The Clean Development Mechanism and Least Developed Countries: Key Determinants for Enhancing Climate Change Mitigative Capacity with Case Study Analysis of Niger

by

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Dedication

To Emily and my family for their love and support.

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AFD	Agence Française de Développement
ASI	Achat Service International
AWG-KP	Ad Hoc Working Group on Further Commitments for Annex I Parties under the Kyoto Protocol
CARMA	Carbon Monitoring for Action
CDM	Clean Development Mechanism
CER	Certified Emission Reduction
CFA	Communauté Financière d'Afrique
CH_4	Methane
CNEDD	Conseil National de l'Environnement pour un Développement Durable
CO_2	Carbon Dioxide
DD	Development Dividends
DNA	Designated National Authority
DOE	Designated Operational Entity
ERPA	Emissions Reduction Purchase Agreement
EU-ETS	European Union Emissions Trading System
FDI	Foreign Direct Investment
FMNR	Farmer Managed Natural Regeneration
g	Grams
GHG	Greenhouse Gas

GDP	Gross Domestic Product
Gg	Gigagrams
GWP	Global Warming Potential
ha	Hectares
HC	Human Capital
HDI	Human Development Index
HFC	Hydrofluorocarbon
ICRISAT	International Crop Research Institute for Semi-Arid Tropics
IISD	International Institute for Sustainable Development
IPCC	Intergovernmental Panel on Climate Change
IRR	Internal Rate of Return
kg	Kilograms
kWh	Kilowatt-Hours
l	Liters
LDC	Least Developed Country
MAC	Marginal Abatement Costs
MENA	Middle East and North Africa
N_2O	Nitrous Oxide
NGO	Non-Governmental Organization
OPEC	Organization of Petroleum Exporting Countries
PAC	Programme d'Actions Communautaires
PDD	Project Design Document
PFC	Perfluorocarbon

PIN	Project Idea Note
PV	Photovoltaic
SF_6	Sulfur Hexafluoride
SIDS	Small Island Developing States
TC	Total Costs
Tj	Terajoules
TR	Total Revenues
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
Wc	Watts Current

Glossary

Acacia Senegal – A small tree species that is native to sub-Saharan Africa and produces gum Arabic.

Adaptation – Actions and policies aimed at coping with the impacts of climate change.

Adaptive Capacity – The capacity for an individual, group, or system to change in response to changes in its environment. With regards to climate change, the changes in the environment result from increased atmospheric greenhouse gases.

Additionality – One of the criteria for CDM project developers to demonstrate in their registration documentation is that the project activities are additional to what would have occurred without the CDM.

Aforestation – Planting trees on land that had not previously had forest cover. Aforestation is one of the methods for sequestering carbon that receives credit from the CDM.

Annex I Parties to the Kyoto Protocol – Developed countries that have ratified the Kyoto Protocol and have agreed to meet greenhouse gas emission reduction targets.

Anthropogenic Climate Change – Changes in the global climate brought about by the emissions of greenhouse gases by human activity.

Baseline – The amount of greenhouse gas emissions expected without CDM project activities. Emission reductions from projects are estimated against baseline scenarios.

Carbon Sequestration – Reducing greenhouse gas levels by activities that pull carbon dioxide out of the atmosphere and place it into long-term storage. For the CDM, forestry-related activities are the primary approach to sequestering carbon.

Carbon Revenue – Revenues from CDM project activities that result from the direct creation and sale of Certified Emissions Reductions (CER).

CDM Executive Board – The oversight group at the UNFCCC responsible for approving CDM methodologies, managing the project registration process, and ultimately issuing Certified Emissions Reductions (CER) for project activities.

CDM Project Developers (also CDM Project Proponents) – Organizations and individuals that develop project ideas, create the required project documentation, and implement CDM project activities that result in emission reductions.

CDM Transaction Costs – The registration and monitoring costs incurred by CDM project developers to participate in the program. The steps in the oversight process help to ensure that emission reductions are real and verifiable.

Certified Emissions Reductions (CER) – The crediting metric for emission reductions created by CDM projects. Each CER represents one metric ton of CO_2 equivalent reduced.

Clean Development Mechanism (CDM) – One of the three flexibility mechanisms of the Kyoto Protocol that allows developed countries to receive credit for emission reductions that take place in developing countries.

Designated National Authority (DNA) – Host country government offices in charge of overseeing and approving potential CDM projects. Approval by the DNA is seen as proof that CDM projects create significant sustainable development benefits.

Designated Operational Entity (DOE) – An independent, third-party organization that validates the CDM project activities during the registration phase of project development and once the project is operational.

Emerging Markets – Developing countries that are on the upper-end of the development spectrum have grown more quickly in the recent past. Specific examples include China, India, Brazil, and Mexico.

Emissions Trading – One of the three flexibility mechanisms of the Kyoto Protocol that allows Annex I parties to trade emissions permits that they do not use to other parties in need of additional permits.

Emissions Reduction Purchase Agreement (ERPA) – A contract between CDM project developers and CER purchasers in which the purchasers agree to buy a specific amount of CERs at a set price at some future date. In return, the project developers receive payment at an earlier date than would otherwise be possible.

European Union Emissions Trading System (EU-ETS) – A trading market for Annex I parties in the European Union to take advantage of one of the three flexibility mechanisms of the Kyoto Protocol by trading emissions allowances.

Foreign Direct Investment (FDI) – Flows of capital from one country to another. When investments are made in a country by outside actors, the investments are called incoming FDI.

GHG Offset Projects – Projects that create greenhouse gas emission reductions that are then used by regulated entities to meet reduction commitments (sometimes voluntary). The key feature of offset projects is that the regulated entity is not reducing their own emissions but is supporting another actor's reductions.

Global Warming Potential (GWP) – A common metric to assess the climate change impacts of different greenhouse gases based upon their lifetime and climate forcing. Global warming potentials are often used to convert other gases to Carbon Dioxide equivalence.

Greenhouse Gases (GHG) – Heat trapping gases that have begun to change the global climate. The Kyoto Protocol aims to reduce emission of these gases including carbon dioxide, methane, nitrous oxide, chlorofluorocarbons, hydrofluorocarbons, and sulfur hexafluoride.

Gum Arabic – A product from the acacia Senegal tree that is used as a food additive and in cosmetics.

Human Development Index (HDI) – A measure used by the United Nations Development Program to assess development levels across countries. The measure includes metrics that assess economic, health, and educational levels.

Intergovernmental Panel on Climate Change (IPCC) – An international body of scientists and climate experts that compiles a consensus report on climate science, impacts, and adaptation and mitigation proposals on a regular basis.

Internal Rate of Return (IRR) – The discount or interest rate needed to balance the costs and revenues from an endeavor over a specific period of time.

Jatropha (specifically, Jatropha curcas) – A plant whose seeds can be pressed to produce oil that can then be converted into bio-diesel.

Joint Implementation – One of the three flexibility mechanisms of the Kyoto Protocol that allows Annex I parties to receive credit for emission reductions that occur in countries in transition.

Kyoto Protocol – An international agreement signed by 182 parties that aims to reduce greenhouse gas emissions in the hopes of mitigating the impacts of climate change. The agreement expires in 2012.

Leakage – Increases or decreases in greenhouse gas emissions due to CDM projects but take place outside of the project boundaries and are not included in the impact calculations.

Least Developed Countries (LDC) – A group of countries that receive low development scores based upon metrics that combine economic, health, and education measures (see Human Development Index). Most of the countries are located in sub-Saharan Africa.

Marginal Abatement Costs (MAC) – A curve representing the abatement options to reduce greenhouse gas emissions starting with the least-cost option first, then the next cheapest option, and so on. By ranking them in this manner, the curve shows the combination of abatement activities that yield a certain amount of reductions at the lowest cost.

Mitigation - Actions and policies aimed at reducing the impacts of climate change by decreasing the concentration of greenhouse gases in the atmosphere.

Mitigative Capacity - The ability to reduce anthropogenic greenhouse gas emissions or enhance natural sinks.

Natural Regeneration – Fuel wood harvesting techniques that selectively take branches and shoots from the main stem without harming or killing the tree.

Nigelec – The national electric utility in Niger.

Non-Annex I Parties to the Kyoto Protocol - Developing countries that have ratified the Kyoto Protocol but are not required to meet greenhouse gas emission reduction targets.

Non-Carbon Revenue – Revenue from co-products of CDM projects in addition to the sale of CERs. Examples of non-carbon revenue include electricity production and natural gas sales.

Offset Percentage – The percentage of a host country's overall greenhouse gas emissions that are being reduced by CDM projects.

Permanence – The likelihood that emission reductions from CDM projects will continue into the future.

Programmatic CDM – Policy changes or programs of activities that result in emission reductions and receive credit as part of the CDM.

Project Costs – The normal construction and operation costs for CDM projects that are in addition to the CDM-specific costs related to project registration and oversight.

Project Design Document (PDD) – A lengthy document required as part of the CDM registration process that describes the project activities and pre-project baseline emissions, employs approved methodologies to estimate greenhouse gas impacts and leakage, proves the additionality of project activities, and describes the expected sustainable development impacts.

Project Idea Note (PIN) – A smaller document required by some host country DNA that is a precursor to the PDD and describes the proposed CDM project activities.

Reduced Deforestation – Preventing tree losses on forested lands. Reduced deforestation does not currently receive carbon sequestration credit from the CDM.

Redundancy – Demonstrating whether or not CDM projects are required by other regulations or laws. If the projects are required by other programs, they are redundant and cannot receive credit through the CDM.

Reforestation - Planting trees on land that had previously had forest cover. Reforestation is one of the methods for sequestering carbon that receives credit from the CDM.

Sub-Saharan Africa – African countries south of the Sahara Desert.

Suppressed Demand – Conditions such as poor infrastructure or fuel shortages that reduce the supply of modern energy services such as electricity. Without the conditions, the amount of demand for the services at market prices would be larger.

Sustainable Development – Increasing levels of wealth and well-being in a manner that is sustainable over time.

Technology Transfer – The importing of new technologies and expertise into countries so that the introduced technologies begin to filter into the larger society.

Unilateral CDM – Project activities that are developed and implemented by host country parties without the support or participation of outside actors.

United Nations Framework Convention on Climate Change (UNFCCC) – The international environmental treaty and UN secretariat tasked with stabilizing atmospheric greenhouse gas concentrations.

Abstract

The Clean Development Mechanism (CDM) of the Kyoto Protocol offers developing countries the opportunity to participate in the effort to reduce global greenhouse gas levels while also benefitting from sustainable development opportunities. To date, the majority of CDM investments have gone to emerging markets such as China, India, Brazil, and Mexico, while least developed countries have largely been absent from the program.

Comparing host country variables to CDM activity finds that human capital and greenhouse gas emission levels are important determinants of which countries have hosted projects and the amount of certified emission reductions (CER) created. Countries that offered growing markets for CDM co-products such as electricity were more likely to be CDM hosts, while economies with higher carbon intensity levels had greater CER production. All of these findings work against least developed countries and help to explain the lack of CDM activity in these settings.

Meanwhile, case study results of potential CDM projects in a least developed country, Niger, demonstrate that the most common variety of CDM project, renewable energy efforts, do not produce enough emission reductions to justify the CDM registration costs. Forestry projects that sequester carbon offer the best combination in terms of financial returns and the dual goals of the CDM. Unfortunately, a ban on forestry-related emission reductions in the European Union Emissions Trading System has significantly reduced the demand for these types of projects. Policy modifications such as simplified methodologies to reduce registration costs and project bundling to increase CER production would improve the chances for least developed countries to host projects.

Through stakeholder interviews, a two-tiered framework of mitigative capacity is applied to Niger to identify impediments to CDM implementation. The framework is also used to analyze a proposed CDM project that is approaching registration. The insights drawn from these applications help to identify successful strategies for navigating through impediments in this setting including targeted capacity building and assistance from outside actors, support for an initial suite of projects, and funding data needs for project registration. These strategies can serve as a roadmap for future efforts in Niger and other least developed countries.

1 Chapter

Introduction

1.1 Introduction

The Earth is warming and a vast majority of world climate scientists agree that society's burning of fossil fuels, deforestation, and other human-induced trends are the primary causes for the warming (IPCC, 2007). As the world's population, development level, and energy consumption continue to grow, so too will atmospheric greenhouse gas (GHG) concentrations, leading to higher average global temperatures and more disruptive changes in climate patterns and lifestyles around the world. Among the cruel realities of climate change is that those nations and peoples with the fewest resources to deal with climate impacts are expected to face the most severe changes in living conditions (Adger et al, 2006). From the poor in sub-Saharan Africa to vulnerable populations in coastal Bangladesh, climate change threatens to destabilize regions that already struggle with famine, disease, and conflict. To improve the prospects for successful adaptation to changes, policies to mitigate climate change through reduced greenhouse gas emissions are also needed. In concrete terms, this requires commitments by nations around the world to limit emissions. This dissertation examines how least developed countries can play a greater role in climate mitigation activities while also receiving sustainable development benefits through the Kyoto Protocol's Clean Development Mechanism (CDM).

The United Nations Framework Convention on Climate Change's (UNFCCC) Kyoto Protocol is the dominant global framework for addressing anthropogenic climate change due to greenhouse gas emissions. As of August 1, 2009, 187 countries and the European Community have ratified the Kyoto Protocol, committing themselves and their people to the goal of mitigating the impacts of climate change (UNFCCC, 2009b). From the beginning, the negotiations over mitigating climate change through reduced GHG emissions have differentiated the responsibilities of the various parties to the Kyoto Protocol. Article 3 of the United Nations Framework Convention on Climate Change states that parties have "common but differentiated responsibilities" to take action in combating the impacts of greenhouse gas emissions (United Nations, 1992). The Framework acknowledges that developed countries achieved their development levels through the large-scale combustion of fossil fuels. While all parties must play a role in meeting emission reduction goals, those parties that have done the least to create the problem should not be penalized for the past deeds of others. As members to the agreement, developed countries, also known as Annex I parties, agree to reduce emissions by a specific amount by 2012. Developing nations or non-Annex I parties are not required to meet emission reduction targets (UNFCCC, 1998).[1]

In order to reduce the compliance cost for Annex I parties, the Kyoto Protocol includes three flexibility mechanisms: Emissions Trading, Joint Implementation, and the Clean Development Mechanism. These policy avenues take advantage of different greenhouse gas abatement options across parties, theoretically resulting in a least-cost approach that Nordhaus and Boyer termed "where efficiency" in climate change

[1] For a list of Annex I and non-Annex I parties, see <http://unfccc.int/parties_and_observers/items/2704.php>.

mitigation (2000, Pg. 122). Of the flexibility mechanisms, only the CDM opens the Kyoto Protocol to mitigation efforts in developing countries, allowing these parties to host projects that result in verifiable emission reductions. Greenhouse gases addressed by the CDM include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), perfluorocarbons (PFC), hydrofluorocarbons (HFC), and sulfur hexafluoride (SF_6) (UNFCCC, 2009a). Project activities include efforts in energy-related areas such as renewable energy, energy efficiency, and fuel switching to less carbon-intensive fuels. Outside of energy industries, projects that promote carbon sequestration through reforestation, reduce methane emissions from agriculture, waste management, and mining industries, and efforts that destroy industrial gases such as SF_6, HFCs, PFCs, and N_2O are also allowed (UNFCCC, 2009a, See Appendix A in Section 1.5 for a breakdown of projects by activity type and size). In return for hosting projects, developing countries are to receive sustainable development benefits from the activities.

As of October 1, 2009, over 1800 projects have been registered with the CDM Executive Board representing emissions reductions of approximately 319 million metric tons of CO_2 per year (UNFCCC, 2009a).[2] The Marrakech Accords stressed "the need to promote equitable geographic distribution of clean development mechanism project activities at regional and subregional levels" (UNFCCC, 2002, Addendum Pg. 20). Despite this call for equity, emerging markets have dominated the CDM while least developed countries (LDC), particularly those in sub-Saharan Africa, have largely been

[2] For comparison sake, the GHG emissions for all eligible CDM host countries in 2005 totaled 17.7 billion metric tons of CO_2 equivalents, making the reductions from CDM projects approximately 1.8% of total emissions (World Resources Institute, 2009).

absent.[3] Four nations (China, India, Brazil, and Mexico) account for approximately 75% of registered projects and 80% of emission reductions, while sub-Saharan Africa has hosted approximately 2% of both (UNFCCC, 2009a). Clearly, the current situation does not meet the call for an "equitable geographic distribution" of CDM projects.

Part of the unequal distribution problem stems from a one-size-fits-all approach to regulating the CDM. China and India are very different from least developed countries in Africa, and a regulatory model that works in one setting is unlikely to work in the other. The CDM was designed to accommodate the highest emitting countries, as one would expect given the goal to reduce global GHG emissions. However, least developed countries should not be left out of the technology transfer and sustainable development benefits offered through the CDM. In order to understand the differential distribution of CDM projects across host countries, one must first look at the economic rationale for participating in the program and the rules that govern its operation.

1.2 Where Efficiency: Abatement Costs under the CDM

All three flexibility mechanisms of the Kyoto Protocol aim to reduce costs in climate mitigation by taking advantage of different abatement options across countries. Figure 1.1 demonstrates the economic rationale behind this approach using a hypothetical example.

[3] Throughout the dissertation, the classification of countries by development level is based upon the United Nations' 2009 Human Development Index. For a description of the Index's methodology and country rankings, see <http://hdr.undp.org/en/media/HDR_2009_EN_Complete.pdf>.

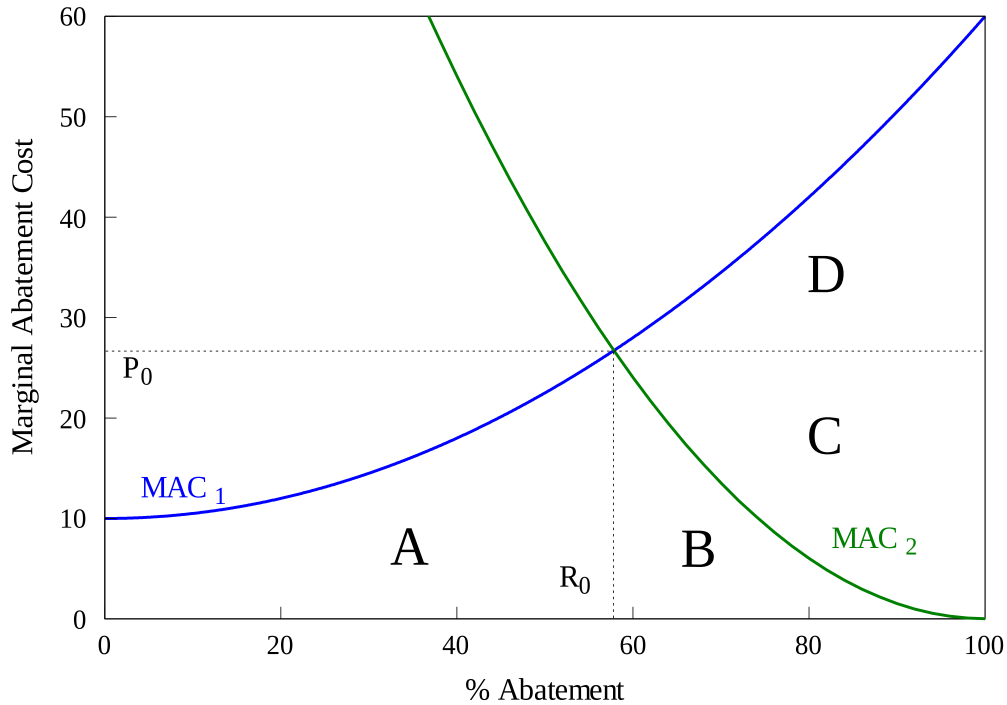

Figure 1.1: Economic Rationale for CDM

Curve MAC_1 represents the marginal abatement costs required to meet reduction targets in the Annex I or developed country. As the country undertakes emission reduction opportunities, it will do so by taking advantage of the least cost options first. As the country approaches 100% of its reduction commitments, the cost of these opportunities will continue to rise. Eventually, if the Annex I country makes all of the required reductions within its borders, the final cost will be the areas represented by sections A, B, C and D. Meanwhile, a developing country may have abatement opportunities represented by curve MAC_2, in this case moving from low-cost options on the right to higher-cost options on the left. With the CDM, Annex I parties are able to count projects that take advantage of the abatement opportunities in the developing country in meeting their reduction targets (represented above by curve MAC_2 to the right of R_0). This gives a total abatement cost of areas A and B and in this hypothetical example results in a ratio in abatement activities of roughly 60/40 between the Annex I and non-Annex I parties. Area D represents a surplus to the parties in the Annex I country required to meet reduction targets. Area C represents a surplus that will be split between parties in the two countries, with the ratio of the split depending upon the funding mechanism used for the project (described below). The price for emission reductions created by the projects is represented by the dashed line P_0.

Unlike emissions trading, where regulated entities are issued emission permits and then allowed to trade any that are not used, project-based mitigation programs such as the CDM require much greater oversight to ensure that real and verifiable emission reductions occur. The CDM Executive Board has identified the following five areas of concern (UNFCCC 2009a):

1) Baseline – What level of emissions would occur without the project?
2) Additionality – Would the project have occurred without CDM funding?
3) Redundancy – Are the projects already mandated by other laws or regulations?
4) Permanence – Will the emissions reductions continue into the future?
5) Leakage – Does the project create higher emissions levels outside its boundary?

In order to protect against these potential problems, the CDM Executive Board has instituted a lengthy registration and verification process for all proposed projects (UNFCCC, 2002). The process for developing, registering, and implementing CDM projects is described below and represented in Figure 1.2.

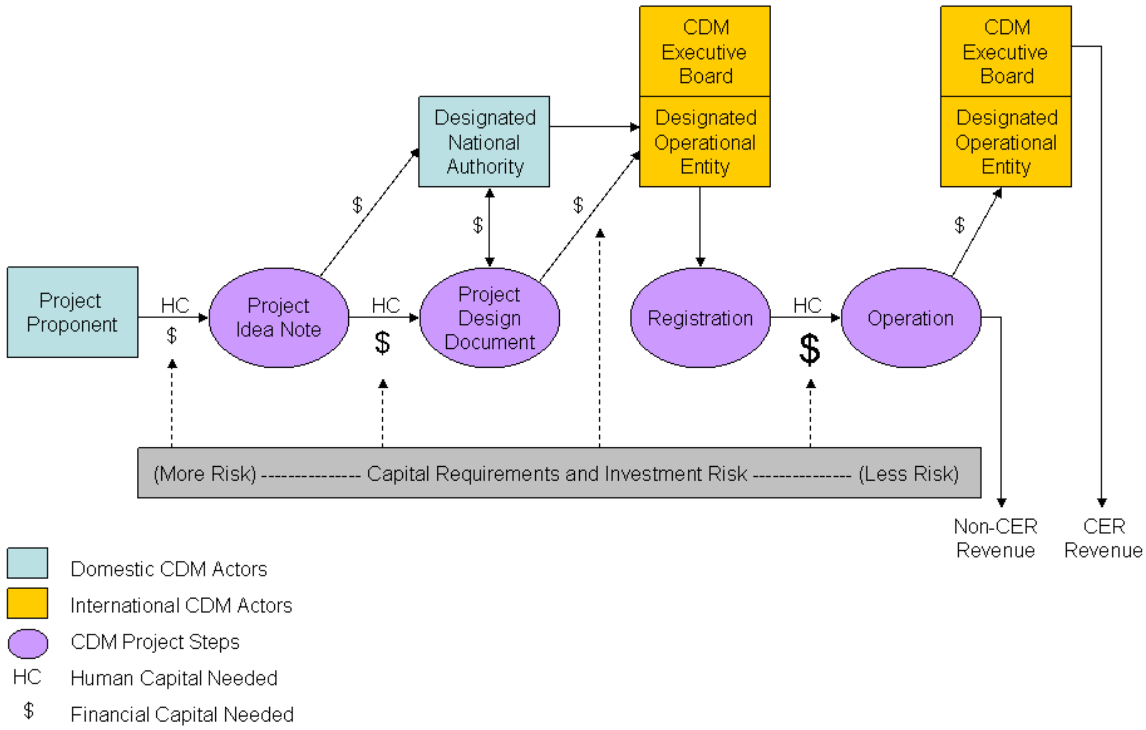

Figure 1.2: CDM Project Cycle

The registration cycle begins with a project proponent that has an idea for a CDM project. While the proponent may include some outside actors or support, domestic actors within the host country must be involved in the process. Although not required by the CDM Executive Board, many host countries require as a first step that a project developer create a Project Idea Note (PIN) that summarizes the proposed activity. This note is generally five to ten pages long and includes information related to the type, size, and location of the project, estimated emission reductions created, financing information, and expected sustainable development benefits. The PIN is submitted to the Designated National Authority (DNA) of the host country government, an agency created by the government to oversee CDM activities and one of the required steps for potential host countries to participate in the CDM. Once the PIN receives DNA approval, the project proponent is required by the CDM Executive Committee to create a longer Project Design Document (PDD) that describes the proposed project activities in much greater detail. In addition, the PDD must utilize methodologies approved by the CDM Executive Board at the United Nations to calculate the project impacts in terms of greenhouse gas emission reductions. The methodologies include calculating the pre-project baseline and activity monitoring plans, taking into account any leakage from the project, and proving the additionality of the activity. Other necessary sections for the PDD include stakeholder input from the host country, potential sustainable development impacts, and an environmental impact statement.

After receiving approval once again from the host country DNA, the document is submitted to the CDM Executive Board for registration. At this point, an independent third-party called a Designated Operational Entity (DOE) must validate that the methodologies have been correctly applied. If no pre-existing methodologies are available for the project activities, the DOE must first submit a new methodology for approval by the Executive Board before it can be applied to a new project. Upon validation, the project is registered and can begin operation as a CDM project. The final step in the process involves a second DOE that must review the project activities once it is underway and certify that the proposed level of emission reductions created are actually occurring. The CDM Executive Board then issues Certified Emission Reductions (CER) to the project proponents that can be sold on the carbon market or can be used to meet emission reduction requirements.

All of the steps in the registration process incur costs for project developers in addition to the normal construction, operation, and maintenance costs for any type of project. These costs are incurred before any revenue, either through the creation and sale of CERs or non-carbon co-products of CDM efforts such as electricity or natural gas can be expected. Project developers must procure financing to support all of the up-front costs incurred in project development. In addition to the large financial capital needed, several different forms of human capital (HC) are required throughout the process. Navigating the CDM registration process requires expertise in emissions accounting in addition to the technical expertise needed to build and operate the project. Finally, each project is developed within the context of a particular developing country whose characteristics, from geography and infrastructure to bureaucratic structure, present unique challenges to project success. At a minimum, project developers must work through or with the host country government in the form of the Designated National Authority to register a CDM project. Depending upon the project type, several other government actors or agencies may also be involved. Overall, the process is complex, expensive, and presents a number of risks to project proponents.

In general, the risks associated with CDM projects fall into three categories: Host Country Risk, Project Risk, and CDM Risks (Cosbey et al, 2006). Host country risk refers to the potential that political instability in the host country could impede project operation and decrease emission reductions. Project risk develops if the implemented project does not perform as designed and creates fewer emission reductions than expected. CDM risk involves several aspects related to the registration, monitoring, and carbon oversight of the CDM. Several authors have highlighted different aspects of the CDM process that could negatively impact the success of projects including failure to register the project with the Executive Board (Lecocq and Ambrosi, 2007), fluctuations in the price received by project developers for CERs (Jahn et al, 2004), and incorrectly applying baseline methodologies so as to over-estimate the quantity of CER production for projects (Jahn et al, 2004; Matsuhashi et al, 2004).

This typology of risks maps closely onto the risk categories for infrastructure investments in developing countries described by Ramamurti and Doh (2004). As many of the projects funded through the CDM qualify as infrastructure projects (renewable energy efforts in particular), the congruence is not a surprise. The authors note that investments in developing countries are hindered by political instability and weak institutions often found in these settings. Additionally, infrastructure sectors tend to be characterized as natural monopolies and produce non-tradable outputs, factors which both reduce competition and require higher levels of government regulation. With politically salient outputs such as electricity, government intervention in a manner that suits domestic clients over foreign investors becomes more likely. Finally, high capital intensity coupled with investment assets that tend to be immobile and specific to particular tasks and settings result in little flexibility for investors. Adapting their typology to the CDM yields Figure 1.3 below.

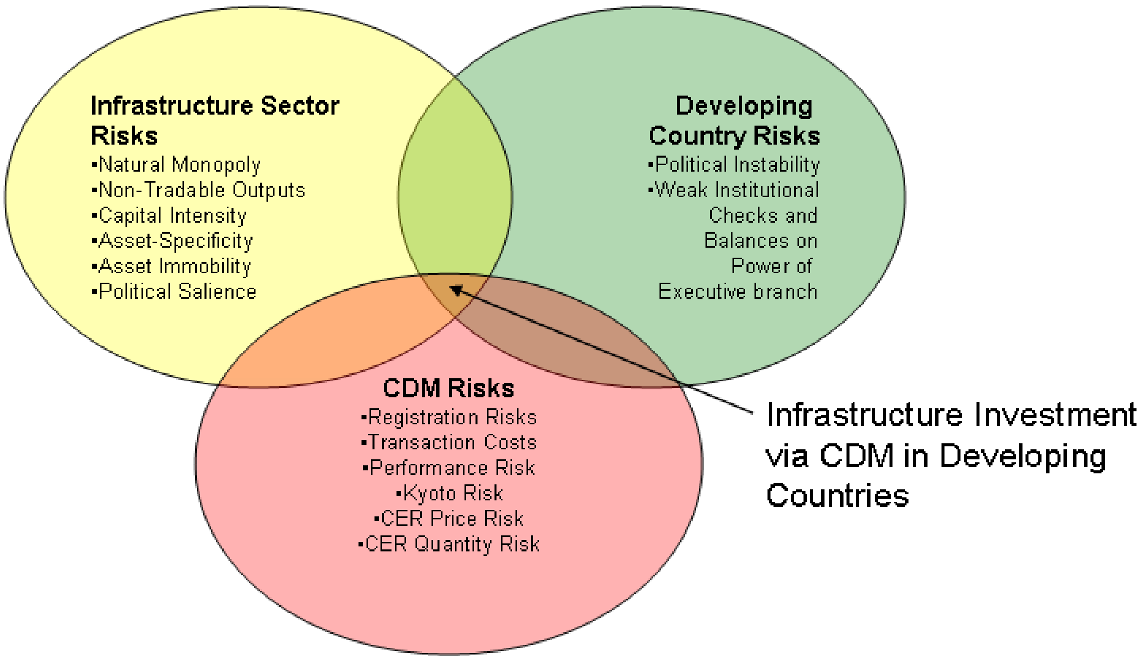

Figure 1.3: Funding Infrastructure Projects via CDM (Adapted from Ramamurti and Doh, 2004, Pg. 156)

Investors in CDM projects must therefore deal with the overlap of these three sets of risks. In order to mitigate this combination of risks, three different project financing models have developed for supporting CDM projects: Foreign Direct Investment (FDI), Emissions Reduction Purchase Agreements (ERPA), and Unilateral CDM (Cosbey et al, 2006, Dechezleprêtre et al, 2008, Niederberger and Saner, 2005). The primary differences between the funding mechanisms are the distribution of risk between financers and project developers and the timing of financing in the CDM project cycle. Originally expected to be the primary pathway for CDM funding, foreign direct investment occurs when an Annex I entity is directly involved in project development, often through a subsidiary. Over time, a number of carbon finance companies have entered the market and serve as intermediaries between Annex I parties needing to meet emission reduction targets and CDM project developers in non-Annex I countries. The intermediaries offer financing to project developers in return for the rights to sell the CERs generated on the carbon market. In general, financing offered earlier in the process when risks are greatest comes at a lower price for the financing unit whereas financing offered closer to CER delivery nets the project developer a higher return. At the extreme, project developers that undertake unilateral project implementation without outside financing are free to sell the CERs they produce on the open market and receive the market clearing price (Jahn et al, 2004). Ultimately, the price received by CDM project developers for the emission reductions that they create is based upon the timing at which they receive financing, the experience of the project developers, and the novelty of the technologies employed (Capoor and Ambrosi, 2008). Inexperienced project developers using untested technologies and requiring financing early in the project cycle will receive the lowest price while experienced developers with tested technologies that are able to self-finance or receive financing late in the cycle will receive the highest carbon prices.

The timing of CDM financing shifts the burden of risk between the project developer and finance provider but also shifts the share of the surplus generated by trade represented by area C in Figure 1.1 above. If project developers undertake the project unilaterally and capture all of the gains from selling CERs on the carbon market, they will receive the market clearing price for carbon (P_0) for their effort and all of area C. On the other hand, if the project is done through foreign direct investment in the host country, the outside investor will likely own the project through a subsidiary and the surplus represented by area C will similarly be theirs. Financing through an Emission Reduction Permit Agreement will split area C between the project developer and CER buyer with greater benefit going to the project developer the later in the process that they receive funding.

Transaction costs to register and operate in the CDM increase the abatement costs for efforts in non-Annex I parties. While the transaction costs are largely an up-front and fixed cost, the project developers will average the payback of transaction costs across the number of CERs created. Although smaller projects are given some breaks in terms of registration and monitoring requirements, the practical difference is not great. The CDM therefore exhibits economies of scale in terms of average costs. Figure 1.4 demonstrates the impacts of transaction costs over time. Project developers and host countries are likely to experience higher transaction costs initially as they become familiar with the procedures of the CDM. As more projects are implemented, these costs will drop to a long-term minimum level. At the same time, assuming that project developers will take advantage of the lowest abatement cost options first, then the marginal abatement costs will rise over time. Combining these two sets of costs gives an aggregate marginal cost per CER created that drops initially and then begins to rise over time as demonstrated in Figure 1.4.

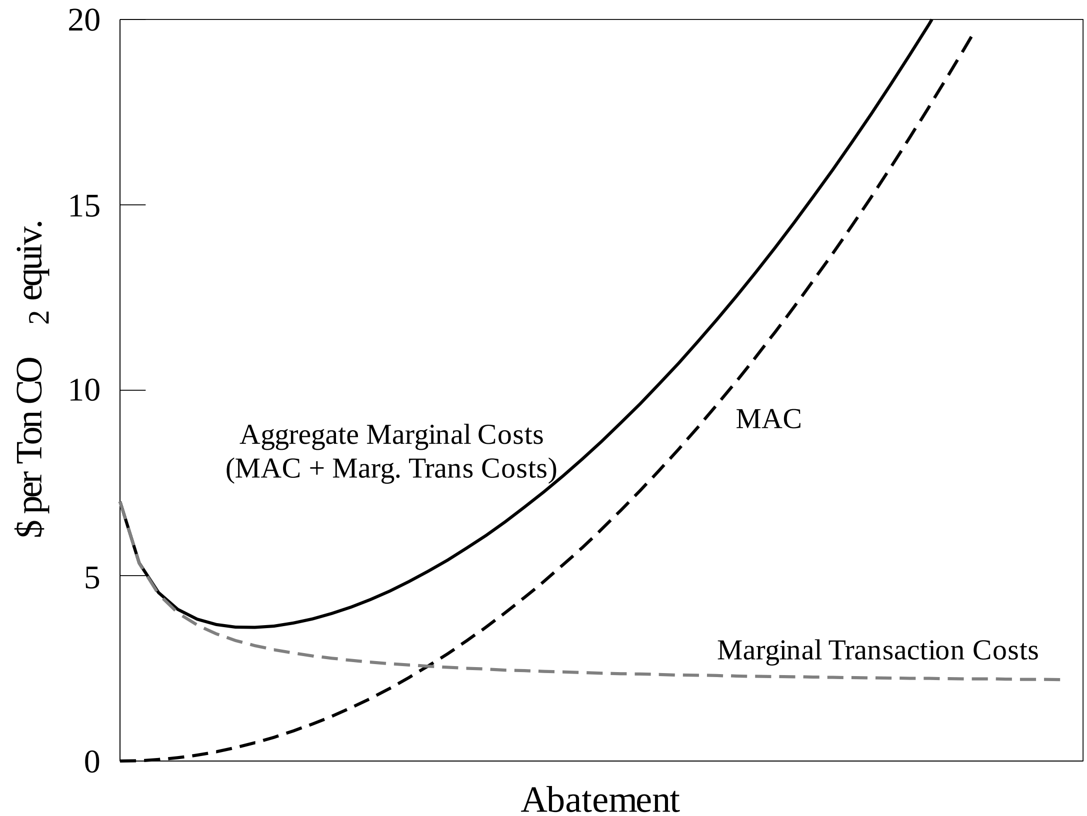

Figure 1.4: Transaction Cost Impacts – Aggregate Marginal Costs

As registration and monitoring costs for the CDM increase, it is possible that the extra expense to operate in the CDM will negate the expected benefit in terms of reduced abatement costs available in non-Annex I countries. If an Annex I entity must pay $10 per CER to register and monitor a CDM project but only saves $8 per CER in reduced abatement costs, the project developer is unlikely to invest in such a project. Similarly, if a project developer in a non-Annex I country will only receive $8 per CER created when the registration and monitoring costs average $10 per CER, they are unlikely to unilaterally develop such a project. Prior to the enactment of the CDM, it was unclear if the savings in abatement costs from projects would be large enough to merit the transaction costs incurred (Harvey and Bush, 1997; Karp, 2004). Given the activity to date in countries such as China, India, Mexico, and Brazil, this has clearly not been the case. However, such a situation may explain the lack of CDM activity in least developed settings.

Returning to the original economic rationale of the CDM, Figure 1.5 demonstrates how CDM transaction costs impact the distribution and cost of abatement activities.

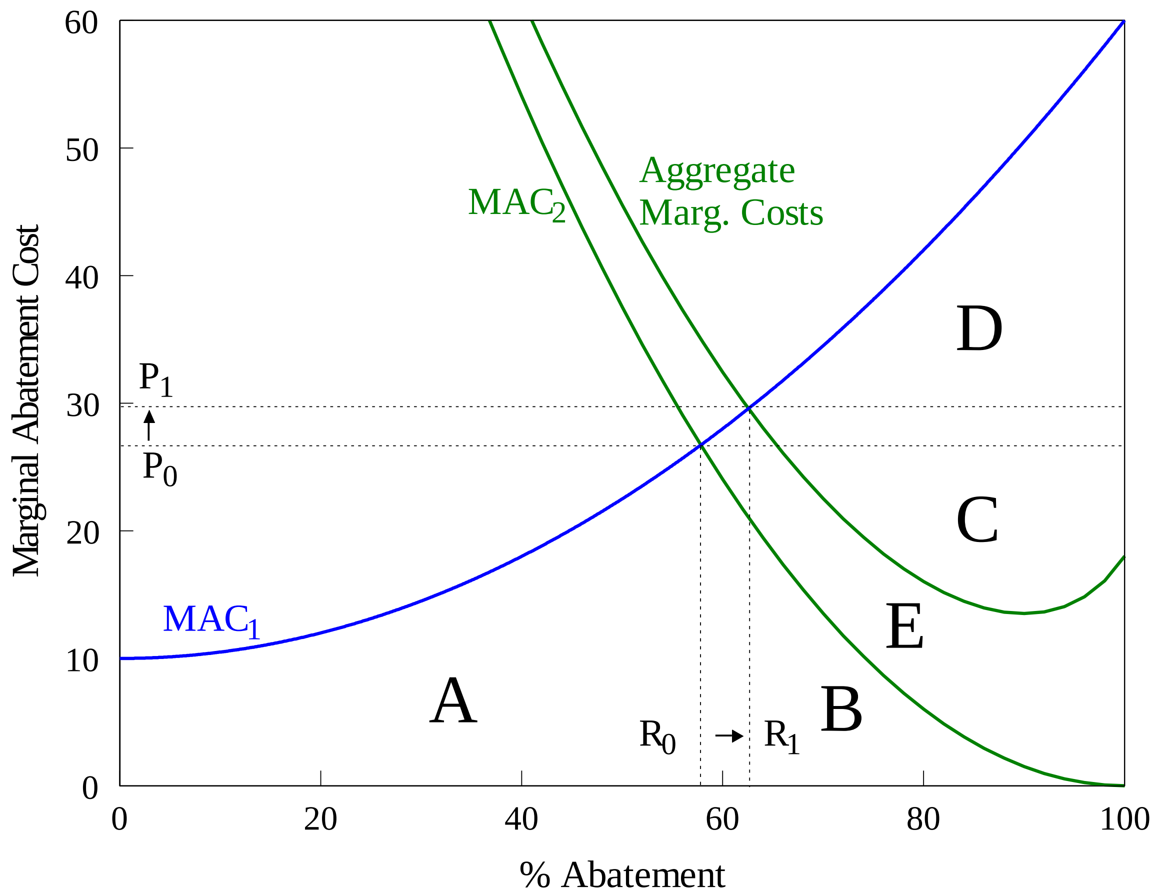

Figure 1.5: Transaction Cost Impacts – Abatement Distribution

The impact of transaction costs for registering and monitoring CDM projects is to increase the overall abatement cost and shift more of the abatement to Annex I parties (moving from R_0 to R_1). The additional abatement cost due to CDM transaction costs is represented by area E and the price of carbon increases from P_0 to P_1. In addition, the surpluses from trade have decreased, with areas D and C both shrinking by the total amount of area E. One can imagine that settings with higher marginal abatement costs and transaction costs for CDM projects would continue to shrink the gains from trade and would eventually make the CDM an unattractive option for Annex I parties. Given this framework, the question becomes how do least developed countries differ from emerging market economies such as China and India in ways that help to explain the lack of CDM activity in least developed settings? Once we know the root causes of this differential distribution, can changes be made to the CDM to help ameliorate the problem? This dissertation aims to shed light on these questions.

1.3 CDM Distribution and Research Questions

While the CDM has attracted much attention in the literature, few of the works have analyzed the factors affecting the differential distribution of projects across host countries. Instead, researchers have focused on reviews of CDM project activities and trends, theoretical predictions of factors affecting project distribution, case studies focusing on particular countries or projects, and analyses of the technology transfer and development impacts of CDM projects. The World Bank publishes an annual review of activity in the carbon market that includes a breakdown of CDM project buyers, host countries, and project types (the most recent being Capoor and Ambrosi, 2009). Other reports focus on the market potential for CDM projects, noting the dominance of China, Latin America, and other emerging markets (Haites, 2004; Halsnaes, 2002). While these reports document the lack of CDM projects in least developed countries, they offer little in the way of explanations or potential solutions. When researchers do offer explanations, the rationale is based upon theory without testing the hypothesized determinants with empirical data (Cosbey et al, 2006; Lecocq and Ambrosi, 2007). Additionally, some researchers conduct case studies of projects or host countries that document the impediments to CDM implementation in particular settings without generalizing to larger distributional issues (Kim, 2003; Krey, 2005; Zhang, 2006). Finally, while one of the two requirements of the CDM is to improve development levels in host countries, many researchers have discussed the lack of development impacts from projects (Boyd et al, 2007; Brown et al, 2004; Cosbey et al, 2006; Olsen and Fenhann, 2008) and technology transfer possibilities (Dechezleprêtre et al, 2009; Seres et al, 2009; van der Gaast et al, 2009). While successful host countries may not be receiving sustainable development benefits from CDM projects to the extent that was envisioned at the program's inception, countries that are left out of the CDM are not benefitting at all.

Three efforts that have attempted to rank host country attractiveness for CDM projects include the web service Point Carbon (2009), and publications by Jung (2006) and Oleschak and Springer (2007). From a theoretical stand point, the three approaches are problematic in a number of ways. First, they use samples that exclude many countries eligible to host projects and include many that are ineligible. In addition, all three use the two required steps needed to host projects, Kyoto ratification and establishing a host country Designated National Authority, as variables in the attractiveness of host countries when the absence of either makes a country completely unattractive. Finally, rather than using the historical success of countries in hosting projects as the dependent variable in the analysis, the three efforts use CDM experience as an explanatory variable.

The analysis described in Chapter 2 differs from these past efforts by attempting to explain the historical distribution of CDM projects and emission reductions using various independent variables. As a sample set, I use only those countries that have ratified the Kyoto Protocol and established their DNA. I conduct two regression efforts: one with a binary dependent variable for CDM involvement and a second regression using the number of certified emission reductions created. To guide explanatory variable selection, I use a model based upon the net revenue created by CDM projects. While project level data is not available for the analysis, the insights from the net revenue model are useful in identifying country-level characteristics that could impact project revenues. Ultimately, it is these country-level measures that are used to explain CDM involvement.

The regression analysis is then augmented by research on a particular least developed country, Niger, to give the broad findings some local context. Much of the attention from researchers investigating the CDM has focused on the countries that have been most active in the program. Tasks such as investigating impediments to project implementation, assessing sustainable development benefits, and estimating project leakage are most easily achieved in countries that have hosted many projects. This means that countries such as China (Zhang, 2006), India (Krey, 2005), and even a relatively active African country such as South Africa (Kim, 2003) receive the bulk of the attention. In order to investigate project opportunities in a least developed country, one must find non-CDM projects that could qualify for the CDM but have not taken the steps to register with the program. Chapter 3 of the dissertation does just that. I develop a three step framework for CDM project success based upon project availability, profitability, and meeting the dual goals of the CDM. This framework is then applied to a particular LDC, Niger, through six case studies. Viewed through the three step framework, case study findings related to the greenhouse gas reductions, sustainable development benefits, and financial balance sheets of the projects demonstrate the reasons why CDM projects may have a difficult time being successful in least developed countries.

Finally, the idea of mitigative capacity, borrowed from the climate change adaptation literature, highlights characteristics that may play a role in promoting or preventing a party from pursuing activities that result in reduced greenhouse gas emissions. Yohe (2001) first proposed this concept and posited that mitigative capacity is the "mirror image" of the well-established idea of adaptive capacity to climate impacts with many of the same determinants (Pg. 247). Refining the definition, Winkler et al. (2007) propose that mitigative capacity is "a country's ability to reduce anthropogenic greenhouse gas emissions or enhance natural sinks" with "ability" in this area being the "skills, competencies, fitness, and proficiencies that a country has attained which can contribute to GHG emissions mitigation" (Pg. 692). The authors propose a suite of characteristics that play a role in determining mitigative capacity in the areas of economics, institutions, and technology (Pg. 695 to 700).

As proposed by Winkler et al., the principle of mitigative capacity has only been applied to the capacity for general mitigation activities without particular reference to specific programs such as the Clean Development Mechanism. Chapter 4 bridges this gap by combining the determinants of mitigative capacity with the idea of a two-tiered approach to capacity building that also comes from the adaptation literature (Tompkins et al, 2008). The resulting framework is applied to Niger in the hopes of identifying impediments to CDM implementation in this particular least developed country.

1.4 Dissertation Goals and Structure

The goals for this dissertation are to investigate the causes for the differential distribution of Clean Development Mechanism projects across host countries. Beginning at the global level, Chapter 2 develops a model for the net revenue production of CDM projects in order to identify country characteristics that may play a role in host country attractiveness. These characteristics are tested through regression analysis that compares the country-level variables with the presence of CDM projects in eligible host countries as well as the amount of CER production for successful hosts.

Moving from the global to the national level, Chapters 3 and 4 investigate a particular least developed country, Niger, for evidence of impediments to CDM investments and the appropriateness of the current regulatory structure for this setting. By focusing on a particular LDC, these chapters attempt to give context to the global findings of Chapter 2. While one cannot necessarily generalize the findings from a particular country to all least developed countries or all of Africa, evidence drawn from individual settings creates a fuller picture of potential reforms to the program that could help accommodate least developed countries. Chapter 3 investigates whether or not CDM projects can meet their dual goals in an LDC like Niger while also providing positive financial returns to the investors. The chapter introduces a three step framework for CDM success based upon project availability, profitability, and meeting the dual goals of the program. Viewed through the framework, the environmental and economic impacts of a number of case studies in Niger help to assess whether or not CDM projects of similar types could be successful in this setting. The analysis estimates greenhouse gas impacts, sustainable development benefits, and the internal rate of return for the case studies. These findings are augmented by stakeholder interviews presented in Chapter 4. The chapter introduces a two-tiered framework for assessing mitigative capacity for CDM projects within developing countries. The framework is then applied to Niger through the stakeholder interviews to identify areas in which the country lacks key ingredients for CDM success. A potential project that is progressing through the registration process in Niger is also viewed through the lens of the framework to shed light on strategies that could help other efforts both in Niger and other least developed countries. The dissertation closes with Chapter 5 which discusses the results of the analyses and presents several policy recommendations to promote greater involvement of least developed countries in the Clean Development Mechanism.

1.5 Appendix A - Registered Project Classification and Statistics

Project Classification

CDM Projects are classified under the following 15 project types, with many projects fitting multiple categories (UNFCCC, 2009a):

1) Energy Industries
2) Energy Distribution
3) Energy Demand
4) Manufacturing Industries
5) Chemical Industries
6) Construction
7) Transport
8) Mining/Mineral Production
9) Metal Production
10) Fugitive Emissions from Fuel
11) Fugitive Emissions from production and consumption of halocarbons and SF_6
12) Solvent Use
13) Waste Handling and Disposal
14) Afforestation and Reforestation
15) Agriculture

Projects are further classified as small or large in size and can be implemented unilaterally by the host country or with outside assistance. Table 1.1 lists the number of projects and CER production by size and by project type.

Table 1.1: CDM Projects by Size and Project Type (UNFCCC, 2009a)

Project Types	Number of Projects	Percent Total	CER Production (Mt CO_2 per year)	Avg. CER Per Project
Large	1017	55.4%	296,591,328	291,634
Small	818	44.6%	22,351,486	27,325
1	1163	63.4%	121,721,648	104,662
2	0	0.0%	0	0
3	15	0.8%	723,847	48,256
4	76	4.1%	5,693,862	74,919
5	56	3.1%	45,490,604	812,332
6	0	0.0%	0	0
7	2	0.1%	287,723	143,862
8	0	0.0%	0	0
9	2	0.1%	121,559	60,780
10	6	0.3%	7,744,293	1,290,716
11	19	1.0%	81,257,444	4,276,708
12	0	0.0%	0	0
13	157	8.6%	23,296,582	148,386
14	8	0.4%	288,518	36,065
15	17	0.9%	352,361	20,727
Multiple	314	17.1%	31,964,373	101,797
Total	1835		318,942,814	

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2 Chapter

Explaining the Differential Distribution of Clean Development Mechanism Projects across Host Countries

Abstract

The Clean Development Mechanism (CDM) of the Kyoto Protocol represents an opportunity to involve all developing countries in the effort to reduce greenhouse gas emissions while also promoting sustainable development. To date, however, the majority of CDM projects have gone to emerging markets such as China, India, Brazil, and Mexico, while very few least developed countries have hosted projects. This chapter investigates the differential distribution of CDM activities across countries. I develop a conceptual model for project profitability, which helps to identify potential country-level determinants of CDM activity. These potential determinants are employed as explanatory variables in regression analysis to explain the actual distribution of projects. Human capital and greenhouse gas emission levels influenced which countries have hosted projects and the amount of certified emission reductions (CER) created. Countries that offered growing markets for CDM co-products, such as electricity, were more likely to be CDM hosts, while economies with higher carbon intensity levels had greater CER production. These findings work against the least developed countries and help to explain their lack of CDM activity.

2.1 Introduction

Nations, states, and intergovernmental organizations have begun to implement legislation aimed at reducing greenhouse gas (GHG) emissions, the primary cause of anthropogenic climate change. To date, the Kyoto Protocol is the dominant framework for regulating global GHG emissions. The Protocol divides participating countries into Annex I and non-Annex I parties, corresponding to developed and developing nations. While developing countries are not restricted in their GHG emissions, developed countries have until 2012 to meet emissions reduction goals (UNFCCC, 1998).

In order to lower the compliance costs for Annex I countries, the Kyoto Protocol includes three flexibility mechanisms: emissions trading, Joint Implementation, and the Clean Development Mechanism (CDM). Of these, only the CDM broadens the activity of the Protocol to include non-Annex I countries. Article 12 of the Protocol establishes the CDM and states its dual goals "to assist Parties not included in Annex I in achieving sustainable development and in contributing to the ultimate objective of the Convention, and to assist Parties included in Annex I in achieving compliance with their quantified emission limitation and reduction commitments" (UNFCCC, 1998). In other words, CDM projects will create GHG emission reductions to offset emissions in developed countries while also contributing to the sustainable development goals of developing countries.

As of August 1, 2009, 187 countries and the European Community have accepted or ratified the Kyoto Protocol. Of these, 148 are non-Annex I countries, thereby making them eligible to host CDM projects (UNFCCC, 2009c). Yet, through October 1, 2009, only 58 have done so (UNFCCC, 2009a). In general, these host countries are on the upper-end of the development spectrum. Four countries dominate, with Mexico, China, India, and Brazil accounting for over 75% of the registered projects. Meanwhile, all of sub-Saharan Africa has hosted less than 2% of all projects, and only one least developed country (LDC), Côte d`Ivoire, has hosted a project (UNFCCC, 2009a). As Cosbey et al (2006) demonstrate, even when one weights the distribution to account for differences in population size and economic activity, least developed countries remain under-represented in the CDM.

Many observers would consider the lack of CDM projects in LDCs to be a minor problem in the context of the CDM's overall success at reducing GHG emissions. The rationale of the mechanism, after all, is to include developing countries in the effort to reduce emissions without requiring them to meet hard targets. Of all the non-Annex I countries, it is important to first engage the highest emitters before moving to less GHG-intensive economies. The active CDM involvement of China, India, Brazil, and Mexico has largely accomplished this mission (though even for these countries problems such as the lack of CDM activity in combating deforestation remain). Yet, as the dual goals state, the Clean Development Mechanism is not simply about emission reductions but about promoting sustainable development as well. It is in regards to the latter goal and an eye towards equitable development among developing countries that the lack of CDM activity in least developed countries becomes a concern. The CDM ultimately should work in all development settings, not exclusively in emerging markets.

The goals of this chapter are to identify the determinants of CDM activity across developing countries and to highlight host country characteristics that explain the disparity in activity. I estimate a probit regression model to assess the determinants of project hosting across the eligible countries, i.e., what explains whether an eligible country has hosted one or more CDM projects? I next estimate a truncated regression model to assess the determinants of certified emission reduction (CER) creation, i.e., what explains country-level CER production across the 58 host countries?[4] Ultimately, the analysis aims to shed light on the barriers to CDM activity in least developed countries and to assist in improving the prospects for these countries in the future.

The chapter is organized as follows. Section 2.2 discusses the geographic distribution of projects to date and reviews the literature on the CDM and similar investments in developing countries. Section 2.3 develops a net revenue model to describe CDM project investment and uses this model to identify potential explanatory variables for the differential distribution of projects across host countries. Section 2.4 reports on the regression analysis. Section 2.5 provides an extended discussion of the empirical results and how they help to explain the lack of CDM projects in least developed countries. Section 2.6 offers concluding remarks.

2.2 Background

2.2.1 Differential Distribution of Projects

Eligibility to host a CDM project requires that developing countries first ratify the Kyoto Protocol and establish a Designated National Authority (DNA) within the country to manage and supervise the CDM registration process. As of September 1, 2009, 115 countries have taken these two steps and are eligible CDM hosts. An additional 33 countries have ratified the Protocol but have not yet established their DNA (UNFCCC, 2009b). These countries – which tend to be Small Island Developing States (SIDS),

[4] For a description of probit models, see Wooldridge, 2003. For the truncated regression, see Greene, 2000.

Organization of Petroleum Exporting Countries (OPEC) members, or have recently experienced conflict – have taken the relatively easy step of signing the Protocol without making the investments needed to establish their DNA.

As of October 1, 2009, the total number of registered CDM projects was 1835, representing emission reductions of approximately 319 million metric tons of CO_2 equivalent per year (UNFCCC, 2009a). Of the 115 eligible host countries, 58 have succeeded in developing and registering CDM projects. From a regional perspective, Latin America and Asia have been most successful, while sub-Saharan Africa has been least involved (see Table 2.1 below). Every eligible country in Latin America has hosted a CDM project, as has every eligible country in Asia except for the weak states of Myanmar and North Korea. The six countries in the Middle East and North Africa (MENA) without a project include four OPEC members (Algeria, Iran, Kuwait, and Saudi Arabia), a frequent conflict zone (Lebanon), and a weak state (Yemen). The eight host countries among the SIDS tend to be bigger islands or countries with higher elevations (Cuba, the Dominican Republic, Guyana, Jamaica, and Papua New Guinea), and thus are less susceptible to rising sea levels, though they will still face other climate impacts. The eight countries in Central Asia without a project are landlocked or have experienced conflict as parts of the former Yugoslavia. Finally, five of the six countries in sub-Saharan Africa to host CDM projects have coastlines, with Uganda being the only successful landlocked country.

One way to measure the success of a particular host country or region in attracting CDM investments is by calculating an offset percentage, or the ratio of certified emission reductions from CDM projects to historical emission levels. Because forestry projects have to date played a small role in the CDM (only eight projects), the historical emission levels used in this calculation do not include emissions from land-use change. Across all eligible host countries, emission levels per year were 17.7 billion metric tons of CO_2 equivalents in 2005 (World Resources Institute, 2009). Compared to emission reductions from CDM projects of 319 million metric tons per year, this gives a global offset percentage of 1.8%. Countries with offset percentages that exceed the global average are considered "High Achievers" when it comes to attracting CDM investments.

Table 2.1 summarizes the number and percentage of host countries, "High-Achievers", and the offset percentage by region. Latin America has had the most "High Achieving" hosts (56%) while the other regions excluding sub-Saharan Africa have had a similar percentage ranging from 15% to 22% of eligible countries. With only one "High Achiever" and only 17% of eligible countries hosting projects, sub-Saharan Africa lags the other regions. However, when one compares the regional ratio of CERs to emission levels, sub-Saharan Africa is actually third behind Asia and Latin America in the percentage of GHG emissions being offset by CDM projects.

Table 2.1: Regional Distribution of CDM Hosts (CER and Emission in Mt CO_2 eq.)

Region	Total	Hosted	%	High Ach	%	CER	Emission	Offset %
Lat. America	16	16	100	9	56.3	47.4	2493	1.90%
Asia	18	16	88.9	4	22.2	253.6	11761	2.16%
MENA	14	8	57.1	3	21.4	7.8	1850	0.42%
SIDS	20	8	40.0	3	15.0	1.1	173	0.64%
Central Asia	12	4	33.3	2	16.7	1.5	439	0.34%
SS Africa	35	6	17.1	1	2.9	7.5	1032	0.73%
	115	58	50.4	22	19.1	318.9	17748	1.80%

2.2.2 Literature Review

While the CDM has attracted much attention in the literature, few of the works analyze the factors affecting the distribution of projects across host countries. Instead, researchers focus on reviews of CDM project activities and trends, theoretical predictions of factors affecting project distribution, case studies focusing on particular countries or projects, and analyses of the technology transfer and development impacts of CDM projects. The World Bank publishes an annual review of activity in the carbon market that includes a breakdown of CDM project buyers, host countries, and project types (the most recent being Capoor and Ambrosi, 2009). Other reports focus on the market potential for CDM projects, noting the dominance of China, Latin America, and other emerging markets (Haites, 2004; Halsnaes, 2002). While these reports document the lack of CDM projects in LDCs, they offer little in the way of explanations. When researchers do offer explanations, the rationale is based upon theory without testing the hypothesized determinants with empirical data (Cosbey et al, 2006; Lecocq and Ambrosi, 2007). Additionally, some researchers conduct case studies of projects or host countries that document the impediments to CDM implementation in particular settings without generalizing to larger distributional issues (Kim, 2003; Krey, 2005; Zhang, 2006). Beyond explaining the lack of CDM projects in LDCs, some authors have begun to look at possible solutions to improve the situation, with discounting of CERs and preferential access to the European Union Emissions Trading System (EU-ETS) being two approaches (Castro and Michaelowa, 2009a; Castro and Michaelowa, 2009b). In both cases, the authors find that the proposed modifications are insufficient to overcome the financial, technical, and institutional barriers in LDCs. Finally, while one of the two CDM requirements is to improve development levels in host countries, many researchers discuss the lack of development impacts from projects (Boyd et al, 2007; Brown et al, 2004; Cosbey et al, 2006; Olsen and Fenhann, 2008) and technology transfer possibilities

(Dechezlêpretre et al, 2009; Seres et al, 2009; van der Gaast et al, 2009). While host countries may not be receiving development benefits from CDM projects to the extent envisioned originally, countries left out of the CDM are not benefitting at all.

One related research area that may shed light on the determinants of CDM activity is the literature investigating the differential flow of Foreign Direct Investment (FDI) to developing countries. In some ways, CDM funding is a form of FDI and is likely to be influenced by the same factors. Fankhauser and Lavric (2003) believe that FDI flows to countries demonstrate a sound business environment as viewed by investors. They use FDI flows as part of a measure for the general investment climate in ranking potential hosts for Joint Implementation projects (the sister program to the CDM for economies in transition). If this relationship holds, then factors that influence FDI flows may also play a role for CDM projects. In general, researchers find that two of the most consistent predictors of FDI flows are gross domestic product (GDP) and growth in GDP (see literature reviews by Chakrabarti, 2001; Gastanaga et al., 1998; Globerman and Shapiro, 1999; Kumar, 1996). In addition, researchers find that factors that promote FDI inflows include effective governance structures, openness to trade, better infrastructure, and a higher return on investments (Asiedu, 2002; Globerman and Shapiro, 2002). Noorbaksh et al (2001) find that higher levels of human capital are a positive and significant determinant of FDI. Finally, low income countries with an agriculture-based economy are found to offer poor investment environments (Kumar, 1996). Taken together, these factors make least developed countries poor candidates for FDI inflows and, if the relationship holds, CDM projects.

However, the connection between FDI and CDM investment may not be perfect, as some countries that have experienced difficulty attracting FDI have succeeded in hosting CDM projects (Niederberger and Saner, 2005). In addition, Asiedu (2002) notes that two types of FDI exist: market seeking and non-market seeking investments. In principle, these two types of FDI are likely to have different determinants, with market seeking investments requiring strong domestic demand for products and non-market seeking FDI being driven by the cost and availability of factor inputs such as cheap labor and natural resources. CDM projects may be either market or non-market seeking. For projects that produce emissions reductions and a co-product such as electricity, CDM determinants are more likely to resemble market seeking FDI. For projects that only produce CERs, host country attractiveness may follow non-market seeking patterns with cheap and abundant emission reduction opportunities driving investment patterns. Finally, the potential for host countries to develop CDM projects without outside investors, so-called Unilateral CDM projects, may make either market or non-market seeking FDI an inappropriate model. (For an additional discussion of why CDM activity may not follow FDI determinants, see Niederberger and Saner, 2005).

Three efforts that have ranked host country attractiveness for CDM projects include the web service Point Carbon (2009), and publications by Jung (2006) and Oleschak and Springer (2007). While Point Carbon does not disclose the exact method used, it does list categories of variables that were considered in ranking the top 16 countries for CDM investments. These categories include measures related to CDM institutional strength, the general investment climate, the number and status of CDM projects, and the GHG mitigation potential of host countries. Jung uses cluster analysis to rank host country attractiveness for CDM projects. Her sample of 114 countries includes 15 that are ineligible for the CDM but excludes 16 that are eligible (though some may have become eligible since the time of her analysis). She places countries into four possible categories: Very Attractive, Attractive, Attractive to a Limited Extent, and Very Unattractive. Her variables include emissions reduction potential as measured by expected GHG emissions in 2010, the CDM institutional strength of countries as measured by Kyoto ratification and DNA establishment, participation in capacity building efforts and production of a national CDM strategy paper, and the general investment climate based upon World Governance indicators for Political Stability, Rule of Law, and Regulatory Quality. Oleschak and Springer rank 106 potential host countries (including 17 that are ineligible but missing 25 that are eligible) by their risk only and do not include mitigation potential. The authors create a composite index using the following variables (with weights for variables based upon Principal Components Analysis): CDM institutions including Kyoto ratification and DNA establishment, national communications submitted to the UNFCCC, number of capacity building programs, memoranda of understanding with other countries, the presence of CDM policy in national communications, CDM experience including the number of CDM projects and stage of registration, and the regulatory environment in the country including enforcing contracts, starting a business, registering property, and economic and default risk. Table 2.2 compares the three ranking systems with the actual distribution of CERs among the top 20 host countries.

Table 2.2: CDM Ranking Comparison (NR = Not Ranked)

CER Level	Point Carbon (2009)	Jung[a] (2006)	O & S (2007)	CER Level	Point Carbon (2009)	Jung[a] (2006)	O & S (2007)
1. China	2	1	2	**11. Colombia**	NR	3	14
2. India	1	1	1	**12. S. Africa**	9	1	8
3. Brazil	5	1	4	**13. Qatar**	NR	NR	NR
4. S. Korea	10	NR	13	**14. Peru**	6	3	26
5. Mexico	4	1	3	**15. Israel**	NR	3	28
6. Chile	3	2	5	**16. Egypt**	16	3	35
7. Malaysia	8	2	15	**17. Thailand**	14	1	12
8. Argentina	15	1	11	**18. Philippines**	13	3	36
9. Nigeria	NR	4	100	**19. Pakistan**	NR	4	54
10. Indonesia	7	1	57	**20. Uzbekistan**	NR	4	81

[a] For Jung, 1 = Very Attractive, 2 = Attractive, 3 = Attractive to a Limited Extent, and 4 = Very Unattractive.

All three approaches score hits and misses with their ranking systems. Point Carbon ranks Peru several places higher than its actual achievement while missing the success of South Korea, Argentina, Nigeria, Colombia, Qatar, and Israel. Jung similarly misses with South Korea, Nigeria, Qatar, Pakistan, and Uzbekistan. The approach taken by Oleschak and Springer demonstrates the importance of mitigation potential in driving CDM outcomes as a risk-only approach ranks the 9th highest reducer (Nigeria) 100th in terms of risk and ranks 6th and 7th countries that are 32nd and 55th in terms of CERs created (Morocco and Singapore, respectively).

While the goals of Jung, Oleschak and Springer, and Point Carbon differ slightly from my goals, their approaches can serve as a starting point for my analysis with some slight modifications. Specifically, the following aspects of their methods can be improved upon when trying to explain CDM project distribution. First, they use samples that exclude many countries eligible to host projects and include many that are ineligible. In addition, all three use the two required steps needed to host projects, Kyoto ratification and establishing a host country DNA, as variables in the attractiveness of host countries when the absence of either makes a country very unattractive. Finally, rather than trying to explain the historical success of countries in hosting projects, the three efforts reverse the logic by using the number of CDM projects hosted and under development as an explanatory variable in determining host country attractiveness.

My analysis differs from these past efforts by attempting to explain the historical distribution of CDM projects and emission reductions using several explanatory variables. As a sample set, I use only those countries that have ratified the Kyoto Protocol and established their DNA. I estimate two regression models: a probit model with a binary dependent variable for a country's hosting of one or more CDM projects, and a truncated regression model with a dependent variable for the number of CERs created within a country. To guide selection of explanatory variables, I develop a conceptual model based upon the net revenue created by a CDM project. While project level data is not available for the analysis, the insights from the net revenue model are useful in identifying country-level characteristics that could affect project revenues and costs. Ultimately, it is these country-level measures that are used to explain CDM involvement.

2.3 Analytical Framework

2.3.1 A Model of Project-Level Net Revenue

In assessing investment opportunities, CDM project developers must estimate the net revenues that potential projects will generate. These net revenues include the carbon revenue from CER production, any non-carbon revenue from the sale of co-products such as electricity or methane, normal project construction and operation costs, and CDM-specific costs from navigating the project registration process. Some projects, such as renewable energy projects, will have both non-carbon and carbon revenues. Other project types, such as those that destroy high global warming potential (GWP) gases, have only carbon revenues.

The CDM-specific costs stem from the lengthy registration process that each project must complete before creating CERs (UNFCCC, 2002). Steps in the registration process include creating a project design document (PDD) that applies UNFCCC methodologies for estimating the greenhouse gas impact of projects, seeking stakeholder input from the host country, and undertaking an environmental impact assessment. Once these steps are complete, project developers must receive approval from the host country DNA and have the project validated by an independent Designated Operation Entity both before and after the project becomes operational. The registration process involves significant costs to the developer, and these may or may not be recouped depending upon the success of the project. One estimate places up-front costs incurred during the registration process at between $70,000 and $115,000 (EcoSecurities, 2002). Estimates of total transactions cost for a project range from $40,000 to $480,000, depending on the project type (Wetzelaer et al, 2007). These translate into $0.01 to $0.70 per metric ton of CO_2 equiv. reduced. Developers incur additional costs throughout the project life-cycle as monitoring, verification, risk mitigation, and sales costs. These all are levied against project returns (EcoSecurities, 2002).

Project developers will analyze the net present value of all expected revenues and costs to assess profitability. The sequence of potential outcomes for the investment decision is the following: 1) do not implement the project, 2) implement the project but not as part of the CDM, or 3) implement the project as part of the CDM. The determination of which category the project falls into depends upon the relationship between three sets of revenues and costs:

- Non-carbon revenues versus normal project costs,
- Carbon revenues versus CDM-specific costs, and
- Total revenues (TR) versus total costs (TC).

Table 2.3 and Figure 2.1 illustrate these cases

Table 2.3: CDM Cost and Revenue Typology

	Carbon Rev < CDM Costs	Carbon Rev > CDM Costs
Non-Carb Rev < Project Costs	A	D1 (TR<TC) / D2 (TR>TC)
Non-Carb Rev > Project Costs	B	C

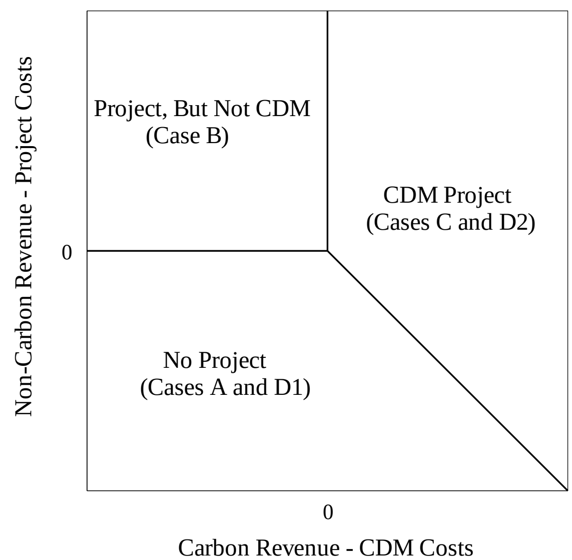

Figure 2.1: CDM Decision Matrix

Case A – If non-carbon revenues are less than the project costs and the carbon revenues are less than the CDM-specific costs, then the project will not be implemented. The Total Revenues are less than the Total Costs, making the project an unattractive investment.

Case B – If non-carbon revenues exceed the project costs but the carbon revenues are less than the CDM-specific costs, then the project will be implemented but not as a CDM project. This is the case in many countries that have implemented renewable energy projects outside of the CDM framework. The projects are profitable without the carbon revenues and the quantity of carbon revenues is not enough to merit the additional expense of CDM project registration.

Case C – If non-carbon revenues exceed the project costs and the carbon revenues exceed the CDM-specific costs, then the project may be implemented as a CDM project. To be approved, project developers must demonstrate that activities are additional to what would have occurred without the CDM. On a financial basis, projects can be shown to be additional if they are not financially feasible or if they are less attractive than alternative project activities (UNFCCC, 2008). Projects in Case C are profitable outside of the CDM, meaning that developers would have to show that other alternatives are more attractive in order for the effort to be financially additional. Beyond financial considerations, additionality can also be shown if the project activities overcome other non-financial barriers. These may include a lack of funding or skilled technicians, high perceived risks, or first-of-its-kind applications (UNFCCC, 2008).

Cases D1 and D2 – For this category, the non-carbon revenues do not exceed the project costs, including cases without non-carbon revenues. However, the carbon revenues do exceed the CDM-specific costs, making the projects more profitable than they otherwise would have been. These projects would not be done except as part of the CDM program. If the additional carbon revenues do not make the total revenues greater than the total costs, the project is an unattractive investment and will not be implemented (Case D1).

However, if the additional carbon revenues are large enough to make the overall revenues greater than the overall costs, then the project becomes an attractive investment and meets the financial additionality requirement to qualify as a CDM project (Case D2).

Due to proprietary concerns, project-level data on costs and revenues from CDM projects are rare. However, a reasonable assumption is that characteristics within potential host countries can affect the balance sheet for CDM projects by increasing or decreasing costs and revenues. The distribution of CDM projects is likely to reflect these characteristics as environments that reduce costs or increase revenues will result in greater CDM involvement and settings that increase costs or reduce revenues will dampen CDM activity. Given the net revenue framework above, the absence of CDM projects in eligible countries can be attributed to one or more of the following circumstances:

- **Low non-carbon revenues** – Low levels of expected non-carbon revenues can keep a CDM project from occurring. If the non-carbon revenues are low enough, a project with high expected net carbon revenues may yet represent an overall loss in which total costs exceed total revenues. Because non-carbon revenues are related to both the amount of the co-product created and its price, reductions in either of these would place a potential host country at a competitive disadvantage.
- **High project costs** – Host country characteristics that increase project costs would negatively impact CDM prospects. Characteristics that could increase costs include high corruption levels and weak human capital, as project developers would be required to train local workers or import a more expensive international workforce.

- **Low carbon revenues** – Net carbon revenues are key to making a developer pursue the CDM option. If the expected carbon returns from a project do not exceed the expected costs of CDM participation, the developer is better off pursuing the project outside of the CDM or abandoning it altogether. Because carbon revenues are related to both the amount of emissions reductions created and the carbon price, reductions in either of these would place a potential host country at a competitive disadvantage.
- **High CDM-specific costs** – Any host country characteristics that increase the CDM-specific costs for potential projects will reduce the likelihood of implementing a CDM project. Undertaking CDM capacity building measures, in principle, reduces the costs for inexperienced project developers to navigate the registration process. Previous experience with the CDM would also tend to reduce costs as the knowledge gained will make developing and hosting future projects less costly. Thus, developers may be drawn to countries with high overall emissions levels, as the prospect for developing multiple CDM projects would increase economies of scale and reduce CDM-specific costs per project. As was mentioned above, a lack of human capital in the host country requires that project developers either incur additional costs to train local staff to navigate the CDM development and registration process or to import higher cost international expertise to assist in the process. Finally, institutional barriers in the host country that prolong or increase the cost of the CDM registration process will reduce the likelihood of project development.

2.3.2 Country-Level Variables

Without project level data, the net revenue framework becomes a heuristic model to guide selection of explanatory variables at the host country level. To test the possible determinants of CDM activity, two sets of regression analyses were performed. First, a probit model of the full sample of 115 eligible host countries was estimated with a dependent variable representing whether or not the countries had hosted registered CDM projects (0 = no projects, 1 = one or more projects). Because Serbia and Montenegro share data for many explanatory variables, they were combined to produce an actual sample of 114 countries. A truncated regression model was then estimated with a sample that was restricted to the 58 successful hosts (for a description of truncated regressions see Greene, 2000). The dependent variable is the estimated number of CERs created by projects within the country according to the Project Design Documents. While the CDM pipeline includes several thousand projects under development, I have restricted the analysis to registered projects for several reasons. First, nearly 10% of projects fail in the effort to register with the CDM either because they are withdrawn by the project developers or they are rejected by the CDM Executive Board (UNFCCC, 2009a). In addition, the analysis looks at both the countries that have registered projects and the CER production from host countries. The estimated CER production for projects often changes as part of the validation process, meaning that figures for non-registered projects are likely to change while CER levels for registered projects are more certain. Finally, the backlog of projects in the pipeline combined with the slow rate of approval by the Executive Board and uncertainty over the future of the CDM post-2012 makes the eventual registration for all projects in the pipeline questionable. Given these factors, limiting the analysis to registered projects appeared to be the prudent option.

The Net Revenue model guided selection of the explanatory variables. Summary statistics for the variables are listed in Table 2.4, including means for Host and non-Host countries. Data sources for variables are identified in the first column of Table 2.4, titled "DS," and are listed below the table. As a proxy for non-carbon revenues, I used eligible host country's average growth in electricity generating capacity from 2003 to 2007. The rationale for this variable is that countries experiencing a growth in electricity sector investments are likely to offer positive returns in this area, which coincides with the primary co-product for CDM projects. This variable could present some endogeneity problems in that CDM investments in the energy sector would result in increased capacity growth levels. However, this is not likely to be a serious problem as more than 50% of the CDM projects began operation after the 2003 to 2007 period, and the capacity added through the CDM is only a small fraction of a country's total increase in electricity generating capacity.

As proxies for carbon revenues, I used the overall greenhouse gas emissions not including land-use change and the emissions intensity of the economy. The idea is that a CDM project can be constructed at a larger scale, and thus produce greater emissions abatement and carbon revenues, when the country has large emissions in both absolute and relative terms. CDM-specific costs were modeled with the number of CDM Capacity Building Efforts used by Jung, a measure that ranges from 0 to 4. Additional cost measures include Human Capital as measured by the Education Index of the United Nations Human Development Index (HDI); an Institutional Capital Index that combines

World Bank measures for Government Effectiveness, Regulatory Quality, and Rule of Law; and a Risk Index that combines two corruption measures and the Political Stability/Absence of Violence variable from the World Bank's World Governance Indicators. These three measures range from 0 (bad) to 100 (good). For the host countries in the truncated regression model, a variable for the number of "Years Since 1st Project" was used to represent experience with the CDM (not shown in Table 2.4). Finally, because SIDS, OPEC and Landlocked countries appear to be less motivated to pursue or at a disadvantage to secure CDM investments, dummy variables for these countries were used.

Table 2.4: Summary Statistics for the Full Sample (114 Countries)

DS	All Countries N=114	Mean All	Mean non-Hosts	Mean Hosts	Std. Dev	Min	Max
1	**CERs**	-----	-----	5,499,014	25,126,046	542	188,586,302
1	**Log CERs**	-----	-----	5.62	1.00	2.72	8.28
2	**GHG Emissions (Mt CO_2e)**	155.7	35.2	272.0	705.4	0.2	7219.2
2	**Log Emissions**	1.20	0.76	1.62	0.91	0	3.86
2	**Carbon Intensity of Economy (tCO_2/Million $)**	425.5	409.6	440.8	362.4	48.4	2151
3	**Electricity Capacity Growth (%)**	2.3	1.2	3.6	3.4	-5.1	16.5
4	**CDM Capacity Building**	0.6	0.39	0.88	0.9	0	4
5	**Education Index (0-100)[a]**	75.6	70.5	80.5	17.2	28.2	99.3
6	**Institutional Index (0-100)**	43.8	41.4	46.0	14.2	15.8	88.4
6/7	**Risk Index (0-100)**	40.5	40.1	40.8	14.2	14.0	86.9
	SIDS[b]	0.18	0.21	0.14	0.38	0	1

	OPEC[b]	0.07	0.07	0.07	0.26	0	1
	Landlocked[b]	0.24	0.30	0.17	0.43	0	1
8	**FDI Inflows**	2083	452	3658	6547	-113	60389

Data Sources:

1. UNFCCC, 2009a.
2. World Resources Institute, 2009.
3. Energy Information Administration, 2009.
4. Jung, 2006.
5. United Nations Development Program, 2009.
6. World Bank, 2009.
7. Transparency International, 2008.
8. UNCTAD, 2008.

[a] North Korea does not have a measure for the Education Index, reducing the number of observations for this measure to 113.

[b] Entries in this row can be interpreted as the fraction of the sample countries in this category (except for the Min and Max entries).

2.4 Regression Results

2.4.1 Main Results

2.4.1.1 Probit Results

As a preview of the probit results, I first focus on the variable for GHG Emissions. This variable's importance in determining a country's potential for projects is evident when viewing the emission levels of potential hosts. Only 3 of the 33 countries with the lowest emissions have hosted projects (9%), with each of the three only hosting one project. Meanwhile, 19 of the 21 highest emitting countries have done so (90%) with the two non-hosts both being OPEC members. Of the remaining 60 countries with a mid-level of emissions, 36 have hosted projects (60%). However, it also becomes clear that outlying countries such as China and India skew the relationship between emission levels and CDM involvement. By using the logs of emissions and CERs, the impact of outliers is reduced.

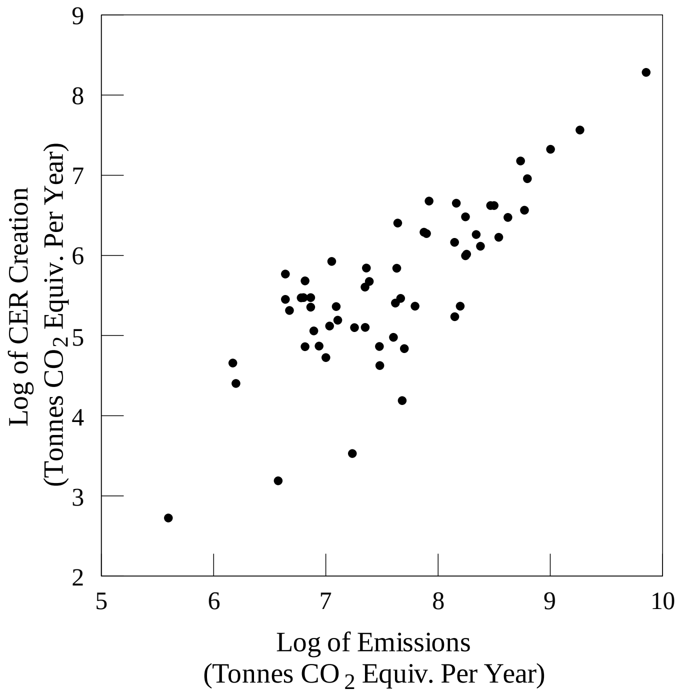

Figure 2.2: Log Emissions versus Log CERs for Hosts Only (Corr. = 0.7879)

Table 2.5 reports the results of the probit analyses using a binary dependent variable for the countries' hosting of projects. Because North Korea does not have a measure for the Education Index, the sample size drops to 113 countries. The marginal effects of independent variables on the probability of hosting are shown along with robust standard errors. Tests for multicollinearity found that it was not harmful in any of the probit or truncated regression models. However, because the Risk and Institutional Indexes are highly correlated (0.91), these two variables and their components were not analyzed in the same regression. Nevertheless, the results do not change if the Risk Index is used in place of the Institutional measure nor if their components are analyzed individually.

Table 2.5: Probit Model Estimates to Explain CDM Host Countries

Variable	Specification 1	Specification 2
Log Emissions	0.2711*** (0.080)	0.3448*** (0.115)
Carbon Intensity of Economy	-0.0003 (0.0002)	-0.0003 (0.0002)
Electricity Capacity Growth	0.0388** (0.019)	0.0460** (0.020)
CDM Capacity Building	0.2046** (0.083)	0.1978** (0.087)
Education Index	0.0102** (0.005)	0.0097** (0.005)
Institutional Index	0.0015 (0.004)	0.0007 (0.006)
SIDS	----------	0.0655 (0.193)
OPEC	----------	-0.5165*** (0.159)
Landlocked	----------	-0.0146 (0.142)
FDI Inflows	----------	0.00003 (0.00006)
Observations	113	113
Pseudo R^2	0.3055	0.3486
Log pseudo-likelihood	-54.368	-50.999

Notes: ***, **, and * denotes significance at the 1%, 5%, and 10% levels, respectively.
Robust standard errors are reported in parentheses.

The first model specification is the base case and uses the proxy variables for the revenue and cost measures. The second specification adds the dummy variables for SIDS, OPEC, and Landlocked countries along with FDI Inflows. The results do not change markedly across the two specifications. In both specifications, Log Emissions, Electricity Capacity Growth, CDM Capacity Building, and Education Index are significant determinants of CDM involvement. Estimated coefficients on these variables have the anticipated signs and are statistically significant. In Specification 2, OPEC members are found to be significantly disadvantaged or disinterested in hosting CDM projects, given the negative and statistically significant coefficient on OPEC. The estimated coefficients on Carbon Intensity of Economy and Institutional Index are not significant, nor are the coefficients on SIDS, Landlocked, or FDI Inflows. The probit specifications correctly predict whether or not a country will host CDM projects for approximately 80% of the eligible hosts.

2.4.1.2 Truncated Regression Results

The truncated regression model is estimated to explain Log CER as the dependent variable. Results for two specifications of the model are presented in Table 2.6. Observations on the 58 countries that have hosted projects are used in these regressions.

Table 2.6: Truncated Regression Model Estimates to Explain CERs

Variable	**Specification 1**	**Specification 2**
Constant	2.7639*** (0.680)	3.4092*** (0.504)
Log Emissions	0.8779*** (0.114)	0.6374*** (0.117)
Carbon Intensity of Economy	0.0002 (0.0002)	0.0005*** (0.0002)
Electricity Capacity Growth	0.0273** (0.014)	-0.0007 (0.016)
CDM Capacity Building	-0.0976 (0.081)	-0.0730 (0.057)
Years Since 1st Project	0.2212*** (0.070)	0.2080*** (0.057)
Education Index	0.0101 (0.008)	0.0105* (0.006)
Institutional Index	-0.0069 (0.009)	-0.0088 (0.006)
SIDS	----------	-0.5549*** (0.206)
OPEC	----------	0.0410 (0.174)
Landlocked	----------	-1.0582*** (0.231)
FDI Inflows	----------	6.84e-6 (0.00001)

Sigma	0.5308*** (0.059)	0.4057*** (0.034)
Observations	58	58
Log pseudo-likelihood	-45.566	-29.976

Notes: ***, **, and * denotes significance at the 1%, 5%, and 10% levels, respectively. Robust standard errors are reported in parentheses. 'Sigma' is an estimate of the standard deviation.

Estimated coefficients on Log Emissions and Years Since 1st Project have the expected signs and are statistically significant in both specifications. The coefficient on Electricity Capacity Growth is significant in the first specification, while coefficients on Carbon Intensity of Economy and Education Index are significant in the second specification. The signs are as anticipated when the coefficients are significant. Estimated coefficients for SIDS and Landlocked countries are negative and significant in explaining CERs, which is a reversal from the probit results in which OPEC has a negative effect. Neither CDM Capacity Building nor Institutional Index are significant determinants of CER production, and FDI Inflows is not a significant determinant in Specification 2. For CDM Capacity Building, this also is a reversal from the probit results.

2.4.2 Robustness Checks

I estimate several regressions to check the robustness of the Main Results to alternative specifications. Robustness checks for the Probit model are shown in Table 2.7 while results for the Truncated Regression model are reported in Table 2.8.

Table 2.7: Probit Robustness Checks

Variable	First-Stage CDM Specification 1	First-Stage CDM Specification 2	Energy Projects Specification 1	Energy Projects Specification 2
Log Emissions	0.3147*** (0.074)	0.4331*** (0.095)	0.2105*** (0.071)	0.3045*** (0.105)
Carbon Intensity of Economy	-0.0006*** (0.0002)	-0.0006*** (0.0002)	----------	----------
Carbon Intensity of Elect. Grid	----------	----------	-0.2576 (0.221)	-0.3470 (0.262)
Electricity Capacity Growth	0.0069 (0.019)	0.0192 (0.020)	0.0482*** (0.019)	0.0661*** (0.021)
CDM Capacity Building	0.1530** (0.068)	0.1384* (0.075)	0.1751* (0.071)	0.1822** (0.091)
Education Index	0.0098** (0.004)	0.0095** (0.005)	0.0063 (0.004)	0.0064 (0.005)
Institutional Index	0.0019 (0.005)	0.0029 (0.005)	0.0058 (0.004)	0.0032 (0.006)
SIDS	----------	0.0402 (0.212)	----------	0.1376 (0.210)
OPEC	----------	-0.3687*** (0.117)	----------	-0.5813*** (0.076)
Landlocked	----------	0.0066 (0.149)	----------	-0.0269 (0.152)
FDI Inflows	----------	-0.00002* (0.00001)	----------	0.00005 (0.00005)
Observations	113	113	113	113
Pseudo R^2	0.2878	0.3234	0.2776	0.3696
Log pseudo-likelihood	-55.074	-52.320	-56.194	-49.042

Notes: ***, **, and * denotes significance at the 1%, 5%, and 10% levels, respectively. Robust standard errors are reported in parentheses.

Table 2.8: Truncated Regression Robustness Checks

Variable	First-Stage CDM Specification 1	First-Stage CDM Specification 2	Energy Projects Specification 1	Energy Projects Specification 2
Constant	2.3882*** (0.745)	3.0893*** (0.777)	3.1348*** (0.721)	3.8760*** (0.498)
Log Emissions	0.8743*** (0.114)	0.7086*** (0.144)	0.6456*** (0.126)	0.4207*** (0.130)
Carbon Intensity of Economy	0.0001 (0.0003)	0.0004* (0.0002)	----------	----------

Carbon Intensity of Elect. Grid	----------	----------	0.3381 (0.254)	0.4233** (0.192)
Electricity Capacity Growth	0.0497*** (0.017)	0.0245 (0.025)	0.0464** (0.022)	0.0122 (0.024)
CDM Capacity Building	-0.1661** (0.065)	-0.1124 (0.069)	-0.1005 (0.095)	-0.0645 (0.073)
Years Since 1st Project	0.2279** (0.091)	0.2038* (0.107)	0.1652** (0.070)	0.1384** (0.058)
Education Index	0.0090 (0.008)	0.0064 (0.007)	0.0126* (0.008)	0.0123* (0.007)
Institutional Index	-0.0012 (0.008)	-0.0023 (0.007)	-0.0146 (0.009)	-0.0153** (0.007)
SIDS	----------	-0.1993 (0.228)	----------	-0.3665** (0.207)
OPEC	----------	0.2544 (0.223)	----------	-0.0207 (0.190)
Landlocked	----------	-0.7452*** (0.278)	----------	-0.8746*** (0.227)
FDI Inflows	----------	4.96e-6 (0.00001)	----------	0.00002** (0.00001)
Sigma	0.5099*** (0.066)	0.4476*** (0.051)	0.5193*** (0.055)	0.4337*** (0.038)
Observations	49	49	51	51
Log pseudo-likelihood	-36.521	-30.142	-38.952	-29.763

Notes: ***, **, and * denotes significance at the 1%, 5%, and 10% levels, respectively. Robust standard errors are reported in parentheses.

2.4.2.1 First-Stage CDM

The Main Results are based on registered CDM projects as of October 1, 2009, which includes 1835 projects and 58 host countries. Does the pattern of results change when only the first stage of CDM projects and countries are considered? I re-estimated the regression models using data on the 898 projects and 49 host countries as of January 1, 2008. This date is significant as it marks the transition from the first phase (2005-2007, the “pilot phase”) to the second phase (2008-2012, the “first Kyoto Commitment Period”) of the EU-ETS for greenhouse gases. The EU-ETS serves as the primary market for the CERs created by CDM projects.

The results for the First-Stage CDM are similar to those in the Main Results. In the probit estimates (for explaining which countries hosted projects), estimated coefficients on the variables for Log Emissions, CDM Capacity Building, Education Index, and OPEC have the same signs, similar magnitudes, and similar statistical significance as in the Main Results (Table 5). A few exceptions occur. The estimated coefficient on Carbon Intensity of Economy is negative and statistically significant at the 0.01 level. I expected a positive and significant coefficient here, yet the tendency of project developers in the first stage to select projects that abate non-CO_2 greenhouse gases could explain why the coefficient is not positive. The coefficient on Electricity Capacity Growth is statistically insignificant. Lastly, the coefficient on FDI Inflows is negative and statistically significant at the 0.10 level. This suggests that FDI might be substituting for CDM project investment in the First-Stage CDM.

In the truncated regression estimates (for explaining how many CERs were supplied by country), estimated coefficients for Log Emissions, Carbon Intensity of Economy, Electricity Capacity Growth, Years Since 1st Project, and Landlocked countries have the same signs, similar magnitudes, and similar statistical significance as in the Main Results (Table 6). Coefficients for Education Index and SIDS countries change to insignificant in the First-Stage CDM results.

2.4.2.2 Energy Projects

I next investigate Energy Projects within the CDM as a second robustness check. The pattern of results might differ for energy projects as such projects create the joint products of energy and CERs, both of which can be sold in markets. Here, I apply data from the entire period, through October 1, 2009. Of 1835 projects, 1356 (74%) are energy projects.

In the probit estimates, the results for Energy Projects are again quite similar to the Main Results (Table 2.5). Estimated coefficients for Log Emissions, Electricity Capacity Growth, CDM Capacity Building, and OPEC have the same signs, similar magnitudes, and similar statistical significance as in the Main Results. One exception is Education Index, whose coefficients now are insignificant. I also replaced a variable in the Energy Project regressions; due to the focus on energy, a variable for Carbon Intensity of Electrical Grid replaces Carbon Intensity of Economy. Its coefficient is insignificant in both specifications of the probit regression.

For the truncated regressions, estimated coefficients for Log Emissions, Electricity Capacity Growth, Years Since 1st Project, SIDS, and Landlocked countries have the same signs, similar magnitudes, and similar statistical significance as in the Main Results (Table 2.6). Three variables have significant coefficients in Energy Projects – Education Index, Institutional Index (in one specification), and FDI Inflows – even though their coefficients are insignificant in the Main Results. The negative coefficient on Institutional Index is unexpected. Lastly, the estimated coefficient on the new variable, Carbon Intensity of Electrical Grid, is positive and statistically significant in the second specification, as expected.

2.4.2.3 Number of Projects

As a final check, I estimated the truncated regression model using a different dependent variable; the number of projects by country (Log Projects) replaces number of

CERs by country (Log CERs). While many results are similar, estimated coefficients for several variables (Carbon Intensity of Economy, Education Index, Landlocked countries, and FDI Inflows) change in their statistical significance when explaining Log Projects. I do not include a table of these regressions due to limited space.

In summary, the robustness checks lend support to the Main Results as a set of regressions that help to explain whether eligible countries host CDM projects and the extent of CER creation across host countries.

2.5 Discussion

The regression analysis investigated two questions: What factors determine who will and will not be host countries for CDM projects? and What factors determine how active host countries will be in creating GHG emissions reductions? In both cases, the emissions level of host countries was a relevant factor. In determining whether a country will host projects, a low level of emissions effectively rules out being a host and a high level of emissions almost guarantees it. One can imagine that with lower overall emissions, fewer opportunities exist for profitable projects, thus reducing the likelihood of becoming a host. As the overall emissions increase, the potential for profitable projects also increases. The three countries in the low emissions group that have hosted projects have each been limited to a single project. In two of the cases, governments were directly involved, with the government of Bhutan serving as the host country partner in one case and the Spanish Community Development Carbon Fund supporting the effort in Guyana (UNFCCC, 2009a). Governments are more amenable to incurring net losses for project implementation than for-profit project developers. In fact, the

Bhutan project creates the second-fewest CERs of any project with just 524 per year, making repayment of CDM registration costs unlikely. As for the two non-hosts in the high emissions group, both were OPEC members (Saudi Arabia and Iran), a group that was found to be significantly less likely to be CDM hosts.

In terms of CERs created, the larger a country's emission level the more active it will be in the CDM. Countries with higher overall emission levels are likely to offer more opportunities for CDM projects, are more likely to have high GWP gas opportunities, and can create economies of scale for developers as the size and the number of possible projects increase. The prospect of creating multiple projects in the same country allows developers to spread some of their operating and registration costs across many units. This phenomenon can be seen in several countries where both host country parties and outside actors develop a number of similar projects. For example, the British and Swiss divisions of AcCert International along with Mexican subsidiaries registered over 45 methane recovery from animal waste projects in Mexico with essentially the same technology and project design (UNFCCC, 2009a). Surely the cost for developing and registering the 45^{th} project was much less than for the first.

Returning to the net revenue model, both emission levels and intensity served as surrogates for the carbon revenues that could be expected from countries. The carbon intensity of a country's economy also was significant in determining the amount of CERs created (though not in determining if the country will or will not host projects). For carbon intensive economies, it is reasonable to assume that being "dirty" offers profitable opportunities for investors and will create a higher level of CERs for a given activity as compared to a "cleaner" setting. As will be discussed below, the importance of overall emissions and emissions intensity in determining CDM activity is discouraging for least developed countries as they tend to have significantly lower levels for both measures as compared to their more developed counterparts.

The model also hypothesized that when the carbon revenues exceeded the CDM-specific costs, project developers will be incentivized to pursue the CDM. Surrogates for the CDM-specific costs included the number of capacity building efforts countries undertook, overall levels of human and institutional capital, and a country's experience with the program. The regression results point to the importance of the capacity building efforts in assisting countries in becoming project hosts. Coupled with evidence for the importance of the human capital in countries, proxy variables representing reduced CDM-specific costs appear to play a role in determining which countries will become hosts. From the perspective of CER production, only the human capital measure was found to be significant. From a capacity building standpoint, once countries have navigated the CDM process and gained hands-on experience, further capacity building does not seem to result in greater CER production. Based upon this evidence, future capacity building efforts should focus on countries that have yet to host CDM projects.

A variable that was significant in determining the CER level of hosts was the number of years since a country first hosted a project. While this measure was posited to be a proxy for CDM-specific costs, that assertion comes with a qualification. Part of the increased CER production from being an early host may be due to the extra time that these early countries have spent producing CERs. Rather than gaining an advantage in reduced registration costs as countries become more experienced with the CDM, early adopters may simply have had a longer time to create projects and CERs. By including this variable in the truncated regressions, the model at a minimum controls for any increased CER production due to longer activity. However, a reasonable conjecture is that, with each project a country moves through the CDM registration process, greater experience and knowledge of the process will make future registration efforts less expensive, at least to a point. To shed light on this, Table 2.9 shows the new CER production for the first three years of involvement in the CDM for the eight most active countries. The general pattern is of increasing levels of CER production over time with the primary exception to this pattern, South Korea, benefitting from large quantities of CERs generated by two high global warming potential gas projects in its first year. This evidence lends support to the idea that it is not only more time producing CERs but greater production over time that is captured by the Year Since 1st Project variable.

Table 2.9: New CER Production over Time for the Top Eight Countries (Millions of CERs)

Country	Year 1	Year 2	Year 3
China	0.3	46.1	45.8
India	7.3	5.3	15.7
Brazil	0.7	6.7	8.5
South Korea	10.6	0.5	3.3
Mexico	0.6	4.4	1.9
Chile	0.6	1.6	1.8
Malaysia	1.7	0.6	0.4
Argentina	0.6	1.1	2.1

In addition to the relationship between carbon revenues and CDM-specific costs, the model hypothesized that negative non-carbon net revenues (the difference between non-carbon revenues and costs) could make projects unattractive. As a proxy for the non-carbon revenue potential in countries, the model used the average growth in electricity capacity from 2003 to 2007. This variable was found to be a significant determinant of the potential for countries to host projects, but was not found to be a significant determinant of the number of CERs that successful host countries produce once the dummy variables were included in the model. One can imagine that countries with stagnant or decreasing electricity generating capacity would not represent strong markets for co-products from CDM projects and would not become hosts. Those countries that do become hosts have stronger markets and the overall growth rate of the sector is not a significant determinant of how many CERs a host will produce.

The dummy variables for SIDS, OPEC, and Landlocked countries provide insight into when these countries become interested or impeded in CDM activity. A large proportion of the SIDS countries did not participate in the CDM program and have not yet established DNA (52%). Of those eligible for CDM projects, a respectable 40% have been successful in hosting projects and were not found to be significantly disadvantaged in the context of the probit analysis. When it comes to generating CERs, however, SIDS countries were found to generate fewer, other things held constant. A smaller percentage of OPEC members failed to establish their DNA (25%), but being an OPEC member significantly reduced the likelihood of hosting projects once eligible. At the same time, being an OPEC country did not affect CER production. It seems that a difference exists within the members of OPEC partly explained by the size of national petroleum reserves. Of the eligible hosts, the three largest countries in terms of oil reserves have not hosted projects (Saudi Arabia, Iran, and Kuwait), yet four out of the five members with lower reserves have (United Arab Emirates, Nigeria, Qatar, and Ecuador). With more to protect, it is conceivable that the three larger members view Kyoto participation, including establishing a DNA, as protection against policies that would reduce the importance of oil and damage future earnings. Meanwhile, countries with lower reserves may view the CDM as a means to diversify local economies and to attract clean investments. Finally, Landlocked countries generated fewer CERs, other things held constant. This likely reflects the extra costs of transporting materials for project construction to and from coasts, costs which reduce net non-carbon revenues and total revenues, making projects less attractive.

The implications of these findings are quite pessimistic for least developed countries interested in attracting CDM investments. As Table 2.10 demonstrates, the average emission level for LDCs is a full order of magnitude lower than countries with higher development levels, placing most into the lowest emissions group (United Nations Development Program, 2009). In fact, the lone LDC to host a project, Côte d`Ivoire, is one of only four LDCs not in the lowest emissions class. Similarly, the average carbon intensity for LDCs is less than half that of other groups. As the proxies for carbon revenue potential, these two variables help to demonstrate why LDCs' CDM involvement is lagging behind other countries. From a non-carbon revenue standpoint, the electricity capacity growth rate for the group as a whole is below 1%. With little growth in domestic electricity sectors, it is hard to imagine CDM project developers being attracted to investment opportunities in LDCs. A self-motivated, unilateral CDM effort would also seem difficult given the human capital and institutional levels in these countries.

Table 2.10: Measures by Development Level

Variable	Low Dev	Mid Dev	High Dev	Very High
Eligible Countries	17	62	25	9
Hosted	1	39	12	6
Percent Hosting	5.9	62.9	48.0	66.7
Average National GHG Emissions (Mt CO_2e)	12.3	215.3[a]	125.3	109.0
Carbon Intensity of Economy (tCO_2/Million $)	182.2	453.1	504.9	462.5
Electricity Cap. Growth (%)	0.6	2.6	2.7	4.3

Education Index	47.0	76.0	89.1	91.3
Institutional Index	33.8	40.2	51.8	69.9

Notes: Development level categories are based upon the United Nations' Human Development Index classification (United Nations Development Program, 2009).
[a] The presence of China and India in the Middle Development category significantly increases the average emissions value for the group as a whole.

While CDM capacity building efforts were shown to improve the chances of becoming hosts, they may not be enough to overcome the predicament of least developed countries. LDCs may simply have too few opportunities for large emission reductions to justify the higher expense of registering and operating a project in these settings. Yet, as a recent World Bank report on the potential for clean energy in sub-Saharan Africa highlights, least developed countries are certainly not without emission reduction opportunities (de Gouvello et al, 2008). The report estimates a potential for 3200 clean energy projects, 170 GW of additional electricity generating capacity, and 740 million metric tons CO_2 equivalent in annual emission reductions for the region (an amount that is twice the current level for all CDM projects). The question becomes how best to incentivize investment in these opportunities. Clearly, the Clean Development Mechanism has not been an effective vehicle for achieving an outcome of this scale.

2.6 Conclusion

The Clean Development Mechanism of the Kyoto Protocol has been at least a modest success in involving developing countries in the effort to reduce greenhouse gas emissions. Yet, as the program approaches its seventh year of operation, least developed countries remain largely absent from participation and, hence, are not utilizing the CDM as a means of sustainable development. My research finds that, among other factors, a high level of overall emissions, economies with high emissions intensities, domestic human capital, and a growing electricity sector all promote greater CDM activity. Capacity building efforts have been helpful in spurring CDM participation for some countries. However, given their low measures on many of the important determinants of CDM involvement, least developed countries are unlikely to benefit from the capacity building programs.

On the positive side, the challenge of developing CDM projects in LDCs has emerged on the policy agenda of the UNFCCC. Since its inception in 2005, the UNFCCC's Ad Hoc Working Group on Further Commitments for Annex I Parties under the Kyoto Protocol (AWG-KP) has been responsible for evaluating various implementation issues related to the protocol and proposing reforms based on the evaluations. In October 2010, the AWG-KP created a proposal to increase CDM activities in least developed countries. The strongest version of the proposal states that Annex I countries "…take measures such that at least 10 percent of all certified emission reductions …in the second commitment period [2012-2016] are sourced from project activities hosted in least developed countries, small island developing States and countries in Africa" (UNFCCC, 2010, p. 41). The proposed 10-percent requirement – while likely not fostering clean development in all LDCs – would catalyze CDM activity in some countries, thereby expanding the reach of sustainable development.

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3 Chapter

Meeting the Dual Goals of the Clean Development Mechanism in Least Developed Countries – A Three Step Framework for Success

Abstract

The dual goals of the Clean Development Mechanism (CDM) are to reduce greenhouse gas emissions and promote sustainable development in developing countries. Although all developing countries are eligible to host CDM projects, investments have primarily gone to emerging markets while least developed countries (LDC) have largely been absent. One explanation for the unequal distribution is that projects in LDCs cannot meet the dual goals while also returning a profit to the project developers. This chapter proposes a three step framework for CDM project success based upon project availability, profitability, and meeting the dual goals. By applying the framework to case studies in a particular LDC, Niger, the results demonstrate the importance of scale in CDM projects. Renewable energy efforts do not produce enough emission reductions to justify the costs of pursuing CDM registration at the scale available in Niger. Additionally, the presence of suppressed demand for electricity necessitates trade-offs between reducing emissions and promoting sustainable development. While forestry projects that sequester carbon offer the best combination of financial returns and meeting

the dual goals, a ban on forestry related emission reductions in the European Union Emissions Trading System has significantly reduced the demand for these projects.

3.1 Introduction

The dual goals of the Kyoto Protocol's Clean Development Mechanism (CDM) are to reduce greenhouse gas (GHG) emissions while supporting sustainable development in developing countries (UNFCCC, 1998). Developed countries that have agreed to meet emission reduction goals as part of the Kyoto Protocol can receive credit for the emission reductions created by greenhouse gas offset projects in developing countries. Project activities fall into 15 different sectors including energy-related efforts, carbon sequestration through forestry activities, and the destruction of industrial gases (UNFCCC, 2009). While developing countries are not required to reduce emissions as part of the Kyoto Protocol, they are able to assist in mitigating climate change impacts by hosting CDM projects. In return, they are to receive sustainable development benefits from the project activities.

The CDM Executive Board has established a rigorous oversight framework to assess and monitor the greenhouse gas impact of projects. The steps needed to register with the CDM include establishing baseline emission levels without the project, proving that the effort is additional to what would have occurred, and ensuring that any unintended greenhouse gas impacts or leakage from project activities are taken into account (UNFCCC, 2009). The determination of what constitutes sustainable development benefits is left to the host country government to define and require. By submitting their approval for the proposed projects to the CDM Executive Board, it is assumed that host country governments have found the sustainable development impacts from the activities to be substantial and beneficial.

As of October 1, 2009, the total number of registered CDM projects was 1835, representing emission reductions of approximately 319 million metric tons of CO_2 equivalent per year (UNFCCC, 2009). Of the 115 eligible host countries, 58 have been successful in developing and registering CDM projects. The vast majority of projects have gone to emerging market countries with China, India, Brazil, and Mexico hosting over 75% (UNFCCC, 2009). Meanwhile, least developed countries (LDC), particularly those in sub-Saharan Africa, have largely been absent from the program. Regression work in Chapter 2 found that greenhouse gas emission and human capital levels influenced which countries have hosted projects and the amount of certified emission reductions (CER) created. In addition, countries with growing markets for CDM co-products, such as electricity, were more likely to be CDM hosts and economies with higher carbon intensity levels had greater CER production.

While this work investigated the explanations for the differential distribution of projects at the global level, perhaps a more fundamental question is whether or not CDM projects can be profitable and also meet the dual goals in a least developed setting. Most observers would agree that emerging markets such as China and India offer a very different investment environment from African nations. However, is the difference large enough that the Clean Development Mechanism cannot work in both settings? If the two settings are too different for one set of oversight mechanisms, should the CDM Executive Board consider a modified set of regulations designed to increase participation of least developed countries? As a new international framework is negotiated and ratified leading up to the end of the Kyoto Protocol's first commitment period in 2012, now is the time to ask these questions.

In the hopes of shedding light on the causes of differential project distribution among host countries, this chapter investigates the factors that affect CDM project success. Specifically, what are the characteristics of potential projects that achieve the dual goals of the CDM while being financially viable for project developers? How do differences between least developed countries and emerging markets impact the prospects for project success? For countries at a disadvantage in attracting investments, what reforms would help to improve their chances for success?

I hypothesize that many project types are likely to have a difficult time meeting the dual goals of the CDM in least developed settings, let alone being profitable to project developers. To begin with, some project types may not be possible because host countries lack activities in the project area. If the project areas are present, the activity may not be an attractive investment for project developers. Of particular importance is the amount of certified emissions reductions created and how these carbon returns compare to the registration and monitoring costs to participate in the CDM. Finally, the CDM regulatory environment may not be amenable to conditions in LDCs. Requirements related to additionality, leakage, and baseline that are appropriate for emerging markets may be a poor fit for conditions in least developed settings. Of particular relevance for LDCs is the idea of suppressed demand for modern energy services. In settings where a large subset of the population lacks access to electricity and other modern energy services, can new energy supplied through clean technologies really create emission reductions if the additional supply gives new users access to electricity and no absolute GHG reductions result? Renewable energy projects can and should be part of the development process for developing countries, but is the CDM the right mechanism for supporting these efforts if projects do not produce actual emissions reductions? Situations such as this draw into question the possibility of meeting the dual goals of the CDM in least developed countries.

Summarizing the critical factors for CDM activities in potential host countries, a successful project must meet three tests: availability, profitability, and supporting the dual goals. Is a project activity possible given local conditions and available industries? Will it return a profit and will the carbon revenues justify the cost to participate in the CDM? Does it meet the dual goals of reducing emissions and promoting sustainable development? If a particular project activity does not meet the three tests, then it will not result in a successful CDM project. I hypothesize that conditions in least developed countries work against project activities passing the three tests and help to explain the lack of CDM activity in LDCs. To test this hypothesis and the three step framework for project success, the chapter examines a number of case studies for potential projects in a particular least developed country, Niger. According to the 2009 Human Development Report, Niger ranks last on the Human Development Index, making it the least developed country out of the 182 nations measured (United Nations Development Program, 2009). As such, the country makes a good test case for applying the three step framework for CDM success. The analysis begins by discussing project possibilities in Niger and the industries available for hosting projects. It then estimates the greenhouse gas impacts and sustainable development benefits from the selected case studies. In addition, the projects' financial standing is estimated using calculations for the internal rate of return (IRR) on investments. Finally, the chapter investigates how countries like Niger would benefit from modified CDM regulations that are more amenable to the situation in LDCs and identifies the project types that best meet the dual goals of the CDM in this setting.

The chapter is organized as follows: Section 3.2 gives background on the CDM and its dual goals; Section 3.3 introduces the three step framework for project success; Section 3.4 applies the framework to Niger through case studies and describes their greenhouse gas, sustainable development, and financial impacts; Section 3.5 discusses the implications of the case study findings; and Section 3.6 concludes with recommendations for changes to the CDM given the findings. Appendix B (Section 3.7) documents the case study methods, data, and calculations.

3.2 CDM Background

The Clean Development Mechanism was a rather late addition to the Kyoto Protocol negotiations. Labeled by some the "Kyoto Surprise", the CDM was added as an enticement to developing countries to support climate mitigation efforts (Werksman, 1998). Negotiators understood that any attempts by developed countries to reduce greenhouse gas emissions would have little impact on mitigating climate change if developing countries continued to increase emissions at projected levels. At the same time, developing countries viewed caps on their emissions as unfairly limiting their ability to develop along a path that other countries had taken before them. Rather than placing a hard emission reduction target on developing countries, the Kyoto Protocol allowed them to increase emissions but participate in climate mitigation efforts by hosting offset projects. In return, the host countries would receive sustainable development benefits from the activities.

From its inception, observers have questioned the possibility for projects to simultaneously meet the dual goals of the CDM. While the greenhouse gas impacts from projects can be easily assessed through the project design documents submitted to the CDM Executive Board, judging the sustainable development impacts is more difficult. The International Institute for Sustainable Development (IISD) has designed a Development Dividends Framework and estimated the development impacts for 215 CDM projects (Cosbey et al, 2006). In general, they find that there is an inverse relationship between the amount of emission reductions created by projects and the development impacts achieved. In other words, projects that are highly successful in reducing greenhouse gas emissions tend to produce the fewest sustainable development benefits. Industrial gas projects and other efforts that reduce high global warming potential gases fair particularly poorly in supporting development goals. Meanwhile, renewable energy and energy efficiency efforts produce some of the best results in supporting development but do not create large amounts of emission reductions. As the development dividends framework was only applied to projects at a relatively advanced stage of development, the host countries analyzed tended to be more developed and no least developed countries were included in the analysis, leaving a significant gap in the literature.

The findings from the IISD report are generally echoed by similar efforts showing a trade-off between emission reductions and development benefits (Boyd et al, 2007; Sutter and Parreno, 2007). Moderating this view somewhat is a review of 744 project design documents by Olsen and Fenhann (2008) that finds only a slightly higher number of sustainable development benefits from small-scale projects over large-scale efforts. They find that small-scale efforts tend to have a greater impact on socio-economic factors while larger efforts create benefits in air and water quality, health measures, and other areas.

Rather than looking at a number of projects across multiple host countries, some researchers have focused their efforts on a few of the leading participants in the CDM. Sirohi (2007) finds that CDM projects in India have tended to benefit individuals with higher incomes to begin with and have not had an appreciable impact on poverty alleviation. In Brazil, da Cunha et al (2007) find that high investment costs and the relatively small scale for available projects have kept renewable energy efforts from locating in Amazonia where they would have substantial development benefits. Rather than focusing on particular host countries, Brown et al (2004) examined differences within a single project type. They found that forestry projects must focus on community engagement and agro-forestry over conservation goals in order to produce local development benefits.

Case studies such as these are augmented by a meta-analysis by Olsen (2007) in which she finds that market forces have tipped the balance between supplying either cheap emission reductions or sustainable development benefits towards the greenhouse gas side of the equation. Given the fact that the CDM has a rigorous oversight system for GHG impacts but leaves the guarantee of development benefits to host country governments, this imbalance should not be a surprise. A review of the approval process by host country governments by Olsen and Fenhann (2008) finds that, among the most active host countries, a simple check-list approach to sustainable development benefits is used and none of the countries require monitoring of benefits at the same level as is required for GHG impacts. Even if project developers claim development benefits in their project design document, few attempts are made to assess whether or not these benefits are occurring and project developers are not held accountable for shortcomings in this area.

While direct development benefits may be uncertain, the CDM can still have an impact through the transfer of clean technologies to developing countries. Dechezleprêtre et al (2009) analyzed 644 registered CDM projects and found that the likelihood of technology transfer actually increases with project size. The authors also found that projects implemented through a developed country subsidiary are more likely to have technology transfer and the level of technological capabilities in the host country can be a benefit or a detriment to technology transfer depending upon the project type. Findings from a larger study by Seres et al (2009) that includes both registered and proposed projects support the correlation between technology transfer and project size as well as the importance of developed country involvement. The authors also found that there is a diminishing return over time in countries with multiple projects of a similar type. In Brazil and China, newer projects tend to have lower rates of technology transfer than similar efforts that preceded them. Much like the work analyzing development impacts, the analyses on technology transfer possibilities within the CDM have primarily focused on emerging market economies. Throughout the research on meeting the dual goals of the CDM, the fact that very little effort has been expended on least developed settings remains a missing portion of the literature. This chapter aims to fill that gap by investigating the potential impacts of CDM projects in a particular least developed country and assesses project success through a three step framework described next.

3.3 CDM Project Success: Availability, Profitability, and Meeting the Dual Goals

In order for CDM projects to be successful, they must pass three tests: availability, profitability, and meeting the dual goals of the mechanism. As Figure 3.1 demonstrates, failing either of the first two tests means that a CDM project is unlikely to be implemented, while failing the third test will result in an unsuccessful project as measured by the goals of the CDM.

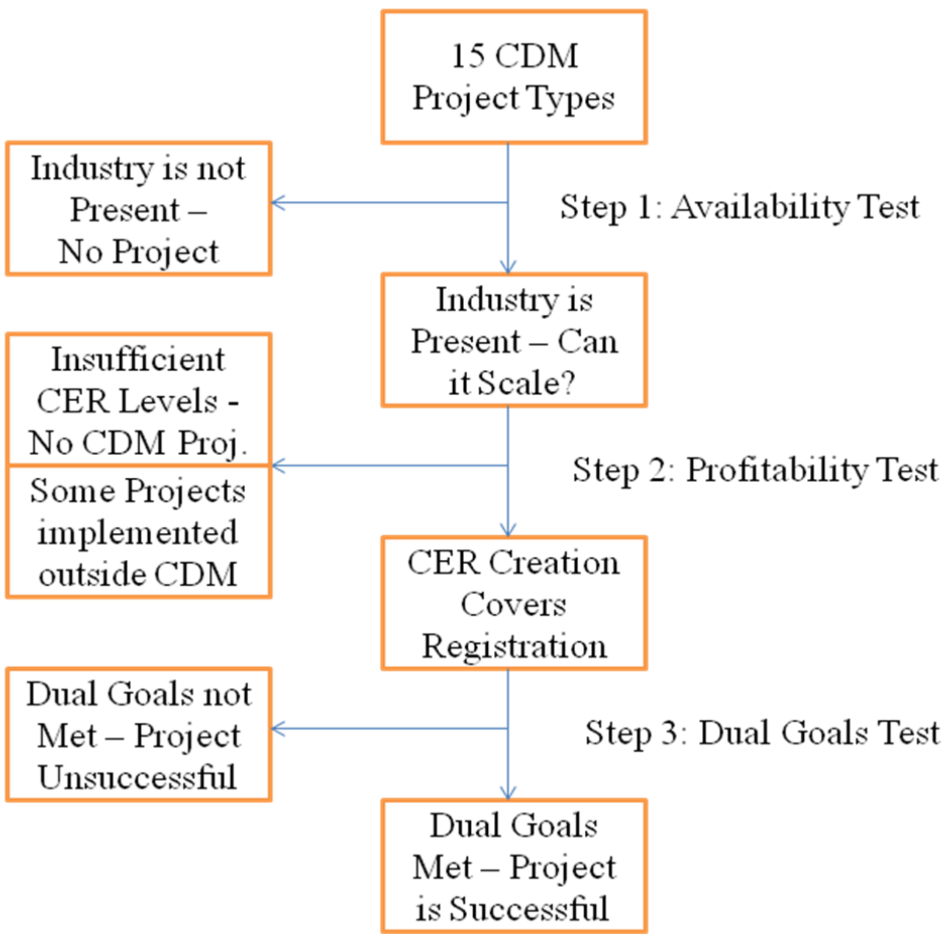

Figure 3.1: CDM Success: A Three Step Framework

3.3.1 Project Availability

While the Clean Development Mechanism allows developing countries to host projects in 15 different project areas, conditions in some host countries may restrict the available opportunities to fewer sectors. The technology areas that are eligible for inclusion in the CDM are divided into the following project types, with some efforts qualifying for multiple areas (UNFCCC, 2009):

1. Energy Industries – Renewable and non-Renewable Sources
2. Energy Distribution
3. Energy Demand
4. Manufacturing Industries
5. Chemical Industries
6. Construction
7. Transport
8. Mining/Mineral Production
9. Metal Production
10. Fugitive Emissions from Fuel (solid, oil, and gas)
11. Fugitive Emissions from Production and Consumption of halocarbons and SF_6
12. Solvent Use
13. Waste Handling and Disposal
14. Aforestation and Reforestation
15. Agriculture

One reason that least developed countries may be under-represented in the CDM is that they have fewer industries than emerging markets from which projects can originate. Larger countries with more advanced and diverse economies such as China and India are likely to have industries operating in all 15 categories of CDM projects. On the other hand, smaller and less developed countries may not have significant manufacturing, chemical, or mining industries. Even within the renewable energy sector, smaller countries may only have access to a single renewable energy source, such as wind, whereas larger countries with varied geography can diversify between multiple renewable sources such as solar, hydro, wind, and biomass. If an industry is not available or if project types within one of the 15 categories are not possible, a host country will be limited in its ability to develop projects.

3.3.2 Project Profitability

For projects that are available in a particular host country, project developers will only pursue those efforts that return a profit. As is described in Chapter 2, one of the key calculations to undertake in assessing potential projects is whether or not the carbon revenues in terms of CER production are large enough to justify the registration and monitoring costs to participate in the CDM. Even if a project returns a net profit, it may not be implemented as part of the CDM if the carbon revenues do not cover the registration costs.[5] In this case, project developers are better off implementing the project

[5] Whether profitable or not, project developers must demonstrate that activities are additional to what would have occurred without the CDM. On a financial basis, projects can be shown to be additional if they are not financially feasible or if they are less attractive than alternative project activities (UNFCCC, 2008). Beyond financial considerations, additionality can also be shown if the project activities overcome other non-financial barriers. These may include a lack of funding or skilled technicians, high perceived risks, or first-of-its-kind applications (UNFCCC, 2008).

outside of the CDM. A profit-seeking project developer will only pursue the CDM option if they believe that their return in carbon revenues exceeds the costs to participate in the program.

Despite simplified methodologies for smaller scale efforts, researchers have found that significant portions of the registration and monitoring costs for the CDM are largely independent of project size and CER creation (Wetzelaer et al, 2007). Ultimately, this results in an advantage for larger projects as their transactions costs are smaller on a per CER-created basis. From a profitability standpoint, a key characteristic for both project types and potential host countries is how easily the CER creation can be scaled to cover CDM-specific costs. Settings and project designs that can link similar efforts into a single, larger project will have an advantage over more dispersed settings or designs. In addition, projects that displace non-CO_2 greenhouse gases can take advantage of accounting practices that convert GHG impacts to CO_2 equivalents based upon the global warming potential of the gas. Because all of the other regulated gases have significantly higher global warming potentials than carbon dioxide, non-CO_2 projects tend to have higher CER production than those that only deal with carbon dioxide. Countries that lack significant sources of high global warming potential gases cannot benefit from this unintended consequence of the accounting rules.

3.3.3 Meeting the Dual Goals

If an activity is available and returns a profit to the developers, it may be implemented as a CDM project. However, just because a project is implemented does not mean that it will be a successful project. For that, the effort must meet the dual goals of reducing emissions and improving development levels in the host country. Of the two goals, only the greenhouse gas impacts are actively regulated by the CDM Executive Board, helping to ensure that they are occurring. Projects that fail to reduce emissions can be rejected or will have the credited CERs reduced. The fact that project developers have a financial stake in seeking higher levels of emission reductions also makes meeting this goal a stronger possibility. From a sustainable development perspective, the guarantee of benefits is less certain. In theory, projects that fail to support sustainable development goals will not be approved by host country Designated National Authority. As the literature review above demonstrates, some registered projects have supported development goals to a greater extent than others. In order to test how conditions in least developed countries affect project success, we now turn to a particular LDC, Niger, and apply the three step framework.

3.4 Applying the Framework to an LDC: Case Studies from Niger

Niger is a landlocked West African nation on the southern edge of the Sahara desert (see Figure 3.2 below). The country has a land area of more than 1.26 million square kilometers, making it approximately twice the size of Texas (United Nations, 2010). Of this area, only 3.9% is arable, forcing most of the country's 14 million people to live along the fertile strip that forms Niger's southern border (World Resources Institute, 2003). As was mentioned previously, Niger ranks last out of 182 countries on the Human Development Index, a measure that assesses economic, education, and health levels across countries (United Nations Development Program, 2009). Poverty levels in Niger are quite high with more than 85% of the population living below $2 per day

(United Nations Development Program, 2009). Access to modern energy services such as electricity is extremely low with per capita consumption in 2006 of 46 kWh per year (Energy Information Administration, 2010). For comparisons sake, the most active CDM host country, China, has per capita electricity consumption of 1924 kWh per year (Energy Information Administration, 2010). The country's GHG intensity is very low at 0.2 metric tons of CO_2 equivalent annually per Nigerien (compared to 4.3 per person in China), and overall emission levels are a tiny fraction of those for China (0.02%) or even neighboring Nigeria (0.9%) (World Resources Institute, 2010).

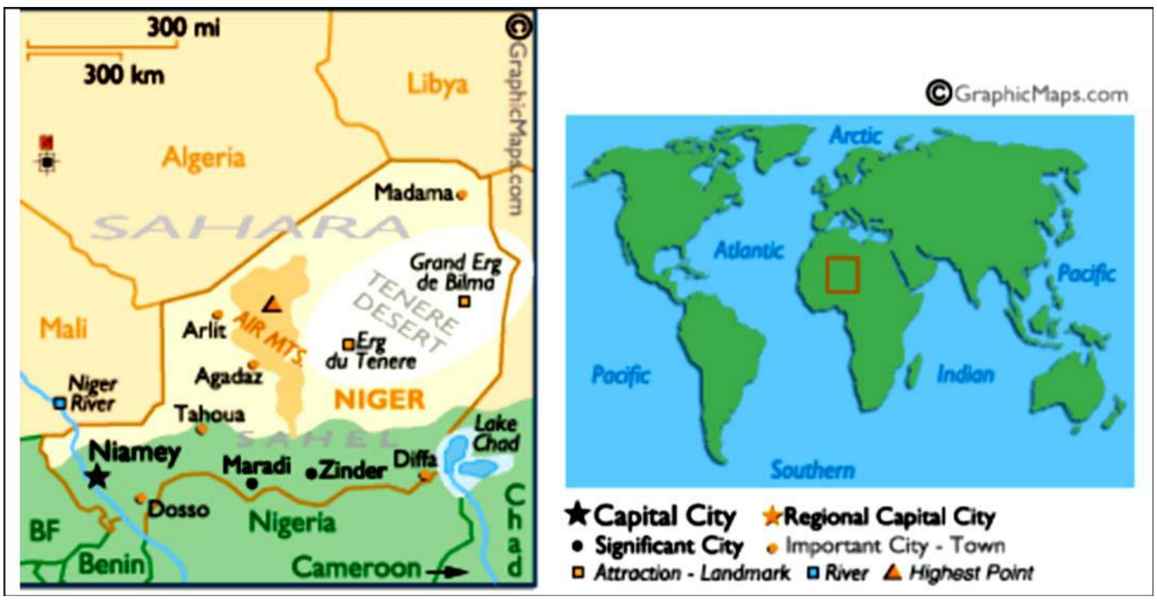

Figure 3.2: Map of Niger (Source: Graphic Maps, online)

While Niger does not represent a large source of greenhouse gas emissions, the country makes an interesting candidate for testing the three step framework for several reasons. First, as the least developed country measured by the UN Human Development Index, Niger is a fitting location to test for the incongruity between the dual goals of the

CDM in least developed settings. At the same time, parties in Niger have shown an active interest in pursuing the CDM and have organized several capacity building efforts, established a host country office to oversee CDM approval, and have begun the process of registering projects with the CDM Executive Board. Finally, although Niger currently has relatively low overall greenhouse gas emission levels and intensities, it is also host to coal and petroleum projects under development that could significantly increase emissions in the future (Republique du Niger, 2008). In other words, Niger is exactly the type of setting in which the CDM can promote clean technology transfer and help to mitigate climate change.

Of the fifteen potential project areas, not all are possible in Niger. The country lacks industries that deal with many of the non-carbon dioxide greenhouse gases, eliminating such categories as Chemical Industries, Metal Production, Emissions from halocarbons and SF_6, and Solvent Use. In other project areas that do have some activity, the scale and concentration of operations are unlikely to be of sufficient size to produce viable CDM projects. This lack of scale eliminates projects in Manufacturing Industries, Waste Handling and Disposal, and Agriculture. Finally, while energy related projects are certainly a possibility, some renewable energy options such as wind or hydroelectricity are limited by the lack of resource availability in the country. The limited project possibilities place Niger at a disadvantage in attracting CDM investments compared to countries like India and China that can host projects in all fifteen areas. Even within the potential project types, Niger is limited by a lack of resource availability (insufficient wind resources) or the small scale of opportunities.

In order to assess the success of potential CDM opportunities, the chapter estimates the financial, greenhouse gas, and sustainable development impacts from a number of existing projects in Niger. While the efforts have not registered with the CDM, they are all of the type that could qualify for the program. Some of the projects are currently operating while others have simply been proposed or studied as potential development projects. In all, six projects are analyzed and estimates are made for the greenhouse gas impacts, sustainable development benefits, and financial balance sheets of the projects.[6] The analyses cover the expected crediting period for CDM projects, which ranges from 21 to 30 years depending upon the project type (UNFCCC, 2009). The following sections detail the methodologies and results for each impact area after the case studies are introduced.

- Energy Efficiency in Government Office Buildings – In 1995, Niger's Ministry of Mines and Energy commissioned studies to estimate the impact of energy efficiency measures at three public buildings in the capital, Niamey. The three buildings studied included the national hospital at the University of Niamey, the Ministry of Finances and Planning, and a third office building with a number of government occupants. The proposed improvements involve replacing lighting and air conditioning units with higher efficiency models, reducing wasteful consumption during non-business hours, and raising thermostat levels to reduce cooling needs (Republic du Niger, 1995a, b, and c).

[6] While the analyses strive to be comprehensive, it is impossible to evaluate all aspects of project costs and benefits. For the financial calculations, evaluation criteria capture the costs and revenues for project developers but leave the social impacts for the sustainable development metrics. Estimating broader economic impacts in terms of GDP and employment would require more sophisticated economic models and data that are not available for Niger. Similarly, while local development impacts are incorporated into the analysis, changes in global economic, environmental, and social systems from projects are not estimated. In general, these ancillary impacts are likely to be less important in influencing the decision of project developers to pursue opportunities in Niger and are thus not as relevant to the current analyses.

- Rural Electrification through Solar Photovoltaic (PV) Installations – The non-governmental organization (NGO) Plan Niger has supplied 27 villages in the Dosso region of Niger with solar photovoltaic arrays. Energy services provided by the solar panels include village water distribution systems and power at local health clinics and community centers. Alternative sources for such services are powered by diesel generators or engines and require imported petroleum products (Plan Niger, 2009).
- Rural Electrification through Electricity Grid Extension – Niger's national electricity utility, Nigelec, has been active in extending the national electricity grid to serve new populations. The case study examines the impacts of extending the grid to serve a village that had not previously had access to formal electricity services. For the baseline scenario, it is assumed that without the grid extension electricity would have been supplied by diesel generators, which are the standard technology in Niger.
- Carbon Sequestration through Acacia Senegal Plantations – With the support of the World Bank, the private entity Achat Service International (ASI) has proposed sequestering carbon through the planting of Acacia Senegal. The project developers have created a project design document but have not yet registered with the CDM Executive Board. Working with local communities in all eight regions of Niger, ASI started planting in 2006 and plans to reach 18,000 hectares under cultivation by 2010. Acacia Senegal plantations produce gum Arabic which can be sold in local and international markets as an input to chemical and food industries (Achat Service International, 2007).[7]

[7] It is unclear from the Project Design Document whether the World Bank support was a loan or a grant. However, the profitability calculations for the case study assume that all costs are levied against future revenues. If the support was a grant, this would simply improve the profitability of the project as the costs covered by the World Bank would not need to be repaid.

- Carbon Sequestration through Natural Regeneration – Farmer managed natural regeneration (FMNR) techniques, coupled with a change in the Niger forestry laws, have resulted in a large increase in forested land over the past 20 years. Farmers use FMNR techniques to harvest fuel wood from fields without cutting down the entire tree, creating a sustainable fuel source for village cooking and heating needs. Using remote sensing techniques, researchers estimate that 5 million hectares of land and 200 million trees have been restored in the Tahoua, Maradi, and Zinder regions of Niger (Reij et al, 2009).
- Biodiesel Production through Jatropha Plantations – The private entity IBS Agro Industries proposes planting 5000 hectares of Jatropha for the production of biodiesel. Partnering with local farmers in six of the eight regions of Niger, IBS will collect the Jatropha seeds and process them to produce biodiesel. The resulting bio-fuel will be used to power engines used to grind grains such as millet and pump water in rural villages. Currently, the engines use imported petroleum-based fuels (IBS Agro Industries, 2007).

3.4.1 Greenhouse Gas Impacts

As one of the primary goals of the CDM, the amount of greenhouse gas reductions from projects is a critical component of measuring project success and plays a direct role in project profitability. Greenhouse gas impacts from CDM efforts are measured in certified emission reductions created by the project activities. Each CER represents one metric ton of CO_2 equivalent reduced from a baseline emissions scenario. For projects that deal with non-CO_2 greenhouse gases such as methane, nitrous oxide, hydrofluorocarbons, etc., the global warming potentials of these gases are used to convert the reductions into CO_2 equivalents. The Niger case studies only deal with changes in carbon dioxide emissions, making these conversions unnecessary.

The greenhouse gas impacts from the Niger case studies range from approximately 1900 CERs for the grid extension project to over 29 million CERs for carbon sequestration through natural regeneration (see Table 3.1 below). Detailed calculations for the GHG impacts from each case study are presented in Appendix B (section 3.7.1). Sequestration levels for the Acacia Senegal carbon sequestration project are drawn directly from the draft project design document (Achat Service International, 2007). The project developers, with support from the International Crop Research Institute for Semi-Arid Tropics, have estimated the total amount of CERs created to reach over 2.3 million for the 30-year crediting period. Estimating carbon sequestration through natural regeneration requires some extrapolation. Researchers have estimated that the amount of reforested land during the past 20 years equals 4,828,500 hectares (Reij et al, 2009, Pg. 14). Assuming that land brought under farmer managed natural regeneration has been relatively steady during this period, the average annual rate of added land is approximately 240,000 hectares per year. The researchers also estimate that in one study area the amount of biomass per hectare is approximately 4.5 metric tons (Reij et al, 2009, Pg.2). Assuming that 2/3rds of the biomass has been added through the natural regeneration techniques, this would give a total of 3 metric tons per hectare or approximately 0.15 metric tons of biomass added per hectare each year (Tappan, 2010). Using carbon fractions of 47% (Tappan, 2010) and a conversion rate of 44/12 for carbon to carbon dioxide, the sequestration estimates during the 30-year crediting period yield over 29 million CERs. This figure is a rough estimate for the amount of carbon sequestered and more accurate calculations would require extensive field measurements before the project could receive credits. However, the figure only covers above ground biomass, meaning that it likely underestimates the amount of carbon sequestered.

The Jatropha bio-fuel project reduces greenhouse gas emissions by displacing petroleum-based diesel that would normally fuel engines to grind grain and pump water. IBS Agro Industries plans to plant 5000 hectares of Jatropha at a density of 2000 plants per hectare, or 10,000,000 plants in all. They estimate plantation productivity of 6 metric tons of Jatropha seeds per hectare. Allowing for 10% losses, this gives a total of 27,000 metric tons of seeds per year (IBS Agro Industries, 2007). A similar Jatropha bio-fuel operation in neighboring Mali that has been in operation for a number of years has found that 3.5 kg of Jatropha seeds are required to produce 1 liter of biodiesel and the biodiesel replaces petroleum-based diesel on approximately a 1-to-1 volume basis (Mali Biocarburant, 2008). Converting the 27,000 metric tons of Jatropha seeds to a mass-basis yields over 6.5 million kg per year of displaced petroleum diesel fuel. Assuming a five-year period to reach full production at plantations and using IPCC conversion factors for diesel fuel yields over 335,000 CERs produced during the 21 year crediting period.[8]

Much like the Jatropha bio-fuel project, rural electrification through solar panels reduces greenhouse gas emissions by displacing petroleum-based fuels with a renewable source. Diesel generators and engines are the standard non-renewable option to supply

[8] The Jatropha calculations only look at the combustion impacts of bio-fuel. If the analysis was expanded to include the total fuel cycle, the Jatropha project would likely look even better. For instance, extraction, processing, and transport of diesel fuel that is imported from the international market has much higher GHG emissions than bio-fuel that is produced locally using traditional agricultural practices (i.e. human and animal powered). However, the CDM methodologies generally take the conservative approach that leakage is only included if it reduces GHG impacts.

rural villages with modern energy services such as water pumps, lighting, and ventilation. The case study analyzes 27 villages supplied with solar panel installations by Plan Niger. Diesel generator alternatives consume 4 liters of diesel fuel per hour and operate approximately 6 hours per day (Habibou, 2009). Across all villages, this yields an estimated 236,520 liters in displaced fuel consumption or approximately 201,000 kg of diesel fuel per year (diesel fuel has a density of 0.85 kg/l). Solar panels powering village health clinics and community centers supply approximately 2.15 kWh per day or 785 kWh per year (Plan Niger, 2009). Locally available diesel generators sized for these applications have consumption rates of 272 g of diesel fuel per kWh generated. Across the 27 villages, this would result in nearly 5800 kg of displaced diesel fuel. Combining the two solar panel applications and using the IPCC conversion factors, the case study yields emission reductions of 622 metric tons of CO_2 per year or approximately 12,750 CERs for the 21-year crediting period (assuming half of the villages are ready in year 1 and the second half in year 2).

Electricity sector projects impact the amount of fossil fuel combusted in order to generate electricity and meet local demand. Niger imports the vast majority of its electricity from neighboring Nigeria. However, several power plants in Niamey augment imports to meet local demand using heavy fuel oil as the fuel source. For the energy efficiency in government offices project, reduced electricity demand results in reduced fuel consumption. Because peak load management is handled by the Niamey power plants and the electricity savings are likely to reduce peak demand, the case study analysis assumes that reduced greenhouse gas emissions will be based on displaced fuel consumption at these units. The energy efficiency studies estimate that electricity savings will result in reduced consumption of over 788,000 kWh per year (Republic du Niger, 1995a, b, and c). Emissions factors for the Niamey power plants average 0.8 kg CO_2 per kWh (see Appendix B for calculations). Applying this emissions factor to the electricity savings yields annual emission reductions of nearly 660 metric tons of CO_2 per year or approximately 13,800 CERs during the 21-year crediting period. The greenhouse gas impacts of this case study assume that the reduced demand in office buildings is not offset by increased supply to other consumers. However, the sustainable development benefits of the project change if the additional electricity generating capacity is now used to bring modern energy services to consumers that did not previously have access. The CDM Executive Board has addressed this situation, known as suppressed demand, and has given credit to projects for reduced emissions even if the amount of electricity does not actually decrease but instead supports new users. The chapter returns to this idea in Section 3.5 and discusses the possible conflict between greenhouse gas and sustainable development benefits.

The final project involves extending the electricity grid to serve new users. As a baseline, the case study assumes that electricity would have been supplied by diesel generators in the village. By electrifying the village through the electricity grid rather than a decentralized generator, the project can take advantage of lower carbon intensive fuel sources in Nigeria. In 2007, the Nigerian electricity grid mix was approximately 28% hydroelectric, 67% natural gas, and only 5% petroleum based fuels (International Energy Agency, 2010).[9] The village in question, Hamdallaye, received electricity services in 2006 and by 2009 had 126 households consuming over 194,000 kWh per year

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[9] Because it is not possible to know the dispatch order for Nigerian power plants, I used the average fuel mix for the Nigerian grid to calculate GHG impacts from the grid extension project.

(Nigelec, 2009). Given the emissions intensity of the Nigerian electricity sector, project activities in the case study result in reductions of 95 metric tons of CO_2 equivalent per year or nearly 2000 CERs over the 21-year crediting period.

3.4.2 Sustainable Development Impacts

In addition to reducing greenhouse gas emissions, projects should also promote sustainable development goals in the host countries. While the UNFCCC has instituted a lengthy and comprehensive system for assessing greenhouse gas impacts from CDM projects, the same cannot be said for the sustainable development benefits. Instead, the CDM Executive Board leaves it to host countries to ensure that sustainable development benefits are occurring. The inherent assumption is that if the host country approves the project, then it must offer some benefits to the local population. In the case of Niger, the Conseil National de l'Environnement pour un Développement Durable (CNEDD) has proposed a preliminary set of development indicators for projects. Included on the list are reductions in global and local pollution, increased employment, improved balance of payments, increased foreign direct investment, cost savings, increased use of locally produced technologies, and a more sustainable use of natural resources (Conseil National de l'Environnement pour un Développement Durable, 2009). However, the lack of CDM activity in Niger has made it difficult to evaluate how effective the above criteria will be in actually supporting development goals or if they will even be considered in the project approval process.

The International Institute for Sustainable Development has designed a Development Dividends Framework for assessing the sustainable development impacts of CDM projects. The indicator includes eleven different criteria areas related to the economic, social, and environmental benefits from projects (Cosbey et al, 2006). Among the economic indicators are significant increases in employment, improved balance of payment and foreign exchange ratios, and boosting the capacity of local manufacturing and users to adapt and utilize new technologies. From a social standpoint, the indicators include benefiting marginalized populations economically, benefiting marginalized populations environmentally, providing energy to energy-poor populations, and increasing the adaptive ability or resilience of communities and regions. Finally, important environmental benefits include reducing polluting emissions, preventing or reducing natural resource degradation, greening the process of energy production, and promoting the development and dissemination of new energy technologies or sources.

The Development Dividends Framework applied by IISD uses weights in each of the categories to create a score of 0 to 100 for sustainable development impacts (0 = little impact, 100 = large impact). The analysis presented here applies the weights used by IISD to create a comparable score for the Niger projects (see Section 3.7.2 in Appendix B for a full list of development categories and weights). In addition, a project receives a score based upon how many of the eleven development categories it positively impacts. For each area that a particular case study is expected to contribute positively, the project will receive a point, giving a possible score range of 0 to 11. For employment, projects that only create jobs during the construction phase will receive a half point whereas projects that create long-term employment will receive full credit.

Applying the indicators to the case studies in Niger, the resulting range of values fall between 3.5 and 8.5 categories with positive impacts and IISD-weighted scores between 29 and 71 (see Table 3.1 below). At the low end, the energy efficiency in government office buildings only creates employment during the retro-fit period, benefits balance of payment by reducing petroleum imports from abroad, boosts the capacity of local users to utilize more efficient technologies, and reduces polluting air emission by reducing electricity production (3.5 out of 11, IISD score of 29). If the reduced consumption in office buildings is offset by new consumption in areas that previously did not have access to electricity, then the project would provide energy to energy-poor populations (an additional category) but would not improve balance of payment issues or reduce polluting air emissions. Extending the electricity grid to serve new consumers creates some construction employment and increases business activity in the new market, increases the ability of local populations to use new technologies, benefits marginalized rural populations economically, provides energy to energy-poor populations, and increases the adaptive capacity and resilience of the community (5 out of 11, IISD 39). The biodiesel project from Jatropha plantations creates long-term employment, improves balance of payment by reducing petroleum imports, boosts the ability of local users to use new technologies, benefits marginalized rural farmers economically, greens the process of energy production, and promotes the development of new energy sources (6 of 11, IISD 53). One potential negative impact from the project could be the displacement of food production for bio-fuel plantations, reducing the adaptive capacity of local populations. Carbon sequestration through Acacia Senegal plantations also creates long-term employment, improves balance of payment and foreign exchange balances by producing an export product in gum Arabic, benefits marginalized rural populations economically and benefits them environmentally by reducing wind erosion and restoring degraded lands, increases the adaptive ability and resiliency of villagers, and reduces degradation of soils and land (6 of 11, IISD 52). The carbon sequestration through natural regeneration techniques benefit marginalized rural populations economically and environmentally, provides sustainable wood fuel to energy poor communities, increases the adaptive capacity of the population, reduces the degradation of forests, and greens the process of wood fuel collection (6 of 11, IISD 55). Finally, at the high end of development impacts, the rural electrification project with solar panels creates employment during project construction, improves balance of payment by reducing petroleum imports, increases the capacity of local populations to use new technologies, benefits marginalized populations environmentally, brings energy to energy-poor populations, increases the adaptive capacity of rural villagers, reduces polluting emissions from diesel generators, greens the process of energy production, and promotes the development of new energy sources (8.5 of 11, IISD 71).

While the development dividends framework gives an idea of the number of development areas impacted by projects, one can also look at the number of people impacted as a measure of development success (see Table 3.1). At the low end, approximately 2600 people would have access to electricity due to the savings from the energy efficiency programs and 3700 people have access to electricity because of the grid extension to the village of Hamdallaye. Between 28,000 and 35,000 people are impacted by the programs to produce biodiesel from Jatropha, sequester carbon through Acacia Senegal plantations, and electrify rural villages with solar panels. By far the largest population impacts occur through carbon sequestration via natural regeneration which has an estimated impact on approximately 3 million people (Reij et al, 2009).

3.4.3 Financial Impacts

While the stated goals of the CDM are to reduce greenhouse gas emissions and promote sustainable development, it is unlikely that projects will be implemented unless they also return a profit to the project developers (the Profitability Test of the three-step framework). One approach to measuring profitability is to calculate an internal rate of return (IRR) for the project. In order to compare costs and revenues over time, financial analyses often designate a discount rate and apply this figure to calculate a net present value for income and expenses. Instead of pre-designating a discount rate, calculating an internal rate of return shows what discount rate would lead to a project that breaks even over the analysis period. In Niger, the national electric utility uses a discount rate of 10% to assess project profitability while some private entities use a rate of 12% (Diarra, 2009). The three relevant variable categories needed for calculating an IRR are the costs, revenues, and the time period of analysis. For CDM efforts, costs include both the normal construction and operation costs for projects as well as registration and monitoring costs to participate in the CDM. On the revenue side, projects will have carbon revenues from the production and sale of CERs and may also create non-carbon revenues from the sale of co-products such as electricity, bio-fuel, and agricultural products. The time period for the case study analysis is determined by the rules governing the CDM (UNFCCC, 2009). The majority of project types have crediting periods of 21 years. Forestry projects that sequester carbon, such as the Acacia Senegal and natural regeneration projects in Niger, are granted longer crediting periods of 30 years. While non-carbon revenues can continue beyond this time period, the IRR analysis will be limited to the 21 and 30 year time horizons depending upon the project type.

As with any forecasting effort, projecting internal rates of return for the CDM case studies in Niger must deal with several sources of uncertainty. Among the most important are the future price for CER sales and the registration and monitoring costs for projects. Rather than selecting a single value for these variables, the analysis will use low and high estimates for the calculations to give a range of IRR values. The World Bank cites prices for CERs of €8-12 for projects at the validation stage, €6-8 for projects at an early development stage, and €7-8.50 for post-2012 production (Capoor and Ambrosi, 2009, Pg. 44). For the Niger case studies, I will use two different values: a lower limit of €6 ($8.22 per CER) and an upper limit of €12 ($16.44 per CER). Transaction costs for registering and monitoring CDM projects have been estimated to be on the order of $200,000 (Cosbey et al, 2005, Michaelowa and Jotzo, 2005) and range in case studies conducted in India from $75,000 to $550,000 (Krey, 2005). These estimates include a 2% tax on CER creation for the United Nation's adaptation fund. As a least developed country, Niger is exempt from this tax. Without the tax, estimated costs in Krey (2005) drop to $65,000 to $338,000. Because most of the case studies are small-scale projects, the Niger efforts will also benefit from reduced registration requirements that come from this designation. However, new project developers in a country that has not yet hosted projects are likely to face higher costs in registering projects until experience gained in the process can lower the costs. For the case studies, I will conduct sensitivity analyses to examine lower and higher estimates of registration and monitoring costs of $100,000 and $200,000 per project.[10]

In general, the projects in Niger return a significant profit with the rural electrification via solar panels being the lone exception (see Table 3.1 for results and Appendix B Section 3.7.3 for calculations). For the solar project, both the low and high IRR estimates are negative. Plan Niger, the project developer, implemented the project as a development effort and does not charge for the services except to cover maintenance costs for the panels. As a CDM project, the sole source of revenue comes from CER generation, which is insufficient to cover the large initial investments in capital and CDM registration costs. Even when the registration costs are cut in half and the CER price is doubled, the project remains a financial loss. Were Plan to charge the going rate for the electricity produced, the IRR would at best rise to -11.5%. However, as a development project, Plan Niger has decided that the capital costs for installing solar powered facilities in the villages are worth the expense. The question then becomes would they benefit from registering the effort as a CDM project. Looking only at the registration and monitoring costs compared to the carbon revenues, this is still an unattractive option. Using the low end of the IRR inputs with registration and monitoring costs of $200,000 and a CER price of $8.22, the project still has a negative IRR of -5.2%. With the most optimistic estimates for CDM costs and carbon returns, the IRR improves to 7.7%, which is on the borderline of profitability. In essence, even under the most optimistic of circumstances, pursuing CDM registration for the solar panel project is unlikely to merit

[10] While the IRR calculations attempt to account for future scenarios, some uncertainties are not included. Chief among them are the price of petroleum-based fuels going forward. Because the price is most likely to increase in the future, it would make the projects that displace diesel and gasoline with alternative sources more favorable. Although this impact is not included in the analysis, it is worth remembering that higher petroleum prices would positively impact the IRR calculations.

the effort and expense. Of course, given the project's significant sustainable development impacts, it is understandable that a development NGO like Plan Niger would pursue the effort despite its poor financial standing.

Of the remaining projects, being a profitable endeavor does not necessarily mean that the developers should pursue registration with the CDM. For example, the energy efficiency at government office buildings project is profitable but the profitability is largely driven by the non-carbon side of the equation. The electricity savings from the project activities cover the construction and maintenance costs and offer a very large payback over the crediting period. However, the CER levels created do not cover the registration and monitoring costs in the low IRR scenario and only have an internal rate of return of 9% in the most optimistic case. In the end, the Ministry of Mining and Energy should pursue the energy efficiency activities but are unlikely to benefit from doing so within the framework of the CDM. The same can be said for rural electrification by extending the electricity grid to serve new users. The non-carbon revenue from the project is driven by the pricing and cost of electricity production in Niger. While all users pay the same price for electricity ($0.165/kWh), electricity from the grid only costs Nigelec 15 CFA/kWh ($0.03125/kWh) whereas electricity from generators costs 120 CFA/kWh ($0.25/kWh) (Nigelec, 2009). In essence, grid connected users subsidize those who receive electricity from generators. Providing grid supplied electricity in place of local generators saves the utility $0.21875 per kWh supplied. For the case study village with annual electricity consumption of approximately 194,000 kWh per year, this translates into an annual profit of over $42,500 (Nigelec, 2009). Costs to connect villages to the electricity grid depend upon the length of the connection and the line capacity. For Hamdallaye, the grid extension in 2006 cost $371,000 (Nigelec, 2009). The Internal Rate of Return for the project is positive but small. At the low end, the project has an IRR of 4.7% while more optimistic assumptions raise the estimate to 7.2%. The carbon side of the calculation has a negative rate of return even under optimistic assumptions. As a non-CDM project, the IRR rises to 9.9%.

For the three projects that fail to repay the registration and monitoring costs through CER production, one approach to analyzing the shortfall is to calculate a multiplier needed to make the carbon side of the investment profitable. Given the amount of CER production from the case studies in Niger, how many of these projects must be bundled together to cover the registration and monitoring costs and return a 10% profit on the investment. For this calculation, it is assumed that the registration and monitoring costs stay constant even though this is unlikely to be true. Table 3.1 gives multipliers for the three projects above for both the optimistic and pessimistic scenarios. In the most optimistic of cases, both the energy efficiency and the solar panel projects are close to justifying the investments to participate in the CDM based upon expected carbon returns. When more pessimistic cost and carbon price estimates are used, the project developers must bundle 4 to 5 similarly sized projects together to make the investment worthwhile. For the grid extension project, between 7 and 30 connected villages are required to make the effort profitable from a CDM standpoint. The minimum project size needed for a 21-year crediting period to return a 10% profit on registration costs of $200,000 given a carbon price of $8.22 requires CER production of 2800 per year. For registration costs of $100,000 and a carbon price of $16.44, the size drops to 700 CERs annually.

The remaining three projects all offer strong financial incentives to both implement the project and to do so as part of the CDM. Of the three, the Jatropha bio-fuel project has the most uncertainty. The carbon side of the equation is positive for both the low and high IRR estimates (30% and 60.5% respectively). However, the non-carbon cost and revenue streams depend upon the price that the project developer pays farmers for Jatropha seeds and the price that they receive for the resulting bio-fuel. IBS Agro Industries (2007) states that the expected price for seeds will be between 50 and 75 CFA per kg (approximately $0.10 and $0.16 per kg given an exchange rate of 480 CFA/$US). Similarly, current prices for diesel would support bio-fuel prices of approximately 288 CFA or $0.60 US per liter. Should either the price for Jatropha seeds rise or the price for bio-fuels drop, the net non-carbon revenue of the project would be reduced. The project also faces uncertainty related to meteorological conditions and pest outbreaks that could significantly impact plantation production. In this case, the carbon revenues of the CDM project would provide some security and help to mitigate the risk of other project variables.

A similar case can be made for the carbon sequestration through Acacia Senegal plantations. Both the carbon and non-carbon net revenues are positive and profitable. The project developers anticipate generating revenues of more than $4 million per year from gum Arabic sales when the plantations are at full production (Achat Service International, 2007). However, these revenues are likely to come several years after the initial project expenses are incurred. Carbon revenues from CER sales could potentially be available earlier than the gum Arabic sales, helping to support the plantations during the interim period. Without the costs and revenues associated with registering as a CDM project, the internal rate of return for the Acacia Senegal plantations would be 32.5%. Participating in the CDM increases the IRR to 37.6% at the low end and 44.7% under the most optimistic of circumstances.

Of all the projects, the carbon sequestration through natural regeneration offers perhaps the strongest financial argument. The fact that farmers have already undertaken the activities without any carbon revenues points to the benefits that they feel the tree re-growth generates. However, with carbon revenues, the chances that farmers will continue the natural regeneration activities and sustainably harvest fuel wood are much greater. The costs and revenues on the non-carbon side of the natural regeneration project are difficult to assess. Farmers undertaking regeneration activities do not pay for new materials or equipment (World Resources Institute, 2008). Labor costs for activities have been estimated at $20 per hectare, though land owners most likely undertake the work on their own and do not actually pay any laborers (Reij et al, 2009). Benefits are even more difficult to monetize. One estimate for the benefits assumes an average value for every new tree of $1.40 per year based upon increased soil fertility, fruit, firewood, and other associated products (Larwanou and Adam, 2008). With an estimated 200 million new trees and approximately 40 trees per hectare, this gives total revenues of $280 million per year (Reij et al, 2009). Another study estimates the internal rate of return for natural regeneration techniques at 31% based upon firewood production and increased crop yields (Abdoulaye and Ibro, 2006), though this figure may underestimate the return by not taking into account other benefits (Reij et al, 2009). Rather than using any of these measures, the case study assumes that the project activities are profitable, otherwise the farmers would not undertake them. The financial analysis simply estimates the profitability of registering as a CDM project. Even under the most pessimistic of circumstances, the cost of registration and monitoring project activities is repaid many times over and the internal rate of return is estimated to be over 300%. Under more optimistic circumstances, the IRR balloons to over 1000%.[11]

Returning to the CDM decision matrix from Chapter 2 (Figure 2.1, page 43), the six case studies can be placed into one of the four cases based upon the expected net carbon and non-carbon revenues from the projects. The solar panel project is not profitable from either a carbon or non-carbon standpoint and is unlikely to be implemented except as a development project (Case A). The grid extension and energy efficiency projects have negative carbon revenues but would be profitable outside of the CDM (Case B). The remaining three projects are all attractive from a CDM standpoint and can be profitably implemented as part of the program. They are profitable from both carbon and non-carbon standpoints (Case C) and should be pursued as part of the CDM. Of the six case studies, none of the projects fall into the area represented by Cases D1 and D2 in which positive carbon revenues make up for losses in the non-carbon side of the equation. The Jatropha biodiesel project is the most likely to fall into this category if either the price for Jatropha seeds rises or the price for biodiesel falls. In this case, the carbon revenues from registering with the CDM would help to make the project profitable and could buffer the effort from outside risks in the marketplace.

[11] It should be noted that social benefit from projects are not captured by any of the IRR calculations. The financial standing of projects is only judged from the project developer's standpoint as they are the ones that must make a profit in order to pursue the project. However, the government may wish to support projects that offer other social benefits not captured by the IRR calculations.

3.4.4 Summary Findings

The case study results show that the efforts in Niger cover a range of values in the impact areas (see Table 3.1 below). Emission reductions are as low as 94 CERs per year for extending the electricity grid to approximately 1 million CERs per year for the natural regeneration project. To give these figures perspective, Niger's overall GHG emissions in 2005 were estimated to be 7.3 million metric tons of CO_2 equivalent (World Resources Institute, 2010). While the solar panel effort is not profitable, the other five projects all have internal rates of return at or above the 10% level that is normally considered an attractive investment opportunity in Niger (Diarra, 2009). Although the solar panel project is not profitable, it does produce the highest score on the development dividends indicator and impacts a relatively large population. Energy efficiency improvements receive the lowest sustainable development score and impact the smallest population. The other four projects all have similar development outcomes with the natural regeneration project impacting the largest population.

The sustainable development impact estimates using the IISD weights can be compared to similar projects analyzed in other countries (Cosbey et al, 2006). The energy efficiency project receives a similar score (29) to efforts in other countries that deal with non-residential projects (average = 23) but is much lower than efforts that improve the efficiency of homes (average = 54). The grid extension project receives a score of 39, which is higher than scores received by fuel switching projects that are the closest match analyzed by IISD (average = 24, high of 34). For both of these efforts, suppressed demand and leakage concerns which will be discussed below draw into question the possibility for significant development impacts and emission reductions at the same time. The Jatropha biodiesel project is also most similar to fuel switching efforts, but its score is much higher (53) due to the local employment and economic impacts for farmers. Should the project create negative impacts in terms of displaced agriculture, this score would drop significantly. Finally, the solar panel project scores much higher (71) than the two solar projects analyzed by IISD (average = 54). This is primarily due to the way in which the Niger project was implemented to provide community needs such as water systems and health services as opposed to powering individual homes and households in the IISD analysis. Unfortunately, the IISD efforts did not assess development impacts from forestry projects, making comparisons with the Acacia Senegal and natural regenerations projects impossible. Overall, the Niger efforts compare favorably on the development impacts generated, though given the relatively small size this fits with the analysis by Cosbey et al (2006) and others that GHG and sustainable development impacts are inversely related. Table 3.1 summarizes the results for the six case studies in Niger.

Table 3.1: Summary Impact of Case Study Projects

Project	Credit Period	Total CER Prod. (tCO_2 eq.)	Overall IRR %	Carbon IRR %	Multiplier	Sust. Dev. (# of DD Categories)	Sust. Dev. IISD Weights	Population Impact
Energy Efficiency Government Offices	21 Years	13,797	48.9% to 79.1%	-4.7% to 9%	4.3 to 1.1	3.5 of 11 1a,1b,1c, and 3a	29	2662 (New Users in Niamey)
Rural Electrification Solar Panels	21 Years	12,751	-23.1% to -19.5%	-5.2% to 7.7%	4.8 to 1.2	8.5 of 11 1a,1b,1c,2b,2c,2d, 3a,3c,and 3d	71	33,836 (27 Villages)
Rural Electrification Grid Extension	21 Years	1,991	4.7% to 7.2%	-16.4% to -8.5%	30 to 7.4	5 of 11 1a, 1c, 2a, 2c, and 2d	39	3708
Bio-fuel Production Jatropha Plantations	21 Years	335,043	39.2% to 42.8%	30% to 60.5%	NA	6 of 11 1a, 1b, 1c, 2a, 3c, and 3d	53	35,000
Carbon Sequestration Acacia Senegal	30 Years	2,344,096	37.6% to 44.7%	61.4% to 102%	NA	6 of 11 1a,1b,2a,2b,2d, and 3b	52	28,399 (41 Villages)
Carbon Seq. Natural Regeneration	30 Years	29,019,889	No* Estimate	335% to 1118%	NA	6 of 11 2a, 2b, 2c, 2d,, 3b, and 3c	55	3,000,000

* The Non-Carbon Revenue and the Project Costs for the Natural Regeneration project were not calculated.

Returning to the three step framework, Figure 3.3 demonstrates how the analysis tool can be applied to the case studies in Niger. Only a handful of project types pass the first test and are available in the country. Of these, the energy projects are of such a small scale that several must be bundled together to increase the CER production and justify the registration and monitoring costs to participate in the CDM. Even if they were able to pass the profitability test, potential negative development impacts (Jatropha biodiesel) and suppressed demand for modern energy services draw into question the possibility for meeting the dual goals of the mechanism. That leaves the two carbon sequestration projects as the most likely efforts to be successful in Niger.

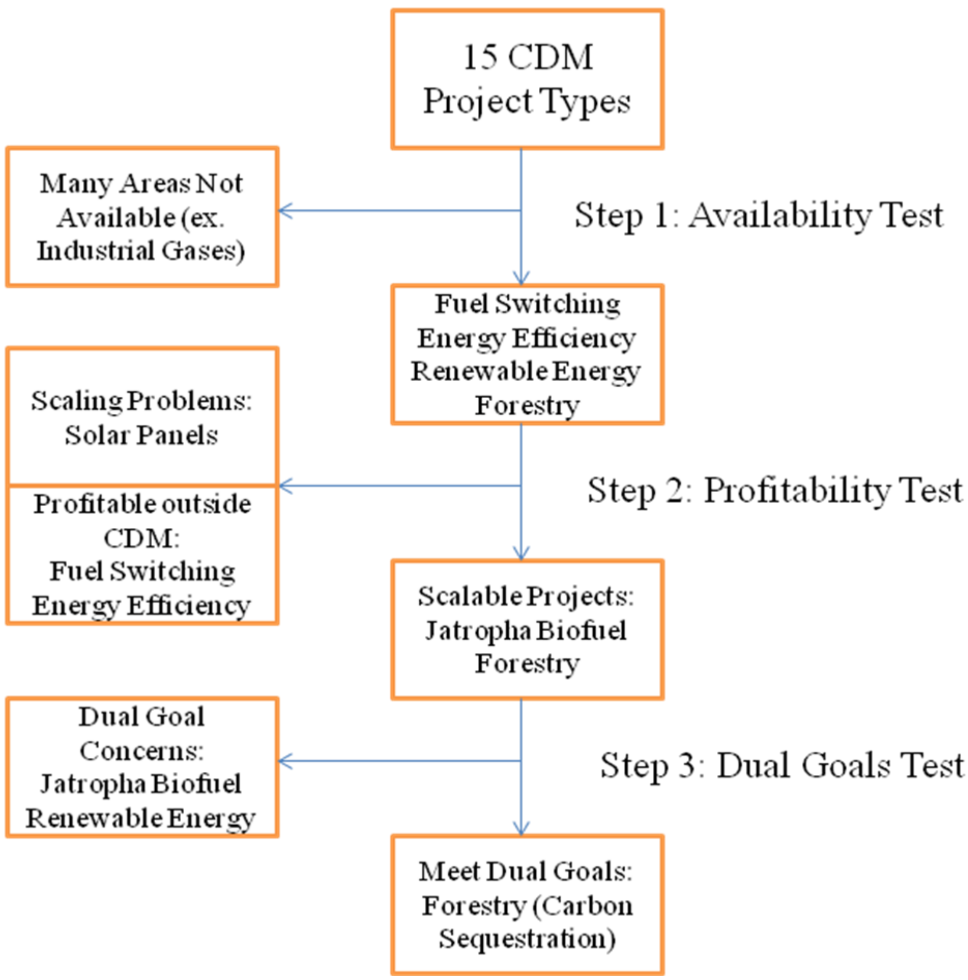

Figure 3.3: Three Step Framework: Applied to Niger Case Studies

3.5 Discussion

When viewed through the three step framework, the case study findings demonstrate that project types are limited in a least developed country like Niger that can meet the dual goals of the CDM while also being profitable. In particular, the two carbon sequestration efforts and the Jatropha biodiesel project appear to offer the most balanced return to the global environment, local sustainable development goals, and financial incentives to project developers. The scale of CER creation for all three projects justifies in financial terms the costs of participating in the CDM. The ability to scale these project types across the country gives them an advantage over other project areas that are limited by such factors as poor infrastructure quality or weak domestic demand. For example, projects that generate electricity such as renewable energy efforts are limited in size based upon the potential demand of consumers and dispersed population centers. Electricity grids with low capacity or restricted geographic range force project developers to size capacity below levels that are optimal from a financial standpoint. It is worth emphasizing that scale is the driving factor in making renewable energy and electricity projects unsuccessful in Niger and other LDCs. Because these project types have a difficult time creating enough emissions reductions to repay the registration and monitoring costs, the projects are unlikely to pass the profitability test. These findings echo the results from the regression work in Chapter 2 in which both emission levels and intensities were found to be important determinants of CDM involvement and activity. Much like Niger, other least developed countries are likely to offer a better setting for forestry and agriculture projects over other project types such as renewable energy technologies that require more supportive conditions.

Of the three successful projects, the Jatropha plantations for bio-fuel production represent the greatest potential for negative impacts. While IBS Agro Industries plans to utilize marginal lands for bio-fuel plantations, the possibility exist that if Jatropha becomes a significant cash crop it could result in farmers switching crops and displacing food production. For a country like Niger that constantly struggles to feed itself and only has 3.9% arable land, such a switch would be disastrous (World Resources Institute, 2003). Furthermore, price uncertainty for Jatropha seeds, bio-fuel, and petroleum-based fuels greatly increases the risks for the project. For the carbon sequestration efforts, the European Union's ban on forestry credits in their Emissions Trading System (EU-ETS) has greatly reduced the demand for forestry projects in the CDM. Concerns regarding the permanence of forestry sequestration have been at the core of this decision. However, deforestation accounts for some 25% of the change in greenhouse gas levels, representing a significant source of climate change that is left out of the regulatory framework (Houghton, 2005). As the case study results demonstrate, forestry projects that sequester carbon are the most promising project type for reaching viable scales in Niger. Their exclusion from the EU-ETS results in limited final demand for forestry CERs created within the CDM and certainly plays a role in LDCs being left out of the mechanism.

For the three electricity related projects, the low demand in Niger reduces the scale of projects in terms of CERs created. Even if the overall projects are profitable, the amount of carbon revenue they produce does not justify the expense of participating in the CDM. Given constraints related to limited electricity demand and the poor distribution system, it is difficult to imagine large enough renewable energy projects to make the registration and monitoring expenses worthwhile to project developers. Two approaches for improving the carbon balance sheets for electricity projects would be to reduce costs through simplified registration procedures and increase CER production by bundling similar projects across the country. The CDM Executive Board has already made some attempts to simplify the registration procedures for projects classified as small-scale. Most of the non-forestry projects in countries like Niger will qualify for these simplified procedures. While the reduced registration burden is helpful, the costs are likely to remain too great for project developers in least developed countries to overcome. Further reductions are needed to make the CDM a viable option for clean development in LDCs.

In addition to reducing registration and monitoring costs, project success can be improved by combining similar activities across the host country into one CDM project. For example, bundling multiple renewable energy projects into one CDM application increases the CER production significantly while having a much smaller increase in registration and monitoring costs. The multiplier variable shown in Table 3.1 gives some idea of the bundling required to make the three energy projects viable in Niger. While bundling already takes place within the CDM, this approach should become a focus for capacity building efforts in LDCs as one avenue for improving the carbon balance sheet for projects. Another approach that has not yet been fully implemented is the idea of programmatic CDM projects. Rather than individual projects, programmatic CDM efforts can best be thought of as policy changes that result in reduced greenhouse gas emissions. Measures such as fuel economy standards or energy efficiency programs increase the scale of operations across the entire country and offer CER creation that makes registering with the CDM an attractive option. In the case of Niger, the natural regeneration project was a result of policy changes by the national government and would qualify as a programmatic CDM effort. International support can further assist in improving CDM chances in least developed settings by providing capacity building, funding data collection needed for baseline calculations, and ushering an initial suite of projects through the registration process. All of these steps would help to reduce the registration costs for projects.

While the steps mentioned above would improve the financial rationale for CDM efforts, they do not deal with the fact that least developed countries present unique challenges for projects addressing energy supply and demand. The CDM registration process aims to ensure that concerns related to the baseline, additionality, and leakage from potential projects do not result in false or unverifiable emission reductions being credited. The idea of suppressed demand is but one example of how least developed countries require a different set of regulatory mechanisms for greenhouse gas offsets. In most LDCs, the amount of electricity supplied is often much less than the amount demanded, even at market prices. Whether through limited generating capacity, fuel shortages, or inadequate transmission networks, a significant portion of the population that is capable of paying for electricity is not able to do so. For the sake of the CDM, some have argued that projects that bring electricity to these populations should not be penalized for a lack of emission reductions simply because the demand was suppressed. In other words, the baseline scenario for a renewable energy project that supplies electricity to the population should count as if the electricity had been supplied through the predominant fuel source in the country. For Niger, this means that electricity projects would receive credit for new production as if they had displaced diesel-fired generators. The end result is a project that receives CERs even though there is no actual reduction in greenhouse gas emissions. Similarly, projects that actually do displace diesel generators are not allowed to receive credit if those generators are moved to another location and continue operating. This represents leakage beyond the project boundaries and would normally be counted against CER creation in the registration process. However, in Niger, grid extension to villages with diesel generators almost always results in the displaced generators moving to new villages to serve the suppressed demand in these settings. Again, the reality is that no reduction in greenhouse gas emissions occurs if the generator continues operating in another setting. On the other hand, the sustainable development impacts of a renewable energy project that simply supplies a cleaner source of energy to populations that already had access to modern energy services are limited. Much greater development impacts are achieved if the project results in energy services being supplied to populations that had been limited to traditional sources such as wood. The situation highlights a tension between the dual goals of the CDM that arises in least developed countries. Renewable energy projects are part of the development process and can certainly play a role in moving LDCs to a cleaner path. But, is the CDM the right mechanism for supporting these efforts if projects do not produce actual emissions reductions? Ultimately, the CDM may not be the appropriate mechanism for supporting renewable energy development in such settings.

3.6 Conclusion

The goals for this chapter were to investigate whether or not CDM projects could meet their dual goals in least developed settings while also returning a profit to project developers. Key research objectives included identifying the characteristics of potential projects that would achieve the dual goals of the CDM while being financially viable and proposing reforms that would help to achieve these goals in countries that currently lack the characteristics. A three step framework was proposed for judging host country and project success based upon availability, profitability, and meeting the dual goals of the mechanism. To test the framework, case studies of potential CDM projects from Niger were analyzed. In doing so, the paper helps to fill a gap in the literature by investigating the potential for CDM projects in least developed countries.

Ultimately, it appears that some CDM projects types are more likely to meet the dual goals than others. In particular, forestry related projects that sequester carbon are more likely to produce significant levels of emission reductions while also promoting sustainable development goals. In the case of Niger, both plantation based forestry projects and programmatic efforts through policy changes demonstrate the potential to be very successful and financially viable. In addition, they address the problem of desertification that has plagued Niger for decades. The sustainable development benefits of the forestry projects follow the pattern described by Brown et al (2004) in which projects with significant community engagement and a focus on agro-forestry produce the best results. However, for forestry projects to succeed, greater acceptance of carbon sequestration in the EU-ETS is required to give the CERs created a source of final demand. Other projects that meet the dual goals in least developed settings may have a difficult time attracting investments as their financial standing is limited by insufficient CER creation. In meeting the profitability test of the framework, the scale of CER creation is extremely important. For project types such as renewable energy efforts, least developed countries lack the scale to make the CDM registration and monitoring costs worthwhile, echoing the findings of da Cunha et al (2007) in Amazonia. Unless the amount of carbon revenue generated by the projects is large enough to cover the registration and monitoring costs of participating in the CDM, project developers will not have the incentive to pursue the opportunity even if the projects are profitable from a non-carbon standpoint and meet the dual goals. Approaches to boost CER levels by bundling multiple projects or to reduce registration and monitoring costs would improve project opportunities in these areas. Finally, conditions in least developed settings are likely to present challenges for project developers pursuing renewable energy projects. Local circumstances such as suppressed demand for electricity complicate the CDM registration process and create conflicts between the dual goals to reduce GHG emissions while promoting sustainable development goals. Compared to more developed CDM hosts such as China and India, Niger offers fewer available project opportunities and those that are available are unlikely to be profitable. A major impediment to the profitability of projects is that expected greenhouse gas reductions and CER creation are not large enough to justify the expense of participating in the CDM. The case study findings demonstrate that sustainable development impacts from projects in Niger would satisfy that portion of the CDM's dual goals. However, the small scale of emission reductions makes projects less viable than emerging market competitors. The scale issues identified by Cosbey et al (2006) in which large scale projects have fewer development impacts appears to be less of a problem in Niger than small-scale efforts lacking the financial incentive to attract project developers.

As international negotiators continue the process of designing the replacement for the Kyoto Protocol, now is the time to address limitations in the Clean Development Mechanism. Among other issues, increasing the involvement of least developed countries in the CDM should be one of the items on the agenda moving forward with climate agreements. Policy recommendations to help achieve this goal include increasing the acceptance of forestry CERs within the European Union Emissions Trading System, reducing the registration and monitoring burden for LDCs, modifying registration requirements to accommodate conditions in least developed settings, increasing the bundling of projects, and supporting an initial suite of projects in countries like Niger. Even with these changes, some project types such as electricity generated from renewable sources will present difficult issues for project developers and regulators alike. Ultimately, the CDM may not be the proper mechanism for supporting such projects. Of course, that does not mean that least developed countries like Niger do not deserve to be part of the clean technology transfer offered by programs such as the CDM. It simply means that other policy avenues are necessary to achieve these goals.

3.7 Appendix B – Case Study Data and Calculations

3.7.1 Greenhouse Gas Impacts

3.7.1.1 Energy Efficiency Government Office Buildings (Republic du Niger, 1995 a, b, and c)

- Existing Electricity Consumption
  - Sonara II: 911,720 kWh per year (1994)
  - Centre Hospitaleir Universitaire: 1,022,296 kWh per year (1994)
  - Ministere de Finance et de Plan: 411,881 kWh per year (1994)
- Electricity Savings
  - Sonara II: 417,114.83 kWh per year (45.75% annual consumption)
  - Centre Hospitaleir Universitaire: 278,130.89 kWh per year (27.2%)
  - Ministere de Finance et de Plan: 92,850.66 kWh per year (23.42%)
- Greenhouse gas reductions from electricity savings of 788,096.38 kWh per year.
  - Apply emission factor of 0.000834 metric tons CO_2/kWh (See calculations in Table 3.3 below)
  - Annual emission reductions of 657 metric tons CO_2 eq. per year
  - Over 21-year crediting period, results in 13,797 metric tons CO_2

3.7.1.2 Rural Electrification – Solar Panels (Plan Niger, 2009)

- 27 Villages with Solar Photovoltaic arrays to power pumps for village water distribution system, health clinics, and community centers.

- Total capacity for each village of installed solar arrays is 320 Wc per community center, 220 Wc per health clinic, and an average of 4309 Wc per water system array. For the 27 villages, this gives a total solar capacity of 130,930 Wc.
- Average pump operation time powered by solar panels is 6 to 8 hours. For fossil fuel powered pumps furnished by the French Development Agency (AFD) in the Maradi region, the operation time is 3 to 6 hours per day (Habibou, 2009). I use 6 hours per day as the figure for displaced pump operation and fossil fuel consumption. The AFD pumps have average consumption of approximately 4 liters of diesel fuel per hour of operation (Habibou, 2009). At six hours per day and 4 liters per hour, average annual fuel consumption per village is 8760 liters. For all 27 villages, this equates to 236,520 liters. Converting to a mass basis with a conversion factor of 0.85 kg/l, displaced fuel consumption by solar panels for water pumping is 201,042 kg of diesel fuel per year.
- Community centers are equipped with lights (18 W x 5 lights), televisions (80 W), and outlets for charging cell phones. Solar panels charge the batteries that then power this equipment in the evening for 5 to 6 hours. Health clinics are equipped with lights (18 W x 6 lights) and refrigerators (80 W), also operated by batteries that are recharged by solar panels. Diesel generators available to meet these needs have fuel consumption of 272 g of diesel fuel per kWh. Each facility (health clinic and community center) requires energy services for approximately 6 hours per day, seven days per week. This amounts to 2.148 kWh of electricity per day, or 784.02 kWh per year. Converted into fuel consumption, this is 213.25 kg

of diesel fuel per village per year. For all 27 villages, this amount to 5758 kg of diesel fuel saved at community centers and health clinics.

- Conversion factors for diesel fuel are 41.4 TJ/Gg and 72,600 kgCO_2/TJ (IPCC, 2006). With total displaced fuel consumption of 206,800 kg of diesel fuel, emission reductions equal 622 metric tons of CO_2 per year.
- Assuming that half of the villages are operational in year 1 and the second half are ready in year 2, this yields a total CER production of 12,751 for the 21-year crediting period.

3.7.1.3 Rural Electrification – Grid Extension (Nigelec, 2009)

- The greenhouse gas impact of extending the electricity grid to new villages depends upon how the idea of suppressed demand is handled. The access to electricity is likely to have a small impact on reducing the GHG emissions in villages, and may even result in an increase in emissions. Services provided by the electricity, such as lighting, fans, and refrigeration, are all new to users and are not actually displacing previous emissions.
- The case study looks at extending the grid to serve the village of Hamdallaye. The grid extension took place in 2006. In 2008, the average number of accounts was 118.5 and the average monthly consumption was 13863.5 kWh or a total of 166,362 kWh. In 2009, the numbers are 126 accounts, the average monthly consumption was 16,202.6 kWh, and total consumption was 194,431 kWh.
- Cities with generators of similar size to those required to power Hamdallaye include Ayarou, In'Gall, Maine, Maradi, and Torodi. The average fuel

consumption for these generators was 259.5 g/kWh in 2007 and 261.6 g/kWh in 2008. Lubricant consumption was 1.60 g/kWh and 1.67 g/kWh in 2007 and 2008 respectively.

- Baseline Emissions: The IPCC Guideline Values for Gas/Diesel Oil (Lower Limits): Net Caloric Value 41.4 TJ/Gg, CO_2 Emission Factor 72600 kgCO_2/TJ (IPCC, 2006). Using the average consumption rates of 2007 and 2008 of 260.55 g/kWh and 2009 electricity demand of 194,431 kWh gives an annual emission level of 152.26 metric tons CO_2 per year. For lubricant used, the Net Caloric Value is 33.5 TJ/Gg, CO_2 Emission Factor 71900 kgCO_2/TJ, average consumption of 1.635 g/kWh, and electricity demand of 194,431 kWh gives emission level of 0.77 metric tons CO_2 per year (IPCC, 2006). Total baseline emissions are 153.03 metric tons CO_2 equiv. per year.
- Project Emissions: There are two possible project scenarios.
    - Scenario 1: The grid supplied electricity can come from generating capacity in Niamey. The two power plants have an emission factor of 0.000834 metric tons CO_2 per kWh (0.834 kg CO_2/kWh). When applied to the consumption in Hamdallaye, this gives an annual emission level of 162.16 metric tons CO_2 equiv. per year. This level actually represents an increase in the amount of greenhouse gas emissions because of project activities.
    - Scenario 2: The other option is to assume that the grid supplied electricity originates from Nigeria. Niger imports approximately 83% of its electricity from Nigeria (Nigelec, 2005). In 2007, Nigeria had carbon

emissions from electricity production of 7,063,598 metric tons of CO_2 to produce 23,600,000 MWh of electricity (CARMA, 2010). This gives an emissions factor of 0.000299 metric tons CO_2 per kWh (0.299 kg CO_2/kWh). Applying this to the electricity consumption in Hamdallaye gives annual emissions of 58.19 metric tons CO_2 equiv. per year.

- Emission reductions from the project activities, assuming that the grid supplied electricity comes from Nigeria, amount to 94.83 metric tons CO_2 equiv. per year or 1991 metric tons CO_2 equivalent for the 21-year crediting period.

3.7.1.4 Bio-fuel Production – Jatropha Plantations (IBS Agro Industries, 2007)

- IBS Agro Industries plans to plant 5000 hectares of Jatropha at a density of 2000 plants per hectare, or 10,000,000 plants in all. Estimates for plantation productivity are set at 6 metric tons of Jatropha seeds per hectare. Allowing for 10% losses, this gives a total of 27,000 metric tons of seeds per year (IBS Agro Industries, 2007, Pg. 7).
- Mali Biocarburant, a private enterprise undertaking Jatropha bio-fuel production in the neighboring country, reports that 3.5 kg of seeds are required to produce 1 liter of biodiesel (Mali Biocarburant, 2008, Pg. 26). However, you have to use more biodiesel than diesel fuel on a weight basis (11.7% more to be exact) given the energy differences (Pg. 18). Specifically, the diesel fuel has 45.34 MJ/kg compared to 39.07 for the Jatropha biodiesel (Pg. 13). On a volume basis, the consumption requirements are much closer (Pg. 18).

- At full production, the 27,000 metric tons of seeds can be converted into 7,714,285 liters of biodiesel. On a volume basis, biodiesel displaces regular diesel at an almost 1-to-1 level (Mali Biocarburant, 2008). Therefore, the volume of displaced diesel fuel is also 7,714,285 liters per year. Converting to a mass basis with a conversion factor of 0.85 kg/l, displaced fuel consumption by biodiesel is 6,557,142 kg of diesel fuel per year
- Plants start producing seeds in 2 years for seedlings (versus 1 year for cuttings). This analysis assumes that it takes 5 years to get to full production. This means that there is no oil production in years 1 and 2, it is at full production in year 7 through 21, and production is scaled up over years 2 through 7.
- IPCC Guideline Values for Gas/Diesel Oil (Lower Limits): Net Caloric Value 41.4 TJ/Gg, CO_2 Emission Factor 72,600 kgCO_2/TJ (IPCC, 2006).
- Converting to CERs gives a total of 335,043 CERs over the 21 year crediting period.

3.7.1.5 Carbon Sequestration – Acacia Senegal Plantations

Table 3.2: Carbon Impacts from Acacia Senegal Plantations – Metric Tons CO_2 Equiv. (Achat Service International, 2007, Pg. 16-17)

Year	Baseline Removal	Project Removal	Leakage	GHG Removal
2006	3532	2,121	0	-1,411
2007	7939	8,573	0	634
2008	12,522	20,225	0	7,704
2009	17,215	36,695	11	19,470
2010	19,089	62,016	23	42,904
2011	19,297	90,133	35	70,801
2012	18,949	118,139	47	99,142
2013	18,108	145,045	51	126,886
2014	16,863	165,070	51	148,155
2015	15,319	178,478	51	163,108
2016	13,585	186,235	51	172,599

2017	11,767	188,265	51	176,447
2018	9,960	184,866	51	174,855
2019	8,240	176,661	51	168,370
2020	6,665	164,518	51	157,801
2021	5,272	149,453	51	144,130
2022	4,077	132,537	51	128,409
2023	3,084	114,803	51	111,668
2024	2,282	97,171	51	94,837
2025	1,651	80,392	51	78,689
2026	1,169	65,025	51	63,805
2027	809	51,430	51	50,570
2028	548	39,780	51	39,181
2029	363	30,092	51	29,679
2030	235	22,264	51	21,979
2031	149	16,111	51	15,912
2032	92	11,403	51	11,260
2033	56	7,893	51	7,786
2034	33	5,344	51	5,259
2035	19	3,538	51	3,467
Total	218,888	2,544,277	1,293	2,344,096

3.7.1.6 Carbon Sequestration – Natural Regeneration (Reij et al, 2009)

- By year 20, the total area under FMNR is 4,828,500 hectares. Averaged over the 20 years, this translates to 241,425 new hectares brought under management each year.
- By year 20, the average amount of biomass per acre in one study area is 4.5 metric tons per hectare. Assuming that 2/3rds of this is new biomass, that would be 3 metric tons per hectare of new biomass or 0.15 metric tons per hectare per year.
- Estimate for carbon fraction of biomass is 47% (Tappan, 2010). Use 44/12 to convert from mass of carbon accrued to mass of CO_2 sequestered.
- Arrive at a figure of 29,019,889 metric tons of CO_2 equivalent in CERs over the 30-year period.

3.7.2 Sustainable Development Impacts

The Sustainable Development indicators proposed by the International Institute for Sustainable Development as part of their Development Dividends metric are as follows (IISD weights in parentheses) (Cosbey et al, 2006, Pg. 14-15):

1) Economic Benefits
    a) Does the project generate employment in significant amounts? (8.2)
    b) Does the project have balance of payment/foreign exchange benefits? (7.6)
    c) Does it boost the capacity of local manufacturing and users to adapt and utilize new technologies? (9.4)
2) Social Benefits
    a) Does the project benefit marginalized populations economically (e.g., employment creation or income supplement)? (8.6)
    b) Does it benefit marginalized populations environmentally (e.g., reduced resource degradation, reduced health-damaging pollution)? (9.3)
    c) Does it provide energy to energy-poor populations? (9.3)
    d) Does it increase adaptive ability or resilience of communities and regions? (8.0)
3) Environmental Benefits
    a) Does the project reduce polluting emissions (air, water, soil)? (10.4)
    b) Does the project prevent and/or reduce natural resource degradation? (10.1)
    c) Does the project “green” the process of energy production? (9.6)
    d) Does it foster development and dissemination of new energy technologies or sources? (9.6)

3.7.2.1 Energy Efficiency Government Office Buildings (3.5 out of 11, IISD 29)

- Development Dividend 1(a) - Creates jobs through construction but no long-term additional employment. (Only 0.5 points for category measure and 2 out of 8.2 points for IISD weighted measure)
- DD 1(b) - If reduced demand is not used to meet the needs of additional customers, then either electricity imports from Nigeria will be reduced or heavy fuel imports to operate power plants will be reduced. Both options address balance of payment issues but are not possible if suppressed demand is met. (IISD: 7.6)
- DD 1(c) - Creates a market for higher-efficiency products such as CFLs and air conditioners. (IISD: 9.4)
- Possible: DD 2(c) - Reduced electricity demand – Reduced blackouts or increased supply for other users. If increased supply, then the number of new customers that can be served by electricity can be estimated by average use rates in Niamey and average home size. However, if the reduce demand from government office buildings is used to supply new customers, then balance of payment improvements and reduced air pollution are unlikely to happen. (IISD: 9.3)

  Population Impacts: The average household size in Niamey is 6.4 people per household. The average electricity consumption for household users in Niamey was 1961 kWh in 2007 and 1825 kWh in 2006. Averaging the 2007 and 2006 usage rates results in 1893 kWh per household per year or an additional 416 households receiving electricity. At 6.4 people per household, this expands electricity services in Niamey to an additional 2662 people. If electricity services were expanded to rural areas, the number of people impacted would be higher as household sizes are larger and the amount of electricity consumed per household is lower.

- DD 3(a) - Reduces polluting emissions (non-GHG) from fossil fuel combustion if suppressed demand is not met and electricity production is reduced. (10.4)
- Additional: Reduced government expenditures result in increased resources for other needs

3.7.2.2 Rural Electrification – Solar Panels (8.5 out of 11, IISD 71)

- DD 1(a): Employment – Construction and maintenance contracts only (0.5 points for category measure and 2 out of 8.2 points for IISD weighted measure)
- DD 1(b): Balance of payment issues – Reduced petroleum importation but solar panels must be imported. As the project was implemented, international NGOs and donor groups paid for the solar arrays whereas local populations would cover fuel costs if diesel generators and engines were used. (IISD: 7.6)
- DD 1(c): Boosts local capacity to use new solar photovoltaic technologies. (IISD gives half of the possible points if a new technology is introduced and another half for training and outreach. The Niger project did the former but not the latter: 4.7)
- DD 2(b): Benefits rural/marginalized populations environmentally by reducing fossil fuel combustion and related pollution. (IISD: 9.3)
- DD 2(c): Provides energy to energy-poor populations. (IISD: 9.3)

- DD 2(d): Increases adaptability through medical facility upgrades and gardening opportunities. (IISD: 8)
- DD 3(a): Reduces polluting emissions (non-GHG) from fossil fuel combustion. (IISD: 10.4)
- DD 3(c): Greens the process of energy production. (IISD: 9.6)
- DD 3(d): Fosters development and dissemination of new solar energy technologies. (IISD: 9.6)

3.7.2.3 Rural Electrification – Grid Extension (5 out of 11, IISD 39)

- DD 1(a): Generates employment during construction. Access to electricity also promotes new business development such as grocery stores, ice production, and entertainment. (Project indirectly provides long-term employment through the opening of new shops and businesses using the electricity. IISD: 4.1)
- DD 1(c): Boosts capacity to use new technologies – New users now have electricity availability and can use technologies such as lighting, refrigerators, televisions, fans, etc. that they were not able to in the past. (IISD: 9.4)
- DD 2(a): Benefits marginalized populations economically – Allows rural populations to run shops, restaurants, refrigerate foods, sell ice, etc. (IISD: 8.6)
- DD 2(c): Provides energy to energy-poor populations – Bringing electricity to communities that did not previously have it or that had to use personal generators. (IISD: 9.3)

- DD 2(d): Increases the adaptive capacity or resilience of communities – Refrigeration, fans, lighting, telephones, and electronic media all increase the adaptive capacity of households and communities. (IISD: 8)

3.7.2.4 Bio-fuel Production – Jatropha Plantations (6 out of 11, IISD 53)

- DD 1(a): Generates employment – Farmers can now grow a cash crop, seed collection requires significant labor, and seed presses will employ seasonal labor. (IISD: 8.2)
- DD 1(b): Balance of payment or foreign exchange benefits – Reduce importation of petroleum products and possible export of biodiesel or Jatropha seeds. (IISD: 7.6)
- DD 1(c): Boosts ability to use new technologies – Jatropha cultivation and biodiesel production would both be new to the country. (IISD: 9.4)
- DD 2(a): Benefits rural populations economically – Increased revenue for rural farmers. Allows them to grow a cash crop in addition to food production. (IISD: 8.6)
- Possible Negative Impacts - DD 2(d): Increases adaptive capacity or resilience of population – Having a source of income from a cash crop would give rural farmers greater flexibility. However, if it displaces food production or if the market crashes, farmers could be more vulnerable than before. (Possible Negative IISD: -8)
- Possible Negative Impacts - DD 3(b): Reduces natural resource degradation – Jatropha can be grown on marginal lands. However, it is possible that it could

also displace agricultural production on productive lands. (Possible Negative IISD: -10.1)

- DD 3(c): "Greens" the process of energy production – Displacing petroleum with biodiesel does "green" the process of energy production. (IISD: 9.6)
- DD 3(d): Creates new sources of energy – Jatropha and biodiesel more generally would be a new source of energy for Niger. (IISD: 9.6)

3.7.2.5 Carbon Sequestration – Acacia Senegal Plantations (6 out of 11, IISD 52)

- DD 1(a): Local employment in villages. 10,000 farming families will manage plantations; approximately 100 full-time jobs will be created through ASI with hundreds of additional temporary jobs each year at gum Arabic harvesting time. Overall population of 41 participating villages is estimated at 28,400. (IISD: 8.2)
- DD 1(b): Foreign exchange inflow of $4 million per year from Gum Arabic sale. (IISD: 7.6)
- DD 2(a): Majority of employment benefits go to rural areas and populations. (IISD: 8.6)
- DD 2(b): Restores degraded lands and reduces wind erosion in rural areas. (IISD: 9.3)
- DD 2(d): Gum Arabic production and sales offer alternative sources of income to subsistence farmers. (IISD: 8)
- DD 3(b): Restores degraded land and reduces wind erosion. (IISD: 10.1)

3.7.2.6 Carbon Sequestration – Natural Regeneration (6 out of 11, IISD 55)

- DD 2(a): Economic Impacts to Rural Populations – Increase food production and expanded use of firewood, fodder, and extra food that families can sell. Women are particularly impacted by the economic benefits. (IISD: 8.6)
- DD 2(b): Environmental Impacts to Rural Populations – Reduces wind erosion and reclaims degraded lands. (IISD: 9.3)
- DD 2(c): Energy to Energy-poor populations – Reduced women's time to search for fuel wood significantly. Creates a sustainable source for fuel wood. (IISD: 9.3)
- DD 2(d): Increases resilience of populations – Populations in FMNR fared much better during the drought and famine of 2004 resulting in much lower death rates than non-managed lands (World Resources Institute, 2008). (IISD: 8)
- DD 3(b): Reduces natural resource degradation – Reduces wind erosion of soil and brings degraded lands back into productive agricultural use. (IISD: 10.1)
- DD 3(c): "Greens" the process of energy production – Creates sustainable fuel wood production. (IISD: 9.6)

3.7.3 Internal Rate of Return Calculations

3.7.3.1 Energy Efficiency Government Office Buildings (Republic du Niger, 1995 a, b, and c)

- Estimated Project Costs
  - Sonara II: 27,561,483 CFA
  - Centre Hospitaleir Universitaire: 8,129,320 CFA

- Ministere de Finance et de Plan: 2,401,500 CFA
- Total Project Costs: 38,092,303 CFA or $79,360 US

- Annual Savings
  - Sonara II: 33,314,960 CFA per Year (from 63,878,992 CFA total)
  - Centre Hospitaleir Universitaire: 22,215,114 CFA per year (from 85,240,694 CFA)
  - Ministere de Finance et de Plan: 7,415,984 CFA per year (from 32,650,521 CFA)
  - Total Annual Savings: 62,946,058 CFA or $131,138
- Carbon Revenues depend upon the expected price received for CERs.
  - For the sake of making conservative estimates, the initial analysis will use a lower end value of $8.22 per CER. At this price, expected carbon revenues are $5400 per year. Over the 21-year crediting period for this type of project, total revenues from carbon are expected to be $113,411, which is significantly less than the $200,000 estimate for CDM transaction costs.
  - At the higher estimate for carbon prices ($16.44) and lower estimate for registration and monitoring costs ($100,000), the CDM side of the financial balance sheet begins to look more positive. The internal rate of return in this case is 9.0%, making the project a possibility in the most optimistic of circumstances.
- Overall, the project has a positive Internal Rate of Return (54.3%). However, this is primarily driven by the non-carbon side of the equation as represented by the

large savings in energy consumption. The carbon side of the equation shows that revenues from CERs are unlikely to compensate for the cost of registering this effort as a CDM project. The government of Niger is better off implementing this project outside of the CDM framework.

3.7.3.2 Rural Electrification – Solar Panels (Plan Niger, 2009)

- Project Costs:
    - Water Tower, Distribution System, and Solar Panel Array: 57,651,000 CFA or $120,106.25 US (Each)
    - Health Clinics: 1,946,000 CFA or $4054.17 (Each)
    - Community Centers: 2,330,000 CFA or $4,854.17 US (Each)
    - Total costs for the combined system is 61,927,000 CFA or $129,014.58 per village.
    - Total cost for 27 villages is approximately 1.67 billion CFA or $3.5 million US. For the sake of calculating the Internal Rate of Return, it is assumed that project construction takes 2 years and the costs will be split evenly between these two years.
- Revenues from the sale of water and other services are minimal. The sales essentially offset maintenance costs. The non-carbon side of the financial equation is shown to be $0 per year once installation is complete.
- CER production is estimated to be 622 per year, with half of the production available in the first year and half in the second. Total CER production is 12,751 and at a price per CER of $8.22 yields carbon revenue of $104,813. Much as with

the energy efficiency project, the revenues from carbon sales are not sufficient to merit the transaction costs of the CDM. Unlike the EE program, the overall project has a negative Internal Rate of Return (-23.1%) and is not likely to be implemented except as a development project by an international NGO.

- If the project was to sell the electricity at the prevailing electricity rate for residential users, 79.25 CFA/kWh or $0.165/kWh (not including fees), the IRR would improve but still be negative. Electricity production for the community centers and health clinics totals 21,168 kWh per year for the 27 villages. With solar array capacities of 540 Wc per village or 14,580 Wc overall, this gives a production rate of 1.45 kWh per Wc per year. Applying this same figure to the water system solar arrays of 4309 Wc gives an estimated electricity production of 6256 kWh per village or 168,913 kWh per year for all of the water systems. This gives a total electricity production of 190,081 kWh per year from all solar arrays. Assuming half are operational in year 1 and the second half in year 2, the IRR improves to -11.5%.

3.7.3.3 Rural Electrification – Grid Extension (Nigelec, 2009)

- The IRR is considered from the project developer's perspective, in this case the national electric utility Nigelec.
- Nigelec charges the same rate for electricity regardless of the source (i.e. from a generator or from the grid). The prevailing electricity rate for residential users is 79.25 CFA/kWh or $0.165/kWh (not including fees). However, electricity from the grid only costs Nigelec 15 CFA/kWh ($0.03125/kWh) whereas electricity

from generators costs 120 CFA/kWh ($0.25/kWh). In essence, grid connected users subsidize those who receive electricity from generators. Providing grid supplied electricity in place of local generator use saves Nigelec $0.21875 per kWh supplied. For the case study village with annual electricity consumption of 194,431 kWh per year, this translates into an annual profit of $42,531.78. (Diarra, 6/4/09).

- In the village, Nigelec charges to connect homes to the grid. For simplicity, it is assumed that the amount charged per home covers the expense of the installation. These figures are left out of the calculation.
- Costs to run electricity lines to villages depend upon the length of the connection and the line capacity. Extension distances are often rather short as the method for village addition is incremental, connecting one village and then moving on to the next village, etc. For Hamdallaye, the grid extension in 2006 cost $371,211.
- With CER creation of 94.83 metric tons CO_2 equiv. per year, the carbon revenues are unlikely to merit CDM registration. Assuming registration and monitoring costs of $200,000 and a CER price of $8.22, it would require connecting 12 villages with similar electricity demand as Hamdallaye to break even with the project costs. With more optimistic assumptions regarding registration and monitoring costs ($100,000) and CER prices ($16.44), only three villages are needed to make the CDM case more realistic. However, this assumes a discount rate of 0%.
- The Internal Rate of Return for the project is positive but small. At the low end, the project has an IRR of 4.7% while more optimistic assumptions raise the

estimate to 7.2%. The carbon side of the calculation has a negative rate of return even under optimistic assumptions. As a non-CDM project, the IRR rises to 9.9%.

3.7.3.4 Bio-fuel Production – Jatropha Plantations (IBS Agro Industries, 2007)

- Total Project Costs for plantation materials and sighting are estimated to be 845,000,000 CFA or $1,760,417 US and would be incurred in the first year of operation.
- Once at full production, Jatropha seed production is estimated at 6 metric tons per hectare. Allowing for 10% losses, this gives 27,000 metric tons per year. At 50 CFA per kg for seeds and 1000 kg per metric ton, this gives annual revenues to farmers of 1,350,000,000 CFA or $2,812,500 US. Divided evenly between the 5000 farmers, each family would receive around $562.50 per year in income.
- The project proponent would purchase the seeds and refine them into biodiesel. Mali Biocarburant report states that approximately 4.6 hectares of plantation are needed to support the operation of 1 lister motor (millet grinders). This means that the IBS plan would support the operation of approximately 1000 installations.
- Jatropha oil press bought in Abidjan, Chinese made, costs 3,800,000 CFA or $7917 US. Would probably need one or more presses in each region. (Personal Communication, IBS, 6/15/09). For now, assume that six presses are bought (1 for each region) in year 2, or an additional $47502 in project costs.
- Finally, assume that the project developer IBS pays farmers for the Jatropha seeds ($2,812,500 per year at full production) but then makes a return by selling this at

below market prices compared to diesel. If the price for biodiesel is approximately 288 CFA/liter, the IRR will be around 39.2%. Much will depend upon the price paid for the Jatropha seeds and the price the biodiesel is sold for.

3.7.3.5 Carbon Sequestration – Acacia Senegal Plantations (Achat Service International, 2007)

- Plantation costs are 89,000 CFA per hectare for sandy soils (Diffa, Zinder, Maradi, and Agadez) versus 150,000 CFA per hectare for hardpan areas (Tilaberi, Niamey, Dosso, and Tahoua).
- 11,927 hectares are planned in low cost areas and 5820 hectares are planned in high cost areas. Total planting costs are estimated to be 1.9345 billion CFA or $4.03 million US.
- Revenues from gum Arabic sales are estimated to be $4 million US per year at full production (2015 onwards, or years 10 through 30).
- Revenues from CER sales are estimated to be $19.27 million over the life-span of the project if planned emission reductions follow as scheduled and the lower estimate for CER prices is used ($8.22 per CER). This estimate uses the lower value for CER price. If CER production is lower than projected, as has been the case to this point, the carbon revenue is likely to be much lower. However, even lower levels would compensate for the $200,000 transaction costs of operating in the CDM.
- Overall, the project has a positive internal rate of return of 42.4%. Both the carbon and non-carbon sides of the equation contribute to the positive returns.

However, the carbon revenues come at an earlier stage and help to ensure the permanence of the project as villagers may give up on the plantations before the later gum Arabic production begins to pay off.

3.7.3.6 Carbon Sequestration – Natural Regeneration

- Farmer Managed Natural Regeneration does not require any purchases of equipment or materials for farmers. This lack of initial investment hurdles is especially important for the risk-averse population in Niger (World Resources Institute, 2008)
- “Farmers regenerating 40 stumps on a 1-ha field could earn an additional 70,000 CFA francs (about US$140) per year—half the average annual income of a poor farming household.” (World Resources Institute, 2008, Pg. 150)
- Benefits from Farmer Managed Natural Regeneration include increased crop yield of 20 to 85% for sorghum and 15 to 50% for millet. This extra yield allows farmers to store surplus for the dry season or to sell a portion at market (World Resources Institute, 2008)
- Costs and Benefits of FMNR: Average cost of $20 per hectare in farm labor, additional crop yields of +100 kg/ha, increased food security for 2.5 million people (average annual per capita food consumption of 200 kg / person, 5 million hectares), 1.25 million farm families involved (Reij et al, 2009, Pg. 2).
- Estimates for the internal rate of return for FMNR are estimated to be on the order of 31% based upon the value of firewood and increased crop production (Abdoulaye and Ibro, 2006). However, this calculation does not include all of the

potential benefits from the practice and is likely an underestimate of the return (Reij et al, 2009).

- Larwanou and Adam (2008) estimate that every tree creates a value stream of $1.40 per year through improved soil fertility and the production of fruit, firewood, and animal fodder. Using FMNR impact estimates of 40 trees/ha and approximately 5 million hectares under management, this translates into 200 million new trees in Niger. At $1.40 per tree per year, this equates to an additional income of $56 per tree each year and a total annual value of $280 million (Reij et al, 2009)

Table 3.3: Emissions Intensity for Niamey Power Plants (IPCC, 2006; Nigelec, 2009)

Power Plant	Year	kWh	Fuel Cons (g/kWh)	NetCalVal (TJ/Gg)	Emiss ($kgCO_2/TJ$)	g/Gg	Metric ton per kg	Metric tons CO_2
Goudel	2007	5601000	227.03	39.8	75500	0.000000001	0.001	3821.02
Goudel	2007	5601000	1.43	33.5	71900	0.000000001	0.001	19.29
Goudel	2008	6500000	227.08	39.8	75500	0.000000001	0.001	4435.29
Goudel	2008	6500000	0.7	33.5	71900	0.000000001	0.001	10.96
Niamey II	2007	4495733	323.97	39.8	75500	0.000000001	0.001	4376.58
Niamey II	2007	4495733	1.48	33.5	71900	0.000000001	0.001	16.03
Niamey II	2008	6575623	335.94	39.8	75500	0.000000001	0.001	6637.87
Niamey II	2008	6575623	1.01	33.5	71900	0.000000001	0.001	16.00
	Metric Tons CO_2	kWh						
2007 Goudel	3840.308	5601000						
2007 Niamey II	4392.611	6500000						
Total	8232.919	1.2E+07						
	Metric Tons CO_2	kWh						
2008 Goudel	4446.252	4495733						
2008 Niamey II	6653.865	6575623						
Total	11100.12	1.1E+07						
2007 Metric Tons CO2/kWh	0.00068							
2008 Metric Tons CO2/kWh	0.00100							
2 Year Avg.	**0.000834**							

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4 Chapter

Mitigative Capacity in Least Developed Countries – A Framework to Assess Barriers to Clean Development Mechanism Projects

Abstract

The Clean Development Mechanism (CDM) of the Kyoto Protocol has been a useful tool in reducing global greenhouse gas emissions. However, it has done so primarily through project activities in emerging market economies rather than least developed countries, falling short of the goal of an equitable distribution of projects across host nations. This chapter develops a framework for analyzing potential CDM host countries and projects that combines determinants of mitigative capacity with a two-tiered approach to capacity building borrowed from disaster risk management and the adaptive capacity literature. The framework is designed to highlight barriers to CDM implementation in particular host countries as well as bridging strategies to overcome these barriers. Through stakeholder interviews, the framework is applied to a particular developing country, Niger, to identify impediments to CDM implementation. The framework is also used to analyze a proposed CDM project in Niger that is approaching registration. Insights drawn from this case study can not only help to identify successful bridging strategies for navigating through impediments in this setting but can also serve as a roadmap for future efforts in Niger and in other least developed countries.

4.1 Introduction

The Earth is warming and a vast majority of world climate scientists agree that society's burning of fossil fuels, deforestation, and other human-induced trends are the primary causes for the changing climate (IPCC, 2007). Among the cruel realities of climate change is that those nations and peoples with the fewest resources to deal with climate impacts are expected to face the most severe changes in living conditions (Adger et al, 2006). From the poor in sub-Saharan Africa to vulnerable populations in coastal Bangladesh, climate change threatens to destabilize regions that already struggle with famine, disease, and conflict. While it is difficult to predict the exact impacts of a changing climate, one probable outcome is that inequality at the global level will increase (Adger et al, 2006). Rich countries with significant resources at their disposal will likely have a greater capability to adapt to changing conditions than resource constrained populations in poorer countries. To improve the prospects for successful adaptation by poor and rich countries alike, policies to mitigate the impacts of climate change through reduced greenhouse gas (GHG) emissions are needed.

The United Nations Framework Convention on Climate Change's (UNFCCC) Kyoto Protocol is the dominant global framework for addressing anthropogenic climate change due to greenhouse gas emissions. As members to the agreement, developed countries, also known as Annex I parties, agree to reduce emissions by a specific amount by 2012 while developing nations or non-Annex I parties are not required to meet emission reduction targets. In order to reduce the compliance cost for Annex I parties, the Kyoto Protocol includes three flexibility mechanisms: Emissions Trading, Joint Implementation, and the Clean Development Mechanism (CDM). All three policy avenues take advantage of different greenhouse gas abatement opportunities across parties, theoretically resulting in a least-cost approach that Nordhaus and Boyer (2000) term "where efficiency" in climate change mitigation (Pg. 122). Instead of meeting their entire abatement obligation in-house, Annex I parties are allowed to pursue cheaper abatement opportunities and apply the resulting emission reductions to their Kyoto commitments.

Of the flexibility mechanisms, only the Clean Development Mechanism opens the Kyoto Protocol to mitigation efforts in developing countries, allowing parties in these nations to host projects that result in verifiable emission reductions. Project activities include efforts in energy-related areas such as renewable energy, energy efficiency, and fuel switching to less carbon-intensive fuels. Outside of energy industries, projects that promote carbon sequestration through reforestation, reduce methane emissions from agriculture, waste management, and mining industries, and efforts that destroy industrial gases such as SF_6, HFCs, PFCs, and N_2O are also allowed (UNFCCC, 2009). In return for hosting projects, developing countries are to receive sustainable development benefits from the activities.

As of October 1, 2009, over 1800 projects have been registered with the CDM Executive Board representing emissions reductions of approximately 319 million metric tons of CO_2 per year (UNFCCC, 2009). The Marrakech Accords stressed "the need to promote equitable geographic distribution of clean development mechanism project activities at regional and subregional levels" (UNFCCC, 2002, Addendum Pg. 20). Despite this call for equity, emerging markets have dominated the CDM while least developed countries, particularly those in sub-Saharan Africa, have largely been absent.

Four countries (China, India, Brazil, and Mexico) account for approximately 75% of registered projects and 80% of emission reductions, while sub-Saharan Africa has hosted 2% of both (UNFCCC, 2009). The current situation clearly does not meet the call for an "equitable geographic distribution" of CDM projects.

Whereas the UNFCCC recognizes that parties have "common but differentiated responsibilities and respective capabilities" to take action in combating the impacts of greenhouse gas emissions (United Nations, 1992, Pg. 4), these differentiated capabilities make an equitable distribution of CDM projects unlikely. Indeed, the dual goals for an efficient, least-cost outcome in mitigation activities and an equitable distribution of CDM projects are at odds with each other as least developed countries' (LDC) low capabilities make them non-competitive in an efficiency-based system like the CDM. A continued trend in which CDM investments flow to emerging markets rather than least developed countries will only serve to reinforce the growing inequality from climate change. In this context, it becomes critical to understand both what capacity deficits stand as barriers to greater CDM involvement and how targeted capacity building efforts can bridge these barriers in LDCs.

In this chapter, I address these questions by developing a two-tiered framework for mitigative capacity within the Clean Development Mechanism. The CDM has instituted a complex system of regulation in the form of project registration and monitoring to ensure that claimed emission reductions are actually occurring. In addition, a second tier of more generic societal capacities and skills are needed to undertake mitigation activities, absorb technology transfers, and accrue sustainable development benefits. The result is two different tiers of capacities required to attract

CDM investments. The regression work from Chapter 2 found that low GHG emission levels, a stagnant electricity sector, limited human capital, and a lack of CDM capacity building can all work to keep countries from entering the CDM marketplace. In addition, deficiencies in the institutional strength of host countries did not appear to be a significant deterrent to investments. While these findings give a broad picture of the factors affecting project distribution, circumstances in any particular host country could be different. Using the two-tiered framework as a guide, a lack of capacity in critical areas will help to explain the disparity in CDM project distribution among host countries. While none of the mitigative capacity areas are necessarily essential for CDM success, the more areas that are missing in a particular setting, the less likely it is that a country will attract CDM projects. Similarly, given a particular set of impediments in a potential host country, can a project developer design a project to navigate this setting and be successful? Can lessons learned from a successful project in one setting be applied to other projects or other settings in the hopes of increasing CDM implementation in least developed countries?

To assess mitigative capacity strengths and weaknesses in least developed countries, I apply the framework to a particular LDC, Niger, where I analyze a relatively successful CDM project approaching registration. As the following literature review and stakeholder interviews suggest, Niger in many ways exemplifies the problems and low mitigative capacity common to many least developed countries. Niger ranks at or near the bottom on measures of economic, institutional, and technological capacity, making it one of the least developed countries in the world. Yet, the country is host to several large-scale fossil fuel development projects and is likely to see both its overall and per capita measures of greenhouse gas emissions increase significantly in coming decades. The combination of these two factors makes Niger a typical setting where CDM projects can help to promote cleaner development but are not able to gain a foothold due to limited mitigative capacity. By applying the framework to Niger broadly and to a particular project, I am able to identify impediments and strategies for overcoming these obstacles while potentially serving as a guide for other LDCs.

The chapter is organized into six sections with Section 4.2 describing the two-tiered framework for mitigative capacity. Section 4.3 reviews the evidence for impediments to investment and growth in developing countries and discusses the relevance of this evidence for mitigative capacity. Section 4.4 applies the mitigative capacity framework to Niger and summarizes stakeholder input on barriers to CDM implementation in this setting. Section 4.5 discusses the impacts of these findings and Section 4.6 concludes the chapter with suggestions on how to improve the chances for CDM implementation in least developed countries.

4.2 Two Tiers of Mitigative Capacity

The concept of mitigative capacity (Yohe, 2001) highlights characteristics that may play a role in promoting or preventing a party from pursuing activities that result in reduced greenhouse gas emissions. In this formulation, mitigative capacity is the "mirror image" of the well-established idea of adaptive capacity to climate impacts with many of the same determinants (Pg. 247). Refining the definition, Winkler et al. (2007) propose that mitigative capacity is "a country's ability to reduce anthropogenic greenhouse gas emissions or enhance natural sinks" (Pg. 692). They define ability as the "skills, competencies, fitness, and proficiencies that a country has attained which can contribute to GHG emissions mitigation" (Pg. 692). The authors propose a suite of characteristics that play a role in determining mitigative capacity in the areas of economics, institutions, and technology (Pg. 695 to 700). From an economic standpoint, mitigative capacity determinants include a country's ability to pay for mitigation, the cost of available abatement opportunities, and the opportunity costs of forgone activities that could have been undertaken in place of mitigation. From an institutional standpoint, the regulatory effectiveness and market rules in a setting are important factors in supporting increased capacity. Societal factors include the education and skills base in a country as well as public attitudes about climate mitigation. Finally, important technology factors include the suite of mitigation technologies available in a particular setting, the ability to absorb new technologies, and the level of infrastructure development in a country. The nine proposed determinants are presented in Table 4.1.

Table 4.1: Determinants of Mitigative Capacity (Winkler et al, 2007)

Economic Factors	**Institutional Factors**	**Technology Factors**
Ability to Pay	Regulatory Effectiveness and Market Rules	Technology Available
Abatement Costs	Education and Skills Base	Ability to Absorb Technologies
Opportunity Costs	Public Attitudes	Infrastructure

Another concept from the adaptation side of the climate change discussion is the idea of a two-tiered approach to building capacity. In general, the two tiers can be thought of as building capacity in a specific area of adaptation coupled with a second tier of structural reform at the societal level. For example, in the area of disaster risk management, Tompkins et al. (2008) believe that "disaster risk reduction needs to be combined with deeper levels of structural reform—such as agrarian reform, education and health reform, income redistribution to name (a) few, for effective vulnerability reduction" (Pg. 737). Without generic reform and capacity building to address larger societal imbalances, adaptation at the specific level (in this case, disaster risk reduction) will not be adequate in addressing the long-term adaptation needs required by likely climate change impacts. In other words, building capacity in disaster risk reduction is necessary but not sufficient to address adaptation concerns if broader societal levels of capacity remain low. In least developed countries especially, risk and societal deficits cannot be decoupled as the roots of incapacity are embedded in economic, social and political structural deficits, making the two sides of disaster risk management inseparable and constantly defining each other in a vicious cycle. Breaking the vicious cycle of poverty and risk depends upon addressing both issues simultaneously in a two-pronged approach to capacity building. This comprehensive approach to capacity building is likely to be needed for both the adaptation and mitigation sides of the climate problem.

Combining these two ideas, mitigative capacity and a two-tiered approach to capacity building, offers a unique analytical framework within which to view CDM barriers and bridging strategies in developing countries. Winkler et al. (2007) proposed their mitigative capacity framework to assess the potential for countries to participate in overall mitigation efforts without particular reference to the Kyoto Protocol or other oversight agreements. Instead, the measures serve as generic assessments of the ability of countries to reduce emissions. Unlike other mitigation efforts, project-based programs such as the CDM require much greater oversight to ensure that real and verifiable emission reductions occur. As such, they require both generic skills and competencies needed for general mitigation and an additional skill set to accommodate the oversight burden of project-based reduction programs. It is here that the two-tiered framework provides unique insights into the barriers to CDM project implementation and can help to explain the lack of project activity in least developed countries. The CDM Executive Board has instituted a lengthy registration and monitoring process to assess the following characteristics of potential CDM projects (UNFCCC, 2002):

1) Baseline – What level of emissions would occur without the project?
2) Additionality – Would the project have occurred without CDM funding?
3) Redundancy – Are the projects already mandated by other laws or regulations?
4) Permanence – Will the emissions reductions continue into the future?
5) Leakage – Does the project create higher emissions levels outside its boundary?

Incorporating these concerns into the CDM oversight process, the registration cycle begins with a project developer that has an idea for a project. This initial idea is often submitted in the form of a Project Idea Note (PIN) to the Designated National Authority (DNA) of the host country government, an agency created by the government to oversee CDM activities and one of the required steps for potential host countries to participate in the CDM. The PIN is usually a short document on the order of 5 to 10 pages that describes the proposed project activities, estimates greenhouse gas and sustainable development impacts, and identifies potential financing arrangements. Once the PIN receives DNA approval, the project developer must create a longer Project Design Document (PDD) that describes the proposed project activities in much greater detail. In addition, the PDD must utilize methodologies approved by the CDM Executive Board at the United Nations to calculate the project impacts in terms of greenhouse gas emission reductions. The methodologies include calculating the pre-project baseline, describing project activity monitoring plans, accounting for any leakage from the project, and proving the additionality of the activity. Other necessary sections for the PDD include stakeholder input from the host country, an environmental impact statement, and expected sustainable development impacts. While the CDM has instituted a lengthy oversight system for ensuring greenhouse gas reductions from projects, verifying that activities result in sustainable development impacts is left to the host country. Positive sustainable development impacts are assumed to occur if the host country DNA approves the Project Design Document.

After receiving approval once again from the host country DNA, the document is submitted to the CDM Executive Board for registration. At this point, an independent third-party called a Designated Operational Entity (DOE) must validate that the methodologies have been correctly applied. If no pre-existing methodologies are available for the project activities, the DOE must first submit a new methodology for approval by the Executive Board before it can be applied to a project. Upon validation, the project is registered and can begin operation as a CDM project. The final step in the process involves a second DOE reviewing the project activity once it is underway and certifying that the proposed level of emission reductions is actually occurring. The CDM Executive Board then issues Certified Emission Reductions (CER) to the project developers that can be sold on the carbon market or can be used to meet emission reduction requirements.

All of the steps included in the registration and oversight process represent additional requirements to operate within the CDM that other mitigation activities are not required to meet. As compared to the mitigative capacity determinants listed by Winkler et al., the skills needed for CDM project developers represent a second tier of capacity requirements. This tier, designated the 1st tier in my framework, is largely comprised of financial, technical and human capital requirements in the areas of greenhouse gas accounting and regulatory burden management. The 2nd tier corresponds to those areas designated by Winkler et al. with emphasis on economic resources, institution levels, and technical needs directly related to the mitigation activity. Table 4.2 summarizes the two tiers of mitigative capacity needed to participate in the Clean Development Mechanism.

Table 4.2: Two Tiers of Mitigative Capacity in CDM

	Mitigative Capacity Determinants	1st Tier CDM Specific Capacity	2nd Tier Generic Capacity
Economics	**Ability to Pay**	• Access to Carbon Financing	• Access to Project Financing
	Abatement Costs	• Project Design Experience	• Domestic Technology • Co-product Production
	Opportunity Costs	• CER Production from CDM Opportunities in other host countries	• Sustainable Development Impact • Competing Needs
Institutions	**Reg. Effectiveness and Market Rules**	• Functional DNA	• Credit Markets • Bureaucratic Hurdles
	Education and Skills Base	• GHG Accounting • CDM Methodologies	• Technical Expertise • Human Capital
	Public Attitudes	• Knowledge of CDM • Acceptance in Government	• Conflict with other Development Priorities
Technology	**Technology Availability**	• GHG Monitoring Equipment	• Range of Technologies
	Ability to Absorb Technologies	• Diffusion of CDM Expertise (GHG Accounting and Project Design)	• Diffusion of Technical Capabilities
	Infrastructure	• GHG Inventory and Data Availability	• Electricity Lines, Roads and Natural Gas Networks

Deficiencies in the 1st tier of mitigative capacity are likely to increase the registration and monitoring costs, or the CDM transaction costs, for project developers hoping to enter the CDM marketplace. All of the steps in the registration process incur costs in addition to the normal construction, operation, and maintenance costs for the actual mitigation activities. These costs are incurred before any revenue either through the creation and sale of CERs or non-carbon co-products of CDM efforts such as electricity or natural gas. Project developers must procure financing to support the up-front costs incurred in project development including the preparation of documents such as the PIN and PDD. Economic factors in the 1st tier of the mitigative capacity framework include access to carbon financing, experience with CDM project design and methodologies, and the comparative CER creation from competing opportunities in other potential host countries. Access to carbon financing through financial mechanisms such as Emissions Reduction Purchase Agreements (ERPA) in which outside actors contract to buy eventual CER production from a Clean Development Mechanism project can improve project developer's ability to pay for mitigation through CDM projects. Similarly, project developers are likely to be drawn to countries with higher expected CER production from projects, resulting in a greater return in terms of carbon revenues for investments. Factors that could increase CER production for projects include the presence of high global warming potential gases, carbon intensive fuel mixes, and demand for large scale energy projects. From a cost standpoint, previous experience with navigating the CDM registration process is likely to reduce the costs for future efforts. This experience can either come through learning-by-doing in the host country itself or through the help of outside expertise and consultants. Ultimately, higher registration costs in a particular country compared to other potential CDM hosts will reduce the likelihood of attracting CDM investments. These 1st tier economic determinants of mitigative capacity within the CDM are in addition to the 2nd tier determinants related to a country's ability to pay, abatement costs, and foregone opportunity costs for project construction, operation, and maintenance.

In addition to the large financial capital needed, several different forms of human and institutional capital are required throughout the CDM registration process. The regulatory effectiveness in a country is important both in dealing with the Designated National Authority to register the project (1st Tier) and in meeting local regulatory requirements for the actual project operation (2nd Tier). As an example, projects dealing with renewable energy must receive DNA approval to register with the CDM Executive Board in addition to agreements with Ministries of Energy or national electric utilities in order to integrate into national electricity grids. From a human capital standpoint, navigating the CDM registration process requires expertise in greenhouse gas emissions accounting in addition to the technical expertise needed to build and operate projects. Public attitudes with regards to CDM projects will depend upon acceptance within the host country government as well as societal acceptance of mitigation activities. At the 1st tier, CDM proponents must educate stakeholders within the host country government about the potential of mitigation opportunities, at least to the point that a DNA is established and approves project activities. At a societal level, meshing the sustainable development impacts from projects with overall national development goals will improve the chances of securing public and political support for mitigation activities.

From a technology standpoint, each project is developed within the context of a particular developing country whose characteristics, from geography and infrastructure to technological capacity, present unique challenges to project success. With respect to the first tier, the technology requirements deal with the ability of project developers to handle the greenhouse gas accounting burden of the registration and monitoring process. This includes both the comprehension of CDM methodologies as well as the data needed to complete the project design documents such as the greenhouse gas intensity of the electricity grid or carbon sequestration rates for native tree species. Sophisticated monitoring equipment may also be needed to evaluate project impacts on GHG emissions. It is not just the presence of these characteristics, but also their distribution throughout the country that is important. In many developing countries, if these skills and competencies are present, they may be confined to capital cities or university centers. A concentration of CDM expertise limits the areas in which projects can be implemented and would tend to reduce mitigative capacity. Of course, similar problems occur if the 2^{nd} tier of technological expertise related to project construction and operation are limited to urban centers or are not supported by national infrastructure networks.

Overall, the process to mitigate greenhouse gas emissions through the CDM is complex, expensive, and requires a number of competencies. Annex I parties participate in the Clean Development Mechanism in the hopes of finding lower-cost greenhouse gas abatement opportunities to help meet their Kyoto Protocol commitments. Developing countries with low mitigative capacity in the 2^{nd} tier of the framework are likely to have higher abatement costs than countries with higher mitigative capacity. In addition, CDM transaction costs are added to the overall price for emission reductions, further increasing the abatement costs through the CDM in a particular host country. It is possible to speculate that settings with higher marginal abatement costs and transaction costs for projects represent reduced gains from trade and would eventually make the CDM an unattractive option for Annex I parties. In essence, reduced mitigation savings (represented by absences in the 2nd tier of mitigative capacity) and additional transaction costs (absences in the 1st tier) can squeeze countries out of the CDM. Given this framework, the question becomes how do least developed countries differ from emerging market economies such as China and India in ways that help to explain the lack of CDM activity in least developed settings? Is the difference between LDCs and emerging markets simply about poverty or is something more at work? The following sections investigate potential explanations from the development economics literature for least developed countries generally before applying the mitigative capacity framework to a particular LDC.

4.3 Development Determinants, Mitigative Capacity and LDCs

The development economics literature is rich with numerous case studies examining the reasons why least developed countries, and sub-Saharan African nations in particular, grow and develop more slowly than other nations. While the economic success of countries such as Botswana (Acemoglu et al, 2001) and Mauritius (Subramanian and Devesh, 2003) demonstrates that African nations can prosper amidst difficult circumstances, the economic performance of the rest of the continent shows that these countries are the exception rather than the rule. In part, this lack of growth and development can help to explain the unequal distribution of CDM projects across host countries, as poorer ones will have fewer resources to pay for greenhouse gas abatement opportunities and lower development levels increase the opportunity costs for mitigation efforts. Beyond the first order characteristics of poverty and low development levels, how might the root causes of these conditions impact mitigative capacity?

Many of the explanations for slow development and growth echo and reinforce the characteristics hypothesized to be important for mitigative capacity in the areas of economics, institutions, and technology. From an economic standpoint, least developed countries and African nations in particular suffer from a lack of investment capital (Boateng and Glaister, 2002). Low savings rates in Africa, estimated at 1/3rd to 1/4th the rates of other developing countries, result in weak domestic financial markets (Abegaz, 2005; Aryeetey and Udry, 2000; Asiedu, 2002; Dupasquier and Osakwe, 2006). In many developing countries, low domestic saving levels can be augmented by foreign direct investment (FDI) to help close the financing gap. Research focusing on the determinants of FDI and its impact on growth find sub-Saharan Africa at a disadvantage in this area as well. Factors affecting many African nations such as political and economic instability, corruption, weak governance, poor infrastructure quality, and a lack of human capital all reduce the attractiveness of a country for FDI (Dupasquier and Osakwe, 2006; Globerman and Shapiro, 2002; Habib and Zurawicki, 2001; Li and Liu, 2005; Noorbakhsh et al, 2001). Meanwhile, factors that promote FDI inflows in other regions, such as higher returns on investment and openness to trade, do not have the same impact in Africa (Asiedu, 2002). Coupled with low domestic savings, the result is an overall lack of capital in sub-Saharan Africa for investment (Boateng and Glaister, 2002). For CDM project developers, weak domestic capital markets require that they seek international carbon financing at an earlier stage, resulting in lower returns on CERs created (Capoor and Ambrosi, 2006).

Much like the story with FDI, policies and initial conditions that promote economic growth in other regions do not have the same impact in sub-Saharan Africa (Block, 2001). Some researchers have faulted the lack of legitimacy found in post-colonial governments in most African countries for this disconnect (Englebert, 2000). This lack of legitimacy promotes policy choices that have more to do with sustaining political power than promoting general development (Collier and Gunning, 1999; Englebert, 2000). The situation is exacerbated in settings with weak property rights or societies with high levels of ethnic fragmentation, conditions that are again found in much of sub-Saharan Africa (Collier and Gunning, 1999; Levine, 2005; Woolcock and Narayan, 2000). Other researchers have pointed to the adverse geographic conditions that characterize much of Africa. In particular, countries that are landlocked, have economies built around natural resource extraction, and suffer from adverse climates are likely to grow more slowly (Collier and Gunning, 1999; Fagerberg et al, 2007; Limao and Venables, 2001; Redding and Venables, 2002; Sachs and Warner, 1997).

Given initial conditions stacked against economic growth, African governments post-independence would have benefited from functional institutions that are the keystones for growth and investment. Instead, a relative lack of such institutions has hindered development (Abegaz, 2005; Goldsmith, 1999; Hope, 2002). Corruption in the public sector has been a particularly rampant concern, creating an uninviting environment for entrepreneurs and reducing much needed investment (Habib and Zurawicki, 2001; Ramamurti and Doh, 2004). Yet, such corruption is not particularly surprising when public servants receive poor pay and must find alternative income sources to augment their livelihoods either through collecting rents or leaving the public sector (Aucoin and Bakvis, 2005; Hope, 2002; Goldsmith, 1999). The "brain drain" of technical expertise to the private sector or out of the country (Baruch et al, 2007; Block, 2001; Fagerberg et al, 2007; Noorbakhsh et al, 2001) exacerbates a general lack of technical capacity in least developed countries (Abegaz, 2005; Archibugi and Coco, 2004). However, amidst conditions that make functional institutions unlikely, some public organizations in developing countries do perform well (Grindle, 1997). By setting performance standards, having autonomy in personnel decisions, and creating a strong organizational culture, public managers can create institutions that function well beyond what one often associates with the developing world (Grindle, 1997). As demonstrated by Botswana, countries with sound institutions are more likely to design and implement good policies, helping to explain the strong economic performance of one of Africa's success stories (Acemoglu et al, 2001). Such virtuous cycles of institutions and development lie in stark contrast to the vicious cycles more commonly found on the continent and point to the vital role capacity building can play in promoting development.

Beyond institution building, improvements in technology are another potential avenue to spur development. Here again, technology "leapfrogs" are often difficult in sub-Saharan Africa as both the creation of technology and the human capital to utilize it are at low levels (Archibugi and Coco, 2004; Fagerberg et al, 2007). A lack of technical expertise in general (Abegaz, 2005; Archibugi and Coco, 2004) is further hindered by factors that push much of the domestic expertise to the private sector or abroad (Baruch et al, 2007; Block, 2001; Fagerberg et al, 2007; Noorbakhsh et al, 2001). The lack of domestic human capital in less-developed settings impacts both the operation of the DNA and the potential for project developers to navigate the CDM registration process without resorting to high-priced international expertise (Capoor and Ambrosi, 2006; Karani, 2000). In addition, overall infrastructure levels are poor on much of the continent, decreasing the potential for new technological advances to diffuse and positively impact the population (Archibugi and Coco, 2004; Limao and Venables, 2001). From a mitigative capacity standpoint, weak infrastructure in least developed countries can add costs to CDM project development as placement of projects may be sub-optimal to accommodate infrastructure availability or extra investments may be needed to upgrade supporting networks such as electricity grids (Capoor and Ambrosi, 2007; Davidson and Sokona, 1999).

Some authors have explicitly examined the relationship between development determinants and CDM involvement with a particular focus on the extent to which FDI flows may predict CDM investments. Much like traditional determinants of FDI, CDM investments are more likely to flow to countries with strong business environments, functional institutions, less political risk, supportive infrastructure levels, and adequate domestic human capital (Cosbey et al, 2005; Ellis et al, 2007; Niederberger and Saner, 2005). Of less relevance for FDI flows, factors such as CDM institutional strength and past experience with project management and registration are likely to be important in drawing climate mitigation investments (Jahn et al, 2004). However, building strong CDM institutions such as the host country designated national authority represents a significant investment for governments that often lack resources. Required tasks for the DNA are costly and include providing data to project developers, coordinating CDM policies with national development and climate goals, promoting and informing the local population on CDM opportunities, and linking project developers with financing (Cosbey et al, 2006). One example of the costs to the DNA come in supporting the data needs of project developers in energy related fields to produce baseline estimates when accurate electricity and fuel consumption data are often scarce in these settings (Cosbey et al, 2005). Given other demands for government resources, scholars have argued that foregone development activities may present substantial opportunity costs in order to establish functional DNAs (Winkler et al, 2007; Yohe, 2001).

As the previous discussion highlights, the congruence between development determinants and mitigative capacity requirements suggests that it is both current development deficits and the root causes of slow development that keep LDCs from participating in the CDM. While the previous discussion covered least developed countries in general, it is worthwhile to examine an individual country and apply the mitigative capacity framework to this setting. With that goal in mind, the chapter now turns to Niger and investigates the impediments and possibilities for the CDM in this setting.

4.4 Niger – Mitigative Capacity in a Least Developed Country

4.4.1 General Country Background

With an estimated population of 14.2 million people, Niger is a landlocked West African nation covering more than 1.26 million square kilometers on the southern edge of the Sahara desert, an area approximately twice the size of Texas (United Nations, 2010). While a huge land area, only 3.9% of the land is arable and the vast majority of the population lives along the southern border where the most fertile land is located (World Resources Institute, 2003). According to the 2009 Human Development Report, Niger ranks last out of 182 countries on the Human Development Index (HDI), a measure that includes metrics for economic, education, and health levels (United Nations Development Program, 2009). The majority of Nigeriens make a living as subsistence farmers and pastoralists with more than 85% of the population living below $2 per day and a corresponding per capita GDP of $627 US on a purchasing power parity basis (United Nations Development Program, 2009). Access to modern energy services such as electricity is extremely low with per capita consumption in 2006 of 46 kWh per year (Energy Information Administration, 2010) and results in per capita GHG emissions of 0.2 metric tons of CO_2 equivalent annually (World Resources Institute, 2010). For comparisons sake, the most active CDM host country, China, has per capita electricity consumption of 1924 kWh per year (Energy Information Administration, 2010) and emissions intensity of 4.3 metric tons per person (World Resources Institute, 2010). On a national basis, overall emission levels in Niger are a tiny fraction of those for China (0.02%) and much less than even neighboring Nigeria (0.9%) (World Resources Institute, 2010).

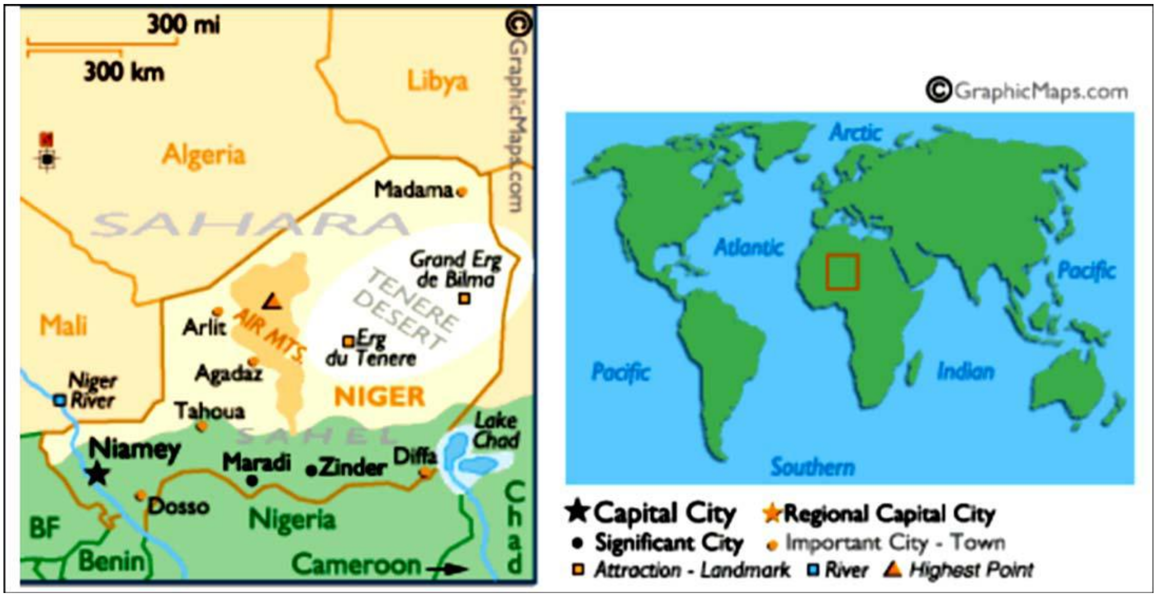

Figure 4.1: Map of Niger (Source: Graphic Maps, online)

With regards to the CDM, Niger is interesting for several reasons. First, as the lowest ranked country on the UN Human Development Index, Niger is likely to be an extreme case for looking at the potential impediments to projects in least developed countries. Second, Niger has been active in pursuing the CDM with multiple projects under development, an established DNA, and several capacity building efforts to promote the CDM. This effort comes despite having relatively low overall greenhouse gas emission levels and intensities. Finally, Niger currently has several large fossil fuel projects under development including coal and petroleum exploration for meeting domestic energy needs (Republique du Niger, 2008). In other words, although current greenhouse gas levels are relatively small, Niger has the potential to increase emissions substantially in the coming years. It is in exactly such an environment that the CDM can foster the transfer of cleaner technologies to help mitigate climate change.

4.4.2 Investment Environment

The overall investment environment in Niger is generally quite poor. The World Bank ranks Niger 172 out of 181 countries in terms of ease of doing business (World Bank, 2009a). Reasons for low investment include corruption, an inconsistent regulatory environment, limited and costly finance options, and poor infrastructure (World Bank 2006). Transparency International's Corruption Perceptions Index ranks Niger 115 out of 180 countries (Transparency International, 2008). In addition, a survey by the World Bank of enterprises operating in Niger found that corruption increases costs and is a serious problem for 58% of firms (World Bank, 2006). The same survey found that, depending upon the sector, informal payments can amount to 4.1% to 13.2% of firms' yearly turnover (World Bank, 2006). From a regulatory standpoint, 60% of manufacturing sector managers believe that courts in Niger are unfair and corrupt, while managers from all sectors spend as much as 15% of their time addressing regulatory and administrative issues (World Bank, 2006). These conditions have forced most of the economic activity to the informal sector of the economy which accounts for 75% of gross domestic product (World Bank 2009b). More recently, stability and risk on a societal scale are of increased concern following the coup d'état in February 2010, the country's third since independence in 1960 (New York Times, 2010).

Financial capital is limited and expensive in the domestic market. Many smaller firms forego formal financing such as loans (World Bank, 2006) and those smaller firms that do seek financing pay on average 2.2% more in interest for the same credit as larger enterprises (World Bank, 2009b). When financing is received, loan guarantees are often exorbitant, averaging 123% of the value of the loan itself (World Bank, 2006).

Meanwhile, operating costs are elevated due to the weak level of infrastructure development in Niger. Being a landlocked country with poor transport infrastructure results in increased costs and reduced external trade as evidenced by the tripling of costs to import or export a container to Niger as compared to neighboring Nigeria (World Bank, 2009b). Problems related to transportation and electricity access are an issue for 41% of firms surveyed by the World Bank, with losses in manufacturing firms' annual turnover of 5.6% due to electricity shortages (World Bank, 2006). Overall, access to modern energy services is low even by sub-Saharan Africa standards with Niger's access to electricity half the rate of the continental average (World Bank, 2009b).

Where investment does take place, it is primarily limited to the mining sector. FDI to this sector has actually risen recently as investments in extractive industries can be profitable and relatively safe without broader economic reform and security (World Bank, 2009b). In the year preceding the recent coup, Niger attracted large investments from several major international enterprises, including the French nuclear company Areva and the China National Petroleum Corporation (New York Times, 2010). The pattern is repeated often in sub-Saharan Africa as extractive industries continue to dominate much of the investment on the continent.

4.4.3 Stakeholder Input – Barriers to CDM Project Development in Niger

In order to apply the mitigative capacity framework to Niger and better understand the potential for and impediments to CDM activity, I conducted thirty in-depth qualitative interviews with project developers and CDM stakeholders concerning project implementation in the country. Given the lack of CDM success in Niger, the interviewee list was expanded to include individuals and organizations with related project experience in addition to CDM-specific expertise. The interviewees included domestic and international development workers, energy industry experts, Niger government employees, local NGO and civil society members, private industry groups, local bank representatives, and five Niger CDM proponents at varying stages of project development. The interviews were conducted over a three-month span from May to August of 2009 in the capital city, Niamey. All interviews occurred in the offices of interviewees and the average length of interviews was approximately one hour, though five of the interviews involved multiple visits and were longer in length. Interviews were conducted in French and English. Appendix C (Section 4.7) gives the number of interviewees by job category followed by a general list of questions asked at each interview. Some additional questions were asked given the specific knowledge and answers given by interviewees.

The general picture from these interviews is that Niger is at a disadvantage in attracting CDM investments because project development and implementation incur higher costs but give a smaller return for the investment. The smaller returns stem from the smaller scale of available projects and the lack of high global warming potential greenhouse gases such as HFCs, methane, and N_2O. Once again, these findings follow the results from Chapter 2 in which higher emission levels and intensities promote greater CDM involvement and activity. Higher project costs are due to a weak domestic credit market, a lack of domestic human capital, bureaucratic impediments when dealing with the government, and the overall poor level of infrastructure in Niger. While the significance of human capital again echoes the findings from Chapter 2, the importance of institutions goes against the regression findings in which variables for institutional capacity were not a significant determinant of CDM activity.

Returning to the mitigative capacity framework, the interviews highlight many areas where Niger is lacking important ingredients for CDM success (summarized in Table 4.3 below). From an economic standpoint, the state of domestic financial markets reduces the ability to pay for both the regulatory side of the CDM and the actual mitigation activities. Bank representatives explained that domestic and regional banks generally loan to businessmen and importers (Personal Interview, 7/29/09). The majority of financing goes to urban areas while rural development projects rarely receive support. The loans that do occur come with a high interest rate, around 12 to 14%, in order to compensate for large default rates (Personal Interview, 7/29/09). Banks do not support energy projects and would not be interested in supporting CDM projects at this time, leaving international donors or the government to finance these efforts (Personal Interview, 7/29/09). Project developers echoed the statements by bank representatives and noted that a lack of financing is the primary problem with project development in Niger (Personal Interview, 7/22/09). The government has shown only mild interest in the CDM with funding for the capacity building efforts coming from international donors (Personal Interview, 7/22/09). Much of the focus and financial resources at the national level have gone to the large fossil fuel projects under development (petroleum and coal) as well as a hydroelectric dam (Personal Interview, 6/17/09). With the exception of a few lower-level government officials, familiarity and enthusiasm for the CDM within the government are quite low.

Compounding the problem of a limited ability to pay for CDM projects is the high abatement costs for mitigation in Niger. While the capacity building efforts have started to build CDM expertise in the country, a lack of experience in registering projects creates high initial barriers to project development. One government employee familiar with the situation noted that Niger needs further capacity reinforcement when it comes to the CDM (Personal Interview, 8/5/09). The methodologies and procedures change constantly and the only domestic CDM experience is in the capital (Personal Interview, 6/22/09). Even then, comprehension of the methodologies is very difficult and Niger would benefit from simplified methodologies (Personal Interview, 6/22/09). With French as the country's official language, a lack of English language fluency serves as another barrier as all CDM documents must be written in English (Personal Interview, 6/22/09). Project developers without English proficiency can hire personnel to translate but it is an additional cost. The capacity building efforts that have taken place to this point have produced several of the relatively simple Project Idea Notes, but in order to take the next step to Project Design Documents will require significantly more training or outside expertise (Personal Interview, 7/22/09). Niger has very few specialists with greenhouse gas accounting knowledge and those that are available are not necessarily familiar with the rules and regulations governing CDM project registration (Personal Interview, 7/22/09).

Perhaps more problematic to CDM success is the lack of domestic technical expertise needed for project construction and operation. Niger suffers from the classic "Brain Drain" scenario found in much of the developing world where a weak local education system combined with limited opportunities for jobs leads to a situation in which those who leave the country for education stay abroad (Personal Interview, 6/9/09). Government agencies are particularly hard hit. According to one international development expert, Niger government ministries are understaffed (at least in terms of quality if not quantity) and their senior leadership is older with outdated knowledge (Personal Interview, 6/28/09). International NGOs attract all of the young, talented Nigeriens and leave very few working for the government, which has lower salaries and a promotion system based more upon patronage than performance (Personal Interview, 6/28/09). Whether inside the government or in the NGO community, human expertise is missing in many technical areas. Niger tends to have technical generalists but people must go through 6 months to 1 year of training to get expertise in specialized areas that are becoming more important such as solar power, petroleum, coal mining, and hydroelectric dams (Personal Interview, 7/9/09). This lack of domestic expertise increases the cost for CDM efforts as project developers must again train local staff to do the work or seek higher-priced international experts. The expertise that is available in the country is often concentrated in the capital with limited presence in rural areas or smaller cities (Personal Interview, 7/7/09). The concentration of technical expertise in Niamey limits the geographic scope for project development or increases transportation costs to operate in distant locations.

Further costs are added when project developers interact with the government. According to one international development worker, government agencies can have a few really good people in an organization, but there are no overall great, functioning ministries (Personal Interview, 6/9/09). Public management is based on the French colonial system and Niger has a large structural government (33 different ministries) but does not have the money or people to make it work. The bureaucracy is too big and requires too much of the state's limited resources (Personal Interview, 6/17/09). Dealing with the bureaucracy is difficult as there are no standard operations. The lack of procedures and controls is a big problem and adds costs as people can come up with new demands as a means to get bribes (Personal Interview, 6/28/09). One Niger government employee noted that the government lacks a fluid communication system with and between ministries (Personal Interview, 7/8/09). The government does not have a forum for communication and any communication that does take place is very formal and official. In order to receive government approval for an activity, interested parties must get a written request with stamps and signatures without the benefit of a website or email avenues to communicate. Requests that should take hours or days to process, instead take weeks to months (Personal Interview, 7/8/09). With specific reference to the CDM, project developers must receive approval from Niger's Designated National Authority before a project can be registered. An environmental office with significant climate change expertise served as the original DNA on an interim basis. The benefits of this group as the DNA included having a concentrated, motivated, and knowledgeable government partner to assist in the registration process for CDM projects. The DNA has since been expanded to include representatives from many other ministries and is likely to be less motivated to pursue CDM opportunities, slowing the registration process significantly (Personal Interview, 6/22/09).

Additional costs are also incurred by the limited infrastructure in the country. One international development worker stated that geography and the poor state of infrastructure networks in Niger are serious constraints (Personal Interview, 6/18/09).

Major roads are functional, but feeder roads are very poor in general and impassable during the rainy season. It is much more expensive to work in Niger because of the large distances and poor roads. For example, similar school building projects in Niger and neighboring Burkina Faso had approximately the same budget for the exact same school design but twice as many schools were built in Burkina Faso as in Niger (Personal Interview, 6/18/09). Internet communications are also a problem as the government lacks an email network or functional website. Instead, government employees all use yahoo as their official email provider and when people move, it is difficult to find them. The government previously had a functional website that included contact information, official documents, and data but it is no longer available (Personal Interview, 6/28/09). For CDM project developers, this greatly complicates the registration process as the greenhouse gas information needed to compile required documentation is difficult to find. Finally, electricity has been a continuous challenge over the past three years. Generating capacity has not kept pace with population growth and back-up generators are ubiquitous at banks, cell phone towers, and government and private offices (Personal Interview, 6/28/09). This adds extra costs to most project developers but could serve as an opportunity to CDM efforts in energy areas. However, CDM projects could be hurt by the poor electricity networks if project locations are dictated in sub-optimal ways based upon electricity grid access rather than resource availability.

In a country with as many development concerns as Niger, the opportunity costs of pursuing CDM projects at the expense of other priorities is obviously a significant concern. The country is among the poorest in the world and has needs in a wide range of areas from health to education to economic development. However, despite such critical constraints, Niger's deep deficits could actually serve as an argument in favor of CDM projects depending upon how closely the sustainable development benefits of activities match local and national development priorities. The dual goals of the CDM to reduce emissions while improving development levels envisioned just such a synergy of climate mitigation and development. It is this hope that has spurred the CDM activity taking place in the country right now. In addition to the capacity building efforts, project proponents have taken action to start the registration cycle, with one particular project progressing as far as the creation of a Project Design Document. The chapter now turns to these efforts with the goal of identifying strategies for further CDM success in Niger.

Table 4.3: Mitigative Capacity Barriers in Niger

<table>
<tr><th></th><th>Mitigative Capacity Determinants</th><th>1st Tier
CDM Specific Capacity</th><th>2nd Tier
Generic Capacity</th></tr>
<tr><td rowspan="3">Economics</td><td>Ability to Pay</td><td>• Weak Domestic Credit Markets
• Little Support by Government
• No Carbon Financing</td><td>• Weak Domestic Credit Markets
• No Project Financing</td></tr>
<tr><td>Abatement Costs</td><td>• No CDM Project Design Experience
• Lack of English Fluency
• High Registration Costs</td><td>• Weak Domestic Technical Capital
• Weak Market for Co-Products (Electricity)
• Landlocked Adds Shipping Costs</td></tr>
<tr><td>Opportunity Costs</td><td>• Generally Low CER Levels from Available Projects
• Competitive Disadvantage</td><td>• Niger has many competing needs
• High Poverty Levels</td></tr>
<tr><td rowspan="3">Institutions</td><td>Reg. Effectiveness and Market Rules</td><td>• Current DNA – Diffuse Interests and Little Knowledge of CDM</td><td>• Many Bureaucratic Hurdles Throughout Government
• Corruption</td></tr>
<tr><td>Education and Skills Base</td><td>• Limited Knowledge of GHG Accounting and CDM Methodologies</td><td>• Brain Drain – Limited Technical Expertise
• Technical Generalists</td></tr>
<tr><td>Public Attitudes</td><td>• Few People in the Government Know about CDM</td><td>• Conflict with other Development Priorities</td></tr>
</table>

Technology	**Technology Availability**	• Limited GHG Monitoring Equipment	• Limited Range of Technologies Available
	Ability to Absorb Technologies	• All GHG Accounting and Project Design Experience Concentrated in Capital	• Most Technical Capabilities Concentrated in Capital
	Infrastructure	• Lack of GHG Inventory and Data Availability	• Very Weak Electricity, Roads and Natural Gas Networks

4.4.4 CDM Project Possibilities – Bridging Strategies for Success

While the greenhouse gas profile and mitigative capacity indicators would appear to make Niger an unlikely host for CDM activity, a number of groups have started the process of designing projects and navigating the registration process. Project developers include both private and public actors and focus primarily, though not exclusively, on energy-related efforts. Nine projects in all have created Project Idea Notes, including one that has progressed to the Project Design Document with the help of the World Bank. The projects that have taken the relatively easy step of developing PINs include energy efficiency improvements at hospitals and a cement plant, solar powered water pumps for irrigation and human consumption, rural electrification via solar photovoltaics, fabricating cooking briquettes from biomass residue, biodiesel production from Jatropha, and composting solid waste at landfills (Conseil National de l'Environnement pour un Développement Durable, 2009). Project developers were aided in creating the PINs through two capacity building efforts spearheaded by the United Nations Environment Programme's (UNEP) Risoe Centre on Energy, Climate, and Sustainable Development. The goals for the capacity building meetings were to introduce stakeholders in Niger to the CDM, explain the project cycle, train local experts, and begin developing several

Project Idea Notes (UNEP Risoe Centre, 2010). A second phase of capacity building efforts are planned that would expand the information campaign on the CDM to new sectors (for example financial institutions), identify regulatory and legal requirements needed to improve the enabling environment for projects, and expand the list of host country experts and consultants for CDM management. However, they have not yet been funded. While most of the PINs developed through the initial phase of capacity building remain at this stage, one project has progressed to create a Project Design Document and has actually begun operation (though it has not yet been registered with the CDM Executive Board). Applying the two-tiered framework of mitigative capacity to this project highlights strategies to help shepherd other potential projects through the impediments in Niger (see Table 4.4 below).

With funding from the World Bank BioCarbon Fund, the private entity Achat Service International (ASI) plans to plant approximately 18,000 hectares of acacia Senegal for gum Arabic production and carbon sequestration. Plantations will be located in all eight regions of Niger and will sequester an estimated one million metric tons of CO_2 equivalent by 2017 (Achat Service International, 2009). As of 2009, approximately 8000 hectares of acacia Senegal have been planted. The project grew out of the Risoe Centre capacity building exercises and represents a public-private partnership with multiple organizations bringing unique expertise to the effort. As the private entity, ASI has experience in marketing and selling gum Arabic, an ingredient used in chemical and food industries, on the international level. Crop research and measurement is supplied by the International Crop Research Institute for Semi-Arid Tropics (ICRISAT), a public research institute located in Niger. Employing crop and soil scientists familiar with the local setting, ICRISAT provides technical training to rural field teams and estimates for plant survival and carbon sequestration rates that serve as the basis for the project's greenhouse gas accounting requirements. The World Bank offered both financial and human capital support in writing the Project Design Document and helped to organize local community efforts through its Community Action Program (PAC). Finally, rural communities supply the labor required to manage tree nurseries, plant acacia Senegal fields, care for plantations, and harvest gum Arabic production.

Viewed through the mitigative capacity framework, the acacia Senegal project takes advantage of a number of unique characteristics that help in explaining its relative success in Niger. To begin with, the project benefited from multiple outside sources of expertise to augment local financial and human capital. For CDM registration, the Risoe Centre trainings provided a baseline level of local expertise in designing projects, managing the registration process, and even educating the DNA on its responsibilities. Meanwhile, the expertise needed to draft the Project Design Document was wholly provided by the World Bank in the form of a consultant with previous experience in writing similar documents (Personal Interview, 5/28/09). The World Bank also provided financial support for project start-up and operation, filling the role that local capital markets were unwilling to play (Personal Interview, 5/28/09). Project revenues from CER production and gum Arabic sales are not expected until several years after the project starts, making the financial support provided by the World Bank a critical ingredient to its success (Personal Interview, 5/28/09). However, the involvement of outside actors such as the World Bank has the potential to result in only limited capacity building in Niger. Rather than training local experts to navigate the registration process or educating domestic financial institutions about the potential for CDM projects, these capacities are dropped into the country for a single project and then disappear. In order to build long-term capacity in Niger for future projects, any external expertise must be combined with capacity building measures to train local institutions so that future CDM projects can be initiated and managed internally. As the Acacia Senegal project shows, combining local strengths with strategic outside assistance and capacity building can result in successful projects, but it will require further commitments from outside partners to continue.

From an abatement cost standpoint, the project has relatively low initial investment requirements as it utilizes locally available equipment and inputs. Acacia Senegal seeds, agricultural tools, and other inputs such as water and fertilizer are all available domestically (Personal Interview, 6/26/09). The plantations are located on marginal lands near villages to avoid displacing agricultural production and actually help reclaim the lands for productive use (Personal Interview, 7/9/09). Labor is provided by the villages near the plantations, augmented by trainings supplied by ICRISAT in acacia Senegal upkeep and gum Arabic harvesting (Personal Interview, 6/26/09). Although the specific plant species may be new to some villages, most rural people in Niger are familiar with the techniques used in reclaiming degraded lands through previous interactions with development projects (Personal Interview, 6/26/09). Geographically, plantations are distributed across the entire country, which adds transportation costs compared to a design concentrated around Niamey. However, even though plantations are located in all eight regions of the country, they tend to be associated with villages near the national highway system and avoid the problems presented by smaller, often impassable rural roads (Personal Interview, 5/28/09). Unlike renewable energy efforts, the project is not affected by other infrastructure constraints related to the electricity grid or natural gas networks.

While it does add costs, the geographically dispersed project design helps to increase political support for the project and makes the effort more salient to government officials (Personal Interview, 7/9/09). The project also benefited from being an early adopter in Niger and had the advantage of dealing with an interim Designated National Authority composed of a small group of motivated and knowledgeable partners in the government (Personal Interview, 6/22/09). At the time that the acacia Senegal project first sought approval from Niger's DNA, an environmental office under the Prime Minister filled the role. This group included a number of individuals that had participated in international climate meetings and attended the Risoe Centre capacity building efforts. The project developers found this group a willing and enthusiastic partner for the CDM and gained approval relatively quickly (Personal Interview, 6/22/09).

Public acceptance of the project was achieved not through the climate mitigation that occurs but because of the development benefits that it achieves. The acacia Senegal project appears to take seriously the dual goals of the CDM and provides a number of development benefits that support local and national priorities. In fact, Niger's most recent Poverty Reduction Strategy Paper calls for increased production of gum Arabic (International Monetary Fund, 2008). For local populations, the project developers estimate that plantations will employee more than 10,000 farming families to manage planting and harvesting operations. These families will be partners in the operations and will share in both the carbon and non-carbon revenues of the project. An additional 100 full-time positions are expected at ASI with hundreds of part-time positions at harvest. For the local environment, plantations are expected to restore soil fertility and reduce wind erosion on degraded lands, bringing these areas back into productive use. At the national level, the project is expected to create significant foreign exchange inflows from gum Arabic and carbon revenue sales, much of which will make its way to local subsistence farmers that are rarely able to participate in the global economy (Achat Service International, 2009).

Finally, abatement costs must be viewed in tandem with the expected revenues from the project. In this case, the plantations will produce both carbon revenues from CER production and non-carbon revenues from gum Arabic sales. For least developed countries like Niger, one of the few CDM project areas that is likely to produce high levels of CERs are projects that sequester carbon. These countries lack both industrial gases with high global warming potentials and energy sectors that can accommodate the large-scale renewable projects that have produced high CER levels in emerging market economies. Instead, many LDCs have both the capacity and the need for reforestation efforts that can address years of deforestation. When these projects also produce a co-product of value, such as gum Arabic, the financial balance sheet is further strengthened and projects have a greater chance of success. However, even projects with large expected net revenues will have a difficult time overcoming the significant hurdles that least developed countries present. It is in this regard that the acacia Senegal project can serve as a guide for future projects in Niger and other LDCs.

Table 4.4: Building Mitigative Capacity: Acacia Senegal Project

	Mitigative Capacity Determinants	1st Tier CDM Specific Capacity	2nd Tier Generic Capacity
Economics	**Ability to Pay**	• World Bank Funding Support	• World Bank Funding Support
	Abatement Costs	• Project Design similar to efforts in Mali • World Bank Supported Outside Consultant	• Known Technology and Locally Available Inputs • Gum Arabic Co-Production
	Opportunity Costs	• High Levels of CER Creation Comparable to More Developed Countries	• Significant Sustainable Development Impacts • Potential Increase of Involved Households' Income
Institutions	**Reg. Effectiveness and Market Rules**	• Original DNA – Concentrated and Knowledgeable	• Credit Markets not needed with World Bank Support
	Education and Skills Base	• Human Capital added by Outside Consultant	• Planting and Harvesting techniques known by villagers
	Public Attitudes	• Concentrated, Knowledgeable, and Supportive DNA	• Coincides with other Development Priorities • Plantations Located throughout country
Technology	**Technology Availability**	• Support from ICRISAT – Local Ag Research Inst.	• Uses locally available technologies
	Ability to Absorb Technologies		• Technology and Inputs are Available throughout Country
	Infrastructure	• Support from ICRISAT – Local Ag Research Inst.	• Plantations Located Near National Highway • Other Infrastructure Networks not Needed

4.5 Discussion

Despite the interest shown in CDM opportunities by the Project Idea Notes and Project Design Document highlighted above, project developers in Niger face many barriers in entering the carbon marketplace. Like other least developed countries, characteristics in Niger tend to increase both the marginal abatement cost for projects as well as the transaction costs to operate in the CDM. In nearly every one of the 18 categories of mitigative capacity, Niger is at a disadvantage compared to more developed host countries (see Table 4.3 above). Geographically, being a landlocked country requires project developers to import materials to ports in neighboring countries such as Benin or Nigeria and then ship them hundreds of miles overland. This act alone increases the cost of importing a container by three times compared to Nigeria. Once the equipment arrives in Niger, distributing materials to project locations throughout the country is expensive and may not be possible during periods when rural roads are impassable. Projects that aim to work in all eight regions of the country face significantly higher costs than projects concentrated in just one or two regions. The acacia Senegal project avoids some of these constraints by relying on locally available materials and locating projects near the national highway system rather than in more remote areas. In this case, the increased costs from operating throughout the country are balanced by the additional political support that such geographic distribution promotes. Meanwhile, Niger also lacks other forms of supporting infrastructure that are taken for granted in more developed settings. For some project types, key infrastructure needs include functioning electricity grids and natural gas networks. Without these supporting structures, project developers may be required to make additional investments or locate projects in sub-optimal areas in order to take advantage of existing networks. Again, the acacia Senegal project is not affected by these issues but renewable energy efforts would have to make special arrangements to deal with these constraints.

From a human capital standpoint, the lack of technical and CDM-specific expertise in Niger requires that project developers make additional investments to either train domestic personnel or pay for higher-priced international consultants to fill technical positions. Either option will increase the costs for project construction and operation. Similarly, navigating bureaucratic impediments in dealing with government ministries and agencies adds to abatement costs. The institutional costs can come in the form of bureaucratic red-tape or more pernicious corruption, but either avenue has the same result. Rather than being an aid and source of expertise in the CDM process, the government reduces the chances that Niger will attract projects. Together, these additional costs increase the marginal abatement cost for emission reductions and reduce the benefit that Annex I parties can receive by shifting their greenhouse gas mitigation activities to Niger. On top of the higher abatement costs, transaction costs for participating in the CDM are also higher as evidenced by the impediments found in Tier 1 of the mitigative capacity framework. Low human capital levels will again increase costs to train domestic personnel in navigating the CDM regulatory landscape or require assistance from international consultants. Dealing with the government, at least in the form of the Designated National Authority, presents the prospect of registration delays and additional costs. Over time, as the DNA oversees a greater number of projects through the registration process, transaction costs are likely to drop. However, until this occurs, the first set of projects through the pipeline will bear the brunt of steeper transaction costs.

In terms of human capital constraints, the acacia Senegal project benefitted from a number of factors that could serve as a guide to future project developers. First, the project had key human capital inputs from the Risoe Centre capacity building efforts and had the support of an independent consultant hired by the World Bank. Second, the agricultural basis of the project utilized skills that were readily available in the local population. Finally, the project had the good fortune to deal with an initial version of the DNA that was more concentrated and knowledgeable than the current arrangement. This combination of local expertise with targeted capacity building and outside support can serve as a model for future projects in Niger and other LDCs. As the findings from Chapter 2 demonstrate, capacity building is most important in getting countries into the CDM but plays less of a role in promoting further project development once countries have hosted their first project. This evidence would point to the need for concentrated efforts in countries such as Niger that have yet to enter the CDM marketplace. As for the composition of the DNA, host countries must balance the size and make-up of the organization to meet local needs and circumstances. However, if the country is serious about attracting mitigation investments, a smaller group with direct CDM experience may be preferential to a larger, more diverse composition.

At the same time that project developers face higher transaction costs, lower project sizes in least developed countries result in transaction costs that are repaid over a smaller number of CERs. CDM opportunities in Niger are unlikely to be of sufficient size or include high global warming potential gases to take advantage of the economies of scale available in other settings. Very few countries in Africa, Niger among them, have industrial sectors that deal with the high-GWP gases that spurred some of the first projects in emerging market countries such as China, India and South Korea. Low abatement levels result in lower carbon revenue for project activities and registration costs are spread over fewer CERs, further increasing the already high average transaction costs per CER created. For many LDCs, the one project area that is likely to produce significant CER levels are forestry-related activities. Much like the acacia Senegal project in Niger, these project types can be scaled to create high CER levels and can benefit from co-products of local or even international importance. This approach also addresses the problem of opportunity costs in pursuing CDM projects. If project designs embrace the sustainable development goal of the CDM, the projects will not be viewed as a diversion of investments from local development needs. By addressing several areas of national importance in Niger, the acacia Senegal project has been embraced by local populations and represents an additional funding avenue for development rather than a diversion of funds.

Returning to the two tiers of mitigative capacity, the success of the acacia Senegal project highlights a broader strategy for project developers dealing with an inhospitable environment for the CDM. While Niger lacks capacity in both tiers of the framework, this may not be the case for all project types. The first tier of mitigative capacity dealing with registering projects is likely to be a problem for all new-comers to the CDM. However, host countries are likely to have some projects areas that are stronger than others in terms of the second tier. For Niger, the acacia Senegal project avoids many of the weaknesses in the second tier of capacity by capitalizing on local knowledge and materials while requiring little in terms of infrastructure. From an economic standpoint, outside funding and non-carbon revenue can ameliorate the problem of a weak domestic credit market. This gives the country a chance to build capacity in the first tier through experience gained in dealing with the CDM registration process. As more projects of this type are pushed through the registration process, project developers and the Designated National Authority will build capacity in CDM oversight and management. This then opens the way for a second wave of projects that can take advantage of newly acquired CDM expertise to attempt projects that do not have the same advantages in the second tier. The host country may require further capacity building in the second tier at this point to implement more challenging project types given local conditions. In the case of Niger, this second wave of capacity building could include training on the construction and operation of renewable energy projects. International organizations can further ease the registration burden in LDCs by providing data needs for project development such as the greenhouse gas intensity of national electricity grids or sequestration rates of local tree species. The Risoe Centre had hoped to do just that with the second phase of capacity building to help lower registration costs for projects in Niger. If an equitable distribution of project activities is a real goal for the CDM, continued capacity building and financial support will increase the chances that projects such as the acacia Senegal effort are successful and countries like Niger can play a role in mitigating climate change.

4.6 Conclusion

The mitigative capacity framework presented in this chapter offers a unique perspective for examining the lack of CDM success in least developed countries and devising strategies to promote greater involvement by all parties to the Kyoto Protocol in the effort to reduce greenhouse gas emissions. Despite the call for an equitable distribution of CDM projects across host countries and regions, the combination of a regulatory system built around cost-efficient mitigation and capacity deficits in least developed countries may make this goal unachievable. Stakeholder interviews from Niger paint the picture of a highly difficult environment for CDM investments. Niger lacks many of the elements highlighted by the mitigative capacity framework. Yet the entrepreneurial spirit and hope of drawing support from the CDM is alive despite critical constraints. Project developers have created several Project Idea Notes for Niger and one, with the help of the World Bank, has taken the next step in the process. If the call for a more equitable distribution of project activities is to become a reality, further support is needed.

Applying the mitigative capacity framework to Niger has highlighted steps that would aid least developed countries in entering the CDM marketplace and beginning to benefit from clean technology transfers currently going to emerging markets. First, outside agencies such as the United Nations or the World Bank should fund efforts to calculate essential elements of Project Design Documents such as electricity fuel mixes and greenhouse gas intensity of national electricity grids and make this information available to potential project developers. In addition, support from international funding agencies in shepherding an initial suite of projects through the registration process will help countries learn from the experience, build capacity in Tier 1 of the mitigative capacity framework, reduce transaction costs, and pave the way for future efforts. The World Bank is doing just that with the acacia Senegal project in Niger, but one project will not be enough.

Finally, the UNFCCC should take steps to increase the acceptability of forestry sector projects. To date, reforestation and aforestation efforts have only played a small role in the CDM, yet these are project types that would be ideal for less-developed settings. In addition, reduced deforestation is not currently allowed as a project type, yet it would bring large sustainable development benefits to developing countries and represents a substantial source of greenhouse gas emissions globally. Excluding these projects represents both a significant driver of anthropogenic climate change not covered by the CDM and further leaves least developed countries on the sidelines of mitigation efforts.

4.7 Appendix C – Stakeholder Interview Information

Stakeholder interviews were conducted over a three-month span from May to August of 2009 in Niamey, Niger. All interviews occurred in the offices of interviewees and the average length of interviews was approximately one hour, though five of the interviews involved multiple visits and were longer in length. Interviews were conducted in French and English. Table 3 gives the number of interviewees by job category. Following the table is a general list of questions asked at each interview. Some additional questions were asked given the specific knowledge and answers given by interviewees.

Table 4.3: Stakeholder Interview Participants

Interviewee Category	Number of Interviews
Niger Government Employees	6
Development Workers (International)	7
Development Workers (Domestic)	6
Niger Civil Society/NGO	2
Private Enterprises	2
Bank Representatives	2
CDM Project Proponents*	5
Total	30

* While CDM Project Proponents include Niger government employees, civil society members, and private enterprise representatives, these interviews were considered a separate category given their specific knowledge of the CDM in Niger.

Stakeholder Interview Questions

1) CDM Project Developers

- Describe your experience in writing or creating the PIN?
- Did you receive assistance in creating the PIN?
- If so, where did the assistance come from and what was the assistance?
- Describe your experience in submitting the PIN to the DNA?
- What is the current status of the project?

- Where did you meet resistance or have support in the process?
- With what aspects of the process do you need further assistance?
- Is there enough human capital domestically in Niger to implement projects? If not, what sort of expertise is needed?
- What are the technological barriers to implementing the project?
- Has the government been helpful or unhelpful in the process?
- Where do you plan to get financing to support the project activities?
- How much do you expect the project to cost? Please categorize the expenses?

2) Participants in Risoe Centre Capacity Building Workshops
   - Please describe your experience with the CDM in general.
   - Please describe your experience at the CDM capacity building workshop. What skill sets did you receive?
   - What areas do you feel are needed but were not covered in the capacity building exercise?
   - Have you found that the capacity building workshop was worthwhile in helping to develop CDM projects in Niger?
   - What organizations or people have been helpful in implementing CDM in Niger?
   - What do you see as barriers to CDM implementation in Niger?

3) Niger Government Officials – CDM Related
   - Describe your experience in the CDM process to date?

- How many project idea notes have been submitted? Project design documents? What is the current status of these projects?
- Please describe the process for reviewing and approving the PIN and Project Design Documents? Is there a formalized procedure for reviewing projects?
- What outside assistance did you receive in designing and managing the program?
- What do you look for or require in Sustainable Development benefits?
- Does Niger have a plan for CDM implementation? If so, what project types are priorities? Are there project types that are not wanted?
- Where do you need further assistance?
- What do you see as barriers to CDM implementation?

4) Niger Government Officials - Others

- What is your experience in developing projects in Niger?
- What do you see as the impediments to successful project development in Niger?
- Are there bureaucratic, human capital, or technological barriers to these efforts?
- Please describe interactions within the government agencies and between the public and the government? What role does the government play in assisting or blocking project implementation?
- How difficult is it to draw financial support for project development in Niger? What do funders cite as problems with Niger?

5) Development Workers – International and Domestic

- What is your experience in developing projects in Niger?

- What do you see as the impediments to successful project development in Niger?
- Are there bureaucratic, human capital, or technological barriers to these efforts?
- How significant is corruption as a problem in Niger? What role does it play in blocking project implementation?
- How difficult is it to draw financial support for project development in Niger? What do funders cite as problems with Niger?

6) Non-CDM Project Developers

- What has been your experience in developing projects in Niger?
- Where have you had success in getting support from government officials? Are there any particular ministries that are better than others?
- Where have you received support for project development (other than government ministries)?
- What do you see as impediments to project development?
- Are there bureaucratic, financial, human capital, or technological barriers to your efforts?

7) Domestic Bank Staff

- What sorts of activities do you fund or how do you invest capital in Niger?
- What are the general terms of credit?
- What is the distribution of your loan portfolio among different investment types?
- Do you have capital available to support development activities?
- Do you have capital available to support energy projects?

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5 Chapter

Conclusion and Recommendations

5.1 Summary of Key Findings

5.1.1 Host Country Determinants of CDM Project Distribution

The research goals for the dissertation were to investigate the differential distribution of Clean Development Mechanism (CDM) projects across host countries and identify impediments to CDM implementation in least developed countries (LDC). The analysis began at the global level with a comparison of dependent variables for CDM activity with host country level explanatory variables. A net revenue model was proposed to guide independent variable selection. While the model discusses project-level factors such as CDM registration costs, construction and operating investments, CER creation, and non-carbon revenue, it is used as a heuristic guide to select potential country-level explanatory variables for CDM success. The overall emission levels in countries plays a critical role both in terms of hosting projects and the amount of certified emission reductions (CER) created. In addition, the emission intensity of an economy is important in determining the amount of CERs created. To get countries involved in the program, surrogates for CDM-specific costs including the number of capacity building efforts countries undertook and levels of human capital were found to be significant predictors of success. Human capital measures and country's experience with the program were also found to be significant for CER production. As a proxy for the non-carbon revenue potential in host countries, the model used the average growth in electricity capacity from 2003 to 2007. This variable was found to be a significant predictor of the potential for countries to host projects but was not found to be a significant predictor for the number of CERs that successful host countries produce.

Taken together, the implications of these findings on the opportunities for least developed countries interested in attracting CDM investments are not positive. On average, LDCs have emission levels a full order of magnitude lower than countries with higher development levels. Similarly, the average carbon intensity for the group is less than half that of more developed countries. As the proxies for carbon revenue potential, these two variables help to demonstrate why least developed countries are being left behind other countries in terms of CDM involvement. From a non-carbon revenue standpoint, the electricity capacity growth rate for least developed countries as a whole is below 1% and is much less than more developed competitors, acting as a further barrier to CDM involvement.

5.1.2 CDM Project Success – Case Study Findings

While the regression work gives a global picture of CDM determinants, case studies and stakeholder interviews from Niger give local context to the impediments to CDM investments. For project types to be successful, they must meet three tests: availability, profitability, and meeting the dual goals of the CDM. The six case studies selected in Niger are all projects that could qualify for the CDM but have not yet taken the steps to do so. Estimates for greenhouse gas impacts and sustainable development benefits demonstrate that forestry projects are likely to offer the best opportunity for meeting the dual goals of the CDM. A project that creates bio-fuel from Jatropha plantations also offers a significant combination of GHG and development benefits but has some potentially significant negative impacts if the plantations displace food production. The remaining three case studies all involve electricity production and cover a range of development benefits, from a relatively low impact for an energy efficiency project to high impacts for a solar energy effort. From a greenhouse gas standpoint, however, the three projects all suffer from a limited scale of emission reductions. When project profitability is taken into account, this lack of CER creation makes the projects unattractive investment options for project developers, at least as part of the CDM. The revenue from certified emission reduction sales is unlikely to merit the cost of registering with the CDM.

5.1.3 Two-Tiers of Mitigative Capacity – Stakeholder Interviews from Niger

Augmenting the case study findings are the insights drawn from stakeholder interviews in Niger. When viewed through a two-tiered framework of mitigative capacity, the interviews highlight areas where Niger is lacking capacity for CDM project success. In areas related to both general mitigation activities and capacities for navigating the CDM registration and monitoring process, Niger lacks the economic, institutional, and technical ingredients needed to be a successful project host. Factors such as a lack of greenhouse gas accounting expertise, weak national infrastructure networks, bureaucratic impediments, and unsupportive capital markets make developing CDM projects extremely difficult in Niger. Other least developed countries are likely to experience similar limitations in their attempts to attract Clean Development Mechanism investments. However, when the framework is applied to the relative successful acacia Senegal project making its way through the registration process, strategies for navigating the mitigative capacity shortcomings in Niger become apparent. By focusing on locally available areas of expertise and inputs, taking advantage of outside financial and human capital support, and combining relatively high carbon and non-carbon revenues, the acacia Senegal project points the way for other potential CDM projects in Niger and other least developed countries.

5.1.4 Implications for other Least Developed Countries

Like Niger, characteristics in least developed countries tend to increase both the marginal abatement cost for projects as well as the transaction costs to operate in the CDM. Weak infrastructure levels place additional costs on project developers in LDCs. The problem is exacerbated for landlocked countries like Niger that require project developers to import materials to ports in neighboring countries and then ship them hundreds of miles overland. These costs are added to already high transport costs to distribute materials to project locations throughout countries on poor road networks. Other supporting infrastructure that is taken for granted in more developed settings is often lacking in LDCs. For the CDM, functioning electricity grids and natural gas networks are two key infrastructure needs that can support different project types. Without these supporting structures, project developers may be required to make additional investments or locate projects in suboptimal areas in order to take advantage of existing networks. From a human capital standpoint, the lack of technical and CDM-specific expertise in LDCs requires that project developers make additional investments to either train domestic expertise or pay for higher-priced international consultants to fill technical positions. Either option will increase the costs for project construction and operation. Similarly, navigating bureaucratic impediments in dealing with government ministries and agencies adds costs to the abatement curves. Together these additional costs increase the marginal abatement cost for emission reductions and shrink the benefit that Annex I parties can receive by shifting their greenhouse gas mitigation activities to developing countries as part of the CDM.

On top of the higher abatement costs, transaction costs for participating in the CDM are also higher in less developed settings. Low human capital levels will again increase costs to train domestic personnel in navigating the CDM regulatory landscape or require assistance from international consultants. Dealing with the government, at least in the form of the designated national authority, presents the prospect of registration delays and additional costs. Over time, as DNAs oversee a greater number of projects through the registration process, transaction costs are likely to drop. However, until this occurs, the first set of projects through the pipeline will bare the brunt of steeper transaction costs.

At the same time that project developers face higher transaction costs, lower project sizes result in transaction costs that are repaid over a smaller number of CERs. CDM opportunities in least developed countries are unlikely to be of sufficient size or include high global warming potential gases to take advantage of the economies of scale available in other settings. Very few countries in Africa, Niger among them, have industrial gas industries that deal with the high global warming potential gases that spurred some of the first projects in emerging market countries such as China, India and

South Korea. Low abatement levels result in a lower payoff for project activities and registration costs are spread over fewer CERs, further increasing the already high average transaction costs per CER created. Meanwhile, projects have elevated risks compared to more developed countries due to a lack of tested technologies and project developers. Finally, because domestic credit markets are unlikely to be supportive of CDM investments, project developers must seek external financing much earlier in the project cycle than is necessary in countries with stronger credit markets. The narrow band for project profitability is further squeezed by lower returns from seeking financing earlier in the process.

In comparison to a low-cost setting such as China, it may be true that transaction costs exceed the abatement cost savings that Annex I parties can receive by doing CDM projects in less developed countries. Figure 5.1 compares the cost curves for a low-cost CDM participant such as China and a high-cost country like Niger.

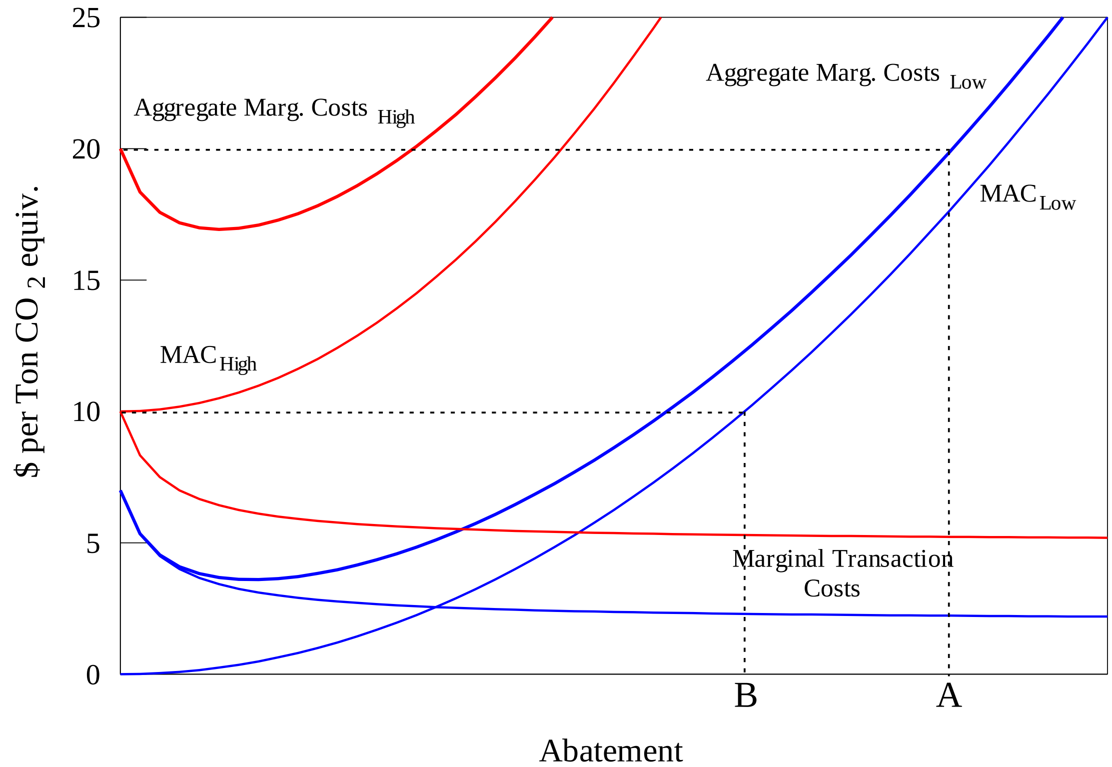

Figure 5.1: Low versus High Cost CDM Hosts

The low-cost provider, as represented by the blue curves, faces decreasing aggregate marginal costs initially as experience is gained with the CDM and transaction costs drop. Over time, as the cheapest abatement opportunities are implemented, higher cost opportunities remain and the aggregate costs begin to rise. A similar situation holds for the high-cost provider, represented by the red curves, except that cost levels are higher on all counts. If Annex I entities hoping to find cheaper emission reduction opportunities only undertake projects on a cost-basis, they will capture the majority of the opportunities in the low-cost country first before moving to the high-cost setting. This move comes significantly later when transaction costs are added to the equation (Point A) than when marginal abatement costs alone are the deciding factor (Point B).

The interplay between transaction costs in the CDM and the goal of guaranteeing "verifiable" emission reductions is a delicate balance. As Capoor and Ambrosi (2008) note "Some critics of the CDM maintain that its rules are too complex, that they change too often and that the process results in excessively high transaction cost; they ask for relief from the rules. Other critics question whether certain project activities are truly additional, or whether CDM can create perverse incentives; they ask for even more rules" (Pg. 4). The seemingly contradictory views expressed in this statement are difficult to reconcile. When is regulation too much, not enough, or preferably just right? Figure 5.2 below demonstrates the interaction between the burden from registration activities and the amount of verifiable abatement that occurs.

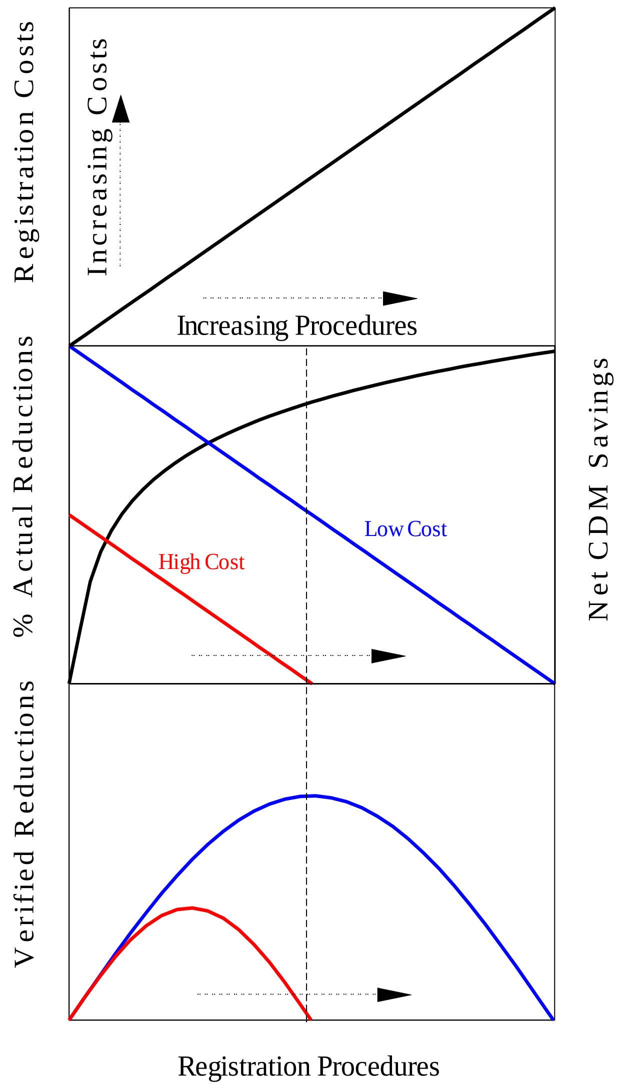

Figure 5.2: Registration Burden and Abatement

Moving from left to right on the x-axis represents increasing amounts of regulatory activities for CDM projects, with a corresponding increase in registration costs as shown in the top panel. The middle panel illustrates two conflicting trends as registration procedures and costs increase. On the one hand, the percent of claimed emission reductions that are real and verifiable increases as registration procedures are added. When no procedures are required, the percent is likely to be quite low and as procedures are added, the additional steps help to ensure that claimed reductions are actually occurring (though 100% may be difficult to achieve). Meanwhile, the additional costs incurred by the registration procedures cut into the abatement cost savings achieved by undertaking CDM activities in developing countries. If the registration costs become large enough, the abatement savings are completely eliminated and Annex I parties have little incentive to participate in the CDM. For a high-cost country like Niger (red curve), the net savings from CDM activities start at a lower point and are eliminated sooner than for the low-cost country (blue curve). Translating these trends to the bottom panel produces two inverted u-shaped curves of verifiable reductions. The dashed line running vertically in the bottom two panels represents the level of registration procedures required by the CDM. As it is currently designed, the procedures balance the two concerns of verifying emission reductions yet not placing too heavy of a registration burden on project developers in low-cost countries such as China and India, at least to the point where all project activity is eliminated. For countries like Niger, the costs from undertaking the registration procedures completely eliminate any savings that Annex I parties could achieve by locating greenhouse gas abatement activities in the country.

Presented in this manner, the one-size-fits-all approach to CDM registration and monitoring appears inappropriate for all settings. The registration and oversight infrastructure established to govern the CDM was designed to fit the largest emitters but has to this point drastically limited the activity in less-developed settings. If an equitable distribution of project activities is a real goal for the CDM, it may be time to modify the registration and monitoring requirements for less-developed countries. Simplified methodologies for small-scale projects and an exemption for least developed countries of the 2% tax on CDM proceeds for an adaptation fund have not been enough to level the playing field. Further assistance is needed to include countries like Niger into the effort to mitigate climate change.

5.2 Future Work

The work presented in this dissertation offers a small glimpse of the wider picture regarding climate change and developing countries. While the Clean Development Mechanism will continue to be an important technology transfer and sustainable development avenue for developing countries moving forward, their involvement in climate change activities, on both the mitigation and adaptation sides of the question, will be much broader. Future work possibilities stemming from this research include an extension of the regression techniques to better understand the impact of different actors in the CDM process and to identify the distribution determinants of other greenhouse gas offset programs. In addition, the mitigative capacity and CDM success frameworks can be applied to other case studies in Niger and to other countries. Finally, the fact that adapting to climate impacts is likely to be more important for LDCs than mitigating climate change suggests that synergies between adaptive and mitigative capacity are required moving forward.

The findings from Chapter 2 represent a solid first step in identifying the determinants of CDM success. However, the carbon marketplace is very dynamic and new actors enter both the supply and demand side of the CDM equation constantly. Additional research avenues to assess this changing environment include applying the techniques to voluntary carbon markets such as the Chicago Climate Exchange, examining the role that specific project developers play with regards to promoting different technologies or host countries, and identifying trends beyond registered projects in the CDM project pipeline.

The frameworks presented in Chapters 3 and 4 have been developed based upon the situation in Niger but can be applied much more broadly. To begin with, the framework for CDM project success has only been applied to a limited number of project types. Applying the framework to other project types such as methane recovery efforts, industrial gas destruction projects, or other renewable energy technologies would give the framework more relevance. Beyond other technologies, a true test of the framework's relevance would come from applying the tool to other settings beyond Niger. Future work in this area might include comparative studies with other least developed countries and emerging markets. For the mitigative capacity framework, the comparative studies might include these actors as well as developed countries or even non-state actors such as corporations, cities, or NGOs.

Finally, the dissertation only tangentially discusses adaptation to climate impacts. For countries like Niger, the primary activity that they will undertake in addressing climate change will be adaptation rather than mitigation through programs such as the CDM. One can make the case that the development benefits from projects could support adaptation efforts. However, another research avenue would be to investigate the potential for synergistic capacity building to promote both mitigative and adaptive capacity in least developed countries. If mitigative and adaptive capacities are truly mirror images of each other, then perhaps the greatest long-term benefit that LDCs will receive from pursuing CDM opportunities will be the improved ability to cope with the likely climate impacts that they will face.

5.3 Policy Recommendations

As negotiators continue to craft the replacement for the Kyoto Protocol, now is the time to think about ways to improve the various aspects of the agreement. For the Clean Development Mechanism, one of the issues to address is how to promote greater involvement by less developed countries in the program. The following steps would go far towards helping countries like Niger enter the CDM marketplace and begin benefitting from clean technology transfers currently going to emerging markets.

1. Continued capacity building for countries that have not yet hosted projects.
2. Funding from international donors for data needs required by project baselines and other registration requirements.
3. Support to usher a suite of projects through the registration process to help with learning and ultimately lower registration costs.
4. Greater bundling of projects and support for programmatic CDM to create higher CER levels in LDCs.
5. Greater acceptance of forestry projects, including developing methodologies for reduced deforestation projects.
6. Simplified registration requirements for LDCs to help lower registration costs. The methodologies must deal with problems presented by LDCs related to leakage, additionality, and baseline considerations.

7. For renewable energy projects, an alternative funding mechanism may be required. A clean energy fund could be one option.

With its costly registration process, the Clean Development Mechanism has not been an effective vehicle for spurring clean technology transfer to less developed settings. As an alternative, one can imagine a clean energy fund with simplified methodologies for calculating emissions reductions that supports projects in LDCs. Initial funding for the fund could come from a tax on CERs created in non-LDC countries, as is currently done for the climate adaptation fund. A tax on projects from non-LDCs would also help to level the playing field and could encourage project developers to seek opportunities in less developed settings. Revenues from the sale of CERs created by clean energy fund projects would then either return to the fund to support future projects or be available to the host country to reinvest in additional projects. In either case, least developed countries would no longer be left on the sideline of climate mitigation activities and could begin to benefit from clean technology transfer as other developing countries have benefited from the CDM.

5.4 Conclusion

While not without its faults, the Clean Development Mechanism has been a moderate success in including developing countries in the effort to mitigate climate change. Among the shortfalls of the program has been the lack of activity in least developed countries. Given the dual goals to reduce greenhouse gas emissions while supporting sustainable development in host countries, the current distribution of projects is both hopeful in that it involves the highest emitting developing countries and disappointing in that those countries most in need of development assistance have been excluded. Many authors have taken it for granted that this distribution is inevitable and that some countries will be better off using their scarce resources for other vitally important needs (Cosbey et al, 2005; Ellis et al, 2007; Jung, 2006). Looking at a particular LDC in Niger, stakeholder interviews do in fact describe a highly difficult environment for CDM investments as the mechanism currently stands. Yet the entrepreneurial spirit and hope of drawing support from the CDM is strong even in this setting. Nine project developers have created Project Idea Notes for Niger and one, with the help of the World Bank, has taken the next step in the process. If the call for a more equitable distribution of project activities is to become a reality, further support is needed. For Niger and other less developed countries, now is the time to expand climate change mitigation and technology transfer efforts to those countries that most need the assistance.

5.5 Bibliography

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