

How best to generate carbon revenue for small-scale projects in sub-Saharan Africa

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Declaration

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

Peter Stuart Atkins

15 July 2013

University of Cape Town

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Abstract

The Clean Development Mechanism (CDM) has not worked for sub-Saharan Africa and its mainly small projects, delivering only 0.3% of the total CDM carbon offsets. This is thought to be because of the low intensity of the greenhouse gas reducing interventions prevalent in sub-Saharan Africa, the lack of institutional capacity relating to the CDM processes, the high transaction costs of the lengthy CDM process – typically amounting to R 500 000 per project per year and taking years to complete the process. An alternative for small carbon emission-reducing projects is to register carbon reductions with the voluntary carbon market and its Verified Emission Reductions (VERs) carbon credits. By examining the carbon markets in some detail through the lens of a particular case study, this dissertation has investigated and identified the main factors affecting the cost-effective generation of small emission reduction projects in sub-Saharan Africa.

The chosen case study was a small-scale South African voluntary carbon project, the Umdoni bio-ethanol gel fuel-switching project. Umdoni was identified as an example of a project that generated carbon revenue outside of the CDM. By assessing the manner in which this project addressed the critical requirements of the carbon market while simultaneously alleviating poverty, the study seeks to provide new insight in the components of effective carbon markets. Both the detailed understanding of the voluntary carbon market components and the exposition of an example in which this market worked effectively is considered important at a time when the efficacy of the CDM is being reviewed, casting uncertainty over the role of market based instruments in addressing the global threat of an anthropogenically warmed climate.

The study has identified the main factors affecting the ability of small carbon projects to generate net-positive carbon revenue and has suggested ways a small project could exploit this information to its benefit:

- The type of carbon market the project operates in – the small voluntary carbon market is best, with higher prices and lower costs
- The inherent attractiveness of the project to potential carbon offset buyers – small projects with strong sustainable development aspects command higher carbon prices
- The registry and carbon standard through which the project trades its carbon offsets – registries and standards which measure and emphasise sustainable development benefits realise higher prices for suitable projects
- The type of buyer – Corporate buyers purchasing carbon offsets for image and public relations purposes are best for small projects with good sustainable development co-benefits
- The supply-demand situation in the relevant carbon markets – the voluntary carbon market has been relatively unaffected by the crash in the compliance market in 2012
- The project size and the calculation methods chosen – the volume of emission reductions is sensitive to the project scale, the emission reducing technology and the emission reduction methodologies chosen
- The transaction costs – the transaction costs for a CDM project are in excess of R500 000, which is far bigger than the likely carbon revenue. Whereas some small voluntary carbon market registry costs are lower by a factor of six and yet they get comparable carbon prices.

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Acronyms

AAU – Assigned Amount Unit: Part of the EU emissions Trading System, an AAU is equivalent to a one tonne reduction of CO₂ equivalent emissions. AAUs are allocated to countries and then to businesses and are used to offset the owner’s greenhouse gas emissions. AAU’s can be traded.

AFOLU – Agriculture, Forestry and Other Land Uses, a VCS methodology.

BAU – Business-as-usual.

BOCM – Bilateral Offset Credit mechanism (Japan scheme) now called the Joint Credit Mechanism – JCM.

BUR – Biennial Update Reports, a new emissions reporting system agreed at COP 18.

CAR – Climate Action Reserve.

CCB – Climate, Community and Biodiversity standard.

CCX – Chicago Carbon Exchange.

CDM – Clean Development Mechanism: The CDM operates under the Kyoto Protocol and allows countries to offset their greenhouse gas emissions by buying carbon credits from other countries.

CDM EB – Clean Development Mechanism Executive Board, the governing body of the CDM.

CER – Certified Emission Reduction: The unit of emission reduction in the CDM. One CER represents a one tonne reduction of CO₂ emissions equivalent.

CO₂ – Carbon dioxide, one of the greenhouse gases.

COP – The Conference of the Parties is the governing body of the UNFCCC. Annual meetings of the COP, held in different parts of the world are named COP followed by a sequence number, for instance COP 17 was held in 2011 in Durban and COP 18 was held in December 2012 in Doha.

CP 1 – The first commitment period of the Kyoto Protocol (2008 – 2012).

CP 2 – The second commitment period of the Kyoto Protocol (2013 – 2020).

CPM – Carbon Price Mechanism, part of the Australian Carbon Tax mechanism.

CSI – Corporate social investment, similar to CSR.

CSR – Corporate social responsibility, similar to CSI.

CU – Carbon Unit, part of the Australian cap-and-trade system.

DALY – Disability-adjusted life years, a measure of health impacts, e.g. due to air pollution.

DNA – Designated National Authority.

DOE – Designated Operational Entity.

EB – Executive Board: The controlling body of the CDM.

EUA – European Union Allowance.

ERU – Emission Reduction Units

EU ETS – European Emissions Trading System.

FBAE – Free Basic Alternative energy Policy.

FBE – Free Basic Energy Policy.

GEF – Grid Emission Factor (CO₂ equivalent emissions per unit of generated power kg/kWh).

GHGs – Greenhouse Gases.

GS – Gold Standard.

IET – International Emissions Trading.

IAP – Indoor air pollution.

JCM – Joint Credit Mechanism, a Japan mechanism, replacing the BOCM.

JI – Joint Implementation.

J-VER – Japan Verified Emission Reduction.

JVETS – Japan Voluntary Emissions Trading Scheme.

LDC – Least Developed Country.

LOA – Letter of Approval, part of the CDM process, the LOA is issued by the government hosting a CDM project which confirms that the project is acceptable to the host government.

LPG – Liquefied Petroleum Gas.

MDG – Millennium Development Goals.

MOU – Memorandum Of Understanding.

NAMAS – Nationally Appropriate Marketing Mechanisms.

NGO – Non-government organisation.

NMM – New Marketing Mechanisms, these are new climate change mitigation options within the CDM such as Nationally Appropriate Mitigation Actions.

OTC – Over-the-counter trade in the voluntary carbon market.

PACE – Promotion of Access to Carbon Equity, a not-for-profit Project Proponent business.

PDD – Project Design Document.

PIN – Project Idea Note.

PoA – Programme of Activities.

PPT – Project Preparation Trust, a project developer.

RGGI – Regional Greenhouse Gas Initiative, a USA emissions reduction scheme.

SWH – Solar water heater.

SD – Sustainable development.

tCO₂e – metric tonne of CO₂ equivalent. Because different GHGs have different impacts on global warming, it is convenient to state GHG quantities in terms of the mass of CO₂ which would have had the same warming effect as would the GHG quantity.

UNFCCC – United Nations Framework Convention on Climate Change.

VCS – Verified Carbon Standard.

VER – Verified Emission Reduction.

VCM – Voluntary carbon market.

WCI – Western Climate Initiative, a US/Canadian GHG emissions reduction scheme.

Glossary

Additionality – This is the CDM requirement that the project in question would not have happened without the carbon credit revenue, i.e. in a business-as-usual scenario, or that the CDM helped the project overcome barriers to its implementation.

Annex I – The Annex I countries under the Kyoto Protocol are those countries which have committed to achieving quantified GHG reductions within an agreed time frame. There are 42 Annex I countries which include the EU, USA, Australia, New Zealand, Japan etc. For the full list, see: http://unfccc.int/parties_and_observers/parties/annex_i/items/2774.php

Cap and trade – This is a greenhouse gas emission reduction system which issues a cap (an upper limit of GHG emissions) to its participants. If the cap is exceeded, the participant will generally be fined. The “trade” part allows participants to trade emission reduction allowances with each other so as to meet the cap.

Chicago Carbon Exchange (CCX) – A self-regulated voluntary carbon exchange in the US.

Designated National Authority (DNA) – The DNA is a body set up by a country’s government to carry out parts of the CDM process under the Kyoto Protocol. For instance; the DNA is responsible for approving the sustainable development aspects of a CDM project.

Designated Operational Entity (DOE) – The DOE is an independent auditor, accredited by the CDM Executive Board that carries out the validation, verification and certification of a CDM project and its GHG reductions.

Emission Reduction Unit (ERU) – These are emission reductions achieved through a Joint Implementation (JI) project. One ERU is 1 tCO₂e.

EU ETS – European Emissions Trading System: A system which enables businesses and countries within the EU to trade carbon credits.

European Union Allowance (EUA) – A tradable unit within the EU ETS, one EUA represents the right to emit 1 tCO₂e.

Executive Board (EB) – The controlling body of the CDM.

Free Basic Alternative energy Policy (FBAE) - This is a South African Policy which addresses energy poverty by supplying qualifying households who do not have access to electricity with an allowance of an appropriate alternative energy amount, roughly equivalent to the FBE’s 50 kWh/household/month.

Free Basic Energy Policy (FBE) – This is a South African Policy which addresses energy poverty by supplying qualifying households 50 kWh/household/month of free electricity.

Fungible – In the context of carbon trading, fungibility means the ability to exchange carbon credits from one carbon trading scheme for carbon credits from another trading scheme. It implies that the buyers of credits in one scheme trust and agree with the standards and verification processes in the other scheme. Fungibility enables different carbon markets to be linked together.

Global Warming Potential – Different GHGs have different impacts on global warming, so in order to make it easier to measure and compare GHGs, the concept of the global warming potential was developed. Each GHG is given a global warming potential value, which is the ratio of the heat trapped by the GHG compared to the heat trapped by an equal mass of CO₂. For instance methane has a GWP of about 21 (and CO₂ is of course 1).

Greenhouse Gases (GHGs) – These are defined by the Kyoto Protocol as: Carbon dioxide (CO₂), Methane (CH₄), Nitrous oxide (N₂O), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs) and Sulphur hexafluoride (SF₆).

Gold Standard (GS) – One of the entities in the carbon offsetting industry. The GS builds on the CDM standards and provides an emphasis on the sustainable development aspects of carbon projects in addition to emission reductions.

International Emissions Trading (IET) – Part of the CDM, the IET enables countries to buy and sell CERs.

Joint Implementation (JI) – This is a mechanism, similar to the CDM, but which operates between Annex B countries only (Annex B countries are Annex I plus four other European countries: Lichtenstein, Monaco, Croatia and Slovenia). It allows Annex B countries to trade emission permits with one another.

Leakage – Leakage is the increase in GHG emissions outside the project's boundary and caused by the project. For example, a project which replaces kerosene with bio-ethanol gel from a constrained source, might cause someone else to have to revert back to higher-emitting kerosene because of bio-ethanol gel availability problems.

Methodology – In the CDM context a methodology is the definition of the calculation methods to be used to determine the GHG reduction caused by an intervention and measured against a baseline of what would have happened in the absence of the intervention.

Millennium Development Goals (MDG) – The UN Millennium Declaration of 2000 listed a set goals aimed at eliminating poverty by 2015.

Non-Annex I – These are countries that are part of the UNFCCC, but which are classed as developing countries and do not have to commit to GHG reductions at this stage. The full list can be found at http://unfccc.int/parties_and_observers/parties/non_annex_i/items/2833.php

Offsetting – This is the practice of buying GHG reduction credits from a GHG emission reduction project in order to reduce one's own carbon footprint. This could be because one has to for compliance reasons, or because one wants to for altruistic, image or corporate social responsibility reasons. An example of compliance offsetting is the Clean Development Mechanism (CDM). The CDM forms part of the Kyoto Protocol, and in terms of this, signatories to the protocol may meet

part of their emission reduction targets by buying carbon offsets generated in non-signatory countries by suitable emission reduction projects. The rationale behind this is that the emitting country can meet their emission reduction targets more cost-effectively and benefit the country supplying the offsets at the same time.

Over-the-counter (OTC) – The most common method of buying carbon credits (VERs) is over-the-counter; meaning through a broker or directly via an online carbon store. The other way is to buy through a private carbon exchange (the biggest of which was the Chicago Carbon Exchange).

Project Design Document (PDD): A formal document, required by the CDM, which defines a CDM project and its deliverables. Similar to a PIN.

PIN – Project Idea Note: A document which outlines the scope, objectives and deliverables of a carbon project. Similar to a PDD.

Programme of Activities (PoA) – one of the measures designed to reduce CDM transaction costs and speed up small project delivery. The PoA allows a project developer to get a project template approved by the CDM EB and then apply that template to many similar projects without having to get each project approved individually.

Retirement of carbon credits – This is a non-reversible process whereby carbon credits, such as CERs or VERs are removed from the register and are formally offset against the owner's carbon footprint – carbon credits can only be retired once and can't be traded again.

Verified Carbon Standard (VCS) – One of the larger standards in the world in terms of the number of registries and projects using VCS in the voluntary carbon market.

Verified Emission Reduction (VER) – the voluntary carbon market equivalent of the CDM CER, one VER represents one tonne of CO₂ equivalent emission reduction.

Vintage – As with wine vintage, a carbon credit's vintage refers to the year in which the carbon credit was created.

Voluntary carbon market (VCM) – This is a carbon market for buyers who wish to voluntarily buy carbon offsets rather than being compelled to (e.g. through the Kyoto Protocol or a cap and trade system).

1. Introduction

“Global warming is a serious problem that will not solve itself. Countries should take co-operative steps to slow global warming”: this was one of the main messages from William Nordhaus, a professor of economics at Yale University in his book “A Question of Balance: Weighing the Options on Global Warming Policies” (Nordhaus & Boyer, 1999) . Climate change is especially serious for sub-Saharan Africa, which is already poverty-stricken. In 2008, close to 50% of people in sub-Saharan Africa were living on less than US\$ 1.25/day (The World Bank, 2011). It is widely accepted that rising anthropogenic greenhouse gas emissions are the main cause of climate change. The Kyoto Protocol, its formal compliance carbon market and the Clean Development Mechanism is one of the mechanisms for facilitating greenhouse gas emission reductions.

Africa, and particularly sub-Saharan Africa, which is the geographical focus of this research, abounds with opportunities for carbon emission reduction projects with good sustainable development (SD) potential. Arens et al. estimated that in 11 of the LDCs in sub-Saharan African countries surveyed in 2012, the total emission reduction potential was 49 million tonnes of carbon dioxide equivalent per year (Arens et al., 2012:7). The extreme levels of poverty in many of the sub-Saharan African countries indicate a great need for SD projects and this need is likely to be aggravated by the current global recession and future climate change impacts. Also, historically SSA has not benefitted as much from investment in infrastructure as have the other developing countries; SSA only received 2.7% of the total investment from 1990 to 2006, the lowest share compared to all the other developing countries (Olsen & Fenhann, 2008a:87 Table 1). Therefore sub-Saharan Africa should have been fertile ground for Kyoto carbon market projects. However this carbon market has largely failed in Africa (discussed in Section 2.3, page 21) and this is serious for sub-Saharan Africa, because of the loss of foreign investment in carbon projects and their sustainable development benefits as well as for climate change, because of missed opportunities to reduce GHG emissions on a large scale.

Nevertheless, there are examples of the carbon market working in sub-Saharan Africa. The Umdoni project, which is used as a case study in this dissertation, is one such example. In order to understand this case study, it is felt that the carbon markets need to be understood in some detail, which has been done in the literature review (Section 2). Then, when the reasons for the success of the Umdoni case study project in these markets have been investigated and understood, suggestions and guidelines for the replication of similar projects can be proposed – this has been done in the analysis, discussion and conclusion sections (Sections 5 and 6).

1.1. Carbon offsetting and carbon markets

The shortage of SD project finance has encouraged projects to try to generate additional revenue from carbon offsetting – where one party needs or wants to buy carbon reduction credits to offset its carbon footprint and a second party is able to generate carbon reduction credits through SD projects. The purchasing entity will naturally only resort to offsetting if this is more cost-effective than reducing its own emissions. The need to offset can either be mandatory or voluntary. For instance, signatories to the Kyoto Protocol, which came into force in 2005, have committed to reduce their carbon emissions and might be forced to buy carbon offsets in order to comply; this would be an example of a mandatory or compliance offset. Voluntary offset purchases, on the other hand, are not obligatory and are motivated by a variety of factors – such as the desire to become carbon neutral for public image purposes (Raab, 2012:2).

There are several facilities for managing and verifying carbon offset projects and their markets. These facilities consist of carbon registries which verify the existence of carbon credits and track the transfer of ownership of carbon credits, manage their certification and finally carry out their sale to entities wishing to purchase carbon offsets. The carbon markets can be broadly split into the regulated/compliance markets and the voluntary markets (Lovell, 2010:353).

The compliance market is where the Kyoto Protocol signatories may purchase certified carbon offsets from other countries in order to partially offset their own GHG emissions in order to meet their emission reduction targets. The compliance offset market operates under the UN's Clean Development Mechanism (CDM).

In the voluntary carbon market anyone may purchase voluntary carbon credits from suitable GHG emission projects in order to offset their own emissions – usually for reasons of Corporate Social Responsibility, image enhancement or for ethical reasons.

If the CDM had operated as intended, the voluntary carbon market would probably not have grown as it has. Unfortunately, the CDM has not worked as well as it was hoped it would, for many reasons which are explored later in this dissertation (see Section 2.3, page 21). In particular, the CDM has not penetrated into Africa and sub-Saharan Africa to any significant degree, mainly due to the small scale and distributed nature of the GHG reducing projects, coupled with the high CDM transaction costs. To make matters worse, the future of the Kyoto Protocol is still uncertain and the compliance carbon market prices have collapsed, making the CDM even less attractive to carbon-reducing projects.

As discussed later in this dissertation, the voluntary carbon market might be better suited to sub-Saharan projects. However, the voluntary carbon market exists in many different forms, ranging from large carbon registries and standards modelled on the CDM down to small registries using their own verification standards. Therefore it is important for a carbon project to consider how best to exploit the carbon market. This is what this dissertation is about – investigating the factors that impact on the ability of small, sub-Saharan African projects to generate carbon revenue cost-effectively.

A South African case study will be used to show how a small VCM registry enables a community project to tap into the VCM and attract carbon credit buyers. The chosen case study is the Umdoni bio-ethanol gel stove project (Cartwright, 2012), which currently consists of a community of about 4 000 households, each having a local government-supplied gel stove and receiving 7 litres of bio-ethanol gel fuel per month free of charge.

The relative success of the case study is used to identify and assess whether the approach adopted holds potential lessons for addressing some of the limitations of the broader carbon market. Problems encountered by voluntary carbon registries and how they are being resolved was investigated and analysed; for example: which standards and processes have been adopted, how suitable projects are found, how the stakeholders were engaged, how to quantify, audit and sell the resulting carbon credits and how to select an appropriate voluntary carbon registry.

1.2. Why this research is important

This research is important because it reveals insights into how small carbon projects, many of which are found in Africa and offer SD co-benefits, might make better use of the carbon market.

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2. Literature Review

The carbon market is important to sub-Saharan Africa for many reasons. It incentivises GHG reductions through creating carbon credits which can then be sold. It helps carbon revenue-supported projects to get off the ground and be sustainable. These projects generally deliver community benefits and contribute to most of the Millennium Development Goals (MDGs) (Hunt et al., 2010:7), such as:

- Poverty alleviation
- Improved education
- The empowerment of women through freeing up their time and improving home conditions
- The provision of healthy homes through interventions such as air pollution reduction and water purification

In addition, if the project is partially funded from foreign sources and uses imported technology, it may result in an inflow of foreign capital and the transfer of technology to the host country.

2.1. Carbon emission offsetting – the theory and the practice

Carbon emission offsetting and the Kyoto Protocol's CDM was briefly discussed in the introduction. Offsetting is a subject cloaked in controversy, with some, such as Nicholas Stern, supporting carbon trading as a way of reducing the costs of CO₂ emission reductions (Stern, 2008), whilst others, such as Nordhaus, argue that the Kyoto Protocol and the CDM are not an efficient way of reducing global emissions at all (Nordhaus & Boyer, 1999:38-39).

The economic theory behind carbon emission trading is grounded in the analysis of pollution control and the most efficient way to control pollution. The theoretical treatment generally assumes that the relevant market system is perfect, with competing firms who have little power to manipulate the market or change prices. It is also assumed that the main variables are all known, these being: the amount of pollution (in this, case GHG emissions), the marginal costs and benefits of controlling the level of pollution – and that all these can be expressed in monetary terms. The system can then be optimised, in economic terms, by increasing the level of control until the marginal cost of further control outweighs the marginal benefit (Spash, 2010:172). So, theoretically, the economic optimum pollution level can then be calculated, and the next step is to apply suitable measures to arrive at that optimum in practice.

According to Spash, assuming that the costs and benefits of pollution control are known, then policy-makers can set taxes that would financially motivate rational actors to change their behaviour until their own optimum point is reached, for instance by reducing their GHG emissions, and thus their carbon tax exposure, until the marginal cost of emission reduction measures exceeds the marginal carbon tax savings. Or policy-makers can set compulsory standards which would force the actors to change their behaviour. Either way the idealised optimum could be reached. In practice, companies tend to prefer the standards route because if they are already compliant it doesn't cost them anything to do nothing, even though it could be argued that they are still doing damage and should pay suitable penalties (Spash, 2010:172). Assuming the standards route was followed (as it was in the case of the Kyoto Protocol, with carbon emissions being capped) the next step would be to manage the standard by issuing "permits to pollute" (Spash, 2010:172). This is where the economic

efficiency of the intervention could be improved through the use of emissions permits that can be traded.

Before carbon credits can be traded, they must be converted into a tradable commodity. This is done through individual projects which are designed to reduce carbon emissions. To be credible, these reductions must be measurable and verifiable and they must be additional to a quantified, business-as-usual baseline (Bumpus et al., 2008:134).

The theory goes on to say that allowing emitters to trade their permits enables an actor who has exceeded its permitted emission level can buy permits from another actor who has surplus emission space. Then provided that the asking price for the permits is less than the high-emitting actor's marginal cost of reducing emissions, it makes sense for the trade to happen. More than this, emissions trading also allows two emitters, both of whom are operating within their permitted level, but who have different marginal costs of emission reduction to exploit this difference to the advantage of both. The emitter with the lower costs can choose to emit less and then sell the surplus permits to the emitter with higher costs at a mutually profitable price (Spash, 2010:173). That is the theory, but the practice is somewhat different, as it usually is.

The real world is complex and many of the theoretical assumptions described above in this section are not valid. Some of the resulting problems as described by Spash (Spash, 2010:175-178) are summarised here:

- Because different countries are at different industrial levels, have different environments and emission profiles, implementing a universal emissions trading system will have very different impacts on the participating countries. This is likely to result in an uneven distribution of costs and benefits. For instance the model-based research by Nordhaus shows that Russia and Eastern Europe would be by far the biggest beneficiaries of unconstrained carbon emission trading, with the US and Europe the biggest losers. Nordhaus suggests that the large potential US costs of Kyoto might be why the US was unhappy with the Kyoto Protocol (Nordhaus & Boyer, 1999:30).
- The marginal costs of controlling GHG emissions are certainly not well-established across the world, partly due to lack of data, but also because of the influence of the carbon price on pollution control costs (e.g. the price of carbon affects the cost of generated electricity which affects energy efficiency measures and other process changes)
- The benefits of emission reduction are often difficult to quantify and so are ignored, these could include beneficial impacts on wildlife or quality of human life.
- The real-world market is not perfect, in that not all actors are equal and some have the power to manipulate the conditions (e.g. prices, issued permit quantities etc.). This then means that the equilibrium price of carbon does not represent a true optimum because of the resulting market distortions.
- The disparity between the power and influence of large emitters (e.g. energy industry) and the many small emitters: the large emitters have market power and can and do influence policy to their benefit. This is compounded by national governments trying to protect their commercial competitiveness.
- Unfair allocation of emissions permits to countries and businesses: instead of this being a calculation exercise, in practice it has been a negotiation, with the powerful actors

influencing the allocations. An extreme example of this was the emissions baseline used by Russia and the Ukraine under the Kyoto Protocol, resulting in non-existent emission reductions known as “hot air”.

Those in favour of carbon trading would no doubt counter these criticisms with arguments of their own. For instance Stern defends the initial allocation of free emission permits as a way of getting industry acceptance, leaving the way open to moving towards auctioned permits. Stern also sees international emissions trading (as done through the trade in carbon credit offsets) between the global North and South) as a way of persuading the poor countries to participate (Stern, 2008:25).

Alex Bowen in “The case for carbon pricing” appears to take a more optimistic view (Bowen, 2011) compared to Nordhaus and Spash. He suggests that one can get around the problems associated with trying to calculate the cost of emission reductions and the marginal cost of future damages to the environment caused by emissions. This can be done by globally agreeing on a climate change impact target (in terms of the maximum acceptable temperature increase above pre-industrial levels i.e. 2°C) and Bowen argues that in agreeing on this target, policy makers have already implicitly struck a balance between the cost of reducing emissions and the cost of future damages. One can then move on to using climate models to estimate the required emission reductions and the carbon price to achieve these reductions. The estimates Bowen quotes range between GBP 30 in 2020 (UK Committee on Climate Change) and GBP 176 also in 2020. Having explored the required carbon price, he goes on to suggest how the price could be influenced by controlling emission quantities or levying a carbon tax. The quantity-control approach is similar to cap-and-trade, with emission quotas being issued (with the associated problems of baseline determination, manipulation of the markets etc.).

Carbon trading can be seen as a form of “market environmentalism” which seeks to protect the environment by pricing environmental services, selling rights of ownership to these services and then trading these globally (Bumpus et al., 2008:132-134). Bumpus further says that, although this goes against the idea that nature and its services belong to us all, it does open the door to increased investment in the non-Annex I countries through the medium of carbon revenue, whilst reducing the emission reduction costs of Annex I countries.

Some researchers have also questioned the cost-effectiveness of the CDM as a mechanism of letting the market find the lowest cost emission reduction opportunities and then exploiting them. For instance, in China there are many end-of-pipe projects involving the reduction of HFC-23 gas emissions. HFC-23 is a waste product in the manufacture of HCFC-22 and HCFC-22 is a refrigerant gas used to replace ozone-damaging refrigerants. With the advent of CDM, the previously worthless HFC-23, suddenly became more valuable than the HCFC-22 manufacture itself. This was because HFC-23 has a GWP of 11 700 and was relatively easy to capture and destroy, so the net revenue from HFC-23 CERs was very high. Research done by the Program on Energy and Sustainable Development (Wara & Victor, 2008:11-12) describes the HFC-23 problem and estimates that the actual cost of capturing and destroying the HFC-23 would have amounted to about Euro 100 million, whereas the total cost of the associated CERs actually totalled Euro 4.7 billion.

Nevertheless, in spite of its shortcomings, carbon trading is thriving, the Kyoto Protocol is still with us and its CDM continues to operate as does the European Emissions Trading System¹ (EU ETS), albeit with very low carbon prices (see Section 2.7.2, page 32). Also, other ETSs are emerging around the world (as described in Sections 2.7.3, page 15 and 2.7.4, page 36).

2.2. Compliance carbon markets

The main instrument in the regulated/compliance carbon market is the Clean Development Mechanism (CDM) operating under the Kyoto Protocol. Carbon credits are validated against the CDM standards and calculations methods and actual performance is audited by authorised carbon auditors. These carbon credits are then formally “issued” by the CDM and are available to be traded – the carbon credits are known as Certified Emission Reductions (CERs). One CER is equivalent in global warming potential to 1 tonne of CO₂. Initially there was one trading mechanism for CDM AAUs², the International Emissions Trading (IET) entity – however there has been very little trading on the IET, possibly because of the development of regional trading entities such as the EU ETS. Countries with compliance obligations could trade their AAUs on the IET. One has to distinguish between primary CERs, credits bought directly through the CDM, and secondary CERs, which are traded on other registries such as the EU ETS. Note that CERs are not necessarily used as offsets, they can be held or retired by the country hosting the carbon project, thus reducing the host country’s GHG emissions (Raab, 2012:44).

2.3. Failure of the CDM in sub-Saharan Africa

At first sight one would think that SSA would be well-placed to capitalise on carbon offset revenues. SSA, with its relatively undeveloped technical infrastructure and a dire need for SD projects should be ideal for the CDM. However, the CDM has struggled to fulfil its potential in SSA – this is evidenced by the fact that SSA CDM projects have only delivered 0.3 % (and Africa 1.4%) of global CDM carbon emission reductions up to 1 July 2012, according to the CD4CDM CDM pipeline spread sheet (Fenhann, 2012), analysed in Appendix A.

This lack of penetration of the CDM into SSA is thought to be due to a number of contributing factors:

- The general complexity of the CDM processes and the lack of decision-makers who understand the CDM in Africa and SSA as compared to countries such as China (Olsen & Fenhann, 2008a:36, 74, 75, 106).
- Lack of institutional capacity. The absence and/or lack of capacity of in-country UN accredited verifiers and auditors (i.e. Designated Operational Entities) is a problem because the CDM is a complex and demanding process, requiring specialists with good analytical skills, a thorough knowledge of the CDM and government backing. Most sub-Saharan countries have bigger issues to deal with than grappling with CDM processes in pursuit of uncertain rewards, so the right resources and backing is often not forthcoming from the governments. It is left to NGOs to push carbon projects and the CDM (Maxwell et al., 2011:4).

¹ The European Union Emissions Trading System was set up in 2003 by the EU as a mechanism to help meet the EU Kyoto targets.

² AAUs – Assigned Amount Units, these being the initial emissions cap, measured in tCO₂e and issued under the Kyoto Protocol. These are described more fully in the section on the EU ETS.

- Lack of political and business support for carbon projects. The extent of the host government's involvement in CDM matters is often small. The presence of a strong Designated National Authority³ (DNA) willing to support carbon projects through the CDM process is important, as are companies and utilities with the means and the will to initiate and implement CDM projects (Maxwell et al., 2011:4). David LeSolle, DNA for Botswana, writing in "A Reformed CDM – including new Mechanisms for Sustainable Development" (Olsen & Fenhann, 2008a:36) states that in most African countries the low awareness of climate change on the part of the DNA, businesses and civil society has a strong correlation with low CDM penetration – the low penetration is especially apparent in the LDCs in SSA (Olsen & Fenhann, 2008a:36 Table 1).
- Small, diffuse projects. In this dissertation 'small' means projects generating less than 5 000 tCO₂e per year. The lack of large projects (concentrated, commercial projects, such as HFC reduction, which accounted for 40% of the CDM CERs up to 2012, versus diffuse, SD projects) (Olsen & Fenhann, 2008b:2826 Table 7) in SSA is a problem. Because of the CDM transaction costs of at least R 500 000 per project per year, the CDM is not worthwhile for these small projects. For the CDM to be cost-effective for a project, it would need to deliver in excess of 50 000 tCO₂e per year (50 000 tCO₂e at R 10/t = R 500 000). The CDM PoA concept is helping because one can group many similar projects together under one umbrella, but PoAs have their own challenges – reams of paper-work to get all the documentation done, lengthy lead times for approval and registration and no guarantee of success. The risk is just generally too high for project developers.
- High transaction costs and high risk. As mentioned earlier, the CDM process requires skilled and experienced practitioners to produce the required documentation, then one needs to get the documentation approved by a DOE (at present DOEs are mainly only available in Western countries, so they have to be flown out at great expense and are paid high per diem rates). All this adds up to prohibitively high transaction costs – R 0.5 million to R 2.6 million. Carbon projects in Africa "are riskier and more costly to develop in Africa than in other regions", because of fewer CDM successes and fewer big projects (Arens et al., 2012:20).
- Lack of project funding because of high risk. The bankability or otherwise of the projects in Africa (availability of working capital, return on investment, risk) has caused difficulty in attracting investment finance (Maxwell et al., 2011:4). This is in contrast to the relative availability of "financial and institutional capabilities" of industrialised countries such as China compared to the LDCs (Maxwell et al., 2011:4).
- Different stakeholders have different expectations. The community wants its social development benefits and a share of the carbon revenue; the project developer wants a quick, low-risk project as does the funder; the local government wants to satisfy its sustainable development objectives; the CDM wants to significantly reduce GHG emissions rather than focussing on sustainable development benefits (Olsen & Fenhann, 2008a:36); the CER buyer wants high-quality (i.e. believable and verifiable GHG reductions and SD benefits) and the various consultants want to make money. Many of these objectives work against each other, for instance, as previously mentioned (see

³ Designated National Authority (DNA) – The DNA is a body set up by a country's government to carry out parts of the CDM process under the Kyoto Protocol.

Section 2.10.1, page 40), there appears to be an inverse relationship between GHG reductions and SD benefits (UNFCCC-CDM, 2011:16-19). Also, small projects generally deliver SD better than large projects, whereas large projects are better at GHG emission reductions (Gupta, Van Asselt, & Van Beukering, 2006). This mix of differing and conflicting agendas is a challenge to successful project initiation and implementation.

- Information asymmetry. The project developer, the project proponent, the carbon auditor and the carbon credit buyer each have access to different levels of information about the project and “addressing asymmetric information is at the core of addressing the structural impediments to carbon market access for small projects in Africa” (Wlokas & Cartwright, 2012). Conte and Kotchen express the same idea more bluntly: “Offset providers know a lot about the projects in which they invest, but offset buyers know only what the providers tell them. The asymmetry gives rise to a standard source of market failure” (Conte & Kotchen, 2010:96). Information asymmetry can pose problems in at least three dimensions. Firstly, from the point of view of the CDM EB there is the risk that the project developer, having access to much more information than the CDM adjudicators, can massage the project information so as to increase their project’s chances of acceptance by the CDM EB (Spalding-Fecher et al., 2012:61). For instance, a project could inflate its baseline emissions so as to show large GHG reductions. Another example is when a host government deliberately relaxes its own environmental constraints so as to allow its projects to appear to be additional – that it then appears that the projects are being done for CDM reasons and not because government policy forces them anyway (Rosendahl & Strand, 2009:3). However, most distortions should be picked up later when the first full audit is done, so a project developer would probably be quite careful about misrepresenting the project.

Secondly, from the point of view of the project developers, although they have an intimate knowledge of the project and all its ramifications, they still they have to be able to communicate the details of their project to the CDM EB in such a way as to get the project approved. Reducing the information asymmetry is difficult and expensive. One can’t expect the CDM EB to make field trips to all the projects, so one has to use proxies, in the form of DOEs and consultants doing endless reports. In order to make the reports on different projects and in different countries consistent, the natural reaction is to force the reporting to conform to standard templates – this then distorts the project information because generalised templates can never do justice to the wide range of projects. The result of all this is that transaction costs are driven up in an attempt to get better information and reduce the risk of accepting dodgy projects.

Thirdly, from the point of view of the buyer of the CERs it is difficult to assess the quality of the project producing the CERs, because of the difficulty of getting enough information. The result is that the buyers tend to be cautious about which projects they support; if a buyer doesn’t understand a project, that project’s CERs price is likely to suffer. In the VCM, buyers often actually visit the project and engage with the stakeholders in order to reduce the information asymmetry risk to some extent.

William Bibby argues that these factors, which cite the limitations of Africa as the reason why SSA has so few CDM carbon projects, do not adequately explain this phenomenon. Rather, he points to the nature of the CDM processes which don’t fit in well with the type of projects in SSA (renewable

energy comprising 39.2% and methane capture 22.8% of the SSA total, but only 0.9% and 0.5% of the CDM total). He also states that the lack of high GHG reduction intensity projects in SSA, such as destruction of HFC is a contributing factor to the low number of CDM projects in SSA (Bibby, 2012:110-112).

There is another aspect of the CDM failure which is relevant for this dissertation and that is to do with 'small' carbon projects⁴. If a project is unable to generate enough carbon revenue to cover the CDM transaction costs of R 0.5 – R2.6 million per project per year (Arens et al., 2012:20) then it wouldn't make sense to even attempt going the CDM route as this would lose money for the project. At the current CDM CER prices of around R10/CER (less than Euro 1/CER (EU ETS, 2013)), a project would need to generate 50 000 tCO₂e per year just to break even. A further consideration is the long time it takes to get from the initial project idea through to CDM registration; historically this has been up to three years (Climate Change Working Group (CCWG), African Task Force (ATF), & UNEPFI, 2009:11). So if the project is relying on carbon revenue for its viability, but hasn't access to finance to carry it through until its CERs have been issued and sold, these long lead times would be a deterrent to attempting to use the CDM mechanism to generate carbon revenue (Bibby, 2012:113). Note that the high transaction costs, long lead times and high drop-out rates of the CDM do not apply to Africa and SSA only, but nevertheless are a problem for small or under-financed carbon projects anywhere.

2.3.1. Future uncertainty clouds the Kyoto Protocol and carbon offset trading

In addition, the future of the compliance market and the CDM was uncertain following the decision at COP 17 to effectively postpone the formal extensions of the Kyoto Protocol until 2015. The first commitment period (CP 1) of the Kyoto Protocol ran until the end of 2012, after which the CDM mechanism is likely to go into a period of stagnation with few new CDM projects entering the CDM project pipeline (Kosoy & Guigon, 2012:52).

COP 18, held in Doha in December 2012, has removed some of the uncertainty about the future of the Kyoto Protocol and offset trading (Climate Connect, 2012) in that the Annex I countries have made some new commitments For instance:

- The Kyoto Protocol Phase II is to run from 1 January 2013 to 31 December 2020 – whereas previously there was some doubt about whether there would be a Phase II at all.
- The main Annex I countries have agreed not to roll over accumulated Phase I AAUs to achieve Phase II targets and the trading of surplus Phase I AAUs is restricted to 2% of unused Phase I AAUs – this should help reduce possible CER surpluses.
- The EU, Australia, Norway and Switzerland have committed to reducing their emissions by 785 million tCO₂e by 2020 – any actions which increase emission reduction commitments is likely to increase the demand for CER offsets.
- CDM: only 2.5% of unused Phase I CERs can be carried over into Phase II – this might help increase the demand for CERs in Phase II.
- CDM: Around 480 million tCO₂e of industrial gas CERs will probably remain unused because the EU, Australia and New Zealand have banned the use of this type of CER – this might also help increase the demand for CERs.

⁴ Small, being defined as less than 2 000 tCO₂e emission reductions per year for the purposes of this study.

- NAMAs⁵: 35 NAMAs are in the process of being formalised of which 8 are in the NAMA Registry and are looking for US\$ 13.5 million in financial support – it is not clear what impact the NAMAs will have on offset trading and carbon prices.
- A new climate deal for post 2020 is to be agreed at COP 21 in 2015 – previously there was more doubt about what will happen post-Kyoto, at least now there is a commitment to something.

Some of the problem areas associated with the Kyoto Protocol are:

- USA: Many words but few commitments
- China: Likely to beat its carbon intensity reduction target of 2.5% per year, but has not committed to absolute emission reductions
- Japan: Will not take part in Phase II of the Kyoto Protocol, but will not use its Phase I AAU's either and will continue with its Bilateral Offset Credit Mechanism (BOCM – now the Joint Credit Mechanism – JCM).

Another factor is that the market for CERs is becoming more selective. For instance, the EU ETS has now stopped trading CERs from the so-called Developing Countries and is concentrating on the Least Developed Countries (LDCs)⁶ only (Raab, 2012:20).

Some would argue that the CDM hasn't worked for SSA on the basis of the very low contribution of SSA CDM projects to the total (0.3% of issued CERs have come from Africa up to mid-2012, see Appendix A: CDM Pipeline analysis spreadsheet, page 93). However, others, such as Michaelowa, point out that Africa is not at all homogeneous and that there are areas of relative success such as Nigeria, Egypt and Morocco (Michaelowa et al., 2011:92). Further, most of the projects registered in the LDCs have done so during 2011, so perhaps the CDM is starting to work in parts of Africa. It should be noted that one should be careful of looking at registered projects statistics; one should rather look at projects that have reached the issuance stage, bearing in mind the high drop-out rate - the ratio of issuing projects to registered projects is only 15.5% (Appendix A).

The upturn in African CDM volumes (and the others) is shown clearly in Figure 1 (page 71) (Kosoy & Guigon, 2012:53-54). Note "post-2012 volumes" refers to the purchase of future volumes of CERs, which is permitted in most ETSs.

⁵ NAMAs – Nationally Appropriate Mitigation Actions, see section 5.1.2.7, page 61

⁶ LDCs 48 countries of which 33 are in Africa, 14 in Asia-Pacific and 1 in Latin America-Caribbean.

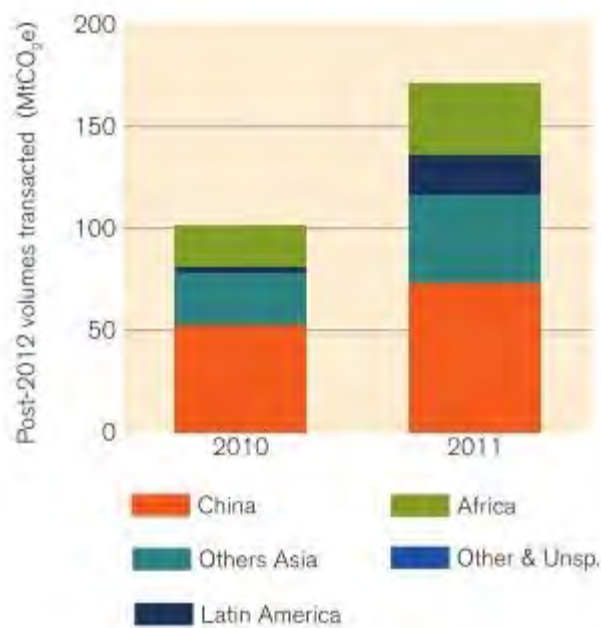


Figure 1: Post-2012 volumes transacted per seller, 2010-2011

Source: (Kossov & Guigon, 2012:53-54)

Africa contributed 21% of forward sales of post-2012 CERs (36 million tCO₂e). Note that African volumes doubled from 2010 to 2011, with most coming from the LDCs because of the EU ETS constraints from 2013 onwards.

2.4. The voluntary carbon market to the rescue?

An alternative revenue source for carbon emission-reduction projects is the voluntary carbon market (VCM) and its Verified Emission Reduction (VER) carbon credits. The VCM, as its name implies is a carbon market for buyers who wish to voluntarily buy carbon offsets for a variety of reasons which will be discussed in Section 2.13.2, page 50.

The VCM uses many different standards and has many registries, each with its own standards and verification systems. Examples of large voluntary carbon offset standards bodies are the Gold Standard (GS, a foundation supported by more than 80 non-government organisations) and the Verified Carbon Standard (VCS, an international non-profit organisation). There are several registries, including GS and VCS themselves that make use of the GS and VCS standards.

However, the large, international voluntary carbon registers, such as the GS and VCS, also have high barriers to entry. These barriers are in the form of the CDM-like standards used by these registries and their standards, which also require extensive project documentation and the use of international carbon auditors – the result is high transaction costs and long delays. Another problem for many projects is the question of ‘additionality’, particularly financial additionality – this is the CDM/GS/VCS requirement that the project in question would not have happened in a business-as-usual scenario (e.g. without the carbon credit revenue) or that the CDM helped the project overcome barriers to its implementation (Taiyab, 2006:3). For many projects this is a problem, particularly small carbon projects with limited GHG reduction potential, because the carbon revenue on its own is insufficient to make these projects financially viable, therefore they need other forms

of finance and consequently cannot generally claim that they would not have gone ahead without the carbon revenue. For these reasons, only large projects with significant GHG reductions find it worthwhile attempting to get carbon revenue from these types of registries⁷. This can be seen from an analysis of the GS and VCS statistics which shows that of projects which have issued VERs only 9% of GS and 12% of VCS projects generate less than 5 000 tCO₂e per year; see Table 1.

Table 1: Analysis of Gold Standard and VCS project sizes

Markit online registry data	Total VERs (tCO ₂ e)	Average VERs per project (tCO ₂ e)	% of projects with <1000 tCO ₂ e	% of projects with <5000 tCO ₂ e
Gold Standard	11,085,931	58,042	2%	9%
Verified Carbon Standard	24,119,107	3768610%	1%	12%

Source: (Markit, n.d.)

However, carbon markets are not homogenous and come in different shapes and sizes with different emphases and regulations that operate in different ways and some markets are well-suited to small projects and some aren't. In this dissertation the SSA carbon market is divided into two types – Type 1 and Type 2.

2.5. Type 1 and Type 2 carbon market and their processes

2.5.1. Type 1 carbon markets

Type 1 markets are characterised by strong additionality⁸ requirements and lengthy processes with result in long delays before carbon revenues start flowing. Projects in Type 1 markets typically achieve relatively high GHG reductions in relation to the costs of the project and the community benefits delivered. Examples of Type 1 markets are the CDM compliance market operating under the Kyoto Protocol and big VCMs using the GS and the VCS. Customers for carbon offsets in the Type 1 VCM tend to be large businesses that wish to offset their carbon footprint for internal company reasons such as Corporate Social Responsibility and Public Relations (PR) (Peters-Stanley & Hamilton, 2012:38). These businesses might also need the stamp of approval from a large registry in order to satisfy their pre-compliance, CSR or PR requirements (Taiyab, 2006:16). This is especially true for pre-compliance buyers⁹, who accounted for two thirds of the VCM transactions in 2011 (Peters-Stanley & Hamilton, 2012:vii). Pre-compliance buyers would naturally favour the rigour and market acceptance found in Type 1 markets and their associated standards in order to maximise the likelihood of being able to use their carbon credits for compliance purposes. The dominance of the big players is reflected in statistics for 2011 which show VCS with a 58% market share and the GS with 12% (Peters-Stanley & Hamilton, 2012:vii Figure 4).

Small community projects generally focus on SD benefits, this being their reason for existing, and usually have low GHG reduction potential by virtue of their small scale. Therefore these projects are not well-suited for the CDM and the compliance market (Type 1).

⁷ Examples of VCM registries: APX Inc., VCS, CDC Climate, Climate Care, TUV Nord

⁸ One common additionality problem for both Type 1 and Type 2 markets is having to prove that the intervention wouldn't have happened anyway.

⁹ Pre-compliance buyers are those who voluntarily buy carbon credits with the intention of being ready for expected carbon emission reduction constraints being imposed on them.

This is where a different form of carbon market comes in: registries, standards and processes that are a better fit for small projects with limited resources and relatively low GHG reduction potential. In this dissertation these have been called Type 2 markets and registries.

2.5.2. Type 2 carbon markets and their projects and processes

Type 2 carbon registries generally focus on small projects which cannot afford the Type 1 processes or the long approval lead times, or do not conform to the Type 1 definitions of additionality. These Type 2 projects tend to focus on the SD benefits of the projects such as:

- Improved energy access
- Health improvements
- Poverty alleviation
- Gender equality
- Education improvements
- Local environmental improvements

An example of a Type 2 registry is Credible Carbon¹⁰ which is described in the case study section. In order to reduce the transaction costs and generate carbon revenues sooner, Type 2 registries have to simplify and accelerate the approval and auditing procedures. However there is a risk that if the approval and verification standards are perceived to be too lax, credibility will be lost and the associated carbon credits will be devalued or even become impossible to sell. In the case of the Type 1 registries, the credibility risk is managed by requiring more documentation with more detail produced by accredited specialists, hence the high costs and long lead times. Type 2 registries do not have this luxury; instead they have had to find more effective ways of bridging the credibility gap

Type 2 markets, as defined in this dissertation, generally do have strict rules to ensure that the GHG reductions are real and do actually result in a permanent, net overall reduction in GHG emissions. However they do not require financial additionality in the CDM sense and will usually require additional external funding to be viable. To be additional, the CDM requires that not only must the project result in a permanent, net overall reduction in GHG emissions, measured against a business-as-usual baseline, but also that the project would not have taken place in the absence of the CDM (CDM Rulebook, n.d.). The idea being that an offset is only a valid means of reducing an entity's GHG emissions if it wouldn't have taken place anyway. The Type 2 market's simpler acceptance criteria and on-going audit processes result in fast approvals and early starts to carbon revenue flows, which are essential to the viability of most small projects. Often, the approval and auditing processes can be done by local agencies instead of having to call in accredited international consultants at great expense. The projects in Type 2 VCM markets also tend to deliver significant SD benefits compared to their GHG reduction potential. The carbon markets do not, of course exist in a vacuum and are there to connect carbon credit buyers with carbon credit sources. The carbon credit sources are the underlying projects, or carbon projects.

2.5.3. Carbon projects

'Carbon' projects, those which reduce GHG emissions and deliver community benefits, also come in different forms and sizes. Some generate huge GHG reductions resulting in large potential carbon revenues compared to the project costs and carbon market costs. This type of project is often well-

¹⁰ Credible Carbon, located in Cape Town, South Africa (www.crediblecarbon.com).

suited to Type 1 carbon markets. Other projects are smaller in scale and in GHG reduction potential, although they might deliver relatively large SD benefits – these projects generally fit well with Type 2 markets.

The carbon projects in Africa and sub-Saharan Africa have a low penetration into the Type 1 market category. This can be seen from an analysis of the CDM, GS and VCS Type 1 markets which shows the low penetration of African projects into these markets. For instance, Africa CDM CERs from 1.4% of the global total up to mid-2012; African VCM VERs sold amounted to 9% of the global total in 2011 (Table 3, Appendix A (Fenhann, 2012) and Table 4 Appendix B (Peters-Stanley & Hamilton, 2012:24)). This raises the question: what do the sub-Saharan African carbon projects look like and why do they not fit into the Type 1 markets?

2.5.4. Sub-Saharan African projects

Typical sub-Saharan African carbon projects in the Type 2 market are small in scale and have low GHG emission reduction potential, need funding from external sources in addition to the carbon revenue, and have limited resources for analysis and documentation related to securing carbon revenue. These carbon projects are usually strong on community benefits as this is their core purpose and is what is required to attract external funding.

These characteristics make most of the sub-Saharan Africa carbon projects completely unsuitable for Type 1 markets, because:

- The transaction costs are too high compared to the carbon revenue likely to be generated (Kossov & Guigon, 2012:20; Taiyab, 2006:7)
- The registration, validation/verification and issuance processes take too long for a small cash-strapped project (Taiyab, 2006:7)
- People with the required skills and experience to navigate the Type 1 process are not readily available in Africa and SSA (for instance, Africa's first, and only so far, UNFCCC accredited carbon auditor or DOE¹¹ was only appointed in April 2011 (Carbon Check, 2011))
- Type 1 buyers tend to focus on the credibility of the GHG emission reduction rather than SD benefits, so a small project with low GHG emission reduction potential but high community benefits will tend to be undervalued (Taiyab, 2006:16)
- The risks of failure are too high, especially in the CDM, with only 15.9% of projects making it through to the issuance stage by mid-2012 (Appendix A, (Fenhann, 2012))
- The future of the compliance market (Type 1) and hence the value of its CERs, is still uncertain, thus adding to the project risk (See Section 1.2.1 and news reports about the collapse of CER prices (Point Carbon, 2013))

Added to all this, whilst they are waiting for the approval, validation and selling process to happen, the carbon price is likely to fluctuate wildly, adding further uncertainty to the viability of the project – this is discussed in Section 2.6, page 30, on carbon pricing.

The Type 2 market is altogether more suitable and appropriate for typical sub-Saharan African projects because:

¹¹ DOE. The DOE is an independent auditor, accredited by the CDM Executive Board that carries out the validation, verification and certification of a CDM project and its GHG reductions

- The Type 2 transaction costs are much lower than those for Type 1 (Arens et al., 2012:20; Guigon, Bellassen, & Ambrosi, 2009:24)
- The unit price of the Type 2 carbon credits is comparable to those achieved in the Type 1 markets whilst the Type 2 transaction costs are much lower so the net revenue from carbon is greater in the Type 2 markets (see Section 2.4 on pricing)
- The projects are approved or rejected and the carbon credits can be sold more quickly (Climate Change Working Group (CCWG) et al., 2009:11; Guigon et al., 2009:30).
- The projects deliver significant SD benefits relative to their size (Corbera, Estrada, & Brown, 2009:46)
- There is a strong market in sub-Saharan Africa for Type 2 carbon offsets because the SD benefits and GHG reductions of the originating projects are attractive to potential buyers wanting to meet corporate social responsibility and carbon footprint reduction targets. This is evidenced by the experience of Credible Carbon (Cartwright, personal communication 2013, May 30) and ClimateCare (Bibby, 2012:112).

All this means that it is easier to fund and implement Type 2 projects instead of going the Type 1 route with the longer lead times and higher costs of the CDM, GS or VCS approval pipelines. However, both the Type 1 and Type 2 markets are characterised by volatile carbon credit pricing and uncertain futures. It is interesting to compare the two in these respects.

2.6. Carbon credit pricing

Carbon credits are not fungible (freely transferable and tradable) between the compliance markets and the VCM, or even between different registries and standards within the VCM. This is because the markets have different standards and governing rules. So, for instance, an Annex I country¹², operating under the Kyoto Protocol, cannot use voluntary carbon credits (VERs) to satisfy its Kyoto obligations, which require CERs and all the associated standards, methodologies and auditing rules. Similarly, a corporation wishing to offset part of its carbon footprint for corporate social responsibility reasons (CSR) by buying carbon credits, will generally not buy CERs. The reason for this is that the corporation usually wants to both reduce its carbon footprint and get favourable publicity through benefitting a local community project that delivers significant and visible social development and poverty alleviation (Peters-Stanley & Hamilton, 2012:7).

Occasionally what does happen is that projects initially try to register in the Type 1 markets (CDM, GS, VCS, etc.), but fail and then try the VCMs. Having tried the CDM route, the projects have often already done much of the paperwork required by the VCMs, thus reducing the time and effort still required to register VERs. An example of this is Reliance Compost¹³ which started off down the Type 1 route with the TUV Nord¹⁴ VER standard without much success, but then switched to Credible Carbon (Type 2) and very quickly managed to sell its accumulated VERs. Sometimes the reverse has

¹² The Annex I countries under the Kyoto Protocol are those countries which have committed to achieving quantified GHG reductions within an agreed time frame. There are 42 Annex I countries which include the EU, USA, Australia, New Zealand, Japan etc. For the full list, see:

http://unfccc.int/parties_and_observers/parties/annex_i/items/2774.php

¹³ Reliance Compost (www.reliance.co.za).

¹⁴ TUV Nord is a large, international Designated Operational Entity or DOE.

also happened – a VCM project that has been set up and running then decides to register under the CDM.

However, in spite of carbon credits not being fungible across the different carbon markets, nevertheless the compliance and VCM prices do appear to follow each other to some degree. This is possibly because the markets are free in that the prices are not set but negotiated for each transaction and buyers and sellers will point to the other market prices as part of the negotiating process. This is discussed in Section 2.7.

2.7. Compliance carbon market processes and pricing

The compliance market has evolved into a complex mechanism from its original, simple roots. It consists of a primary market plus a number of secondary markets. Primary CERs can be bought on the primary market and these can be retired or traded on a secondary market, or simply held.

Retiring CERs is a non-reversible process whereby they are removed from the register and are formally offset against the owner's carbon footprint – CERs can only be retired once and can't be traded thereafter. Before retirement, CDM CERs can be traded on the CDM's own IET as well as on other domestic carbon trading entities such as the EU ETS.

CERs can be traded, or sold to another entity (country agency, corporation or individual) at a mutually agreed price. The title to the traded CERs is transferred to the new owner by an entry in the CDM or the chosen secondary registry (see Section 1.1, page 15). Each transaction, consisting of a CER quantity, transaction date and a unique reference number, can be tracked and ownership proved.

Holding CERs means just that, holding them until you want to retire them or sell them to someone else.

2.7.1. The CDM and how it works

The CDM is managed by the CDM Executive Board (CDM EB, operating under the UNFCCC) whose task is to set up rules and processes to ensure that the claimed CERs are real, permanent and additional to what would have happened in the absence of the CDM. The CDM also acts as a registry for CDM projects and verifies and records the status of each project and its CERs. The life-cycle of a typical project as far as the CDM is concerned consists of eight stages, elegantly described in the CDM Rulebook (CDM Rulebook, n.d.):

1. Project Design Document (PDD).
The PDD must include the following: the project boundary, the baseline methodology, the crediting period, the additionality motivation, the environmental impacts, public funding sources, stakeholder comments, the monitoring plan and documentation of all calculations relevant to the project.
2. Letters of Approval (LOA)
The LOA is provided by the country hosting the project through its Designated National Authority (DNA). The LOA's intention is to make sure that the host country approves of the project and the project's SD outcomes.
3. Validation

The validation must be done by a Designated Operational Entity (DOE)¹⁵ and the object is to confirm that the project meets all the relevant CDM requirements. This step is different to the later Verification step, when a formal audit is done once the project has been running for a while.

4. Registration

This step confirms that the project has been accepted by the CDM EB as a valid CDM project which will appear on the CDM database of projects.

5. Monitoring

This includes the measurement and recording of GHG emissions for the baseline and after the project's implementation, so that the GHG reductions can be quantified as tCO₂e. Any leakage must also be identified and monitored.

6. Verification

Periodically the project's GHG reduction performance as measured by the monitoring process must be audited by a DOE. Only verified CERs can be issued and sold.

7. Issuance

Once the CERs have been certified by a DOE, they are ready to be issued by the CDM registry administrator. This means that the CERs go into a CDM holding account, ready to be forwarded (sold).

8. Forwarding

This is the process whereby CERs are transferred to the party who is buying the offsets. In other words, the CERs are sold from the CER provider (a non-Annex I country) to an Annex I country.

Having generated CDM CERs, the underlying projects now seek to turn their carbon into money. This is done through carbon registries, with the primary one being the CDM registry itself. There are many other secondary carbon registries on which CERs in various forms can be bought and sold by countries, companies and even individuals. These are important for sub-Saharan African carbon projects only in so far as they affect the market for carbon credits generated by these projects. Of course Emissions Trading Systems (ETS) are tremendously important to the bigger picture of using market mechanisms to facilitate global GHG reductions.

In addition to the primary CDM market there are now many secondary markets which deal in carbon credits. There are also derivative markets which trade in carbon credit futures – very much like the financial stock markets and derivative markets. Examples of these are the European Climate Exchange, the Green Exchange (Button, 2008:576). The secondary markets make the carbon market more liquid (Larson & Parks, 1998:33) and they do provide some pricing visibility. The largest by far amongst the secondary markets is the European Union Emissions Trading System.

2.7.2. The European Union Emissions Trading System

The European Union Emissions Trading System (EU ETS) was set up in 2003 by the EU as a mechanism to meet the EU Kyoto targets. Initially it covered the EU-15 countries and, after a trial period, it was expanded to cover the 27 EU member states as well as Iceland, Liechtenstein and Norway (Aasrud, Baron & Karousakis, 2010:42).

¹⁵ The DOE is an independent auditor, accredited by the CDM Executive Board that carries out the validation, verification and certification of a CDM project and its GHG reductions.

The EU ETS is first and foremost a domestic mechanism, designed to serve the EU's interests. Nevertheless, with the EU ETS accounting for about 80% of the global carbon market transactions (Michaelowa et al., 2011:25), the EU ETS has a considerable impact on the carbon markets around the world. The EU ETS started in 2005 with its pilot phase and then went into its second phase which runs from 2008 to 2012, with the third phase planned for 2013. The EU ETS is currently suffering from an over-supply of allowances which has led to a collapse in its carbon price. The mechanisms for controlling carry-overs from previous phases and for the issue of new allowances are currently being debated within the EU in an attempt to get the carbon price up to the point where it will make more of a difference to emission reduction.

The EU ETS is becoming more selective about the CDM offset market (Michaelowa et al., 2011:16). Initially the EU ETS would allow CDM CERs to be offset against EU emissions in the EU ETS regardless of the source country and the project type. However, the EU ETS rules will change from 2013 as it enters its third phase. The new restrictions on imports of CERs include:

- The numerical import limits on CDM CERs will be considerably reduced
- Only CDM CERs from existing projects registered before 2013 or from LDCs will be accepted
- CDM CERs from projects based on reduction of HFC-23 and N₂O from certain sources will not be accepted – and these have been the dominant projects in the CDM in terms of GHG reduction tonnes.

The analysis of carbon pricing is further complicated by the variety of carbon instruments that is traded on the EU ETS, such as: AAUs, EUAs, ERUs and CERs. These are explained as follows:

Assigned Amount Units (AAUs) are equivalent to CERs; that is if an Annex I country holds one AAU it is entitled to emit 1 tCO₂e¹⁶ under the Kyoto Protocol. In order to be able to spread the emission allowances to business entities within a country, the EU Allowance (EUA) was invented. For each AAU there is one EUA, so that if you add up all the EUAs you will get to the correct AAU total for that country.

EUAs are distributed or sold to EU business entities and entitle those entities to emit that many EUAs (1 EUA is equivalent to 1 tCO₂e). If a company finds it is able to emit less carbon than its EUA total, it can trade its surplus EUAs with another company that is struggling to meet its Kyoto obligations.

Emission Reduction Units (ERUs) are similar to CERs except that they result from Joint Implementation (JI) instead of from CDM offsets (PointCarbon, 2012:12). The JI is a mechanism, similar to the CDM, but which operates between Annex B countries only (Annex B countries are Annex I plus four other European countries: Liechtenstein, Monaco, Croatia and Slovenia). The JI allows emission permits to be traded between Annex B countries.

Since 2008, the secondary carbon market in compliance credits has been extremely volatile, both in terms of volumes traded and carbon prices achieved. This can be seen in Figure 2.

¹⁶ tCO₂e – metric tonnes of CO₂ equivalent GHG. That is equivalent in terms of global warming potential.

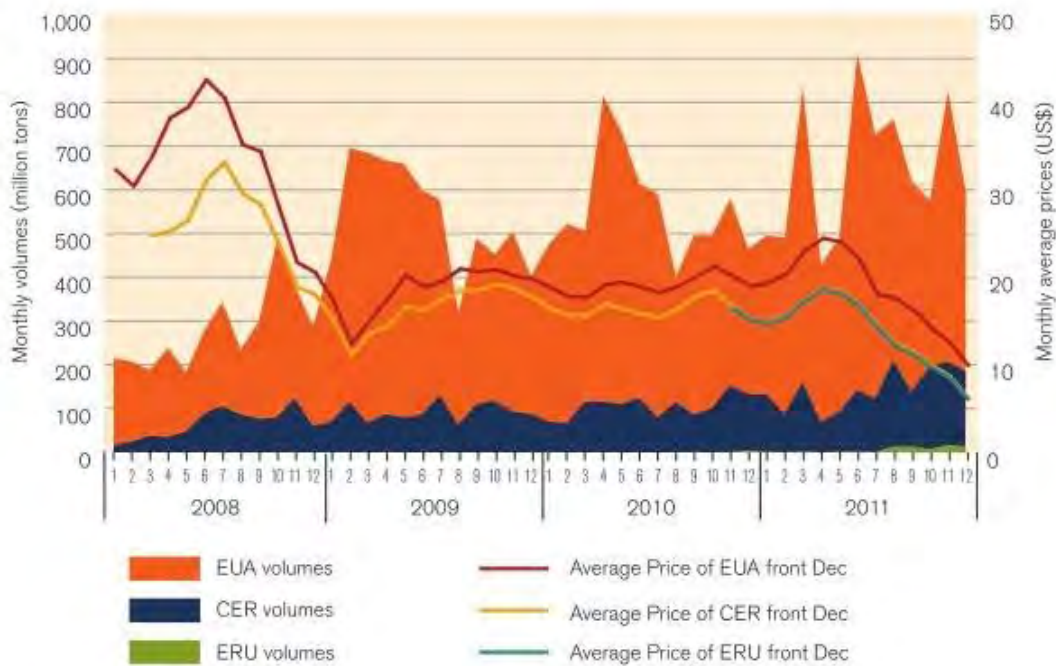


Figure 2: Prices and volumes for EUAs, CERs and ERUs in the secondary market (2008-2011)

Source: (Kossov & Guigon, 2012:18)

Figure 1 shows the enormous amount of EUA trading compared to the amount of CERs actually issued and sold to satisfy the EUA allowances (each EUA is equivalent to one CER). The high EUA volumes (traded on the EU ETS) are because carbon credits can change hands several times as they pass through brokers and are traded. Note also the spread between the EUA prices and the CER prices, with the EUA prices always higher. This is because the number of CERs entering the EU ETS is limited by the EUA allowances, whilst the CDM growth continues to add CERs into the primary CDM market, resulting in an oversupply of CERs in the primary CER market and therefore lower prices (Kossov & Guigon, 2012:37). Note that the ERUs (CERs traded on secondary exchanges) form a very small part of the trade and take their prices from the CER prices at this stage.

In a Point Carbon¹⁷ report (PointCarbon, 2012:6), it can be seen that since December 2011 and up to mid-2012, carbon prices have fallen further, with AAUs trading below €2/tCO₂e.

The Point Carbon analysis shows that the fall in the compliance market carbon prices appears to be due to:

- A surplus of AAUs in most Kyoto countries for both Commitment Period 1 (CP 1 2008 – 2012) and CP 2 (2013 – 2017)
- This surplus leads to a drop in AAU prices and this is followed by a drop in the price of EUAs and ERUs, because if a country has a surplus of AAUs it will not be buying EUAs or ERUs
- General uncertainty about the future of the Kyoto Protocol after COP 17, some of which was resolved at COP 18 in Doha (see section 1.2.1, page 15).

¹⁷ A Thomson Reuters company which provides “independent news, analysis and consulting services for global power, gas and carbon markets.”

The fall in prices was consistent with the classical economic theory of emissions trading in that the market appears to have found a new equilibrium point due to the supply curve shifting to the right because of the surpluses.

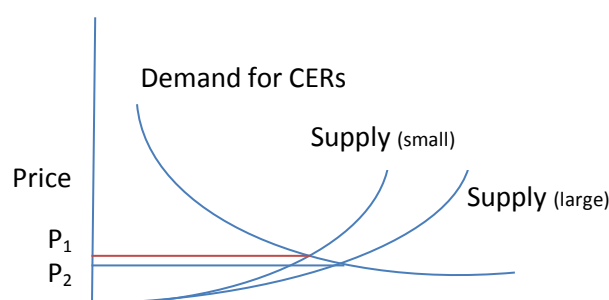


Figure 3: Supply – demand curve for CERs

Source: Author's drawing based on (Ellerman & Decaux, 1998:13 Figure 12)

As the supply of CERs increases, the equilibrium point moves to right and the equilibrium price drops from P_1 to P_2 (Ellerman & Decaux, 1998).

2.7.3. Other Emissions Trading Systems

2.7.3.1. Australia

Australia made some emission related commitments after COP 16 in Cancun in 2010. These included the intention to reduce carbon emissions by 5% from the 2000 levels by 2020. This was to be done by carbon pricing being introduced in 2012 and leading to emissions trading by 2015 (Michaelowa et al., 2011:75). The promised carbon tax was introduced by the Labour party in 2012 in the form of the Carbon Price Mechanism (CPM), against predictable resistance from the opposition party and the energy intensive industries. Tony Abbott, of the opposition Liberal party has sworn to dismantle the carbon tax if his party gets into power in 2013; so it is anyone's guess what will happen in the future. 2012 saw the passing of the Clean Energy Act, which will introduce a cap and trade mechanism by 2015. This scheme will cover about 60% of Australia's emissions initially. The units of emission reduction are the Carbon Units (CUs) issued by the government and the Australian Carbon Credit Units (ACCUs), the latter coming out of the Carbon Farming Initiative – another part of Australia's Clean Energy Future Package. These schemes will be phased in, starting with a fixed price on carbon from 2012-2015 and moving to a flexible price with caps on emission quantities from 2015. The scheme does allow international carbon credits to be imported, initially up to 50% of an entity's emission reduction obligation (Kossov & Guigon, 2012:73).

2.7.3.2. USA

In spite of the fact that the USA, under the Bush administration withdrew from Kyoto and that the Republican-held Congress continues to block key energy bills, there considerable activity at state level concerning emission reduction policy.

There is the Regional Greenhouse Gas Initiative (RGGI), which covers power plant emissions in ten states¹⁸. It is interesting that the revenue from the auctions of RGGI CO₂ allowances gets re-cycled back in carbon-constructive ways, with nearly 50% going to energy efficiency measures, 14% back

¹⁸ RGGI States: Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, and Vermont

into the consumers' pockets via electricity bill assistance and only 20% going into the general state coffers. The initial period yielded a net benefit to the state of US\$ 1.6 billion and a claimed creation of 16 000 jobs. However, offset trading is not part of the RGGI at present (Kossoy & Guigon, 2012:81).

The other big USA-related carbon reduction mechanism is the Western Climate Initiative (WCI). This currently comprises California in the USA plus four Canadian states (British Columbia, Manitoba, Ontario, and Québec). The WCI, will, if all goes well, result in a cap-and-trade system that works across state and national boundaries, with each party controlling its own territory. As could be expected, political challenges abound and so far only California and Quebec have passed their regulations enabling the WCI in their states. In addition to the pending WCI, California will be introducing a cap-and-trade system in 2013. Offset trading will be restricted to USA-based projects and certain developing countries – this part of the scheme is still in its making (Kossoy & Guigon, 2012:81-84).

Note that the Chicago Carbon Exchange (CCX), although it was a big player in the USA VCM, closed down in 2010 and is no longer active. The CCX was set up in anticipation of the USA applying formal GHG emissions reduction constraints, either as part of the UNFCCC or as a USA unilateral compliance measure. When this didn't happen and the USA continued to stay out of the Kyoto Protocol, the CCX collapsed and was closed down, thereafter most of the VER trade was on the OTC markets.

2.7.3.3. Japan

Japan, whilst remaining a Kyoto signatory, unlike Canada which withdrew completely in 2011, has decided not to take part in CP 2. Japan has been a big buyer of CERs (18% in the period 2008-2012, although smaller than the EU with its 79% (Kossoy & Guigon, 2012:71 Table 6)).

Japan implemented the Tokyo metropolitan area cap-and-trade system (which includes offset trading) in 2010. This system aims to achieve a 6% reduction against the "base-year emissions"¹⁹. There is also the Japan Voluntary Emissions Trading Scheme (JVETS). This scheme allows the use of Kyoto CERs as offsets. In spite of being voluntary the scheme has attracted 389 participants who have collectively saved nearly two million tCO₂e.

In addition there are a number of other initiatives such as the Domestic Credit Scheme and the Japan Verified Emission Reduction (J-VER) Scheme for local projects.

However, the big new thing which will follow Japan's withdrawal from CP 2 is the bilateral offset credit mechanism (BOCM) (Kossoy & Guigon, 2012:102). This was established under the Cancun Agreement in 2011. Japan will use the BOCM both to reduce its GHG emissions in line with its Kyoto and Cancun commitments, and also to effectively export its own low-carbon technology to developing countries. If the move away from nuclear power generation results in more coal power plants, then Japan will need the BOCM to work to balance its carbon book (Kossoy & Guigon, 2012:102-103).

2.7.4. Carbon trading in the developing countries – China and India

From a GHG point of view, China and India are by far the biggest emitters amongst the developing countries. They have also been the CDM's biggest providers of CERs as can be seen in Figure 4 (China 59.8%, India 14.9% and Africa 1.4%).

¹⁹ The base year amount is the average of any three consecutive years in the period 2002-2007.

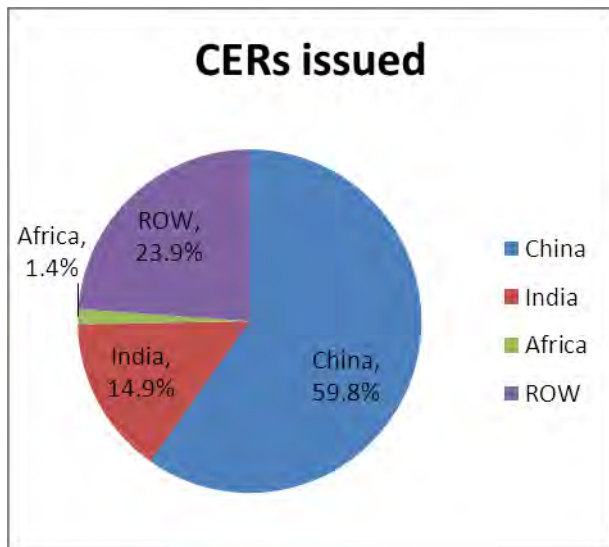


Figure 4: Comparison of quantity by country – in terms of CERs registered and issued

Source: (Fenhann, 2012) and author's analysis in Appendix A.

Being classed as developing countries, China and India have been direct competitors of African projects seeking to capitalise on CDM revenue. This will be changing somewhat in 2013, when the EU ETS will only support carbon projects in the LDCs – which rules out China and India (and South Africa) (Raab, 2012:20).

China proposes to concentrate on the reduction of carbon intensity and energy intensity in its industries and has set targets to achieve a 17% carbon intensity and 16% energy intensity reduction by 2015. China's measures include carbon trading and a voluntary carbon market (Michaelowa et al., 2011: 76 Table 2). Similarly, India will also be concentrating on improving its industrial carbon intensity and is aiming at 20-25% reductions by 2020-2025, using market-based mechanisms.

The carbon markets and their mechanisms have been described in this section and the next step was to examine what is behind it all – how GHG reductions are measured and how SD improvements are assessed. All carbon projects wishing to generate carbon revenue have to convince their carbon customers that they have reduced GHG emissions and have made a contribution to SD.

2.8. Voluntary carbon market pricing

The voluntary carbon market is much less homogenous than the compliance market. This is to be expected because instead of one standard (i.e. the CDM), there are many different standards being used in many different countries. Therefore it is difficult to compare voluntary carbon prices to compliance carbon prices.

Nevertheless, some trends can be identified. First of all, looking at Figure 5 (page 38), taken from the report "State of the Voluntary Carbon Markets 2012" (Peters-Stanley & Hamilton, 2012:24 Figure 23), we can see that in most cases both the volume and the value traded has gone up from 2010 to 2011.

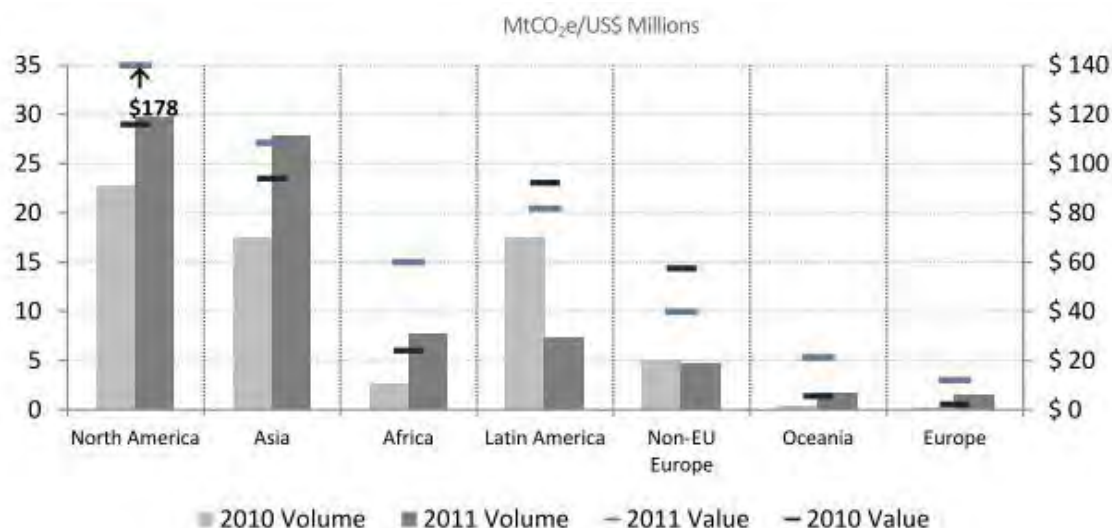


Figure 5: Change in VCM volume and value by region, OTC. 2010 vs 2011

Source: (Peters-Stanley & Hamilton, 2012:24 Figure 23)

By reading the approximate figures off the graph and dividing one by the other, the estimated average unit prices can be calculated as in Table 2 (see also Appendix B: Carbon volume and value analysis for the detailed data) (Peters-Stanley & Hamilton, 2012:24 Figure 23). The CDM figures were taken directly from the 2012 World Bank report (Kosoy & Guigon, 2012:49 Table 3).

Table 2: VCM and CDM volumes, values and prices, 2010-2011

Volume and Value for the VCM and CDM	VCM VERs			CDM CERs (Primary market only)		
	2010	2011	% change	2010	2011	% change
Volume MtCO ₂ e	66	92	39%	224	263	17%
Value US\$ Millions	360	466	29%	2675	2980	11%
US\$/tCO ₂ e	5.5	5.1	-7%	11.9	11.3	-5%

Source for VCM: (Peters-Stanley & Hamilton, 2012:24 Figure 23)

Source for CDM: (Kosoy & Guigon, 2012:49 Table 3).

The compliance market volumes²⁰ went up from 2010 to 2011, while the compliance carbon price fell from around \$ 11.9/tCO₂e to US\$ 11.3/tCO₂e. In the voluntary carbon market, the volumes also went up, and the carbon price went down by 7% (from US\$ 5.5/tCO₂e to US\$ 5.1/tCO₂e).

More recently, in 2012, the VCM prices have overtaken the CDM prices – the volume-weighted average VCM price was \$5.9/tCO₂e whilst the CDM offset price had fallen to below \$1/tCO₂e (Molly Peters-Stanley & Yin, 2013:vii). The next question is what will happen in the next few years?

According to a study done by Conte and Kotchen (Conte & Kotchen, 2010), prices in the VCM appear to be driven by factors to do with the nature of the offsets and the associated projects in addition to the theoretical factors such as the equilibrium between marginal abatement costs in the regulated country and those in the offset project country in a pure regulatory environment as discussed in

²⁰ Note that the CDM primary market volumes as opposed to the secondary and EU ETS volumes were used as these are more comparable to the VCM figures. The comparison aims to show new carbon credits and their prices rather than all transactions between all intermediaries.

Section 2.1 (page 18). Conte and Kotchen developed price functions that attempted to explain VCM offset prices in terms of factors such as where the host project was situated, what type of validation and certification was used (valuing co-benefits or not) and the technologies used in the projects, such as wind, solar or biomass. The findings from Conte and Kotchen's research (Conte & Kotchen, 2010:96), included the following:

- VER providers (registries, brokers, retailers) operating in the EU achieved significantly higher prices (30%) than those situated elsewhere
- VERs from sources (that is the generating projects themselves) that were in developing countries or LDCS realised higher prices (20%) those sources in other countries
- The certifying standards used also make a significant difference, with standard based on Kyoto and the CDM achieved higher offset prices (30%) than others, such as the VCS

The factors influencing VCM offset prices have been discussed further in the analysis section (Section 5.3 (page 82)).

2.9. What is the future outlook for the carbon markets?

The futures of the compliance and voluntary, Type 1 and Type 2 carbon markets are uncertain. For the compliance markets, and especially the CDM and EU ETS, much depends on what happens to global GHG reduction targets and compliance rules in the next few years. The COP 17 and Durban Platform outcomes left us with the Kyoto Protocol hanging in limbo – the Annex I countries have until 2015 to decide what they are prepared to commit. It appears to be the nature of governments (and companies and individuals) to delay awkward decisions in the hopes that the choices will become clearer with time. In the case of climate change and what should be done about it, there are competing points of view: restraint versus innovation – Malthus versus Solow. The Malthusians argue that it is essential for us to stop using up the planet's resource, whereas the Solovians hold that innovations will rescue us from the threat of scarce resources. In the face of this it is tempting to do nothing and wait and see (Martin & Kemper, 2012:52). So some countries will press ahead with their own internal GHG reduction targets and others will probably delay, enjoy the free-ride and hope the problem goes away. The developing world (non-Annex I countries) meanwhile will carry on with their development agendas and resist any attempts to get them to reduce GHG emissions at the expense of economic growth or without some compensation. As previously described in Section 1.2.1 page 15, some progress was made at COP 18 at Doha (Climate Connect, 2012). However, it remains to be seen to what extent countries will act on their intentions; therefore the compliance market uncertainty is likely to remain for the foreseeable future.

In South Africa, it appears that some form of local carbon tax (and possibly a carbon cap and trade later on) will emerge although the details are still being debated and there is much opposition from the trade unions and from the high carbon emitting industries. A draft policy paper was been published for comment (SA National Treasury, 2010) and a carbon price of R 120/tCO₂e was been proposed. The policy was amended and re-issued for comment in May 2013 (SA National Treasury, 2013). However, the policy proposal has been drastically watered down in response to business opposition with the result that the tax will only come into force in 2015 and the tax-free thresholds will remain fixed until 2019. In its current form the South African carbon tax policy will allow carbon emitters to offset their emissions by up to 10% of their total and pay an effective carbon tax of R 72 after rebates (BusinessDayLive, 2012). However, it is not at all clear what form of offsets will be

allowed – will the offsets have to be bought from particular registries, or particular types of registries, and will these be Type 1 or Type 2 or possibly a mixture of these? However, it is likely that the South African government will try to keep the carbon tax revenues within South Africa so as to minimise capital outflows and maximise local project benefits. The impact of implemented carbon tax policies on both Type 1 and Type 2 markets should be to establish a lower limit on the carbon price at least until the supply of local carbon credits exceeds the new demand generated by the carbon tax implementation (Urban Earth, 2012).

Having examined carbon markets and carbon pricing broadly, it is important to recognise that carbon credits are only worth what they can be sold for on the carbon market. The vehicle for selling carbon credits is the carbon registry and there are successful registries and less successful registries. However, it is not only the general carbon market and the chosen registry that determines the value of a particular project – it is also the nature of the carbon project itself.

2.10. Carbon registries and projects

Before looking at why particular registries work well with Type 2 projects, we first need to explore how Type 2 carbon projects work – who gets involved and how and what are the various roles and role-players.

Typically Type 2 projects are not motivated primarily by GHG reduction, but rather by the need to deliver tangible sustainable development and community benefits, such as: poverty alleviation, health and environmental improvements, and energy provision. These needs are well-defined and motivated for in the MDGs. Therefore these projects tend to be created in response to a community need. However, in practice it is difficult to measure the SD impact of a carbon project on its affected environment and communities.

2.10.1. Sustainable development

The problem of measuring SD impacts of a project is complex and often subjective. This is partly because the words “sustainable”, “development”, “social development”, “community benefits” and “poverty alleviation” mean different things to different governments, businesses and people. Perhaps that is why the CDM process and rules delegate the SD management to the government of the host country through its DNA – this is done formally through the Letter of Approval (see Section 2.7.1, page 31 on how the CDM works).

Nevertheless, the UNFCCC does provide some guidance in their report on CDM benefits (UNFCCC-CDM, 2011:9). This report states that there is wide agreement that SD “comprises of three mutually reinforcing dimensions, namely economic development, social development and environmental protection.” To be useful, these three components need to be defined. In the report, the UNFCCC optimistically suggested that all that was required is a list of SD indicators with suitable metrics. Then, presumably, armed with these one applied the metrics to the indicators, applied suitable weighting factors and a number emerged which was a measure of the SD. By comparing the before and after values, the impact of the project could be measured. This was obviously very difficult to do as is evidenced by the scarcity of studies which have actually carried out this exercise. The UNFCCC said that only two such studies have been done. It seems that in the end, no matter how complicated a process one adopts, it comes down to subjective judgements by the parties involved (DNA, DOE and the other project stakeholders).

One interesting fact that emerged from the UNFCCC's analysis of SD outcomes of CDM projects is that there appears to be an inverse relationship between SD improvements and high GHG reductions. So, as one might have expected, the big industrial CDM projects delivered high CER returns but little SD improvements – and the reverse is true too (UNFCCC-CDM, 2011:16-19). The analysis used a set of 15 SD indicators and applied them to 350 CDM projects. The highest scoring indicators in order of the number of claims made in the project PDDs were Economic-Local job creation, Environment-Noise pollution and dust reduction, Environment-Promotion of renewable energy, Economic-Technology transfer, Environment-Protection of natural resources and Environment-Efficient utilisation of natural resources – these scored over 100 claims. Ranked the lowest were the social benefits, none of which scored more than 100 claims. The social benefits were: health and safety (52), engagement of local population (41), poverty alleviation (10), labour conditions and human rights, promotion of education, and, lastly, empowerment of women and care of children scoring only three claims. (UNFCCC-CDM, 2011:12 Figure II-1). Note that this analysis was done on the basis of statements made in the PDDs; what actually happens as the projects unfold is a different story – the study found that there was rather poor agreement between the PDD claims and surveys carried out after the projects had been registered. For instance 19% of the surveys had no matches with the PDD claims at all and only 10% had a better than 50% match. All this shows that applying complicated indicators is difficult to do and likely to be misleading.

Even if it was possible to get a generally accepted methodology for assessing the impact on SD, there remains the problem of getting sufficient information to apply the chosen methodology. The standard CDM PDD and VCM PIN documentation is not sufficient, especially as these documents are usually produced before the project is running and contain intentions rather than facts on actual performance. The next source of information could be the periodic verification audits, but unfortunately these tend to concentrate on the carbon credit calculations because this is where the money is. At present there appears to be no strong governance over the delivery of SD benefits, nor any drive to document these benefits. So researchers in the field are driven to doing detailed case studies on a few examples: for instance a 2006 paper on four case studies in Vietnam, South Africa, Costa Rica and India (Gupta et al., 2006). This study compartmented SD into the usual three components (Environment, Economy and Social) and applied their own SD index methodology to score the projects so that they could be compared and ranked against each other. Apart from being able to rank the projects, the study also concluded that there were four key indicators of success of a project (success in terms of achieving a high ranking using the Gupta et al 2006 paper's methodology) – these were:

- Demand-driven projects deliver the best SD outcomes, this is where the host country has a strong interest in the project and where the local stakeholders are keen participants
- Well-designed projects that are small and inexpensive, with clear baseline analysis, well-defined roles and responsibilities do best
- Good quality documentation is essential
- Demonstrative effect: the successful projects tend to lead the way for other projects

There are several other SD-related indices in use, such as Cosbey's Development Dividend (Cosbey et al., 2006), the OECD-IEA Development Index (OECD-IEA, 2010) and the Action Impact Matrix (Munasinghe, 2011) – but no one universally accepted way of assessing SD impacts.

To establish the need and initiate a suitable project some essential role players are required. Although the actual role players vary from project to project and some roles overlap, in this researcher's experience the role players and roles described in Section 2.10.2 will generally be present in a carbon project.

A particular aspect of SD relevant to the Umdoni case study in this dissertation (Section 4, page 69) is the effect of indoor air pollution (IAP) on health. The Umdoni project is a fuel-switch project which uses bio-ethanol gel fuel to partially displace other commonly used fuels such as wood and paraffin and one of the SD benefits claimed was improved health due to reduced IAP. The seriousness of IAP on people's health in sub-Saharan Africa is apparent from the statistic that 32% of the global deaths and disability-adjusted life years (DALYs) occurred in sub-Saharan Africa (only South Asia was higher at 37%) (Bruce et al., 2006:798 Table 42.3).

2.10.2. Project role players

There will always be a champion or project conceiver who has the vision of what the project should deliver and has the skills and the drive and the connections to make it happen. This person could be a member of the community itself, or someone in a non-government organisation (NGO), or sometimes a local government person, or perhaps a funding organisation looking for suitable projects.

It was shown in Section 2.10.1 that according to Gupta et al. (Gupta et al., 2006) successful projects amongst other things had well-defined roles and responsibilities.

The necessary role-players are:

- Community representatives
- Project Proponent
- Project Developer
- Local Government representatives
- Funders
- Carbon registry, carbon auditor and carbon offset customers

It is worth looking at these in more detail in order to get to grips with typical Type 2 project dynamics, see Figure 6.



Figure 6: Typical role players for a Type 2 project

Source: (Atkins & Prasad, 2012)

Figure 3 attempts to show the idealised interactions between the role players. It is assumed that a project champion has emerged and has started off by finding a suitable project proponent to look organise the project and arrange the carbon credit processes. The project proponent first engages with the community and together they negotiate and define the scope of the proposed project. This is done in the form of a Project Idea Note. Next the project proponent finds and assembles the rest of the team – these being a project developer (who will manage the project), a local government representative (if required), a funder and the carbon registry. The appointed project developer then plans the project in detail and documents this as a Project Design Document (PDD). The PDD is then discussed, modified if necessary, and finally agreed by the community, the local government (if involved), and the funder (often an NGO) with the project proponent driving the negotiations. The project proponent now has to secure funds, usually through the funder. If the funder requires changes to be made to the project design, then this must be negotiated by the project proponent who involves the affected parties (community, project developer, local government, funder). Once the funding has been secured, the project proponent draws up the necessary contracts. This is an important step as it determines who will own the carbon credits, how they will be managed and sold (e.g. contract with a suitable carbon registry) and what will be done with the resulting carbon revenue. The project is then implemented, with the project developer managing the project. Once completed and signed off to the satisfaction of the main role players (community, project proponent, local government and funder), the project moves into the monitoring phase, carried out by the project developer and overseen by the project proponent. The project then runs for a period (usually a year) and then the project proponent requests the carbon registry to appoint a suitable carbon auditor to do the required audit. The carbon registry can then start selling the credits. The carbon revenue would usually be managed by the project developer under the constraints of the relevant contracts and overseen by the project proponent. This whole process is described in more detail in Section 2.10.3, page 45. More detail on the role players follow in the next section.

2.10.2.1. Community representatives

As with all projects, in whatever domain, one of the prerequisites for success is to ensure that the project will deliver what the proposed beneficiaries want (not necessarily 'need'). So one of the first actions should be to find out what the community wants. This is usually done by identifying legitimate community representatives who will act on behalf of the community and interpret the wants (and perhaps needs) accurately and commit the community to the project and its success. The project developer will often assist in the wants/needs analysis by collecting data and analysing it, but the community representatives should have the final say as to what the community wants to get out of the project. As was discussed in Section 2.10.1, projects where the local stakeholders are keen participants deliver the best SD outcomes (Gupta et al., 2006).

2.10.2.2. Project Proponent

The project proponent plays the role of 'deal-maker', much like the producer in the movie business. This involves working with the community representatives and the local government, appointing a suitable project developer, finding a funder and arranging funding and the carbon finance side of things with an appropriate carbon registry. The project proponent is also responsible for producing documentation such as the PIN, approving documentation produced by the project developer (the PDD), checking that the project has been implemented as planned, and, once running, is delivering the promised outcomes. According to Gupta et al. good documentation was an indicator for success in a carbon project (Gupta et al., 2006). One of the outcomes of a carbon project is, of course achieving the predicted GHG reductions. This is based on an agreed GHG reduction calculation method (called a 'methodology' as in the CDM nomenclature) and a monitoring plan. Naturally, the project proponent (and the project developer, carbon auditor and registry for that matter) would need to be paid for these services and this payment can be funded in various ways, such as setting aside some of the future carbon revenue, or including the professional fees as part of the project's costs and getting these funded by the funder. Clear baseline analysis was another indicator of a project's success according to Gupta et al. (Gupta et al., 2006).

2.10.2.3. Project Developer

The project developer does the actual, hands-on work of developing the project plan and seeing that the project goes ahead as planned. As described in Section 2.10.2.2, professional service providers such as the project developer can be funded out of the carbon revenue or form part of the project's costs.

2.10.2.4. Local Government representatives

Sometimes, community projects will need to get the buy-in from a local or national government department. For instance, this could be required when the project is funded by a government agency, or when some form of planning permission is needed or permits required. Local government involvement was required in the Umdoni project (see Section 4, page 69). This could be done through a government representative who will make sure that the project doesn't contravene any rules and regulations. Sometimes the local government can also be a source of funding and expertise.

2.10.2.5. Funder

Most Type 2 projects cannot survive on the carbon revenue alone and so additional funding is required. This is the role of the funder – to provide the agreed funding. The funder will mainly work

with the project proponent. The funder will typically need to be involved during the project planning and implementation as well as once the project is up and running. Most funders will require detailed project documentation before and during the project implementation and regular audit reports once the project is running.

2.10.2.6. Carbon registry, carbon auditor and carbon offset buyers

The carbon registry is responsible for registering the audited carbon reductions in the form of Verified Emission Reductions (VERs), based on the agreed carbon reduction methodology, and then marketing and selling the VERs to their customers.

The carbon registry appoints an independent carbon auditor who will calculate the project's VERs using the agreed methodologies. The auditor should be objective and independent of all the other project participants, have the required carbon auditing skills and be credible in the eyes of the carbon offset customers (Kollmuss, Zink, & Polycarp, 2008:33)

The carbon registry will typically levy a transaction fee (per tCO₂e transacted), this varies from registry to registry. The CDM charges 2% of the CER value for small-scale projects²¹ (Guigon et al., 2009:20). In the case of Credible Carbon, the registration fee of R 1.00/tCO₂e will be paid by the project itself (usually out of the carbon revenue). If the VERs are immediately retired there is no additional fee levied by Credible Carbon, but if the VERs are held and then traded or retired later, then there is a further R 1.00/tCO₂e fee which is payable by the VER owner. Credible Carbon would appoint a carbon auditor and the carbon audit fees are usually paid out of the carbon revenue.

The carbon offset customers can be any individuals or any business entities that need or want to offset their carbon footprints. Their reasons for buying carbon offsets could include: an ethical desire to reduce their carbon footprint, a corporate requirement to do so, a legal requirement, or to meet a commercial objective (such as reducing carbon tax cost-effectively) (Peters-Stanley & Hamilton, 2012:7).

These then are the role players that should be involved in any carbon project. They are involved at different stages of a project's life cycle as described next.

2.10.3. A typical Type 2 project life-cycle

Naturally all projects are different and events unfold in many ways – a typical Type 1 (VCS) life cycle sequence is: PIN → PDD → Validation → Registration → Monitoring → Verification → Issuance → Transfer of ownership (Molly Peters-Stanley & Yin, 2013:6 Table 2). However this study was not able to uncover project life-cycle information for Type 2 projects in general. What was possible was to get this information in the case of Promotion of Access to Carbon Equity (PACE) and the associated Credible Carbon Registry²². In this case the process usually includes the steps shown in Figure 7 (page 46).

²¹ CDM defines small-scale projects as those generating less than 15 000 CERs per year.

²² Personal communications with Anton Cartwright over the period 2011 to 2013.

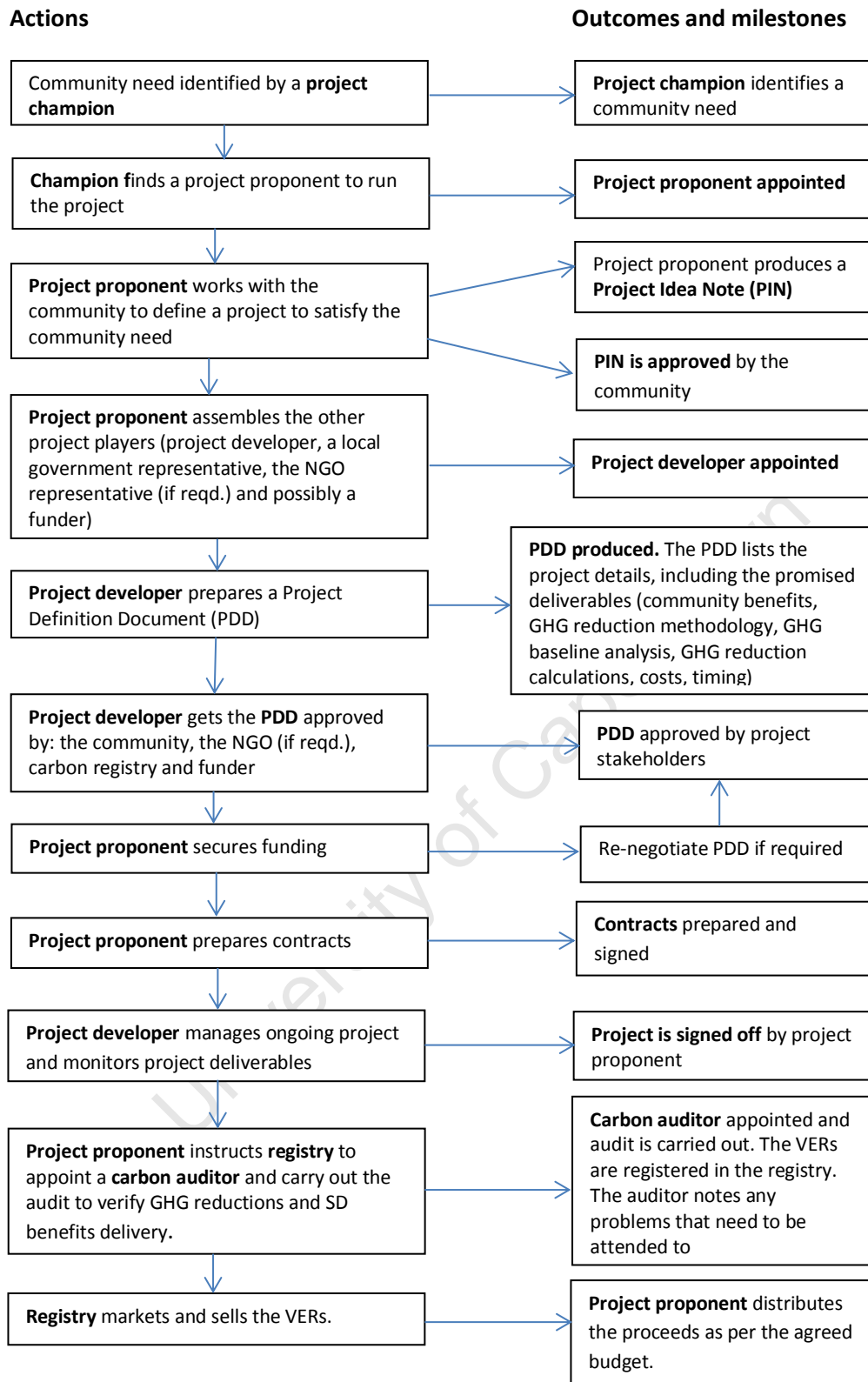


Figure 7: Sample project process diagram

Source: Author's own diagram, based on PACE and Credible Carbon experience

As can be seen, the project process is quite complicated and can become extremely bureaucratic and expensive as has happened with the Type 1 project processes, which are even more complicated and require more documentation and accredited experts to produce the documentation.

The next point of interest for this research was the question of what makes a particular registry successful and attractive to a Type 2 project. Before looking at particular registries, it is useful to set the scene by examining how registries work, what registry standards are being applied and looking at the mechanics of carbon offsetting.

2.11. How does a carbon registry work?

A carbon registry is like a financial stock exchange in that it puts sellers and buyers together and allows them to carry out buying and selling transactions and tracks who owns which VERs and which VERs have been retired by whom. Each block of VERs is identified by a unique transaction code in the registry so that the life cycle of a particular VER block can be tracked – this history includes: which project it originated from and when, who sold it and when, who bought it and when, and who retired it and when. In addition, a carbon registry does a number of other things, the foremost being that it guarantees that the VERs it has registered conform to a set of standards. These standards should be open to the public. The registry also has access to the project documentation (PIN, PDD and audit reports) and can make these available to legitimate, interested parties, such as potential VER buyers. Generally the registry will issue retirement certificates so that an offset customer has evidence of the VERs that have been retired and are eligible for offset purposes. This transaction tracking also helps prevent the same credits being retired more than once (Kollmuss et al., 2008:39-42).

A successful carbon registry will carry a reasonable stock of audited VERs covering a range of projects and will have a track record of selling VERs at competitive prices to a range of buyers – the quality of the VER-generating projects and the legitimacy of the VER auditing will contribute to the price that its VERs will command (Conte & Kotchen, 2010). The efficiency of the registry's carbon auditing processes will determine the cost to the project of registering its VERs and this cost and the VER selling price determines the net carbon revenue available to the project stakeholders.

To be successful a carbon registry has to be able to convince the project supplying carbon credits that the registry will add value by getting a good price for the carbon credits. In order to get a good price for its carbon, a registry has to convince potential buyers that the carbon credits and the underlying projects are real and the projects have delivered the promised community benefits and GHG reductions. One of the ways carbon registries achieve this is to adopt and implement rigorously appropriate carbon registry standards.

2.12. Carbon registry standards

2.12.1. Compliance market standards

The compliance market is regulated by the CDM Executive Board (CDM EB) and other market entities operating under Kyoto Protocol. The guiding principles of the CDM are strong and simple (Fairhurst et al., 2012:15); CDM projects must:

- I. Be approved by the host country and provide benefits to the host country
- II. Contribute to SD as defined by the host country

- III. Result in measurable climate change mitigation outcomes
- IV. Produce emission reductions that are additional to what would have occurred without the project.

The CDM principles look simple and elegant, but in practice they are difficult to apply because of the need to go down into great detail in order to ensure that rules are applied consistently and rigorously. Volumes have been written about the CDM and a whole industry has developed around the preparation of the required CDM documentation and carrying out the monitoring and verification processes (CDM Rulebook, n.d.).

2.12.2. Voluntary Carbon Market standards

The VCM is currently fragmented and evolving rapidly. There are many competing registries and standards and there is no overall standards body, such as the United Nations and the CDM EB. Surprisingly, in spite of this anarchic state of affairs, the VCM is alive and well and growing. For instance, the African VCM volumes went from about 3 million tCO₂e in 2010 to 8 million tCO₂e in 2011 and the African market value went from US\$ 26 million in 2010 to US\$ 60 million in 2011 (see Appendix B) (Peters-Stanley & Hamilton, 2012:24)). The growth in the African VCM in terms of volume and value continued from 2011 to 2012 although at a much lower rate: the African VCM market value went up to US\$ 66 million in 2012 caused by small increases in volume and value (Molly Peters-Stanley & Yin, 2013:28 Figure 3).

The VCM splits neatly into the Type 1 and Type 2 categories.

The main players in the Type 1 market are the Verified Carbon Standard (VCS), the Climate Action Reserve (CAR) and the Gold Standard (GS). Together these accounted for 82% of the over-the-counter (OTC) trade²³ in the VCM in 2011 (Peters-Stanley & Hamilton, 2012:vii). The standards in all of these are closely modelled on the CDM standards.

The Type 2 market is much more diverse in respect of the standards being applied, for instance, in addition to the big three standards discussed in Sections 2.12.2.1, 2.12.2.2 and 2.12.2.3, there are many more, such as VER+, American Carbon Registry, BMV, CarbonFix, CCB, CCX, GHGS, ISO 14064/65, J-VER, Panda, Plan Vivo, Social Carbon Mechanism, VER+, Green-e Climate Protocol for RE, Green-e Climate Program and others. Three of the biggest standards in terms of traded VER volumes using them are described in detail in this section.

2.12.2.1. Verified Carbon Standard

This standard was previously known as the Voluntary Carbon Standard. It is London-based and operates a VER registry. However, the VCS transaction costs are high because the VCS requires much of the CDM overheads; such as the requirement for projects to be audited by a Designated Operational Entity²⁴ (DOE) (Fairhurst et al., 2012:47).

In 2011 VCS projects were traded at an average price of US\$ 3.7/tCO₂e with a volume of 41 million tonnes and 189 projects were validated in 2011 (Peters-Stanley & Hamilton, 2012:69).

²³ OTC. VERs can either be bought through a private carbon exchange or through the OTC market via brokers or online carbon stores.

²⁴ DOE. The DOE is an independent auditor, accredited by the CDM Executive Board that carries out the validation, verification and certification of a CDM project and its GHG reductions.

2.12.2.2. Climate Action Reserve

The CAR is only active in the USA and Mexico. It does carbon accounting only and doesn't track any co-benefits such as community development.

In 2011 CAR projects were traded at an average price of US\$ 7.3/tCO₂e with a volume of 9 million tonnes and 56 projects were validated in 2011 (Peters-Stanley & Hamilton, 2012:67).

2.12.2.3. Gold Standard

The GS started off as an attempt to improve the CDM project screening process so as to get higher quality projects into the CDM pipeline. The GS restricted the range of allowable projects to renewable energy and energy efficiency projects. The standard also tightens up on the CDM additionality rules, which aim to verify that permanent CO₂ reductions are achieved and that the projects do improve SD in the project's host country. Lastly, the GS also forces project developers to undertake full stakeholder consultation about all aspects of the project's impact on the environment and the community. The GS covers both CDM projects and VCM projects. The VCM projects are limited to those that reduce GHG by less than 5 000 tCO₂e per year, these are called Gold Standard Micro projects. The GS Foundation has managed to limit the costs to a first year fee of US\$ 7 500 and an annual fee of US\$ 1 500 per year (for a maximum sized project) (Fairhurst et al., 2012:47).

In 2011 GS projects were traded at an average price of US\$ 10.4/tCO₂e with a volume of 9 Mt and 50 projects were validated in 2011 (Peters-Stanley & Hamilton, 2012:68).

2.12.2.4. Credible Carbon registry and its standard

The registry and its standard used in this dissertation as a case study is Credible Carbon – an example of a small Type 2 registry (Cartwright, 2012).

The Credible Carbon standard and guiding principles are simple and are reasonably easy to implement in practice. Credible Carbon projects must conform to the following conditions: The projects must be real and up and running, they must reduce carbon and contribute to poverty alleviation, 70% of the carbon revenue after audit fees must be returned to the project community, the projects must be situated in sub-Saharan Africa and be locally developed, the total VERs of carbon sequestration projects, such as tree-planting must comprise less than 25% of total VERs from all projects, and lastly, the project deliverables must be audited by recognised carbon project auditors.

In addition, projects must answer four key questions satisfactorily: Is the project real, is the agreed technology installed and working according to plan, are the carbon calculations unbiased, verifiable and done according to industry-accepted methods, and lastly, is the project making a visible difference to poverty in the community?

The benefit of this type of compact standard is that it is intuitively easy to understand, rather than overly legalistic and jargon-dependent, and it is easy to audit for conformance to the standard. Because the standard makes sense to people unfamiliar with the carbon market, it means that potential buyers have more confidence that they are not buying a lot of hot air.

Having discussed the carbon markets, carbon pricing and carbon market standards, the next step is to examine how this invisible and intangible product, GHG reduction, can be turned into money through carbon offsetting.

2.13. Carbon offsetting

This is the process of buying VERs (or CERs in the CDM market) from another entity and using them to offset one's own carbon footprint. The idea with offsetting is to first do all one can to reduce one's own carbon emissions by investing in new, more efficient equipment or changing one's business processes and only then resort to buying offsets. In the compliance market offsets are bought in order to meet carbon reduction targets when other methods have been exhausted or have become too expensive.

In the compliance market for the Annex I countries, subject to CDM rules, the principle of 'supplementarity' is applied. This means that a country should reduce its carbon emissions through its own efforts before buying supplementary offsets. However, the Kyoto Protocol and CDM do not place upper limits on the offset quantities a country can buy; this is left to the individual countries to regulate as they wish. For instance, the EU allowable offset percentage ranges from 0% to 20% with an average of 12% (Climate Lab, 2009).

In the VCM, there are no global controls on what percentage of one's carbon emission reductions can be met through offsets. However, such limits are likely to emerge as individual countries and companies start applying voluntary emission reductions under cap and trade arrangements. This would make sense from the overall climate change point of view as one would want to encourage high-emitters to focus on reducing their own emissions first rather than just buying someone else's efforts. From individual companies' point of view, it makes sense for the company to first get its own house in order before resorting to buying offsets, otherwise it risks losing 'green credibility' and being accused of 'green-washing'.

2.13.1. Carbon credit ownership

The ownership of carbon credits has been identified as a risk area in carbon trading, because potential buyers will not be willing to transact unless it is clear who the legal owner of the credits and whether any constraints have been imposed on the spending of the resulting carbon revenue (Cosbey et al., 2006:115). This applies to both the compliance and voluntary carbon markets. Ownership and revenue allocation issues are generally covered in Emission Reduction Purchase Agreements (ERPAs) and Voluntary Emission Reduction Purchase Agreements (VERPAs).

2.13.2. Voluntary carbon market offset buyers

Peters-Stanley et al suggest that there are two types of buyer: "purely voluntary" and "pre-compliance" (Peters-Stanley et al., 2011:8). The former generally buy to offset their carbon emissions and to satisfy their CSR objectives. The latter buy speculatively, anticipating future compliance implementation which would drive up the VER prices. Guigon goes so far as to say: "One of the main drivers of the voluntary market is 'pre-compliance' market participants who seek early climate investments in hopes of gaining a return in the future compliance market." (Guigon, 2010:3). Another aspect of voluntary buyers is that they do not treat VERs as a featureless commodity; rather they are interested in the story behind the credits (Taiyab, 2006:19). Such as who benefits from the source project, where it is, what technology is being used and what are the impacts on the community and the environment (Peters-Stanley et al., 2011:15). Buyers are prepared to pay a premium for credits with a good story as mentioned in a 2012 VCM report "Credits with a high average price (>\$ 8/tCO₂e) were transacted by purely voluntary buyers who sought to support projects with social, environmental, and – most of all – local benefits" (Peters-Stanley & Hamilton,

2012:31). In 2011 corporate buyers dominated the VCM, accounting for 92% of the transactions. These corporate purchases were mostly for CSR and public relations (PR) purposes (54% of the total), while resale accounted for another 22% (Peters-Stanley & Hamilton, 2012:viii). The PR and reputation drivers for high prices for “charismatic carbon” are supported in a paper by Conte and Kotchen (Conte & Kotchen, 2010:95).

In South Africa, an added dimension appears to be the need for local export companies to reduce their carbon footprint in response to overseas customer pressure (Peters-Stanley & Hamilton, 2012:38). In addition to this a South African carbon tax has been proposed by the South African National Treasury which includes a mechanism for offsetting carbon emissions by purchasing and retiring offsets, is likely to expand the range of VCM offset buyers to include high industrial emitters (Molly Peters-Stanley & Yin, 2013:71). The details of this tax was under discussion at the time of writing and was expected to be implemented as from January 2015 (Momoniat & Morden, 2013).

The motivations of the Global 500 companies with regards to climate change actions and reporting on and reducing carbon footprints is interesting in that environmental drivers are definitely affecting decision-making in large companies and companies that act on these drivers are rewarded with higher stock prices and improved reputation. Companies are also becoming aware of business opportunities arising from changing customer behaviour in the light of climate change and low carbon strategies (PwC, 2012:5).

The regional distribution of VER sources and buyers shows that Africa remains a very small player, both on the supply and the demand side. This is shown in Table 3.

Table 3: Regional analysis of VER sources and sales for 2012 (OTC)

From /To	North America	Latin America	Africa	Asia	Oceania	Europe	Total	Percent
Units	M tCO _{2e}	M tCO _{2e}	M tCO _{2e}	M tCO _{2e}	M tCO _{2e}	M tCO _{2e}	M tCO _{2e}	%
North America	20.30	-	-	-	-	1.20	21.50	33.6%
Latin America	1.10	0.20	-	0.30	1.50	2.80	5.90	9.2%
Africa	0.70	-	-	-	0.03	3.90	4.63	7.2%
Asia	2.50	-	-	1.30	1.00	21.50	26.30	41.1%
Oceania	0.30	-	-	-	1.80	1.70	3.80	5.9%
Europe	1.50	-	-	-	-	0.40	1.90	3.0%
Total (MtCO_{2e})	26.40	0.20	0.00	1.60	4.33	31.50	64.03	100.0%
Percent (%)	41.2%	0.3%	0.0%	2.5%	6.8%	49.2%	100.0%	

Source: (Molly Peters-Stanley & Yin, 2013)

Africa supplied 7.2% of the global total of 64 million tCO_{2e} (VERs), with most of the sales volume to Europe (84%). It should be noted that these figures are for the Type 2 market (mostly under the VCS standard) – similar statistics for the Type 1 market do not appear to be available, neither are statistics showing the distribution within Africa and sub-Saharan Africa.

Increasing awareness of carbon emissions and associated risks and opportunities amongst local South African businesses was demonstrated by the Carbon Disclosure Project report for South Africa 2012 (Carbon Disclosure Project, 2012). The business response rate for the top 100 JSE companies was 78% for 2012, down from 83% in 2011, but still the second highest in the world. The responding companies showed general improvements in their degree of disclosure as well as in their

performance in the various CDP performance categories (with six SA companies now qualifying for the Carbon Performance Leadership Index – CPLI). The extent to which the CDP participants will affect the VCM market for VERs in South Africa is unclear. Most of the responding companies appear to intend meeting their emission reduction targets through their own efforts (energy efficiency, switching to low-carbon energy sources, process changes etc.), rather than by resorting to buying carbon emission offsets. Several of the participants aim to generate VERs through their emission reduction efforts (e.g. SASSA with solar water heaters, Tsb Sugar and Rainbow through using bagasse²⁵ and chicken litter as low-carbon energy sources). Many of the business identified carbon taxes as a potential risk to their businesses.

2.14. What makes a particular carbon registry attractive to a Type 2 Project?

This is the crux of the matter – what are Type 2 projects looking for from a carbon registry and how best can this be provided?

From the project proponent’s point of view the best registry will deliver the highest net cash return quickly and sustainably and with the least disruption to the project stakeholders.

To do this the registry must be credible so that its VERs command high prices; this requires consistent and rigorous carbon auditing against accepted standards and a track record of high quality projects. The project screening and audit processes must be simple and fast so as to keep the transaction costs low and deliver rapid results. The registry must have access to appropriate potential offset buyers so that VERs can be sold quickly and cost-effectively. The registry must also have a good understanding of the project and its deliverables so that it can market the VERs effectively. It must have expert knowledge of the different GHG reduction calculation methodologies and be able to apply them. The registry must have access to a number of independent carbon auditors so as to be able to fit the right auditor to a project. However, even after a project is up and running, is reducing GHG emissions and getting revenue by selling its carbon credits and benefitting its host community, many contentious questions remain (Chapple, 2008:12-14)

2.15. Carbon trading issues and debates

The debates cover a wide range of issues, here a selection:

- Human induced climate change is not happening and if it was it is not caused by human-generated GHG emissions, it is just part of natural variations in climate
- Climate change is much bigger than mere humans and nothing we do will make any difference, so why waste money on this
- Carbon trading doesn’t reduce global GHG emissions, it just gives big polluters the opportunity to duck their responsibility to reduce their own emissions and pass the buck (and bucks) to others
- Reducing GHG emissions and poverty alleviation are two separate issues and should be kept separate
- Carbon trading is just a big scam to make money for Western consultants and it doesn’t reduce global GHG emissions nor does it benefit the poor

²⁵ Bagasse – fibrous remnants from processing sugar cane and sorghum.

- Throwing money at poverty does not solve the poverty problem and this applies to carbon money as well as any other international aid money
- The most important outcome of carbon trading is to benefit and uplift the project communities
- The most important outcome of carbon trading is technology transfer from the developed to the developing world

The most important outcome of carbon trading is to let the market find and deliver the most cost-effective way to reduce GHG emissions. The UK's Department for International Development produced a report on similar issues and found widely differing views amongst the various participants in the voluntary carbon market (Chapple, 2008).

Some of these can be dismissed as the ravings of fringe radicals or the opinions of climate change denialists, but some of them are important and need to be addressed. The choice of which issues are worthy of further discussion is of course subjective, nevertheless, here is one such choice:

2.15.1. What is the most important outcome of carbon trading?

This depends on the point of view:

From the climate change point of view, the most important result is the cost-effective, global reduction in GHG emissions and it doesn't matter where the reduction happens, as long as the emissions are reduced permanently and do not emerge somewhere else due to leakage²⁶(Chapple, 2008:15). Taiyab defines *permanence* as the ability of a GHG-reducing project to "weather variability and uncertainty in circumstances while continuing to deliver carbon emission reductions", and *leakage* as the reduction of a project's carbon reduction that occurs outside the project's boundary, but is due to or related to the project (Taiyab, 2006:4). *So, a climate change mitigation practitioner might say that cost-effective GHG reduction is the most important outcome of carbon trading.*

From the polluting company's point of view, GHG emission reduction is mostly, like all other forms of regulation, a necessary evil. As long as the playing field is level and the rules are fair, GHG reduction can become a business opportunity. Carbon trading adds more flexibility; so if it is cheaper to buy carbon offsets rather than to change a manufacturing process, that's what a business will do. There is also considerable debate as to whether the Kyoto Protocol and its CDM is a cost-effective and efficient method of reducing CO₂ emissions. For instance, Nordhaus and Boyer argue convincingly that the CDM is an expensive way of reducing CO₂ emissions, with a benefit-cost ratio of only 0.14 (Nordhaus & Boyer, 1999:34). *So, the company might say that meeting its emission reduction targets at the least cost is the most important outcome.*

From the polluting country's point of view, GHG emission reduction is mostly something that its government has decided needs to be tackled and the carbon market is an attractive way to do it and avoids the need to micro-manage every company. The government just sets up the rules and applies them and, out of self-interest, the affected companies will do the right thing. An added benefit is that if the carbon money goes to a developing country, it reflects well on the giver and hopefully

²⁶ Leakage is the increase in GHG emissions outside the project's boundary and caused by the project. For example, a project which replaces kerosene with bio-ethanol gel from a constrained source, might cause someone else to have to revert back to higher-emitting kerosene because of bio-ethanol gel availability problems.

benefits the receiver. Of course, some countries, notably the US, decided that the Kyoto Protocol was not the best way to tackle climate change. The analysis by Nordhaus and Boyer shows that the US would have borne the bulk of the costs of the Kyoto Protocol on Annex I countries' production costs, followed by Europe and Japan (Nordhaus & Boyer, 1999:30). *So, from the polluting country's point of view, meeting its emission reduction targets at the least cost is the most important outcome.*

From the point of view of the country hosting the carbon reduction projects, it is good from all points of view. Foreign money and technology flows in, the local people benefit and the climate benefits (Ohlhoff, Markandya, Halsnaes, & Taylor, 2004:11). The desired benefits include social, economic, environmental and technological benefits (Olsen & Fenhann, 2008:2821 Table 1). *So, for the project host country, getting as many projects implemented as quickly as possible, regardless of the GHG reductions, as long as they deliver the promised SD benefits, is the best outcome.*

This is presumably why the carbon market has evolved as it has – it attempts to satisfy the needs of all the stakeholders – meeting GHG reduction targets at the national and industry level, attracting investment into the developing countries to benefit the poor and making or saving money along the way.

2.15.2. Offsetting re-distributes rather than reduces global GHG emissions

This is evidently true because the aim of carbon offsetting is not mitigation but rather to provide a mechanism for more efficient GHG reductions by allowing a GHG emitter who wishes to or has to reduce GHG emissions to purchase carbon credits from another entity which can do it more cost-effectively. And in the case of the CDM and the VCM, benefit the project which is supplying the carbon credits.

Nevertheless, one can argue that offsetting has helped reduce global GHG emissions by assisting the implementation of GHG-reducing projects which would not otherwise have happened. Ulrika Raab in her paper on carbon market mechanisms puts the global CDM reductions at more than 1 billion tCO₂e (Raab, 2012:xiii). The literature is full of confirmed reductions in GHG emissions – after all, this is what the whole, complex and expensive CDM machine is about – making sure that the emissions claimed are additional to what would have happened in the absence of the CDM, permanent and do not result in leakage (the displacement of the emission reductions to somewhere else, outside the project's boundaries). However, there are also strong views that countries and companies shouldn't be let off the hook by being allowed to buy their way out of their emissions problems through offset purchases, rather just force everyone to reduce their emissions for the common good. But it doesn't appear that any government has the stomach to do that unilaterally and who is going to go first and put themselves at an economic disadvantage?

A related question is to do with additionality – would the project that generated and sold the carbon credits have gone ahead and reduced emissions anyway, even if there was no market for the carbon credits?

This question is fundamentally difficult to answer, because it depends on what would have happened in the absence of the GHG reducing project and carbon trading. Would the developing countries have gone ahead anyway and introduced renewable energy, or planted or preserved forests, or increased energy efficiency, or switched to carbon-neutral fuels?

Another question is: does capping the emissions of a business or a country reduce global GHG emissions? If all that happens is that the country/business with an emission cap moves its manufacturing offshore to a country/business that doesn't have a cap, then the global emissions have probably not been reduced (Monbiot, 2013).

This is where the CDM concept of additionality comes in. If the carbon-reducing project would not have been done in the absence of carbon trading and carbon offset revenue, then the GHG reductions are said to be additional. If the carbon reducing project would have been implemented anyway, with or without the carbon revenue, then all that has happened is that the GHG emitter who bought the offsets has met its technical GHG reduction obligations, but the total future GHG emissions are unchanged because neither party has changed its GHG emissions behaviour from business as usual (Schneider, 2009:243).

So does that mean that the additionality requirement will solve the problem? No, the problem has just changed into a new problem, that of proving that a project would not have gone ahead anyway – we are back to the unknowable.

It is relatively easy to make the call with projects such as gas fields venting methane for years and then suddenly starting to flare the gas, thereby reducing the effective GHG emissions by converting methane into CO₂ (methane is about 21 times more potent a global warming agent than CO₂). They hadn't bothered to burn the methane before because this didn't benefit them, but as soon as they were paid to do it they did.

There many examples of dubious additionality claims that have got through the CDM screening process. Research done by the Program on Energy and Sustainable Development (Wara & Victor, 2008:13-14) describes the enormous number of new coal power stations that have been built in China in the last decade (100 GW per year in 2006 and 2007). The large amount of coal powered generation then lead to such serious pollution problems, coupled with coal shortages, that the Chinese government changed its energy policies to favour clean energy and this was reflected in the Chinese CDM projects in 2007, with almost all new hydro, wind and natural gas projects claiming CDM credits. In the opinion of Wara and Victor: "Taken collectively however, these individual applications for credit amount to a claim that the hydro, wind, and natural gas elements of the power sector in China would not be growing at all without help from CDM. This broader implication is simply implausible in light of the state policies...".

It is also difficult to decide what would have happened in the absence of carbon revenue with something like a government housing improvement project which adds ceiling insulation, energy-efficient lights and solar water heaters. Kuyasa, which is such a project, reduces GHG emissions by about 2.4 tCO₂e per household per year (Cosbey, Murphy, Drexhage, & Balint, 2006:119), but would the government have done the project anyway? It might have done it anyway, but the presence of an extra carbon revenue stream might have made the project more attractive and easier to fund.

Sections 2.15.1 and 2.15.2 are possible response to two of the many contentious questions that have arisen about carbon trading and much research has been done on these. However there do appear to be some gaps in the body of research – which this dissertation aims to address to some degree.

2.16. Some notable gaps in the research literature on exploiting carbon revenue

Much has been written about the CDM, VCS, GS and the VCM, but not much about the small end of the carbon market. This is understandable because in order to make an impact on global warming, enormous reductions of GHG emissions need to be achieved, so large scale interventions are required – the Kyoto Protocol and its associated mechanisms was intended to be such a large scale intervention. Note that in itself, a perfectly operating CDM would have a net zero effect on emission reductions. This is because the notion of offsetting and additionality – if the CERs were truly additional then the GHG reductions would exactly balance the emissions the country was trying to offset, if not, a net increase in GHG emissions could result (Spalding-Fecher et al., 2012:55) Big as the CDM's contribution has been towards meeting the demand for CERs and development finance, it has left large gaps. This is evidenced by the low penetration of the CDM in some of the developing and least-developed countries (Fenhann, 2012). Therefore other mechanisms are required and there are several of these have been proposed at successive COP meetings. Examples are the New Marketing Mechanisms (NMMs).

2.16.1. New Market Mechanisms

These are still being fleshed out and it is too early to say what impact the NMMs will have on GHG reductions, the carbon offset market and developing countries. The idea behind the NMMs is that ALL countries should participate, not just the old Annex I countries, and that all should strive to reduce their own emissions and not just produce offsets for other countries (Raab, 2012:55). There will be more flexibility and less prescription and each country will do what is appropriate in that country. The outcome will be internationally acceptable emission reduction credits that can be traded. However, the NMM mechanism is complicated and it appears all too likely that it will suffer from the same problems that beset the CDM – too much bureaucracy resulting in high transaction costs and long lead times. Time will tell (Andersone, 2012). Therefore, it doesn't appear that the NMMs will address the plight of small carbon projects which do not deliver big GHG reductions (of the order of a few thousand tCO₂e per year), but do deliver good community benefits. NMMs will be discussed further in the section 2.17.5, page 15.

2.16.2. So what is the best strategy for small carbon projects?

There is not much research literature on using carbon revenue to help finance small SD projects. This is probably due to the fact that each project is small in scope, that every project appears to be different and that the carbon revenue is too small and the additionality aspect too weak to warrant trying to use Type 1 market mechanisms (such a CDM, GS, VCS, etc.). This dissertation aims to fill some of these gaps.

2.17. Major debates

2.17.1. What would constitute successful carbon trading in the VCM: High offset tonnages, large GHG reductions, environmental protection, economic development, social development or technology transfer?

The answer appears to be all of the above, depending on whose point of view is being considered. The company buying the offsets wants to get the best value from its money. That usually means paying a reasonable price for offsets from a high quality project – high quality in the sense that the project must be seen to be delivering social benefits as well as reducing GHG emissions.

The community affected by the project generating the carbon credits wants to get as much money from its credits as quickly as possible with as little hassle as possible. The project proponent usually wants to deliver the sustainable development first and foremost and sees the carbon revenue as a useful co-benefit.

The host country wants to benefit its people through sustainable development and be able to show real GHG emission reductions.

The carbon registry would like to attract many high quality carbon projects whose VERs are easy to sell at high prices and which are easy and clean to audit.

So the champions of a carbon project should be aware of the different expectations from the different stakeholders and plan to satisfy them.

The answer also depends on which market one is talking about – the compliance market or the voluntary market. The compliance market is very definitely mostly about GHG emission reductions, whereas in the VCM many buyers consider that “a carbon offset’s contribution to social and sustainable development is as important as its climate benefits.” (Peters-Stanley & Hamilton, 2012:29).

2.17.2. What is good sustainable development?

Once again, the answer will depend on who you ask. The list of desirable SD outcomes might contain similar outcomes, but the priority order will vary considerably.

The community will probably want tangible and immediate benefits, such as improved quality of life, improved health and safety, job creation opportunities and poverty alleviation.

The project proponent should want to deliver what the community wants, but the carbon credit purchaser might have different ideas; such as a strong and visible environmental impact.

(Corbera et al., 2009:33)

2.17.3. Have the developing countries benefitted from carbon trading?

If the measure is simply how much outside money has been invested in a country then the answer is yes. The CDM investment amounts to US\$ 150 billion spread over 4 600 projects since 2005 (Raab, 2012:xiii) . It gets more complicated when one tries to see in what way the project’s country benefitted – the claimed economic benefits (e.g. job creation) are usually high, the claimed environmental benefits are middling and the social benefits are almost always very low by comparison (UNFCCC, 2012). A cynic might remark that this is exactly what one would expect a capitalistic system to deliver – money. There has been a significant amount of technology transfer according to studies cited by Ulrika Raab, about a third of CDM projects resulted in technology transfer to some degree (Raab, 2012:21). There is some evidence that GHG reduction efficiency and SD benefits are always traded off against each other. If a project yields high GHG reductions, it invariably is low on SD delivery and vice versa, according to Brown (as cited in Corbera et al, 2009:26).

2.17.4. What will happen to the CDM when the current Kyoto commitment period expires at the end of 2012 and what will the impact of this be on the voluntary carbon market?

This is important to projects trying to decide whether to use the compliance market or the VCM for generating future carbon credits (Michaelowa et al., 2011:21-23).

The question of what will happen to the Kyoto Protocol at the end of 2012 was not resolved at COP 17 in Durban – all that happened was the Parties agreed to come up with a plan and targets to be discussed in 2015 and leading up to formal agreements in 2020. The general feeling was that this was just not good enough and if no serious emission reductions are achieved until 2015-2020, then the global temperature increase will almost certainly not be kept below 2°C. However, there is also increasingly the feeling that the Kyoto Protocol with its present participants does not include enough of the big emitters to make a big enough difference. The USA has stated it will not be part of Kyoto in its current form, Canada has opted out altogether and Japan and New Zealand will not be part of CP 2. The developing country emitters, with China and India being the biggest emitters, have never been part of Kyoto and are still arguing for being allowed a period of catch-up growth whilst the Annex-1 countries do all the emission reduction work. COP 18, held in Doha in December 2012, has firmed up some issues (see section 1.2.1, page 15), but there is still more talk than firm commitments and actions. Meanwhile, the CDM and the EU ETS are in trouble as described next.

As was discussed in the Literature Review (Section 2.7.2, page 32), the compliance carbon prices have crashed and are at an all-time low of €2 on the EU ETS (PointCarbon, 2012:6). This is because of a continuing surplus of credits and the proposed 2013 allowances appearing to be too generous. So, with the carbon price so low, it is difficult to see how the EU ETS can make any impact on emission reductions as things stand – the carbon allowances will have to be radically reduced and the CP 1 surpluses written off instead of being carried over into CP 2. The affected countries and industries, still in the grip of a recession and high national debt, will not be happy with any additional financial pressure. So more stone-walling and delays in decision-making can probably be expected. The CDM, of course, is also affected by low carbon prices, in addition to other problems.

The CDM has been trying to re-invent itself so as to increase the number and range of projects that it can be applied to. This is in response to criticisms that it is not working for the developing countries apart from China and India. In an attempt to streamline the CDM processes and reduce the transaction costs, the CDM has introduced a number of changes. These include:

- The Programme of Activities (PoA), which allows a generic project to go through the CDM process and then many actual implementations of the generic model can benefit from the CDM without each sub-project having to go through the whole process. This does reduce the costs and time somewhat, but it is still a challenge for smaller, distributed projects. One of the objectives of the PoA is to allow projects to start small and then scale up. An encouraging fact for Africa is that 20% of the PoAs registered by 2012 have been in Africa (Raab, 2012:20).
- Simplifying additionality rules.
- Continually adding new methodologies in an attempt to cover the multitude of different projects which do not quite fit any of the current methodologies.

- Standardised baselines and default baseline parameters which will allow projects to choose a baseline off-the-shelf instead of having to carry out research and then justify their chosen baseline.
- Providing funding to help projects get themselves validated and registered through grants and loans, such as provided by the ACAD Facility (Michaelowa et al., 2011:88).

No doubt these CDM measures have helped and will help more projects generate revenue from their GHG emission reductions, but fundamental problems remain. The PoA process is still complex and expensive and will only suit some groups of projects. Simplifying additionality carries the risk of further reducing actual global GHG reductions and devaluing CER value even more as buyers lose faith in the integrity of the CDM. Standardised baselines introduce new problems, such as under-crediting some projects and over-crediting others and not taking into account changing trends (Schneider et al., 2012). Lastly, loan funding, whilst helping projects get started, can result in loan repayment problems later on. What is becoming clear is that the focus of the CDM is moving from big developing economies (China, India and Brasil) to the LDCs in sub-Saharan Africa (Raab, 2012:viii).

Having discussed the possible future of the CDM and the compliance market post 2012, the question of what will happen in the voluntary carbon market can be addressed.

There is likely to be some degree of pre-compliance²⁷ activity as companies prepare for what their government regulators might force on them or whilst waiting for initiatives such as REDD+²⁸ to be included in the EU ETS list. This is already happening in the case of REDD projects which are now included in the VCS methodologies and are growing rapidly; as described by Dinesh Babu (Michaelowa et al., 2011:101).

The current focus on CSR has grown, even under adverse economic conditions, and so is likely to intensify as business improves. One aspect of CSR in developed countries is the reduction of carbon footprints in businesses; therefore if CSR activities grow, then so will the need for carbon footprint reduction and hence the need for VERs for offsetting purposes.

On the downside, if the CDM falls out of favour and no one wants to buy CERs, then many CDM projects will turn to the VCM hoping to sell their credits there. Given the relative size²⁹ of the compliance market and the VCM, the VCM is likely to be flooded with CERs. The additional CERs could amount to 1 billion tCO₂e by 2020 in a VCM sized at 95 million tCO₂e in 2011 (Michaelowa et al., 2011:108; Peters-Stanley & Hamilton, 2012:12). At this stage, national regulation is likely to play a part, in that governments might prefer their industries to buy voluntary carbon credits from local carbon projects rather than from somewhere else – thus keeping the economic and social benefits within the country. However, without regulation or specific CSR pressure to stay local, corporations are likely to shop around for the cheapest offsets.

²⁷ Pre-compliance is the practice of companies hedging their bets by voluntarily reducing their emissions in expectation of being forced to do so in the near future.

²⁸ REDD+ Reducing Emissions from Deforestation and Forest Degradation.

²⁹ In 2011 the VCM was about 1% of the total global carbon market in terms of transacted tonnes (Peters-Stanley & Hamilton, 2012:12 Table 3).

2.17.5. What is the likely impact of the New Market Mechanisms on the carbon markets?

The new market mechanisms (NMMs) and other flexible mechanisms are emerging from the Bali Action Plan, the Cancun Agreement, the COP 17 in Durban and the COP 18 in Doha. They are intended to provide more flexibility in the GHG emission reduction systems and markets in the 150 non-Annex-1 countries. In Ulrike Raab's words, the NMMs "... should stimulate mitigation action across broad segments of the economy. The mechanism should safeguard environmental integrity and ensure a net decrease/avoidance of greenhouse gas emissions" (Raab, 2012:xvii). This sounds very much like the CDM, and it is, but the big difference is that NMMs will focus on whole sectors of a country's economy, not just on specific projects. Also, the policing of the schemes will rely much more on the host country instead of single global managing entity such as the CDM EB. Of course NMMs will probably introduce a whole new set of problems such as how to calculate emissions reductions across a non-homogenous group of emitters (Raab, 2012:xvii).

One of the NMMs is the Nationally Appropriate Mitigation Actions (NAMA) scheme, see page 60. The take-up of NAMAs by the target countries has been good, with more than 50 countries having submitted NAMA proposals by early 2012 (Kossov & Guigon, 2012:62).

Another is REDD+, which allows countries which look after their forests by avoiding deforestation and forest degradation or even planting new forests, to claim carbon credits.

Another is sectoral crediting and trading. Instead of measuring GHG reductions for a particular project or PoA group, the sectoral approach manages the emissions from defined sectors. An emission target for a particular sector, for instance electricity generation, will be defined by the host country. If that sector manages to get its emissions below the target it is awarded sectoral credits. With sectoral trading, a form of cap-and-trade system, a cap for the sector is set and the country would be issued with an appropriate number of tradable units. These credits can then be kept or traded (Michaelowa et al., 2011:116). How fungible the credits are in practice will depend on the governance mechanisms, so it is hoped that these will not get over-complicated and expensive to apply.

Japan, having opted out of any Kyoto CP 2 commitments is embarking on its own scheme, BOCM as discussed in the section on emission trading systems in developed nations (see Section 2.7.3, page 35).

It is still too early to see exactly what the NMMs will consist of let alone estimate their impact on the carbon market. Nevertheless it is worth having a brief look at what is evolving and attempting to assess what impact the NMM might have.

The NMMs started with the Nationally Appropriate Mitigation Actions (NAMAs) at Bali in 2007. The idea behind NAMAs was to move beyond the rigid CDM structures let the host countries put forward emission reduction proposals that would suit their circumstances. By doing this it was hoped that developing countries would become more proactive in conceiving and implementing GHG reduction projects. The NAMA framework is starting to take shape – there are two main types; unilateral NAMAs and supported NAMAs. The unilateral NAMAs are funded and implemented by the host country itself, whereas the supported NAMAs are those which only get carried out if they get support from outside the country. There will be a registry for supported NAMAs which will contain

all the necessary information required to attract and inform potential investors/buyers. The details of the registry were finalised at COP 18 in December 2012 and a “fully operational, dynamic web-based registry” will be implemented by September 2013 (Climate Connect, 2012:3). Other parts of the NAMA system include reporting processes, standards, guidelines and verification processes.

The evolution of climate change mitigation mechanisms is shown in Figure 8.

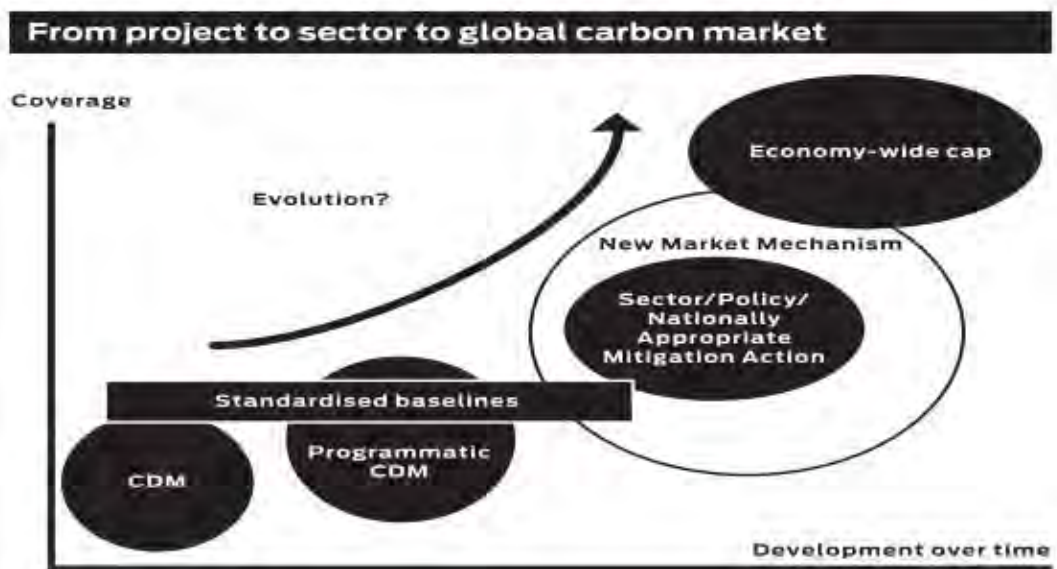


Figure 8: Evolution of carbon market mechanisms

Source: (Raab, 2012:72 Figure 5)

So what will this evolution of the compliance market mean to the VCM?

It is probably bad news for the VCM, in that if the compliance market really succeeds and successfully caters for small, diffuse projects, then the main reason for the existence of the VCM falls away. However, some researchers, such as Guigon, see an on-going role for the VCM in providing a platform for learning and innovation, field-testing new mechanisms and standards, capacity-building in developing countries and offering pre-compliance opportunities (Guigon, 2010).

3. Methodology

This chapter will describe methodology relevant to this dissertation from two points of view. Firstly the *research methodology* used and secondly the *functional methodology* of GHG reduction measurement, carbon market analysis and measuring community impacts.

Firstly, the author would like to make it clear that he is strongly in favour of using carbon trading both as a means of reducing GHG emissions efficiently and also as an excellent way of providing additional revenue and technology to get small, SD carbon projects implemented. These are often projects that otherwise would not have got off the ground. So there will be some bias in the research and findings, but one can take comfort in the words of Robert Stake:

"Research is not helped by making it appear value free. It is better to give the reader a good look at the researcher. Often it is better to leave on the wrappings of advocacy that remind the reader: Beware." (Stake, 1995:95)

Secondly, the generalisations made here are, in the words of Robert Stake (Stake, 1995:7): "petite generalisations", which apply to the case considered here and cannot therefore be safely generalised to all carbon projects. To be able to get enough evidence to provide "grand generalisations" is beyond the scope of this research.

Thirdly, on the question of validation of case study data, the case work researcher should carry out some "triangulation" – Denzin (as cited in Stake, 1995:112-114) identifies four categories of triangulation:

- Data source triangulation (where one looks at similar cases at other times and in other places, or with different people being involved)
- Investigator triangulation (where another researcher is engaged to repeat the research)
- Theory triangulation (conduct a peer review by researchers coming from a different theoretical angle)
- Methodological triangulation (using multiple methods to study the same case from different viewpoints)

However, although it was not possible to achieve these levels of validation, some degree of cross-checking and triangulation on the case study information was possible: for instance, at least six different people from three different organisations were involved in drawing up the Umdoni documentation (namely Anton Cartwright and Derek Morgan of PACE, Carl Wesselink and Shanaaz Moosa then of SouthSouthNorth, and Margaret McKenzie and Amanda Botes of Urban Earth). Also, personal interviews were held with Anton Cartwright (PACE), Nana Ndlovu of PPT and Siya Hlongwane of the Umdoni Municipality – these participants provided some first-hand descriptions of some aspects of the Umdoni case study.

3.1. Research methodology

There are a number of ways this dissertation could have been approached, such as:

- A high level data analysis of the publically available data from the various carbon market registers – This was not feasible because suitably detailed project information is not readily available from sources such as the CDM pipeline, the GS database and the VCS database for example. There is data on GHG reductions and CDM methodologies used, but nothing much on project organisation, project costs, stakeholder engagement and community benefits achieved.
- Field surveys of suitable projects and structured interviews with the relevant participants – This would have been ideal, but time and cost constraints prevented this approach.
- Multiple, detailed case studies of projects so that a comparative analysis of similar projects could be carried out – This would also have been good, but once again, the lack of readily available information in sufficient detail and time and cost constraints meant that this approach was not feasible in this case.
- A single unique case chosen for its relevance, generalisability, convenience, quality of documentation – This approach appeared to be the best option.

Therefore, after considerable investigation into the alternatives, a deep dive into a single case study was chosen.

Case studies are well-suited to this dissertation, where the research questions are about “how” and “why” as shown in Table 4 (Yin, 2009:8). A new column has been added to Yin’s table indicating the suitability or not of each strategy for this particular dissertation.

Table 4: Research methodology choice

Strategy	Form of research question	Requires control over behavioural events?	Focuses on contemporary events?	Suitability for this dissertation
Experiment	How, why	Yes	Yes	Can’t control events in the field
Survey	Who, what, where, how many, how much	No	Yes	Would be suitable, but time and cost rule it out
Archival analysis	Who, what, where, how many, how much	No	Yes/no	Would be suitable, but doesn’t address the “why” question
History	How, why	No	No	Up to date information is required
Case study	How, why	No	Yes	This was the chosen method for this dissertation

Source: (Yin, 2009:8)

Choosing a single case study has several advantages. Within the available resources it is possible to gather detailed information on the project’s history, who the stakeholders are, how the project was organised and is being managed, what the problems were and how these were overcome and how the project community has benefitted. A number of personal, unstructured interviews with some of the participants were also carried out and these gave a deeper insight into the project than could be obtained from the formal reports and audits. The chosen case study project was then analysed against the backdrop of what happens to similar projects that have chosen the Type 1 Market route (e.g. CDM, GS and VCS). However there are some problems associated with limiting the analysis to a single case study.

The main shortcoming of using a single case study is that it is difficult to generalise and extrapolate the findings to similar projects and thereby establish how replicable the project might be. To do this, one would have to repeat the detailed case study analysis with a large number of other projects and this is well beyond the scope of this dissertation. However, as Robert Stake (Stake, 1995:4) notes: “...

many of us case-workers feel that good instrumental³⁰ case study does not depend on being able to defend the typicality of Ø³¹

Nevertheless case study methodology is powerful, as Baxter and Jack (Baxter & Jack, 2008:556) conclude:

“Case study research is more than simply conducting research on a single individual or situation. This approach has the potential to deal with simple through complex situations. It enables the researcher to answer “how” and “why” type questions, while taking into consideration how a phenomenon is influenced by the context within which it is situated. For the novice research a case study is an excellent opportunity to gain tremendous insight into a case. It enables the researcher to gather data from a variety of sources and to converge the data to illuminate the case.”

Finally, this dissertation has researched the compliance and voluntary carbon markets in order to understand the main factors affecting small carbon projects and then has used this knowledge to understand why the chosen case study was successful in its generation of carbon revenue.

3.2. Research design

According to Yin, good case study research design should include: the research questions, possibly a hypothesis, the unit of analysis (scope of the research), data collection needed to address the research questions/hypothesis and finally, how the results will be interpreted (Yin, 2009:27).

3.2.1. Research questions

Choosing the right questions is as important as finding the answers and often more difficult, as Stake says, we need to find questions “that will direct the looking and thinking enough and not too much” (Stake, 1995:15). This dissertation started off with much broader questions and they were narrowed down as the research progressed – this was the final result:

- What are the main factors that contribute to the effective generation of net-positive carbon revenue from small, SSA projects?
 - How can these factors be managed so as to maximise the net carbon revenue?

3.2.2. Unit of analysis

This is about what the case study covered and it is important to define this widely enough so that the research questions and the hypothesis could be adequately covered, but narrowly enough so that the work involved was feasible within the skills and time and money resources of the researcher (Baxter & Jack, 2008:545; Yin, 2009:21). In this dissertation, possible units of analysis could have been:

- CDM and VCM in Africa – *probably too broad*
- VCM projects in Africa – *probably too broad*
- Small community projects and how they are funded – *probably too broad*
- VCM carbon registries – *probably too broad*

The unit of analysis was narrowed down to something manageable but still useful – the chosen unit of analysis is: small, poverty-alleviating projects which successfully manage to capture a useful

³⁰ An instrumental case study is one which seeks to be instrumental in achieving something other than pure understanding (Stake, 1995:3)

³¹ Ø is Robert Stake’s short hand symbol for a case study’s content and context.

amount of net carbon revenue. This process of defining the scope more tightly is also known as “binding”. Baxter and Jack describe a number of ways a case can be bound, and that is using different combinations of where, when, what type of activity and the context (Baxter & Jack, 2008:546).

The last two items on Yin’s list of five research design must-haves are data collection and the interpretation of the results.

3.2.3. Data collection

The relevant data comprised information about the carbon markets and the case study needed to allow the key carbon project enablers and disablers to be identified in order to answer the research question which sought to establish the main factors that contribute to the generation of carbon revenue from small, SSA projects.

The data collection process involved the following:

- Desktop research into: climate change, the UNFCCC, CDM, the nature and theory of carbon markets, carbon market standards, carbon pricing, carbon projects, carbon taxes, GHG reduction calculation methodologies, reports and documentation relating to the case study, etc.
- Meetings and interviews with people in the carbon business and associated with the case study project. Three key people were interviewed during this dissertation’s research – these were:
 - Anton Cartwright of PACE and Credible Carbon, he is an economist and a carbon market expert
 - Nana Ndlovu, a project developer working for PPT
 - Siya Hlongwane, of the Umdoni Municipality and responsible for the Umdoni gel fuel project.
- The author’s own work as a consultant working for PACE and Credible Carbon. The information gathered in this way can be described as “Mode 2” knowledge which is knowledge produced in the process of finding and applying solutions to work-place problems (Gibbons et al., 1994:3-16). Gibbons et al. argue that although this knowledge is not contained or processed in an academic discipline, it can nonetheless be just as useful as traditional, peer-reviewed information.

Once the data had been obtained, the next step was to analyse and interpret the data.

3.2.4. Interpretation of the results

The context in which the chosen case study project operates was analysed and compared to the CDM and big VCM contexts in order to identify the main factors that contribute to the effective generation of net-positive carbon revenue from small, SSA projects. Note that this study is essentially qualitative rather than quantitative, so the plausibility of the interpretation depends on making logical connections and linkages rather than on statistical tests aimed at proving correlations and causations.

3.2.5. Case study choice

A number of candidate subjects for the case study were found and evaluated, these included both Type 1 and Type 2 projects, some examples were:

- Reliance Compost, Western Cape, South Africa (Cartwright, 2012)
- Kuyasa housing improvement project, Western Cape, South Africa (Kuyasa CDM, 2010)
- Cosmo City housing improvement project, Gauteng, South Africa (City-of-Johannesburg, n.d.)
- Cato Manor housing improvement project, KZN, South Africa (Moosa, 2011)
- LifeStraw water purification project, Kenya (Vestergaard-Fransen, 2011)
- Hout Bay Recycling Co-op Project, Western Cape, South Africa (Lin & Cartwright, 2012)
- Umdoni bio-ethanol gel fuel project, KZN, South Africa (Atkins & Prasad, 2012)

The criteria used to select a suitable case study are best described as relevance, generalisability, ease of access to the data, extent and quality of documentation, availability of the role players and ease of access to them and the project's life-cycle stage. Robert Stake, discussing case selection, suggests choosing cases which maximise learning, are easy to get to and whose participants are cooperative, but cases that are too atypical of the field under study should not be chosen (Stake, 1995:4).

This is how the selection process unfolded:

Kuyasa – This is a CDM GS project so it was ruled out on relevance as I was looking for a VCM project.

Cosmo City – This is also a CDM project, based on Kuyasa but it hasn't been implemented yet, so it was also ruled out.

Cato Manor – This was a definite possibility, but the project is still in its early stages and has not yet had its first carbon audit.

Lifestraw – This one was too big and too far away.

Hout Bay Recycling Co-op – Interesting, but too small in terms of GHG reductions.

The Umdoni project had all the right attributes for this case study and was therefore chosen. It was relevant in that it is a poverty-alleviating project, it exploits the pro-poor part of South Africa's energy policy, and it is highly replicable because there are many similar communities where its lessons could be applied.

The ease of access to the data and data quality and detail criteria were satisfied, because the researcher had access to both the project documentation and also the carbon registry data.

The role player access was no problem because of the connections with the businesses, Promotion of Access to Carbon Equity (PACE) and Credible Carbon, of which the researcher is a part. PACE is a project proponent and Credible Carbon a VCM registry.

Life-cycle stage: The project was mature and had been through two carbon audits by two different auditors with different approaches.

3.3. Functional methodology

3.3.1. Carbon project impacts on emissions and development

3.3.1.1. Measurement of emission reduction

The CDM has developed hundreds of "methodologies" or calculation methods for estimating GHG emission reductions, together with processes and auditors to check the accuracy of the emission reduction claims of carbon projects. As has been mentioned previously (Section 2.3, page 21) these

processes are expensive and take a long time, but they do provide strong assurances that the emission reductions are happening. These methodologies can be found on the CDM website (UNFCCC-CDM, 2012a). The UNEP Risoe Centre maintains a spreadsheet of CDM projects, methodologies used and how far each project has progressed in the CDM process (Fenhann & UNEP Risoe Centre, 2008).

The list of approved methodologies is continually growing and at any time there is a queue of proposed new methodologies waiting for the CDM EB to give their stamp of approval so that they can be used by carbon projects. The methodologies cover every conceivable method of reducing GHG emissions, including from large-scale industrial applications such as flaring (burning) GHGs instead of venting them, destroying CFCs, improving energy efficiency, switching fuels from fossil fuels to carbon-neutral bio-fuels, growing forests, and more controversially, agreeing not to cut down forests. Some of these are easy to measure, such as burning methane instead of just venting it, but others are more complicated (UNFCCC-CDM, 2012a).

In all cases the process starts with establishing the “baseline” against which the project’s impacts will be measured. The first step is to decide on the project boundary, which is often not as easy as it sounds – the words used by the CDM are “The project boundary shall encompass all anthropogenic emissions by sources of greenhouse gases under the control of the project participants that are significant and reasonably attributable to the CDM project activity.” (CDM Rulebook, n.d.). The idea of the project boundary is to closely define exactly which emissions are “in” and which are “not” so as to avoid double-counting of emission reductions when projects might overlap and so that the auditors know what has to be checked. Having decided on the project boundary, the next step is to define the baseline and to calculate the anticipated emission reductions – see Figure 9.

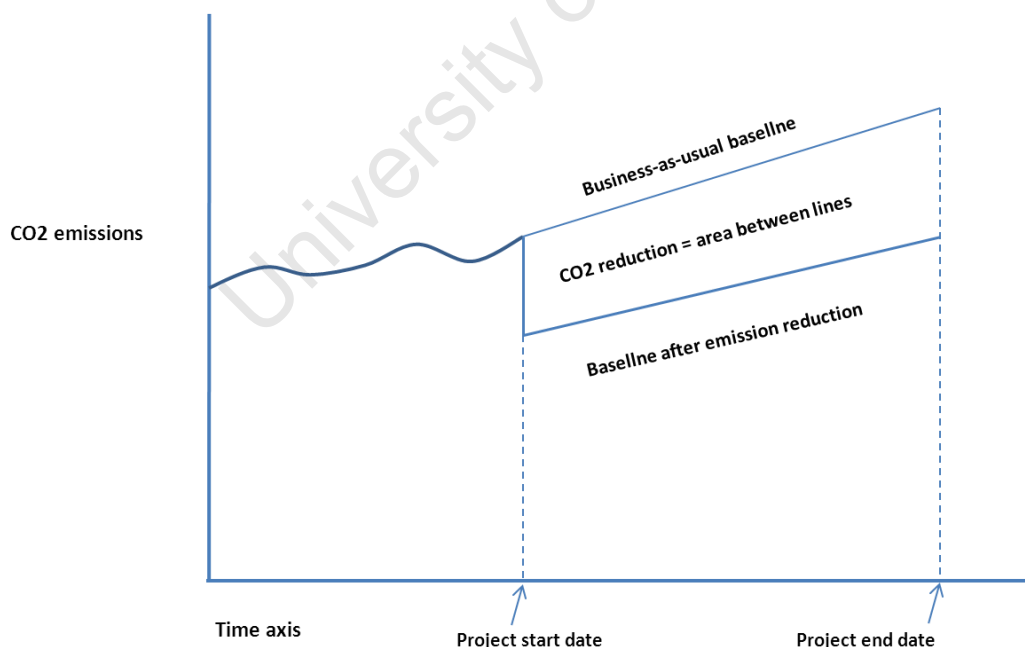


Figure 9: Baseline and emission reductions

Source: Author’s own diagram

The baseline emissions are those that would have occurred in the absence of the project being considered. In other words, what would “business as usual” emissions have been if the project was

not implemented? This immediately raises many questions, because one just doesn't know what might have happened over the next few years which would have affected GHG emissions within the project boundary. In the end the authors of the PIN will decide on a baseline methodology and put forward supporting arguments for its choice. Later, the CDM EB will review the PDD and decide if the baseline is reasonable or not (CDM Rulebook, n.d.). A monitoring methodology must always be chosen to match the baseline methodology.

The process in Type 2 markets is similar, except the project proponent chooses and applies the methodology which is later reviewed by the carbon auditor after the project has run for a period (usually a year) and changed if the auditor sees fit. The Umdoni case study (Section 4, page 69), for example, used the Type II-E Energy Efficiency and Fuel Switching for Buildings methodology (UNFCCC-CDM, 2012a). In this methodology the baseline is calculated assuming that the existing fuel (assumed to be paraffin for Umdoni) will continue to be used and the emissions are calculated using approved emission factors (the emission factor for paraffin was 2.5421 kgs CO₂e per litre of paraffin (DEFRA, 2011:8 Table 1b)). Then the emissions are re-calculated using the intervention technology instead of the existing one – for the Umdoni case study, this involved calculating the emissions produced by using bio-ethanol gel stoves instead of paraffin stoves for a portion of the time determined by the amount of gel fuel and its usage rate (Section 4.4.5.1, page 75). The difference between the two emission quantities is the emission reduction attributable to the project (in Figure 9, page 67, this would be the area between the business-as-usual baseline and the baseline after emission reduction). The CDM website (<http://cdm.unfccc.int/>) provides all the required information to make the correct choice of methodology and apply it.

3.3.1.2. Assessment of sustainable development impact

As was from the literature review (see Section 2.10.1 page 15), SD appears to be difficult to define and quantify, but easy to see when it is there. The Credible Carbon standard does require its projects to deliver SD benefits although it does not specify a quantitative method to be used. This is because the inherent difficulty of measuring SD would drive up the costs of project preparation and subsequent audits and because there is no guarantee that the resulting metrics would be meaningful (Cartwright, personal communications, 2012 on various dates). Nevertheless, the Credible Carbon standard does address the SD impact issue through one of its four audit questions: Is the project making a visible difference to poverty in the community? (See Section 2.12.2.4 page 49). It is left up to the project proponent to describe the expected SD benefits in the PIN and the carbon auditors to interpret and answer this question in their audits. The SD impacts in the Umdoni case study were described in Section 4.

4. Umdoni case study

4.1. Introduction

The Umdoni case study was presented at the “Strategies to overcome poverty and inequality: Towards Carnegie III” conference at UCT in September 2012 and much of this chapter comes directly from the conference paper (Atkins & Prasad, 2012).

This chapter describes the process of how a poor community in Umdoni, KwaZulu-Natal (KZN), South Africa achieved GHG reductions and converted these into carbon revenues and then recycled the bulk of the revenue back into their community. A voluntary carbon project proponent (PACE) and registry (Credible Carbon), specialising in poverty alleviation projects, assisted the community with the project preparation and the auditing, registering and selling of the carbon credits. The project, Umdoni Gel Stoves, is a ‘fuel-switching’ project which makes use of bio-ethanol gel supplied under the South African Government’s Free Basic Alternative Energy (FBAE) policy, and using gel stoves supplied by donors and local government (DME, 2007).

The project enabled poor households to partially displace wood, paraffin and dung fuel sources with cleaner-burning bio-ethanol gel (a by-product of the local sugarcane industry). This results in:

- reduced paraffin fire threat and indoor air pollution, mainly affecting women and children
- less time spent collecting firewood, especially by women and children
- reduced household expenditure on energy
- conservation of dung on croplands with the associated improved soil fertility
- creation of sustainable village businesses selling and distributing the bio-ethanol gel
- reduced GHG emissions.

The bulk of the carbon revenue (70%) went back to the community and is being used in ways determined by them. The remainder of the revenue covers project management and carbon registry fees. The project is described in this section.

4.2. Umdoni Gel Fuel low Income Housing Project



Map of SA with Umdoni in Kwazulu-Natal
Source: (Statistics South Africa, 2011)



Map of Umdoni Municipal area
Source: (Umdoni Municipality, 2009)

Figure 10: Map of Umdoni Municipal area

The Umdoni Local Municipality, part of the Ugu District municipality, is on the east coast of South Africa in the province of KwaZulu-Natal (KZN). It has a population of 75 000 people in about 20 000 households. It is a predominantly poor area, with high unemployment and is approximately half rural and half urban. The map in Figure 5 shows the Umdoni area highlighted on the lower eastern coast.

4.3. How the Umdoni project started

The project was not initially conceived as a GHG reduction project which would attract carbon revenue, rather it formed part of the Umdoni Municipality's drive to implement its Free Basic Alternative Energy (FBAE) obligations under the South African FBAE Policy (DME, 2007). South Africa also has a Free Basic Electricity Policy (FBE) (DME, 2003). This policy provides grid-connected households, which have monthly energy consumption below a certain threshold, with an initial amount of free basic electricity, currently this is 50 kWh/household/month in most areas (Ekurhuleni provides 100 kWh/household/month) (Ballantyne, 2012). The qualifying monthly energy threshold, which is used as a proxy for selecting poor or indigent households, also varies across the country – for instance, for Eskom³² customers in cities it is < 250 kWh/household/month, whilst in the Cape Town municipal supply area it is < 450 kWh/household/month (Ballantyne, 2012).

However, 25% (12.5 million) of South Africa's population are not grid-connected (DOE, 2012) and cannot benefit from the FBE. Note that the 2011 South African census reports that 84.7% of

³² Eskom – Electricity Supply Commission of South Africa.

households used electricity for lighting and 73.9% for cooking (Statistics South Africa, 2011:55). The FBAE policy refers to eligible households as being in areas where “no electricity infrastructure exists”, so it is debateable whether to use the 75% figure from the DOE or the 73.9% to 84.7% from the census.

Instead they are covered by the FBAE which aims to provide indigent households with alternate forms of energy equivalent to that received by FBE beneficiaries. In the DME Policy document this is specified as alternate energy to the value of R 55 per household per month. This amount to be escalated by the South African inflation rate plus 1.5%, 2012, this would come to R81.45/household/month.³³ Umdoni Municipality, after discussions with the proposed Umdoni pilot community of 4 000 households, chose to implement FBAE allowance as 7 litres of bio-ethanol gel fuel per household per month for the pilot community (this was initially 5 litres/month/household) (Umdoni, 2011:179). KwaZulu-Natal is home to large sugar industries of which bio-ethanol production forms part, so this choice appeared to be sensible (Cartwright, 2007). The ethanol stoves were funded by the Umdoni Municipality with some contribution from USAid donations (Siya Hlongwane, Umdoni Municipality, personal interview, 2012 September 26) . At this stage PACE, the future project proponent, and Project Preparation Trust (PPT), as a project developer, started to get involved and developed the plan to capture carbon revenue for the project (Ngubane, 2012). The stakeholders involved were: the Umdoni pilot community, the Umdoni Municipality, PPT, PACE and Credible Carbon and its carbon auditors.



Figure 11: Umdoni residents collecting their gel fuel

Source: (Cartwright, 2012) Credible Carbon Projects

4.4. The process to generate carbon revenue

The first step was to formalise the project by negotiating and producing a set of documents. This was managed by PACE and PPT, working with all the stakeholders. The set of documents comprised: The Project Idea Note (PIN), the Umdoni Verification Report, Umdoni Audit reports, agreements with the Umdoni Municipality, PPT and the carbon auditors. These are described next in Section 4.4.1.

³³ See Appendix C. The 2012 price for bio-ethanol gel fuel is about R 70 for 7 litres (Adrienne Barrett of GreenHeat, personal communication 2012, 16 October). It therefore appears that there is a case to get the 7 litres increased.

4.4.1. Project Idea Note – PIN 2008

This was prepared by Derek Morgan and Anton Cartwright of PACE (Morgan & Cartwright, 2008). The PIN identified the project name, the partners, location, the project boundaries, the 1 July 2008 commencement date and the 10 year duration.

The project was described as comprising 4 000 volunteer households who would be supplied with bio-ethanol gel cooking stoves and 7 litres of bio-ethanol gel per household per month. The benefits were described as (Morgan & Cartwright, 2008:3):

- Fewer accidental indoor fires as ethanol gel is safer than paraffin
- Less air pollution in houses
- Reduced firewood collection
- Less money spent on household energy
- Improved soil quality as more cattle dung would be left on the fields
- Reduction in GHG emissions as bio-ethanol gel is effectively carbon neutral
- Opportunities for local businesses for the distribution and sale of the gel fuel
- Providing a model for replication of similar projects elsewhere
- Part of the implementation would be training for the Umdoni community, working with the Umdoni Municipal resources. The training and awareness-raising would include how to maintain and use the stoves, the problems caused by unsustainable firewood gathering, paraffin fire danger and the health impacts of indoor air pollution. Where the demand for the gel stoves exceeds supply, preference would be given to female- and child-headed households as these were thought to be the most needy.

4.4.2. Baseline methodologies, calculations and assumptions

See Section 8.4 Appendix D, Table 9 for the PIN 2008 calculations. Note that there were some errors in the original PIN 2008 and these have been shown in the table. The CDM methodology chosen for calculating the carbon emission reductions was the Type II–E Energy Efficiency and Fuel Switching for Buildings methodology (UNFCCC-CDM, 2012a). The advantage of choosing an existing, globally endorsed calculation method such as this is that it adds credibility to the VERs and saves time and money by not having to develop and prove a new methodology, also carbon auditors would be familiar with it and have access to resources and precedents.

Part of these methodologies involves calculating the “baseline” (see Figure 9, page 67). The baseline is a forecast of what the GHG emissions would have been if the project intervention hadn’t happened. In Umdoni’s case the business-as-usual (BAU) baseline assumed that the households would have used paraffin if the gel fuel had not been present. In the PIN it was argued that this assumption was conservative (in that it would understate the actual GHG emissions in a BAU case, which would have used an unknown mixture of wood and dung, some of which is unsustainable) (Morgan & Cartwright, 2008:4).

This is where problems can arise because one rarely has enough actual information to prove the validity of the assumptions and gathering the required information takes time and raises the project costs. In the case of Type 1 projects, much time and effort is invested into trying to firm up the baseline, with debatable benefits – a lot of paper is generated, but one is still left with assumptions about what would have happened in the absence of the project.

The baseline further assumed that households typically boil 22 litres of water per day (Section 8.4 Appendix D, Table 9, Row 18); from that the required energy can be calculated and the amount of paraffin required to provide that energy. This again involved a trade-off between making broad-based assumptions about actual heated water quantities and actual paraffin stove efficiencies or doing a full-blown research project to get possibly better figures. The calculation finally came up with carbon emissions of 1.02 tCO₂e/household/year for the paraffin baseline as detailed in Section 8.4 Appendix D, Table 9 Row 28.

At this stage a questionable assumption was made. This was that because 7 litres of gel fuel typically only lasts a household for seven days a month the VER revenue would be used to buy additional 15 l of gel fuel per month, which would then be enough for the whole month. Unfortunately, this additional fuel was never bought (due to having to wait for the project to roll out, get the audits done, sell the credits and for the community to decide what it wanted to do with the money). Consequently, the gel fuel only lasted for a quarter of the month, whilst the calculations assumed the whole month, so the carbon savings were overstated (Table 9, page 96, Row 33 and 35). In addition, an error was made in the gel fuel emission factor calculation (Table 9, page 96, Row 11). As discussed in the 2012 audit (Section 4.4.5, page 75), it could also have been argued that a logic error was made in the PIN 2008, in that gel fuel should be considered to be carbon neutral seeing as it is produced from a renewable and sustainable source (sugar cane waste).

In any event, the Umdoni project went ahead with assumed (incorrect) carbon reductions of between 2 600 tCO₂e and 3 500 tCO₂e per year, depending on how many stoves would actually be rolled out. Once the roll-out had progressed for a few years, a carbon auditor was engaged to do the first verification report, described next.

4.4.3. Umdoni Verification Report 2011

This was prepared by SouthSouthNorth (Wesselink & Moosa, 2011).

The report was based on a review of the PIN documentation, a site visit and some interviews with the key participants and was based on Credible Carbon/PACE's four key principles, shown with quotes from the audit findings:

- Is the project real and working as planned? – “Yes”
- Are the agreed technologies in place and working? – “Yes, with some reservations about stove maintenance being required” (the Umdoni Municipality subsequently replaced all the damaged stoves at its own expense).
- Are the estimated GHG reductions “plausible and unbiased”? – “Yes, but the auditors proposed a different calculation method, which came to similar figures as in the original PIN, these being: 2008 512 tCO₂e, 2009 1 814 tCO₂e, 2010 3 208 tCO₂e”

- Can the poverty alleviation impact be readily seen? – “Yes”

The SD impacts were described in the audit as stemming from cost savings due to buying less paraffin, worth about R50-R70 per household per month, labour saving through not having to collect as much wood and dung fuel (not quantified), possible reduced respiratory problems through improved indoor air quality, and reduced accident risk because the gel fuel stoves were intrinsically safe (Wesselink & Moosa, 2011:2). The audit report went on to say that although these poverty alleviation benefits might appear to be low, they are significant relative to the prevailing levels of poverty in the Umdoni community. Also the project helped facilitate the implementation of the FBAE policy in Umdoni.

So, based on this audit, all looked in order and the baseline calculations, although done in a different and simpler way, reinforced the original PIN 2008 emission reductions.

4.4.3.1. Baseline methodologies, calculations and assumptions

Some simple tests done as part of the audit confirmed that the gel fuel did typically last for about seven days each month, which confirmed the assumption that gel fuel displaced about one quarter of a typical household water heating energy consumption. The audit then said “if the estimate of 4 tons of emissions (from cooking and water heating) per annum per household is accurate, then the displacement of 1 tCO₂ per household per year through the use of gel fuel is plausible and unbiased, given the relative emissions of gel fuel, compared to paraffin.” (Wesselink & Moosa, 2011). However, this author has been unable to establish where the four tonnes of emissions per year per household assumption came from or whether the quantity of water heated is 22 litres or 88 litres – and these are crucial to the calculation of the baseline.

4.4.3.2. SD benefits

The SD impacts were described in the audit as stemming from cost savings due to buying less paraffin, worth about R50-R70 per household per month, labour saving through not having to collect as much wood and dung fuel (not quantified), possible reduced respiratory problems through improved indoor air quality, and reduced accident risk because the gel fuel stoves were intrinsically safe (Wesselink & Moosa, 2011:2). The audit report went on to say that although these poverty alleviation benefits might appear to be low, they are significant relative to the prevailing levels of poverty in the Umdoni community. Also the project helped facilitate the implementation of the FBAE policy in Umdoni.

Following on the 2011 audit, the PIN was updated to reflect the adjusted calculation method and the new assumptions, as is normal practice for carbon reduction projects. It is shown in Section 4.4.5 (page 75) that the second audit, done in 2012, used a third calculation method that depended on the relative amount of paraffin versus gel fuel needed to provide the typical daily energy requirement for these households – and this method detected and corrected the errors in the original PIN and revised the optimistic assumptions made in the first audit.

4.4.4. Updated PIN December 2011

This was prepared by Derek Morgan and Anton Cartwright (Morgan & Cartwright, 2011).

The updated PIN reflects the 2011 audit findings and calculations as detailed in Section 4.4.3, that is GHG emission reductions of 5 535 tCO₂ for the period 2008 to 2010 plus the other community benefits described in Section 4.4.3.

Then, as is good practice in the carbon offset project world, a second audit was commissioned in 2012. The intention was to make sure the project was still delivering as promised and update the GHG reduction calculations if required. This was done by a different auditor to the previous one, also good practice – to get a fresh and possibly different view.

4.4.5. Umdoni Verification Report 2012

The audit was carried out by Urban Earth (Mckenzie & Botes, 2012). This was a much more detailed audit, covering the period January 2011 to April 2012. As in the previous audit, the Credible Carbon/PACE four questions were addressed, shown with quotes from the audit findings:

- Is the project real and working as planned? – “Yes”
- Are the agreed technologies in place and working? – “Yes, the technology is in place and functioning and the households receive 7 litres of gel fuel per month which lasts for about 7 days”
- Are the estimated GHG reductions “plausible and unbiased”? – “No, the estimates do not appear to be reasonable” (This will be explored further in Section 4.4.5.1).
- Does the project have a discernible impact on poverty? Can the poverty alleviation impact be readily seen? – “Yes”

4.4.5.1. Baseline methodologies, calculations and assumptions – paraffin baseline

By now it was evident that the gel fuel would remain at 7 litres per household per month and that this would typically last for seven days, thus displacing about a quarter of a household’s baseline energy, still assumed to be in the form of paraffin. At this stage, the new auditors raised the issue of whether it was reasonable to assume that paraffin should be used for the BAU baseline calculations. Many of the households could not afford to use paraffin exclusively, so this was an important question. The auditors concluded that it was reasonable on the basis of “suppressed demand”.

4.4.5.2. Suppressed demand

The detailed reasoning applied is documented in Appendix One in the second audit report (Mckenzie & Botes, 2012). Suppressed demand is a relatively new CDM concept. In simplified terms, suppressed demand is an attempt to allow deprived communities to benefit from GHG reductions achieved against the higher baseline energy consumption that they would have enjoyed if they could have afforded it. The CDM has an elaborate set of rules to govern this what-might-have-been future and these rules are still in the process of being put to the test of practical implementation. So, in the case of Umdoni it appears to be reasonable to assume that if the residents could, they would use fuel other than firewood and dung. The alternatives are, in order of preference, if they were affordable:

- Electricity – discarded because the project participants are all off-grid

- Gas (LPG) – eliminated because gas appliances are more expensive than gel stoves
- Paraffin – this is feasible and available so should be used for the suppressed demand baseline

The auditors then estimated how much paraffin would be displaced by one day's use of gel fuel, and knowing paraffin's carbon dioxide emission factor (from recognised default parameters published by DEFRA³⁴ (DEFRA, 2011:8 Table 1b)), the GHG reduction of the avoided paraffin could be calculated. It turned out that roughly one litre of paraffin would last one day as would one litre of gel fuel. So, since the gel fuel lasts for seven days per month on average, the emission reduction calculation is simply: 7 litres of paraffin × 12 months × 2.5421 kgs CO₂e per litre of paraffin = 214 kgs CO₂e per household per year." This is in contrast to the original PIN and the 2011 audit which used 1 tCO₂e/household/year.

It should be noted that there are large uncertainties in this method, for instance: it is difficult to determine how long paraffin would actually last a household because it depends on how much water they heat, is cooking done at the same time, the amount of other fuels being used to supplement the paraffin, the type of paraffin stove and how efficient it is in practice and many other factors. Similarly it is difficult to estimate accurately how long the gel fuel typically lasts for the same reasons. Because of these problems the auditors also considered two other ways of calculating the baseline and the emission reductions.

4.4.5.3. Electricity baseline

This method assumes that under suppressed demand, households would choose electricity as their main source of energy and the gel fuel would be displacing the electricity and thus reduce emissions proportional to Eskom's grid emission factor (assumed to be 0.99 kg CO₂/kWh) (Eskom, 2011:Table 3). The calculation was done by working out the energy produced by burning the annual amount of gel fuel (12 x 7 litres = 84 l per household per year) and applying the Eskom grid emission factor. This yields a figure of 290 kg CO₂e per household per year (compared to the original PIN figure of 1 000 kg CO₂e and the paraffin baseline method of 214 kg CO₂e.). However, as simple as it sounds, this method is also dependent on assumptions which are difficult to verify, for example: the useful energy produced by the gel fuel should be compared to the useful energy produced by the electrical heating device. So the relative thermal efficiencies of gel fuel stoves and electric kettles need to be taken into account. These are all unknown factors in the Umdoni community and are influenced by how the gel fuel stoves are operated (vent open or closed), how big the pot of water being heated is, does it have its lid on, how much water is heated and not all used whilst it is hot thus losing energy through cooling of unused water. This information could be acquired through suitable field research using Controlled Cooking Tests (Nexant, 2010:26), but so far this has not been done in the case of Umdoni. Faced with all this uncertainty, all one can do is to make the best assumptions one can with the resources available and try to ensure that the calculations are conservative.

The last methodology considered, and the simplest, was to use the suppressed demand principle of "minimum service level" (UNFCCC-CDM, 2012b:5) and a baseline of the FBE allowance of 50 kWh per month per household.

³⁴ DEFRA - Department of Environment Food and Rural Affairs and Agriculture (UK).

4.4.5.4. Minimum Service Level baseline

The reasoning is that the FBAE policy is intended to be equivalent to the FBE policy that more fortunate households benefit from. Therefore one can argue that the amount of the baseline energy that is being displaced is equivalent to the FBE allowance of 50 kWh per household per month. The emissions reductions are therefore simply:

12 months x 50 kWh x 0.99 (the Eskom GEF) = 594 kg CO_{2e} per household per year.

As the auditors pointed out, this felt wrong, because it results in exactly the same VERs regardless of what fuel is actually being used and how much is being used. Nevertheless, according to the Urban Earth audit report, Steve Thorne of SouthSouthNorth, who worked with the CDM Executive Board on suppressed demand issues, feels that the idea has merit. He is discussing this with the CDM EB working groups (Cartwright and Thorne, email communication, 2013 June 14).

4.4.5.5. SD benefits

The impact on poverty was found to be beneficial and discernible, although this was not expressed in quantitative terms. The audit report stated that the gel fuel project has resulted in less reliance on paraffin, which has reduced the risk of respiratory illnesses and accidental injury (fires and burns). Household costs were reduced through reduced purchases of paraffin. And for households using firewood for fuel, less time was spent on fuel collection thus freeing up the time for more useful activities and reducing exposure to the dangers of firewood collection, as one householder noted "Fetching firewood is very dangerous because of the snakes and bushpigs" (Mckenzie & Botes, 2012:21-22).

4.5. Umdoni case study discussion and conclusions

Each project is different and will encounter different problems and find different solutions, so it is necessary to be cautious in generalising from one case. Nevertheless some lessons can be derived from the Umdoni project experience. The analysis in this section was based on the literature review, the case study and was supplemented by information obtained from the PACE and Credible Carbon experiences and interviews (see Section 3.2.3) (Cartwright, personal communications, 2012 on various dates).

4.5.1. The type of carbon market chosen is important

The Umdoni project could have chosen to try to register in a Type 1 market (e.g. CDM, GS or VCS), but none of these would have been viable for several reasons:

- Transaction costs too high compared to the expected carbon revenue
- The project had already started before the carbon revenue process began, so there would have been additionality problems

Therefore the Type 2 market was chosen for Umdoni.

4.5.2. Was the project type likely to attract high carbon prices?

The Umdoni project, with its green character (bio-ethanol fuel instead of paraffin) and SD co-benefits was thought to be an attractive project for potential offset buyers. Switching to clean energy does have a significant effect on community well-being. This is due to SD benefits such as improved health through less indoor air pollution, freeing up time through less fuel-gathering, less

fire risk and saving some household money through reduced fuel purchases (Sections 4.4.3.2 and 4.4.5.5).

4.5.3. The registry and associated standard was appropriate

PACE, the project proponent, had already tried the VCS route with other projects without success. The main problem was the detailed and complex documentation required and the long time it took to get through the process. PACE therefore recommended using a small VCM Type 2 registry with low audit costs for Umdoni. The track record of the chosen registry (Credible Carbon), demonstrated that the carbon credits traded had attracted prices comparable to GS and VCS in the past – in 2012 the average VER prices realised were: Credible Carbon \$6/tCO₂e, GS \$10/tCO₂e and VCS \$4/tCO₂e (Table 5, page 83). This decision proved to be correct for Umdoni because the average Umdoni VER price achieved in 2012 was \$11/tCO₂e and all the Umdoni credits were quickly sold out.

4.5.4. Would the right type of buyers be attracted to the project?

Buyers of VCM carbon credits tend to buy for two main reasons: pre-compliance (i.e. getting ready for the introduction of carbon emission regulation) or for image and PR reasons (Section 2.13.2, page 50). In the case of the Umdoni project, the buyers were expected to be local South African companies because of Umdoni and Credible Carbon's small scale and lack of international exposure. Also, with no South African carbon regulations as yet on the horizon, pre-compliance buyers were unlikely. However, because of Umdoni's environmental and SD impact as described in Section 4.5.2, it was felt that corporate buyers buying for PR and image reasons would be interested – and this is what actually transpired.

4.5.5. Would the project generate enough carbon credits to cover the setup and transaction costs?

The initial PIN indicated carbon emission reductions of 2 600 tCO₂e per year (Section 4.4.2). Assuming a price of R100/tCO₂e, this would generate R260 000 in the first year, more than enough to cover the audit and project developer costs (of R35 000 plus R90 000, these being the budgeted amounts in the initial Umdoni negotiations (Cartwright, personal communications during 2012). As has been seen in the case study description, the emission reductions had to be radically reduced in later years because of incorrect calculation assumptions. On the basis of the downward-revised VER calculations of 0.219 tCO₂e/household/year (see Section 4.4.5.2, page 75), this resulted in the reduced figure of 800 tCO₂e for Umdoni's 4 000 households. The down-rated revenue would have been 800 tCO₂e × R100/tCO₂e = R80 000 which would not have been enough to cover the audit and project developer costs. The Umdoni experience also showed how sensitive a project's carbon revenue is to the calculation of the emission reductions – apart from the incorrect assumptions made in the earlier years, the possible variations in baseline reductions highlighted in the 2012 audit, namely 0.214 kg/household/year, 0.290 kg/household/year and 0.594 kg/household/year are startling (Mckenzie & Botes, 2012:10-13). Therefore it is important for the project proponent and the carbon auditors to monitor changes in acceptable emission reduction methodologies in the Type 1 markets (especially the CDM, VCS and GS) so as to maximise the legitimate emission reductions from their projects.

The size of the carbon reductions that can be generated from fuel switching in a poor community is small – in the case of Umdoni, the baseline is less than 1 tCO₂e per household per year for water heating (see Appendix D, Table 9, Row 31). The VER revenue generated from this is also small, with a

carbon price of not more than R100/tCO₂e, and leading to less than R 100/household/year for the gel fuel switching. In the case of Umdoni, the weighted average selling price achieved up to February 2013 was R93/tCO₂e as recorded in the Credible Carbon Registry³⁵.

This indicates that the project scale for low emission reduction projects such as household fuel switching is critical. If Umdoni could be scaled up from 4 000 to 20 000 households then the carbon revenue aspect is definitely financially viable, even if the price of carbon drops further. So, although the Credible Carbon audit costs of around R 35 000/year are an order of magnitude less than those of Type 1 markets, they are still high for projects such as the Umdoni project. To cover the carbon market costs and project overheads, a project would need to generate at least 600 tCO₂e/year (600 tCO₂e × R60/t = R36 000, assuming a carbon price of around R60/tCO₂e, this being at least what Credible Carbon has achieved for its smaller projects) (Cartwright, personal communication 2013, May 30).

4.5.6. Carbon credit ownership issues

The risks of not clearly establishing the ownership of carbon credits is that potential buyers might not be willing to risk purchasing VERs where the ownership could be contested or the disbursement of the proceeds could be challenged (Section 2.13.1, page 50). The risks are higher in the case of projects with SD benefits and multiple beneficiaries (Cosbey et al., 2006:115).

In the case of Umdoni ownership of the VERs was clearly defined in a contract between the project proponent (PACE), the project developer (PPT) and the funder/local government (Umdoni Municipality). The VERs are owned by PPT who is contractually bound to disburse the net revenue after audit costs have been covered according to an agreed budget. The budget specified the amount to be paid to PPT to cover their project development costs. The balance of the revenue was to be paid into a fund for the community to spend in specified ways – to be chosen by the community and agreed to by PACE and the Umdoni Municipality and managed by PPT. It is apparent that if complex arrangements such as these had not been formally agreed upfront the project risked becoming embroiled in legal arguments and potential buyers could have been scared off.

In spite of the short-comings of the Umdoni project, with respect to its low GHG emission potential, the various auditors all agreed that the poverty-alleviating co-benefits make it worthwhile even if the VER revenue has been lower than expected.

4.5.7. Umdoni project SD benefits

In UNFCCC terms, SD consists of three interacting elements, these being economic, social and environmental (Section 2.10.1, page 40). The Umdoni case study and its two audits have shown that benefits falling into each of these three categories were possibly realised though not all were quantified (Sections 4.4.3.2 and 4.4.5.5).

4.5.7.1. Economic benefits

The economic benefits were derived from reduced fuel purchases because of the availability of free gel fuel and from the proceeds of the sale of the project's carbon credits. The fuel purchase savings were estimated at R50-R70 per household per month (Section 4.4.3.2), whilst the proceeds from the

³⁵ Note that the detail of individual sales is confidential, but the author, as a partner in the company does have access to this information.

sale of VERs amounted to R 783 888 for the sale of 8 389 tCO₂e at an average price of R93 per tCO₂e. (these figures were obtained by the author from the Credible Carbon registry transaction records, which are not publically available due to confidentiality constraints). Of the R783 888 gross proceeds, R559 896 (71%) went back to the project and the remaining 29% went to the project proponent and project developer for project preparation and audits. This gives an idea of the scale of the economic benefits, which although small per household, are still significant in view of the levels of poverty in the area, as described in the audits (Mckenzie & Botes, 2012:22).

4.5.7.2. Social benefits

The Credible Carbon standard did not require the SD benefits to be quantified and so the audits did not contain quantified data on social benefits and these can only be inferred. The project involved the selection of the volunteer households, the training of the community in the use of the gel fuel stoves as well as the interaction with the project teams, the auditors and the gel fuel distributors. All this might have promoted more social interaction in the community. In addition, the time freed up through less fuel collection effort, could have had a beneficial social effect. Finally, there could have been health benefits from reduced indoor air pollution and fewer fire-related accidents, although these werent quantified either (Sections 4.4.3.2 and 4.4.5.5).

4.5.7.3. Environmental benefits

The level of GHG emission reduction was measured in the audits and amounted to somewhat over 8 000 tCO₂e over the five year life of the project so far – this would be considered a small carbon project. Other possible environmental benefits not mentioned in the audits and not measured could be improved soil conditions due to reduced removal of dung from the fields and a smaller impact on the surrounding bush through less firewood gathering. However, this is conjecture.

5. Analysis and discussion

5.1. Limitations of the case study approach in this study

The Umdoni case study was used in an explanatory sense rather than a predictive sense in this study. The carbon markets were researched and analysed in order to unpack the main factors that affected the Umdoni project and to understand this case study fully. The intention was not to propose an ideal project model based on the case study which could then be replicated throughout SSA, but rather to identify a set of important factors and to put forward suggestions as to how these factors could be taken into account for any project.

It can also be argued that the Umdoni project findings are generalisable with respect to identified factors. For instance, all carbon projects need to choose in which carbon market to operate, select the most appropriate and cost-effective registry and standard, decide how best to position themselves with respect to potential offset customers and emphasise their SD benefits, choose effective role players, apply the most beneficial emission methodology and clarify contractual issues such as carbon credit ownership and the disbursement of the resulting carbon revenue.

5.2. Introduction

The research questions addressed by this dissertation were:

- What are the main factors that contribute to the effective generation of net-positive carbon revenue from small, SSA projects?
 - How can these factors be managed so as to maximise the net carbon revenue?

The net carbon revenue generated by a project is a function of the price per unit of emission reduction credits, the quantity of emission reduction credits and the costs associated with the generation of the carbon credits. These are linked by the equation:

$$\text{Net carbon revenue} = (\text{Price} \times \text{Volume}) - (\text{Costs})$$

Where:

Price = Currency units per tCO₂e or VER

Volume = Quantity of VERs (measured in tCO₂e)

Costs = Transaction costs (measured in currency units)

The transaction costs as used in this analysis consist of:

- Preparation, documentation and validation costs for the PIN and PDD
- Contract costs
- Audit costs
- Registry costs

Each of Price, Volume and Costs are themselves affected by other factors and a possible set of these, based on the research done in this study, have been identified in Figure 12. This figure is a simplified influence diagram which shows influences and dependencies amongst variables as discovered in this study. For instance, the type of market a project trades in was found to influence the price obtained for the project's carbon offsets. The price was also found to be influenced by the 'attractiveness' of the project, which in turn was found to be influenced by its SD benefits and the project type and so on. Each of these influencing factors has been analysed in Section 5.3 and its sub-sections (note that the order in which the factors have been discussed does not imply a ranking in terms of importance or size of impact.)

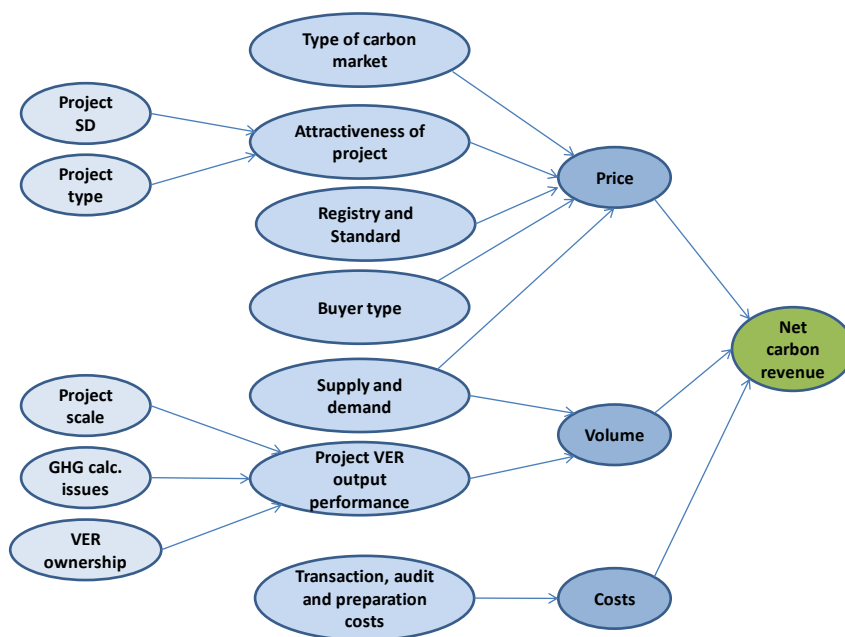


Figure 12: Factors influencing price, volume and cost

Source: Author's own diagram

5.3. Main factors for effective carbon revenue generation for small projects in SSA

For the sake of consistency and comparability, this section has used the “Maneuvering the Mosaic: State of the Voluntary Carbon Markets 2013” report extensively as a source of data (Molly Peters-Stanley & Yin, 2013). This report analysed the 2012 VCM in various ways and compares 2012 to 2011. Unfortunately this report does not show analyses of price by location of source projects, nor does it show SSA as a separate region, nevertheless, it has provided some useful insights for this study in this section.

5.3.1. Carbon market choice influence on price

The possible choices are:

- Compliance market or voluntary market
- Type 1 or Type 2 market

Currently, the VCM is commanding higher prices than the CDM primary market, with prices of \$5.9/CO₂e compared to the CDM prices of less than \$1/tCO₂e (Molly Peters-Stanley & Yin, 2013:vii). Of course this could change in the future depending on what happens in the compliance market over the next few years.

With regards to Type 1 markets within the VCM, the VCS was the dominant standard in 2012 with a market share of 61% and an average price of \$4/tCO₂e (Molly Peters-Stanley & Yin, 2013:34). The VCS was followed in volume by the GS with an average price of \$9/tCO₂e. This study was not able to find equivalent data for Type 1 markets, presumably because they are so small compared to the

Type 2 markets and have not attracted much research effort. The Umdoni case study carbon credits would not have been appropriate for anything other than the VCM because of its small scale compared to the CDM transaction costs.

5.3.2. Project attractiveness influence on price

Projects with strong SD co-benefits generate carbon credits which achieve higher prices than those that don't - this apparent from the price difference between standards that enforce co-benefit measures and those that don't, for instance \$10/tCO₂e for GS credits, and \$7/tCO₂e for VCS+CCB³⁶ compared to just \$4/tCO₂e for VCS only (Molly Peters-Stanley & Yin, 2013:40 Figure 37). Another example is clean cookstove projects, which attract even higher prices, namely \$20/tCO₂e. Fuel-switching projects (similar project type to Umdoni), recorded an average price of \$3/tCO₂e for 2012. (Molly Peters-Stanley & Yin, 2013:30 Figure 27). This was very different from the Umdoni volume-weighted average VER price of \$11/tCO₂e (R93/tCO₂e) – possibly reflecting the small size and attractiveness of the project (this price was calculated by the author from the Credible Carbon Registry, with 8 389 tCO₂e sold for R 783 888). Also, 'charismatic carbon' offsetting may lead to PR and image enhancement for corporate buyers (Conte & Kotchen, 2010:95).

Finally the research showed that smaller VCM projects realise higher prices, with micro projects (<5 ktCO₂e/yr) priced at \$10/tCO₂e in 2012, while prices for small to mega (5-20 ktCO₂e/yr through to 1 MtCO₂e/yr) carbon ranged from \$8.7 down to \$5.8 on average (Molly Peters-Stanley & Yin, 2013:29).

The effect of project attractiveness was also apparent in the Credible Carbon prices achieved for different types and sizes of project; for instance the Umdoni VERs achieved an average price of \$11/tCO₂e compared to the average price of \$6/tCO₂e across all the Credible Carbon projects (Table 5). This difference is probably explained by the much lower price achieved by a compost-related project (which also happened to be much bigger than Umdoni in terms of emission reductions); the compost project was evidently not as attractive as the Umdoni project to potential buyers.

5.3.3. Registry and Standard influence on price

As discussed in 5.3.2, standards which promote co-benefits, such as the GS and VCS+CCB, achieved higher prices in 2012 than the others. A comparison of these with the Umdoni-Credible Carbon prices in 2012 US dollars is shown in Table 5 (the exchange rate used in the conversions for 2012 was R8.1/USD).

Table 5: Registry+Standard price comparison 2012

Standard	\$/tCO ₂ e	R/tCO ₂ e
GS	10	81
VCS+CCB	7	57
VCS only	4	32
Credible Carbon + Umdoni	11	93
Credible Carbon overall	6	46

This comparison shows that the registry plus its associated standard does have an impact on carbon prices achieved as shown in Table 5. Also, the Umdoni project, using the Credible Carbon registry

³⁶ CCB – Climate, Community and Biodiversity standard.

compares well in price terms with the best of the big VCM registries and the overall Credible Carbon average price falls in the middle of the range.

5.3.4. Buyer type influence on price

As discussed in Section 2.13.2 (page 50), types of VCM carbon credit buyers include purely voluntary buyers and pre-compliance buyers. The voluntary buyers have tended to be driven by the quality of the underlying project in terms of SD benefits as well as the credibility of the GHG emission reductions, whereas the pre-compliance buyers have purchased speculatively in anticipation of carbon taxes or compulsory emission reductions driving up the prices. Corporate offset buyers may also buy for PR and reputation reasons and therefore 'charismatic carbon' offsets may achieve higher prices from these buyers (Conte & Kotchen, 2010:95). Umdoni, with its SD co-benefits, has sold almost all its carbon to a single corporate buyer for offsetting its carbon footprint, presumably for image and PR reasons.

Having considered the influences on price, the next sections analyse the effect of various factors on the volume of carbon credits a project generates – and the volume sold directly affects the net carbon revenue.

5.3.5. Supply and demand influence on price and volume

Like any other market, the carbon market prices are largely driven by supply and demand (unless floor and ceiling prices are in effect). The impact of large surplus CERs in the CDM primary market has resulted in the precipitous drop in prices at the end of 2012 – as discussed in Sections 2.7.2, page 32 and 2.17.4, page 58. However, the supply and demand balance is largely out of the control of an individual project, although a project can generally choose which market to operate in and thus try to avoid situations of price crashes and lack of liquidity.

As far as the VCM is concerned, the supply surplus in the compliance markets has not adversely affected the VCM volumes, which have grown by 4% from 2011 to 2012, although the market value dropped by 11%, implying a price drop of about 15%. Suppliers of offsets believe that this drop was caused by "perceived offset oversupply and knock-on effects of the collapse of the EU carbon price" (Molly Peters-Stanley & Yin, 2013:v-vii). The supply demand balance can affect the volume of credit a project can sell at a particular price, and it is possible that CER holders will start trying to sell their carbon credits on the VCM, thus flooding the market and causing prices to crash. However, this hasn't happened yet and less than 1 MtCO₂e of CDM offsets appear to have been sold to voluntary buyers in 2012 (1% of the 2012 VCM total) (Molly Peters-Stanley & Yin, 2013:xiv).

With regards to Credible Carbon, the volumes have gone up enormously from 10 000 tCO₂ in 2011 to 40 000 tCO₂ in 2012, while the average price has dropped from R93/tCO₂e in 2011 to R46/tCO₂e in 2012. This price drop was largely due to the lower prices achieved by a compost project in 2012. The Umdoni VER prices were less affected; dropping from R93/tCO₂e in 2011 to R80/tCO₂e in 2012 (these figures were obtained by the author from the Credible Carbon registry).

5.3.6. Project VER output performance on volume

This study has identified three key factors that influence the volume of GHG reductions a project produces for sale, these being; the project scale or size, the emission reduction calculation methods and issues of ownership as discussed in sub-sections 5.3.6.1, 5.3.6.2 and 5.3.6.3.

5.3.6.1. Project scale (in terms of carbon credit output)

- The GHG emission reduction (VER) potential of a project depends on the scale of the project and the emission reduction intensity of the intervention technology. For instance, in the case of the Umdoni case study, the scale of the project is about 4 000 households, the intervention technology is bio-ethanol gel fuel stoves (switching from biomass and paraffin stoves) and the emission reduction intensity worked out to be 0.214 tCO₂e per household per year in the 2012 audit (see Section 4.4.5.2, page 75). In Umdoni's case, the calculated VER volume is directly proportional to the number of households and the amount of gel fuel supplied and burnt. This is recognised by the Umdoni Municipality which has been increasing the number of beneficiary households by about 1 000 households per year, but it is unclear whether the annual expansion will continue in the future. However, the 7 litres of gel fuel per household per month allowance, which is part of the FBAE policy implementation, has not been increased since the project started in 2008 (Section 4.3, page 70). So Umdoni could increase its carbon credit volumes by increasing the amount of bio-ethanol gel supplied from the current 7 litres per household per month, ideally up to about 30l per household per month, which would last a household for the full month. This is where an active and interested NGO could help by lobbying the local government or finding additional funding.

5.3.6.2. Emission reduction calculation methods

One might think that CDM projects, being subject to stringent regulation, have little choice as to which methodology to use. This is not the case; there are so many methodologies, covering a multitude of variations of different technologies that there is a great deal of choice. Many projects are not simple and one-dimensional and the choice of methodologies is not always straight-forward. In the VCM, and especially in the case of Type 2 projects and registries, there is generally even more flexibility – depending of course, on the particular registry and its standards.

Different VCM registries use different sets of standards and methodologies. However, for a registry to be successful in selling VERs at good prices, it needs to apply standards and methodologies that are acceptable to the potential population of carbon buyers. The easiest way to do this is to use existing CDM methodologies. These are well-documented and usually have been applied to real projects over many years. Thus there is a wealth of case-study material available which helps a project to decide which methodologies to use. Sometimes the CDM methodologies are very restrictive for some project types, for instance in the case of forestry-related projects (Guigon, 2010:13). In these cases, new methodologies have been developed outside of the CDM by some of the bigger standards. The VCS with its Agriculture, Forestry and Other Land Uses (AFOLU) carbon projects is one example.

As has been discussed, it is difficult to calculate the emission reductions achieved by a project because it requires the business-as-usual baseline emissions to be calculated and then the impact of the project intervention relative to the baseline to be calculated. Both of these calculations rely heavily on assumptions about the baseline and the project impact. These assumptions and calculations are often subject to challenge and in the case of the Type 2 VCM; this is the carbon auditor's job. The choice of methodologies that a project uses is made by the project proponent who will have an expert knowledge of CDM and VCM methodologies. This choice is formalised in the PIN or PDD and will be validated by the carbon auditor at each audit. While the project proponent will be motivated to get the highest possible GHG reductions for the project, this should not be done at the

expense of the credibility of the project's carbon reductions. Because the carbon auditor, who is strictly independent, will simply apply the accepted norms in the carbon industry and this might radically reduce the audited amount of carbon. Therefore a project proponent should err on the side of caution and make conservative choices of methodology rather than trying to push the boundaries of acceptability and risk disappointments after the first audit. The carbon registry, for its part, needs to ensure that its VERs are credible so that it can negotiate high prices from its buyers. In the end, though, the auditor's word is final and a good registry will not attempt to influence the auditor, and the auditor, with a reputation to protect will not usually risk producing an audit that might be challenged. In the case of Umdoni it has been shown that the original PIN contained some errors and was far too optimistic as a result; the errors were not picked up by the second auditor either, but were only discovered by the third auditor in 2012 (see Section 4.5, page 77).

In the Umdoni case study, the initial baseline chosen in the PIN by the project proponent PACE was based on the assumptions that the gel fuel would last for about 7 days and that the gel fuel would be displacing whatever the Umdoni households were actually using – such as firewood, animal dung and paraffin. However, it was difficult to find out exactly how much of each fuel was actually being used without mounting a lengthy and expensive monitoring exercise. Even if such a survey was to be done, the variability across the population would probably be unacceptably high. So PACE chose to use the CDM principle of suppressed demand and to assume instead that the households would have used paraffin rather than firewood and dung if they could have afforded it. The baseline thus became paraffin-based. The next step was to estimate the carbon emissions from the use of a paraffin stove. This was difficult, because there are many different types of paraffin stoves with differing thermal efficiencies. Worse, when field trials (using the Controlled Cooking Test protocol for instance) have been carried out on stoves of various types, there is also a big variation in cooking performance (Pennise et al., 2010:24). Factors such as the pot size, pot lids, wind conditions and how high the stove wick was turned up all play a large part in cooking efficiency. So the auditor relied on simple fundamentals – in the Umdoni case the relative stove efficiencies were ignored and the relative calorific values and emissions of bio-ethanol gel versus paraffin were used.

The CDM is attempting to remove these baseline difficulties by introducing standardised baselines (Schneider et al., 2012). When these have been developed and field-proven then the VCM registries will no doubt adopt them too and the transaction costs will be further reduced.

It is important to note that methodologies change over time so the choice of methodologies should be reviewed each year. This should be done by the project proponent rather than relying on the carbon auditor. If the project proponent decides to change the project's methodologies, this is formalised in an updated PIN or PDD – and at the next audit the auditor will check on the appropriateness of the choice. Note that if the auditors disagree with the choice of methodologies or how they were applied, they will propose an acceptable methodology and apply that rather than simply rejecting a project's VERs.

5.3.6.3. *VER ownership issues and their impact on volumes sold*

This issue is not really a function of market dynamics, but it is highly relevant to the successful sale of VERs (2.13.1, page 50). Most registries won't undertake to sell a project's VERs unless the ownership of these is legally clear. So if the ownership is contested, the project might not be able to sell the carbon at all. By the time the project stakeholders become aware that ownership is an issue, it might

be too late for an easy resolution. An example of this would be a solar water heater project, where a funder pays for the capital equipment and installation costs, an installer does the installation and a project developer manages the whole project. The funder could claim ownership of the VERs on the grounds that the funder supplied the equipment without which the project wouldn't have happened, the installer might also claim ownership because of the installation work, the project developer might claim ownership because that is the default position in the CDM world, the owner of the premises on which the solar water was installed might claim ownership as the SWH could be regarded as part of the structure and lastly a tenant might claim ownership of the VERs by virtue of being the one who uses the hot water. The easiest way to avoid such ownership problems is for the stakeholders to contractually agree on which party owns the generated carbon credits and what is to be done with the proceeds.

In the case of Umdoni, the potential owners of the credits were: the Umdoni Municipality who funded the project and the supply of the gel fuel, PPT the project developer who managed the project, PACE the project proponent and the householders themselves. The contract that was finally negotiated stated the PPT, as the project developer would own the credits, but that the proceeds from the sale of the credits would be used to pay Credible Carbon for the audits and PPT for their project development work and that the remainder would be made available to the community to spend as they saw fit. These allocations were quantified and specified in a formal budget. In due course the carbon auditor would check that the sales revenue had been spent correctly (Cartwright, personal communication 2013, May 30). The next section analyses the cost factors.

5.3.7. Transaction costs: Registry audit and preparation costs

The costs involved in carbon trading are critical to small projects with low GHG reduction potential, if the costs outweighed the carbon revenue then the project has lost money. This could happen through lack of knowledge on the part of the project proponent, or because costs that should have been covered by the carbon revenue suddenly aren't because of a drop in carbon prices, or an adverse carbon audit reduced the claimable emission reductions, or the project roll-out didn't proceed as planned – so there is some risk present.

Registry, audit and preparation (costs vary from market to market and register to register. In the CDM environment, some of the registry and audit costs are known, such as the Transfer plus Brokerage costs (1% + 0.03% of the CER value), but the bulk of the costs can vary enormously, ranging from Euro 150 000 up to Euro 590 000 (Axel Michaelowa & Jotzo, 2005:513 Table 1). In a later study, Guigon et al. have estimated costs for the CDM at Euro 249 000 for a typical 50 000 tCO₂e/yr 'large' project and Euro 21 000 for a 'small' project of 5 000 tCO₂e/yr. By comparison, three of the big VCM standards (VCS, GS micro and VER+) have costs of Euro 16 600, 14 800 and 17 300 respectively for small projects (Guigon et al., 2009:24 Tables 4 and 5). The VCS cost of Euro 16 800 is not much less than the CDM figure of Euro 21 000 – this is partly why this study classified VCS as a Type 2 registry and standard.

In the Umdoni case study, the registry, audit and preparation costs were considerably lower – less than R 30 000 per audit (Euro 2 600 in 2009 terms). This huge difference in transaction costs (a factor of 6 or more) between the Type 1 VCM environment (such as the VCS and GS) and Type 2 (such as Credible Carbon) can determine whether it's worthwhile attempting to generate carbon revenue at all.

5.4. Analysis and discussion summary

This study has identified the main factors that contribute to the effective generation of net-positive carbon revenue from small SSA carbon projects (see Figure 12, page 82) and has analysed how these factors and their management can explain the success of the Umdoni project, used as a case study in this dissertation:

- Choice of carbon market effect on price (Section 5.3.1) – Umdoni chose to trade in the Type 2 market because of the higher prices, lower costs, faster turn-around and the less stringent additionality rules applying (i.e. not having to register the project before it had started).
- Project attractiveness effect on price (Section 5.3.2) – the analysis showed that VERs generated under standards that measured co-benefits achieved higher VER prices than those that didn't. Another dimension that emerged smaller VCM projects realise higher prices. With regards to the case study, the Umdoni price was \$11/tCO₂e compared to the average of all Credible Carbon transactions in 2012 of \$6/tCO₂e, this was probably due to the relative attractiveness of Umdoni to the main buyer.
- Registry and standard choice effect on price (Section 5.3.3) – the analysis showed that the standards that measure and audit co-benefits (and therefore SD) achieve higher prices than those that do not. The Umdoni price was shown to be higher than the GS average price (and the GS was top of the VCM prices), whilst the overall average Credible Carbon prices were higher than those of the VCS but lower than the GS prices.
- Buyer type effect on price (Section 5.3.4) – this research was unable to establish a connection between buyer type and the price achieved. With regards to the case study and Credible Carbon all that could be deduced was that particular buyers have strong preferences for which type of project they favour.
- Supply and demand effect on price (Section 5.3.5) – so far the VCM appears to be growing in volume steadily in spite of the upheavals in the compliance market. However the Type 1 VCM total market value dropped from 2011 to 2012 indicating an average price drop of about 15% - so perhaps the over-supply in the compliance market has made itself felt in the VCM.
- Project scale effect on the emission reduction quantity (Section 5.3.6.1) – a project can increase its emission reductions by increasing its scale and/or improving the emission reduction intensity. In the case of Umdoni, the municipality has been increasing scale of the project by increasing the number of households with gel stoves each year. Another way to increase the emission reductions would be to increase the monthly amount of bio-ethanol gel; however this has not happened as yet.
- Emission reduction calculation methods impact on emission reduction quantities (Section 5.3.6.2) – Credible Carbon only uses carbon industry endorsed methodologies, such as the CDM suite, this adds credibility and reduces transaction costs. The Umdoni experience with over-estimating emission reductions showed that errors in assumptions and calculations do happen in spite of using expert auditors and conservative assumptions. Because new methodologies are continually being added and old ones revised, the project proponent and the auditor need to keep up to date so as to be able to make the best selection for the project. The baseline methodologies suitable for Umdoni produced a wide range of baselines from which the 2012 Umdoni audit the auditor conservatively chose the lowest one on the grounds that it appeared to be the best fit to the project. The importance of this factor is

that the choice of the right methodology is critical to avoid loss of credibility and unexpected reductions in VERs which might reduce the revenue to the point where the transaction costs are not covered.

- VER ownership issues (Section 5.3.6.3) – establishing the ownership of the project's VERs is of the utmost importance and this needs to be done before the project starts. The Umdoni project VER ownership was set out in a contract between PACE (project proponent), PPT (project developer) and the Umdoni Municipality (the local government and funder), which gave the ownership to PPT, but with explicit provision for payment of the carbon revenue (net of the documentation and audit fees) to the community once the defined project developer costs had been covered. The contract also documented what the community had chosen to spend its share on, namely renewable energy or energy efficiency technologies.
- Transaction costs (Section 5.3.7) – The total transaction costs for small CDM projects were found to average Euro 21 000, the VCS averaged Euro 16 600 and the GS came in at Euro 14 800. In comparison the Credible Carbon costs are generally about Euro 2 600 (R35 000), lower by a factor of six. Note that this study was unable to find data on other Type 2 registries, so it is not known if Credible Carbon is typical.

These then are the main factors that contribute to the effective generation of net-positive carbon revenue from small, SSA projects and this analysis has shown how these factors applied in the Umdoni case study and how this project was largely able to manage them so as to generate carbon revenue in excess of R 500 000 after all costs had been covered (Section 4.5.7.1, page 79).

6. Conclusions

This study has identified the main factors that contribute to the effective generation of net-positive carbon revenue from small, SSA projects and has explored how these projects could best position themselves to maximise their net carbon revenue. This was done by using the Umdoni case study as a lens through which the market factors were explored.

The key decisions and actions that concern a small SSA project seeking to generate carbon revenue were found to be:

6.1. Choice of carbon market

The choices are:

- Compliance market or voluntary market
- Type 1 or Type 2 market

Both of these choices are affected by the financial viability of the project (in terms of positive net carbon revenue), which is a function of the project size (in terms of GHG reduction potential) and the carbon price compared to the transaction costs

As has been shown earlier in Section 2.3, page 15, the carbon-financial break-even point for CDM projects at current prices is about 50 000 tCO₂e/year – the CDM being a Type 1 compliance market.

At the other extreme, the break-even point for a Type 2 VCM project is about 600 tCO₂e/year under current conditions. This is assuming a VCM price of about R60/tCO₂e (Molly Peters-Stanley & Yin,

2013:vii) and transaction costs of about R35 000 (Case study Section 4.5, page 77) and $600 \text{ tCO}_2\text{e} \times \text{R}60/\text{tCO}_2\text{e} = \text{R}36\,000$.

The Type 1 VCM break-even point would fall somewhere in the middle depending on the registry and the standard, this is because the Type 1 VCM transaction costs, whilst lower than the CDM costs (Bumpus, Liverman, & Lovell, 2010:3), are still higher than Type 2 costs because of the more onerous auditing processes.

A second factor which could influence the market choice is the likely price a project could realise in different markets with different standards. The research showed that at current prices, it is better for a small project to use the VCM ($\text{\$}4\text{-}\text{\$}10/\text{tCO}_2\text{e}$) rather than the CDM market ($\text{\$}1/\text{tCO}_2\text{e}$).

- Therefore the choice between the compliance market (CDM) and the VCM is clear – at current prices any small project would benefit from choosing the VCM.

Within the VCM the prices for Type 1 registries and standards ranged from $\text{\$}4/\text{tCO}_2\text{e}$ (VCS without co-benefits) to $\text{\$}10/\text{tCO}_2\text{e}$ (GS with co-benefits). This showed that projects with verifiable co-benefits attracted significantly higher prices than others. Credible Carbon and Umdoni achieved an average price of $\text{\$}11/\text{tCO}_2\text{e}$; this showed that this example of a Type 2 VCM registry with a small charismatic project was able to outperform the GS average. However, the Umdoni project might be an outlier, bearing in mind that the average price, across all projects that Credible Carbon achieved in 2012 was $\text{\$}6/\text{tCO}_2\text{e}$. Also, although the Type 1 VCM (with co-benefits) prices were higher than the average Type 2 VCM prices; the costs of the Type 1 VCM were found to be higher than those of the Type 2 case study (by a factor of six). Therefore the project would have to be large before the higher prices outweighed the higher costs. So the choice between a Type 1 VCM versus a Type 2 VCM is not so clear.

- The choice between the Type 1 VCM and Type 2 VCM depends on the current prices, the project type (with co-benefits verified or not) and the size of the project.

6.2. Choice of registry and standard

The research showed that standards which recognised and verified elements of co-benefits (SD) outperformed those that didn't. This was shown by the GS price of $\text{\$}10/\text{tCO}_2\text{e}$ and the VCS+CCB price of $\text{\$}7/\text{tCO}_2\text{e}$ (both of these standards measure and verify co-benefits) compared to the pure VCS price of $\text{\$}4/\text{tCO}_2\text{e}$

- Projects that have strong co-benefits will benefit with respect to their VER price by choosing a registry and standard that recognises and verifies co-benefits and markets the carbon credits taking this into account.

Naturally, in choosing a specific registry for a project, the project team would carry out an appropriate due diligence exercise as is generally good practice before appointing any professional service. It is recommended that the points covered include: the registry's track record of governance, prices, volumes in stock, volumes sold and sales turnaround time; the registry's financial standing and credit record should be good; the range of project types carried by the registry should be compatible with the project under consideration; the registry costs should be clearly

defined and reasonable; the registry should offer a secure, online trading platform so as to facilitate the marketing and selling process.

- It is recommended that the project team select a registry with good online facilities, in good financial standing, with an acceptable track record and which is compatible with the project with regards to type and size and whose costs are well-defined and reasonable compared to other registries.

6.3. Positioning of the project

The findings confirmed that not all projects are the same and that projects with strong SD benefits, command higher prices than projects which lack SD features. This was demonstrated by the difference of projects with and without co-benefits in the Type 1 VCM and by Credible Carbon's experience with the Umdoni project attracting a much higher price than the price across all the Credible Carbon projects, some of which were less charismatic. Therefore it appears to be worthwhile when setting up the project to ensure that the co-benefits are defined, measured and managed. This will then enable the registry to market the resulting VERs more effectively.

- Projects that have SD co-benefits will benefit from defining, measuring and managing these in order to attract higher carbon prices.

6.4. Choice of project proponent

The project proponent plays a key role in the success of the project (see Section 2.10.2.2, page 44) and based on the PACE and Credible Carbon experience, the suggested choice criteria are that the ideal project proponent should have:

- a good track record of governance and successful project implementation
- shown itself to be in good financial standing with a clean credit record
- a range of projects previously managed by the project proponent that are compatible with the project under consideration
- costs that are clearly defined and reasonable
- the required technical expertise in applying internationally accepted carbon emission reduction methodologies
- access to a broad range of credible carbon auditors expert in the type of project under consideration
- access to a broad range of project developers expert in the type of project under consideration

6.5. Governing the project

Based on PACE and Credible Carbon experience, this should be done collectively by all the stakeholders, led by the project proponent. Some important issues and suggested best practice that have been identified in this project are:

- It is recommended that all the affected role players be involved in the project from the outset and they be kept updated with progress as the project unfolds
- Ownership of the VERs must be established upfront through formal contracts between all the affected stakeholders

- Future problems can be averted by producing a project budget, formally agreed to by the affected parties, that shows how the carbon revenue is to be distributed, for instance to cover the project preparation documentation, the audit costs, the project developer costs and the final allocation to the project beneficiaries (which could be the host community)
- The allocation and spending of the sales revenue needs to be transparent and communicated to all the stakeholders.

7. Further research

In the context of maximising carbon revenue for small, poverty-alleviating carbon projects, there are many areas which would benefit greatly from additional research.

Some of these are:

1. Investigate the health benefits derived from using cleaner forms of cooking and heating energy and displacing three-stone fires and paraffin stoves.
2. Investigate the impact of black carbon emission from domestic cooking devices on health and GHG reduction.
3. Make a case for adding black carbon to the current set of GHGs as recognised by the UNFCCC.
4. Investigate fuel use and actual stove efficiencies in the field in rural communities in sub-Saharan Africa in order to justify a standardised baseline for cooking stove interventions.
5. Investigate why the mass roll-out of projects such as Umdoni and Kuyasa are not being achieved and propose solutions.
6. Investigate the relative emission reduction and SD benefits of biofuel cooking stoves versus energy-efficient and clean-burning wood fuel stoves.
7. Investigate the implementation of the Free Basic Alternative Energy policy in South Africa: Is it being applied universally? Has the FBAE allowance kept up with inflation as legislated? How could the policy be improved?

8. Appendices

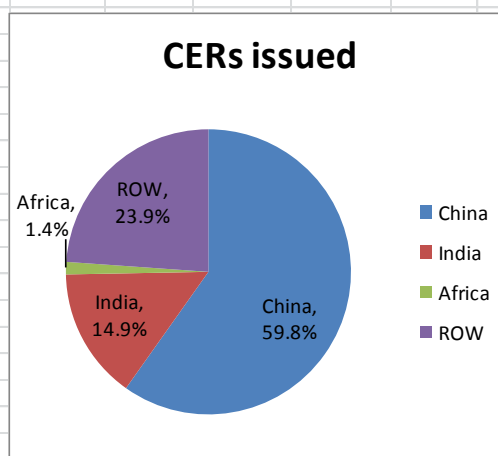
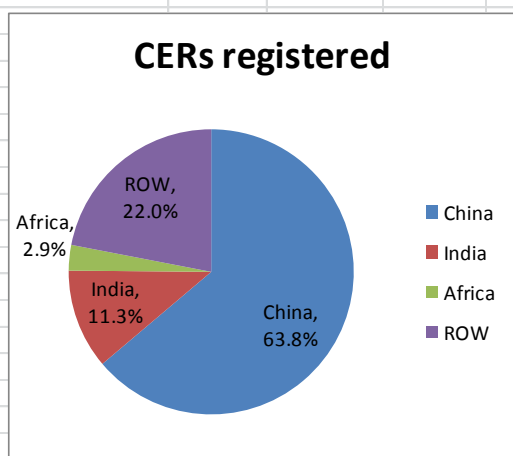
8.1. Appendix A: CDM Pipeline analysis spreadsheet

Table 6: Analysis of the CDM pipeline

Regions	Projects Registered		kCERs/yr Registered		kCERs by 2012		Projects Issuing		kCERs Issued	
	Number	%	kCERs	%	kCERs	%	Number	%	kCERs	%
As at 1 July 2012										
Total CDM	4296	100.0%	611280	100.0%	2187305	100.0%	1620	100.0%	958982	100.0%
China	2101	48.9%	390158	63.8%	1273074	58.2%	841	51.9%	573607	59.8%
India	854	19.9%	69133	11.3%	279855	12.8%	348	21.5%	142832	14.9%
Africa	88	2.0%	17711	2.9%	628845	28.7%	18	1.1%	13505	1.4%
Sub-Saharan Africa	55	1.3%	11995	2.0%	40925	1.9%	11	0.7%	2906	0.3%
South Africa	20	0.5%	3498	0.6%	16666	0.8%	8	0.5%	2537	0.3%
Total CDM incl. rejections and withdrawals	10426	41.2%						15.5%		
Source										
CDMpipeline UNEP Riso 2012.07.01 from the CD4CDM website, retrieved 25/07/2012										
http://cdmpipeline.org/publications/CDMpipeline.xls										

Registered kCERs by region

	Registered		Issued	
	kCERs	% kCERs	kCERs	% kCERs
China	390158	63.8%	573607	59.8%
India	69133	11.3%	142832	14.9%
Africa	17711	2.9%	13505	1.4%
ROW	134278	22.0%	229038	23.9%
Total CDM	611280	100.0%	958982	100.0%



Analysis by size of project

Regions	Registered			Issued		
	Projects	kCERs/yr	Average Project Size	Projects	Cum. kCERs	Average cum kCERs
As at 1 July 2012	Number	kCERs	kCERs	Number	kCERs	kCERs
Total CDM	4296	611280	142	1620	958982	592
China	2101	390158	186	841	573607	682
India	854	69133	81	348	142832	410
Africa	88	17711	201	18	13505	750
Sub-Saharan Africa	55	11995	218	11	2906	264
South Africa	20	3498	175	8	2537	317

8.2. Appendix B: Carbon volume and value analysis

Table 7: Analysis of the Voluntary carbon Market by volume and value

	North America	Asia	Africa	Latin America	Non-EU Europe	Oceania	Europe	Total
2010								
Volume MtCO ₂ e	23	18	3 (5%)	17	5	1	n/a	66
Value US\$ Millions	118	95	26 (7%)	81	40	3	2	360
US\$/tCO ₂ e	5.1	5.3	8.7	4.8	8.0	3.0	n/a	5.5
Euro/tCO ₂ e	3.7	3.8	6.2	3.4	5.7	2.1	n/a	
2011								
Volume MtCO ₂ e	30	28	8 (9%)	7	19	8	2	92
Value US\$ Millions	178	108	60 (13%)	80	40	20	15	466
US\$/tCO ₂ e	5.9	3.9	7.5	11.4	2.1	2.5	7.5	5.1
Euro/tCO ₂ e	4.3	2.8	5.4	8.3	1.5	1.8	5.4	
Change analysis								
Vol increase %	30%	56%	167%	-59%	280%	700%	n/a	
Val increase %	51%	14%	131%	-1%	0%	567%	650%	
US\$/tCO ₂ e incr. %	16%	-27%	-13%	140%	-74%	-17%	n/a	
Euro/tCO ₂ e incr %	17%	-26%	-12%	143%	-73%	-15%	n/a	
Source: State of the Voluntary Carbon Markets 2012. figure 23 p24								
Exchange rates								
	2010	2011	2012					
Euro	1	1	1					
US\$	1.40	1.38	1.28					
ZAR	9.53	10.90	11.24					
Source: http://www.x-rates.com accessed 5/11/2012								
Volume and Value for the VCM and CDM	VCM VERs			CDM CERs (Primary market only)				
	2010	2011	% change	2010	2011	% change		
Volume MtCO ₂ e	66	92	39%	224	263	17%		
Value US\$ Millions	360	466	29%	2675	2980	11%		
US\$/tCO ₂ e	5.5	5.1	-7%	11.9	11.3	-5%		
(Note: the EU and Oceania figures were excluded from the VCM totals because they are relatively small)								
Source for VCM: State of the Voluntary Markets 2012 figure 23 p24								
Source for CDM: State and trends of the carbon market 2012 Table 3 p49								

8.3. Appendix C: Free Basic Electricity Policy inflation adjustment

Table 8: Projected FBAE amounts

Year	CPI	CPI + 1.5%	FBAE amount ZAR
2007	-	-	R 55.00
2008	11.50%	13.00%	R 62.15
2009	7.10%	8.60%	R 67.49
2010	4.30%	5.80%	R 71.41
2011	5.00%	6.50%	R 76.05
2012	5.60%	7.10%	R 81.45

The starting value of the FBAE support is R 55.00 and the annual escalation is the South African inflation rate plus 1.5%,; to be reviewed after five years (DME, 2007).

The inflation rates (Consumer Price Index) were extracted from the StatsSA website (Statistics South Africa, 2012).

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8.4. Appendix D: Carbon Calculations

Note that these were the 2008

Table 9: Calculations for PIN 2008

Row	Assumptions	Units	Original PIN 2008	Corrected calculations	Comments
1	Conversion factors				
2	MJ per kWh	MJ		3.60	http://www.iea.org/stats/unit.asp
3	MJ	J		1.00E+06	
4	TJ	J		1.00E+12	
5	kWh/TJ	kWh/TJ		277777.78	
8	Eskom Grid Factor	kg/kWh	0.93	0.93	
9	Paraffin Emission Factor	kg/kWh	0.245	0.245	http://www.defra.gov.uk/%20environment/climatechange/uk/%20individual/pdf/actonCO2-calc-methodology.pdf
10	Gel Fuel Emission Factor	kg/TJ	79600.00	79600.00	EF ID 118139 see http://www.ipcc-nggip.iges.or.jp/EFDB/ef_detail.php (Energy (1) -> Fuel Combustion Activities (1.A) -> Other Sectors (1.A.4) -> Residential (1.A.4.b))
11		kg/kWh	0.022111	0.287	The conversion factor for converting the gel fuel emission factor from kg/TJ to kg/kWh was incorrect.
13	Calculations				
14	Consider use for water boiling only (conservative)				
15	Specific heat capacity of water	J/kg/C	4186.00	4186.00	
16	Cold water temperature	C	10.00	10.00	
17	Heated water temperature	C	100.00	100.00	
18	Litres of water heated per day (average)	l	22.00	22.00	
20	Paraffin (wick stove) thermal efficiency when boiling 1 kg of water	%	20.10%	20.10%	See P9 of http://www.erc.uct.ac.za/emnews/EMN-Dec05.pdf
21	Gel Fuel thermal efficiency when boiling 1 kg of water	%	49.90%	49.90%	See P9 of http://www.erc.uct.ac.za/emnews/EMN-Dec05.pdf
22	Energy needed for water per day = $4186 \text{ J/kg/C} \times 90\text{c} \times 22\text{L} \times 10^{-6}$	MJ/day	8.29	8.29	
23	Energy needed for water per year	MJ/yr	3025.22	3025.22	

24	Energy needed for water per year using Paraffin with a cooking Efficiency of 20.10%	MJ/yr	15050.86	15050.86	
Row	Assumptions	Units	Original PIN 2008	Corrected calculations	Comments
25	Energy needed for water per year using Gel with a cooking Efficiency of 49.90%	MJ/yr	6062.57	6062.57	
26	Paraffin Energy per cooker in kWh (1kWh = 3.6 MJ)	kW/yr	4180.79	4180.79	
27	Gel Fuel Energy per cooker in kWh (1kWh = 3.6 MJ)	kW/yr	1684.05	1684.05	
28	Paraffin CO ₂ Emission (Energy per yr x emission factor)	tCO ₂ /yr	1.02	1.02	
29	Gel Fuel CO ₂ Emission ((Energy per yr x emission factor)	tCO ₂ /yr	0.04	0.48	The difference is because of the incorrect conversion done in Row 11. But also not a further logic error – this figure should be zero because bio-ethanol gel can be considered to be carbon-neutral.
31	Carbon reduction calculations				
32	Baseline Existing Stoves = CO ₂ existing paraffin	tCO ₂ /yr /cooker	1.02	1.02	
33	Emission after Intervention Existing Stoves = CO ₂ gel fuel	tCO ₂ /yr /cooker	0.04	0.90	Not 0.04 as in PIN. Because the gel fuel only lasts for 23% of the time and not 100%, the calculation is 77% is paraffin at 1.04 and 23% is gel at 0.48 = 0.90
34	Cookers		3000.00	3000.00	
35	CO ₂ reduction/yr	tCO ₂ /yr	2940.00	373.78	Difference because the original PIN assumed there was enough gel fuel to replace all the paraffin in the baseline plus the gel emission factor is incorrect.
38	Summary of GHG saving calculations				
39	Baseline emission per household per year	tCO ₂ e per hh/yr	1.02	1.02	
40	Emissions after the gel stove introduction	tCO ₂ e per hh/yr	0.04	0.90	See row 41 below.
41	Emission reduction	tCO ₂ e per hh/yr	0.98	0.12	Note that the “corrected” figures understate the emission reduction because the gel fuel is carbon neutral. The 2012 figure was 0.214 tCO ₂ e/hh/yr
42	Number of Gel fuel stoves in Year 1	Total	2700	2700	

43	Emission reductions in Year 1	Total tCO₂e per yr	2658	336	
44	Additional of Gel fuel stoves in Year 2-5	Total	3600	3600	
45	Emission reductions in Year 2-5	Total tCO₂e per yr	3543	449	

Source: (Cartwright, 2011; Mckenzie & Botes, 2012; Morgan & Cartwright, 2008; Wesselink & Moosa, 2011).

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