PRICES VERSUS QUANTITIES AND THE CDM
REFORMING THE CDM TO ACCOMMODATE BOTH

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for

Working Paper
December 2009
Not For Citation – But Comments Welcome

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1 Introduction

The Bali Action Plan, the main outcome of the 2007 UN Climate Change Conference, has launched an urgent two-year "comprehensive process" to reach an agreement on an international regime to replace the Kyoto Protocol (UNDP, 2008) . While it is highly unlikely that agreement will be reached in time for the Copenhagen UN Climate Change Conference, it is clear that any future agreement will require a huge effort. The IPCC has estimated that the industrialized world will need to reduce emissions by 25%-40% in 2020 and by 80%-90% in 2050 (relative to 1990 levels) in order to avoid the worst of climate change (Gupta et al., 2007: 776). The costs of mitigation will be substantial, but there is an emerging consensus that as more actors are involved in mitigation, costs come down significantly. For example, recent economic modeling has indicated that the price of carbon needed to drive emission reductions drops dramatically as more countries are included in an agreement—particularly when developing countries are included (Climate Group, 2009; also see Nordhaus, 2007: 33).[1] The big question is, what is the appropriate institutional arrangement to achieve these cost savings?

The 1997 Kyoto Protocol's answer was a carbon market comprised of cap-and-trade system amongst industrialized countries as well as a carbon offsets system known as the Clean Development Mechanism (CDM) which would allow cheaper carbon credits in the developing world to enter the system. By the end of 2012, the CDM is expected to represent nearly 2,800 million tonnes CO_2e of emission reductions from the more than 4,734 projects in the pipeline.[2] If the CDM credits are genuine, "then the CDM would be the largest source of GHG reductions produced by the Kyoto Protocol" (Wara and Victor, 2008: 8).

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[1] The effective price of carbon falls from $65/tCO2 for the EU alone or $45/tCO2 for the US alone to about $8/tCO2 for a global agreement where emissions for Annex 1 countries are 30% below 1990 levels and non-Annex 1 countries are limited to 2010 emission levels (Climate Group, 2009)

[2] As of October 2009, the CDM was associated with 2,797 megatonnes CO_2e (2012 vintage) resulting from 4734 projects; JI is associated with 354 megatonnes CO_2e resulting from 243 projects. See "CDM Pipeline spreadsheet" and "JI Pipeline spreadsheet" at UNEP Risoe Centre (2009c). Mention should also be made of the Kyoto's offset system designed specifically for industrialized countries, known as Joint Implementation (JI), but the rules for JI have largely been copied from the CDM, which itself represents eight times as many carbon credits as JI.

How much an impact might the CDM have? Uncertainties about future emissions in industrialized countries and the extent of reductions achieved through the CDM projects make this assessment difficult. But if we estimate the impact of expected carbon credits in the CDM pipeline on a projection of Kyoto parties' emissions, total emissions of industrialized countries (excluding the USA) would be reduced by approximately 8% below their 1990 baseline levels by 2012—well below their 5% Kyoto targets (Figure 1).[3] The magnitude of the anticipated mitigation of the CDM is not trivial. And given lack of progress on other fronts, the CDM may be the only aspect of the Kyoto Protocol working.

However, there are increasing criticisms that the CDM and similar carbon offset systems are not working (Lohmann, 2006; Wara, 2008; Wara and Victor, 2008). While there are concerns about the contribution of the CDM to sustainable development (Olsen, 2007), the main concern with CDM projects is that the credits created do not represent real emission reductions. In other words, CDM credits are not fungible with domestic emission reductions at source. Key to this is an understanding of the CDM project cycle and the "additionality" criterion. Additionality is a technical term: carbon offset projects are only to be credited if they would be "additional" to what would otherwise have occurred. Where the additionality claim is not met, then a project has gone ahead without the help of the CDM, resulting in the creation of bogus credits. Reform of the CDM is high on the agenda for the upcoming negotiations in Copenhagen (Olsen and Fenhann, 2008).

Some of the most trenchant criticisms of the CDM come from what will be called here Kyoto sceptics who tie their criticisms of the CDM into a larger critique of the Kyoto Protocol's cap-and-trade system. While firm believers in the need for action on climate change, Kyoto sceptics argue that climate change is too complex a problem—a "wicked" problem in the terminology of Prins & Rayner (2007b: 13-14)—to be solved through Kyoto's strict, comprehensive regulatory process steeped in targets and timetables. The uncertainty surrounding the costs of mitigation strategies required for emission reduction targets necessitates emissions trading as a price control

[3] The USA is left out of this projection because, while it would significantly increase emissions amongst industrialized Kyoto countries, it is reasonable to assume that if the USA had ratified Kyoto it would have been a major purchaser of CDM credits and the CDM market would have been larger.

mechanism: "Emission targets beget trading" (Victor, 2001: 11). Noting criticisms of the CDM and its inadequacies as a price control instrument for mitigation, Prins and Rayner (2007a) go so far as to argue that it's time to "ditch" the Kyoto Protocol altogether and start anew.

An alternative to the current climate change regime is a global harmonized carbon tax which, while not guaranteeing a specific amount of emission reductions, removes some uncertainty surrounding the price of carbon that beguiles current policy under Kyoto's cap-and-trade system (Nordhaus, 2007). As for radical changes to avert dangerous climate change, governments should initiate a complete transformation of energy infrastructure through vast leaps forward in R&D into new technologies (Prins and Rayner, 2007b; Simpson *et al.*, 2007; Victor, 2001) while also preparing for geoengineering (Victor *et al.*, 2009). Finally, problems of adaptation and sustainable development in the least developed countries should be addressed through vast increases in public funds, such as official development assistance (ODA) or a climate change fund (Prins and Rayner, 2007b: 35-37; Wara, 2008: 1801).

The problem with Kyoto Protocol then is not politics. Rather, it's that we've selected the wrong *policy* (Victor, 2001: 109): "…the failure [of the Kyoto Protocol is] due, in large part, to the mechanisms chosen. The problems with Kyoto are not merely a matter of mustering the 'political will' to swallow a bitter pill. Rather, Kyoto's troubles originate with its architecture." It is a policy that imposes a quota-based system—"cap-and-trade"—for a complex system which is better addressed through a more administratively efficiency price-based regulatory mechanism such as a carbon tax or subsidy. At the same time, the solution for the quota-based system—the CDM—is plagued with irreconcilable administrative difficulties.

But is the CDM really failing? If it is, is it capable of being reformed? Because so many of the criticisms of the CDM focus in on its perceived dependence on the quota-based system of the Kyoto protocol, we ask here if the only carbon regulatory strategy amenable to the CDM is the quota-based system. Accordingly, this paper considers the performance of the CDM on biocarbon[4] policy in countries at different stages of development—Tanzania, Uganda and Moldova—drawing on extensive field visits and interviews in the four case-study countries over the course of 2009. It will be my argument that both price- and quota-based carbon regulatory strategies are possible under a reformed CDM, though which is the best approach may depend on a developing country's political and socio-economic situation. For common pool resources that suffer from a lack of clear price signal, such as is often the case for biocarbon, carbon finance might be better directed through a quota-based strategy. However, there are some surprising strategies for invoking price strategy to deliver on carbon credits while maintaining an open access system.

2 Prices versus Quantities

2.1 Contrasting Theories of Carbon Regulation

2.1.1 Symmetry of Prices and Quantities

There are basically two means of regulating emissions: setting emission quotas or putting a price on carbon (Hepburn, 2006; Nordhaus, 2007; Weitzman, 1974). If regulators were to have perfect information, the performance of prices and quantities as regulatory policies for climate change would be the same because there is a inherent price-quantity symmetry: a price is always associated with an associated quantity and vice versa. "Under idealized conditions, if the regulated quantity is allocated and then licences are traded the resulting price will equal the optimum price instrument" (Hepburn, 2006: 229).

As is usually the case in economics, these "idealized conditions" are perfect information, zero transaction costs, and competitive markets. Under such conditions "there is no principle informational difference between iteratively finding an optimum by having the centre name prices while the firms respond with quantities, or by having the centre assign quantities with the

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[4] The term "biocarbon" is defined as the broad sector that includes renewable energy derived from biomass and organic wastes as well as the carbon sinks (trees, vegetation, soil and peat) found in agricultural, forest and other terrestrial ecosystems (Purdon, 2009a: 2).

firm reveals costs or marginal costs" (Weitzman, 1974: 478). This is because "in principle exactly the *same* information is needed to correctly specify either." (Ibid.).

But no policy-maker possesses perfect information. And politics won't be kind to a policy maker who, realizing the price/quota combination aren't correct the first time, seeks another "iteration". This is all the more important in climate change policy because of the sheer magnitude of the uncertainties in costs and benefits, particularly when considering the possibility of catastrophic climate change (Weitzman, 2009). And this is exactly the point. Figure 2 shows that a price and quantity mechanism respond differently to uncertainties surrounding movement in the marginal costs of climate change policy, depending on the rate of change (the slope) of marginal benefits. We break down Figure 2 in what follows.

2.1.2 **Performance of Different Mechanisms Under Uncertainty**

Under perfect information, where the marginal cost and benefit curves are known, a carbon tax rate (P_{tax}) would correspond perfectly to an emissions limit set to $Q_{quantity}$. This is because P_{Tax} would equal $P_{quantity}$—they're completely symmetrical. Under these conditions, either a price or a quantity mechanism is set to reach the equilibrium point where marginal benefits meet (expected) marginal costs. But the marginal costs are quite uncertain and, in this particular case, the *actual* marginal costs are greater than what was expected. If we had implemented a quantity-based policy that sets emission quotas at $P_{quantity}$, our example shows that this would over-shoot the actual equilibrium quantity (Q*) and actually correspond to a much higher price ($P_{quantity}$). If we had maintained our carbon tax rate (P_{tax}) however, the actual quantity of emissions reduced (P_{tax}) would have fallen below equilibrium, Q*. Either way, there are inefficiencies associated with a price or quantity approach when the marginal costs change. The question is, which is more efficient?

As it turn outs, the efficiency of a particular mechanism depends not on the marginal cost curve but on the slope of the marginal benefit (MB) curve. A relatively flat MB curve sees efficiency loss associated with the price mechanism (deadweight loss - E_P (green)) to be less than the efficiency loss of the quantity-based mechanism (deadweight loss - E_Q (orange)). But as the drop in marginal benefits accelerates—when the MB curve is steeper—quantity-based mechanisms are more efficient than prices. Hepburn uses the analogy of medical treatment to convey the significance of the MB curve. If a medical condition is such that a patient's health deteriorates only slowly, care should be managed such that each day the patient remains without treatment, the hospital should pay a fine. Ostensibly the patient could remain untreated for a very long period of time, with the hospital absorbing the fines (and presumably dealing with higher priority patients). However, if the medical condition is serious and prone to deteriorate rapidly—such that we know that the patient only has *d* days left to live if not treatment is given—then the hospital only has *d* days to administer the treatment or the patient dies, with a strict penalty attached to such failure (Hepburn, 2006: 231).

So what is the actual slope of the MB curve for climate change mitigation? Here's where climate change science becomes important. It is generally understood that climate change is due to the concentration—or stock—of GHGs in the atmosphere, which does not change rapidly as a function of additional emissions. Costs, on the other hand, are related to the flow of emissions. Nordhaus concludes from this that "This implies that the marginal costs of emissions reductions are highly sensitive to the level of reduction, the marginal benefits of emissions reductions are close to independent of the current level of emissions reductions" (Nordhaus, 2007: 37). In other words, unless we're near a tipping point, the marginal benefits of climate change mitigation won't manifest themselves as quickly as costs will. However if the concentration of GHGs in the atmosphere is such that we're near a tipping point—where even a relatively small additional amount of emissions could be decisive—setting an absolute limit on emissions to avoid such an event would be necessary.

A metaphor might help. Think of a big dump truck, nearly full of coal shovelled in, shovel-by-shovel. Each additional shovel of coal does little to change the full weight of the vehicle. Too much coal though and the truck will break down under the weight. But because of a union agreement we need to keep the workers busy, so the shovelling must go on. But the coal bosses want the dump as full as possible, so they don't want us significantly undershooting the amount of coal the truck can hold. To prevent the truck from breaking down too soon, we can attenuate the impact of their labour by using smaller and smaller shovels (i.e., a pricing strategy). Perhaps this will let us determine exactly how much coal the truck can hold. And the smaller-shovel strategy works unless, of course, it's the shovel-full that breaks the dump truck's proverbial back. If we know when the truck's break-point is within reach, we should put an absolute limit on the amount of coal that could be put in the truck. But the uncertainties are significant.

This basic insight has led a number of economists to claim that a price-mechanism is the appropriate approach to deal with uncertainty in the costs of climate change. As long as a climate change tipping point is not imminent, then a price mechanism such as a carbon tax is preferable. And there are a number of other reasons to prefer a price mechanism including simpler administration (and therefore reduced transaction costs and opportunities for "gaming") as well as reduced price volatility, which makes it easier for planning (Nordhaus, 2007). So what does this mean for the CDM?

3 CDM and the Quota-Based System

Despite the advantages, a price-based approach was not adopted in Kyoto, largely for political reasons (see Victor, 2001). As a consequence, the CDM has been designed with the intention of generating units representing emissions reductions to be purchased for use in the Kyoto cap-and-trade system. These units are known as certified emissions reductions (CERs), each which represents one tonne of CO2 equivalent (tCO2e)—the CDM is thus predisposed to the quota-based system. The question is, is it possible to include price-based approaches in CDM? If so, how? In what follows we quickly review the CDM, highlighting problems with transaction costs, additionality and administrative bottle-necks as well as price volatility in order to ascertain at which points might it be possible to reap benefits from a price-based approach.

3.1 Criticisms of the Clean Development Mechanism (CDM)

3.1.1 Transaction Costs in the CDM

One of the first observations about the CDM is that it is a highly complex mechanism. A (simplified) version of the CDM project cycle identifies nine steps, each of which includes a number of exchanges with government and third-party regulators (Figure 3). The complicated project cycle for the CDM has made transaction costs a real issue. Total transactions costs have been estimated to lie in the range of US$48,000 to $212,000 for large-scale projects (Table 1).

One of the early observations of the CDM was that the high transaction costs involved in CDM project administration would favour large-scale projects (Michaelowa and Jotzo, 2005).

There have been two main approaches to reducing the transaction costs of the CDM. The first attempt was to simplify the CDM administrative process for small-scale projects, most notably through predefined and simplified methodologies and the bundling of discrete CDM project activities (UNFCCC, 2002). Such provisions have brought transaction costs down to range of $29,500 to $71,500 for so-called small-scale projects (Table 1). Small-scale projects are, however, limited in size: about 60,000 tCO2e per year for energy projects and 16,000 tCO_2e per year for reforestation projects (UNFCCC, 2006: para. 28; 2007)—see Table 2.

It's questionable whether the small-scale designation is effective. The market's response to small-scale project category has been rather mute. While the total number of large-scale and small-scale CDM projects is comparable, small-scale projects are expected to account for only about 10% of all CERs expected by 2012 (UNEP Risoe Centre, 2009b). A more recent attempt to manage transaction costs is "programmatic" CDM, which builds on the bundling concept of small-scale projects but, in effect, removes the size limitation (Ellis, 2006; Hinostroza *et al.*, 2007; UNFCCC, 2005a: para. 20). There are currently 15 so-called "programme-of-activities" (PoAs) in the October 2009 CDM "pipeline" monitored by UNEP Risoe Centre (UNEP Risoe Centre, 2009c).

3.1.2 **Baselines & Additionality**

The manner by which the CDM generates carbon credit units is also a source of major concern. The CDM does so through the identification, *a priori*, of a plausible hypothetical baseline scenario if the CDM had not existed. This baseline is then compared to the actual project scenario *post-hoc*—i.e., after the CDM project's implementation. Credits are generated when the project scenario reduces emissions in addition to the hypothetical baseline scenario. Note that in the current arrangement, the CDM project developer identifies the baseline scenario while also undertaking the CDM project activity.

This “additionality” is perhaps the most important aspect of carbon finance as it ensures that carbon credits generated represent genuine emission reductions (or in the case of reforestation, emission removals). That is, if 1 tonne of CERs generated through the CDM is fungible with 1 tonne of domestic emission reductions in an industrialized country. Additionality is defined as follows in the CDM:

> *A CDM project activity is additional if anthropogenic emissions of greenhouse gases by sources are reduced below those that would have occurred in the absence of the registered CDM project activity (UNFCCC, 2005b: para. 43).*

The crux of the additionality debate revolves around the hypothetical baseline scenario. Carbon credits are only to result if the emissions reduced over the course of a CDM project “crediting period” are in ***addition*** to this baseline scenario. Additional and non-additional CDM projects are presented in Figure 4.

The additionality problem is confronted with fundamental problems, which can be broken down into three components. First are misaligned interests. Because the project developer both implements the project and defines the baseline scenario, there is temptation to select a baseline scenario against which the CDM project appears additional. As a result, credits might be granted for projects that would have been implemented anyway—bogus “anyway credits” (Wara, 2008). In response to these concerns, the CDM Methodology Panel has suggested tightening the rules for CDM projects that have potentially high profitability even without carbon finance (CDM Meth Panel, 2008). However, even enforcing these new rules might require more information than might be reasonably expected by regulators, for reasons described below. A better idea would be to separate the determination of the baseline scenario to an independent body, such as the host country government or UN agency.

Second, there are information asymmetries in the regulation of additionality (Wara and Victor, 2008). Basically, project proponents know a lot more about a proposed CDM project than a third-party regulator or the CDM Executive Board—the two chief regulators in the current CDM arrangement. Third-party regulators are basically private auditing consultants, often brought in from Europe or North America, though there are continuous efforts to develop African verifiers as part of the Nairobi Framework for catalyzing the CDM in Africa.[5] It is possible that the discernment of qualitative, context-dependent claims of a CDM project's additionality might be over-looked by regulators (not to mention inflated transaction costs due to the fact that these third-party auditors need to be brought in from abroad). It seems a missed opportunity that auditing responsibilities were out-sourced to private auditing firms, often with little or no presence in developing countries, while relevant UN agencies that do (such as the UNDP) were over-looked. Related to the above discussion of misaligned interests, Wara & Victor (2008) point out that there are also misaligned incentives between project developers and the third-party auditors—who are paid by project developers themselves—and suggest a need to shift payment for third-party verification services to the CDM EB. It remains to be seen if such reforms will be made to the CDM administrative structure.

The third issue is a temporal one: the credibility of a project baseline is only as good as its projection into the future. Things change over time and a project which appears additional at a project's inception may not be so over the entire crediting period. Many CDM projects adopt a baseline approach that permits the project developer to "freeze" the baseline identified at the start of the project over the entire crediting period (Purdon, 2009b). However, such a "frozen" baseline might always be appropriate. A "moving" baseline would attempt to monitor the baseline (still a hypothetical) over the credit period. Such a "moving" baseline would accommodate the possible initiation of the project in the absence of the CDM—indicated at Year 4 in Figure 4—and adjust such that only genuine carbon credits are generated. Yet the difficulty in monitoring a hypothetical baseline is perhaps one reason for the continued preponderance on the "frozen" baseline approach in the methodologies. Also, when discussing baselines, one needs to be clear about how long into the future projections are being made. This is related to the choice of crediting period: that is, to the period over which a CDM project can generate officially-recognised CERs. For non-AR CDM projects, the crediting period is 7-years (up to twice renewable) or a single 10-year period. For AR CDM projects, the crediting period is 20 years (up to twice renewable) or a single 30-year period.

5 http://cdm.unfccc.int/Nairobi_Framework/elements/index.html

3.1.3 Measurement, monitoring and verification (MMV)

Measurement, monitoring and verification (MMV) present considerable challenges for the CDM. Victor (2001) has long argued that any economic efficiency gains associated with carbon trading would be undermined by the costs of measuring, monitoring and verifying carbon transactions. But without effective MMV it is simply difficult to know what is being traded. This is an important challenge to realizing the CDM's potential, but there has been a certain amount of progress made on MMV in recent years.

In terms of measurement, the most important developments have been the development of CDM methodologies (see Purdon, 2009b for a detailed exposition of methodologies for biocarbon). These methodologies present standardized approaches to undertaking a carbon finance project, including the measurement of emissions and carbon pools in baseline and project scenarios. Many of the methodologies are derived from technical guidelines for GHG inventories prepared by the IPCC. But methodologies are developed in an iterative manner: a project developer develops a methodology for a specific project which is vetted by third-parties and ultimately requires approval by the CDM Executive Board for use. But once approved, the methodology can serve as a methodological template for other CDM projects—including those of other project developers. This is one explanation for the timelag in the CDM performance in Figure 1, with the impact of the CDM only really expected to be felt as projects come on-line around 2008.

Monitoring is generally undertaken by project developers themselves and there are elaborate rules described in the CDM methodologies about exactly what, and how, emissions and carbon pools need to be monitored over the course of a project's crediting period (see Purdon, 2009b). For programmatic CDM, the monitoring effort will be largely statistical—assessing the performance of a random sample of the CDM "activities" (Hinostroza *et al.*, 2007). Because self-monitoring represents a clear moral hazard, third-party verification is required. Verification refers to the process of independently checking the accuracy and reliability of reported information under monitoring or the procedures used to generate such information.

3.1.4 **Price Volatility**

Lastly, price volatility is major concern with the quota-based system of which the CDM is a part. Nordhaus (2007: 38) points out the price volatility of the quota-based climate change policy can approach that of oil market. Give such volatility, it is hard for governments and firms to plan as there is a lack of a clear price signal. And volatility is only increased when exposed to shocks, such as the global financial crisis. This has seen the primary and secondary CDM market prices fall to €7 in February 2009 from a 2008 peak of €14 and €20, respectively (Figure 5). While it is too early to tell definitively, there are signs, however, that at least the secondary CDM market price is recovering.

But is price volatility reason to abandon the CDM? Though price volatility is an issue, there are ways of controlling prices through a combination of price ceilings and price floors on the carbon credits (Grubb, 2009). And Hamilton (2009) points out that coping mechanisms have been devised for price volatility, particularly for oil where it would be difficult to argue that volatility has been any real deterrent to its usage. Volatility alone might not be a sufficient reason for discrediting the Kyoto quota-based system.

3.2 **Reforming the CDM**

The problem with administering additionality are misaligned interests surrounding the baseline as well as information asymmetries between project developers and regulators (the host country, third-party auditors and CDM Executive Board) about the baseline. A sectoral approach that would establish a benchmark across an entire sector of the economy might be able to resolve some of these issues (see Neelis *et al.*, 2009 for a state-of-the-art review of benchmarking). In many ways, we see the evolution of the CDM progressing away from a project-based system, towards now programmatic CDM with a sectoral approach being the logical next step (Figure 6). How? First, a sectoral CDM would establish a sector-wide performance benchmark, which would become the baseline for carbon finance. For instance, a certain emission efficiency benchmark (in tonnes CO2e/GJ) would be set for power plants in a developing. Investments at the plant that increase this efficiency would be eligible to receive carbon credits. While this would not avoid politics, setting the benchmark would be contentious and require tact and diplomacy, it would avoid some of the issues plaguing the hypothetical baseline of the current CDM.

A complimentary idea would be to devise a “moving” baseline that would attempt to monitor changes in the baseline scenario over the crediting period and accommodate any possible initiation of the project in the absence of carbon finance. For instance, Liu (2008: 292) describes a method for using national economic output to estimate emissions by assessing the probability of national economic output conditioned on emissions given a certain technological infrastructure in the country. This probability can fine-tuned as conditions, particularly technology, change in the country hosting emission reductions projects/programmes. This moving baseline approach would complement the sectoral baseline approach described above because much of the statistical “noise” that might prevent the application of a moving baseline at the project level might be filtered out if applied at the national, sectoral level.

4 The Carbon “Bounty”: an alternative to the quota-based system

But for many, the administrative convolutions involved in the transition towards a sectoral CDM are neither elegant nor efficient. A price-mechanism is just much better. Alternatives to quota-based approaches to climate change policy are price mechanisms such as a carbon tax or subsidies for renewable energy or carbon sequestration (Liu, 2008; Nordhaus, 2007; Samson and Bailey-Stamler, 2009). In this section, we consider how such mechanisms might “play out” in the developing world.

4.1 The Impossibility of a Carbon Tax in Least Developed Countries

A carbon tax is clearly the most advantageous price mechanism, yet it is unlikely that its application would be politically feasible in developing countries. To begin with, the politics surrounding taxation and its analogue in developing countries, the informal economy, are highly contentious (Migdal, 1988; Niger-Thomas, 2000). Governments in developing countries often do not enjoy a level of legitimacy that would permit them to impose taxes in efficient manner. Large sections of the economy are not regulated, except for clear "choke points" such as ports and major border crossings.

While formalization of the economy is an important development goal (see De Soto, 2000), the possible imposition of a carbon tax at such "choke points" on imported oil and other fuels would be almost unconscionable. Certainly reductions in emissions would be achieved, but this would be achieved at the cost of social welfare as higher fuel prices simply cut people off, rendering fuel inaccessible, rather than driving new low-carbon technologies (see Ojha, 2009). The CDM avoids this conflict of interest by attracting financing into a developing country for emissions reductions projects. From a political perspective, the adoption of a price mechanism for emissions reductions in developing countries would need to have a similar, positive effect.

Lastly, some proponents of carbon taxes would suggest that such an approach would reduce the need for MMV, because assessing the impact of the tax could be largely derived from economic modeling and would fluctuate around a certain emissions quantity (Hamilton, 2009: 5; Nordhaus, 2007: 40-42). In reality, countries claiming to implement a carbon tax might set up tax loopholes in other areas in order to compensate, resulting in a "goulash" of taxes, exemptions and other distortions that would ultimately undermine the elegance of the initial tax model (Victor, 2001: 86).

4.2 The Carbon Bounty Approach

In the absence of an economy-wide policy such as a carbon tax, a price-based strategy that would effectively put a "bounty" on CO2e reduced or sequestered would be an appropriate strategy in developing countries (Purdon *et al.*, 2009; Samson and Bailey-Stamler, 2009). In effect, the "bounty" is a subsidy paid to reduce or sequester a certain amount of emissions. The devil though is in the details. What is the correct price to set for the bounty? One idea would be to determine the carbon cost effectiveness (CC_{Eff}) of different abatement strategies, measuring the cost of sequestering or reducing emissions on a dollar-per-tCO2e basis ($/tCO2e).

Abatement costs curves could be developed for different countries, akin to the McKinsey global cost curve (Figure 7). CC_{Eff} could be used to determine the price at which to set a carbon bounty in order to achieve a desired emission reduction for a specific project or programme. The challenge remains in structuring a carbon bounty in a manner analogous to the CDM, allowing foreign investors or governments to inject money into a specific carbon abatement project or programme and assess its environmental impact.

4.3 Linking the Carbon Bounty to the CDM

If the quota-based CDM system is extended, one possibility would be to generate carbon credits as determined by the quantity of the "bounty" injected into the system by a foreign party multiplied by the project or programme's or policy's overall CC_{Eff}. With regard to our review earlier of criticisms of the CDM, the advantages of carbon bounty strategy would not necessarily be with regard to measuring, monitoring and verification (MMV).

However, the determination of CC_{Eff} curves for the carbon bounty would be an important and perhaps expensive undertaking, similar to current MMV efforts in the CDM. Care would be necessary in order to ensure that the cost information obtained is correct. If interests remain misaligned, as in the baseline determination of the current CDM arrangement, the carbon bounty might not be any more effective than the current CDM. However, cost information on different abatement strategies are reasonably observable and CC_{Eff} may thus remove some of the temporal difficulties of baseline determination that plague the CDM's claims at additionality.

The question remains whether such a price strategy would be more effective than the CDM in developing countries. How might they compare with the CDM's performance? In what follows we consider price-like mechanisms for carbon abatement in the bio-carbon sector in Tanzania, Uganda and Moldova where the CDM is already up and running (UNEP Risoe Centre, 2009a).

5 Case-Study: Tanzania, Uganda and Moldova

5.1 Case-study Design

Results presented here are derived from 2009 fieldwork on climate change policy and CDM project performance in Tanzania, Uganda and Moldova undertaken as part of PhD research of the author. While the countries differ markedly in terms of their level of development, in a comparative politics perspective what is of interest is whether there are similar conditions across these three case-studies necessary for price-based carbon mitigation strategies. The study adopted a "most different systems design" (Meckstroth, 1975; Przeworski and Teune, 1970; Skocpol and Somers, 1980) where the goal was not necessarily to determine how these case-studies differ but to learn if, regardless of level of development, there are some commonalities between them in terms of the performance of price-based mitigation strategies.

The focus of this study was on the performance of biocarbon CDM projects and identification alternative approaches. The objective was to assess the contribution of carbon finance in biocarbon towards sustainable rural development. The term "biocarbon" is defined as the broad sector that includes renewable energy derived from biomass and organic wastes as well as the carbon sinks (trees, vegetation, soil and peat) found in agricultural, forest and other terrestrial ecosystems (Purdon, 2009a: 2). The main research technique used was semi-structured interviews involving key actors such as government officials, donors, NGOs and the private sector. All three countries are involved in reforestation and biomass energy projects through the CDM, approximately a dozen carbon projects were visited in 2009 (Table 3).

The energy situation in all three countries varies in an important way. Biomass in sub-Saharan Africa is the largest source of energy, yet is generally harvested in an unsustainable manner. Fuelwood, for example, accounts for between 61-86% of primary energy consumption (Amous, 1999) and in many areas fuelwood demand is expected to exceed supply (Arnold and Persson, 2006; Drigo, 2005). Despite this, energy policy Tanzania and Uganda is largely silent on renewable biomass energy such as fuelwood and continues to focus on rural electrification. As for liquid biofuels, often only produced for export, the issue has become highly contentious at least in Tanzania where the government recently suspended private sector development in biofuels (Mande, 2009). In terms of carbon mitigation strategies, much attention in sub-Saharan Africa is turning to reducing deforestation—particularly since a $35 million pilot project was initiated by the UN-Norway in 2008 to address the issue (UN, 2008).

In Moldova, internal electricity generation produces only about 30% of domestic consumption, and most of this "internal" supply is from hydroelectric dams located in the semi-autonomous

Transnistria region. Natural gas is sold at subsidized prices well below market (i.e. EU) price by Russia, though there is also an agreement that eventual prices will rise to market levels. At the same time, Moldova has had its natural gas supplies affected by disputes between Ukraine-Russia as well as in the tensions with Transnistria, a semi-autonomous region. Despite extensive agricultural capacity and near total reliance on foreign provision of energy, renewable energy strategies are only beginning to gain political attention while there remains no real bioenergy strategy. However, a Multilateral Carbon Fund (MCCF) operating under the European Bank for Reconstruction and Development (EBRD) and European Investment Bank (EIB) does anticipate generating carbon credits in the future in the bioenergy sector (EIB/EBRD, 2009)

5.2 Example of a Carbon "Bounty" in Tanzania

The clearest example of an existing carbon bounty comes from the Tanzanian forest plantation sector, though it is not current conceived as a carbon abatement strategy. The example is perhaps unique to Tanzania because of the near monopoly the government has on forest products, particularly industrial grade wood from plantations, through Sao Hill—a crown corporation. The government owns 80,000 ha of a total of 150,000 ha of plantation forests in Tanzania (Kihiyo, 1998). Because of Sao Hill's near monopoly, the price that government sets for its forest products reverberates throughout the rest of the Tanzanian forest sector. Reforestation effort in Mufindi District, Tanzania's forestry capital, demonstrate a marked increase in 2006 that coincides with an increase in government set royalty rates for forest products (Figure 8). While the ultimate fate of seedlings planted remains unknown and would warrant a certain monitoring effort if used as a carbon mitigation strategy, the increase in reforested area in Mufindi District more than doubles in size between 2005 (3,740 ha) and 2006 (10,048 ha)—an increase of 6,308 ha in a single year. The impact is far greater than the anticipated 20,000 ha planted over a twenty year period resulting from two CDM projects in the region—an average of 1,000 ha planted each year (Green Resources, 2007, 2008).

Yet perhaps more interesting is the story surrounding the increase in forest products fees in Tanzania where the method of determining the appropriate price for forest products is—in the words of one respondent—"totally political". These fees and other permits are set out in

“Schedule 14”of the official regulations of the Forest Act, which can only be changed through an act of Parliament. In 2006, a first attempt was made by the then Minister of Natural Resources and Tourism, Dr Jumanne Maghembe, to raise the price of forest products. Interviews with relevant stakeholders suggest that the Minister, himself a trained forester, wanted the royalty rights to reflect the environmental value of the forest products and, at least, approach global prices. The rates that were initially proposed were found however too high by domestic consumers groups and, instead, provoked a political backlash that resulted in the Minister’s resignation.[6]

Nonetheless, despite the Minister’s resignation, the rates were eventually raised in 2007—though only slightly more than doubling in value, when Parliament assented to the Forest (Amendment) Regulations which saw changes made to the fees, tree volume tables and tariff tables set out in Schedule 14 of the regulations (Table 4). Respondents interviewed suggested that global market prices for Tanzania’s forest products are nearly four times the 2002 rates. While collection of these fees have been found to be dramatically inefficient—with under-collection of royalties estimated at 96% domestically and trade statistics suggesting that only 10% of Tanzania’s forest exports are officially recorded (Milledge *et al.*, 2007: 4)—the relationship with the timing of this price change and reforestation effort do point towards a potential price-mechanism operating in the Tanzania forest sector.

The politics of surrounding efforts to raise forest products’ royalty rates described are of interest because they resemble the type of politics that many would envision would surround carbon taxes in developing countries if an attempt was made at their implementation. Even if a politician would want a price signal to reflect the full environmental value of emissions or, in the case of

---

[6] See news stories surrounding Maghembe’s policies and resignation (Joe-TZNews, 2007; TRAFFIC International, 2007). An explanation for this political crisis is not readily apparent, but the circumstances suggest political dynamics in developing countries surrounding primary commodity prices in order to promote development and serve urban interests (Bates, 2005 [1981]; Sah and Stiglitz, 2002). Historically, in both developing countries and the former Soviet Union suggest, prices for primary commodities (such as food and timber) have been kept artificially low. This was particularly the case with crop marketing boards in developing countries, which later became the target of free-market structural adjustment progammes during the 1980s-90s. It appears that in Tanzania, politically determined price controls were not entirely expelled.

Tanzania's forests, carbon sequestration, the development imperative as well as vested interests would prevent this from being realized.

But the Tanzania forest products sector also suggests how an international carbon trading mechanism could be politically useful. The idea here would be for a foreign investor to insert a carbon price wedge on top of the government set royalty rate. This would allow forest products to be sold domestically within Tanzania at a politically acceptable level, while also delivering extra financial incentives to those reforesting. It would also give some control over the direction of this development towards more sustainable ends, for instance, by allowing the foreign investor to grant this carbon price only for native tree species (currently, most public and private forest plantations in Tanzania are dominated by foreign species such as pine and eucalyptus). The chief draw back to the system is the scale of the black-market for forest products in Tanzania, discussed above, which might complicate the reliability of the price signal on which the carbon bounty is based. However, the benefits of the price-based system might be such that these drawbacks are found relatively insignificant.

5.3 **Limitations on a Price-Mechanism**

The above example from the Tanzania forest sector suggests how a carbon bounty could create incentives towards emissions trading. But how far can we extend this model? The example from Tanzania actually appears to be quite unique in the course of fieldwork. In the developing world and economies in transition, there are a number of reasons to prefer the quota system. The first is the importance of price shocks and like of transparent markets for fossil fuels as well as, secondly, the fact that the vast potential of emission reductions and sequestration in least developed countries is for improved management of common property resources, such as biocarbon, which might not be as amenable to price mechanisms.

First, fossil fuels are susceptible to price manipulation and supply shocks that make the designation of an appropriate price incentive difficult. This was most evident in Moldova, which is almost entirely dependent on foreign sources of energy. The vulnerability of such position was revealed in early 2009, during the Ukraine-Russia natural gas dispute. Moldova receives the majority of its natural gas supply from Russia via Ukraine and the Transnistria autonomous region. As one respondent noted:

> *Respondent: "…this winter, when the supply of gas to Ukraine [was cut], Moldova was probably the least publicized case in the world, but probably hurting the most, probably even more than Bulgaria, which still has some ability of retaining gas. Moldova had no gas at all, actually, and the entire country with the exception of, I think Kishinev, which for political reasons had to keep going, was shut off from gas for almost two weeks, in the dead of winter. So I think a lot of people will probably start thinking more and more about alternatives to gas."*

There is strong debate as to the extent that Russia uses its natural gas supplies as a political tool (Ericson, 2009; Gelb, 2007). Regardless, the example of 2009 sent a strong message that natural gas supplies to Moldova are at the mercy of politics beyond the country's control.

But the more important effect of Russian price controls on natural gas is perhaps price subsidies when supply is provided. In Moldova, the low price of natural gas was an important reason given by households for not seeking alternative energy sources, such as bioenergy. But not the most important one: respondents consistently indicated that natural gas was an attractive energy source that suggested a modern, progressive heating system, which often led them not to consider the costs and benefits versus bioenergy in greater detail. Regardless, the lack of transparency on natural gas prices—the energy source competing most with bioenergy—suggest that assigning an appropriate carbon bounty in the bioenergy sector for Moldova could be difficult. Subsidies could be adjusted to circumvent price controls.

But price manipulation and supply shocks are not restricted to economies in transition. Particularly in least developed countries, such as in sub-Saharan Africa, abrupt changes in fossil fuel prices can lead to regressive dependence on fuelwood and charcoal (Maconachiea *et al.*, 2009), which leads us to our second point about the utility of the CDM quota-based system : energy sources are typically from non-market, open-access resources which remain outside the ambit of price controls. The clearest example is fuelwood in developing countries. It is well known that fuelwood collection is a daily chore, mainly of women, who collect fallen branches and other wood debris from farms and forest lands (Modi *et al.*, 2005; Purdon, Forthcoming).

Attempts at managing such fuels through price controls has often proven exceedingly difficult, with the charcoal being perhaps the best example (Seboka, 2009). The economy of charcoal operates almost entirely in the black market as its formal use is severely restricted in developing countries, if not outright banned. Yet charcoal and fuelwood continue to be the fuels of choice amongst the poor in developing countries (Drigo, 2005). Thus a carbon tax or fuel subsidy would be far from an optimum strategy because the energy source remains largely in the informal sector. One alternative price strategy however for reducing fuelwood consumption would be to subsidize the costs of technology leading to reduced fuelwood consumption, such as improved woodstoves.

6 **Conclusion**

On balance, there are good reasons to include both a price and quota-based strategies for a reformed CDM. In some circumstances, prices might be better and there may be underappreciated sectors in the economies of developing country where price-mechanisms might be useful. But under other conditions, the quota-based system is more appropriate. Yet the emphasis of critiques of the CDM and Kyoto Protocol remain largely at the level of a need to transform the system to a price-based approach. To the contrary, this points to a need to reform the post-Kyoto agreements in a manner that adds price-based instruments in addition to, not in replacement of, the current quota-based design. It is not time to "ditch" the quota-system but consider under what circumstances a carbon pricing policy is an appropriate, yet additional strategy.

The most important reason is, as has been argued here, that there are certain limitations on a price-based approach in the developing world. Price strategies are more appropriate in developed countries because prices for fossil fuels such as natural gas are relatively stable and predictable. Yet retaining the costs of climate change mitigation amongst industrialized countries alone means that costs remain high. There is little ability to spread costs globally, to areas where mitigation is cheaper, if one is constrained by a policy that can only be deployed in advanced industrialized countries.

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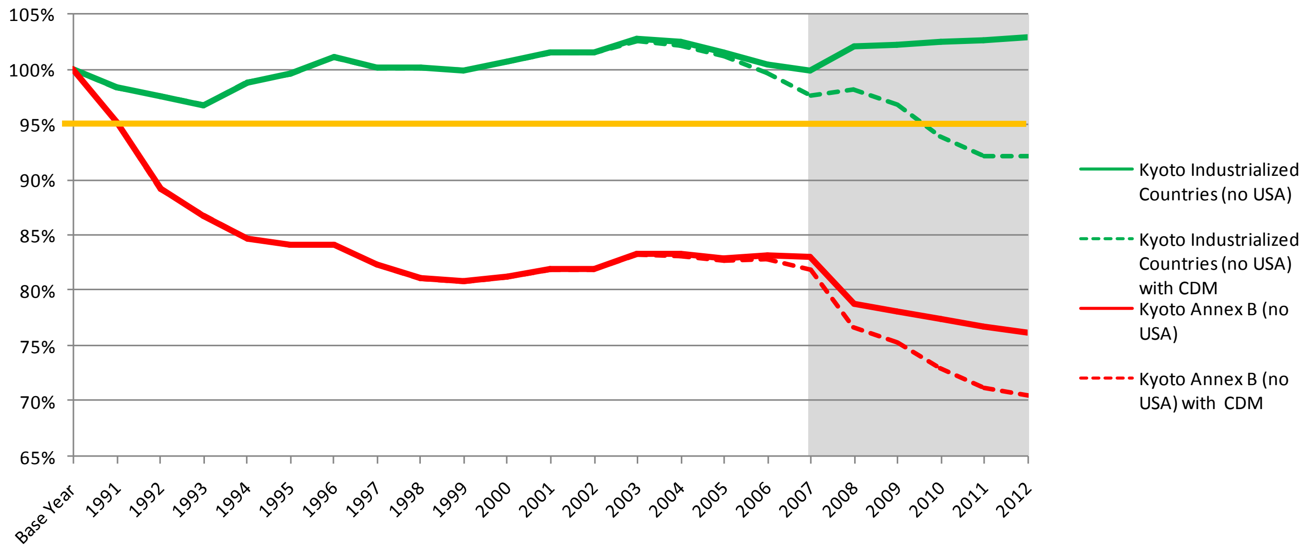
8 Figures

Figure 1: Impact of CDM on Emission Trends of Kyoto Parties[7]



7 Data for emissions trends are available from 1990 through 2007 from UNFCCC. Simple linear regressions from 1990-2007 aggregate emissions trends were used to project post-2007 emissions. Carbon credits anticipated through 2012 under the CDM are derived from the CDM Pipeline maintained by UNEP-Risoe Centre. Because there is a time lag between the initiation of a project and when a project is expected to generate credits, many projects are anticipated to only generate credits late in the Kyoto commitment period. Data on carbon credits in the CDM pipeline are derived from estimations of individual CDM projects as described in their *a priori* Project Design Documents (PDDs) and may slightly over-represent actual emission reductions (UNEP-Risoe anticipates a 97.7% issuance success). Note that this graph only retains anticipated carbon credits from projects that are expected to make their way through the CDM regulatory process. These are "registered" projects, projects "at validation" and those pending registration ("under review" or having submitted a "registration request" or "request for review")—as defined in the CDM Pipeline.

Figure 2: Hepburn's (2006) rendition of the Weitzman (1974) result

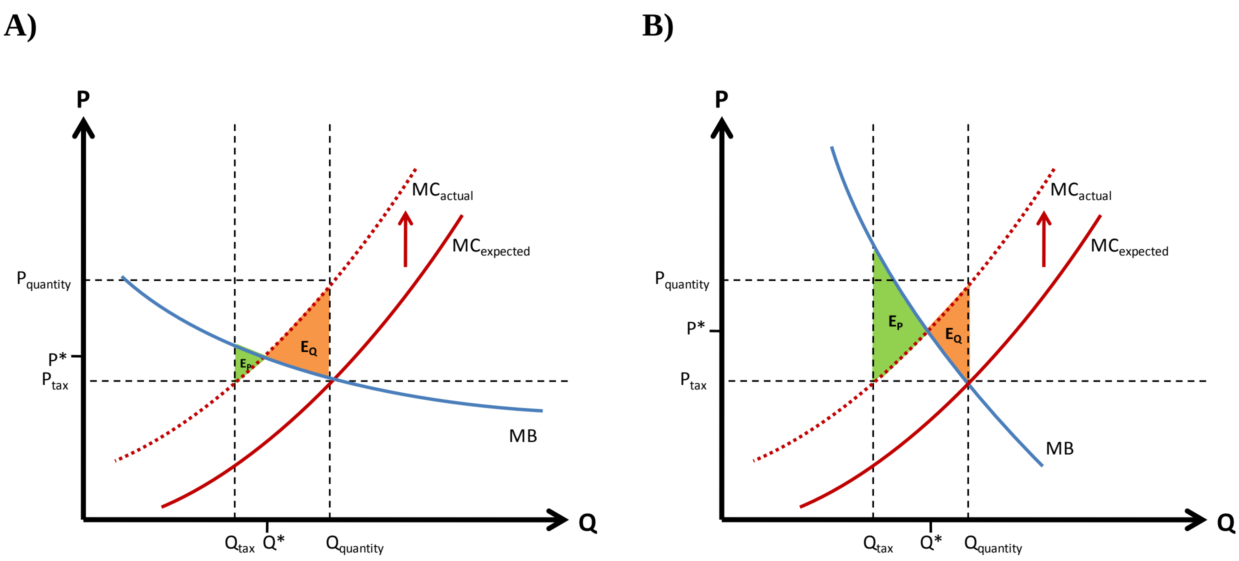


Figure 3: CDM project cycle

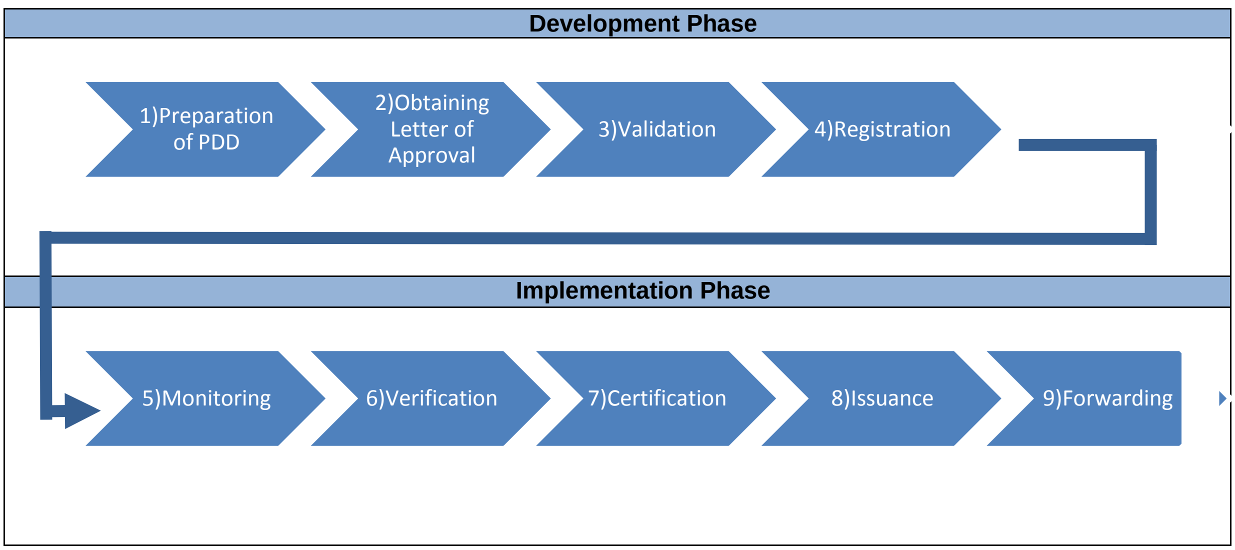


Figure 4: Example of an additional and non-additional CDM project

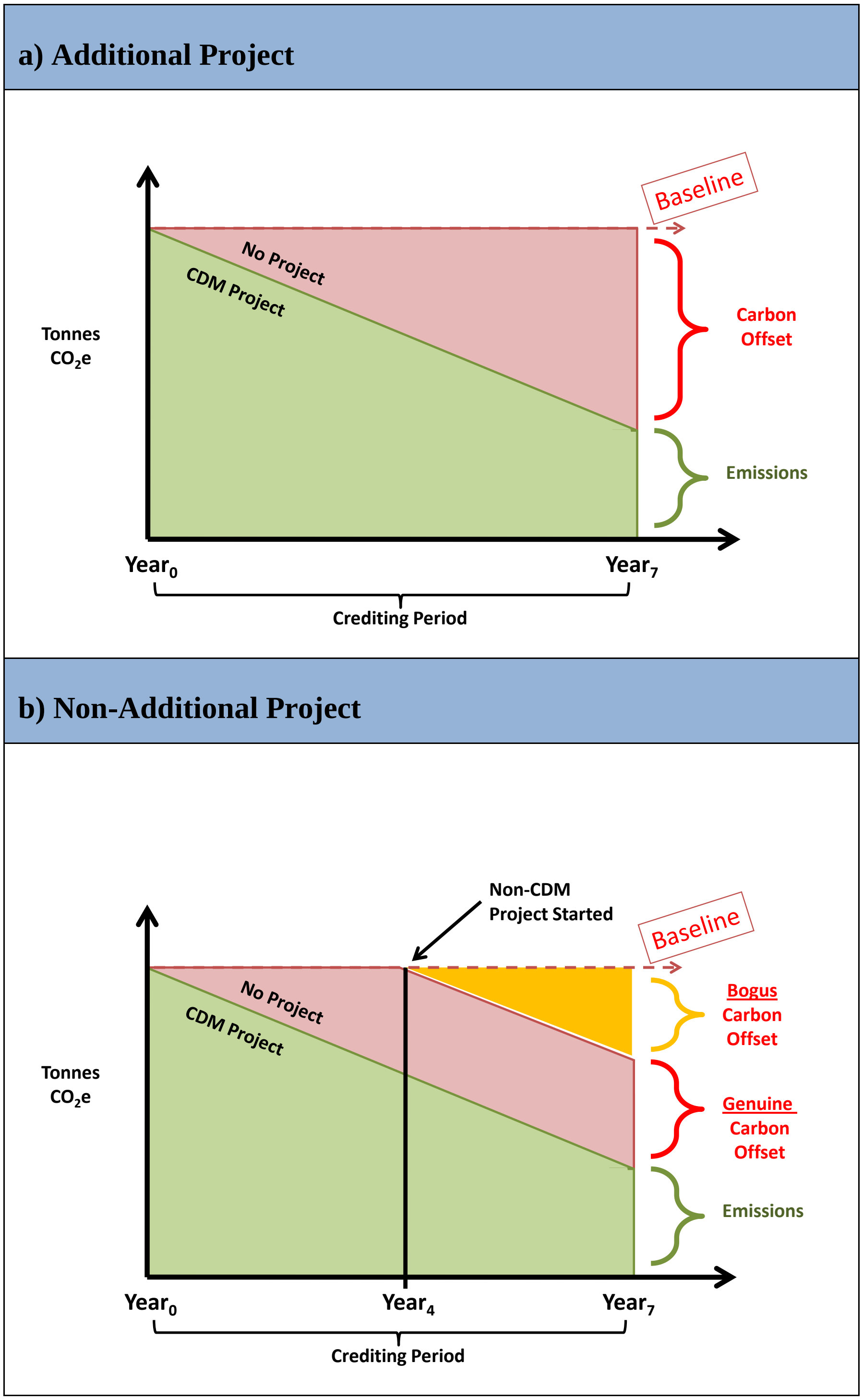


Figure 5: Carbon price response to the global financial crisis (Capoor and Ambrosi, 2009: 32)

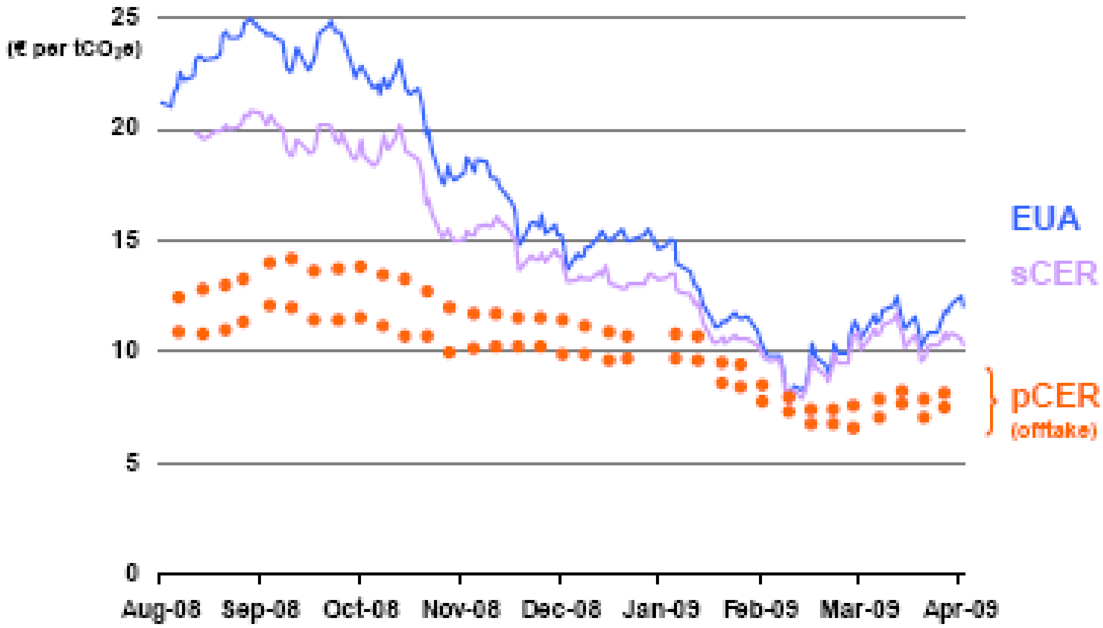
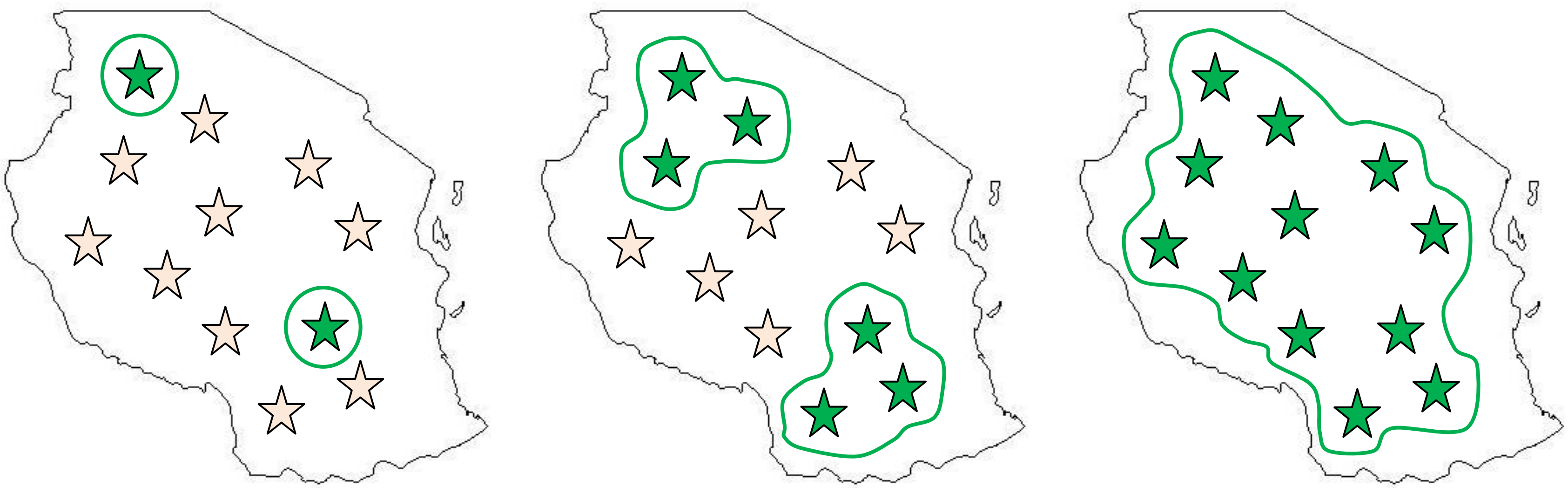


Figure 6: The evolution of CDM administration

a) Project-based CDM **b) Programmatic CDM** **c) Sectoral CDM**



Currently, the CDM operates largely on a project-by-project basis. The demonstration of additionality does not go much further than project boundaries (green lines). Because little information about the environmental performance of non-CDM projects operating in the same sector is presented, regulators do not have sufficient information to assess to what extent the baseline identified by CDM project developers is true.

Programmatic CDM is really an extension of project-based CDM, seeking to reduce transaction costs through economies-of-scale. While there is more baseline information, there are still substantial sectors of the economy which remain outside regulatory purview.

Sectoral CDM would establish a sector-wide performance benchmark, which would then become the baseline for carbon finance.

Figure 7: Global GHG abatement cost curve beyond business-as-usual – 2030 (McKinsey & Co., 2009)

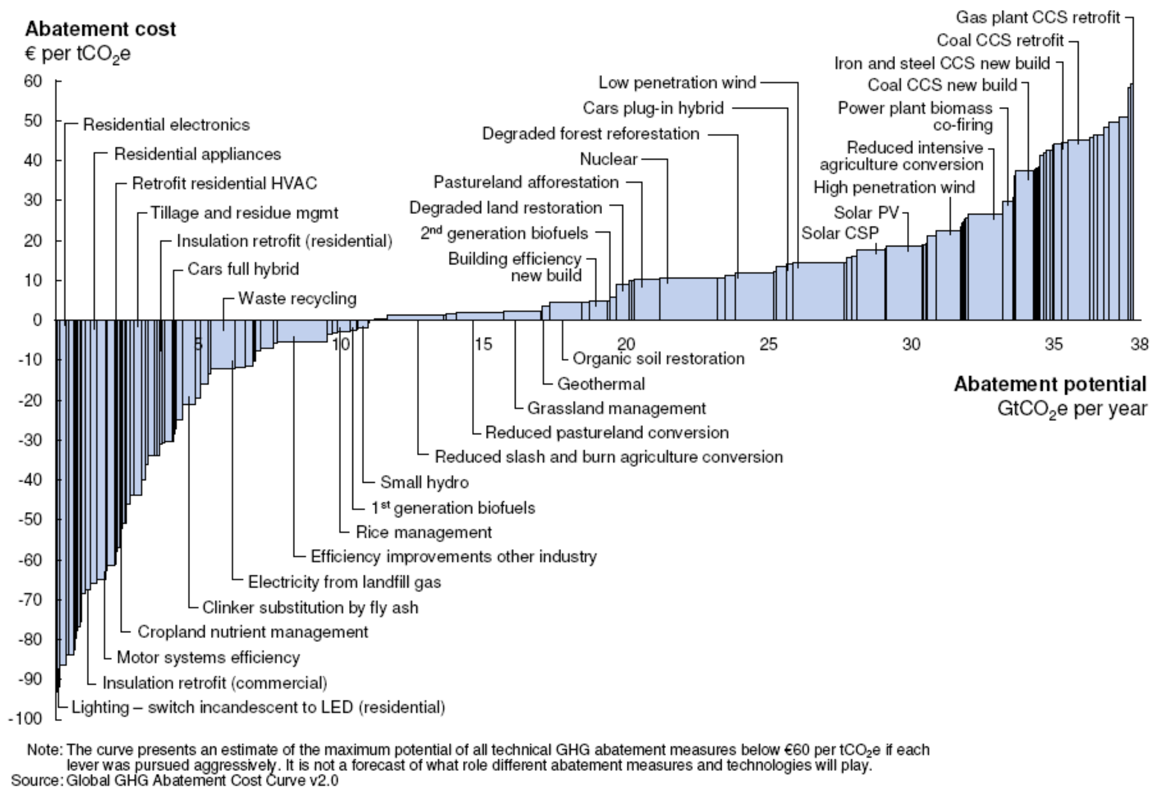
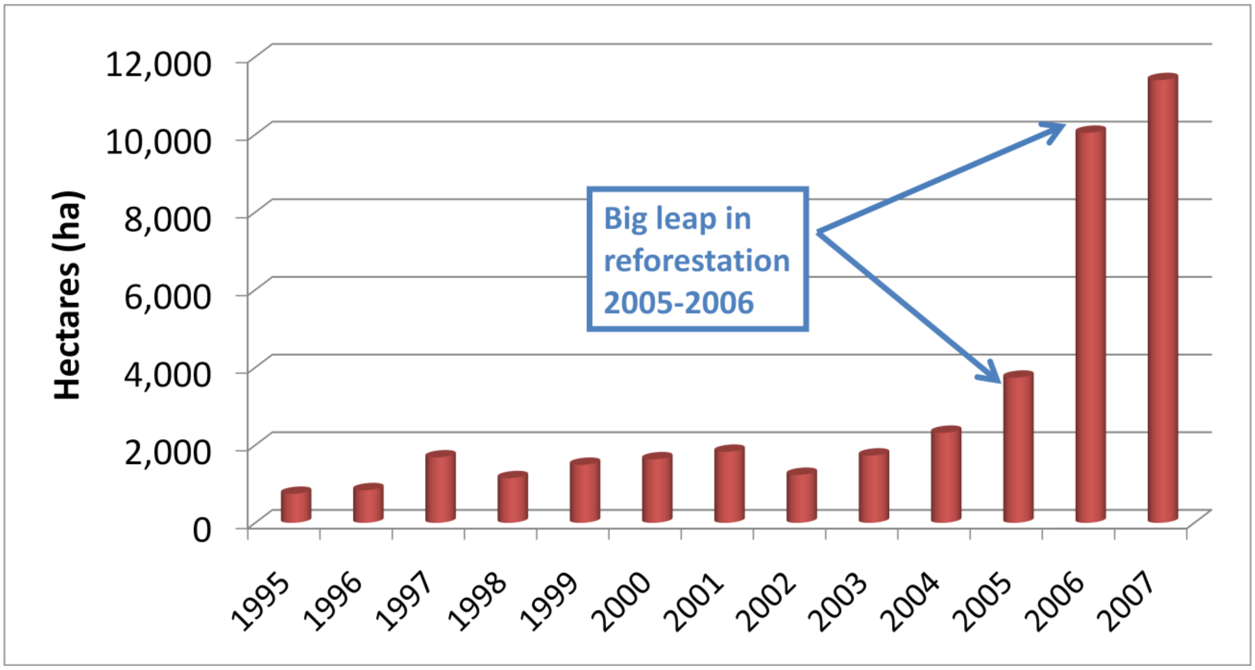


Figure 8: Reforestation effort in Mufindi District, Tanzania



9 Tables

Table 1: Range of transaction costs for non-AR CDM projects

	Low	Average	High
Large-Scale CDM			
Project Preparation Costs	$43,000	$118,000	$193,000
Project Implementation Costs	$5,000	$12,000	$19,000
Total Costs	$48,000	$130,000	$212,000
Small-Scale CDM			
Project Preparation Costs	$24,500	$38,500	$52,500
Project Implementation Costs	$5,000	$12,000	$19,000
Total Costs	$29,500	$50,500	$71,500

Source: Pin (2005)

Table 2: Small-scale CDM project categories and their size limitations

AMS I	Renewable energy	Project activities with a maximum output capacity equivalent of up to 15 MW
AMS II	Energy efficiency	Project activities which reduce energy consumption, on the supply and/or demand side, by up to 60 GWh per year
AMS III	Other project activities that reduce anthropogenic emissions by sources	Directly emit less than 60,000 tCO2e per year
AR-AMS	Afforestation/Reforestation	Project activities sequestering up to 16,000 tCO_2e per year

Table 3: Projects visited during the study

MOLDOVA	
CDM	
Reforestation	3
Biomass Energy (Crop Residues)	2
Demonstration Project	
Biomass Energy (Crop Residues)	(1)
TANZANIA	
CDM	
Reforestation	2
Biomass Energy (Cook-Stove)	1
Biofuel	
Jatropha plantation	(1)
UGANDA	
CDM	
Reforestation	1
Biomass Energy (Sugarcane)	1
Voluntary Market	
Reforestation	1
Biomass Energy (Cook-stove)	1
GRAND TOTAL	**12 (14)**

Numbers in parantheses indicate non-carbon projects

Table 4: Change in Key Fees ("Schedule 14") for Forest Products in Tanzania, 2002 & 2007

	2002 Schedule 14	2007 Schedule 14
B. Fees payable on plantation forest produce when felled and removed with licence		
	Tz Shillings/m^3	Tz Shillings/m^3
All softwood plantation species except Juniperus procera		
Class 1 (DBH < 10 cm)	To be sold as firewood	To be sold as firewood
Class II (DBH 11-20 cm)	1,500	2,000
Class III (DBH 21-25 cm)	2,000	4,000
Class IV (DBH 26-30 cm)	3,000	10,000
Class V (DBH 31-35 cm)	3,500	17,300
Class VI (DBH > 35 cm)	4,500	19,200
Juniperus procera		
All sizes	50,000	50,000
All hardwood plantation species except Eucalyptus		
Cederella, Grevillea, Acacia Acrocarpus and Maeopsis		
Class 1 (DBH < 10 cm)	To be sold as firewood	To be sold as firewood
Class II (DBH 11-20 cm)	To be sold as poles	4,000
Class III (DBH 21-30 cm)	8,000	8,000
Class IV (DBH – 2002: > 30 cm; 2007: 31-35 cm)	10,000	15,000
Class V	/	20,000
Teak		
Class 1 (DBH < 10 cm)	To be sold as firewood	To be sold as firewood
Class II (DBH 11-20 cm)	To be sold as poles	32,000
Class III (DBH 21-30 cm)	8,000	80,000
Class IV (DBH – 2002: > 30 cm; 2007: 31-35 cm)	10,000	120,000
Class V	/	160,000
All Other Hardwood Plantation Species		
Class 1 (DBH < 10 cm)	To be sold as firewood	To be sold as firewood
Class II (DBH 11-20 cm)	To be sold as poles	3,000
Class III (DBH 21-30 cm)	8,000	6,000
Class IV (DBH – 2002: > 30 cm; 2007: 31-35 cm)	10,000	12,000
Class V	/	15,000
All Eucalyptus species		
E. salinga & E. grandis		
Class 1 (DBH < 10 cm)	To be sold as firewood	To be sold as firewood
Class II (DBH 11-20 cm)	To be sold as poles	6,400
Class III (DBH 21-30 cm)	8,000	16,000
Class IV (DBH > 30 cm)	10,000	28,000
All Other Eucalyptus species		
Class 1 (DBH < 10 cm)	To be sold as firewood	To be sold as firewood
Class II (DBH 11-20 cm)	To be sold as poles	To be sold as poles
Class III (DBH 21-30 cm)	8,000	6,400
Class IV (DBH > 30 cm)	10,000	16,000