DRIVERS AND BARRIERS FOR SMALL-SCALE CDM PROJECTS IN THE FACE OF POST-2012 UNCERTAINTY

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Preface

This thesis was written at the Department of Economics and Resource Management at the Norwegian University of Life Sciences as part of a master's degree in economics. The purpose of this thesis is to give an overview of the technologies that are currently represented with small-scale projects in the CDM pipeline, and the barriers and drivers they face as the Kyoto Protocol approaches its expiry.

The initial idea was developed by Kristian Tangen from Point Carbon as part of a wider project about small-scale projects under the CDM mechanism. I am very grateful for getting the opportunity to work with such an interesting subject, and have benefited greatly from his invaluable insights into the carbon market.

My supervisor Eirik Romstad has provided invaluable advice in the development of this thesis. I am very grateful for all the assistance, support and encouragement he has given, and for always finding time for me during this process. My time at UMB has sparked an interest for climate and resource economy thanks to inspiring lecturers like Eirik Romstad and Arild Angelsen.

I would also like to thank Olvar Bergland, along with my co-student Erlend Aas Guldbrandsen for invaluable input. Finally, a special thank you to Luke for proof reading, making late dinners and providing endless support this autumn. I could not have done this without you.

Ås 15th December 2010

Hilde Hallre

Executive Summary

The Clean Development Mechanism (CDM) was introduced as part of the Kyoto Protocol to provide industrialised countries with more low cost ways to meet their GHG emission reductions. It has the dual objective through also aiming to contribute to sustainable development in developing countries.

Small-scale projects have been given a simplified procedure for the CDM process in an attempt to encourage such project. One of the main barriers has been high transaction costs that are not as easily absorbed for small projects, and the simplified process was intended to reduce this. However, recent data indicates that the cost and timeframe connected to clearing the CDM project cycle has increased, and even more so for small-scale projects.

In addition to this the approaching expiry of the Kyoto Protocol leads to uncertainty with respect to the future of the carbon market. Despite predictions of a drop in project applications for the CDM pipeline, there are still projects going in. This thesis focuses on the 6 technologies that have most activity with respect to small-scale projects. These projects do not appear to have any clear characteristics, however some patterns emerge within the different technology categories.

For several of the technologies there appear to be some national drivers behind the applications. India and China are the two dominating host countries for CDM projects, however they are dominant in different technologies. They also differ in that India has a high level of unilateral projects, whereas China hardly has any.

The complexity and subjectivity of the CDM process creates uncertainty for project developers. The decisions of the Executive Board (EB) appear to influence what type of projects that enter the pipeline. A streamlining of the process appears necessary to ensure the integrity of the CDM.

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Abbreviations and Acronyms

BAU	Business As Usual
CDM	Clean Development Mechanism
CER	Certified Emissions Reduction
CO_2	Carbon Dioxide
COP	Conference of the Parties
DNA	Designated National Authority
DOE	Designated Operational Entity
EB	Executive Board
EU	European Union
EU ETS	European Union Emissions Trading Scheme
FDI	Foreign Direct Investment
GWh	Giga Watt hour
GHG	Greenhouse Gas
IET	International Emissions Trading
IGES	Institute for Global Environmental Strategies
JI	Joint Implementation
LDC	Least Developed Countries
LoA	Letter of Approval
MW	Mega Watt
OE	Operational Entity
OECD	Organisation for Economic Co-operation and Development
OLS	Ordinary Least Squares
PIN	Project Idea Note
PDD	Project Design Document
PoA	Programme of Activities
PV	Photo Voltaic
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change

1. Introduction

The Clean Development Mechanism (CDM) was introduced as part of the Kyoto Protocol in an attempt to provide industrialised countries with more low cost way to meet their GHG emission reduction objectives and at the same time contribute to sustainable development in developing countries.

Although small-scale technologies have been seen as part of the solution to a greener future energy path, it is difficult to get past the fact that small-scale technologies generally suffer under a relatively high share of transaction costs. For the projects that fall under the small-scale definition of the CDM this has led to fewer successful projects and generated fewer Certified Emission Reduction (CER) credits than expected.

The CDM has been celebrated and criticised over the past decade. But in the wake of the inconclusive Copenhagen summit and a global financial crisis, the need for reform has been highlighted once more as many projects fail to reach the implementation stage. As the mechanism has grown in size and strength, small-scale technologies are expected to become part of greenhouse gas reduction schemes on a larger scale throughout developing countries. To ease this process a simplified procedure was implemented under the CDM for projects defined as small-scale in 2001.

However, the current development is that the timeframe for the CDM approval process has increased for all projects over the last ten years. For small-scale projects this has increased faster than for large projects, indicating that the simplified procedure is not working as intended. This is unfortunate as delays in the regulatory chain increase transaction costs even further (Bosi et al. 2010).

1.1 The value of carbon

The global carbon emissions market developed as a consequence of the increased awareness of the threat from climate change caused by excessive GHG emissions. Through a market based system of cap and trade the Kyoto Protocol seeks to reverse the trend of carbon emissions. Trading of quotas ensures cost effectiveness, through equalising abatement costs between participants in the scheme. It was also hoped that it would encourage innovation to ensure better energy efficiency and be an incentive for lower emissions.

The revenues generated from trading in carbon permits and the sale of CERs by projects are referred to as carbon finance. These carbon revenues are the result of the volume of credits generated, the carbon price and the length of the purchasing period (Bosi et al. 2010). The basis for carbon finance activities rests on the Kyoto Protocol, and its three underlying market based mechanisms known as International Emissions Trading (IET), Joint Implementation (JI) and the CDM. There were virtually no transactions in the CDM market until 2005 and the implementation of the Kyoto Protocol. Around the same time the EU Emissions Trading Scheme (EU ETS) was established and helped boost growth. These are the two main markets today and were valued at USD 120 billion in 2009 (Kossoy and Ambrosi 2010).

The carbon market faced its biggest challenge in 2009 as the global financial crisis unfolded. It had a negative impact on the market both on the demand and supply side. With the reduction in industrial output, the demand for carbon assets went down and at the same time it became increasingly difficult for project managers to secure funding, bringing many projects to a standstill (Bosi et al. 2010). The turbulent financial climate also affected the CDM market. As investors became more risk adverse buyers, focused on large projects in advanced stages of development (Bosi et al. 2010). Although the crisis has had negative effects, it has been argued that it could be instrumental in establishing a stronger market post 2012.

Another looming issue is the uncertainty connected to the future climate regime as the Kyoto Protocol approaches its expiry. The outcome after 2012 will be influential for the carbon market in the future.

1.2 The role of small-scale technologies

Distributed energy systems are based on electricity generation from many small energy sources. Although the concept of distributed energy systems is mainly used for the supply side of the electricity market, it could be used in a similar way to reduce GHG emissions through a system of small-scale technologies. The projects can be divided between those that generate electricity in an environmentally friendly way, those that reduce electricity consumption and technologies that simply reduce GHG emissions.

Although relatively high transaction costs are an important issue for small-scale projects, these costs could be reduced substantially through the effect of economies of scale if implemented widely and structured through programmatic approaches[1]. The CDM already allows for this through the so-called Program of Activities (PoA), which enables project developers to reduce transaction costs through bundling similar projects together, and building on past applications.

There are also other benefits from distributed systems such as the lowering of costs connected to distribution and transmission. A further streamlining of the CDM process could also be instrumental in lowering transaction costs for these projects. Contrary to the intentions behind the development of the simplified procedures, the verification time for small-scale projects has increased even more than for other CDM projects. According to Bosi et al. (2010), this could be partially caused by the fact that the price for validation of a project is not based on the size, but the complexity of a project, and that many small-scale projects are within areas where validation is more complex.

The uncertainty surrounding future mitigation commitments as the expiry of the Kyoto Protocol approaches should in theory discourage project developers. However, the CDM continues to grow. Some technologies are well represented in the CDM pipeline, whereas others hardly feature at all. The most frequent technology for small-scale projects is hydropower, with 106 projects that are generating CERs so far and many more moving ahead in the pipeline. Biomass and biogas are other project types that have seen a substantial amount of projects entering the pipeline. There are currently 3316 small-scale projects in the pipeline.

1.3 Objectives

The objective of this thesis is to investigate the role of small-scale technologies in the reduction of GHG emissions and the main barriers that are preventing further implementation.

[1] "(P)roject activities under a programme of activities can be registered as a single clean development mechanism project activity provided that approved baseline and monitoring methodologies are used that, *inter alia*, define the appropriate boundary, avoid double counting and account for leakage, ensuring that the net anthropogenic removals by sinks and emission reductions are real, measurable and verifiable, and additional to any that would occur in the absence of the project activity." For more see http://cdm.unfccc.int/EB/032/eb32_repan38.pdf accessed 14.12.2010.

I will initially look at a selection of the current leading small-scale technologies and emerging technologies. Through identifying the main barriers for the chosen technologies, I will then try to find success criteria and potential drivers for the current development.

My main problem statements are:
1. What are the leading small-scale technologies in the CDM pipeline today?
2. What are the main barriers for small-scale CDM projects?
3. What are the characteristics and drivers for the projects currently entering the pipeline?

This thesis consists of four main parts. Chapter 2 covers background information and form the theoretical foundation for the following discussion and analysis. I will start by expanding on the CDM, experience so far and the controversy that has surrounded the mechanism, before using economic theory to address issues like carbon leakage, technology transfer and transaction costs. This section will also include an outline of the requirements and procedures for small-scale projects.

Chapter 3 describes barriers to small-scale CDM projects. Chapter 4 goes on to address the technologies that represent the majority of current validation applications to enter the pipeline. This is linked to an analysis of profitability, country dominance and foreign involvement for the different technologies. Chapter 5 contains the main analysis and links this to the findings from chapter 4, before chapter 6 provides a summary of the problems statements and looks to the future of small-scale projects under the CDM.

2. Background

Under the Kyoto Protocol the countries classified as Annex I[2] countries can fulfil their emissions reductions obligations through domestic reductions or the use of one of the protocol's mechanisms. These three market based mechanisms are (i) International Emissions Trading (IET), (ii) Joint Implementation (JI) and (iii) the Clean Development Mechanism (CDM). The revenues created from these mechanisms are referred to as carbon finance and provide the basis for a global carbon market. These flexible mechanisms aim to ensure that abatement takes place in a cost effective way through enabling the Annex I countries to reduce emissions in countries where the costs are lower. The CDM and the JI also have a second objective. The two mechanisms are linked to poverty alleviation through providing less developed economies with opportunities to achieve sustainable development through the implementation of the projects. I will focus my discussion on the CDM in the remainder of this thesis.

2.1 The Clean Development Mechanism

Despite criticism the CDM has established itself as a considerable mechanism in the carbon market. The underlying thought behind the CDM is to use revenue from carbon finance to enhance the financial viability of GHG[3] reducing projects. Being a system based on payment by performance, it also creates positive incentives, and the hope was to encourage good management and making projects sustainable over time (Bosi et al. 2010).

A baseline scenario is created for each project to be able to establish whether it meets the additionality criteria or not. An approved methodology is then applied to show that without the use of the CDM the project would not be implemented. In the Marrakesh Accords a CDM project is defined as being additional "if anthropogenic emissions of greenhouse gas by source are reduced below those that would have occurred in the absence of the registered CDM project activity."[4] Each project has to show that without the CER revenue from the CDM the

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[2] Annex I countries are defined by the UNFCCC as the industrialized countries listed in this annex to the Convention which were committed to return their greenhouse-gas emissions to 1990 levels by the year 2000 as per Article 4.2 (a) and (b).

[3] The atmospheric gases responsible for causing global warming and climate change, the main GHGs are carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). Source: UNFCCC

[4] Paragraph 43 of the Marrakesh Accords – http://unfccc.int/cop7/documents/accords_draft.pdf accessed 02.12.2010

project would not be implemented due to one of the following; investment barriers, technological barriers, barriers due to prevailing practise or other barriers.

According to Cosbey et al. (2006), the additionality concept has been one of the more difficult aspects of the CDM. The criticism against the additionality requirements includes it being too complex, subjective and focusing too much on investment additionality. The Executive Board met this criticism by introducing a consolidated additionality test that is widely used. For projects that generate other revenues in addition to the CERs, proving additionality will be more challenging, whereas projects only involving costs will pass (Michaelowa 2005).

The balancing act between an environmentally sound methodology and one that is applicable is a great challenge. A very strict additionality test will exclude many projects, whereas a more relaxed test would increase the risk of including projects that are non-additional. The consequence of non-additional projects will be similar to those of market leakage. For a non-additional project the marginal cost of generating CERs will be zero, which will result in downward pressure on the CER price[5] (Michaelowa 2005).

2.1.1 A win-win mechanism?

The initial optimism surrounding the CDM was directly connected to its duality and the bridge between cost effective GHG reductions and sustainable development in developing countries. The CDM was created in the process leading up to the Kyoto negotiations and adopted along with the protocol itself. Agreement on the actual CDM was reached in the late stages of the negotiations, which resulted in it being agreed upon without any guidelines for how it should be implemented. The CDM guidelines and regulations were adopted as late as in 2001, four years after the main agreement, at the COP 7 meeting in Marrakesh (Olsen 2007).

Through the protocol the committed nations are given an initial allowance and then permitted to trade in what is commonly referred to as a cap and trade system. The market based tools were chosen as key policy tools due to their ability to even out mitigation costs across nations and because the impact of emissions into the atmosphere is location insensitive (Bosi et al. 2010). Tradable emission quotas will lead to cost effectiveness as cost minimising agents will

[5] This will change the revenue, how much depends on the price elasticity of CER demand.

continue to trade until the differences in marginal abatement costs are eradicated. This will occur regardless of the initial quota allocation (Golombek and Hoel 2008).

Controversies surrounding the CDM have been over its level of economic efficiency, environmental effectiveness and the regulatory functioning of the system (Figueres and Streck 2009). According to Olsen (2007), several authors have argued that meeting the cost effectiveness objective has been a lot more successful than the sustainable development objective. This is not surprising as the main priority for investors most likely will be the attainable profit, and not sustainable development in the project host-country. A leading argument against the dual objective has been to use one instrument per goal, and not try to achieve two goals with one instrument (Cosbey 2005).

From a theoretical viewpoint the CDM can be seen as another opportunity to find cheap mitigation solutions. The increased flexibility provided by the mechanism may contribute to lower costs. But where the quota trading between nations, International Emissions Trading (IET), over time will equalise abatement costs, the CDM will only reduce the differential between nations. The reason why the CDM can never equalise abatements costs completely is the relatively high transaction costs involved and that not all profitable projects will be implemented (Kallbekken et al. 2007).

2.1.2 Carbon leakage

The hunt for cost effectiveness ties in with the concept of carbon leakage or emissions leakage. Carbon leakage occurs when emission reductions in abating countries are partially offset by increases in emission levels in non-abating countries. This process is driven by the costs incurred by the climate regimes in participating countries when there is not full participation (Kallbekken 2007).

Sijm et al. 2004 define carbon leakage as "the ratio of policy-induced increase of emission from a non-abating country over the reduction of emission by an abating country." Carbon leakage has been discussed extensively in connection with the Kyoto Protocol due to how the benefits to the environment achieved through mitigation by Annex I countries could potentially be offset by the increase in emissions in countries without binding emission reduction targets. Vohringer et al. 2006 divide economic leakage into direct economic leakage and market leakage. Direct economic leakage is caused by changes in demand for input factors and intermediates leading to increased emissions, whereas market leakages come about through changes in price.

This price differential on GHG emissions between countries occurs as a result of the Kyoto Protocol not having full participation. The abatement efforts to reduce emissions in Annex II countries will lead to an increased cost of GHG emitting activities, and hence a positive price development, whereas for countries without a binding cap on emissions the price will still be very low. If no abatement efforts are implemented the cost will be zero. The result of this could be that some producers move their production to non-committed countries as the Annex II-countries loose competitiveness (Kallbekken 2007).

If we assume that carbon leakage takes place, the result is a reduction in the climate effectiveness of the Kyoto Protocol proportional to the leak. When it comes to the significance of leakage on a global level the available literature is inconclusive. Kallbekken et al. (2007) find that most studies estimate global carbon leakage to lie between 5 and 20 percent. Golombek and Hoel (2007) assume that technological change is endogenous, and then find that carbon leakage is no longer necessarily positive, but could also be negative in some cases.

With respect to answering my problem statements the interesting aspect is the impact of the CDM on carbon leakage. Here, the literature is not very comprehensive and equally contradictory. An early study by Bollen et al. (1999) concludes that the overall effect of the CDM is that it will increase carbon leakage, whilst Kallbekken (2007) finds that the mechanism has the potential to reduce it. Bollen et al. (1999) argue that implementation of CDM projects will lead to price decreases in local energy markets, which again leads to increased demand for energy, resulting in increased emissions. According to Kallbekken (2007), this effect may occur, although he expects other effects to be influential too, potentially leaving the net effect to be a lower demand for energy.

Kallbekken et al. (2007) argue that even with relatively low levels of participating countries in a global agreement, the CDM could potentially reduce carbon leakage. This effect takes place through market prices as the lower abatement costs in Annex II countries reduce the price of emissions trading permits. Activities that lead to a reduction in the price differential between

Annex I and Annex II countries will result in a decrease in the extent of carbon leakage. This way, use of the three flexible mechanisms could potentially reduce carbon leakage.

2.1.3 Technology transfer

In addition to the negative effect of carbon leakage, the CDM also has the potential for positive spillover effects due to technology transfer between Annex I and Annex II countries. Transfer of technology and a higher level of innovation around global warming issues a way to finding more solutions for reducing global warming in a more cost-effective way (Sijm et al. 2004).

The CDM has been the strongest mechanism under the UNFCCC for technology transfer, although there are great variations within technologies, project size and countries. Transfer is more likely to take place in projects with foreign involvement than in unilateral projects (Schneider et al., 2008). Small-scale projects are less likely to involve technology transfers than larger projects. Seres et al., 2007 found that it took place in 33 percent of small-scale projects and 44 percent of large projects. This is due to the transaction costs involved in the CDM process and how they are not as easily absorbed by small-scale projects (Schneider et al., 2008).

Table 2.1. Technology transfer for small-scale CDM project types

Projects with technology transfer	**No. of projects in percent**		
	Dechezleprêtre et al. (2008)	Haites et al. (2007)	Seres (2007)
Biogas	29	38	57
Biomass energy	19	21	25
Energy efficiency (industry)	25	14	25
Energy efficiency (own generation)	n.a.	n.a.	42
Hydro power	22	15	9
Solar power	100	80	57
Wind power	63	41	57

Source: Based on Schneider et al. (2008)

Estimates for technology transfers show that they vary widely among project types. Schneider et al. (2008) compare the estimates for various technologies from three studies (Dechezleprêtre et al. 2008, Haites et al. 2006 and Seres et al. 2007) and find similar results despite the studies analysing the pipeline at different points in time.

Schneider et al. (2008) found that technology transfer was likely to occur in 69 percent of end-of-pipe projects, but just in 20 percent of the projects focusing on changes in the production process.

There are also large variations in the transfer of international technology between the different host countries. Dechezlepretre et al. (2009) found that for CDM projects overall, China had a transfer rate of 59 percent, whereas India only had 14 percent. Highest was the technology transfer for projects in Mexico with 75 percent, whereas Brazil had a transfer rate of 40 percent.

2.1.4 CDM experiences so far

The World Bank describes the CDM process as developed through a "learning by doing" approach (Bosi et al. 2010). This bottom-up process has some advantages, but could also explain some of its shortcomings. Extensive overviews and discussions on CDM reforms and challenges can be found in the literature (Cosbey 2005, Cosbey et al. 2006, Michaelowa 2005). In my further discussion I will focus on the issues that are acting as barriers for implementation of small-scale projects.

According to Bosi et al. (2010), the main reasons for CDM-projects being discontinued are: inability to secure financing, delays in the implementation of the project, CDM/JI regulatory delays and changes in regulatory structures, an insufficient carbon finance revenue stream and challenges in clearing the due diligence process. They also describe four key features successful CDM projects tend to possess: (i) A committed and visionary leader who is prepared to tackle the many obstacles a project is likely to meet and carry on. The World Bank recognises the need for technical assistance in some cases, but underlines that external project managers are unlikely to have the required commitment to see the project through. (ii) A strong project plan consisting of feasibility studies along with assessments of financial structures and methodology requirements. (iii) Strong financing (iv) A clear potential to meet the mitigation requirements on a sufficient scale (Bosi et al. 2010:20).

So far it appears that proven technologies benefit the most from the mechanism. Bosi et al. (2010) find that carbon revenues have not altered the investment pattern when it comes to technologies. To date the CDM has made investments in projects using proven technologies with marginal rates of return that involve relatively low risks more attractive through improving profitability. This has increased the development of these types of projects.

2.2 Small-scale projects

Due to lack of scale, small projects are less likely to be economically viable, in particular because administrative and transaction costs tend to contain substantial fixed costs. Recognising this, the CDM Executive Board in 2001 introduced a simplified procedure for small-scale CDM projects through the Marrakech Accord to reduce transaction costs.

For a project to qualify for small-scale status under the CDM there are certain criteria that must be met. A project can come under three different categories. Type I is renewable energy projects, where the maximum output capacity must not exceed 15 MW, type II covers energy efficiency projects with a maximum output of 60 GWh per year and type III which covers other project activities where the annual emission reductions are less than 60 kt CO_2 equivalent.

If a project qualifies for small-scale status, it can follow a simplified procedure.[6] The project still has to follow the steps of the project cycle for CDM projects (see figure 2.1), but to reduce the transaction costs connected to the process some simplifications have been made. There are reduced requirements for the PDD, simplified baseline methodologies by project category, simplified monitoring plans and requirements, and it opens up for the same Designated Operational Entity (DOE) undertaking validation, verification and certification of the project. Another key feature is that project activities may be bundled in the PDD, validation, registration, monitoring, verification and certification stages of the process.

The stages of the project cycle are specified in the modalities and procedures for a clean development mechanism contained in the annex to decision 17/CP.7.

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[6] Appendix B of the Simplified modalities and procedures for small-scale clean development mechanism project activities (735 KB) (decision 4/CMP.1,)

Table 2.2. The CDM project cycle

1. Preparation of Project Idea Note (PIN)	A description of the project and estimated reduction of GHGs. Not mandatory, but often used to attract potential buyers.
2. Preparation of Project Design Document (PDD)	The PDD includes all technical information about the project; including baseline scenario and additionality proof. Small-scale projects face reduced requirements.
3. Issuance of Letter of Approval (LoA)	The project is evaluated by a Designated National Authority (DNA) in the host country. The DNA must issue a Letter of Approval (LoA).
4. Validation of PDD by DOE	A Designated Operational Entity (DOE) carries out an independent evaluation of the project to establish whether it is eligible for the CDM.
5. Registration of PDD	When a project is validated it must apply for registration with the CDM Executive Board (CDM EB). When a project becomes classified as "registered" it is formally accepted as a CDM project.
6. Verification and certification	The project then enters a verification period. An independent review and ex-post determination is carried out by a DOE. The DOE then issues a certification if the project has achieved the projected reductions during a specified period of time.
7. Issuance of CERs	The CDM EB reviews the certification and if approved starts to issue CERs.

Source: Based on Bosi et al. (2010) and Seldal (2008)

Under the current CDM regulations small-scale projects are not required to include an investment analysis, but still many do. Of the projects registered in the pipeline by June 2010 IGES estimates indicate that 55 percent of the small-scale projects have not enclosed an investment analysis with their PDD. Among the remaining 45 percent the most common method used is benchmark analysis (38%). Four percent use a simple cost method and three percent an investment comparison (IGES 2010). Another regularly used method for proving additionality is the consolidated additionality test, which consists of several steps including barrier analysis. Michaelowa (2005) argues that past experience shows that it is relatively easy to manipulate the much used barrier test to achieve validation.

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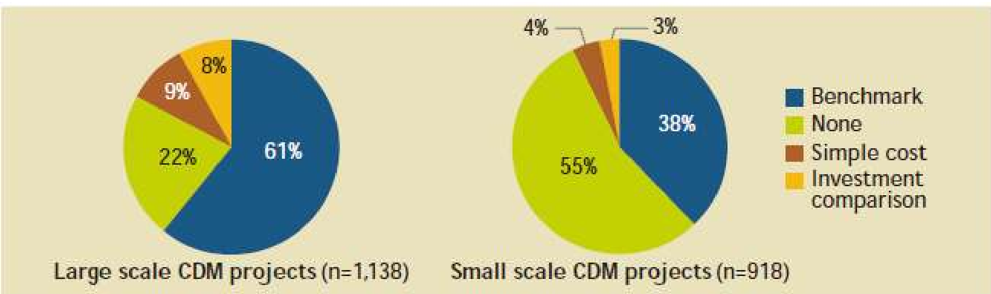


Figure 2.1 Percentage of registered CDM projects by type of investment analysis.
Source: IGES 2010:12

2.2.1 Projects in the pipeline

On 14th September 2010 the United Nations Framework Convention on Climate Change (UNFCCC) had 1044 registered small-scale project activities in the pipeline.[7] In the following discussion I will use data from the Institute for Global Environmental Strategies (IGES). Their database is based on the UNFCCC's data, but is structured in a way that makes it more accessible for my work.

As of 1st October 2010 IGES had 2116 small-scale projects registered under *validation*, 1200 under *requested/registered* and 271 under *issued* in their pipeline. These projects are all at different stages of the project cycle. The way the IGES database is organised, the projects that have been certified and have started creating CERs are still under RD, but have also been isolated in a separate file labelled *issued*. The projects are again classified within these stages based on their current status. Table 2.2 shows the different classifications. A successful project would go straight from VA-00 to CC to RD. However, if a project is rejected at the validation stage it can reapply if the necessary changes are carried out.

Table 2.3: The sub-categories of the IGES database

Stage	Description	April	Oct	
Validation				
VA-00	Opening comments	244	430	
VA-01	Project activity has been republished for global consultation	117	113	
VA-02	Corrective action or clarification has been requested	530	577	
VA-03	Negative validation has been issued	80	87	
VA-04	Validation activities are ongoing	252	282	
VA-05	LOA awaited	28	37	
VA-06	Validation contract has been terminated	329	410	
CC	Undergoing completeness check	185	180	
Requesting registration				
RR-01	Requesting registration	23	26	
RR-02	Review requested	6	11	
RR-03	Under review	2	9	
RR-04	Corrections requested (minor)			
RR-05	Corrections requested (follow)	17	19	
RJ	**Rejected**	52	57	
WD	**Withdrawn**	23	23	
RD	**Registered**	935	1055	
Total				

Source: www.iges.or.jp.

[7] retrieved 15.09.2010 from http://cdm.unfccc.int/Statistics/Registration/RegisteredProjByScalePieChart.html

Over recent years there has been a shift in the composition of projects in the pipeline. When the CDM was first constructed, it was dominated by projects with simple approval processes like hydro and landfill gas projects (Cosbey et al. 2006). Today there is a wide range of technologies over the different stages of the project cycle, although many have only got a handful of projects that have been successful. A market based system like the CDM will naturally favour the cheapest and most secure projects, and the result is an imbalance in the number of projects within different project types. This is simply a result of it being a market based approach (Kjellén, 2005).

Appendix 1 shows the distribution of projects at “validation” by technology as of 1st October 2010. The figures include projects at all the different stages of validation outlined in table 2.1 and are taken from the IGES CDM database. In total there were 2116 projects. The project type that has most applications is run-of-river hydropower projects. In the pipeline overall hydro power also has the largest number of small-scale projects at all stages. There are two countries with a majority of project in the pipeline. Currently China has 456 small-scale projects and India has 909 at the validation stage.

An increasing share of CDM projects are now developed without involvement of investors from Annex I countries. These unilateral projects do not have a committed foreign investor when the project is registered, but are developed by consultants or the government in the host country with the view to sell the CERs at a later stage. The inclusion of projects without Annex I country investors started in February 2005 after the Executive Board (EB) decided to register a small-scale hydro project in Honduras that was developed by forces within the host country. This development was seen as an advantage for small-scale projects and projects using non-proven technologies, as it meant that governments and NGOs in developing countries could develop projects that would not necessarily be attractive to foreign investors up front due to the high level of uncertainty involved in many projects (Cosbey et al. 2005).

Kjellén et al. (2005) argue that generation of CERs from unilateral projects could lead to a freer development of the carbon market through decreasing the price control of major buyers. They also find that such projects reduce the risk for the buyers, which again increases the price of the CERs. Other advantages they find are the potential for increased supply of projects, increased price transparency and reduction of transaction costs. Lower transaction costs may come about as a result of investors that are based in the host country having better access to domestic capital, institutions and infrastructure along with other resources like human capital (Kjellén et al. 2005). The only drawback they see with unilateral projects is that because they do not involve Foreign Direct Investment (FDI) the level of technology transfer is likely to be lower than for other projects. This is supported by Schneider et al. (2008).

Cosbey et al. (2006) find that unilateral projects score higher on environmental benefits, but lower on economic benefits, whereas the development dividend and social development score are fairly similar between unilateral and non-unilateral projects.

Michaelowa (2005) points to how the increased amount of unilateral projects increases the incentives for host country project developers to submit non-additional projects. When a project is developed unilaterally and the whole revenue goes to a project developer in the host country there is a rent to be extracted through the carbon revenue. Whereas if a projects that is developed purely by Annex I investors is non-additional it will be unattractive as none of the revenue generated will remain in the host country. The project could then just as well been carried out by host country developers without the CDM.

The IGES database shows whether or not a project had the involvement of a foreign investor at the start of its inception. In 2005 Cosbey (2005) found that 37 percent of all CDM projects applying for validation had no declared Annex I investor. Currently 1206 of the 2116 small-scale projects, or 57 percent, at the validation stage have not got an Annex I investor and can therefore be classified as unilateral. The majority of these are developed in India, which account for 796, or 66 percent, of the projects. China has a very low rate of unilateral projects.

2.2.2 Small-scale methodologies

For a project to be registered under the CDM, it has to use a suitable methodology. "A methodology clarifies the approved procedures to define project eligibility, to calculate the baseline and project emissions, and to monitor emission reductions from a project activity over time" (Bosi et al. 2010:35).

Under the CDM the development of new methodologies takes place through a bottom-up approach. Unless there is a suitable methodology available, the project has to develop one. Upon development, the methodology can be used free of charge by any other project, and therefore can be seen as a public good. Due to this there is no first mover advantage for the project behind the development. There is also a considerable cost and risk involved in the process. The World Bank operates with an average cost for approving a new methodology of around USD 125.000 for both large- and small-scale projects. Estimates from Bosi et al. (2010) also indicate that there is a 50 percent risk of the methodology being rejected.

Costs increase considerably for projects that require development of a new methodology. Although a wider range of methodologies could potentially open up for access to carbon finance for more projects later on. The Executive Board has also contributed by developing consolidated methodologies for a project type once several methodologies have been approved.

One perceived advantage of bottom-up processes is that only methodologies that are truly of interest to project developers are developed (Michaelowa 2005). However, looking at the data from recent years it appears that so far the majority of the approved methodologies for small-scale projects have only been used by one or two projects, and around 20 percent have never been used at all (Bosi et al. 2010). There are several reasons for this development. First, due to the nature of the process there are no clear incentives to ensure development of more broadly acceptable methodologies, as each project developer will just strive to ensure that the individual project successfully goes through the CDM process at least cost. Second, frequent changes demanded by the CDM Methodology Panel and/or the UNFCCC Secretariat to grant approval, which in some cases has led to the methodology not even being applicable to the underlying project (Bosi et al. 2010).

The empirical evidence so far indicates that there is a sub-optimal use of resources in the development of methodologies, and that the mechanism is not working as intended. Another problematic issue is the balancing act between an environmentally sound methodology and one that is applicable, especially for the smaller projects. I will return to this discussion in the chapter on barriers to small-scale projects.

2.2.3 Transaction costs

The administrative process involved in CDM participation includes a large element of fixed transaction costs as a project will meet CDM related costs at different stages of the project cycle. The transaction costs arising in connection with this process act like a barrier and reduce the use of the mechanism (Michaelowa et al., 2003). Transaction costs are initially roughly the same for large and small projects (Bosi et al. 2010), which is a disadvantage for small projects as they do not have as much potential for absorbing the fixed transaction costs as larger projects (Haites and Seres 2004).

It was expected that the simplified procedure for small-scale projects would lower the transaction costs and make more projects viable. In reality the validation costs have been increasing even faster for small-scale projects than for larger projects, despite the attempt to simplify the procedure to reduce the transaction costs. According to Bosi et al. (2010), this development is due to the prices of validation not being proportional to the project size, but dependent on complexity. Small-scale projects often require a more complex validation. A sharp increase in demand for DOE services, lack of CDM experts, regulatory demands for the CDM (volatility in requirements, restrictions, quality demands), risks (reputational – increased scrutiny and DOE suspensions, financial) and insufficient systematic support from the UNFCCC Secretariat and the CDM EB. Furthermore the timeframe for getting a CDM-project validated has gone up in recent years. Weak capacity at project level is also influential in increasing the validation timeline, along with delays by the host country in issuing the letter of approval from the Designated National Authority (DNA) (Bosi et al. 2010). All these factors will drive up the transaction costs of getting a project through the CDM project cycle.

The transactions costs related to a CDM project proposal include documenting the climate benefits and additionality. It is also required that the projects have desirable development impacts. The CDM then introduces an additional revenue stream to the projects that is often referred to as carbon revenue or carbon finance. This is the revenue stream that is generated from a project through selling the Certified Emissions Reductions (CERs) achieved through GHG reductions. In addition to the added revenue stream the process of developing and getting CDM projects approved also involves some transaction costs. (De Gouvello and Coto 2003:6) operate with the following equation for carbon revenue:

$$CR = V * P - T$$

Where CR is carbon revenue, V is the volume of credits awarded, P is the market price of CERs and T is the transaction costs accrued in connection with the CDM process.

De Gouvello and Coto (2003) found that the main component of the transaction costs faced by CDM projects were the charges in connection with getting the project through the verification process. They estimated that around 90 percent of the transaction costs were such administrative fees to the operational entity (OE).

High transaction costs represent an especially large barrier for small-scale projects in developing countries. One reason why these projects are more vulnerable is that the transaction costs occur up front, whereas the revenue from the CERs is not be generated until the project has successfully cleared the whole project cycle, and hence could be many years into the future (Ellis and Kamel 2007).

The estimates for transaction costs for small-scale projects vary. Ellis and Kamel (2007) break down the transaction costs throughout the project cycle and give an overview for small-scale projects. Using figures from the United Nations Environment Programme (UNEP) they find that the costs are considerably lower for small-scale projects, which was the intention behind the simplified procedure. However more recent analyses indicate that despite the simplified procedure the transaction costs are not that different for small-scale and large-scale projects. According to Bosi et al. (2010), the transaction costs for small-scale projects have risen over the last ten years. This is due to complicated procedures, administrative hold ups and inefficiencies in the system.

Bosi et al. (2010) estimate the cost of *verification* to around 20.000 USD, based on the experiences of the World Bank. They find little difference between small-scale and large-scale projects, and they have both been increasing over recent years. Moreover they find the same for *validation* costs, where the costs for small-scale projects have been increasing faster than for larger projects. In 2010 the small-scale projects have caught up and the average cost for validating a project is 28.000 USD.

Compared to Ellis and Kamel's (2007) estimates Bosi et al. (2010) find that validation costs are more than twice as high if you look at the figures for 2007. Bosi et al. (ibid.) estimate an "ongoing verification" at 5-10.000 USD, compared to the World Bank figures which for 2007 are around 12-13.000 USD. Their figures for 2010 have passed 25.000 USD.

The transaction costs are inevitably linked to the CDM-process. Despite the attempts to simplify the requirements for small-scale projects, the timeframe of the process and the uncertainties surrounding it has increased in recent years (Bosi et al. 2010). This has led to calls for a more professional CDM process and a reduction in the many potential bottlenecks and delays.

2.3 Why encourage small-scale projects?

As outlined above, small-scale projects are often less viable due to the scale of the projects not being sufficiently large to overcome the fixed transaction costs. So why would we push for more small-scale projects under the CDM?

The CDM's dual objective was constructed to achieve efficiency and sustainable development. So far the efficiency aspect of the CDM has been documented as more of a success than the sustainable development side. The intention behind the development of simplified measures for small-scale projects was to promote projects that have little commercial interest due to their size, but are desirable from a sustainable development perspective.

From the empirical evidence that exists on the development dividend, it appears that small-scale projects have more effect. On average, small-scale projects have a high socio-economic profile and contribute to slightly more sustainable development benefits than large-scale projects (Olsen and Fenhann 2008). Cosbey et al. (2006) show how small-scale projects tend to yield greater development dividends. They divide sustainable development into three subcategories: social, economic and environmental, and find that there is a basic relationship that holds across all three. However, the picture is not clear cut. When estimating the development dividend Cosbey et al. (2006) find that project type shows greater variation in the delivered development dividend than project size. They conclude that the tendency is that small-scale projects deliver higher development dividend benefits, although it is not the only way to improve this component of the CDM. Along with focus on project types they also mention programmatic approach as a way of scaling up small-scale activity that shows potential in delivering both quality projects and quantity.

From the experience with the CDM process so far there appears to be structural and administrative bottlenecks that are acting as barriers by increasing transaction costs further. The fact that these have become larger over time indicates that they could also be overcome by streamlining the process. I will address this further in chapter 3 and 4.

Key issues with regards to the CDM have been carbon leakage, and the challenges connected to determining additionality. A full discussion around the level of verification needed for a sound additionality test is beyond the scope of this thesis. With respect to carbon leakage, the commitment of more countries to a potential new climate agreement would restrict the opportunities for production in non-committed countries. According to Kalbekken et al. (2007), more developing countries entering the CDM would lead to a reduction in the differential in the carbon price between Annex I and Annex II countries, which would reduce leakage. So far small-scale projects have contributed less to technology transfer than larger projects due to the limited capacity these projects have for absorbing high transaction costs.

Small-scale projects are potentially a good way to introduce sustainable development in countries and areas where GHG reductions are not on the agenda. By creating incentives and benefits on a local and national level for host countries these projects can contribute to more focus on preserving the environment. They also have great potential in helping to overcome technological and financial barriers in rural areas with limited energy opportunities (Cosbey et al. 2006).

This way the wider implementation of small-scale projects could potentially introduce more environmentally friendly technologies in the least developed areas of the world. Sustainable development and low emission energy options will be central to lift these areas out of poverty without dramatically increasing GHG emissions.

3. Barriers to small-scale projects

For a project to be eligible for the Clean Development Mechanism (CDM) the project developer must prove that it faces barriers that result in profitability being less than or equal to zero without the additional revenue from carbon finance. This implies that all additional projects face some barriers. The CDM was, as mentioned earlier, created to help projects overcome these. One problem for small-scale projects has been that due to large upfront costs and lack of scale these barriers have been more severe than for large-scale projects. In addition to these barriers there are also some CDM specific barriers projects face on their way to approval.

3.1 Investment barriers

When the CDM process was first implemented, it was expected that the CDM financing would help leverage private investments into climate change mitigation. Along with the other market mechanisms it creates incentives for private resources from industrialised countries to finance mitigation efforts in developing countries (Figueres and Streck 2009). Bosi et al. (2010) show how experience from the World Bank indicates that carbon finance has been a catalyst of large amounts of private financial and investment flows to development of low carbon projects.

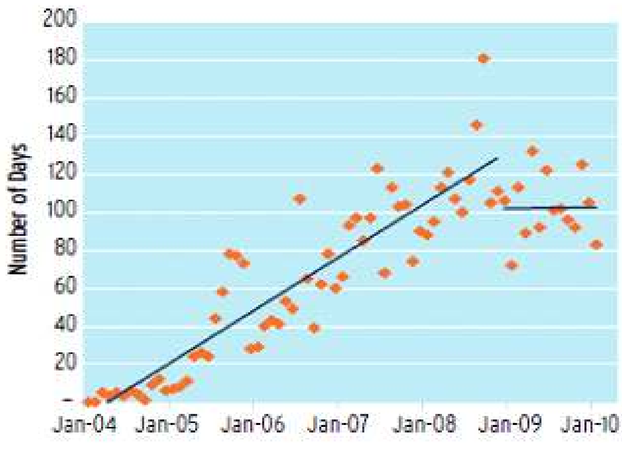
Over recent years securing financing has been a major problem for CDM project development. Ellis and Kamel (2007) refer to financing issues as one of the main barriers for CDM projects. This is particularly a problem for projects facing high initial investment costs, which applies to many small-scale projects. The classic example is renewable energy projects, where the need for high cost capital is large. Ellis and Kamel (2007) underline that many potential small-scale projects in poor host countries are prevented from being successfully carried out as a direct result of failure to secure financing. Cosbey (2005) argues that the few investors who understand the CDM process are reluctant to recognise the potential revenues that can be created and at the same time acutely aware of the large up front costs CDM projects face. Often small-scale projects find financing particularly difficult.

The projects currently in the CDM pipeline represent a considerable variation when it comes to investment requirements. With the massive span of project activities utilising the CDM the abatement costs and investments costs will naturally vary across sectors and technologies. Ellis and Kamel (2007) point out how this massive difference in the investment capital required for different types of projects is also partly due to how some projects use the total cost of the project, whilst others simply include the cost of a "CDM add-on".

Another feature of the CDM is that there is no connection between the level of investment needed and the number of credits produced. This means that the projects also have a large variation in risk-reward ratio. Ellis and Kamel (2007) find that for some project types the CER revenue is most likely just a bonus rather than the reason why a project is carried out. This implies that to attract the necessary investment capital the project will have to be attractive even without the CDM. This underlying profitability goes against the demand for additionality, but appears to be present for the main successful sectors under the CDM. This will be addressed further in chapter 4.

Ellis and Kamel (2007) show that up until 2007 the CDM portfolio was mainly dominated by projects with low capital requirements, low abatement costs and potential for generating large credit volumes. This is not surprising as such projects entail less risk for investors. The CDM portfolio has also been influenced by the recent global financial crisis. It resulted in less available capital, which made it difficult for project developers to secure finance. According to Bosi et al. (2010), project origination practically stopped in the first quarter of 2009.

Figure 3.1: Number of projects entering the CDM pipeline each month, Jan. 04-Feb. 10.



Source: Kossoy and Ambrosi (2010:41).

The financial crisis also led to some structural changes in the carbon market. Several of the large banks that were heavily involved before the crisis were forced to withdraw, and investors became more risk averse and generally returned to projects with low perceived risk (Kossoy and Ambrosi, 2010). However, several authors also see a potential silver lining from the crisis. Figueres and Streck (2009) argue that the financial crisis may lead to the emissions curve forming a downward bend as total emissions are reduced. This could be seen as an opportunity to realise low cost emissions reductions. It could also potentially further promote private investments into clean technologies. Kossoy and Ambrosi (2010) point to how the same problems that have hindered the project-based market may provide a stronger post-2012 market. They argue that future demand will be sustained because EU installations will have used less CERs and ERUs than their import limit allows. Hence selling credits will potentially be easier for sound projects in emerging regions and sectors.

Figueres and Streck (2009) ask whether the financial crisis could provide the pressure needed for a strategic change in energy consumption through improved efficiency and replacing technologies dependent on carbon based fuels with technologies based on renewable resources.

3.2 Technological barriers

The CDM pipeline encompasses a wide range of technologies with differing capital requirements and potential for creating CERs. These also have a varying degree of complexity and they will be influenced by the level of technological capacity already present within the host country (Schneider et al. 2008). Due to this lack of technological competence in the host country can act as a barrier.

Although technology imported from Annex I countries is likely to be more efficient, it is also more expensive. The result is higher initial investment costs than for locally developed technologies. Technologies that are at the early stages of commercialisation will often be considered riskier than more mature technologies. Schneider et al. (2008) also point out how due to size differences and specifications the technology that is available on the world market is not always appropriate in developing countries.

Due to the nature of the mechanism only certain project types will enter the application process. The underlying profitability of the technology itself will most likely have caused certain project types to self-select into the CDM due to how they must prove that they are unprofitable without the CDM. If the additionality constraint holds the pipeline should only consist of projects that are unprofitable without carbon revenue.

Projects using unproven and not yet mature technologies will face more uncertainty and lower returns than those that involve just adjustment investments (Cosbey et al. 2005). It has been expected that the uncertainty over the post-2012 scenario would favour projects with short implementation periods and quick pay back times. According to Cosbey et al. (2005), this has already stopped some project types and will stop even more as the expiry of the current climate agreement gets closer.

The degree of complexity in proving additionality will also be influential. More mature technologies will also benefit here. Straightforward methodologies for certain technologies will favour some project types. Once several methodologies are established for a technology they can be used free of charge by other projects. This could cause momentum for a technology once widely applicable methodologies are established.

The Designated National Authority (DNA) is also free to impose technological transfer as an important criterion for the approval of projects. This way they can favour projects that induce technological transfers, which may act as a driver or barrier for the various project types (Schneider et al. 2008). Seres (2007) found that there are large variations in how different countries have approached this, but that only Mexico, Thailand, Vietnam, Sri Lanka, Ecuador and Honduras significantly encourage technology transfer, whereas in India it has been discouraged.

Looking at the project types currently in the pipeline, the ones that are best represented at VA-00 are hydropower, biomass, biogas, energy efficiency and wind power. In addition to this solar power has seen a massive increase in applications for validation in 2010. Chapter 4 will analyse these technologies.

3.3 National barriers

Every CDM project has to be approved by the host country, which means that on a national level the CDM activity can be restricted and meet barriers such as lack of national capacity, institutional limitations or bureaucratic restrictions. The level of established CDM institutions and a well-functioning Designated National Authority (DNA) will have an impact on the attractiveness for potential investors.

A government may also for various reasons decide to limit the amount of CDM-activity (Haites 2004:65). The consistency of the CDM policy in a country will also be influential, along with the general awareness of climate change and willingness to facilitate renewable energy projects.

The two countries with most small-scale projects in the CDM pipeline, India and China, have had a progressive CDM policy and also encourage development of unilateral projects. In China majority host country involvement is required for CDM projects, and it is also the norm in India (Ellis and Kamel 2007). As more projects are developed in a country, the CDM capacity will improve and project implementation will become easier and more attractive.

Projects will also meet barriers on a national level in the host country that are not directly linked to the CDM process. National policy and general legislative frameworks within a country or region will influence the environment for project development (Ellis and Kamel 2007). The general investment climate and the level and quality of institutions in the society, along with enforcement of law and order, is important to potential investors. It is easier to carry out projects and comply with laws and regulations if there is a transparent and well-functioning system.

The stability of the political regime is also important. CDM projects will generate CERs for many years to come, so an unstable political climate will act as a barrier. Ellis and Kamel (2007) also point to the importance of the perceived efficiency of the government in a host country for a potential investor. Cosbey et al. (2006) emphasise how developing countries in general are considered a higher host country risk for investors. These risks include underdeveloped institutions, political upheaval, corruption, crime and unstable economic investment climates.

The investment climate within a country could influence whether there is a majority of unilateral or bilateral CDM projects taking place. The level of domestic or foreign investment may be influenced by the institutions and policy measures in the country (Ellis and Kamel 2007). Restrictions on foreign ownership within a country will also be a barrier for bilateral projects. Projects carried out in countries with low capacity or complicated regulations and procedures take longer to reach the implementation stage (Bosi et al. 2010).

Another important issue is mastery of the clean technology in the host country. For small-scale projects utilising complex technologies, lack of competence will be a barrier. On the project level the availability of infrastructure, issuance of necessary permits and level of local government and community commitment will influence the potential for successfully implementing a project (Cosbey et al. 2006). Price subsidies to conventional energy will also act as a barrier to renewable energy CDM projects (Schneider et al. 2008).

3.4 International barriers

The current Kyoto Agreement runs until 2012, and so far no new agreement is in place to take over. This lack of certainty over future emission commitments influences the CDM market through the price of CERs, although the CDM is not directly tied to any specific period. To have a well-functioning carbon market there must be a balance between supply and demand. Early worries were over the creation of "hot air"[8] from certain former Soviet nations, as these credits could crowd out CDM credits as they could be sold at any price. There were also concerns over whether the CDM could create enough credits given the long project cycle involved, and thereby whether the number of CERs created would be enough to meet the demand (Michaelowa 2005).

As noted already the size and success of the CDM has exceeded all expectations. Up until the financial crisis created a tougher investment climate across the globe, the number of registered CDM projects was increasing fast. According to Michaelowa (2005), the amount of small-scale projects in 2005 was higher than expected from advance theoretical analyses. He offers a possible explanation for this being high price expectations for CERs and a high share

[8] The term "hot air" refers to surplus emission allowances that arose due to the fall of the Soviet Union.

of unilateral projects being registered[9]. A high price on CERs would increase the expected carbon revenue and lead to more small-scale projects becoming attractive to investors, despite uncertainty regarding a new climate agreement.

However, as we get closer to the expiry of the Kyoto Protocol in 2012 the expected development would be a decline in projects entering the pipeline due to how projects must spread out the fixed transaction costs over a long time period to be economically viable (Haites 2005). This means that as long as there is no new binding agreement post 2012, project developers will face another large risk as they might not be able to sell their CERs if the market collapses. Due to the limited value of reductions taking place after 2012, the costs of the project must be recovered by the emissions reductions carried out before the current agreement expires (Haites 2004). Haites predicted that without an established market value for post 2012 credits, project development would most likely stop by 2008. Michaelowa (2005) found that few projects were likely to start after 2007, and none after 2009, due to low market prices post 2012. Cosbey et al. (2005) argue how uncertainty over a future agreement will favour projects with short implementation periods and quick pay-back times, which may stop projects with long lead times and potentially high sustainability profits. They also comment on how some project types are already out of the picture, and how this problem will increase as the expiry of the Kyoto Protocol approaches.

The issue of a post-2012 agreement also creates another concern. If a new agreement ends up with limited emissions reduction commitments from the key nations, an increased supply of CERs from developing countries as a result of increased CDM activities will lead to a drop in the carbon price (Figures and Streck 2009). For small-scale projects this will lead to lower potential profits from CER sales, which again could lead to fewer realised projects. So the potential limited demand for offsets means that it could be necessary to restrict the supply of carbon credits (Figueres and Streck 2009).

Looking at the development in the database over the last few years it becomes apparent that the predictions of a stop in project activity have not come through. Projects are still entering the pipeline, with a substantial increase of small-scale projects in the VA00 category between April and October 2010. However, the uncertainty over the future demand for emissions

[9] With unilateral projects the transaction costs are lower than for non-unilateral projects.

reductions will discourage project development, and Bosi et al. (2010) show how there has been a decline in all new CDM projects entering the pipeline throughout 2009 (see figure under 3.1.1) They conclude that uncertainty is closely linked to the decline in the number of new projects.

Despite the uncertainty regarding the future structure of global emissions reduction commitments, there are still more small-scale projects entering the pipeline. This is an indication that investors are still finding small-scale projects attractive, despite the uncertainty involved. The next section on CDM specific barriers will show that this is not the only uncertainty investors face when entering into a project.

3.5 CDM specific barriers

Naturally, CDM projects suffer from the same types of project risk as conventional projects, like exchange rate fluctuations, cost overruns, exceeding the project's timeframe, political issues and so on. A potential investor's willingness to invest in a project is directly tied to the risks involved, including the technology used and how proven it is. In addition to the regular risks involved in project development, the CDM projects involve some risks directly tied to the project-cycle. This includes the risk of using CERs as a financing source and the risk of being rejected by the CDM Executive Board.

Ellis and Kamel (2007) use a table to outline the various risks that can influence whether a CDM project successfully completes the project cycle or not.

Table 3.1. CDM-specific project risks.

DNA/Letter of Approval Risk	The risk of having either a delay in the issuance of LoA by DNA or project failing to obtain a Loa. Risk of LoA being revoked after it has been issued
Validation & EB Registration Risk	Risk of DOE unable to complete validation of project due to inconsistencies or lack of data. Risk of having the project reviewed by EB prior to registration. Both delays impact the flow of accumulated CERs
Monitoring & Verification risk	Risk of errors during project monitoring that result into ex-post miscalculation of emission reductions
EU ETS Risk	Risk of EU ETS (biggest source for demand for CERs) having an oversupply of EU Allowances (EUA) which would dampen the demand for CERs.
Methodology risk	Risk of an approved methodology being put on hold for a period of time, such as the case of AM0006, and AM0016)
Review of Issuance Risk	Risk of EB reviewing the project prior to issuance of CERs

Source: Ellis and Kamel (2007:31)

The CDM-process has been criticised for being too subjective and lacking clear guidelines. This increases the risk aspect for investors as it is difficult to calculate costs. Administrative delays in connection with the project cycle combined with evolving and changing procedures make the CDM-process highly unpredictable for potential investors. For a small-scale project where the margins are already small this added aspect of uncertainty could have effects that are decisive for the project's existence.

Experience so far shows that despite the simplified procedure for small-scale projects the current development is that the timeframe for the CDM approval process has increased over the last ten years - and even more so for small-scale projects than large.

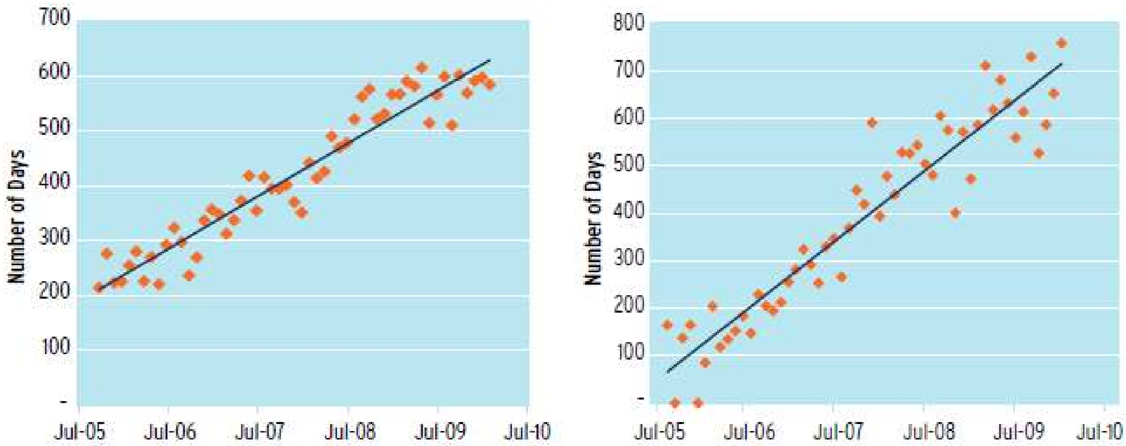


Figure 3.2 Average days for reaching registration and "first issuance"
Figure 3.2a shows average days necessary for projects to reach registration, and figure 3.2b shows average days necessary for a project to move from registration to "first issuance". (Source: Kossoy and Ambrosi 2010:42)

Several factors have driven the increase in cost and time it takes to complete the project cycle. These factors are: "(i) a sharp increase in demand for DOE services; (ii) the lack of CDM experts; (iii) CDM regulatory demands, volatility and restrictions; (iv) risks (reputational, financial); and (v) insufficient systematic support from the CDM EB and the UNFCCC Secretariat (…) (Bosi et al. 2010:23).

These time delays add to the uncertainty faced by project developers. The lack of clear guidelines due to the learning-by-doing nature of the process does not help. The project managers face an undefined time period where the project is put on hold awaiting approval, but at the same time they are required to have the resources to answer an unknown and unlimited amount of questions (Figueres and Streck 2009).

A CDM project can either use an existing methodology or produce its own for approval. One of the main issues is that generally each project faces very different challenges and economic and environmental specifications, making the methodologies difficult to reuse in many cases. The process of developing a new methodology to prove additionality is both time consuming and costly. Because the project developing the methodology application takes the whole cost of developing and getting the methodology approved, it serves as a barrier for new projects aiming at parts of the CDM market without an already approved suitable methodology. There is no first mover advantage involved and the World Bank estimates that the cost of designing a new methodology and getting it approved lies at around 125.000 USD for both small-scale and larger projects. According to their estimates, the process takes around two years to complete. In general there is also a 50 percent chance of a new methodology being rejected.

Given that approved methodologies can be used by future projects free of charge, more approved methodologies results in results in lowered average project cost. This could make more projects economically viable (Haites 2004). However, so far out of the approved small-scale methodologies around 20 percent have never actually been used, and few are used more than once. This indicates a lack of learning and for small-scale projects, the technologies required are so specialised that they are not widely applicable. The most popular small-scale methodology has also been revised 15 times already by the Executive Board. Significant changes in the methodology could cause problems and delays for new projects (Bosi et al. 2010).

3.6 Summary

This chapter has dealt with some general barriers that small-scale projects meet and some that are more technology or project specific. Rising transaction costs connected to the CDM process will, as outlined, hit small-scale projects harder than larger projects where these costs are absorbed more easily. The combination of upfront transaction costs and uncertainty connected to the value of CERs, enhances this barrier.

There are many risk and uncertainty factors involved in the CDM process. IGES considers uncertainty to be the biggest barrier of the clean development mechanism. Too much subjective judgement in the process makes it unpredictable for potential investors. They recommend a checking system and more automation and particularly point to the guidelines for assessing investment analysis. Here they see great room for improvement and reckon improvements could streamline the CDM-process and again reduce the timeframe for project implementation (IGES, 2010). Bosi et al. (2010) conclude that the risks connected to the CDM procedure are consuming more and more of the CDM benefits and hence making the projects less attractive to investors. They recommend an urgent further simplification and clarification of the process to reduce transaction costs and delays in the process leading to project implementation. They also point to the need for simplification of the methodologies and adaptation for smaller projects with less resources and data available. The current trend of increasing lead time is unfortunate as delays in the regulatory chain increase transaction costs even further.

The baseline methodology is closely linked to the additionality demand. An analysis of the balance between simplifying the demand for proof of additionality and keeping an adequate environmental quality is beyond the scope of this thesis. But there is no doubt that some level of standardisation of the requirements would simplify the process (Bosi et al. 2010). Cosbey et al. (2005) argue that the additionality demand should automatically be removed for any project that meets the requirements for a simplified small-scale procedure. This way any project classified as small-scale would be additional and this barrier would be removed.

Although a streamlining and tightening up of the CDM procedure appears necessary to secure the future of small-scale projects, it also has to ensure a sufficient environmental quality. Getting his balancing act right is essential to ensure the environmental integrity of the mechanism, whilst ensuring more small-scale projects are carried out. At the same time the development in the various technologies will also be influential. As technologies mature, prices tend to become lower and the level of knowledge improves.

Increasing transaction costs and other barriers small-scale projects meet could reduce the size of the CDM and change the distribution of projects across the different categories. According to (Michaelowa and Jotzo 2005), transaction costs have a tendency to increase for project categories where the implementation costs are high. Transaction costs are also likely to account for a large share of the fixed costs that a small-scale CDM project faces, especially under low carbon price.

Some countries have built up fairly extensive CDM knowledge and framework, like the two largest CDM countries China and India. In countries where there have been few projects carried out, the national barriers are likely to be more of a problem.

Despite high transaction costs, a surprisingly large amount of small-scale projects have been submitted and cleared the CDM process. Hence there is reason to believe that this is somehow linked to the underlying profitability of the technologies. In turn that supports the initial intuition that the CDM opens up for less costly mitigation measures. Well designed programmatic approaches could therefore imply potentially large efficiency gains.

4. Technologies

As outlined in the previous chapter the most common barriers for CDM projects are lack of financing and high transaction costs. However, despite these barriers and considerable uncertainty regarding the post-2012 climate regime, there are still projects going into the pipeline. A run through of the IGES database in October 2010 shows that in contrast to the expert predictions and warnings of a drop, or even a complete halt in project activity, the number of small-scale projects going into the pipeline is still relatively high.

The CDM pipeline has a wide range of technologies with different capital requirements and potential for creating CERs. The variety in project types and the nature of the CDM process have made it difficult to generalise with respect to success criteria. The available empirical material is divided into two categories: (i) specific projects or PDDs, and (ii) more general analysis of the CDM pipeline (see Ellis and Kamel 2007, Schneider et al. 2010). The empirical evidence so far suggests no clear connection between the amount of created CERs and the success rate for clearing the CDM process (Ellis and Kamel 2007).

The next section will deal with some general trends in the development of renewable energy, before section 4.2 outlines the current trends for small-scale projects entering the CDM pipeline.

4.1 General technology trends

Despite the global economic downturn the world experienced in 2008 and 2009 the capacity for renewable energy continued to grow at similar rates to previous years. In 2009 the capacity for grid-connected solar PV grew at 53 percent, wind power at 32 percent, solar hot water/heating at 21 percent, geothermal at 4 percent and hydropower at 3 percent. Technologies currently experiencing growth in general are grid-connected solar PV, wind power, solar hot water, ethanol production, biomass and geothermal (REN21, 2010).

For hydro power in general, much of the current development of new projects is taking place in Brazil, China, India, Malaysia, Russia, Turkey and Vietnam. After a rush of development within small* hydro power in 2008, the growth was more subdued in 2009. India added 2,5

GW of small hydro capacity in 2009 (REN21, 2010). In 2009 hydro power as a whole grew by 3 percent globally, and by the end of the year it reached an estimated 980 GW. 60 GW of this was defined as small hydro (REN21, 2010).

Power plants based on biomass can now be found in more than 50 countries around the world. According to REN21 (2010), it provides a growing share of electricity generation. In developing countries the use of solid biomass for electricity generation has seen a significant growth in recent years. Use of agricultural waste like rice husks and bagasse for small-scale power production is common in developing countries.

The growth in wind power continued in 2009, with new wind power installations capacity reaching 38 GW. With respect to new capacity, wind power was the renewable technology with highest increase in capacity in 2009. The largest market was China with more than a third of the volume globally. An emerging trend in wind power is a growing market for small-scale[10] wind projects. This includes systems that are not grid connected, and also recently more projects that have a distributed grid-connection. China is currently the largest market for small wind turbines, and updating its capacity annually. India has a five year plan for renewable energy where the target is an additional 12,5 GW of renewables[11]. India also has a 10-year exemption for income tax on wind power projects. Another trend is that these small-scale wind projects are being implemented in many more countries and regions than before. Wind power in general has gone from existing in just a few countries in the 1990s up to 82 countries in 2010 (REN21, 2010).

The substantial growth in grid-connected PV on a worldwide basis is partly explained by decreasing production prices, scaling up and other general market changes taking place in recent years. Solar PV has grown by 60 percent on average for the last decade. In 2009 the total investment in larger scale PV fell, but at the same time small-scale solar PV projects experienced record high investment. Some of this development can be explained by subsidies and tax breaks on solar PV rooftop programmes in several countries (REN21 2010).

For projects that generate excess electricity, access to a grid and feed-in tariffs are important.

[10] REN21 2010 consider small-scale wind to include turbines producing power for single homes, farms or small businesses.
[11] The target is for wind, small hydro and biomass together.

A feed-in tariff guarantees producers of renewable energy access to the power grid at a given price. By 2012 more than 50 countries had implemented feed-in tariffs. These policies have had the largest impact on the development of wind power, but have also been influential for small hydro, biomass and solar PV (REN21 2010).

4.2 CDM trends for small-scale projects

Due to the nature of the CDM process the projects moving along in the pipeline should be additional and hence non-profitable without carbon revenue. As outlined in section 2.2 the project cycle is comprehensive and the average time it takes for a project to clear the project cycle has been increasing.

The IGES database divides the projects into three categories. A project is first included in the database when it reaches the "validation" stage of the project cycle. At this point it has been approved by the Designated National Authority (DNA). The project then applies for registration with the Executive Board (EB), and at this point it leaves "validated" and is moved onto the "request and registration" stage. When this process is completed the project will be implemented and after a successful verification period it is moved onto the "issued" stage when the CERs are then created. Because projects are at various stages in the process, and some are being held back for reviews or being rejected, it is not straightforward to see how many projects are moving from one stage to another at all times.

The projects are given a starting date, but these do not necessarily reflect where in the process the projects currently are, as this depends on how the project is implemented and whether it is a CDM add-on or a project developed from scratch. Type of project is also influential as the investment patterns differ between the various projects. The starting date of a CDM project is defined as "the earliest date at which either the implementation or construction or real action of a project activity begins".[12] This means that the projects in most cases do not enter the database on its starting date.

To make an assessment of the projects that are going into the pipeline I have chosen to look at how many projects are currently at the first stage of validation in this chapter. These are

[12] As defined in the report from the Executive Boards forty-first meeting 02.082008. Retrieved 22.11.2010 from http://cdm.unfccc.int/EB/041/eb41rep.pdf

labelled VA-00 in the IGES database. I will then address the projects currently achieving validation in the next chapter.

Projects at VA-00 have been opened up for public comment, which implies that the project has been approved by a Designated Operational Entity (DOE) and submitted to the UNFCCC for validation. A project is open for public comments for 30 days. The DOE then makes a decision on whether the project should be validated or not. If the project has not reached the registration stage within 6 months upon the end of the public comment period, the DOE is required to update the validation status of the project to one of the other sub-categories (see table 2.2). Projects that are denied validation can apply again after revisions have been carried out[13].

The technologies that have currently got most projects applying for validation are hydro power, energy efficiency, biomass, biogas, wind power and solar power. This chapter will take a closer look at them. The technologies that have few projects in the pipeline and little current activity will not be addressed.

As of October 2009 there were 430 small-scale projects classified as VA-00. Of these projects 427 were opened for public comments in 2010, and 3 in November 2009. They had the following distribution among technologies:

Table 4.1: Projects at VA-00 as of 1st October 2010

Technology	Projects at VA-00
Aforestation/reforestation	2
Biogas	54
Biomass	59
Energy efficiency	53
Fuel switch	12
Hydro power	111
Methane avoidance	4
Methane recovery	9
Other renewable: Hydro	1
Other renewable: Solar PV	27
Transportation	1
Waste gas/heat utilisation	14
Wind power	80
Total amount of projects	**427**

[13] IGES CDM in charts (Updated October 2010)
http://enviroscope.iges.or.jp/modules/envirolib/upload/835/attach/charts.pdf accessed on 14.11.2010.

4.2.1 Dominating technologies

The most established technology within the CDM framework is hydro power. Small-scale hydro power projects top the list when measured in number of projects on all levels of the project cycle, followed by biomass and biogas.

Hydro power projects generate electricity through the use of moving water. It can be generated through the use of existing dams, by constructing new dams or through run of river technology. Run of river projects capture kinetic energy from rivers and streams without the use of a reservoir. This type of technology uses the natural flow and elevation drop already in a river and does not require large alternations to the landscape. In rural areas without access to electricity small-scale[14] hydro installations are often used to replace diesel generators or other small-scale power plants (REN21 2010).

As of 1st October 2010 106 small-scale hydro power projects had reached the "issued-stage" where CERs are being created. Out of the different categories, run of river projects are by far the most used with 470 projects under "validation". New reservoir-projects are also well-represented in the pipeline compared to other technologies, but with far less projects than run of river.

Table 4.2 Hydro power projects by type and status

	Validation			Registration	Issuance
	VA-00	VA-06	Totally		
Hydro power	**111**	**90**	**559**	**414**	**106**
Bagasse*				0	
Existing reservoir	3	6	20	18	6
New reservoir	30	1	69	73	14
New reservoir/ Run of river				1	
Run of river	78	83	470	321	86
Others				1	

Biomass is another technology that has seen a substantial amount of small-scale projects implemented under the CDM. The UNFCCC defines biomass as "by-products, residues and waste streams from agriculture, forestry and related industries"[15]. The small-scale biomass

[14] The definition for small-scale CDM projects limits projects to a maximum output capacity of 15 MW. The global data for small hydro power has been inconsistent between countries, with many different capacity limits. China has used less than 50 MW, Brazil and the US less than 30 MW and India less than 25 MW. As of 2010 the Renewables 2010 Global Status Report has started using a definition of less than 10 MW.

[15] http://cdm.unfccc.int/EB/023/eb23_repan18.pdf accessed 03.12.2012

projects cover power and heat generation from solid biomass like bagasse[16] and rice husks. Currently there are 352 projects classified as validated, 197 under RR and 75 that have started creating CERs. As of 1st October 2010 59 projects were at stage VA-00. The largest amount of projects currently in the pipeline is classified as "others". This includes biomass combined stoves and heaters, thermal energy production, fuel switch and biomass-based power plants among others. Rice husk projects are also well represented throughout the pipeline.

Table 4.3 Biomass projects by type and status

	Validation			**Registration**	**Issuance**
	VA-00	VA-06	Total		
Biomass	**59**	**81**	**352**	**197**	**75**
Bagasse	3	11	26	19	9
Bagasse/others			1	1	1
Composting				2	
EFB	2	4	16	22	7
EFB/others			1		
Non-renewable biomass			2		
Others	33	29	172	92	34
Palm oil	2	1	4		
Rice husk	12	22	83	58	24
Rice husk/bagasse			1		
Rice husk/bagasse/others			2	1	
Rice husk/others			10	2	
Woody biomass			33		
Woody biomass/black liquor			1		

Closely linked to biomass is **biogas**, which is the use of domestic, industrial and agricultural sewage to produce energy for domestic processes such as heating and lighting[17]. So far biogas has mainly been used to generate electricity in OECD countries. However, the technology is also on the increase in developing countries (REN21 2010).

In the CDM pipeline there are currently 329 projects at validated, 248 at requested and registered, and 15 that have started generating CERs. For small-scale projects classified as biogas, animal waste and wastewater treatment are the most frequent project types currently in the pipeline.

In total there are 55 small-scale biogas projects under VA-00, where 34 are wastewater treatment projects, 13 animal waste and 8 household biogas projects.

[16] Bagasse is the by-product of sugar cane processing.
[17] Oxford Dictionary of Chemistry

Table 4.4 Biogas projects by type and status

	Validation			Registration	Issuance
	VA-00	VA-06	Total		
Biogas			329	248	15
Animal waste	12	60	129	144	4
Animal waste/others	1		1		
EFB		2	2		
Household	8		9		
Non-renewable biomass			0	1	
Others		2	6	4	1
Wastewater treatment	34	31	182	99	10

Energy efficiency also encompasses many different types of projects. Factory installations are represented with the most small-scale projects at present. 139 projects are under validation, 55 under requested and registered and 18 have started creating CERs. Out of all the projects currently at the validation stage 53 are at VA-00.

Table 4.5 Energy efficiency projects by type and status

	Validation			Registration	Issuance
	VA-00	VA-06	Total		
Energy Efficiency			232	87	21
Commercial/household	32		42	5	
Composting			3		
Factory	15	38	139	55	18
Household	1	6	31	17	1
Non-renewable biomass			2	1	
Supply side	5	2	15	9	3

Small-scale **wind power** projects are also fairly well represented throughout the pipeline. There are 302 projects in validation and 118 in requested and registered. 36 of these projects have reached the issued category as they have started creating CERs. At the validation stage these projects range between producing 0,225 MW and 9,6 MW, whereas for RR projects the largest one is only 2 MW. At the issued stage the projects have a capacity between 0,225 MW and 1,5 MW. Most of the projects involve several units. As of 1st October 2010 there were 80 projects classified as VA-00.

Table 4.6 Wind power projects by type and status

	Validation			Registration	Issuance
	VA-00	VA-06	Total		
Wind power	80	31	302	118	36

In the IGES database the projects have been divided into solar power and PV[18]. Despite being the fastest growing renewable energy form in the world, solar PV projects have so far not been well represented in the CDM pipeline. Only one project, a PV project in Indonesia, has reached the issued stage.

However, when looking at the current development of solar and PV there are a number of projects applying for validation and registration. For projects defined by IGES as solar power there were only two that were at the validation stage in April, but by October 2010 the number had gone up to 27. All of these 27 projects are at VA-00. Of the projects in VA-00, 12 are from India and 10 from China.

Table 4.7 Other renewable energies by type and status

	Validation			Registration	Issuance
	VA-00	VA-06	Total		
Other renewable energies					
Solar power	24	1	27	0	1
PV	3		12	26	

4.2.2 Profitability

Because of the CDM goal to ensure implementation of projects that would not be implemented without carbon revenue from the sale of CERs, the technologies moving ahead in the pipeline should not be directly linked to general technology development and success. The projects applying for validation should lie below the profitability threshold, and be pushed into profitability by the carbon revenue generated. This implies that as the general cost of a technology is brought down, it either pushes a project closer to the profitability threshold or above it.

Therefore, the project types with the best effect from the CDM should lie just around the profitability threshold. However, whether a project is implemented or not through the CDM also depends on the CDM related transaction costs for each technology. Due to the variations in the methodologies, and costs connected to proving additionality, there are some differences between the technologies. Hydro power projects typically have fairly high start-up costs

[18] I have provided an overview of the two separately the way it is portrayed in the IGES database, but in the following analysis I will address the overall development.

followed by low operating costs. This implies that the payback time is relatively long. Fundamentally, hydro power technology is the same regardless of the size of the project, although with respect to costs the main variable is size. This implies that small-scale hydro power projects lie at the lower end of the predictions for profitability for hydro projects in general.

Schneider et al. (2010) estimate that small[19] run-of-river projects lie around the profitability threshold and that the CDM thereby contributes "rather little" to the profitability of a project of this type. It could be that for the projects classified as small-scale this is enough to push them over the profitability threshold. At the same time they only found small to medium impacts on project implementation through the carbon price for hydro projects.

For biomass, most of the projects also lie around the profitability threshold, but they found that there was a much wider range of project types within this category which lead to a higher variability among individual projects. They explained this with the influence of variations in fuel price in the different locations. Due to the differences between the projects, the effect of the CDM varied a lot more, but it mainly pushed the projects above the profitability threshold.

Ellis and Kamel (2007) place biogas co-generation to the middle for investment costs with fairly low CER returns on investment. Schneider et al. (2010) only found small to medium impacts on project implementation through the carbon price, but that biomass was strongly dependent on regional conditions.

Ellis and Kamel (2007) have looked at biogas projects in general and these were placed fairly low in relation to investment cost, and to the middle of CER return on investment. Schneider et al. (2010) found that for larger biogas projects like landfill and sewage, the CDM lead to a strong push towards profitability. They also found that biogas was strongly pushed by the development in the carbon price.

Energy efficiency projects have been struggling with high transaction costs, long lead times and small credit flows. The dispersed nature of many of the projects has also made them less attractive than other technologies in the CDM market (Cosbey et al. 2006). However, the

[19] Their definition of small is not specified, but as this is an analysis of the CDM pipeline I assume that they apply the small-scale definition.

number of energy efficiency projects has been increasing in recent years. Most of these are developed in India.

Ellis and Kamel (2007) found that energy efficiency projects have large variations both with respect to the level of investment costs required, and the CER return on the investment compared to most of the other technologies they assessed.

As wind power has matured in recent years, it has increased its commercial viability and also attracted more investors (Schneider et al. 2008). For wind power (Schneider et al. 2010) only found small to medium impacts on project implementation through the carbon price, but that wind power projects were strongly dependent on regional conditions. Ellis and Kamel (2007:42) place wind power in general low on the CER return on investment scale, and above average on investment costs. This is supported by the findings of Schneider et al. (2010) who find wind power to have relatively low specific GHG reductions and that these projects are close to profitability without the CDM. They conclude that the CDM therefore contributes "rather little" towards the profitability of wind projects. Although in some cases for small wind projects the CDM could lead to it becoming unprofitable due to the relatively large transaction costs involved.

Solar power is the most recent technology to show an increase in the number of small-scale CDM projects. Working on data from the pipeline in 2008 Schneider et al. (2010) found that solar PV does not become profitable through the use of the CDM. In some cases the mechanism could have a negative impact on the profitability due to the large transaction costs involved in the process. Their analysis also showed that specific GHG reductions were low. They did not analyse this technology any further.

Another problem for solar PV has been that the CDM definition leads to it not being very attractive compared to for instance biomass projects (Cosbey et al. 2006). The recent trend of more applications could be due to the substantial drop solar PV has seen in production costs over the last few years.

The CDM definitions of the various technologies also influence the profitability of the projects. This is for example the case for biomass, where the CDM definition makes it more attractive than some other project types like solar PV (Cosbey et al. 2006).

The main CDM specific barriers for energy efficiency projects have been linked to development of baseline scenarios and methodologies. Project developers have avoided submitting methodologies for complex project types due to problems with the additionality assessment. Demand side energy efficiency projects are often complex, and hence few methodologies and projects have been submitted. Energy efficiency has also had the highest rejection rate for methodologies of all project types (Michaelowa 2005). The cost of methodology development is as already outlined substantial.

On the other hand the methodologies for hydro power have been considered fairly clear-cut, simplifying the process for these kinds of projects. In addition to being an established technology, the CDM approval process for hydro projects is considered to be relatively straightforward and simple (Cosbey et al. 2006). This may also partly explain its frequency rate under the CDM.

An overview of all the projects in the pipeline at the different stages clearly shows that solar power and wind power projects have started to move through the project cycle. Although these two technologies have few projects at the issued stage, the number of validated and registered projects is increasing.

4.2.3 Country profiles

The projects also vary with respect to the degree of regional dependency. Some technologies are strongly dependent on regional conditions, whereas others are not. Schneider et al. (2010) looked at the effect of regional variables for certain technologies and found that hydropower, biomass, solar PV and wind power projects were strongly dependent on regional conditions, whereas biogas was not. Energy efficiency is another technology where geographical location is not as important.

In addition to this some countries have had policies to encourage certain technologies. Subsidies, tax breaks or favourable feed-in tariffs will influence how attractive it is to develop projects in the different countries. In many countries national regulations are making it difficult to feed electricity to the grid. This could be a barrier for private-sector independent power producers (IPPs) wanting to invest, in for example, efficient biogas co-generation (Ellis and Kamel 2007) or other technologies that generate excess electricity.

How widespread a technology is within a country will also be influential as knowledge and access to skilled labour and CDM experience matters. China has for instance seen a massive development of hydropower in general. Other developing countries like Brazil, India, Malaysia, Vietnam and Ethiopia are now also focusing on development of hydro projects (REN21 2010).

There are 111 **hydro power** projects registered under VA-00. Of these 55 are registered in China, 25 in India, 11 in Vietnam and the remaining 20 projects divided between 11 countries[20]. China has for some time promoted small- and micro-hydro projects as part of its rural electrification programme. The initial goal was to make small local communities that are in isolated locations self-sufficient. An expansion of the country's electricity grid has led to more small hydro installations feeding power back into the grid. 2007 figures indicated that around 3 GW of China's then 50 GW of installed small hydro capacity was not connected to the grid (REN21 2010).

The use of **biomass** for electricity generation in developing countries is on the increase. Within small-scale CDM projects India dominates with most projects at all stages of the project cycle. 59 projects are at VA-00, where 29 have India as the host country.

Biogas has 55 small-scale projects under VA-00. Compared to some of the other technologies, biogas has a good spread of countries represented in the pipeline in general, and is not as dominated by Chinese and Indian projects: China has 14, Thailand has 12 and India has 8 projects. The remaining 21 projects are divided between 11 countries. Thailand nearly doubled its capacity for electricity production through use of biogas in 2009 to a total of 51 MW. Another country that is expanding in this direction is Malaysia. However, Malaysia only has 1 project at VA-00 and 17 in validated in total.

India is well represented overall for **energy efficiency** projects. Of the 53 projects at VA-00 43 are from India, which means that the majority of recent energy efficiency projects applying

[20] Armenia, Brazil, Chile, Guatemala, Honduras, Indonesia, Panama, Peru, Republic of Korea, Sri Lanka and Uganda.

for validation has India as the host country. For small-scale CDM **wind projects** India is also the dominant country. At validation stage there are 287, at RR 95 and at issued 29 Indian projects. Out of the 80 projects in the VA-00 category 76 are developed in India; 72 of these are unilateral. Measured in existing wind power capacity India, is on fifth place world wide, and is continuing to expand (REN21 2010). However, India's current wind plants are less efficient than other leading nations (NREL 2010).

China updated its feed-in tariffs for wind power in 2009 based on experience in previous years (REN21, 2010). This led to Chinese wind farm projects being rejected by the Executive Board due to suspicions over Chinese domestic policy to reduce feed-in tariffs to promote CDM projects[21].

In 2009 China alone produced 40 percent of the **solar PV** supply in the world. The Chinese target for solar PV by 2020 is 20 GW, whereas India aims for 20 GW by 2022. The Indian target is set in the Jawalharial Nehru National Solar Mission (JNNSM) to ensure technological development in the national solar industry and reaching grid parity sooner. Currently India has 12 and China has 10 projects at VA-00.

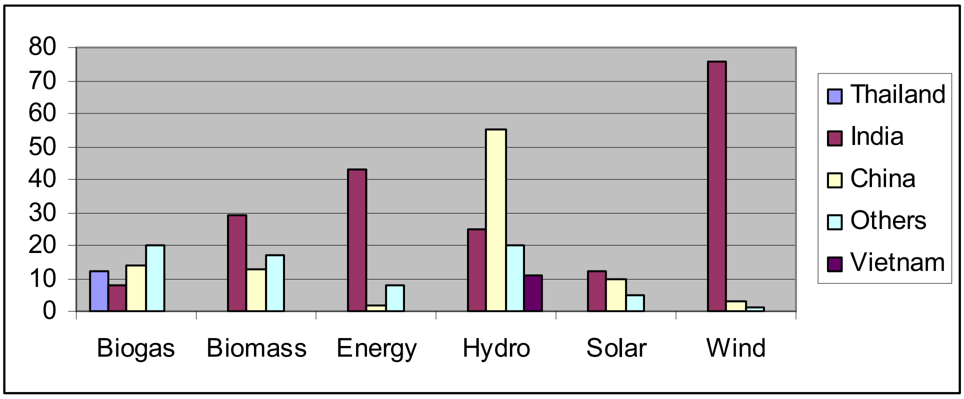


Figure 4.1. Number of applications at VA-00 by country[22]

[21] Source: International Institute for Sustainable Development. (n.d.). Copenhagen Highlights - Wednesday, 9 December 2009 - Copenhagen - Denmark. Date of Access: 31 October 2010: http://www.iisd.ca/vol12/enb12451e.html

[22] All technologies have the number of applications from China and India. Beyond that countries with more than 10 applications have been added. All other countries are under others.

4.2.4 Foreign involvement

In total 57 percent of all small-scale projects in the database are unilateral, which means that they are developed without a committed Annex I investor. For VA-00 the division is 50 percent between non-unilateral and unilateral. For large-scale projects at VA-00 only 33 percent are developed unilaterally.

The share of unilateral projects differs between technologies. Small-scale wind power stands out with a 90 percent share of unilateral projects. Of the 80 projects currently at VA-00, 76 are developed in India. Biomass also has a large share of unilaterally developed projects; 58 percent of these are unilateral. Most of these projects are developed in India where just one of the 29 projects have an involved Annex I partner. All the Chinese projects are non-unilateral. Energy efficiency projects currently have a unilateral share of 47 percent. Again India is the dominant country with 43 of the 53 projects at VA-00. Of the Indian projects 44 percent are unilateral.

Solar PV, hydro power and biogas are at the lower end with less than 40 percent. Solar PV has only got 27 projects at VA-00, where 12 are from India and 10 from China. 37 percent of these have been developed unilaterally. All the Chinese projects are non-unilateral and 7 of the 12 Indian. All these are developed by the same German company. For hydro power and biogas the share of unilateral projects lies at 33 and 31 percent. Around half of the hydro power projects are developed in China and all of these are non-unilateral. India stands out with 21 of their 25 projects being developed unilaterally.

Table 4.8 Percentage of unilateral projects at VA-00

	% of unilateral projects
Hydropower	33
Biomass	58
Biogas	31
Energy efficiency	47
Wind power	90
Solar power	37

Source: IGES database updated 1st October 2010

At the other end of the pipeline the unilateral projects are scarce. Of the 271 projects[23] only 14 are unilateral. Considering that the Executive Board opened up for unilateral projects in 2005

[23] Projects from all technology categories that have reached issued.

and that the number of this type of projects has been increasing, the share of projects at issued is still very low.

4.3 Summary technologies

Bosi et al. (2010) find that it appears like already proven technologies have benefited most from the CDM and that carbon revenues have not altered the investment pattern with respect to to technologies. Up until 2010 the CDM has made investments in projects using proven technologies with marginal rates of return that involve relatively low risks more attractive through improving profitability. This is backed by the findings of Ellis and Kamel (2007) and Schneider et al. (2010) where we see that the most frequently used technology, hydro power, lies around the profitability threshold.

Looking at the pipeline today, the technology that has had the largest increase in project applications is solar PV. According to Schneider et al. (2010), solar PV has had such high costs that the CDM has not been able to push projects above the profitability threshold in the past. However, a large drop in solar panel production costs in the last few years has changed the picture. So far in 2010 there were 27 solar projects applying for validation. This is a massive leap for a technology that has hardly been represented in the pipeline so far.

In total 50 percent of the small-scale projects at VA-00 are unilateral. This is a much larger share than for large-scale projects at VA-00, which only has 33 percent unilateral projects. The category that stands out with most is small-scale wind power projects. Here, 90 percent are developed unilaterally; 76 of the 80 projects are developed in India. For biomass projects, the level of unilateral development is 58 percent, for energy efficiency 47 percent, solar PV 37 percent, hydro power 33 percent and biogas 31 percent. India stands out with the largest share of unilateral projects. Out of all the Indian small-scale projects at VA-00, 78,5 are unilateral, whereas less than 3 percent of the Chinese projects entering the pipeline are unilateral.

There is also some evidence of clustering of project types in certain countries. China and India are the two dominant host countries and India dominates the number of projects when it comes to biomass, energy efficiency and wind power. China has the majority of hydro power projects, whereas biogas has the greatest country spread with no real dominant nation.

With a process like the CDM specific institutions are required on several levels in the host country. Once this is established and a certain amount of projects have been implemented in a country, the process becomes easier. China and India have also consciously encouraged CDM development. For some of the technologies, such as hydro, solar PV, wind and biomass, regional conditions play a role. Biogas and energy efficiency projects are less dependent on location.

5. Analysis

In order to answer the third problem statement and say something about the characteristics of the projects currently entering the pipeline, I analysed the material in the CDM project database statistically using regression analysis. The projects have been limited to those that are at the validation stage in an attempt to show what influences whether they receive the initial approval or not.

5.1 Regression

Because this is a validated/not validated scenario, Ordinary Least Square (OLS) regression is not appropriate. A binary probit regression is used to look at what the success criteria are for gaining validation. Due to the long lead time of CDM projects only the projects that are currently at the validation stage with starting date for public comments in 2009 and 2010 are included. Projects that applied for registration in 2010, which means that they were validated in that time period, are also included in the dataset. Currently the average time from initial application until a project is validated is one year (Bosi et al. 2010). Based on this the regression will then be applicable to projects that have applied and been approved in the last two years.

I have chosen to use data from the projects that applied throughout 2009 and 2010 and were then approved or rejected during 2010. This choice is based on the lead time for validation for CDM projects currently being estimated to around a year. The projects are classified with status CC and RR-01 stage as validated, and projects that are at VA-06 and VA-03 as rejected. The remaining projects at validation are presently at the stage where a decision has not been made, VA-01, VA-02, VA-04 and VA-05. The dataset used contains 469 observations.

The CDM is constructed to ensure implementation of projects that would not otherwise be profitable. This implies that all projects that go through the validation process should have zero or negative profit if the additionality constraint holds. Because y is an unobserved variable, profit smaller or equal to zero, a latent variable model must be used.

$$y_i = \begin{cases} 1 & \text{if} \quad \Pi \leq 0 \\ 0 & \text{if} \quad \Pi > 0 \end{cases}$$

The dependent variable is validation or not (*valid*). The explanatory variables chosen are whether the projects are unilateral or not (*nonuni*), estimated annual average emissions reductions (Ers) (*ann_ers*), dummy variables for the main technologies (*dHydro, dBiogas, dBiomass, dEnergy, dSolar and dWind),* and for the two leading CDM host countries China and India (*dIndia* and *dChina*).

The model then looks like this:

$Pr\{y=1\} = \alpha_0 + \alpha_1$ valid $+ \alpha_2$ nonuni $+ \alpha_3$ ann_ers $+ \alpha_4$ dHydro $+ \alpha_5$ dBiogas $+ \alpha_6$ dBiomass $+ \alpha_7$ dEnergy $+ \alpha_8$ dSolar $+ \alpha_9$ dWind $+ \alpha_{10}$ dIndia $+ \alpha_{11}$ dChina $+ \varepsilon$

The choice not to include any country specific variables is based on how the CDM pipeline is so dominated by Indian and Chinese projects. The majority of the other countries only have very few projects registered for each technology. Instead, dummy variables for China and India have been constructed in an attempt to control for the effect of the projects being from these two main CDM nations.

There are several steps that are appropriate to test the usefulness and adequacy of the model. A probit regression is run with all the chosen explanatory variables to check the significance of the preliminary sign of the coefficients. Due to the nature of the probit model, the coefficients only indicate the direction of the effect. The probit model assumes a standard normal cumulative distribution function (Wooldridge 2009).

The variables that come out significant are non-unilateral along with the dummies for hydro, energy efficiency, solar and wind. Non-unilateral has a p-value of 0,00, and a positive coefficient. The dummy variables for hydro power, solar power and wind power come out positive and significant at 1 percent level. Energy efficiency is significant at 5 percent level and also here the coefficient comes out positive. The partial effects have then been estimated to assess the magnitude of the effects.

Table: 5.1 Regression results (Stata)

Dependent variable *valid*	
Independent variables	**Probit**
Non-unilateral *nonuni*	0,941 (0,186)
Average annual ERs *ann_ers*	-2,49e-07 (4,04e-06)
Dummy Hydro *dHydro*	0,868 (0,242)
dBiogas	0,170 (0,305)
dBiomass	0,267 (0,306)
dEnergy	0,680 (0,336)
dSolar	2,137 (0,603)
dWind	0,859 (0,322)
dIndia	-0,066 (0,217)
dChina	-0,188 (0,214)
Precentage correctly predicted Log-likelihood value Pseudo R-squared	79,53 -210,55 0,124

The significant variables at the 5 percent level are *nonuni, dHydro, dEnergy, dSolar* and *dWind*. For non-unilateral the partial effect comes out at 0,256, which implies that non-unilateral projects have around 25 percent better chance of being validated. For hydro power the partial effect comes out at 0,264. Solar power and wind power come out with partial effect of 0,71 and 0,27. For the dummy variables the effect is for a discrete change from dummy variable 0 to 1. The high effect on solar is possibly due to this category having the lowest number of applications.

The next step is to carry out a goodness of fit test of the overall model. The Hosmer-Lemenshow statistic is a goodness of fit test often used for probit models. It partitions the observations into 10 groups that are equally sized according to their predicted probability. The null hypothesis is that the model fits.

The Hosmer-Lemenshow chi2(8) comes out at 8,86 with a p-value of 0,3545, and shows no evidence of lack of fit based on the Hosmer-Lemenshow statistic. Hence the null hypothesis cannot be rejected. However, it should be noted that the test results are dependent on the sample size of the data. The test is likely to indicate that the model fits for small sample data sets, and fail for larger data samples, even when the model does fit. My data has 469 observations, which is not a particularly small sample. However, the rate of validation is around 20 percent. This is not necessarily problematic, but on the low side. Some of the technologies also have fewer observations than the others, which may be influential.

In OLS regression R^2 is often used as a goodness of fit measure. Probit regression does not have the usual R-squared, however there are several pseudo R-squared options (Wooldridge 2009). To evaluate the ability of the model to discriminate between the two response variable groups I have chosen to use McFadden's R-squared. First the probit regression has been run with just the *valid* variable to assess how much explanatory power that is due to the explanatory variables. This first regression comes out at 79,10 percent. Considering that the original regression containing all the explanatory variables only came out at 79,53 the model gains less than half a percent explanatory power. There is not clear rule for how much the explanatory power should increase, but an increase of at least a few percent should be seen. This unfortunately renders the results not very statistically interesting. So although the goodness of fit test came out showing a good fit, there is a larger underlying problem with the explanatory power, most likely through endogeneity issues.

Endogeneity usually arises in one of three ways; omitted variables, measurement error or simultaneity. An equation may have more than one source of endogeneity, and it can be difficult to distinguish between them. In the case of omitted variables it may be due to data unavailability or a poorly specified model. An explanatory variable is endogeneous if it is correlated to the error term. Correlation of unobservable variables with explanatory variables is often due to self-selection (Wooldridge 2002). In this case there might be unobservable factors that influence a project developer's choice to enter the validation process.

I suspect that the main problem with my model is linked to omitted variables, and unobserved effects. The explanation for this is potentially closely linked to the nature of the CDM process. The small-scale projects that enter the project cycle vary considerably in size, form and implementation. Hence, the potential for omitted variables influencing the process is massive.

Factors such as the quality of the PDD and the CDM competence of the project developers are likely to be influential for whether validation is achieved or not. These are difficult to difficult to quantify. Projects within the same technology category may also require use of different methodologies, or even development of a new one. There are also frequent revisions to the methodologies taking place, influencing individual projects at different points in time. Projects may also be required to provide additional documentation. This delays the process and increases costs.

Intuitively transaction costs connected to the CDM process should be approximately the same for the different project categories. Although, again due to the need for different methodologies for certain project types within a technology category, and requests for revisions, this may vary as well. It appears, as initially suspected, that there are too many individual effects for each project that are difficult to account for. Because the model has very poor explanatory power it is difficult to conclude with respect to clear characteristics for the projects that achieve validation.

5.2 Drivers and characteristics

Although the regression analysis does not show any clear results for characteristics of the projects currently being approved, the projects currently applying for validation are an indication of the investors' expectations. This section will therefore look at the drivers behind this development. It is clear from chapters 3 and 4 that investors from Annex I countries generally remain conservative in their choices. The majority of the projects that are developed by a party in an Annex I country use more mature technologies. At the same time there is a considerable amount of applications from unilateral projects.

Both these dimensions must be considered when assessing the current development in the pipeline. On the one hand there are some trends due to technological specifications, and on the other some country specific features due to national policy and possibly cultural differences between countries.

The empirical evidence suggests that project developers in Annex I countries prefer certain project types. International CDM project developers have a tendency to seek out projects with CERs that have a high certainty to ensure delivery. This implies that international actors more often get involved in end-of-pipe technologies than core processes like energy efficiency. Local firms have more incentives to implement energy efficiency projects and are more likely to see opportunities and find local providers. Similarly end-of-pipe installations have not caught the attention of local firms as their only value to them is the generated CERs (Schneider et al. 2008). This could explain some of the trends seen for unilateral development in certain technologies.

Chapter 4 also shows that there are clear trends in relation to unilateral investments by country. India is the country that stands out in this context with a majority of the unilateral projects, especially in wind power, biomass and energy efficiency. India has generally discouraged projects with technology transfer, whereas China has had a higher share of technology transfer taking place and has a very low share of unilateral projects currently going into the pipeline. China also has a very low share of unilateral project development, and dominates the CDM applications for more mature technologies such as hydro power.

Looking to the projects that have reached the stage where CERs are issued, the majority have been developed with Annex I country involvement. This is in keeping with Michaelowa's (2005) argument that the growing number of unilateral CDM projects being developed create incentives for non-additional projects. This could be linked to how a larger share of non-unilateral projects clear the project cycle successfully, as they are more likely to be additional.

In addition to these two dimensions, there are developments within technology costs and general CDM development that must be considered. There are technologies where the technology costs have been lowered recently, such as solar PV in particular. This will also influence which projects move towards the profitability threshold and change the attractiveness of the CDM. Revisions of methodologies to make them more applicable and adjustments to small-scale definitions will also be influential.

The way countries like India and China have become CDM machines has lead to a higher level of CDM competence and capacity within these countries. This again will be an advantage for project developers. The trend for most of the projects currently entering the pipeline is that India and China dominate the new applications, apart from biogas where there is more diversity.

As outlined, there is also single country dominance for a majority of the technologies. This indicates that some of these drivers may be closely linked to unobservable factors influencing the project developers, such as signals from the Executive Board. If the EB approves a project this may create a perception among project developers that conditions are favourable, which will act as an incentive for entry. This may be enough to cause a rush of similar applications. The way the pipeline looks today, this appears to be happening on country level for wind power and biomass.

Practically all the **wind power** projects currently applying for validation are unilateral Indian projects. The lack of Chinese project applications at this point in time is most likely due to the Executive Board's decision to reject Chinese wind projects due to suspicion of use of reduced feed-in tariffs to make projects eligible for CDM. Wind power in general is maturing, and REN21 reports a growing market for small-scale wind power. Indian wind projects have been considered to have low efficiency, which could be some of the explanation behind the number of Indian projects. Practically all of these projects are unilateral, which would reduce transaction costs further. If these projects lie just below the profitability threshold they would be eligible for the CDM and at the same time attractive to investors due to the carbon finance prospects. However, it is difficult to draw any firm conclusions. Another explanation could be that Indian investors see an opportunity after two unilateral Indian wind power projects started generating CERs halfway through 2009. These are the first two unilateral small-scale wind power projects to reach this stage. This explanation is supported by the amount of Indian unilateral projects currently at the registration stage for this technology. Since the two first unilateral projects reached issued, more than 25 similar projects have applied for registration, and in total there are 80 Indian unilateral projects at the registration stage of the pipeline.

Hydro power projects appear to benefit from the maturity of the technology itself, and also from the benefit of having had many projects clear the project cycle. It is also worth noting that the approval process is considered straight forward for hydro power projects. The majority of these projects are Chinese and developed with the involvement of an Annex I investor. China has seen considerable development of hydro power facilities. Chinese CDM participation has also been encouraged. The EU has a project called the EU-China CDM

Facilitation Project, which aims for the CDM to be central to ensuring a sustainable development path for China[24].

Biomass has also seen a substantial amount of realised projects under the CDM and is considered to have a fairly attractive CDM definition. This category of projects stands out in that it has a fairly large variation in project types, leading to high variability in profitability. This technology has seen a significant growth on a world basis in recent years. Currently the majority of the biomass projects applying for validation are from India. 59 percent of these projects are unilateral, indicating presence of Indian national drivers. Several unilateral biomass projects have reached the issued-stage in recent years and 7 of the totally 14 unilateral projects are Indian biomass projects. The signalling effect this has could be an explanation for the majority of Indian projects.

Biogas is the only technology without one country dominating the allocation of projects currently at VA-00. This indicates that national drivers may not be as decisive as for some of the other technologies. Less dependence on regional conditions will also attract a wider range of countries. Biogas projects also have fairly low investment costs (Ellis and Kamel 2007), which could act as a more universal driver.

Energy efficiency project in general have been struggling with high transaction costs, long lead times and small credits flows preventing implementation through the CDM. The majority of the current applications are from India, and around half of them are unilateral. This indicates national drivers. 22 of the 28 projects that are developed non-unilaterally appear to involve the same UK registered Indian company.

Bosi et al. (2010) argue that the low hanging fruit argument can partly explain the growth in energy efficiency projects; as other more attractive investment options have been exhausted, energy efficiency investments have become more attractive. This may be the case, although the current pipeline does not indicate a wider range of applications in this technology category.

[24] http://www.euchina-cdm.org/media/docs/EU-China%20CDM%202nd%20Policy%20Study%20Tour%20Report.pdf

In the case of **solar power**, the recent project applications are divided between China and India. The increasing amount of projects in this technology appears to be due to the large reduction in production prices in recent years. This would push solar-PV up towards the profitability threshold, where the CDM could be instrumental in making it profitable[25].

So overall there appear to be individual drivers within each technology type, which are again country specific, rather than certain characteristics for each technology. This makes it difficult to generalise. At the same time it highlights a further need for standardisation of the CDM process to send out clearer signals and make the system more predictable.

[25] Schneider et al. (2010) found that in some cases of solar PV projects the CDM made it less profitable due to the large transaction costs involved in the process.

6. Concluding comments

The previous chapters have shown that despite theoretical predictions of no new projects going into the pipeline in the absence of a climate agreement beyond 2012, there is still activity in the CDM pipeline. This implies that either these projects are so cheap to implement that project developers are willing to take the risk, or that the projects are in fact non-additional. Another possibility is that the expectation among project developers is that the carbon market will continue to function beyond 2012, and that carbon finance is a potentially good investment for the future.

This chapter provides a summary of my problem statements and then goes on to look at market implications and the future for small-scale CDM.

6.1 Problem statement summary

1. What are the leading small-scale technologies in the CDM pipeline today?

A run through of the IGES CDM database based on figures as of 1st October 2010, shows that hydro power is the leading technology in terms of number of projects. This applies to all the three stages of the project cycle. Biomass has also got a substantial amount of projects at all levels. Although biogas has more projects at the registration stage, biomass is second in terms of projects that have started generating CERs.

Wind power, energy efficiency and solar power have not yet got as many projects at the issued stage. However, all of these technologies show an increase in projects that are moving into the registered category. They are also showing a higher rate of applications for validation than the remaining projects in the database. So although hydropower, biomass and biogas are clearly the most established technologies within the CDM, wind power, energy efficiency and solar power projects appear to have an increasing trend.

2. What are the main barriers for small-scale CDM projects?

The barriers small-scale projects meet can be divided into investment barriers, technological barriers, CDM barriers and national and international barriers. Some of these apply to all CDM projects, whereas others are more severe for small-scale projects.

As a consequence of the financial crisis and uncertainty about the future climate regime, investments in CDM projects in general have gone down in the last two years. At the same time the CDM related transaction costs have gone up. This has hit small-scale projects particularly hard as these have less capacity to absorb fixed transaction costs. In addition to this, the risks and uncertainty connected to the CDM procedure have made many projects less attractive to investors.

Small-scale projects also face some technological barriers. The complexity of projects is not proportional to the scale, and often smaller projects require more complex technology adjustments. In addition to this the CDM process appears to have favoured some technologies over others through the way they are defined and how strict the additionality demand has been exercised.

3. What are the characteristics and drivers for the projects currently entering the pipeline?

My regression attempts failed to produce clear statistical results for characteristics for projects being validated in the last two years. However, the IGES database sheds some light on possible drivers for the current development. For most of the technologies there are some clear drivers.

Overall there are two trends that appear from the projects currently applying for validation. The projects using the most established technologies continue to dominate, and those that are starting to mature and experiencing a drop in production costs have increasing activity. At the same time India in particular is developing an increasing share of unilateral projects, especially within wind power and energy efficiency. This development could be linked to national policy focusing on renewable energy and favourable national measures, along with how India has discouraged technology transfer so far in the history of the CDM. China on the other hand has hardly got any unilateral CDM projects going into the pipeline, and has a majority of hydro projects. This is an indication of country specific drivers within India and China influencing the project type and technology choices. China is generally not as strong on innovation as India has been, which may account for some of the difference in terms of number of projects that include technology transfer[26].

At the same time the incentives connected to non-unilateral projects cannot be ignored. Manipulation of the additionality process has occurred in the past, but it is often difficult to prove. Michaelowa (2005) argues that project developers are quick to react to the EB's decisions on additionality. He uses the example of a small-scale biomass project from India with questionable additionality, and how once this project was approved a stream of other similar projects was submitted.

However, as outlined the type of technology and process involved in the project is also decisive for whether it is attractive to foreign investors or not. Some projects are simply considered too risky for Annex I investors, who tend to favour more mature technologies with a proven track record within the CDM. This way unilateral CDM projects open up for different types of projects. The advantage of unilateral projects is that they are developed by local project developers with better prerequisites, which reduces risk and potentially the transaction costs.

The CDM process is complex and cumbersome. Despite the many rules and regulations to ensure environmental quality there is some evidence of non-additional projects gaining validation and registration, and countries adjusting their policies to facilitate CDM development. This makes it hard to draw firm conclusions with respect to causes for the current development.

6.2 Market implications and the future for small-scale CDM

After the disappointing outcome of COP15, expectations for a new binding climate agreement have been low, jeopardising the future of the carbon market. However, the CDM is not linked to a commitment period, so the expectation among investors appears to be that the carbon market will continue to function beyond 2012. So far only the EU-ETS has generated a real market, and the CDM is by far the most successful instrument in terms of volume. The voluntary market for carbon has not had the expected growth.

[26] http://www.businessweek.com/magazine/content/05_34/b3948401.htm

There are several factors that influence the price on carbon and demand for credits. Some are linked to the CDM-process and some are not like the oil price, power demand due to weather conditions and the general financial environment. The recent financial crisis has also led to a lower level of production than expected, leading to many industrialised countries already being on their way to fulfil their current commitments. The uncertainty connected to the future climate regime will put downward pressure on the carbon price.

There are three possible scenarios post 2012:

- An extension of the Kyoto Agreement
- A new climate agreement
- No agreement

The outcome with respect to level of abatement efforts will influence the market. A stricter agreement will cause increased demand for CERs, which will put upward pressure on the carbon price. An initial worry was that the CDM would not generate enough credits to meet the demand. Today however, the main worry is that the uncertainty connected to the post 2012 scenario will lead to a high perceived risk connected to CERs. This will put downward pressure on carbon. Presence of non-additional projects in the pipeline will also contribute to lower prices as these projects have a marginal cost of CER generation that is zero.

A lower carbon price would again act as a barrier for small-scale projects. One hypothesis for why a surprising amount of small-scale projects were submitted after 2003 was that the relatively high carbon price lowered the profitability threshold (Michaelowa 2005). Schneider et al. (2010) found that it varied how sensitive the various technologies were to changes in the carbon price. They concluded that biomass[27] was strongly pushed by the carbon price, whereas the impact on wind power, biomass and hydro power was small to moderate. In other words, carbon price is not the only important factor for the profitability of small-scale projects.

The other important issue for the future of small-scale projects is the level of transaction costs. As outlined this has been going up in recent years, despite the simplified procedures

[27] They looked at large-scale sewage and landfill project

that were implemented. Along with clearer rules and regulations and more widely applicable methodologies, a reduction in the CDM related transaction costs would greatly benefit small-scale projects. Wider implementation of programmatic approaches is another way to reduce transaction costs for small-scale projects.

The market incentive created by the CDM has led to environmentally friendly and renewable energy technologies being implemented more widely in developing countries. Small-scale projects as part of more distributed systems is a way of ensuring a higher standard of living for people in developing countries, and at the same time contributing to their emission path not developing the way it has in the already industrialised part of the world. Despite the shortcomings of the CDM it has contributed to spreading technology and small-scale projects appear to have a higher development dividend than large-scale projects. In addition to improving access to energy in developing countries, the CDM has also helped raise awareness of climate issues and alternative energy sources in these countries. Unfortunately the Least Developed Countries (LDCs) are not well represented in the pipeline yet.

An interesting recent development is that at COP16 the discussion has been going in the direction of a sectoral approach to the CDM, due to the complications involved with additionality testing. This has been suggested by several authors, but a Nordic pilot project is now looking into whether focusing on a whole sector within a host country can simplify the control with total emissions[28].

Further streamlining of the CDM process appears necessary to reduce the time it takes to clear the project cycle and include also LDCs. However, if this compromises the environmental integrity of the mechanism it will eventually undermine it. This appears to be the biggest and most serious challenge the CDM faces today.

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[28] Dagens Næringsliv 09.12.2010

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8. Appendix 1

Number of small-scale projects at validated by country (1st October 2010)

Albania	2	Fiji	1	Panama	5
Argentina	11	Georgia	3	Papua New Guinea	5
Armenia	5	Guatemala	4	Paraguay	3
Azerbaijan	1	Honduras	13	Peru	10
Bangladesh	3	India	909	Qatar	1
Bolivia	4	Indonesia	53	Rwanda	2
Brazil	130	Iran	3	Singapore	3
Cambodia	2	Israel	7	South Africa	10
Cameroon	2	Kenya	2	Republic of Korea	35
Chile	25	Lebanon	1	Sri Lanka	21
China	456	Macedonia	1	Tajikistan	1
Colombia	21	Madagascar	1	Tanzania	3
Costa Rica	1	Malaysia	64	Thailand	71
Côte d'Ivoire	1	Malta	1	The Philippines	41
Cuba	1	Mexico	67	Tunisia	1
Cyprus	1	Moldova	1	Uganda	8
Dominican Republic	3	Morocco	6	United Arab Emirates	5
Ecuador	6	Nepal	3	Uruguay	7
Egypt	2	Nicaragua	4	Vietnam	54
El Salvador	1	Pakistan	8		