.04	-3.10	4.37	20.24	
2023	20	9.474			15.28	0.000	0.148644	1.408				-12.04	-3.10	4.37	20.24	
2024	21	9.474			16.80	0.000	0.135131	1.280				-12.04	-3.10	4.37	20.24	
2025	22	9.474			18.48	0.000	0.122846	1.164				-12.04	-3.10	4.37	20.24	
	Sum		**22546000**					**0.000**		**-17.83**	**-115.42**	**-230.79**	**-59.83**	**83.08**	**384.58**	**0.00**

Country			China / Xiaogushan Hydropower Project														
Prouject Contents			a) 98MW run-of-river hydroelectric plant (380GWh/y gross) b) rural electrifiction c) institutional strengthening program														
Base Case			Coal-fired thermal plant					PAD p4, PDD p8									
Project Implementation			?	years													
Lifetime			30	years				PDD p21									
PCF			2170000	tCO2e	2007-2016	by	$9.22	million	with	$4.25	/tCO2e	HP table, Period:PAD p40, p48					
ER TOTAL			total	2932600	tCO2e			HP table									
				2640109	tCO2e	2007-16 (10 yrs.)		PAD p48	"about 3 million tCO2e" in p4								
				2649119	tCO2e	10 yrs.		WB PDD p8									
				3706600	tCO2e	10 yrs.		CDM Watch "Under consideration by the PCF. A PIN for this project is available on the PCF website"									
				not available				UNFCCC PDD									
Cost			$87.0	million				PAD p30 table, p2, p4-5									
				$17.4	million	Equity		$73.3	million	a) 98MW hydroelectric power							
				$35.0	million	ADB		$0.9	million	b) rural electrification							
				$34.6	million	the Bank of China		$0.7	million	c) instituitional strengthening							
Financial Analysis			PAD p12-3, p40-48			34 years (2003-35)			34 years (2003-35)				in Chinese Yuan @ $1=8.28CY (PAD p0)				
			FIRR			w/o	6.53%	0.7	w/	7.06%							
			NPV	WACC	4.66%	w/o	$19.20	million	w/	$24.40	million						
Technology			Small Hydro														
	C value inflator		**10%**														
	Discount rate		**10%**														
UNIT		mil $	tCO2e		$	mil $	-	mil$		Cost & Benefit information: PAD p48, p42-47							
w/ Carbon Revenue :										Cap. Exp.	Cap. Exp.	Op. Cost	Op. Cost	Op. Cost	Revenue		
	Year	**Net CF**	**C credit**	**Year**	**C value**	**C revenue**	**DF**	**PV**			Working Cap.	O&M			electricity		
2003	0	-13.703			2.59	0.000	1.000000	-13.703		-13.703							
2004	1	-36.977			2.85	0.000	0.909091	-33.616		-36.977							
2005	2	-32.612			3.13	0.000	0.826446	-26.952		-32.612							
2006	3	2.977			3.44	0.000	0.751315	2.237		-7.798	-0.143	-1.618			12.536		
2007	4	9.263	124000	1	3.79	0.470	0.683013	6.648				-3.273			12.536		
2008	5	9.263	124000	2	4.17	0.517	0.620921	6.073				-3.273			12.536		
2009	6	9.263	249570	3	4.58	1.144	0.564474	5.874				-3.273			12.536		
2010	7	9.263	306077	4	5.04	1.543	0.513158	5.545				-3.273			12.536		
2011	8	9.263	306077	5	5.55	1.697	0.466507	5.113				-3.273			12.536		
2012	9	9.263	306077	6	6.10	1.867	0.424098	4.720				-3.273			12.536		
2013	10	9.263	306077	7	6.71	2.054	0.385543	4.363				-3.273			12.536		
2014	11	9.263	306077	8	7.38	2.259	0.350494	4.038				-3.273			12.536		
2015	12	9.263	306077	9	8.12	2.485	0.318631	3.743				-3.273			12.536		
2016	13	9.263	306077	10	8.93	2.733	0.289664	3.475				-3.273			12.536		
2017	14	9.263			9.82	0.000	0.263331	2.439				-3.273			12.536		
2018	15	9.263			10.81	0.000	0.239392	2.218				-3.273			12.536		
2019	16	9.263			11.89	0.000	0.217629	2.016				-3.273			12.536		
2020	17	9.263			13.07	0.000	0.197845	1.833				-3.273			12.536		
2021	18	9.263			14.38	0.000	0.179859	1.666				-3.273			12.536		
2022	19	9.263			15.82	0.000	0.163508	1.515				-3.273			12.536		
2023	20	9.263			17.40	0.000	0.148644	1.377				-3.273			12.536		
2024	21	9.263			19.14	0.000	0.135131	1.252				-3.273			12.536		
2025	22	9.263			21.06	0.000	0.122846	1.138				-3.273			12.536		
2026	23	9.257			23.16	0.000	0.111678	1.034				-3.279			12.536		
2027	24	9.257			25.48	0.000	0.101526	0.940				-3.279			12.536		
2028	25	9.257			28.03	0.000	0.092296	0.854				-3.279			12.536		
2029	26	9.257			30.83	0.000	0.083905	0.777				-3.279			12.536		
2030	27	9.257			33.91	0.000	0.076278	0.706				-3.279			12.536		
2031	28	9.257			37.30	0.000	0.069343	0.642				-3.279			12.536		
2032	29	9.257			41.03	0.000	0.063039	0.584				-3.279			12.536		
2033	30	9.257			45.14	0.000	0.057309	0.531				-3.279			12.536		
2034	31	9.257			49.65	0.000	0.052099	0.482				-3.279			12.536		
2035	32	9.257			54.62	0.000	0.047362	0.438				-3.279			12.536		
	Sum		**2640109**					**0.000**		-91.091	-0.143	-96.594	0.000	0.000	376.087	0.000	0.000
	Assumed data																

(PAD p4) about 3MtCO2e over 10 yrs.
$4.0-4.5/tCO2e

Country			Costa Rica / Cote Hydroelectric Subproject (under Umbrella Project for Renewable Energy Sources)												
Prouject Contents			6.3 MW Hydro to replace thermal power generation												
Base Case			Thermal plant												
Project Implementation			17	years		2003-19		PAD p1							
Lifetime			40	years		2003-42		PAD p38; p117							
PCF			172110	tCO2e	14 yrs	by	$0.60	million	with	$3.49	/tCO2e	HP table, PAD p9 (period)			
ER TOTAL			total	215138	tCO2e		HP table								
				(180600)	tCO2e	21 yrs	PAD p118 (expected annual income by carbon credit divided by $3.0/tCO2e specified in p117)								
				not available			WB PDD								
				204000	tCO2e	21 yrs	CDM Watch "validated 21 June 2002"								
				not available			UNFCCC PDD								
Cost			$10.5	million				PAD p36 Annex 3		$10.9	million			PAD p18, p38	
				$4.9	million	Local									
				$5.6	million	Foreign									
Financial Analysis			PAD p18-9, p37-9, p117-20			41 years			41 years	($3.0/tCO2e * 21 yrs. (p117) <-- $3.5/tCO2e (p38))					
			IRR			w/o	8.22%		w/	8.39%					
			NPV	WACC	7.74%	w/o	$0.80	million	w/	$1.07	million				
Technology			Small Hydro												
	C value inflator		**10%**												
	Discount rate		**10%**												
UNIT		mil $	tCO2e		$	mil $	-	mil$		Cost & Benefit information: PAD p117, p120					
w/ Carbon Revenue :										Cap. Exp.	Op. Cost	Op. Cost	Op. Cost	Op. Cost	Revenue
	Year	**Net CF**	**C credit**	**Year**	**C value**	**C revenue**	**DF**	**PV**			O&M	admin.	insurance	canon	electricity
2002	0	-10.920	0		10.38	0.000	1.000000	-10.920		-10.920					
2003	1	0.925	10,600	1	11.42	0.121	0.909091	0.951			-0.036	-0.039	-0.011	-0.031	1.042
2004	2	0.925	8,100	2	12.56	0.102	0.826446	0.849			-0.036	-0.039	-0.011	-0.031	1.042
2005	3	0.925	9,100	3	13.82	0.126	0.751315	0.789			-0.036	-0.039	-0.011	-0.031	1.042
2006	4	0.925	8,100	4	15.20	0.123	0.683013	0.716			-0.036	-0.039	-0.011	-0.031	1.042
2007	5	0.925	9,500	5	16.72	0.159	0.620921	0.673			-0.036	-0.039	-0.011	-0.031	1.042
2008	6	0.925	5,900	6	18.39	0.108	0.564474	0.583			-0.036	-0.039	-0.011	-0.031	1.042
2009	7	0.925	7,100	7	20.23	0.144	0.513158	0.548			-0.036	-0.039	-0.011	-0.031	1.042
2010	8	0.925	8,600	8	22.25	0.191	0.466507	0.521			-0.036	-0.039	-0.011	-0.031	1.042
2011	9	0.925	9,000	9	24.48	0.220	0.424098	0.486			-0.036	-0.039	-0.011	-0.031	1.042
2012	10	0.925	8,900	10	26.92	0.240	0.385543	0.449			-0.036	-0.039	-0.011	-0.031	1.042
2013	11	0.925	9,000	11	29.61	0.267	0.350494	0.418			-0.036	-0.039	-0.011	-0.031	1.042
2014	12	0.925	9,000	12	32.58	0.293	0.318631	0.388			-0.036	-0.039	-0.011	-0.031	1.042
2015	13	0.925	8,900	13	35.83	0.319	0.289664	0.360			-0.036	-0.039	-0.011	-0.031	1.042
2016	14	0.925	8,600	14	39.42	0.339	0.263331	0.333			-0.036	-0.039	-0.011	-0.031	1.042
2017	15	0.925	8,600	15	43.36	0.373	0.239392	0.311			-0.036	-0.039	-0.011	-0.031	1.042
2018	16	0.925	8,600	16	47.70	0.410	0.217629	0.291			-0.036	-0.039	-0.011	-0.031	1.042
2019	17	0.925	8,600	17	52.46	0.451	0.197845	0.272			-0.036	-0.039	-0.011	-0.031	1.042
2020	18	0.925	8,600	18	57.71	0.496	0.179859	0.256			-0.036	-0.039	-0.011	-0.031	1.042
2021	19	0.925	8,600	19	63.48	0.546	0.163508	0.241			-0.036	-0.039	-0.011	-0.031	1.042
2022	20	0.925	8,600	20	69.83	0.601	0.148644	0.227			-0.036	-0.039	-0.011	-0.031	1.042
2023	21	0.925	8,600	21	76.81	0.661	0.135131	0.214			-0.036	-0.039	-0.011	-0.031	1.042
2024	22	0.925			84.49	0.000	0.122846	0.114			-0.036	-0.039	-0.011	-0.031	1.042
2025	23	0.925			92.94	0.000	0.111678	0.103			-0.036	-0.039	-0.011	-0.031	1.042
2026	24	0.925			102.24	0.000	0.101526	0.094			-0.036	-0.039	-0.011	-0.031	1.042
2027	25	0.925			112.46	0.000	0.092296	0.085			-0.036	-0.039	-0.011	-0.031	1.042
2028	26	0.925			123.71	0.000	0.083905	0.078			-0.036	-0.039	-0.011	-0.031	1.042
2029	27	0.925			136.08	0.000	0.076278	0.071			-0.036	-0.039	-0.011	-0.031	1.042
2030	28	0.925			149.69	0.000	0.069343	0.064			-0.036	-0.039	-0.011	-0.031	1.042
2031	29	0.925			164.66	0.000	0.063039	0.058			-0.036	-0.039	-0.011	-0.031	1.042
2032	30	0.925			181.12	0.000	0.057309	0.053			-0.036	-0.039	-0.011	-0.031	1.042
2033	31	0.925			199.23	0.000	0.052099	0.048			-0.036	-0.039	-0.011	-0.031	1.042
2034	32	0.925			219.16	0.000	0.047362	0.044			-0.036	-0.039	-0.011	-0.031	1.042
2035	33	0.925			241.07	0.000	0.043057	0.040			-0.036	-0.039	-0.011	-0.031	1.042
2036	34	0.925			265.18	0.000	0.039143	0.036			-0.036	-0.039	-0.011	-0.031	1.042
2037	35	0.925			291.70	0.000	0.035584	0.033			-0.036	-0.039	-0.011	-0.031	1.042
2038	36	0.925			320.87	0.000	0.032349	0.030			-0.036	-0.039	-0.011	-0.031	1.042
2039	37	0.925			352.96	0.000	0.029408	0.027			-0.036	-0.039	-0.011	-0.031	1.042
2040	38	0.925			388.25	0.000	0.026735	0.025			-0.036	-0.039	-0.011	-0.031	1.042
2041	39	0.925			427.08	0.000	0.024304	0.022			-0.036	-0.039	-0.011	-0.031	1.042
2042	40	0.925			469.78	0.000	0.022095	0.020			-0.036	-0.039	-0.011	-0.031	1.042
	Sum		**180600**					**0.000**		-10.920	-1.440	-1.560	-0.440	-1.240	41.680
	Assumed data														

Costa Rica Cortega Wind project

Country			Costa Rica / Cortega Wind Power Subproject													
Project			8.4 MW wind farm to displace thermal capacity addition													
Base case			Thermal plant													
Project Implementation			17	years		2003-19		PAD p1								
Life time			25	years		2003-28		PAD p40								
PCF			262660	tCO2e	14 yrs	by	$0.92	million	with	$3.50	/tCO2e	HP table, PAD p9 (period)				
ER TOTAL			total	323850	tCO2e		HP table									
				(302800)	tCO2e	21 yrs	PAD p110 (aggregated income with carbon creidt minus without carbon creidt divided by $3.0/tCO2e specified in p109)									
				not available			WB PDD									
				300000	tCO2e	21 yrs	CDM Watch "validated 21 June 2002"									
				not available			UNFCCC PDD									
Cost			$17.3					PAD p36 Annex 3			$17.3	million		PAD p20; p40		
				$7.0	million	Local										
				$10.3	million	Foreign										
Financial Analysis			PAD p19-20, p40-41, p109-116			25 years			25 years	($3.0/tCO2e * 21 yrs. (p109) <-- $3.5/tCO2e (p40))						
			IRR			w/o	8.32%		w/	8.61%						
			NPV	WACC	5.41%	w/o	$6.05	million	w/	$6.61	million					
Technology			Wind Farm													
	C value inflator		**10%**													
	Discount rate		**10%**													
UNIT		mil $	tCO2e		$	mil $	-	mil$		Cost & Benefit information: PAD p109, 110, 114 until 2027						
w/ Carbon Revenue :										Cap. Exp.	Op. Cost	Op. Cost	Op. Cost	Revenue	Revenue	
	Year	**Net CF**	**C credit**	**Year**	**C value**	**C revenue**	**DF**	**PV**			O&M	admin.	insurance	electricity	other	
2002	0	-17.330	0		6.74	0.000	1.000000	-17.330		-17.330						
2003	1	1.603	16200	1	7.41	0.120	0.909091	1.566			-0.055	-0.089	-0.210	1.905	0.052	
2004	2	1.603	13700	2	8.15	0.112	0.826446	1.417			-0.055	-0.089	-0.210	1.905	0.052	
2005	3	1.603	14900	3	8.96	0.134	0.751315	1.305			-0.055	-0.089	-0.210	1.905	0.052	
2006	4	1.603	13900	4	9.86	0.137	0.683013	1.188			-0.055	-0.089	-0.210	1.905	0.052	
2007	5	1.603	15400	5	10.85	0.167	0.620921	1.099			-0.055	-0.089	-0.210	1.905	0.052	
2008	6	1.743	11800	6	11.93	0.141	0.564474	1.063			-0.055	-0.089	-0.070	1.905	0.052	
2009	7	1.743	13000	7	13.13	0.171	0.513158	0.982			-0.055	-0.089	-0.070	1.905	0.052	
2010	8	1.743	14500	8	14.44	0.209	0.466507	0.911			-0.055	-0.089	-0.070	1.905	0.052	
2011	9	1.743	14800	9	15.88	0.235	0.424098	0.839			-0.055	-0.089	-0.070	1.905	0.052	
2012	10	1.743	14700	10	17.47	0.257	0.385543	0.771			-0.055	-0.089	-0.070	1.905	0.052	
2013	11	1.743	15000	11	19.22	0.288	0.350494	0.712			-0.055	-0.089	-0.070	1.905	0.052	
2014	12	1.743	15000	12	21.14	0.317	0.318631	0.656			-0.055	-0.089	-0.070	1.905	0.052	
2015	13	1.743	14900	13	23.25	0.346	0.289664	0.605			-0.055	-0.089	-0.070	1.905	0.052	
2016	14	1.743	14200	14	25.58	0.363	0.263331	0.555			-0.055	-0.089	-0.070	1.905	0.052	
2017	15	1.743	14400	15	28.13	0.405	0.239392	0.514			-0.055	-0.089	-0.070	1.905	0.052	
2018	16	1.743	14400	16	30.95	0.446	0.217629	0.476			-0.055	-0.089	-0.070	1.905	0.052	
2019	17	1.743	14400	17	34.04	0.490	0.197845	0.442			-0.055	-0.089	-0.070	1.905	0.052	
2020	18	1.743	14400	18	37.45	0.539	0.179859	0.410			-0.055	-0.089	-0.070	1.905	0.052	
2021	19	1.743	14400	19	41.19	0.593	0.163508	0.382			-0.055	-0.089	-0.070	1.905	0.052	
2022	20	1.743	14400	20	45.31	0.652	0.148644	0.356			-0.055	-0.089	-0.070	1.905	0.052	
2023	21	1.743	14400	21	49.84	0.718	0.135131	0.333			-0.055	-0.089	-0.070	1.905	0.052	
2024	22	1.743			54.83	0.000	0.122846	0.214			-0.055	-0.089	-0.070	1.905	0.052	
2025	23	1.743			60.31	0.000	0.111678	0.195			-0.055	-0.089	-0.070	1.905	0.052	
2026	24	1.743			66.34	0.000	0.101526	0.177			-0.055	-0.089	-0.070	1.905	0.052	
2027	25	1.743			72.97	0.000	0.092296	0.161			-0.055	-0.089	-0.070	1.905	0.052	
	Sum		**302800**					**0.000**		**-17.330**	**-1.375**	**-2.225**	**-2.450**	**47.625**	**1.300**	
	Assumed data															

Costa Rica Vera Blanca Wind project

Country			Costa Rica / Vera Blanca Wind Power Subproject													
Project			9.6 MW wind farm to displace thermal capacity addition													
Base case			Thermal plant													
Project Implementation			17	years		2003-19		PAD p1								
Life time			25	years		2003-28		PAD p43								
PCF			284660	tCO2e	14 yrs	by	$1.00	million	with	$3.51	/tCO2e	HP table, PAD p9 (period)				
ER			total	355825	tCO2e		HP table									
				(329100)	tCO2e	21 yrs	PAD p103 (aggregated income with carbon creidt minus without carbon creidt divided by $3.0/tCO2e									
							WB PDD								specified in p102)	
				327000	tCO2e	21 yrs	CDM Watch "validated 21 June 2002"									
							UNFCCC PDD									
Cost			$18.7					PAD p36 Annex 3			$20.4	million		PAD p21; p43		
				$9.0	million	Local										
				$9.7	million	Foreign										
Financial Analysis			PAD p20-21, p43-44, p102-108			25 years			25 years	($3.0/tCO2e * 21 yrs. (p102) <-- $3.5/tCO2e (p43))						
			IRR			w/o	7.29%		w/	7.55%						
			NPV	WACC	4.85%	w/o	$6.33	million	w/	$6.96	million					
Technology			Wind Farm													
	C value inflator		**10%**													
	Discount rate		**10%**													
UNIT		mil $	tCO2e		$	mil $	-	mil$		Cost & Benefit information: PAD p103; p105; p106 until 2027						
w/ Carbon Revenue :										Cap. Exp.	Op. Cost	Op. Cost	Op. Cost	Revenue		
	Year	**Net CF**	**C credit**	**Year**	**C value**	**C Revenu**	**DF**	**PV**			O&M	admin.	insurance	electricity		
2002	0	-20.363	0		13.11	0.000	1.000000	-20.363		-20.363						
2003	1	1.702	17600	1	14.42	0.254	0.909091	1.778			-0.054	-0.062	-0.240	2.058		
2004	2	1.702	14800	2	15.87	0.235	0.826446	1.601			-0.054	-0.062	-0.240	2.058		
2005	3	1.702	16200	3	17.45	0.283	0.751315	1.491			-0.054	-0.062	-0.240	2.058		
2006	4	1.702	15100	4	19.20	0.290	0.683013	1.360			-0.054	-0.062	-0.240	2.058		
2007	5	1.702	16700	5	21.12	0.353	0.620921	1.276			-0.054	-0.062	-0.240	2.058		
2008	6	1.702	12800	6	23.23	0.297	0.564474	1.129			-0.054	-0.062	-0.240	2.058		
2009	7	1.702	14100	7	25.55	0.360	0.513158	1.058			-0.054	-0.062	-0.240	2.058		
2010	8	1.702	15700	8	28.11	0.441	0.466507	1.000			-0.054	-0.062	-0.240	2.058		
2011	9	1.862	16100	9	30.92	0.498	0.424098	1.001			-0.054	-0.062	-0.080	2.058		
2012	10	1.862	16000	10	34.01	0.544	0.385543	0.928			-0.054	-0.062	-0.080	2.058		
2013	11	1.862	16300	11	37.41	0.610	0.350494	0.866			-0.054	-0.062	-0.080	2.058		
2014	12	1.862	16300	12	41.15	0.671	0.318631	0.807			-0.054	-0.062	-0.080	2.058		
2015	13	1.862	16100	13	45.27	0.729	0.289664	0.750			-0.054	-0.062	-0.080	2.058		
2016	14	1.862	15400	14	49.79	0.767	0.263331	0.692			-0.054	-0.062	-0.080	2.058		
2017	15	1.862	15700	15	54.77	0.860	0.239392	0.652			-0.054	-0.062	-0.080	2.058		
2018	16	1.862	15700	16	60.25	0.946	0.217629	0.611			-0.054	-0.062	-0.080	2.058		
2019	17	1.862	15700	17	66.27	1.041	0.197845	0.574			-0.054	-0.062	-0.080	2.058		
2020	18	1.862	15700	18	72.90	1.145	0.179859	0.541			-0.054	-0.062	-0.080	2.058		
2021	19	1.862	15700	19	80.19	1.259	0.163508	0.510			-0.054	-0.062	-0.080	2.058		
2022	20	1.862	15700	20	88.21	1.385	0.148644	0.483			-0.054	-0.062	-0.080	2.058		
2023	21	1.862	15700	21	97.03	1.523	0.135131	0.457			-0.054	-0.062	-0.080	2.058		
2024	22	1.862			106.74	0.000	0.122846	0.229			-0.054	-0.062	-0.080	2.058		
2025	23	1.862			117.41	0.000	0.111678	0.208			-0.054	-0.062	-0.080	2.058		
2026	24	1.862			129.15	0.000	0.101526	0.189			-0.054	-0.062	-0.080	2.058		
2027	25	1.862			142.06	0.000	0.092296	0.172			-0.054	-0.062	-0.080	2.058		
	Sum		**329100**					**0.000**		**-20.363**	**-1.350**	**-1.550**	**-3.280**	**51.450**		

Country			India / Municipal Solid Waste Treatment cum Energy Generation Project																
Prouject Contents			Capturing landfill gas by processing 300 TPD Municipal Solid Waste as biogass and organic manure, which brings about a gross 5.6 MW power generation and a gross 75 TPD organic manure																
Base Case			1) Methane release without landfill gas capture system with gradual improveoment due to new Rule; 2) CO2 displacement with power generation 3) CO2 displacment without using chemical manure																
Project Implementation			11	years		2004-14		PAD p6											
Lifetime			30	years				PAD p12; PDD p10											
PCF			1000000	tCO2e	2005-14	by	$4.25	million	with	$4.25	/tCO2e	HP table; PAD p37 (amount); p6 (unit price)							
ER			total	1898649	tCO2e			HP table											
				1018477		2005-14 (10 yrs.)		PAD p6; p19											
				not available				WB PDD											
				1018477		10 yrs		CDM Watch		"The baseline & monitoring methodology for this project has been approved."									
				1018477				UNFCCC PDD p18		only for capturing methane portion >> Methodology review under #NW0032 >> Methodology Approval #AM0012									
Cost			$17.49	million				PAD p6; p30; p34; p35				$18.44	million	PAD p56					
				$4.84	million	Equity				million									
				$3.33	million	Subsidy				million									
				$9.32	million	Loan													
Financial Analysis			PAD p20; p33-41			? years			? years										
			FIRR			w/o	3.17%		w/	10.88%									
			NPV	WACC	7.75%	w/o	$1.13	million	w/	$4.51	million								
Technology			Landfill gas management																
	C value inflator		**10%**																
	Discount rate		**10%**																
UNIT		mil $	tCO2e		$	mil $	-	mil$		Cost & Benefit information (assumed): PAD p13; p13-14; p35-37; p38; p56; p57									
w/ Carbon Revenue :										Cap. Exp.	Op. Cost	Op. Cost	Op. Cost	Op. Cost	Op. Cost	Op. Cost	Op. Cost	Revenue	Revenue
	Year	**Net CF**	**C credit**	**Year**	**C value**	**C revenue**	**DF**	**PV**		project cost	Royalities	ngine Operatin	O&M	Repairs	Spares	Grit Removal	Contingency	electricity	Compost
2004	0	-18.444			-9.38	0.000	1.000000	-18.444		-18.444									
2005	1	0.231	125,738	1	-10.31	-1.297	0.909091	-0.969			-0.030	-0.289	-0.350	-0.049	-0.099	-0.044	-0.042	0.708	0.426
2006	2	2.058	113,164	2	-11.35	-1.284	0.826446	0.640			-0.030	-0.289	-0.350	-0.049	-0.099	-0.044	-0.042	2.365	0.596
2007	3	2.635	113,164	3	-12.48	-1.412	0.751315	0.918			-0.030	-0.289	-0.350	-0.049	-0.099	-0.044	-0.042	2.771	0.767
2008	4	2.823	113,164	4	-13.73	-1.554	0.683013	0.867			-0.030	-0.289	-0.350	-0.049	-0.099	-0.044	-0.042	2.959	0.767
2009	5	3.021	113,164	5	-15.10	-1.709	0.620921	0.815			-0.030	-0.289	-0.350	-0.049	-0.099	-0.044	-0.042	3.157	0.767
2010	6	3.201	88,017	6	-16.61	-1.462	0.564474	0.981			-0.030	-0.289	-0.350	-0.049	-0.099	-0.044	-0.042	3.337	0.767
2011	7	3.387	88,017	7	-18.27	-1.608	0.513158	0.913			-0.030	-0.289	-0.350	-0.049	-0.099	-0.044	-0.042	3.523	0.767
2012	8	3.549	88,017	8	-20.10	-1.769	0.466507	0.831			-0.030	-0.289	-0.350	-0.049	-0.099	-0.044	-0.042	3.686	0.767
2013	9	3.623	88,017	9	-22.11	-1.946	0.424098	0.711			-0.030	-0.289	-0.350	-0.049	-0.099	-0.044	-0.042	3.759	0.767
2014	10	3.698	88,017	10	-24.32	-2.141	0.385543	0.600			-0.030	-0.289	-0.350	-0.049	-0.099	-0.044	-0.042	3.834	0.767
2015	11	3.698			-26.75	0.000	0.350494	1.296			-0.030	-0.289	-0.350	-0.049	-0.099	-0.044	-0.042	3.834	0.767
2016	12	3.698			-29.43	0.000	0.318631	1.178			-0.030	-0.289	-0.350	-0.049	-0.099	-0.044	-0.042	3.834	0.767
2017	13	3.698			-32.37	0.000	0.289664	1.071			-0.030	-0.289	-0.350	-0.049	-0.099	-0.044	-0.042	3.834	0.767
2018	14	3.698			-35.61	0.000	0.263331	0.974			-0.030	-0.289	-0.350	-0.049	-0.099	-0.044	-0.042	3.834	0.767
2019	15	3.698			-39.17	0.000	0.239392	0.885			-0.030	-0.289	-0.350	-0.049	-0.099	-0.044	-0.042	3.834	0.767
2020	16	3.698			-43.09	0.000	0.217629	0.805			-0.030	-0.289	-0.350	-0.049	-0.099	-0.044	-0.042	3.834	0.767
2021	17	3.698			-47.39	0.000	0.197845	0.732			-0.030	-0.289	-0.350	-0.049	-0.099	-0.044	-0.042	3.834	0.767
2022	18	3.698			-52.13	0.000	0.179859	0.665			-0.030	-0.289	-0.350	-0.049	-0.099	-0.044	-0.042	3.834	0.767
2023	19	3.698			-57.35	0.000	0.163508	0.605			-0.030	-0.289	-0.350	-0.049	-0.099	-0.044	-0.042	3.834	0.767
2024	20	3.698			-63.08	0.000	0.148644	0.550			-0.030	-0.289	-0.350	-0.049	-0.099	-0.044	-0.042	3.834	0.767
2025	21	3.698			-69.39	0.000	0.135131	0.500			-0.030	-0.289	-0.350	-0.049	-0.099	-0.044	-0.042	3.834	0.767
2026	22	3.698			-76.33	0.000	0.122846	0.454			-0.030	-0.289	-0.350	-0.049	-0.099	-0.044	-0.042	3.834	0.767
2027	23	3.698			-83.96	0.000	0.111678	0.413			-0.030	-0.289	-0.350	-0.049	-0.099	-0.044	-0.042	3.834	0.767
2028	24	3.698			-92.36	0.000	0.101526	0.375			-0.030	-0.289	-0.350	-0.049	-0.099	-0.044	-0.042	3.834	0.767
2029	25	3.698			-101.59	0.000	0.092296	0.341			-0.030	-0.289	-0.350	-0.049	-0.099	-0.044	-0.042	3.834	0.767
2030	26	3.698			-111.75	0.000	0.083905	0.310			-0.030	-0.289	-0.350	-0.049	-0.099	-0.044	-0.042	3.834	0.767
2031	27	3.698			-122.93	0.000	0.076278	0.282			-0.030	-0.289	-0.350	-0.049	-0.099	-0.044	-0.042	3.834	0.767
2032	28	3.698			-135.22	0.000	0.069343	0.256			-0.030	-0.289	-0.350	-0.049	-0.099	-0.044	-0.042	3.834	0.767
2033	29	3.698			-148.74	0.000	0.063039	0.233			-0.030	-0.289	-0.350	-0.049	-0.099	-0.044	-0.042	3.834	0.767
2034	30	3.698			-163.62	0.000	0.057309	0.212			-0.030	-0.289	-0.350	-0.049	-0.099	-0.044	-0.042	3.834	0.767
	Sum		**1018479**					**0.000**		-18.444	-0.900	-8.670	-10.500	-1.470	-2.970	-1.320	-1.260	106.777	22.493
	Assumed data																		

Country			Mexico / Waste management and carbon offset project for Guadalajara portion																		
Prouject Contents			a) Capturing landfill gas to be utilised for resource of a 4.45MW (35.1GWh) power generation b) Remediation program to improve the integrity of closed landfills (the leachate collection systems)																		
Base Case			the methane release without landfill gas capture system (*The CO2 emission associated with power generation is counted as emission reduction.)																		
Project Implementation			10	years		2006-15		PAD p1													
Lifetime			21	years				PAD p31													
PCF			1500000	tCO2e	2006-12	by	6.3	million	with	$4.20	/tCO2e	HP table		For 6 bundled projects							
ER TOTAL			UNLIKE OTHER PROJECTS, IT IS ONLY PAD, WHICH HAS ER TOTAL DATA AVAILABLE FOR THIS PROJECT.																		
			For 3 pjts	3000000	tCO2e	2006-15	PAD p1;p6;p12;p14;p31														
			For 3 pjts	2006800	tCO2e	2006-12	PAD p12		For Guadalajara CH4			1050000	tCO2e	2006-12	PAD p12	For 2 pjts CO2		26270	tCO2e	2006-12	PAD p12
			For 3 pjts	2243952	tCO2e	2006-12	PAD p31					1050000	tCO2e	2006-12	PAD p31	For 2 pjts CO2		133240	tCO2e	2006-12	PAD p31
Cost			$9.46	million for 3 project combined				PAD p30					For Guadalajara portion (Equity Investm				$1.14	million)			
				$8.60	million	landfilll gas capture & use			$4.5	million	Local		$4.55	million	landfilll gas capture & use					PAD p31	
				$0.49	million	Remediation program			$5.0	million	Foreign		$0.49	million	Remediation program (Support by ERs proceeding					PAD p6	
				$0.37	million	RE supply (not for Guadalajara)							<--	Implementation cos		$0.32	million (for Leon $0.35 million)			PAD p23-6	
Financial Analysis			PAD p13, p31-33, p35-36			22 years (2005-26)			22 years (2005-26)				with PCF transaction costs								
			FIRR			w/o	8.06%		w/	18.62%											
			NPV	DR ?%		w/o	-$0.29	million	w/	$1.07	million										
Technology			Landfill gas management																		
	C value inflator		**10%**																		
	Discount rate		**10%**																		
UNIT		mil $	tCO2e		$	mil $	-	mil$		Cost & Benefit information: PAD p31-32, p36-37									EXTRACT	EXTRACT	
w/ Carbon Revenue :										Cap. Exp.	Op. Cost	Op. Cost	Op. Cost	Op. Cost	Op. Cost	Op. Cost	Op. Cost	Op. Cost	Op. Cost	Op. Cost	Revenue
	Year	**Net CF**	**C credit**	**Year**	**C value**	**C revenue**	**DF**	**PV**		project cost	Royalities	O&M	ias System	Insurance	liscellaneou	.&Soc.prog	Land Renta	oject Adm.	F trans acti	F trans acti	electricity
2005	0	-4.550			0.17	0.000	1.000000	-4.550		-4.550											
2006	1	0.509	199500	1	0.19	0.038	0.909091	0.498			-0.383	-0.947	-0.071	-0.045	-0.001	-0.054	-0.020	-0.081	0.037	0.023	2.051
2007	2	0.509	188100	2	0.21	0.040	0.826446	0.454			-0.383	-0.947	-0.071	-0.045	-0.001	-0.054	-0.020	-0.081	0.037	0.023	2.051
2008	3	0.509	177500	3	0.23	0.041	0.751315	0.414			-0.383	-0.947	-0.071	-0.045	-0.001	-0.054	-0.020	-0.081	0.037	0.023	2.051
2009	4	0.509	168100	4	0.25	0.043	0.683013	0.377			-0.383	-0.947	-0.071	-0.045	-0.001	-0.054	-0.020	-0.081	0.037	0.023	2.051
2010	5	0.509	158700	5	0.28	0.044	0.620921	0.344			-0.383	-0.947	-0.071	-0.045	-0.001	-0.054	-0.020	-0.081	0.037	0.023	2.051
2011	6	0.472	149200	6	0.31	0.046	0.564474	0.293			-0.383	-0.947	-0.071	-0.045	-0.001	-0.054	-0.020	-0.081		0.023	2.051
2012	7	0.472	141900	7	0.34	0.048	0.513158	0.267			-0.383	-0.947	-0.071	-0.045	-0.001	-0.054	-0.020	-0.081		0.023	2.051
2013	8	0.450	133100	8	0.37	0.050	0.466507	0.233			-0.383	-0.947	-0.071	-0.045	-0.001	-0.054	-0.020	-0.081			2.051
2014	9	0.450	133100	9	0.41	0.055	0.424098	0.214			-0.383	-0.947	-0.071	-0.045	-0.001	-0.054	-0.020	-0.081			2.051
2015	10	0.450	133100	10	0.45	0.060	0.385543	0.196			-0.383	-0.947	-0.071	-0.045	-0.001	-0.054	-0.020	-0.081			2.051
2016	11	0.504			0.50	0.000	0.350494	0.176			-0.383	-0.947	-0.071	-0.045	-0.001		-0.020	-0.081			2.051
2017	12	0.504			0.55	0.000	0.318631	0.160			-0.383	-0.947	-0.071	-0.045	-0.001		-0.020	-0.081			2.051
2018	13	0.504			0.60	0.000	0.289664	0.146			-0.383	-0.947	-0.071	-0.045	-0.001		-0.020	-0.081			2.051
2019	14	0.504			0.66	0.000	0.263331	0.133			-0.383	-0.947	-0.071	-0.045	-0.001		-0.020	-0.081			2.051
2020	15	0.504			0.73	0.000	0.239392	0.121			-0.383	-0.947	-0.071	-0.045	-0.001		-0.020	-0.081			2.051
2021	16	0.504			0.80	0.000	0.217629	0.110			-0.383	-0.947	-0.071	-0.045	-0.001		-0.020	-0.081			2.051
2022	17	0.504			0.88	0.000	0.197845	0.100			-0.383	-0.947	-0.071	-0.045	-0.001		-0.020	-0.081			2.051
2023	18	0.504			0.97	0.000	0.179859	0.091			-0.383	-0.947	-0.071	-0.045	-0.001		-0.020	-0.081			2.051
2024	19	0.504			1.06	0.000	0.163508	0.082			-0.383	-0.947	-0.071	-0.045	-0.001		-0.020	-0.081			2.051
2025	20	0.504			1.17	0.000	0.148644	0.075			-0.383	-0.947	-0.071	-0.045	-0.001		-0.020	-0.081			2.051
2026	21	0.504			1.29	0.000	0.135131	0.068			-0.383	-0.947	-0.071	-0.045	-0.001		-0.020	-0.081			2.051
	Sum		**1582300**					**0.000**		-4.550	-8.035	-19.892	-1.496	-0.935	-0.017	-0.540	-0.420	-1.700	0.186	0.159	43.069
	Assumed data																				

Country			Mexico / Waste management and carbon offset project for Monterrey II portion																		
Prouject Contents			a) Capturing landfill gas to be utilised for resource of a 3.99 MW (31.4GWh) power generation b) Renewable energy supply at a rural poor community																		
Base Case			the methane release without landfill gas capture system (*The CO2 emission associated with power generation is counted as emission reduction.)																		
Project Implementation			10	years		2006-15		PAD p1													
Lifetime			21	years				PAD p31													
PCF			1500000	tCO2e	2006-12	by	6.3	million	with	$4.20	/tCO2e	HP table		For 6 bundled projects							
ER TOTAL			UNLIKE OTHER PROJECTS, IT IS ONLY PAD, WHICH HAS ER TOTAL DATA AVAILABLE FOR THIS PROJECT.																		
			For 3 pjts	3000000	tCO2e	2006-15	PAD p1;p6;p12;p14;p31														
			For 3 pjts	2006800	tCO2e	2006-12	PAD p12			For Monterrey II CH4		780500	tCO2e	2006-12	PAD p12	For 2 pjts CO2		26270	tCO2e	2006-12	PAD p12
			For 3 pjts	2243952	tCO2e	2006-12	PAD p31					780500	tCO2e	2006-12	PAD p31	For Monterrey II CO2		129444	tCO2e	2006-12	PAD p31
Cost			$9.46	million for 3 project combined				PAD p30					For Monterrey portion								
				$8.60	million	landfilll gas capture & use				$4.5	million	Local	$3.69	million	landfilll gas capture & use					PAD p31	
				$0.49	million	Remediation program (not for Monterrey II)				$5.0	million	Foreign	<--	Implementation cost		$0.15	million (for initial + O&M)			PAD p27-8	
				$0.37	million	RE supply							$0.37	million	RE supply	(Supported by ERs prroceeding)				PAD p6	
Financial Analysis			PAD p13, p31-33, p36-37			22 years (2005-26)			22 years (2005-26)				with PCF transaction costs								
			FIRR			w/o	10.60%		w/	20.90%											
			NPV	DR ? %		w/o	$0.09	million	w/	$1.27	million										
Technology			Landfill gas management																		
	C value inflator		**10%**																		
	Discount rate		**10%**																		
UNIT		mil $	tCO2e		$	mil $	-	mil$		Cost & Benefit information: PAD p31-32, p36-37									EXTRACT	EXTRACT	
w/ Carbon Revenue :										Cap. Exp.	Op. Cost	Op. Cost	Op. Cost	Op. Cost	Op. Cost	Op. Cost	Op. Cost	Op. Cost	Op. Cost	Op. Cost	Revenue
	Year	**Net CF**	**C credit**	**Year**	**C value**	**C revenue**	**DF**	**PV**		project cost	Royalities	O&M	Gas System	Insurance	Miscellaneous	Env.&Soc.prog	Land Rental	Project Adm.	PCF trans action	PCF trans action	electricity
2005	0	-3.690			-0.09	0.000	1.000000	-3.690		-3.69											
2006	1	0.447	147400	1	-0.10	-0.015	0.909091	0.393			-0.335	-0.833	-0.070	-0.035	-0.007	-0.053	-0.020	-0.080	0.028	0.017	1.836
2007	2	0.447	141100	2	-0.11	-0.016	0.826446	0.357			-0.335	-0.833	-0.070	-0.035	-0.007	-0.053	-0.020	-0.080	0.028	0.017	1.836
2008	3	0.447	134900	3	-0.12	-0.016	0.751315	0.324			-0.335	-0.833	-0.070	-0.035	-0.007	-0.053	-0.020	-0.080	0.028	0.017	1.836
2009	4	0.447	129400	4	-0.13	-0.017	0.683013	0.294			-0.335	-0.833	-0.070	-0.035	-0.007	-0.053	-0.020	-0.080	0.028	0.017	1.836
2010	5	0.447	124000	5	-0.15	-0.018	0.620921	0.266			-0.335	-0.833	-0.070	-0.035	-0.007	-0.053	-0.020	-0.080	0.028	0.017	1.836
2011	6	0.419	119400	6	-0.16	-0.019	0.564474	0.226			-0.335	-0.833	-0.070	-0.035	-0.007	-0.053	-0.020	-0.080		0.017	1.836
2012	7	0.419	113800	7	-0.18	-0.020	0.513158	0.205			-0.335	-0.833	-0.070	-0.035	-0.007	-0.053	-0.020	-0.080		0.017	1.836
2013	8	0.402	102300	8	-0.19	-0.020	0.466507	0.178			-0.335	-0.833	-0.070	-0.035	-0.007	-0.053	-0.020	-0.080			1.836
2014	9	0.402	102300	9	-0.21	-0.022	0.424098	0.161			-0.335	-0.833	-0.070	-0.035	-0.007	-0.053	-0.020	-0.080			1.836
2015	10	0.402	102300	10	-0.24	-0.024	0.385543	0.146			-0.335	-0.833	-0.070	-0.035	-0.007	-0.053	-0.020	-0.080			1.836
2016	11	0.456			-0.26	0.000	0.350494	0.160			-0.335	-0.833	-0.070	-0.035	-0.007		-0.020	-0.080			1.836
2017	12	0.456			-0.29	0.000	0.318631	0.145			-0.335	-0.833	-0.070	-0.035	-0.007		-0.020	-0.080			1.836
2018	13	0.456			-0.31	0.000	0.289664	0.132			-0.335	-0.833	-0.070	-0.035	-0.007		-0.020	-0.080			1.836
2019	14	0.456			-0.35	0.000	0.263331	0.120			-0.335	-0.833	-0.070	-0.035	-0.007		-0.020	-0.080			1.836
2020	15	0.456			-0.38	0.000	0.239392	0.109			-0.335	-0.833	-0.070	-0.035	-0.007		-0.020	-0.080			1.836
2021	16	0.456			-0.42	0.000	0.217629	0.099			-0.335	-0.833	-0.070	-0.035	-0.007		-0.020	-0.080			1.836
2022	17	0.456			-0.46	0.000	0.197845	0.090			-0.335	-0.833	-0.070	-0.035	-0.007		-0.020	-0.080			1.836
2023	18	0.456			-0.51	0.000	0.179859	0.082			-0.335	-0.833	-0.070	-0.035	-0.007		-0.020	-0.080			1.836
2024	19	0.456			-0.56	0.000	0.163508	0.074			-0.335	-0.833	-0.070	-0.035	-0.007		-0.020	-0.080			1.836
2025	20	0.456			-0.61	0.000	0.148644	0.068			-0.335	-0.833	-0.070	-0.035	-0.007		-0.020	-0.080			1.836
2026	21	0.456			-0.67	0.000	0.135131	0.062			-0.335	-0.833	-0.070	-0.035	-0.007		-0.020	-0.080			1.836
	Sum		**1216900**					**0.000**		-3.690	-7.043	-17.501	-1.470	-0.735	-0.147	-0.530	-0.420	-1.671	0.138	0.118	38.553
	Assumed data																				

Country			Mexico / Waste management and carbon offset project for Leon portion																		
Prouject Contents			a) Capturing landfill gas to be flared b) Remediation program to improve the integrity of closed landfills (the leachate collection systems)																		
Base Case			the methane release without landfill gas capture system																		
Project Implementation			10	years		2006-15		PAD p1													
Lifetime			21	years				PAD p31													
PCF			1500000	tCO2e	2006-12	by	6.3	million	with	$4.20	/tCO2e	HP table		For 6 bundled projects							
ER TOTAL			UNLIKE OTHER PROJECTS, IT IS ONLY PAD, WHICH HAS ER TOTAL DATA AVAILABLE FOR THIS PROJECT.																		
			For 3 pjts	3000000	tCO2e	2006-15	PAD p1;p6;p12;p14;p31														
			For 3 pjts	2006800	tCO2e	2006-12	PAD p12				For Leon CH4	150000	tCO2e	2006-12	PAD p12	For 2 pjts CO2		26270	tCO2e	2006-12	PAD p12
			For 3 pjts	2243952	tCO2e	2006-12	PAD p31					150000	tCO2e	2006-12	PAD p31	For 2 pjts CO2		129444	tCO2e	2006-12	PAD p31
Cost			$9.46	million for 3 project combined				PAD p30				For Leon portion									
				$8.60	million	landfilll gas capture & use			$4.5	million	Local	$0.36	million	landfilll gas capture & use						PAD p31	
				$0.49	million	Remediation program			$5.0	million	Foreign	$0.49	million	Remediation program (Support by ERs proceeding)						PAD p6	
				$0.37	million	RE supply (not for Leon)						<--	Implementation cos		$0.35	million (for Guadalajara $0.32 million)				PAD p23-6	
Financial Analysis			PAD p13, p31-33, p36-37			ERs are only revenue.			22 years (2005-26)				with PCF transaction costs								
			FIRR			w/o	-		w/	7.40%											
			NPV	DR ? %		w/o	-		w/	-$0.01	million										
Technology			Landfill gas management																		
	C value inflator		**10%**																		
	Discount rate		**10%**																		
UNIT		mil $	tCO2e		$	mil $	-	mil$		Cost & Benefit information: PAD p31-32, p36-37									EXTRACT	EXTRACT	
w/ Carbon Revenue :										Cap. Exp.	Op. Cost	Op. Cost	Op. Cost	Op. Cost	Op. Cost	Op. Cost	Op. Cost	Op. Cost	Op. Cost	Op. Cost	Revenue
	Year	**Net CF**	**C credit**	**Year**	**C value**	**C revenue**	**DF**	**PV**		project cost	Royalities	O&M	as System	Insurance	iscellaneou	.&Soc.prog	Land Renta	oject Adm.	F trans acti	F trans acti	electricity
2005	0	-0.363			2.74	0.000	1.000000	-0.363		-0.3625											
2006	1	-0.028	25800	1	3.01	0.078	0.909091	0.045			-0.010					-0.016	-0.010		0.005	0.003	
2007	2	-0.028	24200	2	3.31	0.080	0.826446	0.043			-0.010					-0.016	-0.010		0.005	0.003	
2008	3	-0.028	22700	3	3.64	0.083	0.751315	0.041			-0.010					-0.016	-0.010		0.005	0.003	
2009	4	-0.028	21200	4	4.00	0.085	0.683013	0.039			-0.010					-0.016	-0.010		0.005	0.003	
2010	5	-0.028	19900	5	4.41	0.088	0.620921	0.037			-0.010					-0.016	-0.010		0.005	0.003	
2011	6	-0.033	18700	6	4.85	0.091	0.564474	0.033			-0.010					-0.016	-0.010			0.003	
2012	7	-0.033	17500	7	5.33	0.093	0.513158	0.031			-0.010					-0.016	-0.010			0.003	
2013	8	-0.036	16900	8	5.86	0.099	0.466507	0.029			-0.010					-0.016	-0.010				
2014	9	-0.036	16900	9	6.45	0.109	0.424098	0.031			-0.010					-0.016	-0.010				
2015	10	-0.036	16900	10	7.09	0.120	0.385543	0.032			-0.010					-0.016	-0.010				
2016	11	0.000			7.80	0.000	0.350494	0.000													
2017	12	0.000			8.58	0.000	0.318631	0.000													
2018	13	0.000			9.44	0.000	0.289664	0.000													
2019	14	0.000			10.39	0.000	0.263331	0.000													
2020	15	0.000			11.43	0.000	0.239392	0.000													
2021	16	0.000			12.57	0.000	0.217629	0.000													
2022	17	0.000			13.83	0.000	0.197845	0.000													
2023	18	0.000			15.21	0.000	0.179859	0.000													
2024	19	0.000			16.73	0.000	0.163508	0.000													
2025	20	0.000			18.40	0.000	0.148644	0.000													
2026	21	0.000			20.24	0.000	0.135131	0.000													
	Sum		**200700**					**0.000**		-0.363	-0.100	0.000	0.000	0.000	0.000	-0.161	-0.100	0.000	0.026	0.022	0.000
	Assumed data																				

Moldova Sequestration project (crediting period, not for project lifetime)

Country			Moldova / Soil Conservation Project									
Prouject Contents			Afforesting 14,500 hectares of degraded agricultural lands on 1,891 plots distributed throughout the country. (PAD p5)									
Base Case			no afforestation/reforestation activity due to financial constraints backed up by the data for the period 1994-2000 (PDD p6)									
Project Implementation			15	years		2003-17		PAD p1				
Lifetime			15	years				PDD p8		*FA is adopted with 30 years without salvage value and 100 years with salvage value.		
PCF			1300000	tCO2e		for	$4.55	million	by	$3.50	/tCO2e	HP table *PAD p10 1,480,000 tCO2e
ER			total	3215296	tCO2e			HP table				
				1812178	tCO2e	21 yrs.		PAD p10; p31				
				1812178	tCO2e	15 yrs.		WB PDD p14-15				
				1935223	tCO2e	7 yrs w/ renewable		CDM Watch				
				not available				UNFCCC PDD				
Cost			$14.42	million				PAD p1				
				$8.32	million	Borrow						
				$0.92	million	Grant						
				$5.18	million	PCF						
Financial Analysis			PAD p11-12; p30-38			30 years			30 years			with PCF transaction costs by calculating credit purchase price $0.2/tCO2e
			FIRR			w/o	n.a.		w/	3.90%		lesser than contractual $3.5/tCO2e
			NPV	DR	10%	w/o	-$7.53	million	w/	-$5.62	million	
Technology			Afforestation									
	C value inflator		**10%**									
	Discount rate		**10%**									
UNIT		mil $	tCO2e		$	mil $	-	mil$		Cost & Benefit information: PAD p28		
w/ Carbon Revenue :										Cap. Exp.	Op. Cost	Revenue
	Year	**Net CF**	**C credit**	**Year**	**C value**	**C Revenue**	**DF**	**PV**		project cost		timber + nontimber
2002	0	-2.035			6.19	0.000	1.000000	-2.035		-2.050		0.015
2003	1	-2.598			6.81	0.000	0.909091	-2.362		-2.621		0.023
2004	2	-2.119			7.49	0.000	0.826446	-1.752		-2.150		0.031
2005	3	-2.284	49394	1	8.24	0.407	0.751315	-1.410		-2.325		0.042
2006	4	-1.699	58788	2	9.06	0.533	0.683013	-0.796		-1.720		0.021
2007	5	-0.984	82727	3	9.97	0.824	0.620921	-0.099		-1.098		0.114
2008	6	-0.699	88788	4	10.96	0.973	0.564474	0.155		-0.777		0.077
2009	7	-0.378	117576	5	12.06	1.418	0.513158	0.534		-0.450		0.072
2010	8	-0.246	133939	6	13.26	1.777	0.466507	0.714		-0.329		0.082
2011	9	-0.247	85398	7	14.59	1.246	0.424098	0.424		-0.329		0.082
2012	10	-0.247	85398	8	16.05	1.371	0.385543	0.433		-0.329		0.082
2013	11	-0.247	85398	9	17.66	1.508	0.350494	0.442		-0.329		0.082
2014	12	-0.247	85398	10	19.42	1.659	0.318631	0.450		-0.329		0.082
2015	13	-0.247	85398	11	21.36	1.824	0.289664	0.457		-0.329		0.082
2016	14	-0.247	85398	12	23.50	2.007	0.263331	0.463		-0.329		0.082
2017	15	-0.247	85398	13	25.85	2.207	0.239392	0.469		-0.329		0.082
2018	16	-0.247	85398	14	28.43	2.428	0.217629	0.475		-0.329		0.082
2019	17	-0.247	85398	15	31.28	2.671	0.197845	0.480		-0.329		0.082
2020	18	-0.247	85398	16	34.41	2.938	0.179859	0.484		-0.329		0.082
2021	19	-0.247	85398	17	37.85	3.232	0.163508	0.488		-0.329		0.082
2022	20	-0.247	85398	18	41.63	3.555	0.148644	0.492		-0.329		0.082
2023	21	-0.247	85398	19	45.79	3.911	0.135131	0.495		-0.329		0.082
2024	22	-0.247	85398	20	50.37	4.302	0.122846	0.498		-0.329		0.082
2025	23	-0.247	85398	21	55.41	4.732	0.111678	0.501		-0.329		0.082
	Sum		**1812178**					**0.000**		-18.454	0.000	1.711
	Assumed data											

Bibliography

Anthoff, David (2004) Social Cost of Carbon: Equity Weighting MSc Thesis for Environmental Change and Management, University of Oxford, http://www.economics.ox.ac.uk/members/cameron.hepburn/Anthoff(2004).pdf (accessed on June 1, 2005)

Asian Development Bank (ADB), (2001) Guidelines for the Economic Analysis of Projects ISBN: 971-561-127-3, available also online http://www.adb.org/Documents/Guidelines/Eco_Analysis/default.asp (accessed on June 1, 2005)

Asuka, Jusen (2004) Research about the Methodology to Evaluate Quality of Emission Reduction Allowances of Greenhouse Gases (in Japanese), prepared for the New Energy and Industrial Technology Development Organization, Japan's largest public R&D management organization for promoting the development of advanced industrial, environmental, new energy and energy conservation technologies, http://www.tech.nedo.go.jp/servlet/HoukokushoDownloadJyohoServlet?BARCODE=100003445&db=n (accessed on June 1, 2005)

Asuka, Jusen (2002) The Utilization of Public Fund for the Kyoto Mechanism – An Additionality Issue and Institutional Design (in Japanese) http://www2s.biglobe.ne.jp/~stars/pdf/asuka_2002_kyoto.pdf (accessed on July 1, 2005)

Asuka, Jusen; Takeuchi, Kenji (2004) Additionality reconsidered: lax criteria may not benefit developing countries Climate Policy 4 (2004) 177-192

Barrett (1998) Political economy of the Kyoto Protocol Oxford Review of Economic Policy, Vol. 14. No. 4

CAN (Climate Action Network) (2004) eco December 9 Synergy Issue. NGO Newsletter issued at Conference of Party 10 in Buenos Aires http://www.climatenetwork.org/eco/cops/cop10/en/ECOCOP1004.pdf (accessed on July 31, 2005)

Carbon Finance (2005) News & Analysis of Market Solutions to Climate Change, Carbon Finance May 2005 Volume 2, Issue 5

CDM Watch (2005a) the Clean Development Mechanism Watch website http://cdmwatch.org/ (accessed on July 1, 2005)

CDM Watch (2005b) the Clean Development Mechanism Watch website on project list http://cdmwatch.org/pcf_list.php (accessed on June 27, 2005)

CDM Watch (2005c) The World Bank and the carbon market Rhetoric and Reality CDM Watch April 2005 http://cdmwatch.org/files/World%20Bank%20paper%20final.pdf (accessed on August 1, 2005)

CDM Watch (2005d) the website for Chile Chacabuquito hydroelectric project http://cdmwatch.org/project_details.php?ID=13 (accessed on June 27, 2005)

CDM Watch (2005e) the website for Brazil Plantar avoided fuel switching and sequestration project http://cdmwatch.org/project_details.php?ID=12 (accessed on June 27, 2005)

CDM Watch (2005f) the website for China Jincheng Coal mine methane power generation project http://cdmwatch.org/project_details.php?ID=374 (accessed on June 27, 2005)

CDM Watch (2005g) the website for Colombia Jepirachi carbon offset project http://cdmwatch.org/project_details.php?ID=14 (accessed on June 27, 2005)

CDM Watch (2005h) the website for The Costa Rica Umbrella Project for Renewable Energy Sources. Chorotega wind sub-project http://cdmwatch.org/project_details.php?ID=131 (accessed on June 27, 2005)

CDM Watch (2005i) the website for The Costa Rica Umbrella Project for Renewable Energy Sources. Cote hydroelectric sub-project http://cdmwatch.org/project_details.php?ID=132 (accessed on June 27, 2005)

CDM Watch (2005j) the website for The Costa Rica Umbrella Project for Renewable Energy Sources. Vara Blanca wind sub-project http://cdmwatch.org/project_details.php?ID=130 (accessed on June 27, 2005)

CDM Watch (2005k) the website for China Xiaogushan hydroelectric project http://cdmwatch.org/project_details.php?ID=286 (accessed on June 27, 2005)

CDM Watch (2005l) the website for India Luknow municipal solid waste project http://cdmwatch.org/project_details.php?ID=203 (accessed on June 27, 2005)

CDM Watch (2005m) the website for Moldova soil conservation project http://cdmwatch.org/project_details.php?ID=196 (accessed on June 27, 2005)

CGER (2005) the Center for Global Environmental Research website http://www-cger.nies.go.jp/cger-j/db/enterprise/gwdb/A00/A0n/a0132.html (accessed on July 31, 2005)

Ceronsky, Megan (2004) Checking the price tag on catastrophe: An investigation of the sensitivity of FUND's Social Cost of Carbon estimates to the incorporation of non-linear climate responses, MSc Thesis for Environmental Change and management, University of Oxford http://www.economics.ox.ac.uk/members/cameron.hepburn/Ceronsky(2004).pdf (access on June 1, 2005)

Chomitz (1998) Baselines for Greenhouse Gas Reductions: Problems, Precedents, Solutions: prepared for the Carbon Offsets Unit, World Bank http://www.worldbank.org/nipr/work_paper/base14/base14.pdf (accessed on June 20, 2005)

Clarkson, Richard; Deyes, Kathryn (2002) Estimating the Social Cost of Carbon emissions, Government Economic Service Working Paper 140, prepared for the Department for Environment, Food and Rural Affairs http://www.hm-treasury.gov.uk/media/209/60/SCC.pdf (accessed on June 1, 2005)

Cline, William R. (2004) Meeting the Challenge of Global Warming (Copenhagen Consensus Challenge Paper) http://www.copenhagenconsensus.com/Files/Filer/CC/Papers/Climate_Change_300404.pdf (accessed on December, 2004)

Cogen, Jack and Varilek, Matthew (2003) Overview of Emerging Markets for Greenhouse Gas Commodities. In International Emission Trading Association (eds) Greenhouse Gas Market 2003: emerging but fragmented http://www.ieta.org/ieta/www/pages/getfile.php?docID=169 (accessed on July 31, 2005)

Cosbey, Aaron; Parry, Jo-Ellen; Browne, Jodi; Babu, Yuvaraj Dinesh; Bhandari, Preety; Drexhage, John; Murphy, Deborah (2005) Realizing the Development Dividend: Marking the CDM Work for Developing Countries, Phase 1 Report – Pre-publication Version http://www.iisd.org/pdf/2005/climate_realizing_dividend.pdf (accessed on July 31, 2005)

Curry, Steve and Weiss, John (1993) Project Analysis in Developing Countries London: Macmillan

DTI (2005) the Department of Trade and Industry website http://www.dti.gov.uk/ccpo/glossary_kyoto_1.htm (accessed on August 10, 2005)

Dopazo, Eduardo (2005), Senior Operations Officer, Carbon Finance Business in the World Bank, interviewed on August 12, 2005 at Washington D.C. office in the World Bank

Eco Securities (2005) Pedro Moura Costa analyses the pros and cons of using the additionality tool in the assessment of CDM methodologies Features, Issue number 15, March 2005 http://www.ecosecurities.com/200about_us/222world_press/222Actis_15_Mar_2005.html (accessed on August 10, 2005)

Ellis, Jane; Corfee-Morlot, Jan; Winkler, Harald (2004) Taking Stock of Progress Under the Clean Development Mechanism (CDM), OECD/IEA paper, http://www.oecd.org/dataoecd/58/58/32141417.pdf (accessed on August 9, 2005)

Fichtner, W.; Graehl, S; Rentz, O. (2003) The impact of private investor's transaction costs on the cost effectiveness of project-based Kyoto mechanisms Climate Policy 3 (2003) 249-259

EC (2005a) the European Commission the website http://europa.eu.int/comm/environment/climat/emission.htm (accessed on July 31, 2005)

EC (2005b) EU Emissions Trading ISBN 92-894-8139-0 http://europa.eu.int/comm/environment/climat/pdf/emission_trading2_en.pdf (accessed on July 31, 2005)

GEF (2005) the Global Environment Facility website http://www.gefweb.org/ (accessed on June 20, 2005)

GEF (2002) The First Decade of The GEF, Second Overall Performance Study, January 25 2002 (OPS2), Global Environment Facility

GEF (1996) Outline of Paper on Incremental costs http://www.gefweb.org/COUNCIL/council7/c7inf5.htm (accessed on April 2005)

Haites, Erik (2004) Estimating the Market Potential for the Clean Development Mechanism: Review of Models and Lessons Learned, prepared for World Bank Carbon Finance Business PCF*plus* Research program, the International Energy Agency and the International Emissions Trading Association, downloaded from the bottom left-hand side link on http://carbonfinance.org/pcf/router.cfm (accessed on June 27, 2005)

Hepburn, Cameron (2004) The Rise of Declining Discount Rates, *mimeo*

Hiratake, Masahito (2005) Senior Operations Officer, Carbon Finance Business in the World Bank, interviewed on August 12, 2005 at Washington D.C. office in the World Bank

Hagiwara, Yoshitaka (2005) Senior Operations Officer, Carbon Finance Business in the World Bank, e-mailed on April 19, 2005

Houghton, John (2004) Global Warming Third Edition ISBN 0-521-52874-7 Cambridge, UK: Cambridge University Press

Institute for Global Environmental Strategies (IGES) (2004) CDM and JI in Charts Version 2.1 as of March 2005 http://www.iges.or.jp/en/cdm/pdf/charts2.1.pdf (accessed on August 1, 2005)

International Rivers Network & CDM Watch (IRN & CDM Watch) (2004) CDM large hydro status note for the World Bank/IETA Carbon Expo http://www.irn.org/programs/greenhouse/pdf/COP10hydrostatusnote.pdf (accessed on July 1, 2005)

Kolstad, Charles D. (2000) Environmental Economics ISBN 0-19-511954-1 New York: Oxford University Press, Inc.

Kolstad, Charles D. and Toman, Michael (2001) The Economics of Climate Policy, Resources for the Future Discussion Paper 00-40REV, http://www.rff.org/Documents/RFF-DP-00-40.pdf (accessed on December 2004)

Lecocq, Franck; Capoor, Karan (2005) State and Trends of Carbon Market 2005, prepared for World Bank Carbon Finance Business and the International Emissions Trading Association, downloaded from the bottom left-hand side link on http://carbonfinance.org/pcf/router.cfm (accessed on June 27, 2005)

Lumby, Steve; Jones, Chris (1999) Investment Appraisal & Financial Decisions, Sixth Edition, ISBN 1-86152-257-6, London, UK: Thomson

Matsuo, Naoki (2004) CDM Methodologies Guidebook Tokyo: Ministry of the Environment, Japan (MOE); Global Environmental Centre Foundation (GEC); Climate Experts Ltd., available also online http://gec.jp/gec/gec.nsf/EN/Publications-Reports_and_Related_Books-CDM_Meth_Guidebook (accessed on July 31, 2005)

Michaelowa, Axel; Stronzik, Marcus; Eckermann, Frauke; Hunt, Alistair (2003) Climate Policy 3 (2003) 261-278

Motta, Ronaldo Seroa da; Srivastava, Leena; Markandya, Anil (2002) The CDM and Sustainable Development: Case Studies from Brazil and India. In Markandya, Anil and Halsnaes, Kirsten (eds) Climate Change & Sustainable Development – Prospects for Developing Countries, ISBN 1 85383 910 8 London: Earthscan Publications Limited. pp. 247-284

Nordhaus, William D. and Boyer, Joseph G (2000), Warming the World: Economic Models of Global Warming – Web Version, Ch. 1, 2, 5, 6, 8 and 9 (This is same as the book published in 2000 by MIT press.) http://www.econ.yale.edu/%7Enordhaus/homepage/web%20table%20of%20contents%20102599.htm (accessed in December 2004)

Oxera (2005) Synthesis of climate change policy evaluations: preliminary unpublished second draft

Pacudan, Romeo (2004) CDM Market Overview. The presentation documents for URC-IGES Workshop on Capacity Development for CDM in Asia. http://www.cd4cdm.org/countries%20and%20regions/Asia/Second%20Extended%20Regional%20Workshop/MarketOverview_Pacudan.pdf (accessed on July 31, 2005)

Pearce, David (2003a) The Social Cost of Carbon and its Policy Implication Oxford Review of Economic Policy, VOl. 19 No. 3

Pearce, David (2003b) International Seminar on the Social Cost of Carbon: Rapporteur's summary (A rapport for International Seminar on the Social Cost of Carbon organized DEFRA on July, 2003) http://www.defra.gov.uk/environment/climatechange/carbonseminar/pearce.pdf (accessed on August 1, 2005)

Pearce, David, Groom, Ben, Hepburn, Cameron & Koudouri, Phoebe (2003) Valuing the Future – Recent advances in social discounting World Economics Vol. 4 No.2 April-June 2003 p121-141

Point Carbon (2005a) CDM & JI Monitor 26 July 2005 View Point: CER overestimates – exceptions or the rules http://www.pointcarbon.com/wimages/CJM_26_07_2005xkdfghv.pdf (accessed on July 31, 2005)

Point Carbon (2005b) CDM & JI Monitor 14 June 2005 View Point: CER exchangers: Outsider trading or Nasdaq next? http://www.pointcarbon.com/wimages/CJM_14_06_2005_1.pdf (accessed on July 31, 2005)

Point Carbon (2005c), the Point Carbon webste on historic prices http://www.pointcarbon.com/category.php?categoryID=390 (accessed on July 31, 2005)

Springer, Urs (2003) Can the Risks of the Kyoto Mechanisms be Reduced Through Portfolio Diversification? Evidence from the Swedish AIJ Program Environmental and Resource Economics **25**: 501-513, 2003

Sutter, Christoph (2004), Sustainability Check-up for CDM Projects: How to assess the sustainability of international projects under the Kyoto Protocol, ISBN 3-936846-59-6, also available online http://www.up.umnw.ethz.ch/en/research/research_sutter-frame.html (accessed on June 1, 2005)

Tietenberg, Tom (2003) Environmental and Natural Resource Economics Sixth Edition ISBN 0-321-18536-6 USA: Pearson Education, Inc.

Tol, Richard S.J. (2005) The marginal damage costs of carbon dioxide emissions: an assessment of the uncertainties Energy Policy 33 (2005) 2064–2074

Tol, Richard S. J. (2003) The Marginal Costs of Carbon Dioxide Emissions: An Assessment of the Uncertainties, Working Paper FNU-19, http://www.uni-hamburg.de/Wiss/FB/15/Sustainability/margcostunc.pdf (accessed in December 2004)

Turner, R. Kerry, Pearce, David, and Bateman, Ian (1994) Environmental Economics: An Elementary Introduction 1st edition, Harvester Wheatsheaf

UN (2000) Stewart, Richard (Lead Author) The Clean Development Mechanism, Building International Public-Private Partnerships, Under the Kyoto Protocol, Technical, Financial and Institutional Issues http://r0.unctad.org/ghg/publications/cdm-report.pdf (accessed on July 31, 2005)

UNEP (2005) CEO briefing: a document of the UNEP FI Climate Change Working Group January 2005 http://www.unepfi.org/fileadmin/documents/CEO_briefing_finance_for_carbon_solutions_2004.pdf (accessed on July 1, 2005)

UNEP (2004) Olhoff, Anne; Markandya, Anil; Halsnaes, Kirsten; Taylor, Tim CDM Sustainable Development Impacts, ISBN 87-550-3341-5 http://www.cd4cdm.org/Publications/CDM%20Sustainable%20Development%20Impacts.pdf (accessed on July 1, 2005)

UNFCCC (2005a) the United Nations Framework Convention on Climate Change website on a project cycle http://cdm.unfccc.int/CommonImages/ProjectCycleSlide and http://cdm.unfccc.int/Projects/pac/index.html (access on July 31, 2005)

UNFCCC (2005b) the United Nations Framework Convention on Climate Change website on registration http://cdm.unfccc.int/Projects/registered.html (access on July 31, 2005)

UNFCCC (2005c) the United Nations Framework Convention on Climate Change website on validation http://cdm.unfccc.int/Projects/Validation (access on July 31, 2005)

UNFCCC (2005d) the United Nations Framework Convention on Climate Change website on methodology http://cdm.unfccc.int/methodologies/PAmethodologies/approved.html (access on July 31, 2005)

UNFCCC (2005e) the United Nations Framework Convention on Climate Change website on small scale projects' methodology http://cdm.unfccc.int/methodologies/SSCmethodologies/approved.html (access on July 31, 2005)

UNFCCC (2005f) the United Nations Framework Convention on Climate Change website on aforestation and reforestation methodology http://cdm.unfccc.int/methodologies/ARmethodologies/index.html (access on July 31, 2005)

UNFCCC (2004) CDM-Executive Board "Tool for the demonstration and assessment of additionality 22 October 2004" http://cdm.unfccc.int/methodologies/PAmethodologies/AdditionalityTools/Additionality_tool.pdf (accessed on June 1, 2005)

UNFCCC (2002) "Decision 17/CP.7 Modalities and procedures for a clean development mechanism as defined in Article 12 of the Kyoto Protocol" http://unfccc.int/resource/docs/cop7/13a02.pdf#page=20 (accessed on July 31, 2005)

UNFCCC (1997) Kyoto Protocol to the United Nations Framework Convention on Climate Change http://unfccc.int/resource/docs/convkp/kpeng.pdf (accessed on June 27, 2005)

UNFCCC PDD (2004a) Clean Development Mechanism Project Design Document Form (CDM-PDD) Version 02 – in effect as of: 1 July 2004 http://cdm.unfccc.int/UserManagement/FileStorage/FS_790768463 (accessed on June 27. 2005)

UNFCCC PDD (2004b) Clean Development Mechanism Project Design Document Form (CDM-PDD) Version 02 – in effect as of: 1 July 2004 (Brazil Plantar PDD) http://cdm.unfccc.int/UserManagement/FileStorage/FS_258955548 (accessed on June 27, 2005)

UNFCCC PDD (2004c) Clean Development Mechanism Project Design Documents (CDM-PDD) Prototype Carbon Fund Colombia: Jepirachi Wind Power Project September 8, 2003 / April 7, 2004 as amended on November 28, 2003 in response to the draft recommendations of the Methodology Panel to the CDM Executive Board contained in F-CDM-NMmp ver 03 – NM0024, as revised on April 7 and 12, 2004 in response to Methodology Panel recommendations as approved by the CDM Executive Board contained in F-CDM-NMmp ver 3 – NM0024 resubmitted for reconsideration by the Methodology Panel and the CDM Executive Board http://cdm.unfccc.int/UserManagement/FileStorage/FS_837711305 (accessed on June 27, 2005)

UNFCCC PDD (2003) Clean Development Mechanism Project Design Document (CDM-PDD) Municipal Solid Waste Treatment cum Energy Generation Project, Lucknow, India Submitted to Prototype Carbon Fund (PCF) September 2003 by Infrastructure Development Finance Company limited ITC Centre, 3rd Floor 760, Anna Salai, Chennai – 600 002 http://cdm.unfccc.int/UserManagement/FileStorage/FS_415553625 (accessed on June 27, 2005)

Victor, David G (2001) The Collapse of the Kyoto Protocol and the Struggle to Slow Global Warming ISBN 0-691-12026-9 Woodstock, UK: Princeton University Press

WB (2005a) the World Bank Prototype Carbon Fund website http://carbonfinance.org/pcf/Router.cfm?Page=About (accessed on August 1, 2005)

WB (2005b) the World Bank Prototype Carbon Fund website on partners http://carbonfinance.org/pcf/router.cfm?Page=Partic (accessed in August 1, 2005)

WB (2005c) Prototype Carbon Fund a public/private partnership Annual Report 2004, downloaded from the bottom left-hand side link on http://carbonfinance.org/pcf/router.cfm (accessed on June 27, 2005)

WB (2005d) the World Bank Carbon Finance Business website http://carbonfinance.org/pcf/router.cfm?Page=Projects (accessed in June 1, 2005)

WB (2005e) Kyoto and Beyond: Opportunities & Strategies for Carbon Finance Energy Week 2005 (Marcu, Andrei; Smith, Julie Galvin; Youngman, Rob; Atur, Varadan; Bishop, Veronique)

(presentation document)
http://iris37.worldbank.org/domdoc/PRD/Other/PRDDContainer.nsf/All+Documents/85256D2400766CC785256FFF0075B000/$File/Bishop_EW05.pdf (accessed on July 31, 2005)

WB (2004) Community Development Carbon Fund Brochure, posted at the WB website document library on April 3, 2004, down loded from http://carbonfinance.org/cdcf/Router.cfm?Page=DocLib&Dtype=33&ActionType=ListItems (accessed on June 27, 2005)

WB (2002a) Prototype Carbon Fund, The PCF and other World Bank Carbon Funds Pioneering Greenhouse Gas Emission Reductions Training Workshop: Project Formulation for the Clean Development Mechanism Hanoi, Vietnam September 30- October 2, 2002 (presentation document), posted at the WB website document library on June 2, 2003, downloaded from http://carbonfinance.org/pcf/Router.cfm?Page=DocLib&Dtype=5&ActionType=ListItems#Gen1 (accessed on June 27, 2005)

WB (2002b) Introduction to Climate Change and the Clean Development Mechanism Training Workshop: Project Formulation for the Clean Development Mechanism Hanoi, Vietnam September 30 – October 2 (presentation document), posted at the WB website document library on June 2, 2003, downloaded from http://carbonfinance.org/pcf/Router.cfm?Page=DocLib&Dtype=5&ActionType=ListItems#Gen1 (accessed on June 27, 2005)

WB (2002c) Creating the Carbon Asset: PCF Approaches to Additionality, Baselines, Validation and Verification (presentation document), posted at the WB website document library on June 2, 2003, downloaded from http://carbonfinance.org/pcf/Router.cfm?Page=DocLib&Dtype=5&ActionType=ListItems#Gen1 (accessed on June 27, 2005)

WB (2002d) Impact of Carbon Finance on Project Financing, Prototype Carbon Fund, April 17, 2002": (presentation document), posted at the WB website document library on June 2, 2003, downloaded from http://carbonfinance.org/pcf/Router.cfm?Page=DocLib&Dtype=5&ActionType=ListItems#Gen1 (accessed on June 27, 2005)

WB PAD (2005a) Project Appraisal Document on a Proposed Purchase of Emissions Reductions by the Prototype Carbon Fund in the Amount of US$ 8.4 Million to Sistemas De Energia Internacional S.A. De C.V. (SEISA) for the Mexico: Waste Management and Carbon Offset Project February 15, 2005 (Acquired by Personal Communication on June 6, 2005, with Jason Steele in Carbon Finance Business in the WB)

WB PAD (2005b) Project Appraisal Document on a proposed in the amount of US$ to the for Soil Conservation Project (Acquired by Personal Communication on June 6, 2005, with Jason Steele in Carbon Finance Business in the WB)

WB PAD (2004a) Project Appraisal Document on a Prototype Carbon Fund in the Amount of US$10 Million to the People's Republic of China for a Jincheng Coal mine Methane Project, July 1, 2004 (Acquired by Personal Communication on June 6, 2005, with Jason Steele in Carbon Finance Business in the WB)

WB PAD (2004b) Project Appraisal Document on a Proposed Purchase of Emissions Reductions in the Amount of US$ 8 Million Minimum to the Ministry of Finance People's Republic of China for CN-PCF-Xiaogushan hydropower Project June 30, 2004 (Acquired by Personal Communication on June 6, 2005, with Jason Steele in Carbon Finance Business in the WB)

WB PAD (2004c) Project Appraisal Document on a Proposed Purchase of Emissions Reductions by the Prototype Carbon Fund in the Amount of US$ 4.25 Million from the Asia Boioenergy India Ltd. (India) for the ABIL Solid Waste management Project in the City of Lucknow November 10, 2004 (Acquired by Personal Communication on June 6, 2005, with Jason Steele in Carbon Finance Business in the WB)

WB PAD (2002a) "Project Appraisal Document on a Proposed Purchase of Emissions Reductions from the Prototype Carbon Fund in the Amount of US$ 5.3 Million to the Republic of Brazil for the PCF Minas Gerais Plantar Project, April 1, 2002" http://carbonfinance.org/pcf/router.cfm?Page=Projects&ProjectID=3109 and http://carbonfinance.org/pcf/router.cfm?Page=Projects&ProjectID=3109 for Annex 1-6 (accessed on June 1, 2005)

WB PAD (2002b) Project Appraisal Document on a Prototype Carbon Fund in the Amount of US$3.2 Million for Empresas Publiccas de Medellin (EEPPM) for the Jepirachi Carbon Off Set Project, October 30, 2002
(Acquired by Personal Communication on June 6, 2005, with Jason Steele in Carbon Finance Business in the WB)

WB PAD (2002c) Project Appraisal Document on a Prototype Carbon Fund in the Amount of US$10 Million to the Republic of Costa Rica for the Umbrella Project for Renewable Energy Sources, October 30, 2002
(Acquired by Personal Communication on June 6, 2005, with Jason Steele in Carbon Finance Business in the WB)

WB PAD (2001) "Project Appraisal Document on a Proposed Purchase of Emissions Reductions from the Prototype Carbon Fund (PCF) in the Amount of US$ 3.5 Million from the Hidroelectrica Guardia Vieja, S.A. (Republic of Chile) for the Chacabuquito Hydroelectric Power Project, December 5, 2001" http://carbonfinance.org/pcf/router.cfm?Page=Projects&ProjectID=3107 (accessed on June 1, 2005)

WB PDD (2004) Annex 15: Project Design Document for Xiaogushan Hydropower Project (Acquired by Personal Communication on June 6, 2005, with Jason Steele in Carbon Finance Business in the WB)

WB PDD (2003a) Clean Development Mechanism Project Design Document (CDM-PDD) Municipal Solid Waste Treatment cum Energy Generation Project, Lucknow, India Submitted to Prototype Carbon Fund (PCF) September 2003 by Infrastructure Development Finance Company limited ITC Centre, 3rd Floor 760, Anna Salai, Chennai – 600 002 http://carbonfinance.org/pcf/Router.cfm?Page=Projects&ProjectID=3125 (accessed on June 1, 2005)

WB PDD (2003b) Clean Development Mechanism Project Design Document (CDM-PDD) Prototype Carbon Fund Colombia: Jepirachi Wind Power Project, September 8, 2003 http://carbonfinance.org/pcf/Router.cfm?Page=Projects&ProjectID=3119 (accessed on June 1, 2005)

WB PDD (2002a) Clean Development Mechanism Project Design Document (CDM PDD Version 01 (in effect as of: 29 August 2002) http://carbonfinance.org/pcf/Router.cfm?Page=Projects&ProjectID=3133 (accessed on June 1, 2005)

WB PDD (2002b) Prototype Carbon Fund Brazil: Sustainable Fuelwood and Charcoal Production for the Pig Iron Industry in Minas Gerais, The "Plantar" Project Design Document, Submitted with Documents for Validation, 17 October, 2001, Updated and resubmitted for Validation March 2002 http://carbonfinance.org/pcf/Router.cfm?Page=Projects&ProjectID=3109 (accessed on June 1, 2005)

WB PDD (2001) Prototype Carbon Fund, Chile: Chacabuquito 26 MW Run of River Hydropower Project, Project Design Document, Final Draft October 1, 2001 http://carbonfinance.org/pcf/router.cfm?Page=Projects&ProjectID=3107 (accessed on June 1, 2005)

Weitzman, Martin L. (2001) Gamma Discounting, American Economic Review Vol. 91 No. 1, p260-271

Wysham, Daphne (2005) A Carbon Rush at the World Bank, Foreign Policy Special Report http://www.fpif.org/pdf/reports/SR0502wbank.pdf (accessed on June 27, 2005)

WWF (2005a) the World Wildlife Fund website http://www.panda.org/about_wwf/what_we_do/climate_change/our_solutions/business_industry/finance_investment/gold_standard_q_a.cfm#necessary (accessed on April 18, 2005)

WWF (2005b) The Gold Standard, Premium quality carbon credits http://www.panda.org/downloads/climate_change/goldstandard.pdf (accessed on April 18, 2005)

WWF (2005c) The Gold Standard CLEAN DEVELOPMENT MECHANISM PROJECT DESIGN DOCUMENT (GS CDM PDD) http://www.panda.org/downloads/climate_change/gspddfinal120703.doc (accessed on April 18, 2005)

WWF (2003) The Gold Standard – Background and Review http://www.panda.org/downloads/climate_change/thegoldstandardoverview.doc (accessed on April 18, 2005)

WWF (2002) The Gold Standard: Quality Standards for CDM and JI Projects http://www.panda.org/downloads/climate_change/COP8_standards.pdf (accessed on April 18, 2005)