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Carbon Offsetting: An Efficient Way to Reduce Emissions or to Avoid Reducing Emissions?
An Investigation and Analysis of Offsetting Design and Practice in India and China

by

Barbara Kresch Haya

A dissertation submitted in partial satisfaction of the

requirements for the degree of

Doctor of Philosophy

in

Energy and Resources

in the

Graduate Division

of the

University of California, Berkeley

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Professor Richard B. Norgaard, Chair

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Professor Kate O'Neill

Fall 2010

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Abstract

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An Investigation and Analysis of Offsetting Design and Practice in India and China

Barbara Kresch Haya

Doctor of Philosophy in Energy and Resources

University of California, Berkeley

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Carbon trading is being implemented on international, national and sub-national scales in most places where greenhouse gas (GHG) emissions targets are enacted. The appeal of carbon trading is efficiency, lowering the cost of climate mitigation by allowing the market to find the least expensive sources of reduction. In this dissertation I probe the assumptions that carbon trading is efficient and effective through grounded case study.

A multi-year study on how the Kyoto Protocol's Clean Development Mechanism (CDM) – the world's largest carbon offsetting program – is working in practice in the Indian power sector (Chapter 2) documents large uncertainties associated with the emissions reduced by the program. This uncertainty has resulted in large numbers of CDM projects that do not actually reduce emissions (are “non-additional”) and regulatory uncertainty that undermines the effectiveness of the program in supporting new projects. In the medium- and long-term, even if the quality of offsetting projects can be assured, the purported efficiency of offsetting must be weighed against ways that offsetting at large scale makes international climate change cooperation more difficult over the next decades.

There has been a lot of interest in continuing offsetting by ensuring that the credits generated represent real emissions reductions. Chapter 3 examines the prospects for developing a more rigorous “additionality test” for filtering out proposed CDM projects that are business-as-usual and therefore do not represent real emissions reductions under the program. Through in depth case studies of additionality testing for wind, biomass and hydropower projects in India, I conclude that at today's carbon prices there is no accurate verifiable indicator of whether CO₂ reduction projects would be built without the CDM.

Chapter 4 probes the effectiveness of carbon crediting in incentivizing emissions reductions. A focused look at the history of support for bagasse cogeneration in India reveals that a range of shifting barriers have impeded the development of this cost effective technology. A carbon price alone would not have overcome the barriers to this technology, and parallel support efforts were needed to spur this technology.

Post-2012 climate change agreements and legislation include provisions for replacing CDM additionality testing with standardized project eligibility criteria and indicate a shift away from project-based offsetting towards offsetting on a sectoral level as ways to retain the efficiency of offsetting, but avoid the current problems with the CDM. I examine this range of proposals for reforming or replacing the CDM with a study of the design of a sectoral crediting programs in the cement sector in Shandong province in China. This study indicates that for most

conceptions of sectoral crediting programs, the problems with the CDM documented in Chapters 2, 3 and 4 risk being even worse when offsetting is implemented on a sectoral level.

I conclude with a brief discussion of how some of the inefficiencies of offsetting may feature in carbon trading generally by tracing parallels between the design and implementation of the CDM and California's Low Carbon Fuel Standard. I end with a policy discussion of the political space within which offsetting is being negotiated internationally, and within the US, and alternatives to the CDM and offsetting that might fulfill political and environmental goals together.

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Chapter 1. Introduction

“And let me be clear on this point. In the long run, market-based solutions will prevail... we must put a price on carbon.”

-- Anders Rasmussen, Former Danish Prime Minister, at Climate Change: Global Risks, Challenges and Decisions Conference, Copenhagen, 10-12 March 2009

“We are going to do this by allowing the market to determine which alternative vehicle fuels are the most cost effective and energy efficient.”

-- Arnold Schwarzenegger, speech given when signing the Executive Order establishing California’s Low Carbon Fuel Standard on 18 January 2007, Sacramento

The term “market-based” is being used as an adjective to imply that an environmental regulation is efficient, effective and leaves decision-making in the hands of the private sector rather than the government. In the context of climate change policy, “market-based” most often refers to the mechanism of carbon trading under a cap and trade program, and not to its two main alternatives: direct regulation and/or carbon taxes which are not currently viewed as politically feasible in the EU and the US. Cap and trade with offsets is being implemented on international, national and sub-national scales in most places where greenhouse gas (GHG) emissions targets are enacted. Cap and trade with offsets is the backbone of our global climate change regime under the Kyoto Protocol, and the backbone of EU climate policy under the EU Emissions Trading Scheme (ETS), California’s climate change regulation, regional agreements among states and provinces in northeastern and western US and Canada, and regulation proposed at the national level in the US and being considered for adoption in China. It is a huge global experiment in environmental regulation, based on economic theory and the limited experience of sulfur dioxide and nitrogen oxide emission allowance trading in the US, for which the emissions were easier to monitor and the results were mixed (e.g. Farrell 2001).

The theoretical appeal of cap and trade is efficiency. It sets a cap on emissions, and lowers the cost of compliance by purportedly allowing the market to find the least expensive sources of reduction. In this dissertation, I probe the assumptions that carbon trading is efficient and effective. I contribute a multi-year study on the effects of the world’s largest offsetting program – the Clean Development Mechanisms (CDM) – established under the 1997 Kyoto Protocol. I find that the CDM is creating large numbers of credits that do not represent real emissions reductions, and that the CDM is having no more than a weak influence on project development decisions for most project types. Efforts to reform the CDM or replace it with another offsetting program are hindered by structural hurdles that make offsetting extremely difficult to regulate. These findings question the overall approach being taken to control GHG emissions. Given that global emissions scenarios with even medium chances of staying below a two degrees increase in global average temperatures show global emissions beginning to decline in the next five years (Intergovernmental Panel on Climate Change 2007, Meinshausen et al 2009), we do not have time for false solutions.

Cap and trade establishes emissions caps on emitters, such as countries under the Kyoto Protocol,¹ or power plants and factories under domestic cap and trade programs, and allows those capped entities to trade emissions credits. The cap regulates the outcome of concern – emissions – and lets the regulated entities decide how to control their emissions. Trading should lower the cost of reductions. Instead of requiring each regulated entity to meet emissions standards, emissions can be reduced in the regulated facilities where reductions are least expensive, and carbon credits can be sold to facilities where reductions are more expensive. Offsets extend the trading regime beyond the boundaries of the capped regions or sectors. The Kyoto Protocol's Clean Development Mechanism (CDM) allows countries, or firms within countries, to partially meet their GHG emissions reduction obligations by reducing emissions in developing countries. The most common project types under the CDM are hydropower, wind power, biomass energy, and methane avoidance such as with landfill gas capture. Projects that reduce or burn industrial gases, like HFCs from refrigerant manufacturing facilities, are fewer in number, but generate approximately one third of all CDM credits because of the high potency of these gases as greenhouse gases. In theory, the CDM improves the efficiency of the Kyoto Protocol by allowing emissions to be reduced wherever in the world it is least expensive to do so.

The main hurdle to the CDM, and to offsetting generally, is the need to assure credited activities are “additional.” Measuring emissions reductions under an offsetting program is inherently more difficult than under a cap and trade program. Under cap and trade, reductions are estimated by comparing total emissions during the compliance period with emissions in a past year. If current emissions are lower than past emissions, emissions were reduced. Measuring emissions reduced by an individual offset project requires comparing the emissions from the project with a counterfactual scenario of what would likely have happened in the absence of the offsetting program – a hypothetical future scenario that is inherently uncertain. The most difficult task in determining an appropriate counterfactual scenario is assessing whether the credited activities would not have gone forward had it not been for the ability to earn credits. The underlying justification for the CDM is that industrialized countries can buy CDM credits in place of reducing their own emissions because they *cause* the equivalent emissions to be reduced in a developing country. The CDM therefore requires each project applying to generate carbon credits under the CDM to demonstrate that it is “additional,” that is, that it only went forward because of the additional revenues from the sale of carbon credits, and would not have been built otherwise. Verifying that an activity is additional is difficult because it involves assessing the considerations of project developers under a counterfactual scenario.

In the chapters below, I examine the efficiency and effectiveness of carbon offsetting through a grounded study of how the CDM is working in practice in the Indian power sector. I assess the influence the CDM is having, factors that limit that influence, and possible ways to improve the CDM's outcomes through reform or replacement. This research focuses on wind, biomass and hydropower in India with a more focused study of the history of the development of bagasse cogeneration (the generation of electricity and steam from sugar cane waste). I find that additionality testing is failing to prevent large numbers of non-additional projects from registering under the CDM. At the same time, additionality testing is compromising the ability for the CDM to incentivize the building of new projects by introducing substantial uncertainty

¹ The Kyoto Protocol, adopted by countries in 1997 and entered into force as a legally binding agreement in 2005, requires industrialized countries to reduce their emissions as a block to 5.5% below their 1990 levels during 2008-2012. Emissions caps vary country to country, and compliance credits may be traded between countries. See http://unfccc.int/kyoto_protocol/items/2830.php (Last accessed on 16 December 2010).

into the CDM application process. In other ways, contradictions in the basic structure of the CDM lead to a systematic over-crediting emissions reductions.

Proposals for reforming or replacing the CDM largely fall into three categories: (i) strengthening additionality testing procedures, (ii) replacing project-by-project additionality testing with standardized eligibility criteria whereby whole categories of projects would automatically be eligible to generate credits under the CDM, and (iii) crediting reductions on a sectoral scale, rather than for individual projects. The most common conception of the latter category would establish a sectoral baseline, for example, some number of tons of CO₂-equivalent emissions per ton of cement produced, and would generate credits if emissions in the entire sector are below that baseline. I examine each of these options in the chapters below. I show that additionality testing for individual projects is inherently inaccurate with an examination of wind power, biomass power and hydropower projects in India, and therefore will not be sufficiently improved with strengthened additionality testing procedures. In a different context – the cement sector in Shandong province in China – I perform a policy design analysis covering the other two categories of proposals for CDM reform and replacement. I explore how various sector-based crediting approaches might improve upon the outcomes of the CDM in terms of effectiveness and efficiency, and conclude that sector-scale crediting risks expanding the CDM's problems unless carefully and narrowly designed. To draw more general conclusions about conditions that compromise the efficiency and effectiveness of carbon trading broadly, I end by highlighting some noteworthy similarities between the CDM and California's Low Carbon Fuel Standard (LCFS) based on my experience working on the design of this California program.

The efficiency and effectiveness of a carbon trading program, whether cap and trade or carbon offsetting, depends on a number of factors. Can emissions reductions be measured with reasonable accuracy so as to ensure that the target is met? Carbon trading is only as effective as the ability to measure emissions reduced by the activities covered under the program. Uncertainties in the quantity of emissions reduced mean uncertainty as to whether the target is met. If uncertainties in emissions measurements are greater than the differences in emissions between competing activities, the program might be sending the wrong price signal, increasing emissions. To what extent might the program create perverse incentives, direct or indirect, that lead to emissions increases? Does the program create incentives that match what is needed to overcome barriers to low carbon technologies and other changes that reduce emissions? How high are the program's transaction costs compared to other policy options? Does the program create strong enough and long-term enough market signals to incentivize activities needed to achieve deep reductions over the next decades? Is the program accompanied by public sector actions supporting activities needed for long-term mitigation, for which the net social benefits are high, but for which the costs to any one private sector entity are much higher than the benefits to that entity, such as the building of infrastructure and basic research? A result of this research is that simply creating a price signal is not always sufficient or productive. A carbon price functions within the limitations of our regulatory institutions, and the context of the specific barriers to, and opportunities for, reducing emissions in specific sectors in specific regions. Careful analysis of this context is needed in the design of carbon trading programs and any climate policy.

Offsetting is a lynchpin of current and proposed international climate change agreements. It is both the main cost control mechanism offering industrialized countries access to relatively inexpensive compliance options, especially important if mitigation costs turn out to be

substantially higher than anticipated. It is also the main source of the financing promised to developing countries for climate change mitigation. The CDM is fulfilling these political goals while weakening the environmental outcome of our international climate change agreements.

In response to heavy criticism from both environmental and business communities, negotiations are going forward over reforming or replacing the CDM under post-2012 climate change agreements. These negotiations are happening within a narrow political space of what is acceptable to countries in the global North and South. Researchers are seeking ways that the CDM can be reformed or replaced so that it can continue to fulfill its important political goals with greater environmental integrity. I show that most configurations of each of these options continue to risk the large scale over-crediting of emissions reductions. An international offsetting program with lower risk of over-crediting would need to be relatively narrow and conservative in scope and carefully regulated, requiring political will that has not yet been demonstrated.

We were recently reminded that markets need regulation to function with the collapse of the US mortgage market following the deregulation of the US financial industry triggering a global financial crisis. Much more is at stake with regulation of the carbon market. We are entrusting the carbon market with the stability of the earth's climate for many generations to come. Before establishing such a market we need to be confident that it is regulatable and does the job needed, not based on theory, but on grounded cautious analysis. The analysis contained herein, grounded in the Indian power sector, with analysis in the Chinese cement sector, shows that offsetting is inherently difficult to regulate, adds uncertainty to the emissions outcomes from a cap and trade program, and unless very carefully and conservatively designed, undermines the strength of a cap and trade program.

1. CONTRIBUTIONS TO THE LITERATURE

1.1. The efficiency and effectiveness of international carbon offsetting

This dissertation addresses practical policy questions about the use of offsets and design of offsets programs to meet greenhouse gas (GHG) emissions targets. Offsets have been included in cap and trade programs on the basis that they lower the cost of compliance, improve the efficiency of the program and support low carbon development in developing countries.

Some researchers describe the CDM as successful in supporting sustainable development in developing countries without questioning the environmental integrity of the credits it generates (e.g. Gao et al 2007). Expanding the CDM has been proposed so that it can better reach a wider range of countries (e.g. Byigero et al 2010) and sectors (e.g. Winkler & Es 2007). Economic analyses estimate that offsets substantially lower the cost of cap and trade regulation. For example, it is estimated that offsetting could lower the cost of California's climate legislation (AB 32) by 78% (California Air Resources Board 2010b, table ES-2).

Critical studies estimate the proportion of registered CDM projects that are truly additional as 60% of projects registered by 2007 (Schneider 2009) and "a fraction" of projects registered by 2008 (Wara & Victor 2008). Analyses show that the additionality of wind projects (He & Morse 2010) and natural gas projects (Wara & Victor 2008) in China are highly questionable. Others have documented that uncertainty in the benefits to project developers from the CDM are undermining the CDM's ability to affect project development decisions (Duan 2008). With regard to HFC reduction projects from refrigerant manufacturing plants, the CDM is

much more expensive than it would cost to pay for the reduction technology directly such as through a climate fund (Wara & Victor 2008), and the CDM creates perverse incentives for companies to create more pollution in order to gain more revenues from destroying it with a CDM project (CDM Watch via Det Norske Veritas Certification AS 2010, Wara & Victor 2008).

My research supports these CDM critics with a grounded multi-year study in the Indian power sector. I provide evidence that the majority of CDM projects are non-additional and that the CDM's effects are compromised by the uncertainty associated with its benefits. I raise additional issues associated with the systematic over-crediting of emissions reductions, and the effects of large-scale crediting on international cooperation towards deep reductions over the next decades.

Some researchers who have written critically on the CDM suggest solving the additionality problem by tightening the CDM's additionality testing procedures (e.g. Michaelowa 2010, Schneider 2009, Wara & Victor 2008). I perform a detailed examination of project development considerations for wind power, biomass power and hydropower projects in India and conclude that a reasonably accurate additionality test is infeasible for most CO₂ reduction projects at current carbon prices.

Replacing project-by-project additionality testing with standardized project eligibility criteria has also been proposed (e.g. Sterk 2008) and language along these lines is included in international climate change negotiating texts (UNFCCC 2010: 41 para 9) and domestic climate change legislation in the US (American Clean Energy and Security Act 2009, California Air Resources Board 2009). A shift from project-based to sector-scale crediting has been proposed by some CDM proponents as a way to expand the effects of the CDM and by some CDM critics as a way to replace the CDM with something more effective (e.g. Schmidt et al 2008). Sectoral crediting programs are being proposed for inclusion in California's cap and trade program (California Air Resources Board 2009), US federal legislation (American Clean Energy and Security Act 2009), EU climate policy (European Commission 2010: p. 8 & footnote 19), and post-2012 international climate change agreements (Belgium and the European Commission on behalf of the European Union and its member States 2010).

A variety of concerns have been raised about sectoral approaches. Concerns have been raised about the effectiveness of creating financial incentives for government action, especially when payments are made for reductions after they have been achieved rather than up front (Sterk 2010). Some discuss the challenges of avoiding over-crediting emissions reductions, particularly with regard to measuring emissions reduced by government policies and programs (Millard-Ball 2010b, Sterk 2010) and estimating a business-as-usual sectoral baseline (Millard-Ball 2010b, Schneider & Cames 2009), and the potential for creating perverse incentives for governments to refrain from action in order to generate more credits in the future (Ellerman et al 2008, Schneider & Cames 2009). Host country capacity to perform the necessary monitoring, reporting and verification has been raised as an important challenge to sectoral-scale crediting (Cai et al 2009, Center for Clean Air Policy 2010). Though many of these studies discuss similar concerns, their conclusions differ widely. Some suggest that sectoral crediting should be avoided generally (Sterk 2010) or for specific sectors (Millard-Ball 2010a) and others conclude that sectoral crediting is promising if carefully designed (Center for Clean Air Policy 2010, Schmidt et al 2008, Schneider & Cames 2009). I offer a study of the design of a sector-scale offsetting program in the Shandong cement sector, including standardize eligibility criteria as one possible variation of a more sector-scale approach. This work supports some of the concerns raised, and

raises others. Chapter 5 of this dissertation may be the most detailed study performed so far on the design of a sectoral crediting program for a specific sector.

1.2. The neo-liberalization of environmental regulation

Markets for environmental pollution are emerging in all areas of environmental regulation, as a part of a trend towards the neo-liberalization of environmental regulation. Offsets are included in regulation in the US under the Clean Water Act, the US Endangered Species Act, the Canadian Fisheries Act, and in environmental regulations in the EU, Switzerland and Brazil (ten Kate et al 2004). Under the 1972 US Clean Water Act, developers given permission to build on wetlands that are unable to reduce their impact to zero, must compensate for that damage by restoring other wetlands with equivalent ecosystem function. In 1991, a tradable wetlands crediting system emerged crediting wetland restoration from established wetland “banks” (see Robertson 2004, 2006). In 2005 there were around 400 existing wetland “banks” around the US and another 200 being proposed (U.S. Army Corps of Engineers 2008). Similarly, the US Endangered Species Act contains a provision that has allowed for species banking – a developer can harm endangered species if they protect that species elsewhere. Payment for Environmental Services programs create international markets for environmental services such as forest conservation (McAfee & Shapiro 2010). Such payments have gained dominance in discussions over environmental protection in some places. In the 2005 international climate change negotiations in Montreal, Papua New Guinea and Costa Rica proposed a new program that would provide funds to help developing countries prevent deforestation, the form of which has been actively negotiated since. This program, called Reducing Emissions from Deforestation and forest Degradation (REDD), could be supported by an international fund, carbon trading, or some combination of the two. Study of the effectiveness of carbon offsetting has implications for the direction of environmental regulation in a wide range of areas.

The processes of enactment and implementation of two different programs involving carbon trading – CDM on a global scale and the LCFS in California vehicle fuel sector – are surprisingly similar. The CDM and California’s LCFS were both enacted as one- or two-pages of legal text (Office of the Governor of the State of California 2007, UNFCCC 1997) before fundamental design issues had been worked through. In the process of implementation and program design, it became clear that regulators faced substantial uncertainties in estimating emissions reductions from both of these programs. Questions were raised about non-additional projects registering under the CDM (Haya 2007, Haya 2009, He & Morse 2010, Michaelowa & Purohit 2007, Schneider 2009, Wara & Victor 2008). In an exciting period of rapid academic discovery, research documenting large uncertainties in measuring lifecycle emissions from biofuels emerged, particularly around its indirect land use effects (O’Hare et al 2009, Plevin et al 2010, Searchinger et al 2008). Policy makers and academics working on both programs responded with calls for more research to determine the “right” numbers and procedures without questioning whether carbon trading itself is appropriate in these contexts. Many of the strongest critics of additionality testing under the CDM called for strengthening additionality testing criteria (e.g. Michaelowa 2010, Schneider 2009, Wara & Victor 2008). A flurry of research over the last few years has focused on developing models that could home in on the indirect land use effects of biofuels (e.g. Al-Riffai 2010, Dumortier 2009, Fritsche 2010, Hertel 2010, Tyner 2010). The California Air Resources Board is designing its LCFS regulation with the expectation that a reasonably accurate value is attainable with more study. It is not clear that this is a

reasonable expectation (Plevin et al 2010). Calculating emissions reductions and assessing additionality under the CDM and calculating lifecycle emissions of vehicle fuels and the over all design of the LCFS are very complex. This complexity makes it difficult for the public to understand and monitor the effects of these two programs.

We are now seeing the same process repeated in the context of sectoral crediting approaches. As mentioned above, a number of studies examine how sectoral crediting could broadly work (e.g. Schmidt et al 2008, Schneider & Cames 2009) but few studies focus on details of implementing a sectoral program in a specific sector and country (Millard-Ball 2010a). Yet sectoral crediting is being written into draft international negotiating text and into domestic legislation based on the assumption that it can work. Economic theory belies much of the political rationality advancing these policies. We have seen this before.

The history of international development assistance is full of programs based on neo-liberal economic theory that fail on the ground (Escobar 1995, Scott 1999). Joseph Stiglitz, in his 2003 book *Globalization and its Discontents*, criticized the International Monetary Fund (IMF) for following neo-liberal policies with a religious fervor, even though history has shown that these policies have harmed economies more than helped them. For example, Malaysia did not suffer as much as many other Asian countries following the Asian Financial Crisis because it did *not* follow the prescriptions of the IMF prior to the crisis (Stiglitz 2003). Ha-Joon Chang, in his book *Kicking Away the Ladder*, describes multiple periods over the last few centuries when wealthier countries have pressured poorer countries to open their borders to trade based on economic arguments that free trade brings economic growth. These policies resulted in the extraction of wealth and market power from the poorer countries to the wealthier countries. Free trade policies were promoted based on claims that they result in economic growth even though almost all of today's industrialized countries developed with strong policies protecting domestic industries (Chang 2002).

In another global experiment in energy policy, the World Bank pressured developing countries around the world to restructure and privatize their power sectors (World Bank 1993). Developing countries were asked to follow a blueprint of reforms modeled after the restructuring process in the UK, US and Norway (Dubash 2002, Williams & Ghanadan 2006). The Asian Financial Crisis of 1997-98 and the California electricity crisis in 2000-1 shook confidence in the restructuring process worldwide (Williams & Ghanadan 2006). By a few years later the World Bank revised its restructuring blueprint, calling for more considered power planning appropriate for each country, (while also keeping many underlying objectives intact) (ibid.). In the mean time, there was a large transfer of assets from governments in the South to private companies in the North, with notable examples of independent power producers (IPPs) (Eberhard & Gratwick 2007, Phadke 2009, Woodhouse 2006). For example, Enron sold power to Maharashtra state in India at extremely expensive rates from its notorious Dabhol project, straining the Maharashtra State Electricity Board financially (Dubash 2002, Phadke 2009). The transfer of wealth from the public to the private sector also happened in industrialized countries. Enron and other power generators are estimated to have extracted on the order of \$4 billion from California during 1998-2000 by exercising market power in California's partially restructured market (Borenstein et al 2002), in part through the strategically closing power plants for "maintenance" during peak periods contributing to large price spikes.

The literature on development aid provides many other examples of projects failing because they are designed without adequate understanding of the local context in which they are carried out (Ferguson 1994, Scott 1999). Solar panels sit idle on village rooftops because solar

panel programs lack attention to maintenance infrastructure, training for panel owners, and the availability of parts (Green 2004, Martinot 2002). International finance institution prescriptions have been copied and pasted from one country to another based on technical analysis that ignores the actual economy conditions and the local political context in which the prescriptions are carried out, resulting in negative effects (Ferguson 1994).

How is it that with growing criticism about the environmental outcomes of the CDM, that policy-makers and researchers enthusiastically support sectoral approaches prior to careful grounded analysis, potentially replacing one loophole in our international climate agreements with another even bigger loophole? Sectoral offsetting is being promoted before we can be assured it reliably reduces emissions, just as were both the CDM and the LCFS. We must ask, what *does* this project do (Ferguson 1994, Ghanadan 2008, Mitchell 2005)?

Offsetting does several things. First, as mentioned above, offsetting fits a narrow political space in international climate change agreements, providing industrialized countries and their regulated industries with inexpensive compliance options, and providing developing countries with funds towards mitigation activities, in a manner that is acceptable by major negotiating countries. Second, offsetting provides a way to appear to address environmental concerns with technological solutions that do not require the fundamental societal changes that are needed (McAfee 1999, Spash 2010). Third, using “market-based” as a positive adjective supports a worldview that even environmental regulation, which has been the responsibility of public sector, is better done by private industry and the market. It supports a neo-liberal view that the role of government should be minimized and that decision-making is best left in the hands of consumers and producers, serving the interests of those benefiting from less government oversight and a wider reach of the market (McAfee 1999).

2. METHODS

The research for this dissertation involved semi-structured and unstructured interviews, CDM project document review, analysis of CDM project financial spreadsheets, analysis of the UNEP Risoe database of proposed and registered CDM projects,² and participant observation.

I started the research for this dissertation in May 2004 with interviews exploring the influences that enabled and limited the dissemination of bagasse cogeneration (the efficient generation of electricity and steam from sugar cane waste) in India. My two co-researchers³ and I sought to understand the barriers to the dissemination of bagasse cogeneration in India, and the effects of international and domestic efforts to overcome these barriers and to support this technology. This research involved visits to nine sugar mills in Maharashtra and Tamil Nadu states in India, review of project documentation from the support programs analyzed, and semi-structured interviews with individuals involved in bagasse cogeneration projects and support programs. We interviewed individuals from various levels of Indian government, non-governmental organizations (NGOs), multilateral agencies, energy consulting firms and research institutions in New Delhi, Pune, Chennai and Bangalore.

Since it is much easier to understand what happened than why it happened, and oftentimes individuals deeply involved in a project have misconceptions of the influences on

² UNEP Risoe CDM/JI Pipeline Analysis and Database, September 1st, 2010 <http://www.cdmpipeline.org/>

³ I conducted this research as a part of a team project funded by the UC Berkeley-UNIDO “Bridging the Divide” Fellowship with two UC Berkeley PhD students – Malini Ranganathan and Sujit Kirpekar.

their own decisions, we relied on triangulation and scepticism to come to our findings. With triangulation, we used multiple varied sources to support our conclusions. With scepticism, we constantly questioned our understanding, looking for other possible explanations, and asking more questions until we were confident in our findings.

These early interviews raised doubts about the influence the CDM is having on project development decisions and the additionality of proposed CDM projects. The largest share of my PhD research explored and documented the influence the CDM is having (and is not having) in the Indian power sector, and ways the mechanism might be restructured or replaced to have a stronger influence. I spent twenty additional months in India during 2006 through 2009. In my second research visit to India in 2006, a picture quickly emerged of the CDM as crediting many business-as-usual projects and having little influence on the development of new projects. I returned to India two more times, for ten months in 2007-8 and three months in 2009, to probe these findings more deeply and gather evidence. Since the CDM's rules and procedures became stricter after its first two years, the chapters herein are based only on the interviews conducted during 2007-2009.

Chapters 2 and 3 on the CDM in the Indian power sector are based on: (i) over 75 interviews conducted in India during 2007 to 2009, (ii) an analysis of project documents from 80 CDM projects registered in India and China, and (iii) analysis of the UNEP Risoe CDM project database containing information about all projects currently registered under the CDM and in the application process.

I conducted semi-structured and unstructured interviews with experts involved in all stages of CDM project development (mostly in India and several at international conferences), including project developers from a range of project types (32 individuals), CDM consultants (14), validators from four out of the five largest validation firms in India (hired to audit projects applying for CDM registration, 7), carbon traders (5), employees of banks lending to renewable energy projects (2), government officials (2), members of the CDM governance panels (2), and researchers involved in renewable energy and hydropower development and the CDM (11). Interviewees were identified in three ways. Many of the interviewees were participants at carbon and climate conferences and workshops, providing the opportunity for informal discussions, sometimes over several days, and the chance for more frank discussions than would typically happen at a meeting in someone's office. I sometimes arranged follow-up interviews after a conference or workshop. Second, snowball methods were used whereby interviewees recommended other key experts. In addition, I identified and contacted key individuals at the largest validation and CDM consulting companies. Questions focused on the decision-making processes determining the financing and building of wind power, biomass power, hydropower and fossil fuel projects in India, including government involvement, regulatory processes, and factors affecting the decisions of individual lenders, investors and developers. I also asked experts general questions about their views on the influence the CDM is having in India, and how the CDM can be improved to more effectively promote renewable energy in India.

I analyzed CDM project documents for the additionality arguments used to register all of the large (over 15 megawatt (MW)) wind, biomass and hydropower projects registered by the CDM in India since 2007, and the 20 most recently registered hydro projects in China as of December 2009, totaling 80 projects (see Table 1.1). I chose to review only "large" projects since the additionality testing procedures for projects above 15 MW are more rigorous than for "small" projects. I chose to review only projects registered from 2007 because additionality has gradually been strengthened, and was particularly weak during the first two years of the CDM as

the market was being built. I chose the three most numerous project types in India, and hydropower in China because it is by far the most numerous project type in the CDM pipeline, comprising 17% of all projects. A focus on several project types allowed for a more comprehensive analysis than would be possible if projects were randomly chosen. The four project types represent one third of all projects registered under the CDM and applying for registration worldwide when small-scale projects are also taken into account.

Table 1.1: Projects analyzed

	Projects analyzed	Projects in the CDM pipeline (registered & applying; large & small)	
		Total number of projects*	Percent of all projects in CDM pipeline*
Wind in India	25	416	8%
Biomass in India	19	315	6%
Hydro in India	16	161	3%
Hydro in China	20	942	17%
TOTAL projects of these four types	80	1834	34%
TOTAL projects in the CDM pipeline		5444	

* UNEP Risoe CDM/JI Pipeline Analysis and Database, September 1st, 2010 <http://www.cdmpipeline.org/>

I also had the opportunity to attend four annual international climate change negotiating sessions⁴ and two CDM Coordination Workshops in Bonn⁵ between 2005 and 2009. At these conferences, and to a lesser extent at climate change and CDM conferences in India, I was able to talk to validators (CDM project auditors), consultants and project developers from other countries, as well as CDM governance panel members familiar with CDM projects from many countries. The statements commonly made by Indian CDM and energy practitioners were very similar to statements made in my discussions and interviews with individuals working in a range of countries.

As an active member of the Climate Action Network flexible mechanisms working group⁶ at the international climate change negotiating sessions, I was able to talk with the CDM negotiators from various country delegations to understand their positions on the CDM and CDM reform. Understanding of the politics of CDM reform informs the policy conclusions discussed below.

Chapter 5 presents the results of a design analysis of a sectoral crediting program in the cement sector in Shandong province, China. This analysis differs from my study of the CDM in two important ways. The program does not yet exist, so there are no outcomes to study, and I did not visit China or conduct interviews. I relied on literature, and more so, on the substantial expertise on the Chinese cement sector of my colleagues in the Lawrence Berkeley National

⁴ Conferences of the Parties to the UNFCCC in 2005 in Montreal, 2007 in Bali, 2008 in Poznan, and 2009 in Copenhagen

⁵ I attended as a member of the Roster of Experts for the CDM Methodology Panel.

⁶ The Climate Action Network is a network of over 500 environmental NGOs worldwide that are active in the international climate change negotiations and domestic climate change policy. This network is well organized with working groups that follow, analyze, develop consensus positions on and weigh in on key negotiating issues.

Laboratory (LBL) China Group with whom I worked on this design analysis. I first created a typology of design options from the literature on sectoral crediting with the Chinese cement sector in mind. We then thought through the pros and cons of each design option as they apply specifically to the Shandong cement sector. This analysis of the pros and cons of different options was modeled after the design analysis process in which I participated for California's Low Carbon Fuel Standard (LCFS).

In 2007, I worked with a team of professors and graduate students from the University of California at Berkeley and at Davis that was tasked with a design analysis of California's LCFS for the State of California. This process involved laying out key design decisions and options, and active discussion, debate and drafting on their pros and cons and our recommendations on each. The process also involved discussions with program stakeholders. Through this process I witnessed certain similarities between the CDM and the LCFS that I discuss in the Conclusion to this dissertation.

3. IN WHAT FOLLOWS

Chapter 2 – *Measuring Emissions Against an Alternative Future: Fundamental Flaws in the Structure of the Kyoto Protocol's Clean Development Mechanism* – shows: (1) Large numbers of CDM projects are “non-additional” (would have gone ahead regardless of support from the CDM) and therefore do not reduce emissions; (2) Uncertainty associated with the benefits of the CDM compromises the CDM's influence on project development decisions; (3) The CDM systematically over-credits emissions reductions; (4) Even if the environmental integrity of carbon offset credits could be assured, the large-scale use of carbon credits generated in developing countries to meet industrialized country emissions targets undermines climate change mitigation over the next decades. Uncertainties involved in measuring emissions against a counterfactual scenario mean that offsetting risks weakening the effectiveness of global climate change agreements to control greenhouse gas emissions to the extent that they are used.

Three proposals for reforming or replacing the CDM have received the most attention in international policy discussions. These are (i) making project-by-project additionality testing more accurate with more rigorous additionality testing procedures, (ii) replacing project-by-project additionality testing with standardized eligibility criteria, such as project, type, size, location and efficiency level, that would automatically allow projects fulfilling the criteria to generate credits under the CDM, and (iii) replacing the CDM with approaches that credit reductions on a sector-scale, with a range of such proposals under discussion. The first option is the topic of Chapter 3 and the two others are analyzed in Chapter 5.

Chapter 3 – *Can the CDM's Investment Analysis Accurately Test Additionality? A Focused Look at Wind Power, Biomass Energy and Hydropower Projects in India*. The “investment analysis” is considered the most accurate way to filter projects that are only able to go forward because of the additional financial boost from carbon credits sales. The investment analysis is used to demonstrate that a project is not financially viable without carbon credits, by showing that the project's financial returns, most often in terms of internal rate of return, are below a viability benchmark for the project. I perform sensitivity analyses on the financial projections used in the investment analyses of wind, biomass and hydropower CDM projects in India. Even with the

best case technology for an accurate investment analysis – wind projects in India for which the main costs and revenues are documented in contracts before construction begins – cost and revenue assumptions can still be gamed to show that some financial viable projects are not viable. For most other project types there is much more room to manipulate cost and revenue inputs. Even if financial projections were assumption-free, the viability benchmark against which project financial return is compared is highly sensitive to assumptions. Large hydropower in India is inappropriate for additionality testing because development decisions are mainly made by a government process, and because tariffs are adjusted to guarantee hydropower developers a pre-determined return on their equity investment, rendering the IRR analysis relatively meaningless. I conclude that an accurate project-by-project additionality test is infeasible for CO₂ reduction projects.

Chapter 4 – *Barriers to Sugar Mill Cogeneration in India: Insights into the Structure of Post-2012 Climate Financing Instruments* – examines the effectiveness of the CDM through a focused study of the history of the development of a single technology in India – the generation of electricity and steam from sugar cane waste called bagasse cogeneration. We examine the barriers this technology has faced over time, and how well a range of international and domestic efforts have helped to overcome these barriers. We compare how well the CDM helped address the barriers to bagasse cogeneration compared to more traditional fund-based approaches such as projects of international financial institutions like the World Bank and grant agencies like USAID and the Global Environmental Facility. Bagasse cogeneration has faced layers of informational, technical, regulatory and financial barriers that have changed over time, and differed between the private and cooperative sugar sectors. We find that each of the programs designed to support bagasse cogeneration had a role to play in enabling the bagasse cogeneration currently installed, and no single program would have been successful on its own. Any effort to exploit the remaining estimated national potential for high efficiency bagasse cogeneration will need to address the special financial and political conditions facing cooperative mills. I would like to highlight two conclusions from this chapter. First, some barriers to bagasse cogeneration needed directed efforts designed to address the specific context of the sugar sector in India; simply subsidizing the technology or putting a price on carbon was not enough. Second, where climate (global) and development (local) priorities differ, projects that bring about international goals risk conflicting with more pressing domestic goals.

Chapter 5 - *Concrete Emissions Reductions in Shandong's Cement Sector: Design Options for a Sectoral Crediting Program* – performs a design analysis for a sectoral crediting program in the cement sector in Shandong province in China. The goal of this paper is to explore the possible design of a sectoral crediting program that substantially improves upon the main problems with the CDM. We analyze potential sectoral crediting designs against three criteria: their potential to effectively promote efficiency improvements, ensure that the number of credits generated by the program does not exceed the reductions enabled by it, and meet international standards for reporting and verifying emissions reductions. We offer a typology of sectoral crediting design options being discussed in academic and gray literature and in official post-2012 country submissions and negotiating texts. We then analyze these design options in the specific context of the Shandong cement sector against the evaluation criteria. We find that for most design options sectoral crediting could perform worse than project-based offsetting along the three criteria assessed. Two specific design architectures stand out as having the potential to

effectively support verifiable emissions reductions without a high risk of over-crediting those reductions if designed and implemented well.

Chapter 2. Measuring emissions against an alternative future: fundamental flaws in the structure of the Kyoto Protocol's Clean Development Mechanism

1. INTRODUCTION

Industrialized countries have two obligations under international climate change agreements: to meet their emissions reduction obligations, and to support climate change mitigation and adaptation in developing countries. The Kyoto Protocol's Clean Development Mechanism (CDM) has been critical to meeting both obligations. The CDM allows industrialized countries to invest in emissions reduction projects in developing countries and use the resulting emissions reduction credits towards their Kyoto targets. Any project registered under the CDM can produce carbon credits, called certified emissions reductions, or CERs, totaling the estimated tons of CO₂-equivalent emissions avoided by the CDM project. The CDM is the most used of the Kyoto Protocol's "flexibility mechanisms," which are meant to lower compliance costs by allowing industrialized countries to partially meet their emissions targets with reductions made outside of their own borders. The CDM is also the main instrument supporting climate change mitigation in developing countries, facilitating transfer of roughly three billion Euros per year to developers of low-emitting projects in developing countries.⁷

A key challenge of the CDM is to measure the emissions reduced by a single project. Measuring emissions requires comparing the emissions from that project to emissions from a counterfactual scenario of what would likely have happened without the project. This of course involves assumptions about the future. The biggest challenge in determining the counterfactual baseline scenario is assessing whether the project itself is in that counterfactual scenario, or in other words, if the proposed CDM project would have gone ahead anyway, without the expected revenues from the CDM. Any carbon credits generated by projects that would have gone ahead regardless of the carbon credits, allows an industrialized country to emit more than their Kyoto targets without causing emissions to be reduced elsewhere. Each project applying for CDM registration must demonstrate their "additionality," that is that the project would not likely have gone forward had it not been for the expected CDM income. Only projects certified as "additional" are allowed to generate carbon credits under the CDM.

Another key challenge relates to the nature of the CDM credit market. A common appeal of the CDM is that it is a market mechanism meant to create a global market for emissions reductions, lowering the cost of compliance by allowing industrialized countries to reduce emissions wherever in the world it is least expensive to do so while engaging the private sector. In practice, the CDM does not create a market for emissions reductions. It creates a market for emissions permits. It is the permit to emit that is the primary interest of most CER buyers, seeking low cost options of complying with domestic climate regulations. Typically, neither the buyer nor the seller of CDM credits has a strong interest in ensuring the climate benefit represented by the permits. In addition, these permits to emit are wholly human created, numbers in databases, such that no extra cost is incurred from producing more permits. CDM project proponents not only have little incentive to protect the integrity of the permits, they have a financial interest to do the opposite, to exaggerate the number of carbon credits generated by

⁷ The CDM projects currently registered under the CDM would produce 380 million tons of CERs a year if they meet the expectations in their PDDs (Fenhann J. 2010. September 1, CDM Pipeline Overview. UNEP Risø Centre, <http://www.cdmpipeline.org/>). Primary CER prices are currently around 10 Euro per CER.

CDM projects. Therefore, the integrity of this market in terms of emissions reductions relies almost entirely on effective governmental regulation. These features – the buyer is unconcerned with the quality of the underlying physical thing represented by the wholly human-made tradable asset – are also features of many of the financial instruments whose deregulation in the US caused the current global financial crisis, reminding us of the importance of regulation for markets to achieve social ends. As mentioned above, the market in CDM credits is especially difficult to regulate because it requires measuring emissions reductions against a hypothetical scenario, and determining whether the project itself is a part of that scenario.

I examine how the CDM is working in practice in the Indian power sector and how it might be improved. I argue:

- Large numbers of non-additional, business-as-usual projects are registering under the CDM.
- Uncertainty associated with the benefits of the CDM weakens the influence of the CDM on project development decisions.
- Beyond additionality testing, the CDM structure leads to a systematic over-crediting of emissions reductions.
- Even if the additionality of CDM projects could be assured, the large-scale use of offsetting makes long-term international cooperation to mitigate climate change more difficult over the next decades in a number of ways.

In what follows, Section 2 provides background on the state and functioning of the CDM. Section 3 describes the methods supporting this analysis. Section 4 documents how non-additional projects have been able to register under the CDM. Section 5 examines how the effectiveness of the CDM is compromised by the uncertainties associated with its benefits. The next three sections discuss ways that the fundamental structure of the CDM limits its environmental integrity. Section 6 argues that project-by-project additionality testing is inherently inaccurate for projects that reduce carbon dioxide given today's carbon prices. Section 7 presents a number of other ways that the CDM structure systematically leads to the over-generation of credits. Section 8 shows that the large-scale use of offsetting credits undermines long term global cooperation to mitigate climate change over the next decades, even if the quality of those credits could be assured.

2. BACKGROUND

2.1. How the CDM works

Developers of low-carbon projects in developing countries can submit their projects to the CDM Executive Board (EB) for CDM registration. An application for CDM registration includes a Project Design Document (PDD) describing the project, a validation report from an independent third party auditor, and a letter of approval from the host country government. The PDD gives a detailed description of the project, including an estimate of the emissions that it will reduce following the procedures laid out in an approved CDM “methodology,” and evidence that the project is additional. A CDM project can involve the building of a new facility, where the baseline is the sector without that new facility; the building of a more efficient facility, where the baseline is a less efficient version of the same new facility; or the upgrading of an existing facility or process, where the baseline is the facility or process without the upgrade. The

developer must hire a certified third party auditor, called a validator,⁸ to validate that the project meets all of the requirements of the CDM. After a project is approved by the CDM Executive Board, the developer chooses how often to submit requests for the issuance of CERs, which go through a similar process of third party verification and then approval by the CDM Executive Board. Typical end buyers of CERs are governments of and regulated facilities owners in countries that have Kyoto Protocol targets. Often the first buyers of CERs from the developer are intermediary companies that trade in carbon credits. The developer can choose to enter into a CER purchasing agreement with a buyer at any time in the CDM project cycle. They can also choose to sell credits after they are generated. Figure 2.1 presents the key steps in the process of registering a project under the CDM and applying for CER issuance.

2.2. The current state of the CDM

As of August 1, 2010 there were a little over 2,300 registered CDM projects, and another 3,000 proposed CDM projects in the validation process. The total number of registered CDM projects is presented by country in Figure 2.2, and by type in Figure 2.3. China and India host 62% of all registered CDM projects, with few projects registered in Africa and in many other smaller developing countries. 31% of all registered CDM projects are renewable energy projects and 28% are hydropower projects. The high potency greenhouse gases – HFC, PFC and N₂O⁹ – make up 4% of all registered CDM projects but are expected to produce 35% of annual CERs, if all projects were to produce the amount of credits predicted in their PDDs (see Figure 2.4).

This paper focuses on CO₂ reduction projects, which compose 73% of all registered CDM projects and 48% of all credits expected from registered CDM projects through 2012. The findings are most relevant to CO₂ reduction projects and some methane reduction projects for which carbon credits are an additional rather than the primary revenue source. Projects that reduce emissions of the extremely potent HFC gas have a high likelihood of being additional since CERs are their sole revenue source. However, the effectiveness of the CDM in reducing these emissions has been questioned on the grounds of efficiency and perverse incentives (see Section 7 for a discussion of this).

2.3. The *Additionality Tool*

The “Tool for the demonstration and assessment of additionality,”¹⁰ is the most common method used for proving the additionality of proposed CDM projects. The *Additionality Tool* requires developers to demonstrate the additionality of their proposed CDM project by an investment analysis, a barrier analysis, or a combination of both.

⁸ A validator is also called a Designated Operational Entity, or DOE.

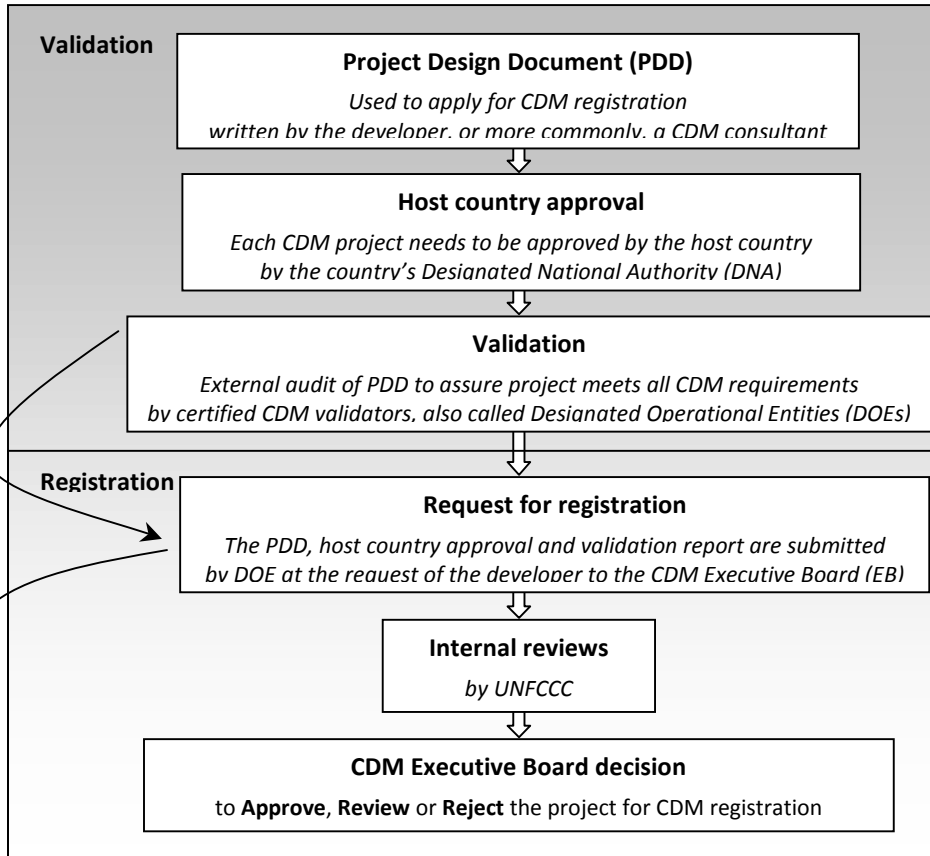
⁹ Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs), and Nitrous oxide (N₂O)

¹⁰ The *Tool for the demonstration and assessment of additionality*, and a version of this tool that is combined with a baseline identification methodology - *Combined tool to identify the baseline scenario and demonstrate additionality* - can be found here: <http://cdm.unfccc.int/methodologies/PAMethodologies/approved.html>

Figure 2.1: The CDM Project Pipeline Step-by-Step

Time
(for the average
CDM project)

Registering a project under the CDM:

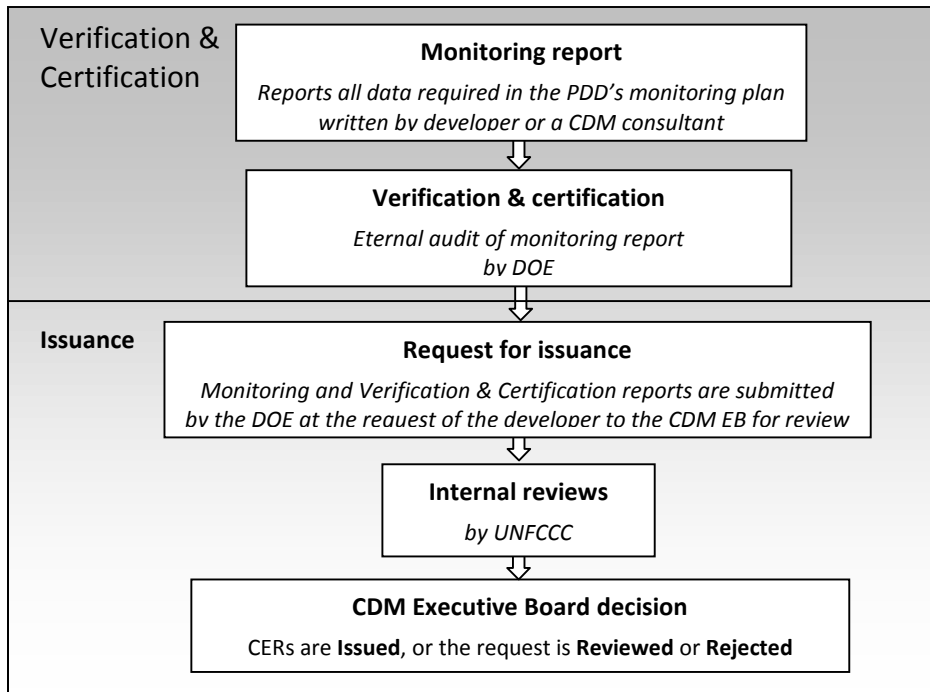


10.7 mos.

4.9 mos.

Registration approved

Receiving carbon credits from that project:



14.7 mos.

1st credits issued

Credits can then be sold by the project developer to a credit buyer, typically per a credit purchasing agreement.

Figure 2.2: Registered CDM projects by host country

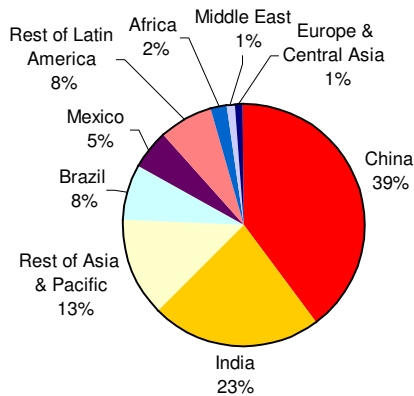


Figure 2.3: Registered CDM projects by type

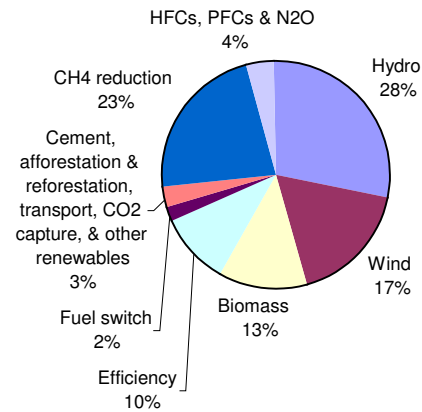


Figure 2.4: Annual expected CER generation from registered CDM projects by type

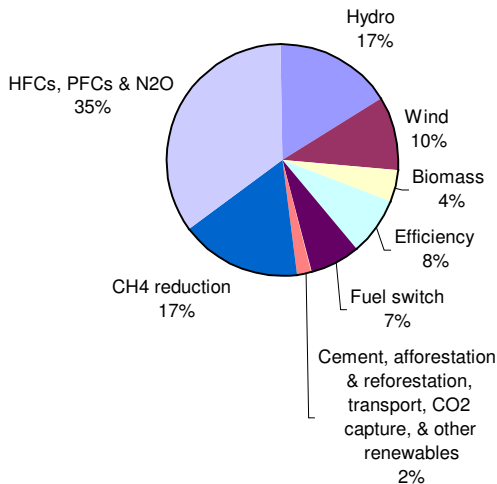
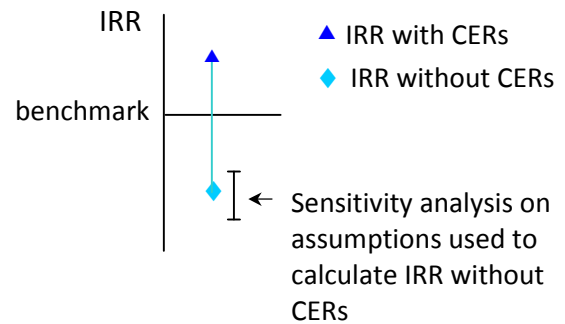


Figure 2.5: The investment analysis



- The investment analysis is used to show that a project is not financially viable without carbon credits. A benchmark is determined that represents the threshold financial return, or hurdle rate, defining whether the project would likely go forward. For renewable energy and hydro projects, the benchmark is most commonly defined in terms of project or equity internal rate of return (IRR).¹¹ If the expected financial return of the project is below the benchmark, then it is assumed that the project most likely would not have gone forward without carbon credits and the project is considered additional. The financial assessment is tested with a sensitivity analysis of the most important cost and revenue inputs. It is optional to show that CERs bring the financial return of the project above the benchmark. Figure 2.5 illustrates the investment

¹¹ Internal rate of return (IRR) is the discount rate that would be applied to the cash flow of a project so that the net present value of the project is zero. A higher IRR indicates better financial return.

analysis for a project that is additional and uses IRR as the metric used to assess project financial return.

- The barrier analysis describes and presents evidence for the existence of one or several barriers that prevent the proposed CDM project from going forward without the additional income from carbon credit sales. Examples of barriers are uncertain hydrological flows for a hydropower project and risk of corrosion from the combustion of biomass for a biomass power project.

2.4. Why additionality matters

Additionality is a challenge for any climate mitigation program. Estimation of emissions reduced by policies, programs, and projects is often highly inexact in a complex world in which there are multiple influences on behavior and industrial and consumer choices. International funds that pool contributions to support emissions reduction projects in developing countries, the main alternative to crediting mechanisms, could also end up supporting activities that would have happened anyway. An important difference between crediting mechanisms and funds is that when a fund supports a BAU project, it fails to reduce emissions through that project; when the CDM supports a BAU project, it also weakens an industrialized country target. A second concern is that the complex and technical nature of offsetting programs, and a general, sometimes quite ideological faith in the efficiency of market mechanisms, combine to provide policy-makers with a false confidence of the effectiveness of an offsetting system. To have a high likelihood of limiting global temperature increase to less than two degrees Celsius, substantial efforts are needed in both industrialized and developing countries. Industrialized countries need both to substantially reduce their own emissions and to support mitigation in developing countries. To the extent that CERs are over-credited to CDM projects, the CDM fails in both regards at the same time.

3. NON-ADDITIONAL PROJECTS ARE ABLE TO REGISTER UNDER THE CDM

The poor quality of the barrier and investment analyses used to prove project additionality during 2005 through the first half of 2007 has been well documented (Michaelowa & Purohit 2007, Schneider 2009). Barriers used in the barrier analysis were subjective, not credible, poorly documented, or were so general that they are common to a wide range of CDM and non-CDM projects. Investment analyses left out or did not document important values affecting the feasibility of the projects (ibid.).

Since early 2007, guidelines published by the CDM Executive Board have prevented some poor quality additionality argumentation from passing the additionality test. This section shows that projects have still been able to register during the last three years using dubious additionality arguments. One analysis stands out in the literature. In China, wind developers commonly use 8% IRR as the benchmark needed to make a project viable. This benchmark was introduced by the Chinese government in 2003 and has not been updated to reflect the very different environment of today's Chinese power sector (He & Morse 2010). Further, developers commonly argue that a coal plant would be inappropriate for a benchmark comparison even though coal composes 80% of the Chinese power grid, for the bizarre reason that there are no coal fired power plants as small as the proposed wind projects. If coal were used, additionality

would be disproved, since wind projects typically receive higher returns than coal plants in China, because of the promotional tariffs set by the Chinese government (ibid.).

The 80 projects reviewed for this paper provide numerous other examples of questionable additionality arguments. Construction on 16 of the 80 projects reviewed in this analysis began before the Kyoto Protocol entered into force in February 2005 and before the first project was registered under the CDM in November 2004. None of these PDDs mentions a contract with a carbon buyer through which credits will be bought even if the project were not successfully registered as a CDM project. (All of these projects were registered since 2007.) It is highly unlikely that a developer started building a project because of the expectation of generating carbon credits from an offsetting program for which the rules had not yet been decided under a treaty that had not yet come into force.

Seventeen of the 39 Indian projects analyzed for this paper that provide both with- and without-CER IRRs have with-CER IRRs below the benchmark, some by several percentage points. The premise behind the investment analysis is that it should accurately predict whether a project would be built according to the norms of economic and financial rationality and the estimated costs and revenues in the analysis. The investment analysis for these projects predicts that these projects would not be built even with CDM revenues, yet all of these projects were built.

The Xiaogushan hydropower project in China¹² was registered as a CDM project on the basis of having an IRR under the government defined benchmark of 8% for power projects. However, the Asian Development Bank, in its evaluation of the project, describes the project as the least cost project in the entire province, and as being financially viable with an IRR above the 4.53% WACC of the company.¹³ The PDD for the Allain Duhangan hydropower project in India uses the company's WACC of 12.6% as the benchmark, while a draft of the project's Environmental & Social Impact Assessment released December 2003 states that: "The project would be one of the cheapest sources of power generation in the Northern Region as compared to alternative of thermal or nuclear power generation."¹⁴ Both of these projects were described by international finance institutions, not only as cost effective, but as the most cost effective in their region. Yet the CDM benchmark analysis was used to "prove" they were unviable.

A murmur of agreement went through the audience at a carbon markets conference in 2007 in Mumbai when a panelist mentioned that board minutes documenting early consideration of the CDM in the decision to build proposed CDM projects are being forged and post-dated. In 2009 one validator proudly told me how he discovered one of these forged documents. One CDM consultant told me that he presented two sets of investment analyses to a bank for a single project – one for the CDM application showing that the project would not be financially viable without carbon credits, and a second for the loan application showing that the project is financially viable on its own.

In India, wind power is often an attractive investment in large part because of the tax benefits offered by the central government. India offers wind power developers the ability to take 80% depreciation for wind project capital costs in the first year of operation along with a 10-year

¹² I worked out this example together with independent television news producer and journalist Janet Klein.

¹³ Asian Development Bank. 2003. *Report and Recommendation of the President to the Board of Directors on a Proposed Loan to the People's Republic of China for the Gansu Clean Energy Development Project*

¹⁴ Himanshu Thakkar from the South Asia Network on Dams, Rivers & People (SANDRP) in New Delhi first alerted me to this quote.

<http://www.ifc.org/ifcext/spiwebsite1.nsf/b7a881f3733a2d0785256a550073ff0f/9c7eed7ed0ec2b2e852576ba000e25a0?OpenDocument> (Website accessed September 29, 2010; quote is found on page 7 of the report in English.)

tax holiday. Twenty-five large wind projects totaling 1,600 MW of wind power were registered in India under the CDM since 2007. Of these, at least eleven projects incorrectly calculate the tax benefits offered by the Indian government, showing that the projects are less cost effective than they actually were.¹⁵

At least seven developers and consultants told me that the CDM projects that they proposed would have been built anyway, without the CDM. It was surprising how easy it was to find developers who would say this, given their interest in defending the additionality claims in their CDM application documents. Given the subjectivity involved in project development decisions, possibly the strongest evidence that a project is non-additional is the admission of developers themselves. Many other developers and consultants responded to my probings with general statements that very few CDM projects are additional.

It is a widely held belief among CDM and renewable energy professionals in India is that many CDM projects are non-additional and that the CDM is having little effect on renewable energy development in the country. Interviewees commonly made statements such as: CDM revenues are just “cream on the top”; developers decide to build projects “on their own terms,” not based on the small and uncertain change in IRR from carbon credit sales; “any project can be registered under the CDM.” While it is very difficult to assess with certainty if a project is additional (the topic of the next section), the poor quality of the additionality arguments used to register CDM projects, evidence of fraud, and the widespread opinion of CDM and renewable energy professionals in India together suggest that many non-additional projects are registering under the CDM.

4. UNCERTAINTY COMPROMISES THE CDM'S INFLUENCE

The proportion of credits from additional projects to non-additional projects is a function both of the non-additional projects able to register, and of the truly additional projects enabled by the program. This section examines how effective the CDM is at enabling new projects to go forward.

The CDM is anticipated to improve the financial return of most of the projects analyzed for this paper by 1% to 7% according to their PDDs. That incentive is weakened by the range of uncertainties associated with CDM revenues throughout the CDM project lifecycle (see Figure 2.1 above for a description of the lifecycle of a CDM project):

Validation risk: Of the 3611 projects that started validation between the beginning of 2007 and the first half of 2009, 600 (17%) were either negatively validated or the validation was terminated by the validators.^{16 17}

Registration risk: Approximately 8% of all projects submitted for registration between the beginning of 2007 and the first half of 2009 were rejected by the CDM Executive Board.^{18 19}

CER issuance/delivery risk: Projects requesting the issuance of CERs on average received 84% of the CERs predicted in their PDDs.^{20 21} In addition, 20% of all projects

¹⁵ Axel Michaelowa first alerted me to this problem. The details of this assessment is described in Section 5.2.1 below

¹⁶ Data taken from UNEP Risoe CDM/JI Pipeline Analysis and Database, September 1st, 2010 <http://www.cdmpipeline.org/>

¹⁷ For the four project types analyzed in this paper, 16% were negatively validated.

¹⁸ Ibid.

¹⁹ For the four project types analyzed in this paper, 6% were rejected.

registered during 2006 with the expectation of generating credits for reductions starting in 2006 or earlier have not yet had credits issued. Some of these projects might not be able to generate credits because of a failure to follow the plan laid out in the project application documents for monitoring emissions reductions. Uncertainties in CER quantity and price are reflected in CER market valuation. For example, the CER prices offered directly to the project proponents of registered CDM projects (primary CERs) were lower than the price of existing CERs that are being resold (secondary CERs) by 10% to 21% between February to July 2010.²²

CER price risk: Between January 2007 and July 2010, secondary CER prices fluctuated between a high of 23 Euro in June 2008 to a low of 10 Euro in February 2009.²³

CER value post-2012: At the time that this paper was written there was still substantial uncertainty about the structure of the post-2012 climate change regime and how CER credits will be used under it.

The behavior of CDM project developers indicates that the financial value of CERs does not provide a go/no-go influence for most projects. Developers are going forward with their projects with the risk that they will receive no benefit from the CDM. Approximately three-quarters of all registered CDM projects worldwide were operational at the time they were successfully registered under the CDM.²⁴ This means that an even higher proportion had started construction before registration. Further, 76 out of the 80 projects analyzed for this paper started construction before the beginning of the 30-day public comment period, which typically happens

²⁰ Ibid.

²¹ For the four project types analyzed in this paper, developers received an average of 90% of the CERs expected.

²² CER prices are taken from Point Carbon's CDM & JI Monitor, which is published every two weeks. The percentages were calculated as the average spread over six months of the difference between the secondary CER price and the high and low primary CER prices reported for registered CDM projects. The low bid price for primary CERs was used for the low primary CER price, and the high offer price was taken as the high primary CER price.

²³ CER prices are taken from Point Carbon's CDM & JI Monitor.

²⁴ In the UNEP Risoe CDM pipeline database, as of September 1, 2010, 82% of all registered CDM projects have "Credit start" dates equal to, or earlier than, the "Date of registration." The "credit start" date is the date named in the PDD when the developers expect to start generating credits from the project. If a project is expected to be commissioned after the expected date of registration, the credit start date should be named as the expected commissioning date. As of 31 March 2007 projects were no longer allowed to generate credits retroactive to registration (see paragraph 78 of the 28th Meeting Report of the CDM Executive Board). So all projects registered March 2007 that were expected to already be commissioned by the date of registration should have credit start dates equal to the registration date. As of September 1, 2010, only 18% of all registered projects have credit start dates after the date of registration and 24% have credit start dates before the date of registration. What proportion of the 58% of projects with credit start dates equal to the registration date were actually commissioned before the date of registration? Of the 80 project reviewed for this paper, 29 have credit start dates equal to the date of registration. Of these, only two were commissioned after the date of registration, and 25 were commissioned before the date of registration. (The commissioning dates for two of the projects were not found in the CDM project documents or on company and utility Websites.) I also reviewed the PDDs for the large hydro projects registered in China between May 2007 and April 2009. Of the 70 projects reviewed that include the commissioning date in their project documents, 68 were commissioned before the date of registration and only two were commissioned after. In total, only 4% of the 99 projects with registration dates equal to credit start dates reviewed here were commissioned after the date of registration; 96% were commissioned before. Extrapolating this analysis to the whole body of registered CDM projects, this suggests that around three-quarters of all registered projects were completed at the time of registration.

in the first few months of the validation process.²⁵ This suggests that the large majority of CDM project developers also begin construction before the start of validation, and therefore absorbed both the registration and validation risks. Even though both the validation and registration risks can be avoided by registering a project under the CDM before deciding to go ahead with the project, most project developers do not choose to wait the long, typically over one and a half year, validation and registration process before starting construction.²⁶ The developers of almost all CDM projects are willing to take the risk that their projects will not be successfully registered.

Multiplying the CER risks together indicates that at the time the decision to build the projects were made, the “rational” value of the CERs expected to be generated by the CDM project was less than half of the value of the funds project developers would actually receive if the projects generate the CER revenues expected:

83% of the projects submitted for validation receive a positive validation	Validation risk
Of those, around 92% are accepted for registration by the CDM Executive Board	Registration risk
The average project that generates credits generates 84% of the credits expected	CER delivery risk
If post-2012 CERs are valued at half of the expected CER price before 2012 because of the large uncertainties associated with the post-2012 climate change regime, ²⁷ the net present value of the CER revenue stream is one quarter lower ²⁸	Post-2012 risk

The uncertainties associated with CDM benefits for a typical project is calculated as:

$$83\% * 92\% * 84\% * 75\% = 48\%$$

In addition to these risks is the CER price risk.

Project decision-makers, such as the typical lender and some project developers, who are primarily concerned with recovering costs rather than profit earnings, are also more risk-averse and therefore less likely to be influenced by uncertain CDM benefits. Lenders are typically primarily concerned that projects generate the minimum cash flows needed to make loan repayments since they do not benefit from higher profits. This is reflected in the interview

²⁵ The construction start date was taken from the PDDs. The beginning of the 30-day public comment period is listed in the UNEP Risoe CDM pipeline database as the “comment start” date. Typically the validator puts the PDD up for the public comment period in the first few months of validation.

²⁶ Using the Risoe CDM pipeline database, the average time between the start of validation and the date of registration for projects registered over the last two years, between September 2008 and September 2010, was 19 months.

²⁷ Half of the value is a conservative choice for this analysis; the perceived value of post-2012 CERs is probably less than this given the level of uncertainty about the post-2012 regime.

²⁸ To do this calculation, a discount rate of 13%, the average benchmark for the 80 projects reviewed for this paper, was applied to two CER revenue streams and averaged. Both revenue streams start in 2008; one generates credits for a single ten-year crediting period and the other for three back-to-back seven-year crediting periods (the two options offered CDM project developers).

responses. It is common understanding among CDM practitioners in India that CERs are having little influence on bank lending decisions because of the uncertainties associated with CDM registration and CER generation and value. The two bank representatives with whom I spoke said that CERs have little influence on their decisions to lend to energy projects. Also, project developers whose main motivations are the projects' social and environmental benefits rather than their investment opportunity, such as many non-governmental organizations and community groups, are often primarily concerned with accessing the necessary capital to build the project rather than the potential to earn profits from it. For the most part, CERs do not provide upfront capital, since most carbon credit buyers do not offer upfront payments for future CERs. Those that do pay for CERs upfront offer a heavily discounted price per CER to cover their risk and only very rarely offer upfront payments against post-2012 CERs.²⁹ CDM transfers have limited benefit to this group of developers.

Many projects have multiple barriers of which low financial return is only one. For example, the development of bagasse cogeneration in India (the cogeneration of electricity and steam from sugar cane waste) required a series of support programs to overcome a range of barriers affecting the dissemination of this cost effective technology. These programs included demonstration projects, information dissemination programs, increased regulatory certainty, easier access to credit, and financial incentives like subsidies and tax breaks. Financial incentives alone were not enough to promote this technology (Haya et al 2009). For many project types, the CDM may work best alongside other complementary support measures, and might not on its own offer the incentives needed to overcome project barriers. More traditional forms of development aid funds, the main alternative to the carbon market, have the versatility of providing many different types of support that can be customized to address the barriers facing different project types in different countries (ibid).

The CDM's uncertainty does not seem to be decreasing over time, and in fact might be increasing. In late 2006, a bank representative expressed his expectation that over time, as banks become more familiar with the CDM, and as more experience is gained with the registration of different types of CDM projects, that his and other banks would start to take carbon credits into account in their loan appraisals. By 2009 the uncertainties associated with the CDM seemed to have increased, rather than decreased. Interviewees in 2009 expressed sometimes bitter frustration with the increased complexity and time involved in the CDM application process, and their perception that the CDM Executive Board is inconsistent and arbitrary in their decisions to reject projects and put projects on hold for extra review.³⁰ They perceived the Executive Board's efforts to strengthen the system as being hard to work with because the lead to frequent changes in the CDM requirements. Several developers and consultants complained that they could not count on precedence as a predictor of future decisions of the CDM Executive Board. An increase in the number of rejections and extra reviews over the last two years has also increased registration risk.

While previous sections of this paper show that project-by-project additionality testing is currently and potentially relatively ineffective at filtering out non-additional projects, it is one of the key sources of uncertainty in the CDM undermining the value of the CDM to developers to

²⁹ From interviews with carbon traders and project developers

³⁰ Also in the Brazilian sugar sector, the efforts made by the CDM Executive Board to strengthen the environmental integrity of the CDM increased the uncertainties associated with the CDM and lessened the influence the CDM had on project development (Pulver S, Hultman N, Guimaraes L. 2010. Carbon market participation by sugar mills in Brazil. *Climate and Development* (2): 248-62).

less than half of the funds actually passed. A high proportion of the risk, time and cost of the CDM application process is associated with additionality testing. PDD consultants and validators describe that a large portion of the time spent writing the PDD and validating the project are devoted to the additionality section. Additionality is the cause of most reviews and rejections by the Executive Board, and is also the most common reason projects do not pass validation.³¹

Lowering the uncertainty associated with additionality testing is much easier than increasing its accuracy. Project-by-project additionality testing can be replaced by clear objective criteria for eligible projects, such as project type, location (e.g. all wind development in sub-Saharan Africa) and level of efficiency (such as the most efficient refrigerators manufactured in Ghana). The challenge in this shift is avoiding allowing even larger numbers of non-additional projects to more easily register under the CDM.

Because project-by-project additionality testing is ineffective, the CDM in essence is a subsidy for the project types allowed under it, albeit, a relatively inefficient subsidy as is argued in this section.

As a result of the uncertainties associated with CDM benefits, the predominant influence the CDM may be having on CO₂ projects is to potentially make cleaner commercial technologies more profitable when developers or investors are willing to accept the risk that they will not receive revenues from carbon credit sales, but value the possibility of doing so.

5. SYSTEMATIC OVER-GENERATION OF CREDITS

Apart from additionality testing, there are two other ways that the CDM's incentive structure leads to the generation of more credits than actual reductions, and can actually increase in emissions.

5.1. Perverse incentives

One of the early criticisms of the CDM is that it could create perverse incentives for a government to refrain from implementing a policy that reduces emissions, or for a business to increase emissions in order to generate more credits from reducing those emissions with a CDM project. HFC destruction from HCFC production facilities provides a good example of both types of perverse incentives. HFCs, a potent greenhouse gas (GHG) regulated under the Kyoto Protocol, is a byproduct in the production of HCFC-22, a temporary substitute for CFCs as a refrigerant. Due to the very high global warming potential of HFCs – 11,700 times that of CO₂ – the value of the CERs generated from HFC reduction projects can exceed the profits from the production of HCFC-22 itself, making HCFC-22 production profitable even if there were no market for HCFC-22 (Wara & Victor 2008). If a country imposes regulation requiring HCFC-22 production facilities to destroy the HFC gas byproduct, facilities should no longer be able to generate the substantial income from the sale of carbon credits, disincentivizing such regulation.

To prevent companies from producing HCFC-22 just to sell CERs generated from the destruction of HFCs, the CDM Executive Board does not allow new or expanded HCFC-22 production to generate CERs. The CDM still disincentivizes companies from decreasing the production of HCFC-22, which could be replaced by a less harmful alternative (Schneider 2007). Also, by not allowing HFC gas from new or expanded facilities to generate CDM credits, while

³¹ From interviews with validators

creating perverse incentives against government regulation, the HFC gas is not being destroyed from new HCFC-22 production facilities. The CDM creates a third type of perverse incentive. It has recently been documented that HCFC producers are inefficiently managing their plants to maximize HFC gas, which they can burn for CDM credits, rather than HCFC production.³² Since HCFC-22 itself is an ozone depletor being phased out under the Montreal Protocol, 5% as potent in depleting the ozone layer as CFCs, the CDM is in direct contradiction with the goals of the Montreal Protocol because of these perverse incentives. Crediting emissions *reductions* rather than taxing emissions improves the profitability of high emitting or harmful projects whenever CERs generate profits rather than simply covering the costs of the abatement technology. Clean coal is another example of a project types for which this can happen.

In the HFC case additionality is relatively straightforward because the only reason to burn the HFC gas is to prevent it from releasing into the atmosphere; there are no other benefits to doing so. For many methane projects, also a potent greenhouse gas, for which CERs would be an additional but not sole reason to implement a CDM project, and for CO₂ reduction projects if the CER price were to increase substantially, testing project additionality becomes easier, since the larger influence of CERs on project financial return estimates can overwhelm the effect of the choice of project cost and revenue assumptions. However, in all of these cases, perverse incentives also become more important, as we have seen so clearly in the case of HCFC production.

5.2. The viability paradox

The CDM should result in reductions in emissions in developing countries at least as large as the credits it generates. Each CDM project is allowed to produce carbon credits for its full lifetime, defined either as a single 10-year period or 21 years (3 consecutive 7-year periods) without its additionality being reevaluated. In the power sectors of India, China and elsewhere, hydropower and wind sites are often planned for many years before they are built, and are built in the order of their attractiveness. Let's take for example, a CDM wind project that was built in 2010 because of the CDM, but would have been built in 2014 without the CDM. It is additional at the time it is registered and so is able to generate credits for a full crediting period of 10 or 21 years (depending on which option the developer chooses). By enabling the project to be built four years earlier than it would have, the CDM reduces emissions for only those four years. If that project is able to generate credits for a full crediting period, then it is being over-credited for the remainder of the crediting period when there is no difference between actual emissions, and the emissions in the true baseline scenario, which also includes the CDM project. Supporting projects that would not have otherwise been built for 10 or 21 years would result in a portfolio of relatively unattractive projects, and the odd outcome of enabling substantially less attractive projects, that qualify for the CDM, to be constructed before more attractive projects.³³ In practice, the CDM only tests if a project is additional at the time of the CDM application, leading to the over-crediting of reductions, since many of these projects would have built sometime during their 10 or 21 year crediting lifetimes.

³² See http://www.cdm-watch.org/wordpress/wp-content/uploads/2010/06/hfc-23_background-information_gaming-and-abuse-of-cdm3.pdf (accessed July 9, 2010)

³³ This realization came from a conversation with Bill Golove.

6. THE LARGE-SCALE USE OF OFFSETTING CREDITS MAKES CLIMATE CHANGE MITIGATION MORE DIFFICULT OVER THE NEXT DECADES

Even if we manage to design an international offsetting mechanism that effectively reduces emissions and accurately credits them, what effects does large scale offsetting have on global efforts to mitigate climate change over the next decades? Scenarios put forward by the Intergovernmental Panel on Climate Change (IPCC) suggest that a reduction in industrialized countries by 25% to 40% below 1990 levels by 2020, on a path towards 80% to 95% reductions by 2050, still corresponds with a 2.0-2.4 degree Celsius temperature increase (Box 13.7 from Gupta et al 2007, Table SPM.6 from Intergovernmental Panel on Climate Change 2007). These scenarios correspond with reductions in developing countries by 15% to 30% below business-as-usual growth projections by 2020 (Höhne & Ellermann 2008). Even deeper reductions would be needed globally if we wish to have a high likelihood, rather than an almost 50% chance, of not exceeding a two degree increase. Further, since these scenarios were published, additional research suggests that climate sensitivity (the increase in radiative forcing resulting from the increase in GHGs in the atmosphere) is higher, and feedback effects even greater than the assumptions used to produce the IPCC scenarios (McMullen & Jabbour 2009).

Industrialized countries are proposing high levels of offsetting post-2012, which if used, would put these countries far away from the 25%-40% reductions by 2020 from the IPCC scenarios. The EU Climate and Energy Package passed by the EU Parliament in December 2008 included emissions cuts in the EU by 20% below 1990 levels by 2020 outside of an international agreement,³⁴ allowing 68% of those reductions to be met through international offsets.³⁵ If all of these offsets are used, the EU would achieve a less than 17% reduction compared to 1990 levels by 2020. In the US, a prominent draft climate bill, the Waxman-Markey American Clean Energy and Security Act of 2009,³⁶ would require the US to cut its emissions to 4% below 1990 levels by 2020. This bill allows up to two billion tons of CO₂ as offsets, equal to 28% of its 2005 emissions. Half to three-quarters of these, depending on the availability of domestic offset credits, can be from international sources. The international portion, if used in full, would allow the US to postpone making any reductions in its emissions from 2005 levels until 2020 to 2024. This postponement would be even longer if some portion of domestic offsets is non-additional.

Two justifications are commonly given for high quantities of offsets. The first is simple market efficiency. Trade in emissions reductions allows industrialized countries to reduce emissions less expensively than if they were required to reduce them domestically. Second, by providing low cost compliance options, offsets help bring buy-in from domestic industries, making it easier and more likely for industrialized countries to accept deeper targets than they would have otherwise.

However, large-scale access to these potential lower-cost compliance options also introduces risk to present mitigation efforts and would most likely make climate change mitigation more difficult in the future. First, domestic reductions are more certain than

³⁴ Those reductions would be increased to 30% in the context of a global agreement containing comparable targets from other industrialized countries and “adequate action” by developing countries.

³⁵ Hanley N. 2009. *EU Climate and Energy Package, December 2008*. Presented at the Energy and Resources Group, University of California, Berkeley, March 18. The package recommends that 50% of all reductions in the ETS, covering approximately 40% of EU emission, and 80% of reductions in non-ETS sectors can be met with foreign credits.

³⁶ <http://www.govtrack.us/congress/bill.xpd?bill=h111-2454>

international offsets.³⁷ Any country has more knowledge about and control over activities within its own borders than it does for projects and activities which it funds elsewhere. Also, measuring emissions, as is done in a cap-and-trade program, is easier than measuring reductions in an offsetting program, as described in detail above. As such, offsets introduce various uncertainties regarding the amount of emissions reductions they actually represent. Any offsetting in developing countries, whether it is project-based or sector-based, involves measuring emissions against a BAU growth scenario, which is inherently uncertain, and politically difficult to set at a low level.

Second, cap-and-trade weakens incentives for innovation by allowing a larger portion of compliance to be met with existing and low cost technologies (Driesen 2003). Decarbonization to 80-95% below 1990 levels by 2050 in industrialized countries will require major shifts in all high emitting sectors. Transportation, the electricity sector, buildings, and agriculture all involve complex systems. Major shifts in each of these sectors requires time to allow for changes in behavior and in support industries, for experimentation and learning, research, development and deployment, etc.

The high level of offsets allowed could easily place the majority of global reductions up to 2020 in developing rather than industrialized countries. In the context of meeting the global reductions suggested in the IPCC scenarios, if 50% of all Annex 1 reductions are made through offsets (remember that the EU and the US are proposing substantially higher than that as upper limits) and that these offset projects are performed in addition to the suggested 15%-30% decrease from BAU in developing countries, then around 70% of all global reductions through 2020 would likely come from developing countries rather than the high per capita emitters.³⁸

If industrialized countries postpone domestic reductions as they are proposing through the use of offsets, they are either committing to steeper annual reductions in the future, or to long-term inequalities in emissions in the North and the South. Both options make future cooperation more difficult. In industrialized countries, a gradual migration of infrastructure is likely to be less costly than rapid transitions that could require retiring technology and infrastructure before the end of their lifetime. If the costs of mitigation are expected to be high, there will be more resistance from industry.

In addition, a high future dependence of offset credits from developing countries poses compliance risks on industrialized countries. The further actual domestic emissions are in an industrialized country from their targets for a given commitment period through the help of offset credits, the harder it will be for that country to commit to meaningful reductions in the following period. Large quantities of offsets might make it easier for industrialized countries to take on deeper commitments now, but could also make it harder for them to accept deeper targets in the future.

We live in a world with a widely shared linear view of development and progress (Norgaard 1994). Deep in urban and rural India, visions of “development” and symbols of high status are heavily influenced by images of consumption from the North. The discourse of development used by the World Bank is also used by country governments, and is disseminated through participants in and those affected by World Bank projects. Developing country citizens have learned that they are “backwards” and “underdeveloped” (Escobar 1995, Gupta 1998).

³⁷ Here offsets refer to credited emissions reductions generated by any activity whose emissions are not capped under a cap-and-trade program.

³⁸ Reductions are defined here as reductions from the Kyoto Protocol caps for industrialized countries, and reductions from BAU in developing countries.

Rural electrification has allowed more and more people to view western lifestyles on TV, and TV commercials spreading a culture of consumerism and awareness of not having (Jacobson 2004). Development in India is highly status driven – beyond getting out of poverty is a pursuit of symbols of high status, such as a big car and a new cell phone. In a world dominated by a single vision of “progress” sustainability requires changing the image of what “developed” means. Ultimately, promoting low-carbon development in the South requires demonstrating it in the North.

Advanced developing countries are being asked to join the global community in accepting obligations to mitigate their emissions below BAU growth projections. Will developing countries commit to controlling the growth in their already low per capita emissions if it is clear that there is relatively little willingness in the industrialized world to reduce their much higher per capita emissions? Developing countries will need to make voluntary reductions before it is fair, given how quickly we need to reduce globally. Politically, it will be unlikely that developing countries will take calls for global cooperation seriously, if industrialized countries do not take on commitments to curb their own emissions as prescribed by the IPCC.

Chapter 3. Can the CDM's investment analysis accurately test additionality? A focused look at wind power, biomass energy and hydropower projects in India

1. INTRODUCTION

We saw in the last chapter that additionality testing is failing to prevent large numbers of non-additional projects from registering under the CDM. At the same time it is compromising the ability for the CDM to incentivize the building of new projects by introducing substantial uncertainty into the CDM application process. Two sets of proposals have been put forward for controlling the number of business-as-usual projects registering under the CDM. Some researchers propose improving the rigor of additionality testing requirements used by developers to demonstrate the additionality of each individual proposed CDM project (Michaelowa 2010, Schneider 2009, Wara & Victor 2008). Others propose replacing project-by-project additionality testing with standardized criteria, such as size, type, location and efficiency level, to target categories of projects that are likely additional (American Clean Energy and Security Act 2009, California Air Resources Board 2009, UNFCCC 2010: 41 para 9). Under the latter proposal, any project that meets the criteria would automatically be eligible for CDM registration. In this chapter, I explore the feasibility of the first set of proposals. I examine the possibility of designing an additionality test for individual proposed CDM projects that is reasonably effective at distinguishing additional from non-additional projects. Focusing on wind, biomass and hydropower projects in India, I explore whether there exists a relatively accurate and verifiable indicator of the decisions of investors, lenders and developers to go forward with these projects. In Chapter 5, I examine the potential use of the second set of proposals – standardized criteria.

The appeal of project-by-project additionality testing, used by almost all types of CDM projects as well as most voluntary offsetting programs, is efficiency. Theoretically, the most efficient program would allow the widest range of types of reductions to be credited. Testing the additionality of individual projects, if reasonably accurate, would put the least restrictions on the range of reduction activities that could be credited. Alternatively, standardized criteria rely on the evaluation of categories of projects. This approach would theoretically be more restrictive – only project types on the list are eligible – as well as more lenient with regard to registering non-additional projects – any project which fits the criteria is eligible regardless of whether it is truly additional.

Offsetting programs are only efficient if they are able to be regulated. If regulators cannot have enough information to accurately assess the additionality of individual proposed projects, then the system is only efficient in textbooks.

The CDM's *Additionality Tool*³⁹ includes two options for demonstrating the additionality of a proposed CDM project – the “barrier analysis” and the “investment analyses.” I start with a brief discussion of the barrier analysis (Section 2) and focus this chapter on the investment analysis, considered to have the higher potential for being accurate if made more rigorous (Section 3). Section 4 summarizes and draws conclusions from this study.

³⁹ The *Tool for the demonstration and assessment of additionality*, and a version of this tool that is combined with a baseline identification methodology - *Combined tool to identify the baseline scenario and demonstrate additionality* - can be found here: <http://cdm.unfccc.int/methodologies/PAMethodologies/approved.html>

2. BARRIER ANALYSIS

The CDM *Additionality Tool's* barrier analysis requires listing barriers, often described in terms of risks, which prevent the proposed CDM project from going forward, but do not prevent an alternative to the project from going forward. For example, barriers common to cost effective energy efficiency include lack of information about or experience with the technology, and the existence of other higher priorities for limited investment capital. The CDM may overcome barriers by improving the expected return from the project activity. Validators are instructed to audit the barriers test by first determining if the barriers are real and supported by sufficient evidence, and then applying their “local and sectoral expertise to judge whether a barrier or set of barriers would prevent the implementation of the proposed CDM project activity.”⁴⁰ But practically all projects face barriers of some sort. The question is whether it is possible and practical to distinguish barriers with a high likelihood of preventing projects from going forward without carbon credits, from the many barriers that project developers commonly face and overcome doing business-as-usual.

Many of the biomass projects reviewed here (14 out of 19) use a barriers analysis either alone or in combination with an investment analysis to prove additionality. The most common barriers mentioned are: technical uncertainties especially with regard to corrosion in the furnace, that such projects are not “common practice,” and uncertainties about the future tariff and the timing of payments considering the bad financial standing of most state electricity utilities. Validators, the auditors responsible for reviewing the application documents of each proposed CDM project, have confirmed the existence of these barriers with reports documenting risks of corrosion from the combustion of biomass, the numbers of biomass projects built in the state compared to fossil fuel projects, and reference to instances of non-payment by state utilities for power produced by renewable energy providers. At best, such evidence can demonstrate that the barriers are real, and that it is feasible that the barriers would have prevented the projects from going forward. The evidence does not demonstrate that the barriers are likely to have prevented the projects from going forward without the CDM. In each case, the developer might have gone forward with the projects without the CDM. In fact, many Indian biomass projects experienced these barriers and did go forward without the CDM.

3. INVESTMENT ANALYSIS

Additionality testing should predict the decision that the developer, lender and investor would make if there were no CDM. The investment analysis presumes that it is possible to accurately predict these decisions from the sign (positive or negative) of a single number – the difference between a benchmark, and the expected financial return from the proposed CDM project, most often defined in terms of internal rate of return (IRR).⁴¹ If the return is below the

⁴⁰ Clean Development Mechanism Validation and Verification Manual, ver 1.1, released December 2009
http://cdm.unfccc.int/Reference/Manuals/accr_man01.pdf

⁴¹ Internal Rate of Return (IRR) - the discount rate that would be applied to the cash flow of a project so that the net present value of the project is zero. A higher IRR indicates better financial return. Net present value is the present value of net project costs and revenues over the project lifetime, taking into account the time-sensitivity of money by applying a discount rate to future costs and revenues.

benchmark, the project is putatively not economically rational and would therefore not be built; if above, the project most likely would be built. It is important to keep in mind that estimating the financial return from a proposed project involves estimating future costs and revenues all of which are predicted with varying degrees of certainty.

The investment analysis is accurate to the extent that developers report the same cost and revenue assumptions and benchmark in their CDM applications as they use in their internal decision-making. Developers have incentives to choose the benchmark and project cost and revenue inputs that show that their proposed CDM projects are additional, so when a range of values is possible, they can choose values strategically. Some investment analysis inputs are distinct values, like the cost of a wind turbine if a supply agreement has already been signed with a wind manufacturer. Other cost inputs have a range of reasonable choices, such as the future prices of biomass fuel.

Figures 3.1 and 3.2 illustrate the accuracy of the investment analysis for two hypothetical sets of projects. Figures 3.1 and 3.2 express project IRRs as a range of values resulting from a range of reasonable cost and revenue assumptions. In Figure 3.1 the projects all have a single benchmark, the choice of input assumptions does not have a large effect on project IRRs, and the effect of CERs on project IRR is larger than the effect of the choices of input assumptions. The first four projects in Figure 3.1 are clearly non-additional – their IRRs are above the benchmark for all possible input values. The last five projects are clearly additional – their IRRs are below the benchmark for all possible input values. The additionality of only the fifth project is unclear. The additionality of the fifth project depends on the actual costs and revenues expected by the developer and how the developer understands and treats risk. If the developer were required by the CDM Executive Board to choose conservative values favorable to the project without the CDM for all project inputs, then it is possible that this project would be ineligible for the CDM even if it were truly additional. In this case, the CDM would miss the opportunity to enable a truly additional project to be built. If, on the other hand, the CDM allows for any reasonable input to be used, then the fifth project could register for the CDM even if it would have been built regardless. Additionality testing is relatively accurate for this set of projects.

Figure 3.2 presents a different set of projects. The range of reasonable cost and revenue inputs can change project IRR by a larger amount. There is also a range of reasonable benchmarks for projects in this sector, and the CDM has a smaller effect on project IRR. In this scenario only the first project is clearly non-additional, and only the last project is clearly additional. All other projects could be additional depending on the project developers' actual cost and revenue expectations as well as the developers' actual hurdle rates, or benchmarks. If the CDM rules require developers to choose conservative assumptions for all cost and revenue inputs and the benchmark, then only one project would be considered additional. It is not clear if this one project would go forward even with the CDM since the effect of the CDM might not be large enough to raise the IRR above the benchmark, depending on the actual cost and revenue expectations of the developer. Alternatively, if the full range of reasonable assumptions may be used in the investment analysis then all but one project could be considered additional, whether or not they actually are. The CDM additionality test is not accurate for the project type represented in Figure 3.2.

Figure 3.1: IRR ranges for 10 hypothetical projects

Varying assumptions within reasonable ranges changes the IRR of each project by less than the effect of CERs

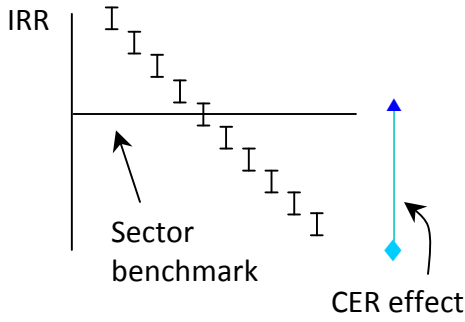
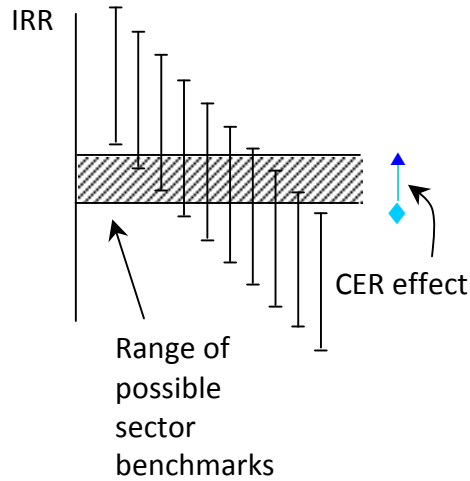


Figure 3.2: IRR ranges for 10 other hypothetical projects

Varying assumptions within reasonable ranges changes the IRR of each project by more than the effect of CERs



These two figures show that the accuracy of the investment analysis is a function of the relative effects on project return of CERs compared to the range of reasonable assumptions that can go into the investment analysis. If the effect of CERs is large compared to the effect of assumption choices (illustrated in Figure 3.1) then there is not much room for developers to game their investment analyses, and the CDM has a strong effect on projects. If the effect of the assumption choices is large in comparison to the CER effect (illustrated in Figure 3.2), then developers have a lot of room to choose assumptions to show that cost effective projects are not cost effective, while the CDM does not do much to support new projects.

The rest of this section examines the extent to which varying assumption inputs within reasonable ranges affect the expected IRRs of wind and biomass projects in India compared to the effect of CERs. This is followed by an examination of the use of the investment analysis for large hydropower projects in India.

3.1. Wind projects: a best case for an accurate investment analysis

Wind in India is a best case for an accurate investment analysis because of the typical organizational arrangement between the project investor and the wind turbine manufacturer. Wind power is often an attractive investment in India because of the tax benefits offered by the central government. India offers wind power developers the ability to take 80% depreciation for wind project capital costs in the first year of operation along with a 10-year tax holiday. A common organizational arrangement for wind development involves an agreement between two sets of actors: a wind turbine manufacturer who identifies and secures a site with good wind resources, and single or multiple investors. The investors are most often profitable businesses and wealthy individuals who are relatively unfamiliar with the energy industry but find wind

power an attractive investment in large part because of the depreciation tax benefits. Investors often partially finance the project with a loan. The wind turbine manufacturer typically takes full technical responsibility for the project, and signs a supply agreement with the investors for the sale of the wind turbines and land, plant construction, and operations and maintenance.

A typical result of this arrangement is that all of the main costs of the project to the investor are well documented in three documents: (1) The supply agreement between the wind manufacturer and the project investor documents actual major project costs as agreed between the two parties. It also includes an estimate of the expected generation of electricity that is typically on the high end, which is conservative from the perspective of additionality testing. (2) The tariff for the first ten to twenty years of the project is signed into a power purchasing agreement (PPA) with the utility buying the power. (3) If a loan is taken, the loan interest rate is documented in a loan agreement. Still, three investment analysis inputs are not included in these documents, and involve assumptions that can each have a range of reasonable values that can affect the results of the financial assessment: (1) the per kilowatt-hour (kwh) tariff after the end of the PPA, (2) the tax benefits the developer will receive, and (3) the viability benchmark.

For this best case technology, for which most of the uncertainty in a financial assessment is concentrated in just three values, how accurate is the investment analysis and how validly can additionality be determined? The rest of this section presents the details of a sensitivity analysis I performed on these three values.

3.1.1. Sensitivity analysis on the post-PPA tariff

Electricity tariffs, the prices that power distributors pay power generators per kwh of electricity produced, are determined in India by state electricity regulatory commissions and are published in state-level tariff orders. These tariffs form the basis of legally-binding PPAs between the electricity distributor and generator. State electricity regulatory commissions must balance two competing interests in determining wind power tariffs – supporting the development of renewable energy resources and keeping electricity rates low for electricity customers.

The complete set of twenty-five large wind projects registered under the CDM in India from 2007 to the present are in five states. Fifteen of the wind tariff orders are in Maharashtra and Karnataka. These orders specify 13- and 10-year PPAs respectively and leave uncertain the tariffs after the end of their PPAs. The other ten wind projects are in Gujarat, Rajasthan and Tamil Nadu, where wind tariffs are defined for the full 20-year lifetimes of the projects. Therefore ten projects face little risk about their lifetime tariffs, while the fifteen projects in Maharashtra and Karnataka do face this risk.

Until now, the electricity regulatory commissions in Maharashtra and Karnataka have provided little clarity as to how post-PPA tariffs will be determined. Most state electricity regulatory commissions derive their state-wide wind tariffs on a cost-plus basis for a typical wind project. “Cost-plus” means that the tariff is calculated so that it provides enough revenues to cover all expected project costs plus a specified return on equity (investor profit) each year.⁴² It could be reasonable to expect electricity regulatory commissions to rule that post-PPA tariffs will increase to cover inflation. Currently the Maharashtra wind tariff has an escalation rate of 0.15 rupees per year. It is also reasonable for post-PPA tariffs to decrease since project costs are lower after any loans have been paid off. Tariffs calculated on a cost-plus basis for the years after loans are fully repaid would be lower than for the earlier years of the project if the reduced costs were taken into account.

⁴² Based on a 70:30 debt-equity ratio.

Karnataka's current tariff order for wind power, published in 2005, defines a tariff of 3.4 rupees per kilowatt-hour for the first ten years of a new project.⁴³ Regarding the tariff after the end of the first ten years, it states only that the post-PPA tariffs for existing projects will likely be lower than the tariffs for newly commissioned projects for the same year, considering debt will have already been repaid. How much lower is not indicated.

Maharashtra's 2003 wind tariff order divides wind projects into three categories according to their date of commissioning.⁴⁴ The tariff for projects commissioned before 1999 follow policies that were in place during the time of their commissioning. These tariffs increase annually throughout the 20-year project lifetime.⁴⁵ The tariffs of projects commissioned between 1999 and 2003 increase with an escalation rate for the first eight years of the project; after eight years wind producers are requested to submit tariff petitions to determine the post-PPA tariffs. In June 2010, the post-PPA tariffs for these projects were defined through 2010 as Rp. 2.52.⁴⁶ This is around one rupee lower than the tariffs during the eighth year of the PPAs for these projects. The tariff for projects commissioned after 2003 increase with an escalation rate for their first thirteen years. This 2003 tariff order states that wind power should be supported with preferential tariffs, but at the same time customers should not bear an undue price burden, and that the tariff during the first years should be higher than during later years because of the debt burden. At the time these CDM projects were built their post-PPA tariff was still unknown.

Of the fifteen large wind CDM projects in Maharashtra and Karnataka, eight assume that the post-PPA tariff will remain constant following the last year of the PPA. Three in Karnataka assume that the post-PPA tariff will be calculated on a cost-plus basis assuming a 16% return on equity; one project in Karnataka assumes a 10% drop in tariff after the end of the PPA; and two in Maharashtra assume a substantial drop in tariff, applying escalation rates during the subsequent years. One project in Maharashtra did not make their investment analysis spreadsheet publicly available (see Table 3.1 at the end of this chapter).

The post-PPA tariff assumptions for all of these proposed CDM projects are reasonable. On the lower end, it is reasonable to assume that post-PPA wind tariffs will be calculated on a cost-plus basis for a typical wind project after loan repayment is complete. Another entirely feasible assumption is that post-PPA tariffs will remain the same as the final year of the PPA. This is still lower than the tariffs for new projects, but higher than if the tariff were recalculated on a cost-plus basis.

I varied the post-PPA tariffs of the ten large wind projects registered in Karnataka and Maharashtra whose investment spreadsheets have been made publicly available and for which the calculations were straightforward. Varying the post-PPA tariffs between a constant value equal to the tariff in the last year of the PPA, and tariffs calculated on a cost-plus basis changes the IRRs of these projects by 2.4% on average. This is comparable with the 2.7% average expected increase in IRR from CERs for these projects (see Table 3.1 at the end of this chapter). The actual influence of the CDM on the investment decision would be smaller if the

⁴³ Karnataka Electricity Regulatory Commission tariff order, 18 January 2005, *In the matter of Determination of Tariff in respect of Renewable Sources of Energy*

⁴⁴ Maharashtra Electricity Regulatory Commission tariff order, 24 November 2003, *In the matter of Procurement of Wind Energy & Wheeling for Third Party-Sale and/or Self-Use*

⁴⁵ They start at 2.25 rupees per kilowatt-hour in 1994, increase at a rate of 5% per year for ten years, are level from year 10 to 13, and then increase at 0.11 rupees per year through year 20.

⁴⁶ Maharashtra Electricity Regulatory Commission draft tariff order, 21 June 2010, *In the matter of Determination of Generic Tariff under Regulation 8 of the Maharashtra Electricity Regulatory Commission (Terms and Conditions for Determination of Renewable Energy Tariff) Regulations, 2010*

uncertainties associated with these revenues were factored in to the CER effect, described in Section 4 of the Chapter 2.

3.1.2. Sensitivity analysis on the tax benefits

The Indian government allows wind producers to take 80% depreciation of the capital costs of the project in the first year of operation, as well as a 10-year tax holiday during which time developers pay a reduced tax on project profits. My examination of the investment analysis spreadsheets associated with these 25 projects finds that the owners of at least 11 of the 25 large wind projects registered in India since 2007 incorrectly calculate either the depreciation tax benefits or the 10-year tax holiday offered by the Indian government.⁴⁷ These miscalculations result in underestimates of the IRRs for these projects allowing them to more easily pass the additionality test.

The investment analyses for 16 registered Indian wind projects, out of the 25 analyzed here, do not assume that the project owners take the full depreciation tax benefits offered by the Indian government. The investment analyses for these projects calculate the accelerated depreciation benefits as if the projects were independent stand-alone entities functioning off balance sheet for tax purposes, such that the project owners could not use the depreciation benefits to offset their individual or company taxes. Of these 16 projects, the PDDs for only six explain why the project owners would not take the full depreciation tax benefits.⁴⁸ Of the remaining ten projects that do not provide explanations, six are made up of a bundle of smaller projects with multiple investors whose main businesses are in a variety of industries. Such an arrangement is typical of investors who use the depreciation benefits to offset taxes in the main part of their business, indicating that these tax benefits were most likely calculated improperly.

Depreciation tax benefits have an especially large influence when equity IRR is used for the investment analysis.⁴⁹ Correctly calculating depreciation tax benefits results in IRRs that are 10.2%-19.2% higher than the IRRs included in the PDDs for the six projects that test project additionality with equity IRR, bringing their IRRs far above the named benchmarks. The one project that tests additionality with project IRR would have an IRR that is 3.1% higher if the depreciation benefits were calculated correctly. The depreciation tax benefits affect equity IRR much more than project IRR because the financial benefit from the tax incentives is compared against a smaller capital investment. As a result, another way that developers can affect the results of the investment analysis is to base the analysis on project IRR instead of equity IRR, even if the investment decision were the key decision enabling the project to go forward.

⁴⁷ It is unclear if the depreciation benefits for another four projects are calculated correctly, because the financial structures of the projects are not discussed in the PDDs. An additional four projects do not make their financial spreadsheets available.

⁴⁸ Reasons for not being able to avail of the depreciation benefits include: the developer is foreign owned; the developer does not expect to earn enough profits during the early years of the project; and the project is off-balance sheet. "Off

⁴⁹ Equity IRR calculates the IRR from the perspective of the equity investor. Outlays include the equity investment, loan repayment, loan interest payments, and all operating costs of the project. Inflows include the revenues from the project. Project IRR calculates the IRR of the whole project. Outlays include the full capital investment, including the loan and equity portions, and all operating costs of the project. Inflows include the revenues from the project. (Note, when a project owner does not take a loan for the project, there is no difference between equity and project IRR.)

Five wind projects incorrectly calculate the benefits from the 10-year tax holiday. This miscalculation results in IRRs that are 1.3%-2.9% lower than they should be, making it that much easier to prove the additionality of these projects.

Miscalculations of the 10-year tax holiday are easy for auditors to catch. Similarly, when it is clear that the investors can use the full depreciation tax benefits, a proficient validator can catch strategic miscalculations. However, in some cases the ability of the investor to use the tax benefits may be unclear. For example, if the investor does not expect to earn enough personal income or company profits to absorb the tax benefits in the first year of the project. This claim may be difficult to audit because it involves assessing an expectation of income in a future year. Also, if a project applies for CDM registration before the owners are fully identified, it will not be known if the project will be on or off balance sheet for each of the owners.

Preventing manipulation of tax benefit estimations is more straightforward than for other types of assumptions like the developer's expectation of their post-PPA tariffs. Government-offered incentives should be assumed to be fully used, leaving the burden of proof on the developer to provide evidence if they are unable to use those benefits.

3.1.3. Sensitivity analysis on the benchmark

According to the latest guidance from the CDM Executive Board on the investment analysis, the developer should choose from among four options for identifying the project IRR or equity IRR benchmark: (1) Local commercial lending rates (for project IRR), (2) weighted average cost of capital (WACC)⁵⁰ (for project IRR when there is only one possible project developer), (3) required/expected return on equity (for equity IRR), and (4) benchmarks supplied by relevant national authorities if the validator can validate their applicability (for both project and equity IRR).⁵¹

Of the 25 large wind projects in India, 16 use equity IRR for the investment analysis. The earlier projects typically use 16% as the benchmark; 16% is the return on equity the Government of India suggests the state electricity boards use to calculate wind tariffs on a cost-plus basis. Following CDM Executive Board guidance in 2008, more recently registered projects calculate the expected return on equity using the Capital Asset Pricing Model (CAPM). CAPM is a commonly used means for estimating the cost of equity capital. CAPM estimates the equity return required by investors from a project as a risk free rate (e.g. government securities), plus a risk premium that takes into account the higher expected IRR needed to counterbalance the risk associated with the particular project type. CAPM uses the following formula based on historical return on equity:

$$\text{investor expected return} = \text{risk free rate} + (\text{market rate} - \text{risk free rate}) * \text{beta}$$

where government securities are typically used for the risk free rate, the market rate is the rate of return from the stock market generally, and beta captures the correlation between the fluctuation of the value of stocks in the specific industry of the project being analyzed and the stock market generally. For example, the milk industry should have a low beta, since purchases remain

⁵⁰ Weighted Average Cost of Capital (WACC) is the cost of capital to the project developers, normally combining two components: the costs of a loan (loan interest rates) and the costs of equity (return on equity required by an equity investor).

⁵¹ Executive Board Report 51, Annex 58, *Guidelines on the Assessment of the Investment Analysis (version 3)*, report from EB meeting ending 4 December 2009, http://cdm.unfccc.int/EB/051/eb51_repan58.pdf

relatively steady regardless of the state of the economy, but luxury goods have high betas, since their purchase rates increase and decrease according to the state of the economy. In other words, beta indicates if wind investments are more risky or less risky than the stock market in general.

Several CDM consultants who wrote the PDDs for some of the Indian wind projects analyzed here view the choice of project benchmark as the assumption that is most vulnerable to manipulation in a CDM investment analysis for an Indian wind project.⁵² One consultant said that uncertainty in the benchmark practically makes the investment analysis meaningless even for wind projects. Principles of Corporate Finance, a leading textbook on corporate finance, after discussing possible variations to one input into the CAPM model, writes: “Out of this debate only one firm conclusion emerges: Do not trust anyone who claims to *know* what return investors expect.” (Brealey & Myers 2003, p. 160)

Table 3.2 presents the benchmarks used for the four most recently registered Indian wind projects that use the CAPM model to determine the benchmark, and the three variables used in the CAPM equations.

The first thing to notice is the relatively wide range of benchmarks – from 14.6% to 18.7% – derived from the CAPM model. This 3.1% range is comparable with the effect of CERs on wind projects, which ranges from 0.8% to 4.9% for the wind projects analyzed in this dissertation. The interest rate on government securities (risk free rate) varies somewhat over time, but is relatively straightforward. However, Table 3.2 shows that project developers are using a wide range of values and data sources for the other two variables based on a number of choices: the date range and the choice of index (BSE 30, 200, or 500) for the expected market return, the individual companies used for the beta calculation, and whether beta is taken as the average for the companies assessed or the minimum beta value of these companies. These are assumptions for which there are no clear preferred choices.

Table 3.2 – Benchmarks and Capital Asset Pricing Model (CAPM) inputs for calculating the expected return on equity for four recently registered wind projects in India

Project #	Construction start date	Benchmark	Risk free rate	Expected market return	Beta
1291	Aug 2005	17.8%	6.11% Government securities 2004-5	17.25% BSE* 200 4/1991-7/2005	1.05 Minimum of four large energy companies 2002-5
1168	Mar 2006	18.7%	7.34% Government securities 2005-6	18.83% BSE 30 4/1979-2/2006	1.34 Average of six large energy companies 2002-5
2925	June 2007	15.1%	7.89% Government securities 2006-7	14.50% BSE 30 5/1997-5/2007	1.08 Average of eight large energy companies 1997-2007
2605	May 2008	14.6%	7.89% Government securities 2006-7	22.61% BSE 500 4/1999-3/2007	0.45 Minimum of eight large energy companies 2001-7

* BSE = Bombay Stock Exchange

⁵² Interviews with CDM consultants conducted in the summer of 2009.

A sensitivity analysis on a single project, project #2605, shows that reasonable assumptions can change the benchmark by over twelve percentage points (the results are very similar for all four projects). The PDD for this CDM project defines the expected market return as the compounded market return from an index of 500 companies on the Bombay Stock Exchange (BSE 500) between April 1999 and March 2007, and calculates the beta as the minimum unlevered beta of eight large energy companies. The following examples demonstrate easy ways to vary the benchmark calculation:

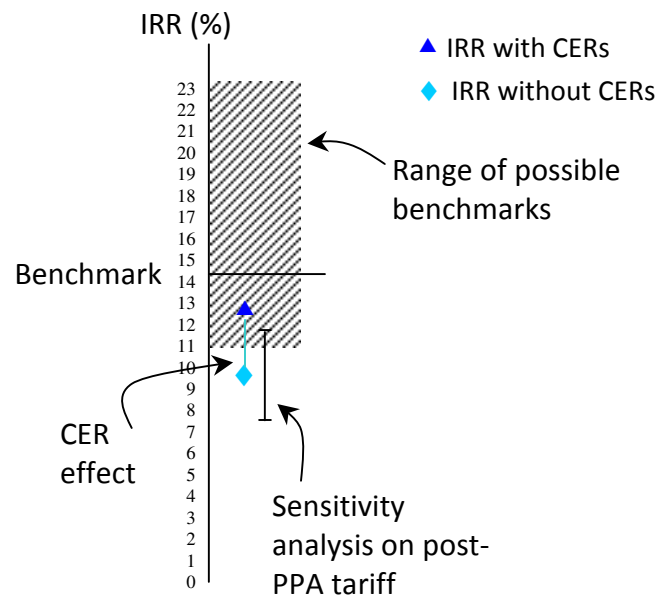
- Using BSE 500 values for ten years and one month, rather than ten years (starting from March 1999 instead of April 1999), lowers the calculated benchmark by 1.08%, from 14.56% to 13.48%. This is as much as the expected effect of CERs on the equity IRRs of some wind projects.
- Using BSE 30 instead of BSE 500 for the same dates lowers the IRR by 3.61%.
- Using the average value instead of the minimum value for the beta increases the benchmark by 4.22%.
- Using the same beta figure as is used by project #2925 increases project IRR by 9.23%.

Varying all of these assumptions simultaneously can change the benchmark by well over 12%, much larger than the effect of CERs.

The main alternative benchmark for wind projects in India, per CDM Executive Board guidance, is the use of local commercial lending rates when project IRR is used. Local commercial lending rates can be too low a benchmark since equity investors generally expect higher return than the lending rate. Combining local commercial lending rates with expected return on equity to cover the equity portion of the capital costs features the same problems as equity IRR described above.

The actual benchmark used in investment decisions can also be influenced by a range of non-monetary factors or factors that are not easily incorporated into the IRR analysis. For example, it is difficult to assess the financial benefits to a company of the reliability offered by a captive generation unit, the political support gained by investing in the project owner's home community, the positive publicity that goes along with doing a green project, or simply the desire to support renewable energy for its climate benefits. Each particular investor has different knowledge of the wind industry and connections in it, which can affect the choice of investment. Further, as the results of the above analysis suggests, investors have varying assessments of wind power as an investment compared with their other investment options.

Figure 3.3: Investment analysis for wind project #2605 with sensitivity analysis on benchmark and post-PPA tariff



The CAPM benchmark used for wind projects in India could apply to any Indian power project, since the companies chosen for the beta calculation are large power producers. The lack of a clear benchmark is a weakness of the investment analysis generally.

3.1.4. Summary of results: The investment analysis as a predictor of wind power development in India

The benchmark is the weakest part of the investment analysis in predicting the building of wind power projects. Small changes in arbitrary factors used to calculate the benchmark return expected by equity investors result in a range of possible benchmarks more than triple the effect of CERs on equity IRR for most projects. In addition, even with this best case technology for which almost all of the cost inputs and revenues are documented in agreements before construction begins, for over half of the projects, the range of reasonable assumptions about the post-PPA tariff can change the IRRs by around the same amount as the effect of CERs. Figure 3.3 illustrates a sensitivity analysis of possible benchmark values and post-PPA tariff on the investment analysis compared to the effect of CERs on one sample wind project. If the depreciation benefits were also unclear, which is an issue in some cases, the range of possible without-CER IRRs would be greater.

For the investment analysis to be accurate even at this level, the supply, loan and PPA agreements would need to be signed before project validation so that the values from them would be included in the investment analysis. Once these agreements are signed, the decision would have already been made to go forward with the project. Developers that wait to make sure their projects are successfully registered under the CDM, or positively validated, before making the decision to build it would be able to use a wider range of assumptions as they construct their investment analyses, since fewer inputs would have been written into contracts by that time.

3.2. Biomass projects: a more typical technology, with a wider choice of assumptions

Developers of biomass cogeneration projects typically manage the projects themselves, rather than contract out project implementation and operations and maintenance through supply agreements as is commonly done for wind projects. Therefore, the IRR analysis for biomass projects includes many more assumptions for which the expectations of the developer are not clearly documented and for which there may be a range of reasonable values.

For example, for projects that purchase all or part of the biomass used for electricity generation from near-by farms (7 of the 19 large biomass CDM projects in India), assumptions must be made about future biomass prices. Biomass prices have been erratic in the recent past due to an absence of a developed supply market (Ghosh et al 2006), rainfall variability year-to-year⁵³ and rising demand for biomass from pulp and paper mills and for electricity generation.⁵⁴

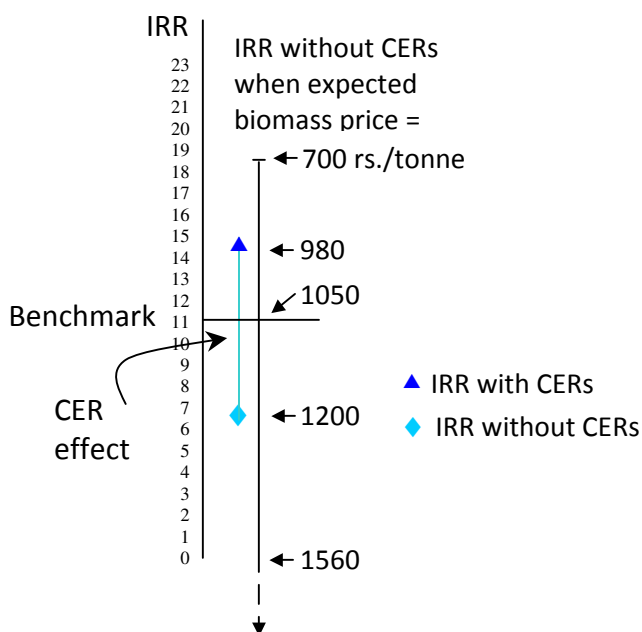
Focusing on just this one cost assumption, I examine the effect of the projected future price of biomass on the project IRRs of the four biomass projects in India that purchase biomass fuel from outside their facilities and make their investment analysis spreadsheets publicly available.⁵⁵ These four projects use rice husk purchased on the market to supplement the

⁵³ Raised in a number of interviews with developers and consultants of bagasse (sugar cane waste) cogeneration projects.

⁵⁴ *ibid.*

⁵⁵ The idea for doing an analysis on biomass prices comes from Sivan Kartha from the Stockholm Environment Institute.

Figure 3.4: Investment analysis for biomass project #2708 with sensitivity analysis on future expected biomass prices



biomass generated by each facility's own rice or sugar processing, and all are in Uttar Pradesh (UP), the Indian state with the most large biomass CDM projects.

The investment analyses of these four projects forecast future rice husk prices that vary by a factor of four (2650, 1200, 1150 and 700 rupees per metric ton) with varying annual escalation rates (0%, 4%, 2% and 0% respectively) (see Table 3.3 at end of chapter). These projects all started construction within a year and a half of one another, and the assumptions used in the investment analysis should reflect expectations at the time the decisions were made to build the projects. The timing of the project development decision does not explain the large variation in their assumptions about future rice husk prices.

All values within this wide range of price assumptions and escalation rates are reasonable assumptions, since the full range is reflected in the range of biomass prices assumed in UP and central government tariff orders. The UP tariff for biomass from 2005 was based on a price of 740 rupees per tonne of biomass fuel.⁵⁶ Three years later a UP tariff order for biomass mentions sugarcane waste (bagasse) fuel prices of 2250-2500 rupees/MT during the off-season.⁵⁷ The Central Electricity Regulatory Commission tariff order for renewable energy sources of 2009 forecasts biomass prices in UP to be 1518 rupees/MT during 2009-10 and assumes a 5% annual escalation rate in biomass prices.⁵⁸ It is difficult to predict future biomass prices because the market for biomass is new, undeveloped, and growing, and because availability of biomass is dependent on rainfall.

The choice of just this one variable puts into question the validity of the investment analysis for biomass projects that purchase biomass fuel (See Table 3.3). Figure 3.4 illustrates a sensitivity analysis of the choice of biomass price for one biomass project. A decrease in biomass price of just 220 rs./tonne, from 1200 to 980 at the beginning of the project, increases the IRR by an amount equivalent to the effect of CERs on IRR. Similarly, keeping the biomass price at 1200 at the start of the project, and lowering the expected annual escalation rate in biomass prices

⁵⁶ Mentioned in the updated draft tariff order: Draft "Uttar Pradesh Electricity Regulatory Commission (Terms and Conditions of supply of power from Captive and Non-conventional Energy Generating Plants) Regulations, 09" (CNCE Regulations'09). http://www.uperc.org/UPERC%20CNCE%20Order%20%20_Final.pdf

⁵⁷ Suo-moto proceeding on procurement of power through competitive bidding and alternative fuel for use of bagasse based co-generation capacity during off-season. 1 May 2008. <http://www.uperc.org/Order%20for%20CNCE%20Regulation%202008%20-%201st%20May%202008.pdf>

⁵⁸ Central Electricity Regulatory Commission (Terms and Conditions for Tariff determination from Renewable Energy Sources) Regulations, 2009, http://www.cercind.gov.in/Regulations/CERC_RE-Tariff-Regualtions_17_sept_09.pdf

from 4% to 1.6% changes the IRR by the same amount as CERs. Both of these changes are small compared to the range of assumptions for the four projects analyzed.

Biomass price is only one of many assumptions that can be varied by a developer who wishes to show a lower project IRR in their PDD. Operations and maintenance is another cost that is fairly uncertain for biomass projects. Also, as with wind projects, the actual benchmark is difficult to predict, especially since it is difficult to place a value on the reliability that captive power offers, and often investment in biomass cogeneration is weighed against other potential investments into a factory that are plant specific.

3.3. Hydropower projects: inappropriate for an investment analysis

Additionality testing is inappropriate for large hydropower in India for two reasons: the development of hydropower is a government decision, and large hydropower developers are guaranteed a specified return on their equity investment making an IRR analysis meaningless.

3.3.1. Hydropower development is largely a government decision

The Government of India employs a central decision-making process to determine the development of its rivers, in recognition of rivers as a national resource with multiple competing uses – electricity, irrigation, flood control. River development is determined through a government planning process involving a range of public and private actors. This planning process identifies potential hydropower sites and determines which specific sites will be developed in what order and by which sector – central, state or private. The private sector participates in hydropower development mainly by responding to bids put out by state and central state-owned companies. Additionality testing is not meant to predict the decision-making processes of governments which typically involves a multiple and complex set of considerations extending beyond cost effectiveness.

3.3.2. Developers of large hydropower projects in India are guaranteed a certain return on their equity investment

Developers of large hydropower projects (defined in India as over 25 MW) are guaranteed a pre-determined return on their equity investment, typically 14% or 15.5%.⁵⁹ The tariff the developer receives per kwh from electricity sales is calculated on a cost-plus basis for each hydropower facility and adjusted periodically to ensure that the developer receives the agreed return on equity based on their true costs and revenues. This means that most project costs are “passed through,” since they are returned to the developer through the tariff. Therefore hydropower developers do not take the risk that there will be cost overruns during construction, or that less power will be produced than expected.

Project IRR does vary slightly among large hydropower projects in India, because the costs that determine the tariff differ somewhat from the costs included in a typical CDM project IRR analysis. But these differences do not capture the main factors that determine the order in which hydropower sites are built and if private developers are interested in putting forward bids. First, to incentivize efficient plant operation, operations and maintenance (O&M) costs are calculated as 2% of capital costs annually with an annual escalation rate in the tariff calculation,

⁵⁹ 14% is the return on equity from the Central Electricity Commission’s 2005 tariff order and 15.5% is the return on equity from the 2009 tariff order. The CERC order applies to all central plants, and plants whose electricity is traded between more than one state. Each state writes its own tariff policy for its own plants, typically modeled after the CERC policy.

regardless of the actual costs.⁶⁰ In contrast, the IRR analysis uses the actual expected O&M costs, calculating lower IRRs for projects with higher ratios of O&M to capital costs. Second, capital costs are not always fully passed-through, depending on a reasonability check by the appropriate electricity regulatory commission. Projects that are judged by regulators to be built or managed inefficiently will have lower IRRs since the full capital costs are not passed through.⁶¹ Third, projects with longer construction times, which typically is the case with larger projects, projects built under more difficult geological conditions, or projects against which there is substantial public protest, will have lower IRRs. This is due to the way IRR takes into account time – give greater weight to costs and revenues in the early years than the later years. For one cost variable the IRR analysis actually points in the wrong direction. Counter-intuitively those projects that are able to attract *better* loan terms will calculate *lower* IRRs, since loan interest payments are passed through in the tariff calculation, but are not included in project IRR calculations. Perhaps the only significant indicator of project viability that is reflected in the calculated IRR is the longer expected construction time. When the tariff is determined on a cost-plus basis per project, an IRR analysis is not an appropriate indicator of whether a project would be built.

4. DISCUSSION AND CONCLUSIONS

I show that the accuracy of the investment analysis is a function of the relative effects on project return of CERs compared to the range of reasonable assumptions that can be used in the investment analysis. If the effect of assumption choices is small compared to the effect of CERs then there is not much room for developers to game their investment analyses. If the effect of the assumption choices is large in comparison to the CER effect then developers have room to choose assumptions to show that cost effective projects are not cost effective.

Even the best case for an investment analysis – wind projects in India – in which all of the main inputs into the financial assessment are documented, there is still some room to vary cost and revenue assumptions within ranges equivalent to the effect of the CERs in some cases. For most other project types there is much more room to manipulate cost and revenue inputs. The choice of the biomass price for biomass projects in India is one example. Even if cost and revenue figures were assumption-free, the viability benchmarks against which project IRR is judged are themselves sensitive to assumptions. The sensitivity of risk assessments to small changes in benchmark calculation parameters seem to preclude a benchmark for most projects that is meaningful within the relatively small improvements carbon credit revenues have on the IRR of CO₂ reduction projects. Both the IRR analysis and the benchmark IRR are adjustable in tandem.

A look at Indian hydropower suggests that it is important to look at the specific conditions under which technologies are developed to determine if the investment analysis and additionality testing more general is appropriate for that specific technology. Large hydropower in India is inappropriate for additionality testing because decisions to build large hydropower sites are made by the government rather than the private sector based on multiple considerations,

⁶⁰ For projects commissioned after April 2004.

⁶¹ Interviews with hydropower consultants indicate that private hydropower developers that experience costs overruns are typically able to pass through the full actual costs through a higher tariff. Public companies can find it more difficult to get cost overruns passed through in full.

and hydropower tariffs are determined so that developers receive a specified return on their equity investment rendering the IRR analysis meaningless in most cases.

The claim that additionality testing is manipulatable corroborates the views of the validators interviewed. Four validators from four of the five largest validation companies in India, tasked with auditing CDM additionality claims, hold the view that current additionality testing procedures are subjective and can be manipulated. One validator described the many “knobs you can turn” to change the results of the financial analysis. Several validators suggested ways to lessen the manipulation, but did not believe that it is possible to prevent it. This view is held by many more CDM experts as well.

In conclusion, an accurate project-by-project additionality test is impractical for CO₂ reduction projects. Another means for determining which projects are worthy of receiving international support through international climate change agreements is required.

Table 3.1 – Sensitivity analysis on choice of post-PPA tariff on wind project financial return

Project #	State in India	Construction start date	PPA length (years)	Tariff in year 1 (rp/kwh)	Tariff escalation rate	Tariff after end of PPA (rp/kwh)	Based on?	IRR when post-PPA tariff calculated on cost-plus basis	Sensitivity of IRR when post-PPA tariff is same as last year of PPA period		Effect on IRR from CERs
									IRR when post-PPA tariff is same as last year of PPA period	(difference between previous 2 columns)	
1687	Karnataka	14-Dec-07	10	3.4	--	3.4	same as PPA	7.82%	9.34%	1.52%	4.00%
1949	Karnataka	27-Apr-07	10	3.4	--	3.4	same as PPA	9.88%	11.93%	2.05%	1.72%
1824	Karnataka	15-Jan-07	10	3.4	--	3.4	same as PPA				
1268	Karnataka	1-Jan-07	10	3.4	--	1.6-3.0 (varies)	cost-plus	9.45%	11.36%	1.91%	1.68%
2265	Karnataka	23-Jun-06	10	3.4	--	3.06	lower without justification	10.38%	13.62%	3.24%	4.94%
1259	Karnataka	10-Mar-06	10	3.4	--	1.5-3.1 (varies)	cost-plus	8.68%	10.84%	2.16%	1.43%
1291	Karnataka	1-Aug-05	10	3.4	--	1.5-3.1 (varies)	cost-plus				
998	Karnataka	2001-5	10 (assumed)	3.1	--	3.1	same as PPA	12.40%	15.40%	3.00%	2.30%

Project #	State in India	Construction start date	PPA length (years)	Tariff in year 1 (rp/kwh)	Tariff escalation rate	Tariff after end of PPA (rp/kwh)	Based on?	IRR when post-PPA tariff calculated on cost-plus basis	Sensitivity of IRR when post-PPA tariff is same as last year of PPA period		Effect on IRR from CERs
									IRR when post-PPA tariff is same as last year of PPA period	(difference between previous 2 columns)	
2605	Maharashtra	8-May-08	13	3.5	0.15	3.5 with escalation rate	without justification	7.30%	11.80%	4.50%	3.00%
2092	Maharashtra	9-Feb-07	13	3.5	0.15	5.3	same as last yr of PPA	6.46%	8.42%	1.96%	2.18%
1615	Maharashtra	1-Jan-07	13	3.5	0.15	5.3	same as last yr of PPA	11.19%	12.56%	1.37%	??
1600	Maharashtra	28-Dec-06	13	3.5	0.15	3.89 with escalation rate	without justification				
1115	Maharashtra	27-Jun-05	13	3.5	0.15	5.3	same as last yr of PPA	12.23%	14.28%	2.05%	2.77%
967	Maharashtra	2005	8	2.91	0.11	3.68					
744	Maharashtra	2005	8					Spreadsheet not available			

Values are left blank for projects for which the calculations are not straightforward, such as for projects funded 100% by equity, and projects with spreadsheets containing circular references.

Table 3.3 – Effects of future biomass price on biomass project financial return

Project name	PDD Date	Start project construction	Rice husk price in first year rs./ton	Rice husk price annual escalation rate	Change in IRR or DSCR* from CERs	Decrease in rice husk price needed to increase return same amount as CERs	Decrease in escalation rate needed to increase return same amount as CERs
Rice husk based Co generation project at Dujana unit of KRBL Limited	Jan-08	Oct-05	2650	0%	0.45	380	
15 MW Biomass Residue Based Power Project at Ghazipur	Nov-08	Dec-06	1200	4%	7.86%	220	2.4%
DSCL Sugar Ajbapur Cogeneration Project Phase II	Feb-07	May-05	1150	2%	7.11%	430	
KM RE project	Jan-07	Feb-06	700	0%	8.07%	490	

^a DSCR (Debt Service Coverage Ratio) is a common financial metric used by banks to assess loan applications. A DSCR of less than one means that annual project revenues are less than the annual debt service. Here, the first project uses DSCR to measure project viability, and the other three use project IRR.

Chapter 4: Barriers to sugar mill cogeneration in India: insights into the structure of post-2012 climate financing instruments

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1. INTRODUCTION

In this chapter we offer an in-depth look at the history of the development of high efficiency bagasse cogeneration (the generation of electricity and steam from sugar cane waste) in India. The story of the bagasse cogeneration, played out in a complex development context interlinked with multiple sectors of the Indian economy, offers a rich case study for exploring the barriers to a technology, opportunities for supporting a technology, and how the incentives created by the CDM match those barriers and opportunities as they change over time and vary among states and facility types. We compare the effects of the CDM with the range of other programs supporting the development of this technology. We describe the development of bagasse cogeneration in India from its early projects through its capacity by the end of 2007, at 711 MW, 14% of its potential, examining why this cost effective technology has not achieved greater deployment.

Efficient bagasse cogeneration in India has been ranked among the highest for its potential for cost-effective emissions reductions and other development and environmental benefits (Banerjee 2006, Smouse et al 1998). India's sugar industry competes with Brazil for being the largest in the world and has the potential of contributing 5000 MW to the country's electricity grid (Ministry of New and Renewable Energy 2008, Natu 2005), which currently stands at a total capacity of 145,600 MW (Ministry of Power 2008). More recent estimates have been slightly higher, indicating a potential of 5575 MW (Purohit & Michaelowa 2007). The technology improves the profitability of the sugar sector, which employs approximately 500,000 people (Natu & Zade 2002), and on which 50 million sugarcane farmers depend (Department of Food & Public Distribution 2003). We examine how it came to be that only 14% of India's estimated potential for bagasse cogeneration has actually been exploited to date, despite its cost effectiveness, multiple purported benefits, and numerous domestic and international programs to designed to support the technology. This study focuses on bagasse cogeneration development in Maharashtra and Tamil Nadu, two of the largest sugar producing states in India. In Maharashtra, sugar is predominantly owned by sugar cooperatives, whereas in Tamil Nadu the sugar sector is largely private. These divergent trends in agrarian development have important implications for the capacity of these two states to exploit their bagasse cogeneration potential.

The following section of this paper provides background information on India's energy and sugar sectors, bagasse cogeneration development in the country, and previous government and international programs supporting the technology. We then describe our research design and study sites in Maharashtra and Tamil Nadu. This is followed by a detailed analysis of the barriers that have faced bagasse cogeneration over the last decade in both the private and cooperative sectors, and the effects of support programs in overcoming them. The following discussion

examines the implication of these findings on the structure of financial instruments under the post-2012 climate regime.

2. BACKGROUND

2.1. India's energy sector

The potential benefits of increasing the implementation of bagasse cogeneration can be understood in the context of India's rapidly growing, predominantly coal-based power supply. The combined impacts of urbanization, population growth, and economic liberalization in the 1990s increased electricity consumption by five times from 1980 to 2003 (Energy Information Administration 2007). There continues to be a considerable demand-supply gap as well as poor quality of supply (low voltage and grid instability) and substantial transmission and distribution losses and theft are estimated to be greater than 40% of power generation (Planning Commission of the Government of India 2006). In order to bridge the supply-demand gap and to keep pace with its rapid growth in GDP, India plans a rapid expansion of its power sector infrastructure. The government targeted an increase of 100,000 MW between 2002 and 2012 constituting a doubling in capacity (Ministry of Power 2005) of which 10% is to come from renewable resources. Between 2002 and 2008 India has achieved an increase in capacity of approximately 40,000 MW (Ministry of Power 2008, Planning Commission of the Government of India 2002), 20% of which is from renewable energy.⁶² In 2005, 69% of India's electricity was generated from coal (International Energy Agency 2005).

In order to increase the diversity of its energy portfolio, India has made efforts to increase its renewable power capacity. Total grid-connected renewable energy capacity⁶³ stands at around 12,200 MW (Ministry of Power 2008), of which wind and small hydro dominate (Ministry of New and Renewable Energy 2008). This figure, however, is only a small proportion of India's total resource potential in renewable energy. Overseeing the various policy incentives for renewable energy is the Ministry for New and Renewable Energy (MNRE, and until recently called the Ministry for Non-Conventional Energy Sources or MNES). Its activities include, among other things, coordinating demonstration programs, collecting and compiling resource data, and offering various tax, custom duty and capital and interest subsidy benefits (MNES 2004).

India's power sector is severely financially constrained. Most state electricity boards (SEBs) are functioning at substantial losses, and have experienced a spiraling decline in their financial standing and the quality of electricity they provide. Since the 1970s, high industrial tariffs have cross-subsidized low tariffs paid by residential customers and in the agriculture sector and helped cover large transmission losses. Over time, industrial customers started to install dedicated generators which they found to be more reliable and cost effective than grid electricity with its frequency fluctuations and brown and blackouts. As these customers left the grid, utilities saw their revenues base diminishing. This weakened the financial stability of the utilities, including their ability to build more capacity to keep up with increasing demand, which further compromised the quality of the power they produced. With the resulting decline in the reliability of the grid and electricity quality, industrial facilities continued to build captive plants

⁶² Figures taken from Ministry of New and Renewable Energy Annual Reports

⁶³ Including small hydropower plants, defined as hydropower plants below 25 MW

to replace grid electricity and continuing customers became more resistant to tariff increases (Dubash & Rajan 2002).

A number of reforms in the power sector have been underway since the late 1990s to tackle these inefficiencies with mixed results to date. In 2003, in an attempt to formalize various state-led initiatives, the central government passed the Electricity Act 2003, replacing all previous legislation in the sector. This electricity reform process involves the vertical debundling of generation, distribution and transmission, the establishment of independent electricity regulatory commissions in every state, and the implementation of competitive bidding for electricity contracts. .

2.2. Sugar sector and cogeneration technology

India's sugar sector competes with Brazil's as the largest in the world, and is the second largest agriculture-based industry in India behind textiles (Natu & Zade 2002). A majority of its production is destined for domestic markets (FAO 2003 in WADE 2004). India has over 500 sugar mills, 95% of which are located in nine states (Uttar Pradesh, Bihar, Punjab and Haryana in the north, Maharashtra and Gujarat in the west, and Andhra Pradesh, Tamil Nadu and Karnataka in the south). India's sugar sector is very heterogeneous. Mill size ranges from 500-10,000 tonnes crushed per day (TCD), with an average capacity of 3,300 TCD (Tuteja Committee 2004). However, small mills with a capacity of less than 2,500 TCD are considered less efficient and less economically viable than larger mills. Recognizing this, the central government issued a mandate that only factories of above 2,500 TCD would receive new licenses. The government also provided additional incentives for mills that undertook expansion projects (i.e. for those mills that wanted to expand from 1,250 TCD to 2,500 TCD and beyond). However, many mills established between 1950-1980 are smaller in size and use outdated technology.

Approximately 60% of India's sugar sector is owned and run by farmers through cooperatives, a situation that is unique to the country, while private sugar mills in India are the second largest producer. As with other agricultural cooperatives in the developed and developing world, in the sugar cooperative system in India individual landowning farmers are also shareholders in the sugar factory. Between 10,000-50,000 farmers belong to a single cooperative. Farmers deliver cane to the factory during the crushing season, and theoretically have a say in the functioning of the cooperative as well through their vote. Revenue earned from sugar sales are redistributed to farmer-members in the form of a sugarcane price (Ranganathan 2005). The cooperative system generally suffers from poorer coordination and is therefore less efficient than the plantation system most common in other sugar-producing countries like Brazil. This is because the timing for harvesting and crushing sugarcane is crucial, and should be done when the sucrose content in the cane is at peak maturity. There therefore must be coordination among many small sugar farmers and the sugar mill so that sugar is harvested at its peak, while there is a steady and adequate supply of raw material to the factory (Attwood 1992). Given its lesser efficiency, the reasons why the cooperative system is still dominant in sugar production in India are rooted in colonial history. Unlike colonial expansion in the New World, British policy did not involve expropriating large amounts of land from the Indian peasantry to cultivate sugar (ibid.).

As a means of meeting their factory needs for electricity and steam, and of disposing of the large quantities of bagasse (fibrous waste) left over after processing sugarcane sugar mills all

around the world burn bagasse in boilers to produce both steam and power. In the 1960s efficient bagasse cogeneration was pioneered in Mauritius and Hawaii. The implementation of higher pressure (60 bar and higher) and higher temperature (450 degrees C and higher) boilers, and corresponding turbines allowed the more efficient burning of bagasse with export of electricity to the grid. Today, a minority of mills around the world export surplus power to the grid via more efficient, high temperature, high-pressure boilers. For instance, Mauritius, an island country with very little fossil fuel reserves, meets 8% of its electricity demand through sugarcane waste alone (Deepchand 2001).

In order to maximize the use of steam for electricity generation, steam-drives are replaced with electrical drives, ensuring more power from the same amount of bagasse. Bagasse cogeneration also creates incentives for increased mill efficiency to maximize the electricity available for export to the grid. Since most cooperative mills have outdated inefficient technology, a considerable amount of investment must be made.⁶⁴ Even though both the low efficiency and high efficiency cogeneration of bagasse can technically be considered bagasse cogeneration, in this paper the term “bagasse cogeneration” refers to the high efficiency technology.

The sugar industry is well-suited for cogeneration for several reasons: (i) the continuous manufacturing process of sugar (as opposed to a batch process) is useful for continuous electricity generation, (ii) sugar processing requires only low-pressure steam, making higher pressure steam available for electricity generation, and (iii) decentralized sources of electricity supply reduce efficiency losses on state grids. Bagasse cogeneration produces net zero emission of carbon dioxide, since the carbon released as CO₂ when bagasse is combusted, was taken out of the atmosphere through photosynthesis.

2.3. Support for bagasse cogeneration in India

In India, interest in high efficiency bagasse cogeneration started in the 1980s when the supply of electricity started falling short of demand. Since high efficiency bagasse cogeneration has been perceived as an attractive technology both in terms of its potential to produce carbon-neutral electricity as well as its economic benefits to the sugar sector, a number of domestic and international programs were launched to support the dissemination of this technology, the largest of which are listed in Table 4.1 and described below.

Table 4.1. Largest programs that have supported bagasse cogeneration in India

Funding institution	Type of support provided
Ministry of Non-Conventional Energy Sources (MNES)	Interest subsidy, capital subsidy, tax benefits, workshops, pilot projects in the cooperative sector, and lower customs duty for importing technologies
USAID	Up to 10% equity contribution for 9 demonstration projects, trainings, workshops, newsletter, and outreach activities
Indian Renewable Energy Development Agency (IREDA)	Multilateral lines of credit for renewable energy development provided through IREDA from international and bilateral finance institutions. The Asian Development Bank (ADB) provided funds dedicated for bagasse cogeneration.

⁶⁴ Interview with sugar engineer, July 2004

Clean Development Mechanism (CDM)	A project-based carbon offsetting program established under the Kyoto Protocol
Global Environmental Facility (GEF)	Project under preparation to provide creative financing to cooperative mills

Ministry of Non-Conventional Energy Sources (MNES)

The national program on Promotion of Biomass Power/Bagasse Based Cogeneration was launched in 1992. It involved demonstration projects specifically in the cooperative/state sugar sector, as well as biomass resource assessment studies, training, and assistance to states in formulating their power purchase policies. In 1994, MNES expanded its bagasse program by offering capital and interest subsidies, research and development support, accelerated depreciation of equipment (e.g. boilers, turbines, waste heat recovery systems), a five-year income tax holiday, and excise and sales tax exemptions. Capital subsidy for cogeneration projects in the cooperative/public sector sugar mills were Rs. 3.5-4.5 million/MW (\$0.87-1.1 million/MW) depending on the level of pressure of the boiler. Interest subsidies for commercial biomass power projects were 1-3% depending on the pressure of the boiler. MNES also offered a range of other services, such as biomass resource assessments, and funding for bagasse cogeneration workshops and prefeasibility studies. Jawahar SSK, a cooperative sugar factory in Maharashtra and one of the nine mills visited for this study, was one of MNES's pilot projects.

USAID Alternative Bagasse Cogeneration Project

A major source of international funding for bagasse cogeneration has been the United States Agency for International Development (USAID). Complementing the Indian government's efforts through the 1990s, USAID carried out an initiative from 1994-2003 called the Greenhouse Gas Pollution Project (GEP) with a special component for bagasse cogeneration (the Alternative Bagasse Cogeneration or ABC component). This project built on prior work by the USAID in the late 1980s in which a series of feasibility studies assessing the potential for bagasse cogeneration were carried out. Nine mills were chosen as demonstration projects and were screened for their financial viability. The criteria were that the mills had to have a capacity above 2500 TCD, and had to install boilers that were 60 bar and 480°C or above. The chosen mills were required to operate for 270 days per year only on biomass. In order to elicit participation by sugar mills, USAID issued a request for proposals inviting mills to apply for the grant assistance. The nine chosen mills received grant assistance of \$1 million per project (or 10-20% of the project cost). Another component of this project involved a series of trainings and workshops, a quarterly newsletter, and outreach efforts to inform Indian sugar mills of the possibility of exporting electricity to the grid. Two mills visited in this study, TA Sugars and EID Parry, were USAID demonstration projects.

Asian Development Bank (ADB)

ADB is one of several international finance institutions that extend lines of credit to the Indian Renewable Energy Development Agency (IREDA) for loans for biomass cogeneration, some with portions reserved for bagasse cogeneration. A loan to IREDA from ADB contains a portion specifically dedicated to supporting bagasse cogeneration projects, and in 2004, had supported 130 MW of the technology.

Clean Development Mechanism (CDM)

In September 2008, India hosted 356 registered CDM projects, just under one-third of the global total, with an additional 690 projects in the process of applying for inclusion in the CDM (Fenhann 2008). Of these, 33 are bagasse cogeneration projects totally 534 MW capacity. During September 2008, 55 more bagasse cogeneration projects were in the CDM pipeline seeking approval for registration, amounting to 1050 additional megawatts if all are built.

Global Environment Facility (GEF)

The GEF was established in 1992 to support activities in developing countries that have positive benefits on global environmental problems. The GEF funds the “incremental costs” of activities with global environmental benefits, that is, the additional costs of performing a sustainable activity over the costs of a convention project. The GEF also provides technical assistance grants (for instance, it has provided \$5 million to IREDA). Country or state governments apply for GEF funds by submitting project proposals. The GEF has initiated a project, entitled “Removing Barriers to Biomass Power Generation in India,” part of which is aimed at developing a model for overcoming the financial barriers specific to bagasse cogeneration in cooperative mills in India. During the time this study was conducted this GEF project was still in its planning stages.

3. STUDY DESIGN AND METHODS

This research, primarily conducted in 2004, involved visits to nine sugar mills in Maharashtra and Tamil Nadu (see Table 4.2), review of project documentation from the support programs analyzed, and interviews with individuals involved in various aspects of the development of efficient bagasse cogeneration projects. The nine sugar mills chosen comprised five cooperative mills in Maharashtra, three private mills in Tamil Nadu and one state-owned mill in Tamil Nadu. We selected mills with varying situations in terms of stage of implementing bagasse cogeneration, financial standing, and size. In Maharashtra, we interviewed one mill that had successfully upgraded its boilers to enable high efficiency cogeneration through financial support from MNES, and five mills that had not yet done so. In Tamil Nadu, we visited three private mills—all of which had installed cogeneration—and one state-owned mill that had not as yet. We visited several highly profitable mills and loss-making mills running for only a fraction of the crushing season. In each of these sites, we conducted interviews with senior management and engineers and technicians in charge of the mill’s everyday operations.

We interviewed individuals working on bagasse cogeneration from the Indian government, non-governmental agencies (NGOs), multilateral agencies who were in charge of implementing renewable energy and/or climate change funding programs, energy consulting firms and research institutions in New Delhi, Pune, Chennai and Bangalore.

Table 4.2. Sugar mills visited

Name of mill and location	Ownership type	Installed capacity in 2004 (MW)	External funding source/s in 2004
<i>Maharashtra</i>			
Ajinkyatara	Cooperative	--	--
Baramati	Cooperative	--	--

Hutatma	Cooperative	--	--
Jawahar	Cooperative	25.5	MNES
Pravara	Cooperative	--	--
<i>Tamil Nadu</i>			
Chengalryan	State-owned	--	--
EID Parry	Private	24.5	USAID, MNES/IREDA
Rajshree Sugars	Private	15	None
TA Sugars	Private	110	USAID, MNES/IREDA, proposed CDM

4. BARRIER ANALYSIS AND EVALUATION OF SUPPORT PROGRAMS

When high efficiency bagasse cogeneration was first introduced in India in the early 1990s, several informational, technical and regulatory barriers prevented the rapid uptake of the new technology. Mill owners and managers were largely unaware of the technology, and did not have the technical expertise needed to implement it. Also, the lack of regulatory structures ensuring evacuation of the electricity from the mill and payment for it was major obstacle to the technology (Smouse et al 1998). By the time this study was conducted in 2004, mill owners and managers knew about the technology and its benefits, and had access to the substantial technical expertise that had been gained in the country. However, regulatory uncertainties were still a substantial barrier, and the poor financial conditions that had overcome both the sugar and power sectors made the high capital costs required to implement the technology even harder to access. Moreover, the cooperative sugar sector, comprising 60% of the total sugar production in India, faced additional financial problems due to their institutional structure, and today these problems present the most significant challenge to scaling up bagasse cogeneration. In the following sections we trace these shifts and discuss how well various international and domestic programs have addressed these barriers.

4.1. Informational and technical barriers

Prominent early barriers to the use of highly efficient bagasse cogeneration were informational and technical. Sugar mill owners and managers were largely unaware of the technology. Nor did they have experience working with high-pressure boilers, which involve a higher level of expertise and skill to run than do low-pressure boilers. The demonstration projects, trainings, workshops, newsletter and outreach from both the USAID and the MNES programs are considered highly successful at overcoming the informational barriers and lessening the technical barriers. A decade after the USAID project started in 1995, mill owners in India were widely aware of the practice of cogeneration with export to the grid. Demonstration projects proved that the technology was cost effective, and technical information was available to mills considering implementing the technology.

One problem with the USAID program was that its knowledge transfer component (e.g. newsletters such as Cane Cogen India, other publications, workshops, etc.) did not sufficiently reach out to cooperatives. Published materials were predominantly in English, whereas most

cooperative leaders are not educated in English. Many of the study tours (e.g. to Mauritius) also required hefty participation fees that cooperatives could not pay.⁶⁵ In addition, though many mills in India expressed interest in being a USAID demonstration project in response to calls for applications, not one of the applicants was a cooperative mill.

4.2. Regulatory barriers

A persistent barrier to the dissemination of bagasse cogeneration was regulatory uncertainty. At the time that the technology was first being introduced in India, regulations had not yet been put in place ensuring that excess electricity produced by sugar mills would be purchased by state electric utilities or defining the terms and tariffs under which it would be purchased. In 1994, MNES issued guidelines to state electric utilities to purchase power from local generators at avoided costs, plus a 50% contribution to grid connection costs (WADE 2004). The tariff prescribed by MNES was \$0.049/kWh for 1994-1995 with a 5% compounding escalation per year thereafter, making it \$0.067/kWh in 2002. MNES also issued guidelines for wheeling and banking of power from distributed generators. Based on this, several states independently announced policies for electricity purchase from bagasse cogenerators.

Several sugar mill owners report that state electricity boards have historically not been creditworthy, which makes project developers and lenders cautious about investing in bagasse cogeneration. Many interviewees for this study recalled stories that state electricity boards in various states lowered the tariffs to bagasse cogeneration facilities mid-contract, failed to make payments for six months to a year, or reneged on contracts altogether. For instance, the tariff guidelines for cogenerated power issued by the Maharashtra electricity regulatory commission, faced considerable resistance by the state utility on the grounds that they did not strictly “need” the power from sugar mills. They insisted on compensation by the government for the higher tariffs they were being required to pay (Deo 2004). This initial resistance on the part of MSEB resulted in the delaying of the first cooperative bagasse cogeneration project in Maharashtra,⁶⁶ and in turn dissuaded other cooperatives from installing bagasse cogeneration since they believed that they would not be guaranteed a buyer for the electricity they generated. It was generally understood that the reason for these regulatory problems was that state electricity boards, already functioning at substantial losses, resisted purchasing power from independent power generators, especially at supportive rates they deemed excessively high. Experiences with broken contracts, lowered tariffs and delayed payments added substantially to the perceived risk of bagasse cogeneration by mill owners and lending banks.

The prospects of overcoming regulatory barriers are favorable. The Maharashtra electricity regulatory commission, established in the process of power sector restructuring, has made the state electricity board more accountable. Due to this, state electricity boards are less likely to rescind their power purchase agreements with bagasse cogeneration mills. Furthermore, the Electricity Act allows for open access to the grid. At least one private company (Indal Ltd.) has been allowed open access to the Karnataka state grid. This would give sugar mills the opportunity to sell power to customers directly, while they would only pay wheeling charges to the state electricity board.

⁶⁵ Interview with engineer at cooperative sugar mill, June 2004

⁶⁶ Interview with engineer at cooperative sugar mill, June 2004

4.3. Financial barriers

In 2003-2004, drought in major sugar producing states led to low capacity utilization in sugar mills. In the same year, the price of sugar reached a low point in part due to low global sugar prices. These conditions together led to a serious financial crunch in the sugar industry for both private and cooperative mills.

Early implementers of bagasse cogeneration, including the nine mills participating in USAID's pilot program, had proved bagasse cogeneration to be a profitable technology—especially in that it provided benefits beyond the sale of sugar alone. At EID Parry and TA Sugars, two of the USAID pilot projects, the sale of electricity to the grid provided a steady flow of revenue. Electricity production is viewed as a major revenue source at these mills, and a more stable revenue source than sugar production whose price and yield fluctuates. Electricity is treated as one of their primary businesses. In the context of low sugar prices and drought, electricity production for sale to the grid has provided enough additional revenue to keep some mills out of bankruptcy.

Despite the cost-effectiveness of the technology, mills that had not implemented bagasse cogeneration typically faced a range of difficulties accessing the necessary investment capital—a major on-going barrier to the widespread use of this technology. Financial institutions were hesitant to lend to sugar mills to implement bagasse cogeneration because of the high risk involved. Bagasse cogeneration projects conventionally require investment of Rs. 1 billion (around \$25 million), while smaller allied projects, e.g. alcohol distilleries, ethanol producing plants, require an investment of only 10 million rupees.⁶⁷ Smaller projects are often successful at attracting the requisite finance for these small projects, but bagasse cogeneration requires an order of magnitude investment that banks are not willing to risk in this industry.⁶⁸

In 2004, most of the mills that had implemented bagasse cogeneration were large private sector mills. Some were owned by large multi-faceted companies such as EID Parry, a well-known company which produces a range of known products of which sugar was only one. Banks are likely to fund a bagasse cogeneration plant at such a company because of the financial standing of the company, even if they are not familiar with the sugar sector or the technology. Smaller lesser known mills had a much harder time finding debt. By 2004, the poor condition of the sugar sector, compounded by the poor condition of the electricity sector and the increased regulatory uncertainty this brought, made the sugar sector an even riskier investment, and made it even more challenging for mills to access financing.

Each of the support programs discussed in this paper had a role to play in helping some mills gain access to the investment capital needed to implement bagasse cogeneration. MNES's guidance to states to implement preferential tariffs, and various tax and other benefits, supported the cost effectiveness of the technology. However, these policies were not always carried out by states or the federal government, introducing substantial risk that undermined the incentives these program were designed to create. In addition to the problems with power purchasing contracts discussed above, MNES has been criticized for failing to deliver the subsidy payment for implementing the technology as per MNES policy.⁶⁹

⁶⁷ Interview at cooperative sugar mill, July 2004

⁶⁸ Interview with cooperative sugar mill owner, July 2004

⁶⁹ Interview with manager at private sugar mill, July 2004, who was still waiting to receive the MNES subsidy long after the bagasse cogeneration plant was installed

The IREDA multilateral lines of credit enabled some mills to acquire loans that otherwise would not have had access to debt, though at high interest rates. High interest rates charged by ADB and other lenders translate into high lending rates to mills by IREDA of around 13%, compared with 7-8% from local banks.⁷⁰ IREDA's positive appraisals were commonly used by local banks in their own lending decisions, and as such helped developers to refinance IREDA loans through local banks at much lower interest rates.

Similarly, USAID demonstration projects not only received a subsidy from USAID, but also benefited from the USAID "stamp of approval" from being chosen as a demonstration projects, which enabled them to receive better loan terms. It is also interesting to note that by choosing mills with the strongest financial standing and which were most likely to successfully implement bagasse cogeneration as their demonstration project, USAID was also choosing those mills which were most likely and able to implement the technology without USAID support. For example, TA Sugars had already invested in a bagasse cogeneration plant in one of its mills before the USAID project, and was preparing to shift two other plants to bagasse cogeneration without USAID support. Still, the USAID project was praised because of its success in supporting projects that were successful, and thus demonstrating the successful implementation of the technology.

The GEF project was specifically designed to address the financial barriers of cooperative sector mills. The CDM was designed to improve the financial returns from low emissions projects. Both of these programs are described in more detail below. Despite all of these programs, substantial financial barriers still exist, especially in the cooperative sector as described in more detail in the following section.

4.4. Barriers particular to the cooperative sugar sector⁷¹

In 1998, 55% of sugar mills in India were in the cooperative sector accounting for 60% of total sugar production in India (Godbole 2000). Almost half of these mills are in Maharashtra, and 99% of sugar produced in Maharashtra is in the cooperative sector. The cooperative sector has certain political and financial characteristics that make it difficult for them to stay financially solvent; as a result, more than one-third of the cooperative sugar factories in Maharashtra have been loss-making for the past three years, or are running at less than 75% of their capacity.

There are a number of reasons for the poor performance of cooperative mills and for the perception that they are more risky investments than private sector mills. Their institutional structure creates yet additional financial barriers to implementing the technology. First, cooperative mills have historically been smaller than private mills, commonly 2,500 TCD or less. Lower crushing capacity mills are less efficient than higher capacity ones, and it is costly to undertake mill expansion in order to install bagasse cogeneration. Second, as stockholders in the mill, farmers also own a share of the mill profits. These profits are paid to the farmers in the price paid for sugarcane. Therefore mills hold little capital that they can use for investments (Natu & Zade 2002), and certainly not enough to cover the level of equity needed to invest in cogeneration. Collecting the equity needed would involve a political process whereby farmers would agree to pay for the cost of the equity portion of the investment, such as through receiving

⁷⁰ Interview with IREDA employee, June 2004

⁷¹ This whole section is based on: Ranganathan M. 2005. *Can Co-ops Become Energy Producers Too? Challenges and Prospects for Efficient Cogeneration in India's Co-operative Sugar Sector*. Master's thesis. University of California, Berkeley, Berkeley

a lower price for their sugarcane. Third, because cooperative mills are democratically run, with typical election cycles of five years for board members, there is a high chance of policy change if a new management board is elected. The perception that cooperative mills are less creditworthy expresses itself in state guarantees and collateral requirements by banks (UNDP 2005), that also, cooperatives are unable to meet. Fourth, some interviewees described the mills as lacking professionalism and not well-managed (also described in Natu & Zade 2002). The “un-corporate” culture of cooperatives is something international agencies are not used to, which is one reason they have focused on the more profitable private mills. The cooperative sector’s poor financial health, perception by banks and the central and state governments as not creditworthy, and their lack of equity holdings all make it difficult for cooperative mills to access the equity and debt needed to invest in cogeneration.

Support programs to date have done little to help the majority of cooperative mills implement cogeneration. In 2006, only 50 MW from eight sugar mills were in the cooperative sector (Purohit & Michaelowa 2007), compared to approximately 600 MW in the private and public sectors. This is despite the higher subsidies cooperatives receive from MNES, and early MNES demonstration projects specifically in the cooperative sector. At the time of this study, the GEF project was being developed specifically to develop a creative financing program to address the specific barriers facing the cooperative mills.

5. DISCUSSION

Over the last decade, bagasse cogeneration faced a dynamic and varied set of substantial informational, technical, regulatory and financial barriers. These barriers changed over time, and differed between the private and cooperative sectors. Each of the programs designed to support bagasse cogeneration had a role to play in supporting the 711 MW of bagasse cogeneration currently installed, and no single program would have been successful on its own. MNES promotional policies, including capital and interest subsidies, a variety of tax benefits, and guidelines to states to implement preferential tariffs made bagasse cogeneration cost effective to implement in India. The USAID program is considered especially effective in increasing experience in country with the technology, bringing awareness of the technology to sugar mills throughout the country, and offering technical resources and support to mills considering implementing it. Various multilateral lines of credit offered through IREDA offered loans to some mills unable to access debt through other institutions. Still, to date, support programs have done little to address the unique financial barriers facing the cooperative mills due to the institutional structure of these mills, currently the most pressing barriers facing the technology.

Against this story of bagasse cogeneration development in India, we explore the effectiveness and limitations of the CDM and the GEF, and carbon trading and fund-based instruments more generally, as they are being discussed for inclusion in the post-2012 climate change regime.

Financial instruments currently being debated for the post-2012 regime

Under negotiations over the post-2012 climate change regime, proposals for structuring mechanisms which will support climate change mitigation in developing countries largely fall into two categories in country submissions and the research literature. One category comprises various credit trading mechanisms that create tradable carbon credits by comparing actual

emissions to specified baselines. The Kyoto Protocol's CDM is a project-based credit trading mechanism, generating credits from projects in developing countries that supposedly reduce emissions. Proposals for the CDM post-2012 vary widely, from replacing it to expand it. Another set of proposals involves implementing a sector-based crediting trading mechanism such as "no-lose" sector-based targets (e.g. Schmidt et al 2006). Sectoral targets are targets applied to specific sectors rather than to the whole economy, and can be absolute (a defined figure covering the whole sector) or intensity-based (such as a target per kWh produced, or per ton of steel produced). No-lose targets are targets for which the country can sell credits if their emissions are lower than their target, but do not need to purchase credits if their actual emissions exceed their target.

A second category of proposals involves various types of global funds. There are various ways that the funds could be generated. Contributions from each country can be calculated based on principles of responsibility and capability (Mexico 2008), auction (Norway 2008) or taxes (Switzerland 2008). These funds would then be administered through an international body to support specific policies, programs and projects in developing countries. Add policies and measures, funding for which could be credit-based or fund-based

The CDM – limitations on the barriers it addresses

It is useful to ask how well a carbon trading mechanism like the CDM would address the past and current barriers to bagasse cogeneration if the additionality problem were solved. For example, we can ask if bagasse cogeneration in India would be an appropriate project type for the CDM if the CDM were limited to a defined set of project types (sometimes referred to as a "positive list"), foregoing the project-by-project additionality test.

The barrier analysis carried out in this study indicates that bagasse cogeneration in India should not be included in such a positive list. The CDM supports projects by improving their anticipated financial returns, adding an additional revenue source through the generation of tradable carbon credits. These additional revenues can make a marginally viable project viable (reflected in the investment analysis option of the standard CDM additionality-testing tool). Alternatively, additional revenues from the CDM can overcome project barriers by compensating for high financial, regulatory or other risks, or by otherwise convincing actors to take action to reduce project barriers (reflected in the barrier analysis option of the standard CDM additionality-testing tool).

While bagasse cogeneration is already cost-effective in India, with the help of MNES incentives, it is unclear how the CDM would overcome the other barriers facing the technology. The additional revenues from the CDM would not address the many reasons banks perceive that bagasse cogeneration, especially in the cooperative sector, is a risky investment. Also in most cases, it does not directly help cooperative mills access the equity needed to invest in the technology. While the CDM involves a new set of entities in the project development process, including CDM consultants, carbon credit purchasers, and auditors, none of these entities generally involve themselves in the details of project development and planning, and therefore do not engage directly in activities that overcome informational, technical or regulatory barriers. The CDM would not directly incentivize the outreach, workshops and newsletters that were so important when the technology was first being introduced in India, since those performing such activities would not be eligible for CDM credits.

An underlying rationale for the CDM, and market mechanisms more generally, is to put a price on emissions reductions, and let the market find cost effective reductions. Certainly it is a

positive thing to change the relative prices of low and high emitting technologies. The CDM could potentially help mills access equity capital if their contract with a credit buyer involves up-front payments in addition to or rather than payment for credits once they are generated. Some credit purchasing agreements are already structured in this way. Also, we can envision that if CDM revenues were guaranteed for any new bagasse cogeneration plant in India, this could allow for lower tariffs, relieving the burden on ailing utilities and possibly the regulatory barriers.

In sum, even if the CDM were recognized as a subsidy for project types allowed under it, and the additionality problem were thus solved, the direct effects of the CDM are still limited and would not address many of the barriers that face this technology now, or have faced it in the past. Other mechanisms would still be needed to address a wider range of barriers.

Acknowledging competing (global) climate and (local) development goals

One debate in discussions about future financial transfer under international climate agreements is how climate and development benefits are to be weighed against one another. Within the climate policy literature, some argue that climate projects have the potential to have significant synergies with other domestic development goals (Davidson et al 2003), and are more likely to be successful if they also address these other goals (Swart et al 2003).

This study of bagasse cogeneration suggests that where priorities differ across scale (international, national and local) these priorities can compete with one another. This is an inherent problem with climate aid. Projects funded based on the international priority of climate change mitigation, run a risk of conflict with other more pressing local goals.

In areas of Tamil Nadu, due to drought and the resulting high price of biomass, paper mills are paying high prices for bagasse. A number of sugar mills that have implemented high pressure boilers for bagasse cogeneration have chosen to sell their bagasse to paper mills and burn coal in their new boilers instead, which would not be economical feasible with the old low pressure boilers. Many mills are choosing this option because the current high prices offered for bagasse makes it economic to do so. Therefore, projects meant to support bagasse cogeneration for climate change purposes, might actually lead to an increase in emissions by enabling mills to replace bagasse with coal throughout the year. This situation exists as long as the price of biomass remains high, and for mills located relatively close to paper mills.

A second example of a conflict between goals across scale is the interest of electricity companies to remain solvent on the one hand, and the national goal of increasing the renewable energy share on the other. In both Tamil Nadu and Maharashtra the state electricity boards went back on contracts they signed with bagasse cogeneration and wind power plants, rejecting MNES guidelines to offer preferential tariffs for renewable energy while they were running at losses. This conflict produces regulatory uncertainties that are a substantial barrier to investments in renewable energy.

Discussion of an alternative to credit trading mechanisms – international funds

The variety of barriers that have faced bagasse cogeneration over the last decade and the range of programs that have been important in enabling its implementation to date, imply that for this technology several support instruments working together would likely be more effective than a single instrument. While the CDM creates a price for carbon emissions reductions, treating all projects uniformly, according to the amount of emissions reduced, international funds like

USAID and the GEF are able to customize their projects to address the specific barriers and conditions of the technology they are promoting.

One reason the USAID program was as successful as it was, was that it was developed by individuals who had been working on renewable energy, and bagasse cogeneration specifically, in India for many years. They were familiar with the barriers to the technology and the local conditions under which the programs would be implemented and could design their program so that it is suited to these needs and conditions. While the GEF project was still in its planning stages at the time of this study, its intension of developing creative financing strategies for the cooperative sector directly addresses the most pressing barriers currently facing the technology. Such a program can only be successfully developed with in depth understanding of the cooperative sugar sector in India.

Still, bridging the global/local gap is a challenge for international funds. Several GEF projects in India supporting renewable energy technologies have been criticized by individuals familiar with them for the lack of transparency regarding how decisions are made as to what GEF proposals are funded, the amount of time it takes to go through the GEF approval process, and lack of accountability and oversight the GEF has to assure positive project results.

6. CONCLUSIONS

This study finds that bagasse cogeneration has faced layers of informational, technical, regulatory and financial barriers that have changed over time, and differed significantly between the private and cooperative sugar sectors. Each of the programs designed to support bagasse cogeneration had a role to play in enabling the bagasse cogeneration currently installed, and no single program would have been successful on its own. Some barriers to the technology needed directed efforts designed for the specific context in which they were implemented; simply subsidizing the technology or putting a price on carbon would not be enough. This, along with the fact that bagasse cogeneration is already cost effective in India, implies a limitation to the effects carbon trading mechanisms like the Kyoto Protocol's Clean Development Mechanism (CDM) could have in supporting the technology, even if the additionality problem were solved. Interviews at mills attempting to access carbon financing through the CDM indicate that additionality testing is a serious challenge to the effectiveness of this mechanism. Where climate (global) and development (local) priorities differ, projects that bring about international goals risk conflicting with more pressing domestic goals. Any effort to exploit the remaining 86% of the estimated national potential for high efficiency bagasse cogeneration will need to address the special financial and political conditions facing cooperative mills.

Chapter 5: Concrete emissions reductions in Shandong's cement sector: design options for a sectoral crediting program

1. INTRODUCTION

Sectoral crediting approaches are being proposed as a partial replacement for the CDM under the post-2012 climate change regime. Sectoral crediting shifts the metric of carbon offsetting from reductions by individual projects to reductions in an entire sector, and refers to a wide range of proposed programs. This chapter contributes an in depth analysis of the design of a sectoral crediting program in a specific sector in one region – the cement sector in Shandong Province in China. I offer a typology of sectoral crediting design options being discussed in academic and gray literature and in official post-2012 country submissions and negotiating texts. I then analyze these design options in the specific context of the Shandong cement sector focusing on the ability for sectoral crediting to avoid the main problems with the CDM documented in Chapters 2, 3 and 4. I assess sectoral program design options against three criteria: their potential to (i) effectively promote efficiency improvements, (ii) ensure that the number of credits generated by the program does not exceed the reductions enabled by it, and (iii) meet international standards for reporting and verifying emissions reductions. I find that for most design options, sectoral-scale crediting could perform worse than project-based offsetting along the criteria assessed. I outline two specific design architectures that may have the potential to effectively support verifiable emissions reductions in the Shandong cement sector without high risk of over-crediting those reductions if designed and implemented well. However, conservative decisions would be needed with regard to program scope and crediting baselines. The obstacles to an effective sectoral crediting program discussed below suggest that sectoral crediting is being included in international climate change agreements and domestic legislation prematurely. Carbon offsetting programs, whether project-based or sectoral-scale, add uncertainty to the emissions reduction estimates from cap and trade programs, must not be assumed to be workable, and must be adopted only after careful grounded design analysis in the specific sectors in which they are being considered for implementation.

The shift from project-based to sectoral-scale crediting in developing countries has been proposed for a number of reasons. First, the CDM has been heavily criticized by both the environmental and business communities, so much so, that is clear that changes to the CDM are necessary. From the climate perspective, the CDM is criticized for generating many credits from business-as-usual activities that do not represent real emissions reductions (California Air Resources Board 2009: 77, Haya 2009, Wara & Victor 2008). Project developers, traders and developing country governments criticize the CDM for being difficult to work with, in large part because the process of submitting a project for CDM approval is long, cumbersome and unpredictable (Haya 2009, International Emissions Trading Association 2010). A second issue is one of scale. The major shifts in development trajectory needed in developing countries are thought to require sector-scale effort, more than is achievable through a series of uncoordinated projects as are supported under the CDM (California Air Resources Board 2009: 77-78). Also, as industrialized countries commit to deeper post-2012 targets and the US comes on board as an active participant in the international climate change regime, a substantially larger demand for offset credits is expected. Sectoral crediting is thought to be able to produce a larger supply of credits. Third, some countries and industries are concerned that efforts to reduce emissions in

domestic industries that compete internationally could lessen their international competitiveness and lead to the “leakage” of production to countries without such regulation (California Air Resources Board 2009, Meckling & Chung 2009). Lastly, sectoral crediting could bring developing countries more deeply into the climate change regime, by requiring the monitoring and reporting of emissions on a sectoral basis, and sector-level targets that could be binding or voluntary.

A range of approaches for the sector-scale crediting of emissions reductions in developing countries has been proposed and discussed in the literature and in country submissions to the UNFCCC. These fall broadly into three categories.⁷² The most common conception of a sectoral crediting program would credit reductions in a sector as a whole against a sector-wide crediting baseline. Second, a reformed CDM could facilitate easier and more coordinated efforts in specific sectors or for specific technologies. Standardized criteria for CDM project approval set on a sector-level could more simply and predictably support certain technologies. A third family of crediting approaches with sector-scale focus credits reductions from a potentially wide range of policies, programs and other support measures. This proposal can be considered a form of credited Nationally Appropriate Mitigation Actions (NAMAs), and is sometimes referred to as “policy-” or “programmatic-CDM.”

A number of studies examine the advantages and disadvantages of various types of credited and non-credited sector-scale programs in developing countries. Studies discuss a range of program designs generally (Sterk 2010) or focus on a sectoral no-lose target program that credits against a sectoral baseline (Schmidt et al 2008, Schneider & Cames 2009, Ward et al 2008). Some focus on sectoral programs for specific countries or sectors: China, Mexico and Brazil (Center for Clean Air Policy 2010) and transportation (Millard-Ball 2010a). These studies raise a range of concerns about programs that generate credits from sector-scale actions. Some question the effectiveness of creating financial incentives for government action, especially when payments are made for reductions after they have been achieved rather than up front (Sterk 2010). Some discuss the challenges of avoiding over-crediting emissions reductions, particularly with regard to measuring emissions reduced by NAMAs (Millard-Ball 2010b, Sterk 2010) and estimating a business-as-usual sectoral baseline (Millard-Ball 2010a, Millard-Ball 2010b, Schneider & Cames 2009), and the potential for creating perverse incentives for governments to refrain from action in order to generate more credits in the future (Ellerman et al 2008, Millard-Ball 2010a, Schneider & Cames 2009). Host country capacity to perform the necessary monitoring, reporting and verification has been raised as a potential challenge to sectoral-scale crediting (Cai et al 2009, Center for Clean Air Policy 2010). Though many of these studies discuss similar concerns, their conclusions differ widely. Some conclude that sectoral crediting should be avoided generally (Sterk 2010) or for specific sectors (Millard-Ball 2010a) and others conclude that sectoral crediting is promising if carefully designed (Center for Clean Air Policy 2010, Schmidt et al 2008, Schneider & Cames 2009).

I examine how and if these potential hurdles can be addressed. By performing a design analysis for one sector in one province, I am able to examine how a program might work in the particular context of the institutional culture and structure, government-factory relationships, opportunities for reducing emissions, etc. of this one particular sector, and uncover opportunities and potential hurdles that might not be seen by a more general analysis. I probe how the concerns raised in the literature might play out in this particular context. I focus this analysis on

⁷² For a broader taxonomy of sectoral approaches, including credited and non-crediting options, see Meckling JO, Chung GY. 2009. Sectoral approaches for a post-2012 climate regime: a taxonomy. *Climate Policy* (9): 652–68.

identifying potential program designs that solve the main concerns raised about sectoral crediting programs, two of which are also the main critiques of the CDM: (1) providing effective incentives and support for emissions reductions and efficiency improvements, and (2) ensuring that the number of credits generated by the program does not exceed the reductions enabled by it. I discuss advantages and disadvantages of different design options on measuring, reporting and verifying (MRV) requirements, a third important concern about sectoral crediting, but a full discussion of the concerns over MRV is beyond the scope of this chapter.

The Shandong cement sector was chosen for this analysis for a number of reasons. First is its significance in terms of global emissions. Globally, the cement sector produces 5% of total GHG emissions; China produces approximately half of the world's cement; and Shandong produces the most cement of any province in China (10% of China's production) (Price et al 2009). Second, the cement sector is commonly viewed in the literature as promising for a sectoral trading program in part because it is a fairly homogeneous, somewhat internationally-traded product with a large potential for reducing emissions (e.g. California Air Resources Board 2009: 78, Schmidt et al 2008). Third, China is one of the countries for which sectoral trading is being proposed (e.g. Schmidt et al 2008). Fourth, there is domestic interest in China for reducing the energy consumed by cement and concrete manufacturing, and Shandong province has been particularly aggressive in its energy conservation efforts. Lastly, California is moving forward with the design of an international sectoral crediting program for a number of high-emitting sectors in specific developing countries under its cap-and-trade regulation (California Air Resources Board 2009). The Shandong cement sector is one of the sectors it is considering for this program.

Section 2 provides background on the Shandong cement sector and opportunities for reducing emissions in this sector. Section 3 offers a typology of sectoral crediting design options being discussed for application in developing countries. Section 4 explores how these design options might fare in the Shandong cement sector. The paper concludes with a policy discussion of appropriate options for the Shandong cement sector specifically, as well as for a basis structure for sectoral programs worldwide.

2. BACKGROUND ON THE SHANDONG CEMENT SECTOR

China's cement sector was estimated to be the third most CO₂ intensive (per ton of cement produced) in the world in 2005 (International Energy Agency 2007) because of its large proportion of small inefficient factories using inefficient vertical shaft kilns (VSKs). Only the US's⁷³ and India's cement sectors were more CO₂ intensive. China reinvigorated its economy-wide energy efficiency efforts in 2005, setting a domestic goal of reducing the energy intensity of its economy, in terms of energy consumption per unit of GDP, by 20% between 2006 and 2010. A range of measures has resulted in a reduction in energy intensity in China's economy over the last few years, including in its cement sector. Most important in the cement sector has been the closing of small production units with inefficient kilns and replacing the lost capacity with modern plants using rotary kilns. In 2006, Shandong was home to 980 inefficient VSK plants and only 61 newer larger rotary kilns plants. Just two years later, the proportion of cement produced by the more efficient rotary kilns had increased from 38% to 58% (Price et al 2009).

⁷³ Owing to the age of the factories and the use of energy intensive wet process kilns (Baron 2007)

China expects to phase out most of its VSK cement production lines by 2015.⁷⁴ In addition, there is ample opportunity to improve the efficiency of the rotary kiln factories. A 2009 study of sixteen rotary kiln plants in Shandong estimated a potential for decreasing the CO₂ emissions of these sixteen plants by 5% with cost effective measures,⁷⁵ and another 3% with other technically feasible improvements (Price et al 2009).

The Chinese and Shandong governments are aggressively implementing a range of programs and regulations expected to reduce emissions in the cement sector. Higher electricity pricing for the least efficient facilities in high-emitting industries led to the closing and upgrading of around 1300 inefficient firms in energy intensive industries throughout China between 2004-6 (Price et al 2010). China's Top 1000 Energy-Consuming Enterprises program aims to improve the efficiency of the largest energy consumers in the country, including many large cement factories. This program requires each participating facility to perform energy audits and develop energy conservation plans. The government provides various supportive trainings to plant managers under the program. The Chinese government has funded provincial energy conservation centers throughout the country for several decades, which provide information and assistance supporting industrial efficiency. The successful fulfillment of the associated conservation agreements is factored into the individual performance evaluations for provincial government officials and company managers, affecting their ability to receive annual awards, honorary titles, and promotions. The *Financial Rewards on Energy-Saving Technical Retrofits in China* program rewards factories for approved technical renovation projects in proportion to actual reductions in primary energy use. Sixty percent of the expected payments are provided upfront to help pay for the technical upgrades. The Chinese government has recently initiated a program to subsidize qualified efficiency projects performed by Energy Service Companies (ESCOs) called the *Accelerating Energy Performance Contracting to Promote the Development of Energy Service Industry in China* program which also provides support in proportion to the verified energy savings achieved.⁷⁶ In 2007 China published mandatory conservation standards for new and existing cement factories, regulating the coal, electricity and energy consumed per unit of clinker and cement produced and in specific plant processes.⁷⁷

Cost effective and low cost opportunities to lower emissions exist at all stages of the cement production process (Price et al 2009). The cement production process starts with the transport of limestone and other materials containing oxides, normally clay or shale, to a cement factory. These raw materials are ground up and blended, and heated in a kiln to extremely high temperatures (commonly 1450 degrees Celsius) to produce clinker. Clinker is then cooled, ground up, and mixed with gypsum and other materials, to make fine powdered cement. Cement is mixed with water and binding materials, like crushed rock, gravel and sand, to produce concrete, which is poured to make buildings, bridges and other infrastructure.

⁷⁴ Wang, Y., 2010. Cement Industry's Industrial Policy for the 12th FYP is going to be released. *China Business News*, September 17, 2010. Last accessed on December 9, 2010. <http://finance.jrj.com.cn/2010/09/1704348191239.shtml>

⁷⁵ Cost effective is defined as net negative cost using a discount rate of 30%, ignoring externalized social costs.

⁷⁶ See State Council of China, 2010. The Notice on Accelerating Energy Performance Contracting to Promote the Development of Energy Service Industry in China, April 2, 2010. http://www.gov.cn/zwggk/2010-04/06/content_1573706.htm

⁷⁷ See mandatory standards GB 16780-2007 (English translation: <http://china.lbl.gov/sites/china.lbl.gov/files/Summary%20of%20GB%2016780-2007.pdf>) and GB 50443-2007 (English translation: <http://china.lbl.gov/sites/china.lbl.gov/files/Summary%20of%20GB%2050443-2007.pdf>)

Typically a little over 50% of CO₂ emissions from cement manufacturing are from the chemical process of converting limestone into clinker. The intense heat breaks limestone (CaCO₃) down into CaO and CO₂. The CO₂ is released into the atmosphere and the CaO combines with the other oxide inputs to produce compounds that make up clinker. The largest opportunities for cost effectively reducing the emissions from cement manufacturing are associated with this phase of cement manufacturing (Price et al 2009). Emissions can be substantially reduced by lessening the amount of clinker in the final concrete product, either by blending clinker with a greater proportion of other materials to produce blended cement,⁷⁸ or by mixing cement with a greater proportion of alternative binding materials in the production of concrete. Another way to substantially reduce emissions in the kiln process is to replace the coal used to fire the kiln with alternative fuels, such as agricultural waste, non-agricultural waste like sewage sludge and saw dust, petroleum products like tires and waste oil, and hazardous waste (Murray & Price 2008). Third, the efficiency of the kiln can be improved, such as by lining the kiln with better insulating materials to prevent heat loss, improvements to process control systems, and waste heat recovery for power generation (Price et al 2009).

There are also various ways to improve the electrical efficiency in the pre- and post-kiln processes, with the potential for large greenhouse gas reductions since most of China's electricity is produced from coal. These include installing efficient high pressure roller presses, or more efficient roller mills for pre-grinding and grinding raw materials, motor and fan system improvements, more efficient roller mills for coal grinding, and process control systems (Price et al 2009).

Several interventions stand out as having the potential to enable these improvements in Shandong (Price et al 2009).⁷⁹ Capacity building and information are important to raise awareness of the advantages and use of blended cement, the availability of alternative fuels, potential cost savings from efficiency measures, and factory-level energy auditing tools. Analysis is needed on the use of blended cement in climates and construction patterns in China, and on the availability, market potential and impacts of alternative fuels, including biomass and waste-derived fuels, and including regulation requiring the use of those fuels. Financial incentives, along with improving the profitability of a project, can also raise the visibility of cost savings from efficiency measures to plant managers who are often most concerned about other parts of their business, and provide support for efficiency-improvement plans put forward by plant sustainability managers. Cement and concrete from new low carbon and carbon neutral production technologies⁸⁰ could be explored with information exchange and possibly demonstration projects. More research is needed on the specific barriers to cost effective measures.

⁷⁸ Portland cement that is comprised of less than 20% additives other than gypsum made up around 60% of cement produced in China in 2007 (Price L, Hasanbeigi A, Lu H, Ian W. 2009. *Analysis of Energy-Efficiency Opportunities for the Cement Industry in Shandong Province, China*, Lawrence Berkeley National Laboratory, Berkeley). Various materials, such as pozzolans, fly ash from power plants, and blast furnace slag from iron-making facilities, can be blended with clinker to produce various types of blended cement. Blended cement has different properties dependent on the materials used. Blended cement is often just as strong or stronger than Portland cement, but often takes longer to harden once poured.

⁷⁹ Also drawn from the years of experience Lawrence Berkeley National Laboratory has working in China on cement sector efficiency.

⁸⁰ New cement products with substantially lower CO₂ emissions or even negative emissions include CemStar, Energetically Modified Cement (EMC), and Calera.

3. TYPOLOGY OF DESIGN OPTIONS FOR A SECTORAL CREDITING PROGRAM

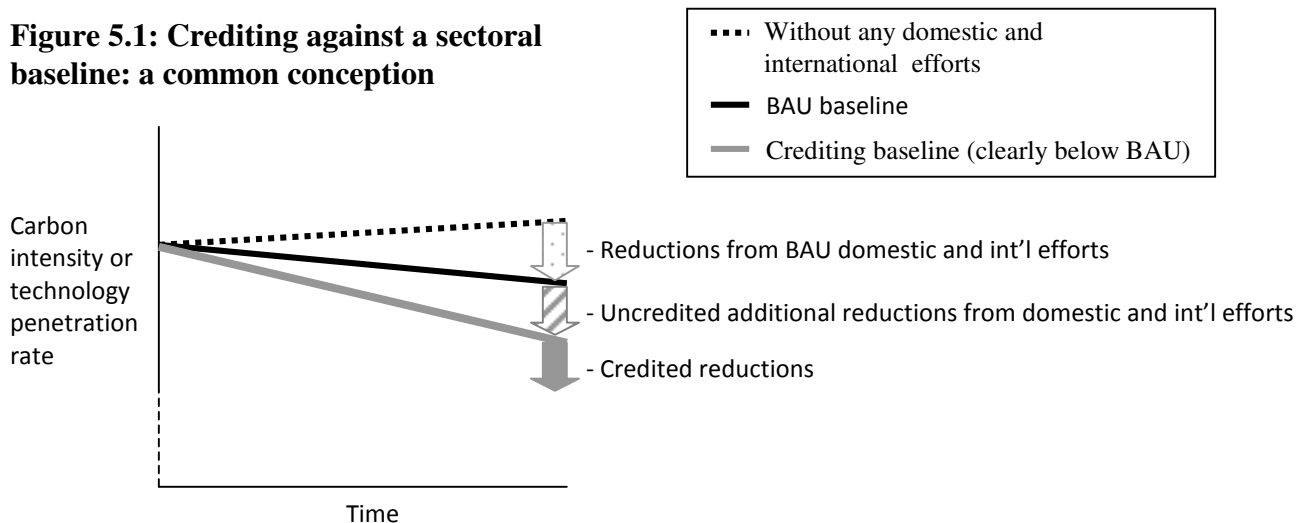
As mentioned above, proposals for sectoral crediting in developing countries largely fall into three categories:

- (i) crediting against a sector-wide baseline
- (ii) reformed CDM using standardized project eligibility criteria
- (iii) credited NAMAs.

One conception of program which credits against a sector-wide baseline (Schmidt et al 2006) has had traction in climate policy circles. Key elements of this proposal form the basis for sectoral crediting programs being proposed for inclusion in California’s cap and trade program (California Air Resources Board 2009), in US federal legislation (American Clean Energy and Security Act 2009) and under a post-2012 international climate change agreement (Belgium and the European Commission on behalf of the European Union and its member States 2010). This proposal establishes a crediting baseline for a participating sector against which emissions are measured. As proposed, this target would be voluntary, or “no lose,” rather than binding, meaning that the country can sell emissions credits if its emissions are below the crediting baseline, but does not have to purchase emissions credits if its emissions are above the target. Targets can be a fixed “absolute” value, such as a total number of tons of CO₂ emissions taken as targets by Annex 1 countries under the Kyoto Protocol, or they can be intensity based, defined as a certain quantity of emissions per some other unit, such as per ton of cement produced or per kilowatt hour of electricity produced. Targets can be in terms of tons of CO₂-equivalent, or technology penetration rates, such as the percentage of cement produced from plants that use waste heat recovery power generation.

In this proposal, a crediting baseline is set against which credits are generated (gray line in Figure 5.1). This crediting baseline is deeper than optimistic business-as-usual (BAU) forecasts for the industry (black line in Figure 5.1) to assure that credits are not generated for activities not resulting from the program. The BAU forecast should take into account BAU domestic and international efforts that are expected without the crediting program (dotted downward arrow). Action, some of which would be supported internationally, would be needed to bring the emissions levels down to the crediting baseline before credits start to be generated (striped downward arrow). All reductions below the crediting baseline are credited (gray downward arrow).

Figure 5.1: Crediting against a sectoral baseline: a common conception



Under this proposal, credits would be generated by the Shandong government, rather than by each individual cement factory. It would be difficult for factories to be directly awarded for making reductions, since the total number of credits generated depends on the actions taken by all emitters in the sector together. The international program would reward the Shandong government periodically for reductions made below the crediting baseline after reductions are made. It would be up to the government to pass those incentives onto the factories making the reductions, which they could do through financial incentives, regulation, informational programs, demonstration projects, etc. The Shandong government could then sell those credits to credit buyers. Procedures for reporting and verifying sectoral emissions inventories and total clinker and cement produced would need to be established.

As a second category of design options, proposals for reforming the CDM expand the mechanism so it has a more sectoral- rather than solely project-based focus. Proposals for replacing project-by-project additionality testing with standardized criteria to determine project eligibility for offsetting have been put forward by governments for use in climate policies on a range of scales (American Clean Energy and Security Act 2009, California Air Resources Board 2009, UNFCCC 2010: 41 para 9). Standardized criteria would identify project types with high likelihoods of being additional based on criteria such as project type, location, size, construction start date, and efficiency level. All projects that meet these criteria are automatically registered under the CDM. Standardized criteria could include, for example, all wind power development in sub-Saharan Africa, or all cement factories in China that exceed some defined efficiency level. Currently CDM methodology AM0070 uses standardized criteria for project eligibility. Under this methodology, all refrigerators manufactured that are within the 20th percentile of efficient refrigerators in the host country are automatically considered additional and eligible to generate credits under the CDM. A reformed CDM would function under the same or similar institutional arrangements as the current CDM. Standardized criteria reduce the transaction costs and uncertainty associated with the CDM application process, making the CDM more predictable and therefore effective at supporting new projects. However, this reform would need to avoid allowing larger numbers of non-additional projects to more easily register and generate credits.

Credited NAMAs would generate credits from reductions resulting from government programs or policies (Republic of Korea 2009a, Republic of Korea 2009b). The proposals for credited NAMAs are very similar to proposals for programmatic- or policy-CDM, which would expand the CDM to cover policies and government programs. In the international climate change negotiations, “NAMAs” is a broad term meaning any activity carried out in a country that reduces emissions. The reductions resulting from these actions could be estimated and credited. Appendix II of the Copenhagen Accord, signed at the 15th Conference of the Parties that took place in December 2009 in Copenhagen, is a list of NAMAs developing countries pledge to carry out.⁸¹ The NAMAs submitted to this list fall into three categories. One category sets targets in terms of absolute emissions, emissions intensity or technology dissemination at the national or sectoral level. A second category names specific investment in projects, such as investment in specific hydropower and energy efficiency projects. A third category of NAMA, that is distinctly different from the types of activities covered under sectoral crediting and from the current CDM, is the crediting of policies or programs. Appendix II contains only broad commitments in this third category, such as supporting energy efficiency and performing analysis of actions that can be taken. For this paper, credited NAMAs refer to specific actions that would fall under the third

⁸¹ Appendix II of the Copenhagen Accord- Nationally appropriate mitigation actions of developing country parties <http://unfccc.int/home/items/5265.php> (Last accessed on November 15, 2010)

category of NAMAs – the crediting of the emissions reduced by specific policies and programs. Credited NAMAs, as defined here, differs from crediting against a sectoral baseline in a key way. Programs that credit against a sectoral baseline start with a crediting baseline, and credit any reductions below that baseline, blind to the means of reducing emissions. Credited NAMAs focus on a specific policy or program and estimate the emissions it reduces.

To examine the advantages and disadvantages of these three categories of sectoral crediting programs (crediting against a sector-wide baseline, reformed CDM using standardized project eligibility criteria, and credited NAMAs) and the variations within them, I identify and discuss four key design decisions. These design decisions capture the most important differences among the range of possible design architectures:

- (1) ***Sector-scale vs. factory-scale crediting***: Will reductions be measured for the entire sector (crediting against a sectoral baseline) or per participating factory (reformed CDM)?
- (2) ***Payment to government vs. to factories***: Will payments for credits be made to the Shandong government (crediting against a sectoral baseline and NAMAs), or directly to participating factories (reformed CDM)?
- (3) ***Full emissions inventories vs. technology/program-based crediting***: Will emissions be measured comprehensively through emissions inventories, or will the program focus on the increased use of a few specific technologies? (Can apply to all three categories of sectoral programs.)
- (4) ***Payment for credits vs. upfront payment for program***: Will payments be made through the purchase of credits, or upfront in the form of capacity building, technology subsidies, etc? Or a combination of the two options? (Can apply to all three categories of sectoral programs.)

The rest of this section discusses the advantages and disadvantages of each of these design options, focusing on how well they avoid the main problems with the CDM using the following criteria and sub-criteria:

- Effectively support emissions reductions
 - Match the support needed to enable cost effective reductions and overcome the barriers to emission reduction activities
 - Provide benefits with minimum uncertainties
- Avoid over-crediting emissions reductions
 - Avoid crediting non-additional reductions (reductions not caused by the program)
 - Avoid perverse incentives to increase emissions
 - Enable actions that effectively reduce emissions, but would not have been pursued without the crediting program (are additional)
- Data availability
 - Require data that are available, reliable and monitorable
 - Minimize transaction costs in data gathering

The design of a sectoral crediting program requires assessments of both the effectiveness of the program in the context of the specific sectors it is applied to, and the ability to measure the program's effects. If we could measure the emissions reduced by the crediting program with a high degree of accuracy, understanding the pathways of that influence would be less important.

Or if we could be confident about the influence the program will have, conservative assumptions could be applied to avoid over crediting. If both emissions reduction estimates and the actual of influence of the program are uncertain, both need to be assessed together.

4. ADVANTAGES AND DISADVANTAGES OF THE DESIGN OPTIONS IN THE CONTEXT OF THE SHANDONG CEMENT SECTOR

4.1. Sector-scale vs. factory-scale crediting

The most significant design decision distinguishing different architectures of a sectoral crediting program is whether that program will measure emissions reduced in the sector as a whole, or only in each participating factory as is done by the current CDM. Sector-scale crediting involves the establishment of a crediting baseline for an entire sector (as illustrated in Figure 5.1 above). Credits are generated only when emissions or technology penetration rates in the sector as a whole are better than the crediting baseline. With factory level crediting, each factory that implements a technology or meets emissions requirements, and that meets the requirements of the program, will be able to generate credits, regardless of actions taken in other factories.

An important distinction between these two approaches is who receives carbon credits through the program and therefore who is responsible for taking action to reduce emissions. Factory level crediting would typically credit each participating factory directly. Crediting against a sectoral baseline requires credits to be generated by the government.

Sector-level crediting has the advantage of measuring emissions more comprehensively. Crediting on a factory-level ignores increases in emissions in non-participating factories. In this way, sector-level crediting avoids “leakage” within the sector. “Leakage” occurs when an increase in efficiency in one factory *causes* a decrease in efficiency in another factory. This is best explained through an example. If one factory increases the proportion of blended cement it produces, but demand for pure Portland cement does not change, another factory may increase its production of Portland cement to meet demand. In total, the amount of blended cement and Portland cement produced may not have changed, though the increase in blended cement in the participating factory could be credited.

The comprehensiveness of sectoral-scale crediting comes with several important trade-offs. A disadvantage of sector-level crediting is the greater uncertainty associated with carbon credit payments. As discussed in previous chapters, the ability of the CDM to influence project development decisions is compromised by the high levels of uncertainty associated with the benefits of the CDM. When crediting is done on a sectoral-level, as opposed to a factory-level, the uncertainties are even greater. Since credits are only generated after the baseline is achieved sector-wide, and since that baseline needs to be below BAU in order to prevent over-crediting, the number of credits that will be generated by the program is uncertain when first efficiency investments are made. The Shandong government must first take action to reduce emissions to the crediting baseline and beyond, and only at the end of the crediting period will know how much they will be paid for their efforts through carbon credits. In contrast, factory-level crediting could generate credits for each participating factory, in predictable amounts, as soon as they reduce emissions according to program requirements.

A second possible disadvantage associated with the comprehensiveness of sector-scale crediting is the greater data requirements. Factory-level crediting is less data intensive since only factories that voluntarily participate in the program need to release data. The data requirements of a sector-level crediting program can be managed, in part, by carefully defining the boundary of the sector. In Shandong, since the majority of cement factories are small inefficient vertical shaft kiln plants that are being phased out, requiring all of these plants to monitor and report emissions is challenging, and should soon be irrelevant. It may make more sense to define the crediting sector as the subset of larger and more modern cement plants for which data collection is more manageable. On the other hand, crediting all cement plants creates incentives to carry out the phase out of the factories that use small inefficient vertical shaft kilns. These data concerns deserve more analysis.

Additionality is a challenge for both sector-scale and factory-scale crediting. Factory-level crediting under a reformed CDM credits actions in all factories that meet the eligibility criteria of the program, regardless of whether the actions are additional for each particular factory. For example, if all cement factories in Shandong that use alternative fuels in their kilns were categorically allowed to generate credits, the program would credit the BAU alternative fuels that would have been used without the crediting program. A deration rate, sometimes referred to as a “discount rate,” which can also be in the form of a conservative baseline, is therefore needed to account for the proportion of BAU activities that would generate credits under a factory-level program. The deration rate discounts the number of credits generated by each participating factory. Determining such a deration rate is arbitrary since it involves estimating the proportion of new projects that will be enabled by the crediting program to BAU project that will be done regardless of carbon crediting long before the total number of projects is known.

The common conception of a program that credits against a sectoral baseline would set a crediting baseline that is clearly below BAU to avoid over-crediting, and would incorporate capacity building and other non-credited activities into the program in order to help bring emissions down to the crediting baseline. Given the uncertainties associated with BAU forecasting, it can be difficult to determine a baseline that is both clearly below BAU and not so low to be irrelevant (Millard-Ball 2010a). If the baseline is set above actual BAU projections, too many credits will be generated. If the baseline is set far below actual BAU, then it will be irrelevant, since the baseline will be hard to meet, and even if it is, the quantity of credits will be low compared to the effort exerted (ibid). The feasibility of setting an appropriate below BAU crediting baseline is a function of the uncertainty in BAU projections and the expected influence of the crediting program. Figures 5.2 and 5.3 describe this visually.

If the uncertainty in the BAU forecast is small compared to the expected effect of the crediting program on emissions, as represented in Figure 5.2, then over-crediting is unlikely or unimportant. In Figure 5.2, the gray area behind the black line shows the uncertainty in the BAU projection, which is small compared to the expected uncredited and credited reductions spurred by the program, represented by the downward arrows. The middle of the three scenarios presents the uncredited and credited reductions if the assumed BAU baseline is correct. The left arrow shows what happens if actual BAU emissions are below the projected BAU baseline, and the right portrays actual BAU emissions as above the forecasted BAU baseline. Assuming the same amount of reductions below BAU for each of the three scenarios, a larger proportion of the reductions are credited if BAU emissions are below the forecasted value (the left arrow) than if the BAU projections were correct. If actual BAU emissions are higher than BAU projections,

more effort is needed to bring emissions down to the crediting baseline and a smaller proportion of reductions are credited (the right arrow). Since the uncertainty in BAU projections is small compared to the effect of the crediting program, the program works for each of these scenarios.

Figure 5.2: Crediting against a sectoral baseline: uncertainty in the baseline is *small* compared to the effect of the program

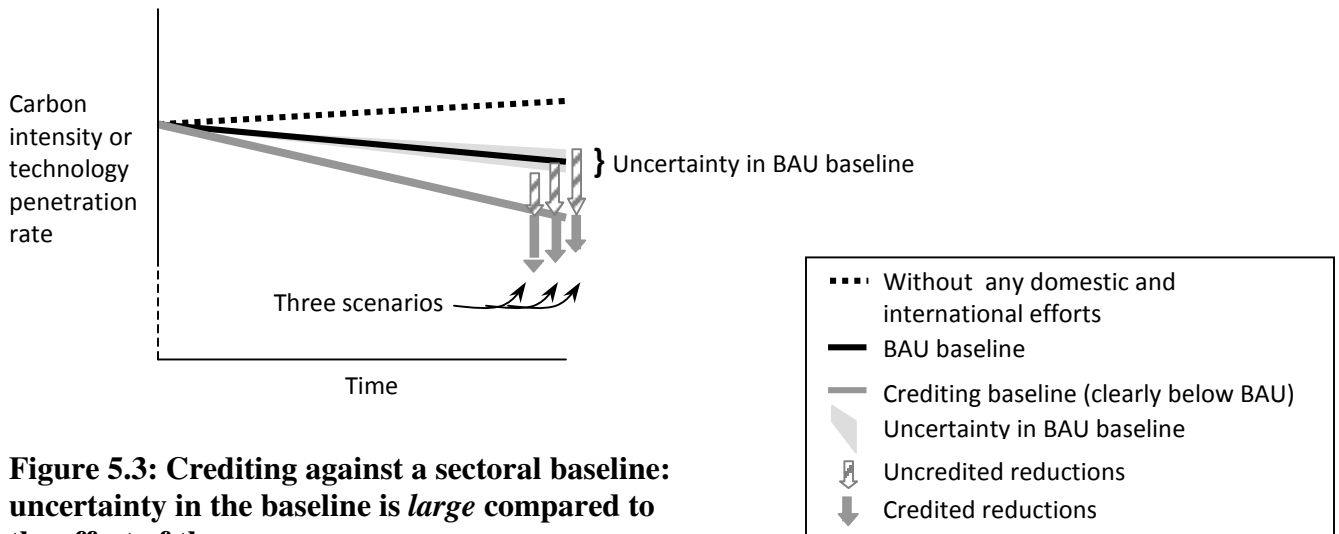
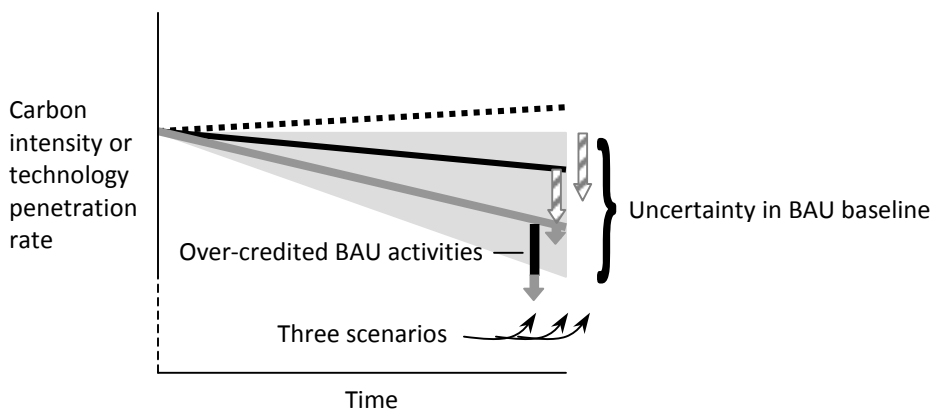


Figure 5.3: Crediting against a sectoral baseline: uncertainty in the baseline is *large* compared to the effect of the program



In Figures 5.2 and 5.3, the three arrows represent three BAU scenarios: a deep BAU scenario, a middle scenario in which the crediting baseline accurately represents BAU emissions, and a high BAU scenario. The total sizes of the arrows are the same representing the same quantity of reductions for each scenario, but each shows a different distribution between credited and uncredited reductions.

If uncertainty in BAU emissions is large compared to the reductions expected from the crediting program, illustrated in Figure 5.3, then the risk of either over-crediting or setting an irrelevant baseline is high. Figure 5.3 shows a larger range of possible BAU scenarios in gray, and a smaller expected effect from the crediting program represented by the shorter downward arrows. Again, if the projected BAU baseline were accurate (the middle scenario) some of the reductions made will be credited and some uncredited. If actual BAU emissions are low and

below the crediting baseline (the leftmost arrow), the program would generate credits from BAU activities. If actual BAU emissions are high, then the crediting part of the program is irrelevant, since much more effort would be needed to bring emissions down to the crediting baseline in order to start generating credits (the rightmost arrow).

Figures 5.2 and 5.3 illustrate the effects of uncertainty in emissions forecasts, but not the uncertainty in the magnitude of the effect of the program (uncertainty in the length of the downward arrows). Since the effect of the program is also uncertain, that uncertainty must also be taken into account in the design of the program. This uncertainty would be incorporated into Figures 2 and 3 as error-bars around the heads of the arrows.

Evaluating a program that credits against a sectoral baseline would require comparing the uncertainty in BAU projections in Shandong's cement sector with the expected effect of the crediting program, taking into account uncertainty in that effect. Emissions or technology forecasting can be based on (i) government targets, planning documents, anticipated policies and expected industrial trends, and/or (ii) extrapolated historical trends. Government targets and plans are not always accurate. The Chinese government sometimes exceeds its sector-scale policy targets and sometimes falls far short of them. For example, in its 11th year plan, the targets set by China's Top-1000 Program and its program to close small inefficient industrial plants in some sectors were met two years early (Levine et al 2010) implying that the emissions reduced by these programs will most likely exceed their targets by 40% or more. China met its goal of commissioning an additional 73 gigawatts of hydropower one year early.⁸² However, programs in other sectors did not meet their goals. For example, a program to close small inefficient electrolytic aluminum production facilities reached only 16% of its 2010 target by 2008, and little progress was made towards targets for energy savings from upgrading existing buildings and heat system reform (Levine et al 2010).

A second possible concern with taking government targets and plans into account in baseline setting is that doing so creates "perverse incentives" for the government to scale back their targets and plans in order to receive credits for the actions it expects to take. Such perverse incentives are not a concern today in China, given its well established planning processes. It could become a concern in the future if revenues earned by a sectoral program once established are large enough. Further, defining the crediting baseline on future projections in one country or province could send a signal to other governments to wait to take action until they can receive credits for those actions.

Basing the crediting baseline on historical trends or other indicators, instead of expected government actions, would avoid creating such perverse incentives. The California Air Resources Board, in designing an international sectoral crediting program, has progressed the furthest in the forestry sector. It has proposed basing the business-as-usual scenario on historical trends in order to prevent perverse incentives (California Air Resources Board 2010a). Historical trends also have not been good predictors of future trends (Schneider & Cames 2009). For example, in China, energy intensity per GDP decreased steeply between 1980 and 2000, increased between 2000 and 2005, and started decreasing again in 2005 in response to Chinese government policy (Levine et al 2009). Historical trends would not have predicted the ups and downs of China's energy intensity over the last three decades.

⁸² Data on Chinese hydropower capacity are from <http://www.cec.org.cn/news/>.

4.2. Payment to government vs. payment to factory

Under the current or reformed CDM, payments for credits are made directly to the participating factories. The credit buyer negotiates a credit purchasing agreement directly with the CDM project developer; the host country government is involved only in providing an approval signature attached to the application for CDM registration. Crediting against a sector-wide baseline and credited NAMAs both require credits to be generated by the government. It is not practical for credits to be generated directly by factories when emissions are measured for the whole sector, since the total quantity of credits generated is a function of the actions taken by all emitters in the sector. Incentives for factories to reduce emissions would be created by policies/programs/regulations/enforcement by the Shandong government.

The effects of directly incentivizing the private sector versus supporting government programs and policies vary sector to sector and country to country. In China, the central and provincial governments have been the main drivers promoting industrial efficiency. Their efforts over the last three decades have led to a dramatic decoupling of GDP growth and energy (Levine et al 2009). The large existing potential for cost effective efficiency improvements implies that further improving their financial outcomes may not do much to overcome their barriers. Financial incentives are only one of several measures understood to support emissions reductions in Shandong's cement sector mentioned above in Section 2. Capacity building and various analyses are also understood to be promising and potentially cost effective avenues towards cement sector efficiency improvements but would not likely happen as a result of directly crediting factories for emissions reductions.

The influence of carbon credits on government action is both weaker and more difficult to verify than on private sector investments. The private sector is primarily motivated by profit generation; improving project profits through the sale of carbon credits can change private sector investment decisions. Chapter 3 above shows that even with a relatively straightforward bottom line, it is extremely difficult for an external auditor to verify the go/no-go influence of carbon credits on individual CDM projects. Project developers can often game the financial assumptions used in CDM registration applications to show that cost effective projects are not cost effective. Additionality testing is even more difficult with public sector actions. While revenues can influence governments, it is often only one influence among a complex set of other factors affecting policy formation and enforcement. Governments often implement policies that are not cost effective in purely monetary terms; and many policies that lead to efficiency improvements and emissions reductions are free or revenue generating for the government.

Revenues from a sectoral trading program could influence the actions of a government if the government wishes to take action that would reduce emissions, but does not do so because of the cost of those actions. The prospects of future revenues can also influence government action to raise revenue for other programs or because of corruption. Also, the increased attention given to efficiency improvements by a concentrated international program could invigorate domestic action and enforcement. But how is it possible for an external agency to understand and verify these effects to assure that the program is having an influence at least as large as the credits it produces?

A sectoral crediting program may be able to support government policies, programs or specific technologies that would not have gone forward or been implemented as quickly without the crediting program. In the Shandong cement sector several efficiency technologies have large efficiency improvement potentials but fairly costly and are not being widely installed, such as

high efficiency roller mills for grinding raw materials (Price et al 2009). Such activities may not be widely used in the near term without financial or other incentives and could potentially be enabled by a crediting program. Second, there is a large potential for reducing emissions with the use of alternative fuels in cement manufacturing, but little progress has been made so far. A focused international support effort starting with an assessment of the availability of alternative fuels in China could spur this technology option forward more quickly than without that support. Third, new low carbon and carbon neutral cement and concrete technologies could have a large potential in China's rapidly growing cement sector; international interest in exploring the use of these technologies in China and support for pilot factories could possibly lead to a much faster adoption of these technologies in China.

The sectoral program could be designed to target these actions with a credited NAMAs program, categorically making projects of these types eligible for CDM credits, or through a program which credits against sectoral technology penetration rates. There are several challenges with each of these approaches. First, the financial benefits from carbon credit sales only directly address the main barrier to the first example above – the higher cost technology improvements. The main impact of the crediting program on the other two examples – alternative fuels and new low-carbon cement technologies – is the initial international support in the form of information, involvement in research, and possibly support for demonstration projects. Second, also focusing on the first option above – the higher cost efficiency improvements – does it make sense to focus a crediting program on more costly technologies that are more likely to be additional rather than first supporting the faster implementation of less expensive options? Third, the national Chinese and Shandong governments are already actively implementing programs to improve the efficiency of cement manufacturing in China, and have been successful in their efforts so far. Those technologies that are candidates for successful near-term implementation might also be pursued by the government without international support. This crediting program would be limited to a few technologies, such as possibly the ones named just above. Inside knowledge of the considerations of the government and grounded knowledge of opportunities in the sector is needed to assess the influence of international involvement. Such inside knowledge would be difficult to require for a broad-reaching international crediting program.

4.3. Full emissions inventories vs. technology/program-based crediting

Full emissions inventories set a crediting baseline in terms of total emissions from the cement sector or individual cement factories. Full emissions inventories are calculated by estimating total fuel, electricity, limestone and other raw materials used in the cement-making process.

Technology- or program-based crediting estimates and credits the emissions reductions resulting from specific technologies or from a specific conservation program. Examples of sector-scale technology penetration rates baselines are: a certain percent of fuel energy in cement kilns from agricultural waste, or a certain percent of raw materials ground with high efficiency roller mills. Emissions reductions are credited for reductions estimated from the use of the technology exceeding the baseline.

Measuring emissions comprehensively with a full emissions inventory has two main advantages. First, everything that a factory does that reduces emissions can be credited under this option. The emissions from a cement plant are not only affected by the technologies installed, but also by how technologies are used and how the plant is maintained. Full emissions

inventories reward the effective use of technologies and efficient plant management practices, not just the implementation of technologies and therefore more accurately measure actual changes in plant emissions. A second advantage is that comprehensive accounting can allow for greater flexibility in how reductions can be achieved, and avoid “choosing winners.” All actions taken by the Shandong government or individual enterprises are counted, rather than only those technologies or actions explicitly included under a technology-based program.

A technology-based approach also has several important advantages. First, it can be easier to monitor whether a technology has been installed and is functioning, than to conduct full emissions inventories of entire cement factories. China policies already involve the monitoring of the use of technologies and so implementing this program will fit easily into monitoring and enforcement mechanisms already being used (Center for Clean Air Policy 2010). Second, a technology-based program could start small, focusing on a few technologies, and then be expanded. This is especially advantageous in China where many policies and programs are started on a trial basis and then expanded. Third, for some technologies, business-as-usual technology penetration forecasts can be more accurately estimated than the emissions trajectory of an entire sector. Emissions intensity in the cement factory can be influenced by a large number of factors making it difficult to set an accurate business-as-usual baseline for the emissions of the entire sector. It may be easier to trace the influence of the support program if it focuses on a few technologies. This is especially true for technologies that are not cost effective on their own, or for focused programs that promote a technology that most likely would not have been pursued by the host country on its own.

Fourth, basing a program on full emissions inventories may possibly involve greater difficulty accounting for leakage, or changes in emissions outside of the sector caused by the program, since the program is blind to the specific activities and technologies used to bring down emissions. For example, if the boundary of the program is defined as the cement industry, promising opportunities for reducing emissions in the lifecycle production of concrete can be overlooked. Blending with alternative materials typically happens either at the cement production stage or at the concrete production stage but not both. So crediting blending at the cement factory can ignore missed opportunities to blend cement with other materials in the production of concrete.

4.4. Payment for credits vs. upfront payment for program

Most proposals for sectoral crediting programs assume that payments will be made in the form of carbon credit purchases, as is done with the CDM. Another option is for the support program to be funded upfront. The funding entity would then receive the number of credits estimated to result from that program after emissions are reduced. This approach decouples the amount of money paid and the number of credits received.

The main difference between these two approaches is who takes the risk that emissions will not be reduced as expected. When payments are made in the form of credit purchases the risk is borne by the government or the participating factories. Action is first taken in China to reduce emissions, and credits are rewarded based on the results of those efforts. The government and factories take the risks that the actions will not be successful, that credit prices will be lower than expected, and possibly that the credits will not be purchased at all. When upfront payments are offered, program risk is taken by the entity offering the upfront payments.

Upfront payments could be considered for two reasons. First, it eliminates the uncertainty associated with the benefits of the crediting program to the factory or the Shandong government. Second, the funder can support emissions reductions through a range of support measures, rather than only through paying for carbon credits. In the Shandong cement sector, a funder could work with the Shandong and Chinese governments on the various capacity building and analysis efforts identified in the background section above. These efforts could be necessary to enable the installation of certain technology, or could be less costly than financial incentives in the form of carbon credit sales, if they address non-financial barriers. A program involving upfront payments can take many forms, including capacity building, upfront subsidies, low interest loans, technical support, etc.

An advantage of paying for carbon credits in proportion to the reductions achieved is providing ongoing incentives based on performance. This avoids the problem, so common with development programs of, for example, solar panels sitting on rooftops not generating electricity (Green 2004), or technologies being installed in cement factories without being used effectively. Payment for credits creates a financial incentive not just to install a technology, but to properly run it and maintain it.

Second, while capacity building, analysis, technological assistance, etc. can all be important efforts to promote conservation in the cement sector, it can be difficult to measure the emissions reductions resulting from such efforts. How do you quantify the emissions resulting from information workshops, for example? More importantly, it can be difficult to determine how much of the reductions made in a sector are a result of the international program, versus a result of domestic efforts taken by the Chinese or Shandong governments and by the factories themselves. If all reductions below a baseline result in credits that are given to the payer of the international program in exchange for their upfront support, too many credits can be granted, and the incentive for domestic action will be lessened since credits for the reductions will go abroad.

This last concern could possibly be overcome if credits are shared between the participating industrialized and developing countries. Another possibility is for some proportion of the expected credit payments to be made upfront to help pay the costs of technology installment as is currently being done with the *Financial Rewards on Energy-Saving Technical Retrofits in China* program through which the Chinese government pays for reductions in primary energy use in participating factories.

5. CONCLUSIONS

This design study of a sectoral crediting program in the Shandong cement sector reveals a number of hurdles to implementing such a program. I discuss in turn the three main categories of sectoral crediting programs – crediting against a sectoral baseline, reformed CDM using standardized eligibility criteria, and credited NAMAs.

Crediting against a sectoral baseline has the challenge of determining a baseline that is both below BAU but also not too low to be irrelevant. BAU projections involve uncertainty that must be compared to the expected effect of the program. Revenues from sectoral-scale crediting are even less certain than from factory-scale crediting such as under the CDM, implying even weaker incentives generated by the program. Crediting against a sectoral baseline requires governments, instead of the private sector, to generate credits. Since governments have a range of motivations for its choice, design and enforcement of policies and programs, revenues have a

weaker effect on decision-making and it is more difficult for an external program regulator or auditor to verify these effects.

Reformed CDM using standardized project eligibility criteria reduces two important hindrances to the effectiveness of the CDM: the uncertainty associated with the CDM's benefits, and the transaction costs associated with project registration. As a result, the support provided by a reformed CDM should better incentivize activities that reduce emissions. One important challenge to this approach is that unless project types and criteria are carefully chosen, this CDM reform could allow even larger numbers of non-additional projects to register and generate credits. Determining a deration rate to apply to credits generated under a factory-based program is just another version of the puzzle of determining an accurate sectoral baseline; the uncertainties are similar. Political will is needed to implement conservative deration rates, and to restrict a reformed CDM to project types that have a high likelihood of being additional and of being enabled by the revenues from the crediting program. A second weakness of this approach is that improving the financial viability of a technology that lowers emissions may not directly or cost effectively address the barriers to that technology. Possibly addressing non-financial barriers to technology improvements directly, such as through information, analytic tools or access to financing, can be more effective and less costly than the effects of directly crediting cement factories. This is evidenced by the substantial potential to reduce emissions in the Shandong cement sector with technologies that are already cost effective.

NAMAs, since they also credit government actions, have many of the same challenges as crediting against a sectoral baseline. Additionality is even more difficult to assess than individual projects under the CDM, and for many types of NAMAs, such as capacity building and information dissemination, emissions reductions are more difficult to estimate.

A hurdle that applies to any program targeting one or several specific technologies, in any of the three categories, is that those technologies that are most likely to be effective under a sectoral crediting program are also most likely to go forward without that program. A challenge of sectoral crediting targeting specific technologies is identifying those technologies that are both likely to be effective under the program but also not likely to have been pursued on their own.

Two architectures for a sectoral crediting program might effectively support emissions reductions in the Shandong cement sector while avoiding the over-crediting of emissions reductions if designed carefully. First, is a sectoral crediting program with crediting baselines that are clearly below BAU and which involves international support in collaboration with domestic efforts to bring emissions in Shandong's cement sector down to the crediting baseline. This international support, which could be in the form of trainings, provision of factory-level analytical tools, analytical support regarding the use of blended cement and alternative fuels, financing, and other efforts listed in the background section above, is important for assuring the crediting program will result in reductions at least as large as credits generated. Even though the effects of credit generation on government action are questionable and difficult to assess, and the baseline is uncertain, the concentrated pre-crediting support effort has the potential to make substantial improvements and is the central pillar of such a program.

A second potential program would focus on a few technologies with potentials for significant emissions reductions, but which most likely would not have been pursued in the near term without focused international support. This program could be structured like a reformed CDM or could credit against a technology penetration rate. Example technologies could be alternative fuels or new low-carbon or carbon neutral cement or concrete technologies. A potential challenge to this approach in Shandong is that those technologies that have a large

potential for efficiency improvements and of being successfully implemented, such as the two named, may be implemented on their own without the international program but at a slower pace. It is difficult to assess how much slower it would have been pursued in a counterfactual scenario. This approach may be difficult to adopt as a global program used in many countries and sectors, since identifying technologies that are appropriate for this approach requires grounded knowledge of the sector and of the considerations of the host country government.

I offer these two options for further study with caution. The political will is needed for them to be enacted narrowly enough and conservatively enough to avoid over-crediting. Both developing and industrialized countries have financial incentives to exaggerate the number of carbon credits from a sectoral crediting program. Industrialized countries are seeking sources of relatively inexpensive offset credits to lessen the cost of meeting their emissions targets and are receiving pressure from domestic industries to enable this. Developing countries wish to receive as many credits as possible for the actions they take.

An underlying conclusion of this study is that sectoral offsetting programs must be designed based on grounded understanding of the sector in which it is being implemented, with careful analysis of the influence a crediting program can have, and the accuracy of setting a baseline. In designing a sectoral crediting program, it is important to assess both the ability to avoid over-crediting reductions by the program, and the effectiveness of the program at reducing emissions. It is worth examining the potential for bi-lateral approaches to program development, since bi-lateral cooperation could be based and built on the understanding, relationships and trust over time that is needed for such a program to be successful. The ability to design sectoral crediting programs that are both effective at reducing emissions and avoid generating spurious credits is not yet assured.

The analysis for this chapter was performed in collaboration with researchers at the Lawrence Berkeley National Laboratory China Energy Group: Lynn Price, Stephanie Ohshita, Nan Zhou, Ali Hasanbeigi and Hongyou Lu. The opinions expressed in this chapter are my own.

Chapter 6. Conclusion

Pressure to continue and expand international offsetting

Industries in industrialized countries are putting pressure on their governments to provide options for controlling costs of compliance with GHG emissions limits. An effective offsetting program has several strong appeals. Offsetting, in principle, allows entities with emission reduction obligations to find the cheapest options globally for reducing emissions, lowering the cost of meeting those obligations, and improving the efficiency of the whole regulatory system. By putting a price on carbon emissions reductions, offsetting creates incentives for those actors who have the most grounded knowledge of emissions reduction opportunities to reduce emissions. A reformed CDM also takes advantage of existing institutions. The CDM was promoted with numerous trainings, workshops and promises, and has attracted new players and new interest into the clean energy, energy efficiency and other low-emitting industries in India and elsewhere. Researchers and policy-makers have sought ways to reform the CDM to retain these benefits while improving its environmental integrity. In this dissertation, I examine the functioning and outcomes of the current CDM, and prospects for improving those outcomes through more rigorous additionality testing and reforming or replacing the CDM with sector-scale crediting approaches.

The CDM in practice

This study on how the CDM is working in practice in the Indian power sector reveals that large numbers of projects have been able to register using poor quality arguments to demonstrate additionality. Uncertainties associated with CDM registration and CER value reduce the useful value to developers of the funds passed through the CDM by more than half, and by much more to risk averse decision-makers such as lenders. In India, home of almost a quarter of all CDM projects, there is widespread opinion among those working with the CDM that the CDM is having little influence on project development and that many non-additional projects are registering under the CDM.

There are several limitations to improving the environmental integrity of the CDM as a project-based offsetting program. First, the “investment analysis,” used to show that a proposed CDM project is not financially viability with an estimate of the project’s expected financial return, is considered the most reliable method for proving the additionality of a project. But choices of assumptions used in a financial assessment have at least as large an effect on the financial return of CO₂ reduction CDM projects as the effect of CERs for most projects. This allows financial assessment inputs to be chosen strategically to demonstrate that cost effective projects are not cost effective. The investment analysis is not accurate even for a best case technology – wind energy in India – for which almost all costs and revenues are documented in official contracts prior to the start of construction. The investment analysis is even more gameable for other project types.

Second, an issue widely discussed in the literature is that the CDM creates “perverse incentives” for governments to refrain from implementing policy, and for companies to increase emissions, in order to enable the generation of more credits under the CDM. Another form of perverse incentives is that crediting emissions *reductions* rather than taxing emissions can improve the profitability of high emitting and harmful projects whenever CERs generate profits rather than simply covering the costs of the abatement technology. Examples include increasing the profitability of the production of HCFCs and electricity from coal-fired power plants. Testing

additionality would become more accurate if CER prices were to increase substantially, making the influence of CERs on project financial return estimates large enough to overwhelm the effect of the choice of project cost and revenue assumptions. Currently, additionality testing is much more accurate for the more potent greenhouse gases, both because of the larger financial effect of CERs, and because for some projects CER generation is the only benefit from the project activity. However, in these cases, because of the greater financial benefit from the CDM, perverse incentives are also larger, as we have seen with the HFC example.

Third, project-based offsetting must choose between two sub-optimal strategies. It can credit only projects that would not have otherwise been built for the full crediting period, causing for example, less attractive wind power sites to be built before more attractive wind sites. Or it can credit wind projects even if they would likely have been built within the crediting period of the offset project, over-crediting reductions from the project. Neither are good options.

Lastly, even if we had perfect knowledge of future emissions, offsetting at a large scale as are currently being proposed in both US and EU, while lowering the cost of mitigation today, in a number of ways, risks make future global cooperation more difficult, especially considering the very weak post-2012 targets being proposed by industrialized countries.

Just as it is difficult for a CDM validator to assess if a proposed CDM project is additional, so too is it difficult for a researcher to estimate the percentage of CDM projects that are additional. Together, these findings indicate a high likelihood that the majority of CDM projects, and a large majority of CO₂ reduction projects registered under the CDM, is non-additional.

Is there a place for offsetting in our international climate change regime?

This study on the CDM suggests that any new or continuing offsetting program should: (i) employ an alternative approach to project-by-project additionality testing that would conservatively prevent the over-crediting of emissions reductions by the program, (ii) involve minimal risk for project developers targeted by the program, (iii) be designed to avoid creating perverse incentives, and (iv) be designed to match the support needs in the specific sectors and countries in which it is being implemented.

A range of approaches for the sector-scale crediting of emissions reductions in developing countries has been proposed as a partial replacement for the CDM. These approaches fall broadly into three categories: crediting against a sectoral baseline, a reformed CDM using standardized eligibility criteria instead of project-by-project additionality testing, and credited NAMAs.

Crediting against a sectoral baseline has several challenges. A crediting baseline needs to be determined that is clearly below business-as-usual emissions to avoid over-crediting, while not being too low to be irrelevant. Business-as-usual emissions and emissions intensity projections involve uncertainty, especially in growing sectors. The magnitude of these uncertainties must be compared to the expected effect of the crediting program. If the magnitude of the uncertainties is clearly less than the effect the program will have, then it is possible to set a crediting baseline that avoids over-crediting and is still relevant. If the uncertainties are large, a deep crediting baseline is needed with substantial uncredited support to bring emissions to the crediting baseline. Regarding the effectiveness of the program, revenues from sectoral-scale crediting are even less certain than from factory-scale crediting, such as under the CDM, implying even weaker incentives generated by the program. This is because investments must first be made to bring emissions down to the crediting baseline before credits start to be

generated, and actions taken by all emitters in the sector affect the total amount of credits generated by the program. Further, crediting against a sectoral baseline requires governments, instead of the private sector, to generate credits. Since governments have a range of motivations for its choice, design and enforcement of policies and programs, revenues have a weaker effect on decision-making and it is more difficult for an external program regulator or auditor to verify these effects.

A reformed CDM using standardized project eligibility criteria, would lessen the uncertainties, as well as the cost and time, associated with the CDM application process, and therefore should be more effective than the CDM at enabling new project development. However, this approach risks allowing larger numbers of non-additional projects to also more easily register under the CDM. Project types would have to be carefully chosen that have a high likelihood of being additional and of being enabled by the revenues from the crediting program.

NAMAs, since they also credit government action, have many of the same challenges as crediting against a sectoral baseline. Additionality is even more difficult to assess than individual projects under the CDM, and for many types of NAMAs, such as capacity building and information dissemination, emissions reductions are more difficult to estimate.

The design of a sectoral crediting program requires assessing both the effectiveness of the program in the context of the specific sectors it is applied to, and the ability to measure the program's effects. If we could measure the emissions reduced by the crediting program with a high degree of accuracy, understanding the pathways of that influence would be less important. Or if we could be confident about the influence the program will have, conservative assumptions could be applied to avoid over crediting. If both emissions reduction estimates and the actual of influence of the program are uncertain, both need to be assessed together.

In the context of the Shandong cement sector, two architectures for a sectoral crediting program stand out as having the potential to effectively support emissions reductions while avoiding the over-crediting if designed carefully. First, is a sectoral crediting program with a deep below-BAU crediting baseline, involving international support in collaboration with domestic efforts to bring emissions down to the crediting baseline. This international support, which could be in the form of trainings, provision of factory-level analytical tools, analytical support, financing, etc, is important for assuring the crediting program will result in reductions at least as large as credits generated. Even though the effects of credit generation on government action are questionable and difficult to assess, the concentrated pre-crediting support program has the potential to make substantial improvements and is the central pillar of such a program.

A second potential program would focus on a few technologies with potentials for significant emissions reductions, but which most likely would not have been pursued in the near term without focused international support. A potential challenge to this approach is identifying those technologies that have a large potential for efficiency improvements and of being successfully implemented but also have a high likelihood of not moving forward without international support. Such an assessment requires grounded knowledge of the sector and of the considerations of the host country government, difficult to carry forward under a global program in many countries and sectors.

The CDM is governed in a passive manner since the CDM governance bodies simply respond to proposals of eligible project types (methodologies) and projects submitted to them. I have argued above that it is not possible to evaluate the additionality of most CDM projects. Evaluating methodologies also involves a high level of grounded analysis. Approaches, such as the two proposed above, can be actively developed based on grounded understanding of the

sectors in which they are being implemented to be likely to be effective at incentivizing new reductions and to avoid over-crediting (what Sterk 2008 calls a "top-down" approach). A bilateral approach to designing and implementing such programs might foster the relationships, understanding and trust needed to carry out an offsetting program that is effective and has environmental integrity.

These proposals require the political will to be carried out in a way that is narrow enough and conservative enough to avoid over-crediting. One sentence from an interim negotiating text from the climate change negotiations in December 2009 in Copenhagen is informative. The negotiating text, titled *Further guidance relating to the clean development mechanism* looked like this on December 10:

“*Decides to extend the abolishment of the payment of the registration fee and share of proceeds at issuance to clean development mechanism projects hosted in small island developing states.*”

And a few days later looked like this (not exact quote):

“*Decides to extend the abolishment of the payment of the registration fee and share of proceeds at issuance to clean development mechanism projects hosted in small island developing states, least developed countries, and countries in Africa, Latin America, southeast Asia, south Asia and central Europe.*”

Will a committee set up to develop targeted offsetting programs, or determine which project types in which locations are eligible, be buffered from political pressure imposed by countries to include those projects they are currently building? And then will this committee be able to take technologies off of the list as the likelihood of their additionality is periodically reassessed?

A regulatory challenge posed by offsetting is that both the buyers and the sellers gain financially from a lenient offsetting program. Industrialized countries are seeking sources of relatively inexpensive offset credits to lessen the cost of meeting their emissions targets. Developing countries wish to receive as many credits as possible for the actions they take. This confluence of interests is directly at odds with the environmental integrity of the system.

Implications for carbon trading generally

Two similarities between California’s Low Carbon Fuel Standard (LCFS) and the CDM suggest that some of the hurdles to an effective offsetting program should also be considered when designing any carbon trading program. My familiarity with the LCFS comes from being involved in an initial design analysis of the program (Farrell et al 2007a, Farrell et al 2007b). The LCFS⁸³ was enacted under California’s Global Warming Law, AB32, requiring a reduction in the carbon intensity of California’s vehicle fuels by at least 10% by 2020. The LCFS allows for carbon credits to be traded among the fuel producers and importers regulated under the program.

The first similarity between the LCFS and CDM that I would like to highlight is that uncertainties in measure emissions reductions undermine the effectiveness of both programs. If uncertainties in emissions measurements from an activity are larger than the differences in emissions between that activity and its alternatives, then the program could send a market signal in the wrong direction, increasing emissions. Under the LCFS, uncertainties in measuring lifecycle emissions from biofuels, especially emissions from changes in land use, make it unclear whether biofuels increase or decrease emissions compared to gasoline (Plevin et al 2010). If the

⁸³ See <http://www.arb.ca.gov/fuels/lcfs/lcfs.htm> (Last accessed on 16 December 2010)

program uses the best estimates of lifecycle emissions from biofuels, which are lower than the emissions from gasoline, promoting biofuels under the program could lead to an increase in emission if those estimates are incorrect. If this were the case, the LCFS would put us years behind in our efforts to reduce transportation emissions, while creating a new set of interest groups, supportive industries, infrastructure, and changes in land use that can lock in biofuels production in place of activities that have more certain emissions benefits.

Second, like with the CDM and sectoral trading, the outcomes of the LCFS are affected by the structure of the sector in which it is implemented and the specific opportunities for reducing emissions in it. The LCFS is basically a biofuels policy. The current vehicle fuel producers and importers – oil refineries, and gasoline and diesel blenders and importers – constitute the majority of those regulated under the policy, and therefore are the decision makers regarding the means for complying with the regulation. These companies are not only interested in the least expensive ways to comply with GHG regulation, but they are also interested in maintaining market share. They prefer meeting the regulation with biofuels rather than other transportation fuels like electricity, since biofuels are mixed with gasoline and diesel. Instead of seeking solutions that may be most efficient for California in the long run, taking into account a range of social factors, regulated companies will choose solutions that are in their own best interest.

Simply creating a price signal is not always sufficient or productive. A carbon price functions within the limitations of our regulatory institutions, uncertainties in emissions measurements, and the context of the specific barriers to and opportunities for reducing emissions in specific sectors in specific regions. Careful analysis of this context is needed in the design of carbon trading programs and any climate policy. Program designers need to examine the specific opportunities for reducing emissions in particular sectors and how the incentives created by the carbon trading program match those opportunities compared to other policy options.

Last thoughts

The CDM creates a market for emissions permits, not emissions reductions, since it is the permits to emit that are the interest to the credit purchasers. Since typical buyers and sellers of CDM credits are not primarily concerned about the quality of the credit in terms of emissions reductions, the main actor ensuring the quality of the credits is the program regulator. Offsetting is particularly difficult to regulate because it involves measuring emissions against an inherently uncertain counterfactual scenario. Even with the best of intentions and political will, it is very difficult to design an effective offsetting program, particularly because it is difficult to assess the influence the program is having, compared to what would have happened without it.

The most certain way for industrialized countries to reduce emissions is to reduce their own emissions. Developing countries will take calls for global action to control greenhouse gas emissions more seriously if they see that industrialized countries are serious about reducing their own emissions rather than buying possibly spurious credits from abroad. More attention and research should be placed on other means to contain costs, such as a safety valve, that could possibly fund activities that aid global efforts to reducing emissions.

Before establishing an offsetting program, or a carbon trading program of any kind, confidence is needed that the program is regulatable and does the job needed, not based on theory, but on grounded cautious analysis. The analysis contained herein, grounded in the Indian power sector, with analysis in the Chinese cement sector, shows that offsetting is inherently

difficult to regulate, adds uncertainty to the emissions outcomes from a cap and trade program, and unless very carefully and conservatively designed, undermines the strength of a cap and trade program.

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