Evaluating the feasibility of a carbon reducing project: A case study in the mining industry

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To whom it may concern

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3 April 2013

Dear Mr / Ms

Re: Language editing of manuscript: **Evaluating the feasibility of a carbon reducing project: A case study in the mining industry**

I hereby declare that I language edited the above-mentioned manuscript by Ms Colette Esterhuizen (20027052) on 19 March 2013.

Please feel free to contact me should you have any enquiries.

Kind regards

Cecile van Zyl
Language practitioner

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ABSTRACT

Evaluating the feasibility of a carbon reducing project: A case study in the mining industry

Keywords: Global warming, greenhouse gas, carbon dioxide, carbon emissions, Kyoto Protocol, carbon tax, ESCOs, carbon credits, trading of credits

Today, global warming is commonly known due to the major impact on the earth's weather conditions. The increase in the average temperature of the lower atmosphere is causing a drastic change in weather conditions. Human intervention is the main cause of global warming and the latter will be limited if greenhouse gas (GHGs) emissions are reduced by individuals and companies in all countries around the world. Carbon dioxide (CO_2) is one of the biggest contributors of GHGs and, therefore, a number of measures were implemented to reduce CO_2 emissions.

In 1997, the Kyoto Protocol was signed by the Annex 1 countries, of which South Africa is not part, under the United Nations Framework Convention on Climate Change (UNFCCC) to reduce GHG emissions. It is not only the responsibility of the Annex 1 countries to stabilise global warming, but all countries have to contribute to the reduction of GHG emissions.

Enabling countries to meet these reduction targets, they implemented the following measures: carbon tax, Energy Service Companies (ESCOs) and carbon credits. Carbon tax has been implemented in many countries over the last decade with different levels of success. Carbon tax will be implemented in South Africa during 2013/2014. ESCOs have been implemented to assist companies with the implementation of energy saving projects. These projects will assist in reducing carbon emissions and meeting the set targets and it will also assist in reducing the effect of carbon tax. Clean Development Mechanism (CDM) projects are implemented under the UNFCCC for

companies that want to register carbon reduction projects. If the projects meet the CDM registration criteria, the project can be registered as a CDM project and it has the ability to earn tradable carbon credits. These credits can be traded on national or international carbon trading markets.

This study considered a combination of all the measures a company can implement to improve energy efficiency and thereby reducing GHG emissions. An evaluation of the feasibility of a carbon reduction project, the ‘Vaal River compressed air energy efficiency improvement project’ of AngloGold Ashanti (AGA) was performed to determine whether the project can be registered as a CDM project. It was concluded that AGA will be able to register the project as a CDM project and earn tradable carbon credits. Furthermore, it is recommended that AGA makes use of the option to finance the carbon reducing project by using external funding provided by EDF (the French equivalent of South Africa’s Eskom).

OPSOMMING

Evaluering van die haalbaarheid van ŉ koolstofverminderingsprojek: ŉ Gevallestudie in die mynbedryf

Sleutelwoorde: Aardverwarming, kweekhuisgas, koolstofdioksied, koolstofemissies, Kyoto Protokol, koolstofbelasting, ESCO's, koolstofkrediete, handeldryf in koolstofkrediete

Vandag is aardverwarming algemeen bekend as gevolg van die groot impak wat dit op die aarde se weerstoestande het. Die toename in die gemiddelde temperatuur van die laer atmosfeer veroorsaak ŉ drastiese verandering in weerstoestande. Menslike ingryping is die belangrikste oorsaak van aardverwarming en laasgenoemde sal beperk word indien kweekhuisgas (KHG)-vrystellings deur individue en maatskappye in alle lande regoor die wêreld verminder word. Koolstofdioksied (CO_2) is een van die grootste bydraers van KHG en daarom is ŉ aantal maatreëls geïmplementeer om die CO_2-emissies te verminder.

In 1997 is die Kyoto Protokol deur die Annex 1-lande onderteken, waarvan Suid-Afrika nie deel is nie, onder die Verenigde Nasies se Raamwerkkonvensie oor Klimaatsverandering (UNFCCC) om KGH-vrystellings te verminder. Dit is nie alleen die verantwoordelikheid van Annex 1-lande om aardverwarming te stabiliseer nie, maar alle lande moet ook ŉ bydrae lewer om KHG-vrystellings te verminder.

Om lande in staat te sel om hierdie verminderingsteikens te kan bereik, is die volgende maatreëls geïmplementeer: koolstofbelasting, Energiediensfirmas (ESCO's) en koolstofkrediete. Koolstofbelasting is oor die afgelope dekade in baie lande geïmplementeer met verskillende vlakke van sukses. Koolstofbelasting in Suid-Afrika sal gedurende 2013/2014 geïmplementeer word. ESCO's is geïmplementeer om maatskappye te help met die implementering van energiebesparingsprojekte. Hierdie projekte sal help met

die vermindering van koolstofemissies en die bereiking van die gestelde koolstofverminderingsteikens. Dit sal ook help met die vermindering van die effek van koolstofbelasting. “Clean Development Mechanism (CDM)”-projekte kan ook onder die UNFCCC geïmplementeer word vir maatskappye wat koolstofverminderingsprojekte wil registreer. Indien die projekte aan die CDM-registrasiekriteria voldoen, kan die projek as ŉ CDM-projek geregistreer word en het dit die vermoë om verhandelbare koolstofkrediete te verdien. Die krediete kan op nasionale of internasionale koolstofhandelsmarkte verhandel word.

Hierdie studie beskou ŉ kombinasie van al die maatreëls wat ŉ maatskappy kan implementeer om energiedoeltreffendheid te verbeter en sodoende KGH-vrystellings te verminder. ŉ Evaluering van die lewensvatbaarheid van ŉ koolstofverminderingsprojek, die “Vaal River compressed air energy efficiency improvement project” van AngloGold Ashanti (AGA), is uitgevoer om vas te stel of die projek as ŉ CDM-projek geregistreer kan word. Daar is bevind dat AGA in staat sal wees om die projek as ’n CDM-projek te registreer en verhandelbare koolstofkrediete sal verdien kan word. Verder word aanbeveel dat AGA gebruik maak van die opsie om die koolstofverminderingsprojek te finansier deur van eksterne befondsing gebruik te maak wat verskaf word deur EDF (die Franse ekwivalent van Suid-Afrika se Eskom).

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LIST OF ABBREVIATIONS

AGA	AngloGold Ashanti
AMS II.D	Small Scale Methodology
ARR	Accounting rate of return
ASX	Australia Stock Exchange
BBE	Bluhm Burton Engineering
CDM	Clean development mechanism
CER	Certified emission reduction
CH_4	Methane
CPR	Commitment period reserve
COP	Conference of Parties
CO_2	Carbon dioxide
DNA	Designated National Authorities
DOE	Designated Operational Entities
EB	Executive Board
EBITDA	Earnings before interest, tax, depreciation and amortisation
EDF	French equivalent of SA “Eskom”
EE	Energy efficiency
EPC	Energy Performance Contracting
ESCO	Energy Service Company
EU	European Union
EUA	European Union Allocated units
GHG	Greenhouse gas
GhSE	Ghana Stock Exchange
GS	Guaranteed savings
HFC & PFC	Halocarbons
ICER	Long-term certified emission reduction
IRR	Internal rate of return

ITTCC	Industry task team on climate change
JI	Joint implementation
JSE	Johannesburg Stock Exchange Limited
kWh	Kilowatt hour
LSE	London Stock Exchange
MOP	Meeting of Parties
MYPD	Multi-year price determination
NGO	Non-Governmental Organisation
UNFCCC	United Nations Framework Convention on Climate Change
NPV	Net present value
NYSE	New York Stock Exchange
N_2O	Nitrous oxide
PDD	Project design document
PIN	Project idea note
ROA	Return on assets
ROI	Return on investment
POLES	Prospective Outlook for the Long term Energy System
SA	South Africa
SS	Shared savings
SF_6	Sulphur hexafluoride
tCER	Temporary certified emission reduction
US	United States
VER	Voluntary Market

CHAPTER 1

1 INTRODUCTION

1.1 Background

Global warming is a term often used and refers to the increase in the average temperature of the earth's lower atmosphere. Measurements and observation already indicate a rise in global temperatures combined with a rise in sea levels. An increase in the intensity and frequency of extreme weather events has also been noted (Nussbaumer, 2007:3081). Rising temperatures of one to three percent in the next hundred years have the potential of dramatically affecting the economic, agricultural and industrial sectors of society (Gundimeda, 2005:973). Global warming is a result of human intervention and will be limited if greenhouse gas (GHGs) emissions are reduced by individuals and companies in all countries around the world (Arava, Bagchi, Suresh, Narahari, & Subrahmanya, 2010:275). GHGs are made up of the following: carbon dioxide (CO_2), methane (CH_4), halocarbons (HFCs and PFCs), nitrous oxide (N_2O) and sulphur hexafluoride (SF_6). These GHGs act as a natural blanket that retains the earth's heat (Arava *et al*., 2010:275). The carbon cycle indicates that 60% of global warming is caused by increasing carbon dioxide concentrations (Grace, 2004:190).

During the United Nations Framework Convention on Climate Change (UNFCCC) held in 1992, the Annex 1 countries (Australia, Austria, Belgium, Belarus, Bulgaria, Canada, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Latvia, Lithuania, Luxembourg, the Netherlands, New Zealand, Norway, Poland, Portugal, Romania, the Russian Federation, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, the United Kingdom and the United States) committed to a target of stabilising carbon dioxide and other GHGs by 2002 to the level it was in 1990 (Zhang, 2000:491-492).

After the reduction targets were set in 1992 by the UNFCCC, the Kyoto Protocol was signed in 1997, which committed the Annex 1 countries to higher reduction targets. These set targets included reducing the emissions of the six GHGs between 2008 and 2012 by 5.2 present below the 1990 levels.

These targets were set for all the Annex 1 countries, excluding the European Union (EU), the United States and Japan. These three countries were requested to reduce their emissions by 8, 7 and 6%, respectively. Of the original 37 countries committing to the UNFCCC, two countries, namely Belarus and Turkey, did not sign the agreement, leaving 35 countries agreeing to the Kyoto Protocol (Zhang, 2000: 491-493).

Although South Africa (SA) was not part of the Kyoto Protocol, the country has a role to play in prohibiting global warming by reducing GHG emissions. One option considered by the South African government to reduce carbon emissions is to implement carbon taxes. Carbon taxes have been implemented in many other countries (India, Canada, United Kingdom and Australia) in the past (Deloitte, 2011). However, the application of this tax varies from country to country. The South African government proclaimed the new regulation on carbon tax during February 2012 and indicated that tax will be levied on carbon dioxide emissions. The SA government is of the opinion that it will lead to a change in consumer behaviour and will encourage the use of cleaner-energy technology, energy-efficiency measures and will result in more research and development into lower carbon options (SA Budget review, 2012). However, research in India has shown that carbon taxes are not reducing carbon emissions as was expected and this is also true in most other countries (Deloitte, 2011).

Another measure to encourage the reduction of GHG emissions is the introduction of carbon credits. Carbon credits have been implemented under the Kyoto Protocol by the Clean Development Mechanism (CDM) (Wysham, 2008:23). The CDM is a framework encouraging developing countries to implement emission reduction projects. After a company residing in a developing country has registered a project, the company can earn carbon credits, or so-called certified emission reductions (CERs). One carbon credit is equal to the saving of one tonne of carbon dioxide emitted into the atmosphere (Swanepoel, 2011). Carbon credits can be traded either (i) on an organised carbon trading market, which includes relevant commercial banks, or (ii) with companies in developed countries (Wysham, 2008: 24). Since

February 2005, over 1 600 projects were proposed to the CDM, of which only 696 have been approved (in 2007) (Johnson & Wittman, 2008:10).

South Africa is listed under the top 20 GHG emitters in the world (Hobden, Scholtz & Trollip, 2007:35). The first carbon credits received in South Africa were in June 2008 (Tucker & Gore, 2008:54), and these carbon credits were received for the Lawley fuel switch project (Van der Merwe, 2008).

1.1.1 Case study

AngloGold Ashanti (AGA) is one of the leading gold-mining companies in the world, with an annual production of over four million ounces of gold (AngloGold Ashanti, 2011:1). Gold is produced in South Africa, Australia, South America and North America and other African countries (De Wet, 2012a). AGA has six gold-producing mines in South Africa and eight in the rest of Africa. Four gold mines are located in North and South America, while another one is located in Australia. These mines exclude the five developing projects located in Africa, Australia and South America (AngloGold Ashanti, 2010:8-9).

AGA currently employs over 63 000 employees (Groenewald, 2012:22) and is listed on the following stock exchanges: JSE Limited in South Africa, London, New York, Ghana, Australia, Paris and Brussels (AngloGold Ashanti, 2010). AGA is committed to reducing the negative impact of their operations on the environment and has therefore identified a number of carbon reduction projects. The 'Vaal River compressed air energy efficiency improvement project' in South Africa is one of these identified projects. The project aims to reduce 55 000 tons of CO_2 in the first year of the project (55 000 tons of CO_2 is equal to approximately 275 000 trees) (Greenhouse Gas Emission Calculator, 2012). This aimed carbon reduction will provide AGA the opportunity to register this project as a CDM project and thereby earning carbon credits from the project, which will then be available for trade. As mentioned before, there are two options to trade carbon credits and, in terms of the Vaal River compressed air energy efficiency improvement project, these options are to (i) trade the carbon credits with a local commercial bank, or (ii) trade the carbon credits with EDF (which is the French equivalent of South Africa's Eskom).

1.1.2 Motivation for this study

The emission of carbon dioxide is causing the average global temperature to rise. The average temperature has already risen by 0.8°C and international consensus concludes that an average global temperature increase of more than 2°C will put too many parts of the world at risk (Anon, 2011b:11). The risks associated with increasing global temperature include i) a decrease in snow and ice covers, ii) the average sea levels rising, iii) changes in precipitation patterns, and iv) the frequency and intensity of extreme weather events (Nussbaumer, 2007:3081).

AGA, as one of the biggest gold-producing companies in South Africa, is expected to take up their responsibility to reduce carbon emissions. A project such as the 'Vaal River compressed air energy efficiency improvement project' will be a positive contribution to improve the reduction of carbon emissions in South Africa.

Furthermore, South Africa can earn up to R6 billion through carbon trading by 2012 (Anon, 2008a:27). If more projects can be registered by South African companies at the CDM, this income can increase. These funds can then be made available to increase energy efficiency and develop projects and thereby reduce the dependency on electricity produced using coal.

1.2 PROBLEM STATEMENT

Registering a project as a CDM project demands the validation of the project. This validation ensures that the project meets the requirements outlined in the Technical Guidelines of ISO 14064, the International Standard for Carbon Trading (Anon, 2008b:21). There are numerous requirements that need to be met to register a project and meeting all the requirements can be complicated. It is therefore imperative that AGA ensures that the project meets all these requirements before investing funds that will not yield a return.

Furthermore, registering a project such as the 'Vaal River compressed air energy efficiency improvement project' requires financing. Considering the best financing options is important. If the project does not qualify to be registered, it will result in lost capital or debt that needs to be repaid.

1.3 RESEARCH OBJECTIVES

The main objective of this study is to evaluate the feasibility of the 'Vaal River compressed air energy efficiency improvement project' of AGA.

The secondary objectives of the project include the following:

1. To discuss the history behind carbon-reducing projects and the earning of carbon credits; and furthermore, to identify the criteria to register a project as a CDM Project;
2. To conceptualise capital investment appraisal techniques from the literature;
3. To ascertain whether the 'Vaal River compressed air energy efficiency improvement project' meets the registration criteria as set by the CDM;
4. To investigate whether the best financing option is utilised by AGA to finance the registration of the project;
5. To compare the methods of trading carbon credits to determine the most beneficial method; and
6. To investigate how the funds earned through the carbon trading by AGA can be optimised.

1.4 RESEARCH DESIGN

Both a literature review and empirical study will be conducted.

1.4.1 Literature review

The literature review will focus on published research, including academic articles and other research publications. The literature review will also include key governmental policies regarding carbon credit and the trading of carbon credits in the context of this study.

The literature review aims gain knowledge pertaining to carbon credits, carbon trading and CDM projects to be able to evaluate the feasibility of the Vaal River compressed air energy efficiency improvement project.

1.4.2 Empirical study

The empirical study will be conducted as a case study focusing on a carbon emission reduction project of AGA, namely 'The Vaal River compressed air energy efficiency improvement project'.

The data will be obtained from i) previous studies performed by Promethium Carbon, an external consultant contracted by AGA, and ii) information obtained from structured interviews conducted with AGA employees dedicated to work on the project. Promethium Carbon has provided a report identifying various options for AGA in selling the carbon credits created by the identified project. This research project will use some of the data provided by Promethium and expand their study to include the objectives set in section 1.3, page 5.

1.5 OVERVIEW

The research study will be presented as follows.

Chapter 1: Introduction

Chapter 1 provided the background to the study and the motivation for conducting the research. This chapter also provided the problem statement and objectives for the research. It concluded with a discussion on the research methods to be followed.

Chapter 2: Research method

This chapter will explain and elaborate on the research method followed.

Chapter 3: History of carbon reducing projects and carbon credits

Defining carbon credits and the method of calculation will be included in Chapter 2. This chapter will also provide background pertaining to the requirements to register a project to qualify for carbon credits and the role CDM plays in trading carbon credits. The financing of CDM projects will be considered and a background to the mining industry and carbon emission reduction targets and plans.

Chapter 4: Capital Investment Appraisal techniques

This chapter will explain and elaborate on the capital investment techniques used.

Chapter 5: Case study

A study will be performed on the concept of the Vaal River compressed air energy efficiency improvement project, the registration of the project, financing the project and the carbon trading options.

Chapter 6: Conclusion and recommendations

This chapter will provide conclusions and recommendations on the research conducted.

CHAPTER 2

2 RESEARCH METHODOLOGY

2.1 INTRODUCTION

The purpose of this chapter is to describe the research methodology used in this study to address the research problem formulated in Chapter 1. A research methodology can be described as the 'how' in collecting and processing data within the framework of a research process, according to Brynard and Hanekom (2006:35).

Henning, Van Rensburg and Smith (2009:36) defined a research methodology as a process not only including a group of methods, but also indicating the worth of the study by using a specific method and the reason for using it. The theoretical paradigms within a social science will be discussed, followed by the plan on how the study is performed – also referred to as the research design. Also discussed in this chapter is case study research approach, followed by a discussion of the varioustypes of research. The chapter concludes with a discussion on the data collection techniques and research ethics.

2.2 RESEARCH OBJECTIVES OF THE STUDY

The secondary objectives of this research are the following (refer Chapter 1, page 1):

- Objective 1: To discuss the history behind carbon-reducing projects and the earning of carbon credits; and furthermore, to identify the criteria to register a project as a CDM project.
- Objective 2: To conceptualise capital investment appraisal techniques from the literature.
- Objective 3: To ascertain whether the 'Vaal River compressed air energy efficiency improvement project' meets the registration criteria as set by the CDM.
- Objective 4: To investigate whether the best financing option is utilised by AGA to finance the registration of the project.

- Objective 5: To compare the methods of trading carbon credits to determine the most beneficial method.
- Objective 6: To investigate how the funds earned through carbon trading by AGA can be optimised.

To meet the set objectives of this study, consideration will be given to the theoretical paradigms within the social sciences.

2.3 THEORETICAL PARADIGMS WITHIN THE SOCIAL SCIENCES

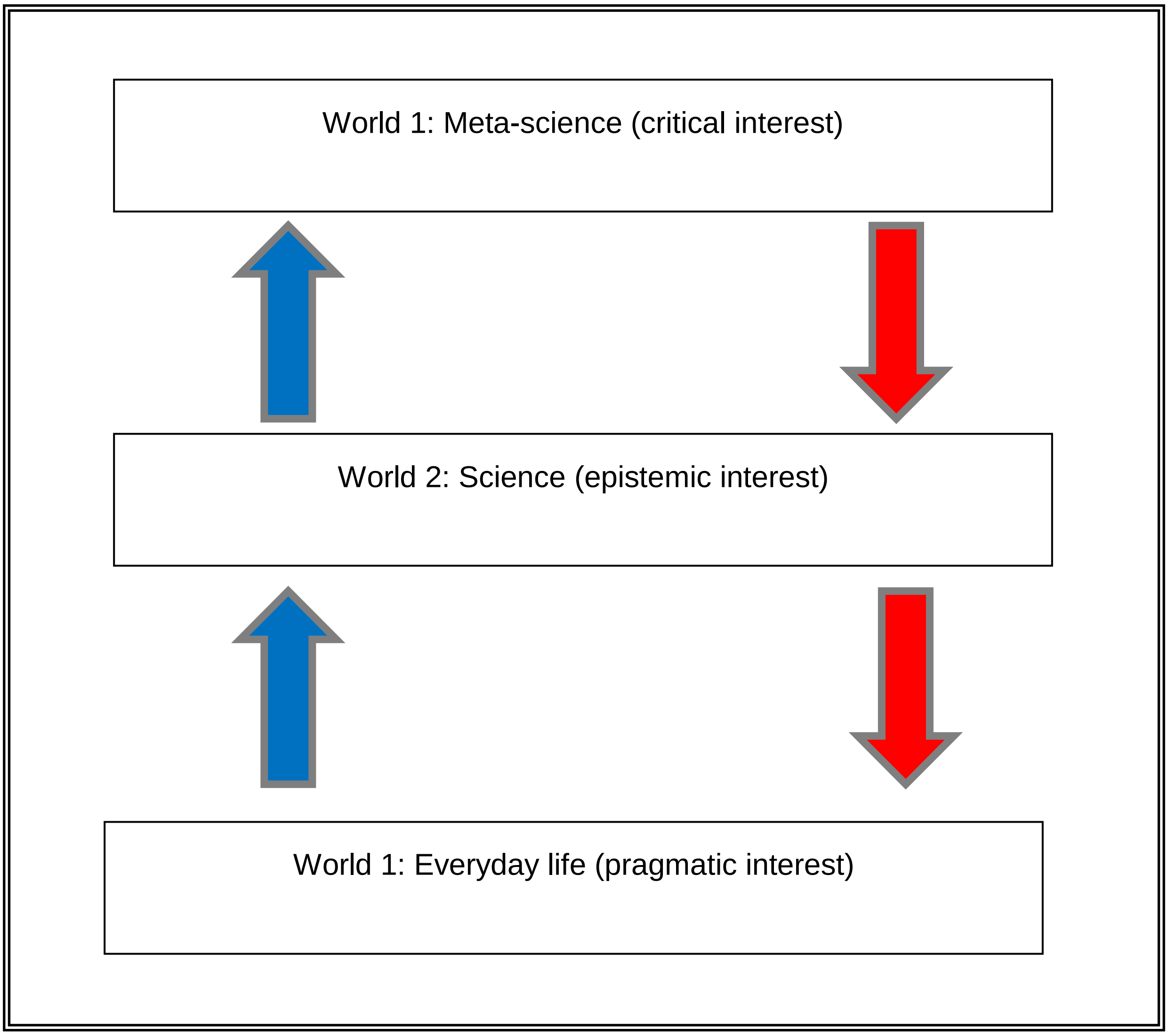
Organising your thinking about the practice of scientific research when engaging in a research project is important, and this must be done before deciding on a specific research design as well as the most appropriate research methodology (Mouton, 2008:141). Part of organising one's thinking is to identify the framework in which the study is performed (Mouton, 2008:137). The 'Three Worlds Framework', developed by Mouton (2008:137), distinguishes between the following three worlds (Refer to Figure 2.1):

- World 1: The world of everyday life and lay knowledge
- World 2: The world of science and scientific research
- World 3: The world of meta-science

The world we spend most of our lives in is World 1. World 1 includes the social and physical activities our ordinary life exists in. World 2 is the world described as the world of science, with the ultimate goal being truthful knowledge. The phenomena (or processes) are taken from World 1 and, by turning the inquiry into objectives, the truth contained therein is obtained in World 2. World 2 goes beyond the search for truthful knowledge and reflects on the nature of science (Mouton, 2008:138).

Considering this study, it is clear that it can be categorised in both World 1 and World 2. World 1 will indicate the current GHG problem facing the world, as well as the contributions that manufacturing companies have added to the problem. In this study, specific consideration will be given to the contribution that AGA is making to the current carbon dioxide situation. World 2 will focus on all studies conducted to observe the real effect that GHG has on the environment and, specifically in this case, the effect that carbon dioxide has on South Africa and the part it is playing in global warming.

Figure 2.1: The Three Worlds Framework

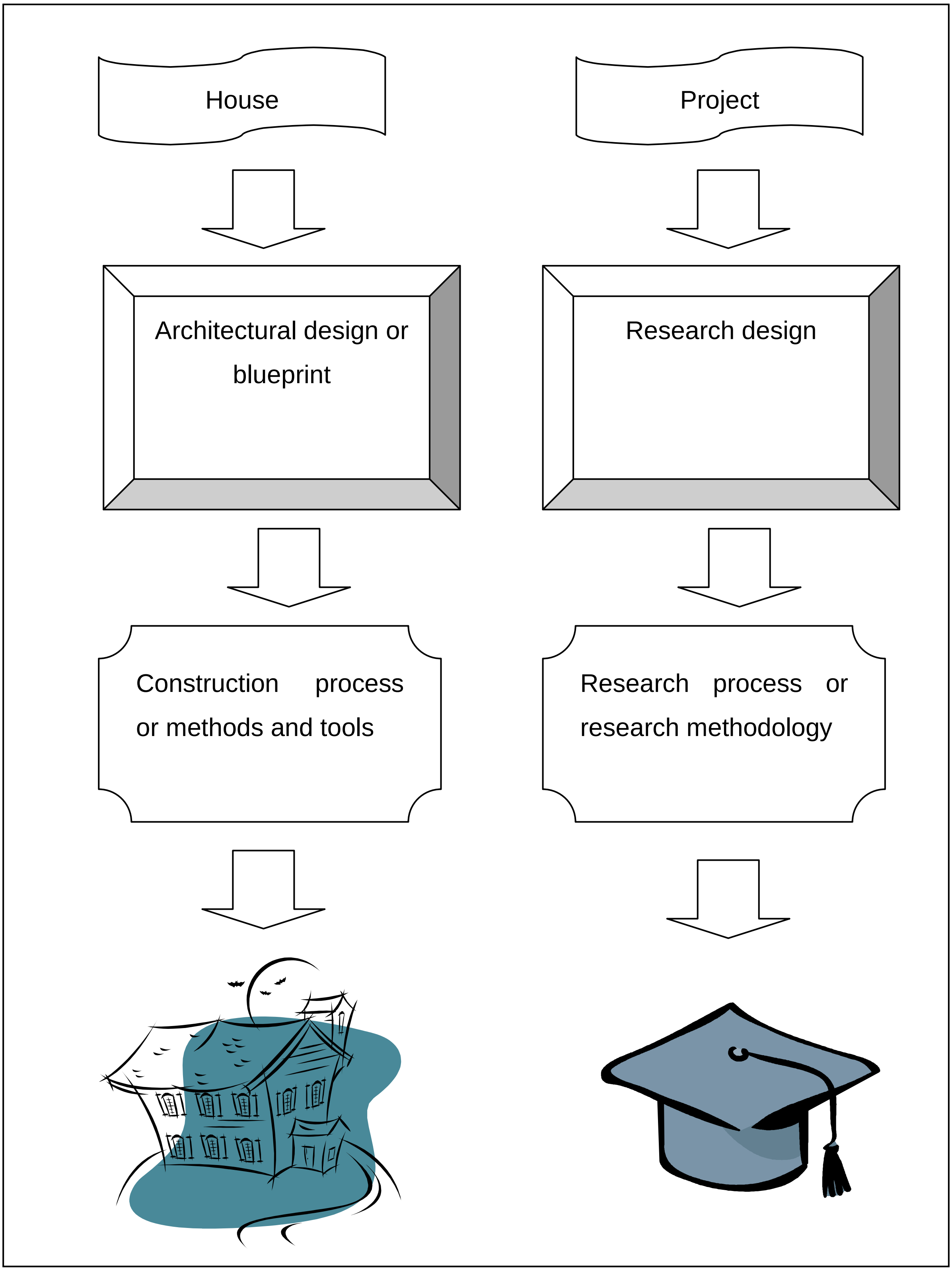


Source: Adapted from Mouton (2008:139-141)

2.4 RESEARCH DESIGN AND METHODOLOGY

Bless and Higson-Smith (1995:46) described the research design as "the plan how to proceed in determining the nature of the relationship between variables", according to Maree (2010:293). In other words, it can be stated that the research design provides a map for the researcher to travel on in order to reach a conclusion, using the research objectives as landmarks along the way. Therefore, it is important to follow the correct research design to answer the research problem. The difference between the concepts' of research design and research methodology can be explained by an analogy of building a house (refer to Figure 2.2). When building a house, you start with the idea, the size and style of the house. The ideas are then used to draw up plans for the house (the blueprint). This ’blueprint’ will then be changed by the owner until he is satisfied with it. After finishing the plans, the building contractor will start building the house using the approved plans. Different tools and methods will then be used by the contractor in all the different tasks to build the house (Mouton, 2008:138). Comparing the analogy of building a house to a research project, the plans from the architect represent the research design. The plans keep the end product in mind as well as planning the process of performing the research by deciding on the type of study to perform the blueprint (research design). The tools and methods used by the contractor in building the house are compared to the research methodology. The research methodology focuses on the process and the kind of tools and procedures used to reach the finish line (Terre Blanche *et al*., 2006:161).

Figure 2.2 Metaphor for research design



Source: Adapted from Mouton (2008:56)

To summarise, it is clear that the research methodology as a group of coherent methods complement each other so that data can be delivered and findings can be made that reflect the research questions and suit the research purpose (Henning, Van Rensburg and Smith, 2009:36)

2.5 CASE STUDY RESEARCH

2.5.1 Definition

Gilham (2005:1) defines a case study as the investigation of a group, individual, community or institution to answer a specific research question. According to Schumacher and McMillan (1989), a case study is highlighted by the fact that it does not necessarily refer to the study of one site, while Merriman (1988) defined a case study as a bounded system (Maree, 2010:75). Studying individuals as individuals and not as members of a population is the definition of a case study according to Lindegger (2006:460-461). It can therefore be concluded that a case study is defined as studying individuals in order to address a specific research question.

2.5.2 Strengths of case study research

A researcher makes use of case study research based on the research problem as well as the research question, according to Merriam (2009). She is also of the opinion that the strengths of case study research are greater than the limitations. This is due to case study research providing insight into real-life situations and the advancement of a certain field’s knowledge base. Gibbert, Ruigrok and Wicki (2008:1465) are of the opinion that case studies are utilised as tools to generate test theories. This result in a methodology ideally used to create managerially relevant knowledge. However, there are also limitations to case study research.

2.5.3 Limitations of case study research

Despite all the strengths of case study research, the method has also been cited concerning the methodological rigor in terms of the validity and reliability thereof (Gibber *et al*., 2008:1465). In order to overcome this limitation, a framework was developed to ensure the methodological rigor of a case study to provide a guideline on how to ensure internal, external and construct validity and reliability. However, Merriam (2009) is of the option that case study research is also limited by the sensitivity and integrity of the investigator, as the researcher is the only instrument that collects and analyses the data. To place case study research in perspective, it is compared to other research methods.

2.5.4 Comparing case study research to other methods

Drawing a comparison between the different research methods utilised in the social sciences is important. The different research methods that exist include surveys, experiments, case studies and historical studies (Mouton, 2008:107, Yin, 2009:5). All research methods can be used for one of the following types of research, namely exploratory, descriptive or explanatory research. The following three differences distinguish these research types (refer to Table 2.1):

- The type of research question posed;
- The extent of control that a researcher has over actual behavioural events; and
- The degree of focus on contemporary rather than historical events.

Table 2.1: Comparison of research techniques

Method	Form of research question	Requires control of behavioural events	Focuses on contemporary events
Experiment	How, why?	Yes	Yes
Survey	Who, what, where, how many, how much?	No	Yes
Archival analysis	Who, what, where, how many, how much	No	Yes/No
History	How, why?	No	No
Case study	How, why?	No	Yes

Source: Adapted from Yin, Batesman & Moore (1985)

This study aims to answer the ‘who’, ‘what’ and ‘where’ questions of whether it is feasible to have a carbon-reducing project in the mining industry. The study does not require control over any behavioural events and it focuses on contemporary events. This research study does not include multiple case studies and only focuses on a single set of conclusions that will be drawn in Chapter 5.

2.6 TYPES OF RESEARCH

According to Durrheim (2006:44), research can be divided into three different categories, which include:

- Exploratory, descriptive and explanatory research;
- Quantitative and qualitative research; and
- Applied and basic research.

Each category will now be discussed briefly.

2.6.1 Exploratory, descriptive and explanatory research

Exploratory studies are designed to develop a hypothesis or question that can be researched further. The structures of these studies tend to be flexible and they have the objective of discovering areas for future research (Cooper & Schindler, 2008:146). The purpose of *descriptive research* is to define the subject for a group of problems; and it does this by creating a profile of the problem. This study involves obtaining data and then investigating the distribution and number of times that a single characteristic was observed by a researcher (Blumberg, 2008:10; Brynard & Hanekom, 2008:7-8) In a descriptive study, the observations made are explained beyond the original description by performing an *explanatory study* (Blumberg, 2008:11). An exploratory study was used during this case study research.

2.6.2 Quantitative and qualitative research

Maree (2010:145) describes quantitative research as a systematic and objective process in the way it uses numerical data that was selected from a subgroup of a population to generate the findings pertaining to the study population. According to Adams *et al*. (2009:26), quantitative research contains characteristics of quantitative width. Therefore, undertaking quantitative research can be defined as drawing a conclusion on evidence that was obtained by data and statistical analysis.

On the other hand, research yielding evocative data is classified as qualitative research. It obtains a researcher's experience and the perception is documented in writing. Usually, no numerical specifications or models are included in qualitative research (Brynard & Hanekom, 2010:37). According to Adams *et al*. (2009:26), quantitative research portrays a characteristic that includes social interaction, hermeneutics and phenomenology.

In this study, quantitative research is used in the feasibility calculations, while qualitative research techniques are used in the analysis of the information gathered during structured interviews on the carbon-reduction project.

2.6.3 Applied and basic research

The findings derived from basic research are most of the time used to expand our knowledge of the world we live in. Findings derived from an applied study will have direct application. The aim thereof is to enhance decision-making, problem-solving and policy analysis (Durrheim, 2006:45). The difference between basic and applied research is what the findings will be used for; it would either be to enhance general knowledge or it would be to apply the results directly (De Villiers, 2012). In this study, an applied research approach was followed, because the findings are used to evaluate whether a carbon-reducing project is feasible. This will have an influence on how AGA will finance the Vaal River compressed air energy efficiency improvement project and whether it is feasible to invest in at all.

2.7 DATA COLLECTION TECHNIQUES

Two basic methods can be distinguished for collection data, namely qualitative and quantitative methods (Brynard & Hanekom, 2008:35). Qualitative techniques include participant interviewing, in-depth interviewing, case studies and document analysis (Blumberg, 2008:201-202). In this study, data was collected by conducting interviews.

2.7.1 Interviews

Face-to-face interviews were conducted. According to Yin (2009:106), interviews is one of the most important sources of case study information. A personal interview can be described as a two-way conversation that is initiated by an interviewer to collect information from the interviewee (Blumberg, 2008:281).

In this study, a structured interview approach was followed as a approach to collect data. During the structured interview, the researcher used a very detailed interview guide that was similar to a questionnaire (Blumberg, 2008:385). The validity and reliability of the data will be discussed in the following section.

2.7.2 Validity and reliability

Validity is known as the 'what' of data collection techniques, procedures and measures, according to Brynard and Hanekom (2008:47-48). Henning *et al.* (2009:147) described validity as a measure to ensure that the researcher investigates what was meant to be investigated by making use of certain methods. Validity therefore uses methods to measure to what extent we are investigating what we said we are investigating.

Reliability refers to the precision and uniformity of measures (Bryman & Bell, 2007:162). Brynard and Hanekom (2008:48) indicated that the same instruments and measures must be able to deliver the same data under similar circumstances. It can be concluded that reliability results in the measurement of what is meant to be measured according to the problem statements and the qualitative approach used in the collection of the data.

Data is collected by obtaining information published by Promethium, the external consultants appointed by AGA, as well as calculations performed by them. However, the study performed by Promethium only considered various aspects of the Vaal River compressed air energy efficiency improvement project. Therefore, study elaborated on the work already performed by Promethium. Personal interviews with employees of AGA were finally performed to confirm the information and obtain clarity on some outstanding issues. After the data was collected it was processed to achieve the secondary objectives set in Chapter 1 (section 1.3 p. 5). In this study, we have evaluated whether it will be feasible for AGA to have a carbon-reduction project and whether it will be to their benefit. Because published data and calculations were used, the data may be seen as valid and reliable.

2.8 ETHICS AND VALUES IN CONDUCTING RESEARCH

According to Adams *et al*. (2009:35), ethics can be described as being honest, responsible and with the necessary level of integrity. Ethics can also be defined as a set of rules and standards wherein a community performs its actions to ensure that behaviour is controlled and what they regard as right and wrong in reaching a specific goal (May, 1993:4). Ethical research plays an important role in making sure that correct behaviour is practised. The responsibility to conduct ethical research stays with the researcher. In the last decade, the processes, methods and latitude of research have increased. They have increased the focus on the researchers to ensure that the research is performed in an ethical manner (Berg, 2007:53). As a result, researchers must strive to keep to research objectives and perform the research with the highest level of integrity (Mouton, 2009:40).

2.9 SUMMARY

The aim of this chapter was to provide an understanding of the research design and methodology used in this study. A case study research using AGA as the object of research was conducted making use of the following research types: descriptive, applied, qualitative and quantitative research. Data was collected by way of interviews and published information from Promethium. The validity and reliability of the processed data were discussed. The chapter concluded by highlighting the importance of ethical research.

The next chapter will provide an overview of the history of carbon reducing projects and carbon credits.

CHAPTER 3

3 HISTORY OF CARBON REDUCING PROJECTS AND CARBON CREDITS

3.1 INTRODUCTION

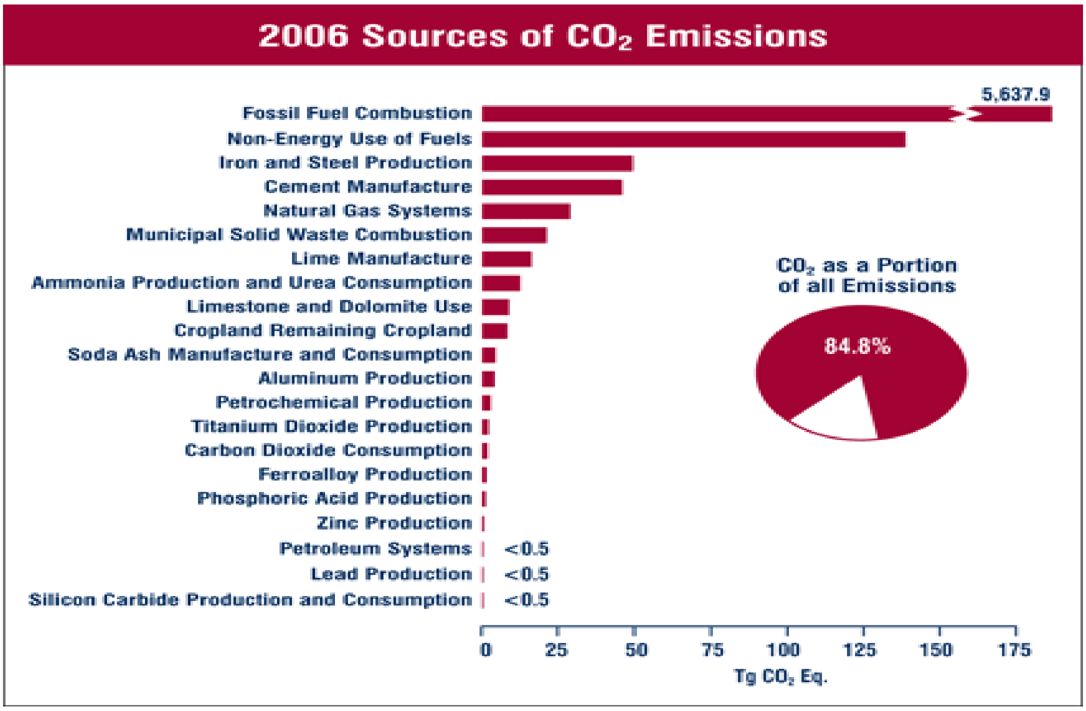
Global warming (the increase in the average global temperature) is largely caused by excessive emission of carbon dioxide. The effect of global warming can be seen in the change of weather conditions and animal behaviour. The Kyoto Protocol has been set up to encourage carbon emission reduction and to legally bind countries to reduce their contribution to carbon emissions (Anon, 2012c). Two commonly known systems (carbon tax and carbon credits) have been introduced by governments in an attempt to reduce carbon dioxide emissions. Projects can be introduced to reduce carbon emissions. These carbon emission savings, referred to as carbon credits, can be traded. However, the project has to be registered as a CDM project first. After the carbon credits have been awarded to the project, the credits can be traded on different carbon markets.

The layout of this chapter is as follows: Firstly, carbon dioxide as an emission product will be discussed, followed by an introduction to global warming and the Kyoto Protocol. The section that follows deals with carbon tax. The fifth and sixth sections discuss the Energy Service Company and Clean Development Mechanism, respectively. The chapter concludes with a section on gold mining and a chapter summary. The secondary objectives that will be addressed in this chapter will be (i) to explain the history behind carbon reducing projects and the earning of carbon credits, and (ii) to identify the criteria to register a project as a CDM project.

3.2 CARBON DIOXIDE

Carbon dioxide is a major emission product that is the result of biological and industrial activities. Different atmospheric processes use carbon dioxide, but unfortunately the atrophic balance is disturbed and carbon dioxide accumulates causing the greenhouse effect (Ochiai & Endo, 2005: 184). Atmospheric processes refer to all the tons of carbon dioxide used in natural processes, such as the oceans and growing plants. Carbon dioxide is released back into the atmosphere. Naturally, a balance exists between the carbon production and carbon usage; however, the carbon balance has been disturbed by human activities (Anon, 2011a).

Figure 3.1 Sources of CO_2 emissions



Source: Anon, 2011a

The different processes contributing to the atmospheric disturbance are (Anon, 2011a):

(a) **The burning of fossil fuels**, to produce energy that is stored as carbon, is almost entirely emitted as CO_2. Mostly petroleum oil (which in 2006 accounted for 47% of fossil fuel consumption), natural gas and coal are used in this process. Produced energy is commonly used for electricity generation, transport and industrial use. Refer to Figure 3.1 for the different sources of CO_2 emissions.

(b) **Industrial processes and products**. Petroleum products are used in the manufacturing of solvents, plastics and lubricants, releasing CO_2.

(c) **Carbon sequestration** is the process where plant life takes up CO_2 from the atmosphere and then stores it as biomass. In this natural process, the rate of CO_2 removal was always higher than the releasing rate. Young, fast-growing trees take up more carbon dioxide than they release.

(d) **Geologic sequestration** is the term used for a chain of activities resulting from the collection and transport of concentrated CO_2 gas from large emissions sources.

The next section will focus on a discussion of the impact of carbon dioxide on global warming.

3.3 GLOBAL WARMING

Global warming, also referred to as climate change, is causing an increase in the average temperature of the lower atmosphere. There are different causes of global warming, but the most common one is human intervention in the form of excessive amounts of GHG being released into the atmosphere (Kim, Granger, Puckett, Hasar & Francel, 2010).

Carbon dioxide does have a big impact on global warming (as mentioned in section 3.2) and the greenhouse effect; unfortunately, it is not only carbon dioxide that is causing global warming. The GHGs causing global warming are made up of carbon dioxide (CO_2), methane (CH_4), halocarbons (HFCs and PFCs), nitrous oxide (N_2O) and sulphur hexafluoride (SF_6) (Arava *et al*., 2010:275).

Greenhouse gases (GHGs) act like a greenhouse around the earth, meaning that they let heat from the sun into the atmosphere and they do not allow the heat to escape back into the atmosphere. The higher the number of GHGs, the higher the percentage of heat being trapped in the earth's atmosphere. The excess heat leads to the following global warming effects: (i) rising sea levels, ii) rising sea surface temperatures, iii) changing precipitation patterns (Kim *et al*., 2010), and iv) an increase in the intensity and frequency of extreme weather events (Nussbaumer, 2007:3081).

SA, being one of the most carbon intensive countries in the world, also has a part to play in reducing global warming (Pather-Elias, 2010:157). If SA wants to meet its emission reduction targets of 34% in 2020 and 42% in 2025, a strong enforcement mechanism and policy framework are needed. Tabulated below is the carbon emissions per SA sector (in 2010 and 2011) and the reduction target set per sector (Makholwa, 2011:46).

Table: 3.1 CO2 emissions by sector

Sector	CO_2 emissions (000 tons) 2010	CO_2 emissions (000 tons) 2011	Target medium-term CO_2 emission reduction (%)
Mining	110 440	112 342	13%
Liquid fuels	74 982	74 836	15%
Manufacturing	9 141	9 007	Target not stated
Financial services	1 164	4 760	9%
Media communication	691	1 265	20%
Diversified groups	684	693	20%
Retail	497	501	30%
Luxury consumer goods	64	79	Target not stated
Health care	0	48	Target not stated
Property & real estate	44	43	5%
Total	**197 707**	**203 574**	

Source: Adapted from Makholwa (2011:46)

Global warming can only be slowed down by reducing GHGs and the effect that they have on the atmosphere. This led to the Kyoto Protocol (under the United Nations Framework Convention on Climate Change (UNFCCC)).

3.4 KYOTO PROTOCOL

Adopted in 1997 (Hobden *et al*., 2007:35), the Kyoto Protocol has the objective to stabilise the atmospheric concentration of GHGs at a level that will prevent dangerous interference with the climate system. In the protocol, binding limits on the emission of six GHGs were set for the Annex 1 countries (Australia, Austria, Belgium, Belarus, Bulgaria, Canada, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Latvia, Lithuania, Luxembourg, the Netherlands, New Zealand, Norway, Poland, Portugal, Romania, the Russian Federation, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, the United Kingdom and the United States) (Zhang, 2000:491-492). Non-Annex 1 countries (South Africa and India) have no obligation to reduce GHG emissions (Hobden *et al*., 2007:35).

The Kyoto Protocol is a binding commitment to reduce or limit GHG emissions by 5% of the 1990 levels from 2008 to 2012 referred to as the first commitment period (Hobden *et al*., 2007:35). Exceptions were made for five of the Annex 1 countries, namely (i) the base year used for Bulgaria is 1988, (ii) for Hungary, an average of the years 1985 to 1987 was used, (iii) for Poland 1988, (iv) Romania 1989, and (v) Slovenia 1986. However, Annex 1 countries and Non-Annex 1 countries take part in i) the development of climate-friendly technologies, and ii) the education, training and public awareness of climate change.

The Kyoto Protocol does allow Annex 1 countries to add or subtract from their initial amount assigned emissions over the first commitment period (2008 to 2012) by trading these emissions, referred to as Kyoto units (one example is carbon credits) with other parties. These additions or subtractions must be carried out in accordance with the so-called Kyoto mechanisms. According to the Kyoto Protocol Reference manual (2008), these mechanisms include three options, namely i) emission trading, ii) joint implementation (JI) and iii) clean development mechanism (CDM).

3.5 CARBON TAX

An option introduced by governments to reduce carbon emissions is the implementation of carbon tax. According to the South African government, carbon tax seeks to reflect the external cost of GHG emissions causing climate change. It also tries to create a level playing field between high- and low-carbon emission sectors (National Treasury, 2012).

The purpose of carbon tax is to provide the producer (also known as the polluter) with one of two options: i) to improve efficiency so that they use less carbon per unit of energy produced, or ii) to pay for the damage they are causing through the pollution (Sathiendrakumar, 2003:1243). Carbon tax has been implemented in many countries, such as (i) India, (ii) Canada, and (iii)

Sweden. Carbon tax is however no guarantee that carbon emissions will be reduced. In the case of India's carbon tax, the Clean Energy Cess (implemented in July 2010), the results indicated that it will not reduce the usage of coal or reduce CO_2 emissions. The tax will only be used to fund mechanisms for research into clean energy technologies (Deloitte, 2011). Considering the outcome from the carbon tax implemented in Canada (implemented in July 2008), it is also evident that the tax itself does not seem to change behaviour and will have to be used with other initiatives that will assist in reducing CO_2 emissions (Deloitte, 2011).

However, in other countries, carbon tax has been successful in reducing carbon emissions. The Swedish government implemented carbon tax in 1991 and their GHG emission did drop by 9% in 2010, while at the same time, their economy has grown by 48%. Carbon tax was charged at €28 per tonne at the beginning (1991) and in 2010 it was charged at €128 per tonne. The success of the Swedish carbon tax is attributed to an easy-to-administer system and a broad acceptance by all political parties, stakeholders and the public. Taking the Swedish carbon tax as an example, it shows that carbon tax can encourage improved consumer behaviour and reduce carbon emissions (Rowan, 2010:70).

3.5.1 Carbon tax in South Africa

In the SA budget speeche of 2012, the SA government introduced a draft carbon tax policy. This draft carbon tax policy will be used in this study to indicate the effect of carbon tax on the SA economy. The aim of carbon tax is to mitigate climate change. Carbon tax will price the carbon dioxide emissions so that the external cost resulting from the emissions will be incorporated into production cost and consumer prices. Incentives will also be created for the change in behaviour and this will encourage the incorporation of cleaner-energy technologies, energy-efficiency measures and research and development of lower carbon options (South African Budget Review, 2012). The proposed design for SA carbon tax policy include: (i) percentage-based rather than absolute emissions thresholds, below which the tax will not be payable, (ii) a higher tax-free threshold for process emission, with consideration given to the limitations of the cement, iron and steel, aluminium and glass sectors to mitigate emissions over the near term, (iii) additional relief for trade-exposed sectors, (iv) the use of offsets by companies to reduce their carbon tax liability, and (v) phased implementation.

Tax will be applied to carbon emissions using agreed methods. A basic tax-free threshold of 60 per cent (with additional concession for process emissions and for trade-exposed sectors) and maximum offset percentage of 5 to 10 per cent until 2019/2020 are proposed. Additional relief will be considered for firms that reduce their carbon intensity during this first phase. The reduction in carbon intensity will be measured with reference to the base year of industry benchmark to be developed by government. Tax-free thresholds will be reduced during the second phase (2020 to 2025) and may be replaced with absolute emission thresholds thereafter. According to the National Treasury, alignment with the proposed carbon budget, as per the national climate change response white paper (2011), will be important. A carbon tax of R120 per ton of CO_2 above the suggested threshold is proposed to take effect during 2013/2014, with annual increases of 10 per cent until 2019/2020. Revenues from the tax will not be earmarked, but consideration will be given to spend the money to address environmental concerns. Incentives such as the proposed energy-efficiency tax incentive and measures to assist low-income households will be supported (SA Budget Review, 2012).

Table 3.2: Proposed emission thresholds per sector

Sector	Basic tax free threshold (%) below which no carbon tax will be payable during the first phase (2013 to 2019)	Maximum additional allowance trade exposure	Additional allowance for 'process' emissions	Total	Maximum offset percentage
Electricity	60%	-	-	60%	10%
Petroleum (Coal to liquid)	60%	10%	-	70%	10%
Petroleum – oil refinery	60%	10%	-	70%	10%
Iron and steel	60%	10%	10%	80%	5%
Aluminium	60%	10%	10%	80%	5%
Cement	60%	10%	10%	80%	5%
Glass & Ceramics	60%	10%	10%	80%	5%
Chemicals	60%	10%	10%	80%	5%
Pulp & paper	60%	10%	-	70%	10%
Sugar	60%	10%	-	70%	10%
Agriculture, forestry and land use	60%	-	40%	100%	-
Waste	60%	-	40%	100%	-
Fugitive emissions: coal	60%	10%	10%	80%	5%
Other	60%	10%	-	70%	10%

Source: Adapted from SA Budget Review (2012)

In addition to the proposed percentage thresholds as highlighted in Table 3.2 above, firms will be encouraged to reduce the carbon intensity of their products during the first phase of the scheme.

According to Shaun Nel, director of BDO Consulting Services, Eskom is accountable for 50% of SA's carbon emissions. If the carbon tax is implemented in 2013, it will lead to an increase in electricity costs. The Industry task team on climate change (ITTCC) has commissioned an independent consulting group to conduct surveys on 13 energy-intensive firms. Eight of the 13 firms are from the mining and mineral sectors. The study concluded that the carbon tax along with the electricity tariff increases will lead to the increase of 96c/kwh (as expected by 2014 under the National Energy Regulator's MYPD (Multi-year Price Determination) that will cause a 63% weighted average reduction in the operating profit of these firms (Anon, 2012a).

The challenge for the South African Government regarding carbon tax is to design and implement it effectively, taking into account the balance between development and environmental goals. South Africa's economy has long been founded by mining and heavy industry along with the cheap coal-fired electricity. This leads to various interest groups expressing their concerns about the implementation of carbon tax. Business is worried about losing their competitiveness (especially in the export markets for minerals and metals). Labour unions are worried about more job losses and civil society is concerned about rising energy prices (Thurlow, 2011).

The next section will consider the assistance available to companies committed to reduce their GHG emissions and thereby reducing the impact of carbon tax.

3.6 ENERGY SERVICE COMPANY (ESCO)

An energy service company (ESCO) was established in North America in the 1980s (now operating in 38 countries outside the United States (US)). ESCO guarantees energy savings leading to less CO_2 emissions and on the long run it will assist in reducing carbon tax. Companies making use of ESCOs can use it to finance or assist them in financing an energy system by guaranteeing energy savings. ESCO operates under an Energy Performance Contracting (EPC) arrangement. They implement projects that will deliver energy efficiency (EE) or they implement renewable energy projects, and the savings generated from the projects will be used to repay the cost of the initial project (Okay, Okay, Konukum & Akman, 2008:1821-1822). Not only do companies get the benefit of the energy saving, this will also reduce energy costs and in the case of South Africa and other countries, it will assist in reducing the impact of carbon tax.

Financing for EPC projects is provided by banks, direct customer financing, public financing (bonds), ESCOs itself or third-party financing. The financing cost thereof will be repaid with the electricity savings. The financing mechanism of ESCOs can generally be classified into two groups, i.e. (i) guaranteed savings (GS) and (ii) shared savings (SS). In the case of the GS mechanism, the ESCO guarantees a certain level of energy savings that will be sufficient to cover the annual debt obligation and it will also protect the client from any performance risks, while the financing is done directly by a bank or a financing agency. The client repays the loan, but the credit risk remains with the lender. Refer to Figure 3.2 for a GS mechanism of ESCO-market finance.

Figure 3.2 Guaranteed savings (GS) structure

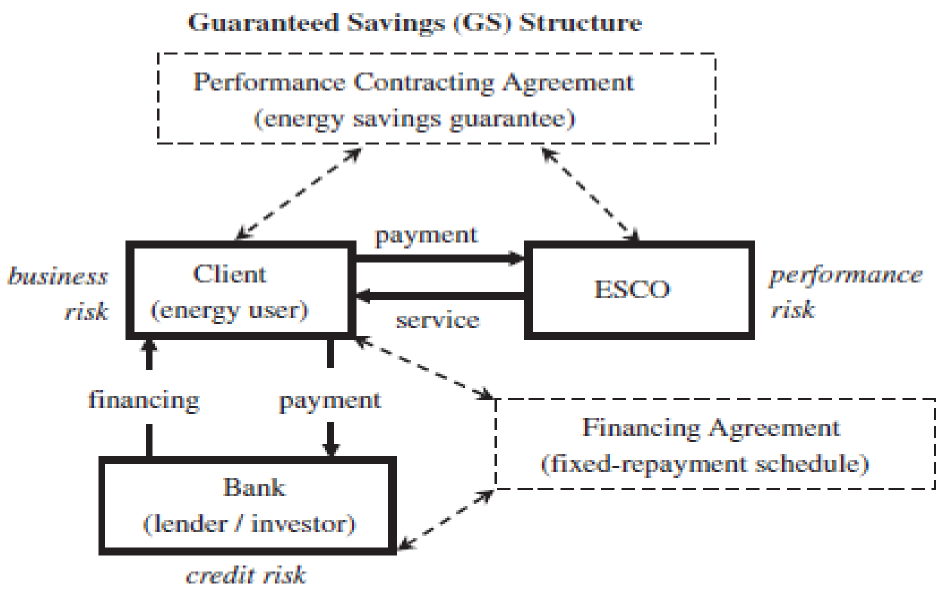


Fig. 1. Guaranteed savings (GS) mechanism of ESCO-market financing.

Source: Okay *et al*. (2008:1822)

In the case of the SS mechanisms, ESCO carries both the performance and credit risk. ESCO is responsible for the repayment of the loan, but the credit also remains with them leaving no financial risk for the client. The negative aspect is that the ESCO market is less competitive in the long run. In countries where the ESCO market is developing, the SS mechanism is more suitable because the client assumes no investment repayment risk and no financial obligations other than paying a percentage of the actual savings to ESCO over a specified period. The portion of savings paid to ESCO will always be higher for the SS projects than for the GS projects because of the higher risk carried by ESCO (Okay *et al.*, 2008:1821-1822). Refer to Figure 3.3 for the SS mechanism of ESCO market financing.

Figure 3.3 Shared savings (SS) structure

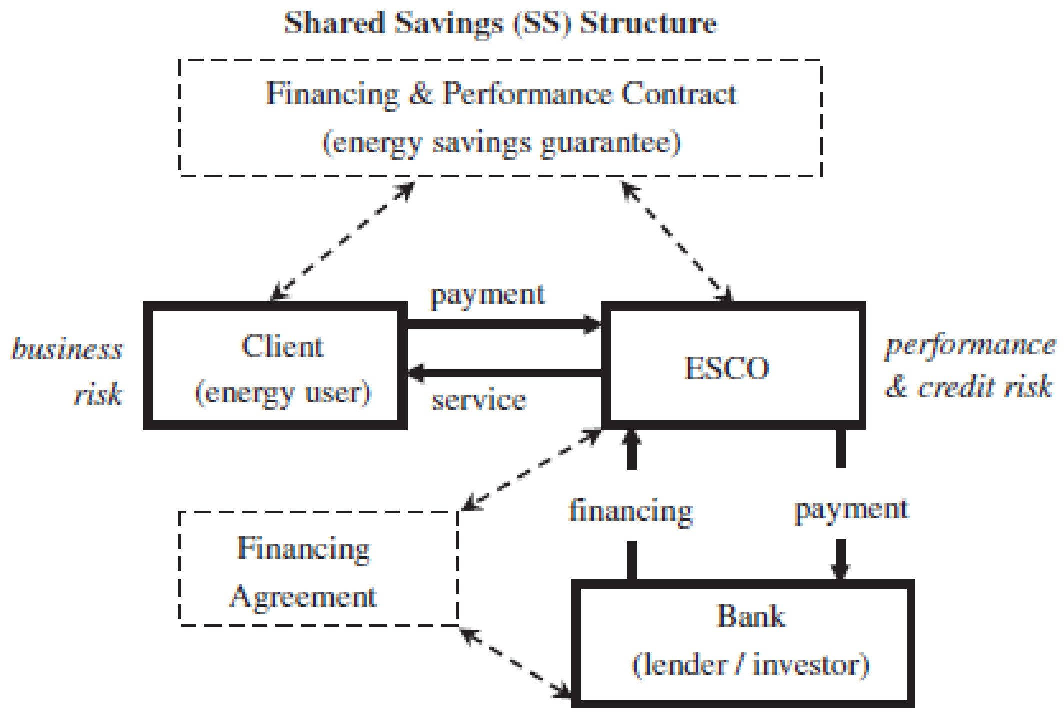


Fig. 2. Shared savings (SS) mechanism of ESCO-market financing.

Source: Okay *et al*. (2008:1823)

There is a similarity between ESCO and CDM projects and therefore it is feasible and beneficial to combine the conventional ESCO and CDM frameworks to promote energy conservation activities in developing countries. Figure 3.4 below shows the combination that can be used between ESCO and CDM (Ren, Zhou, Gao & Wu, 2011:8125-8127).

Figure 3.4: The combination of ESCO and CDM project

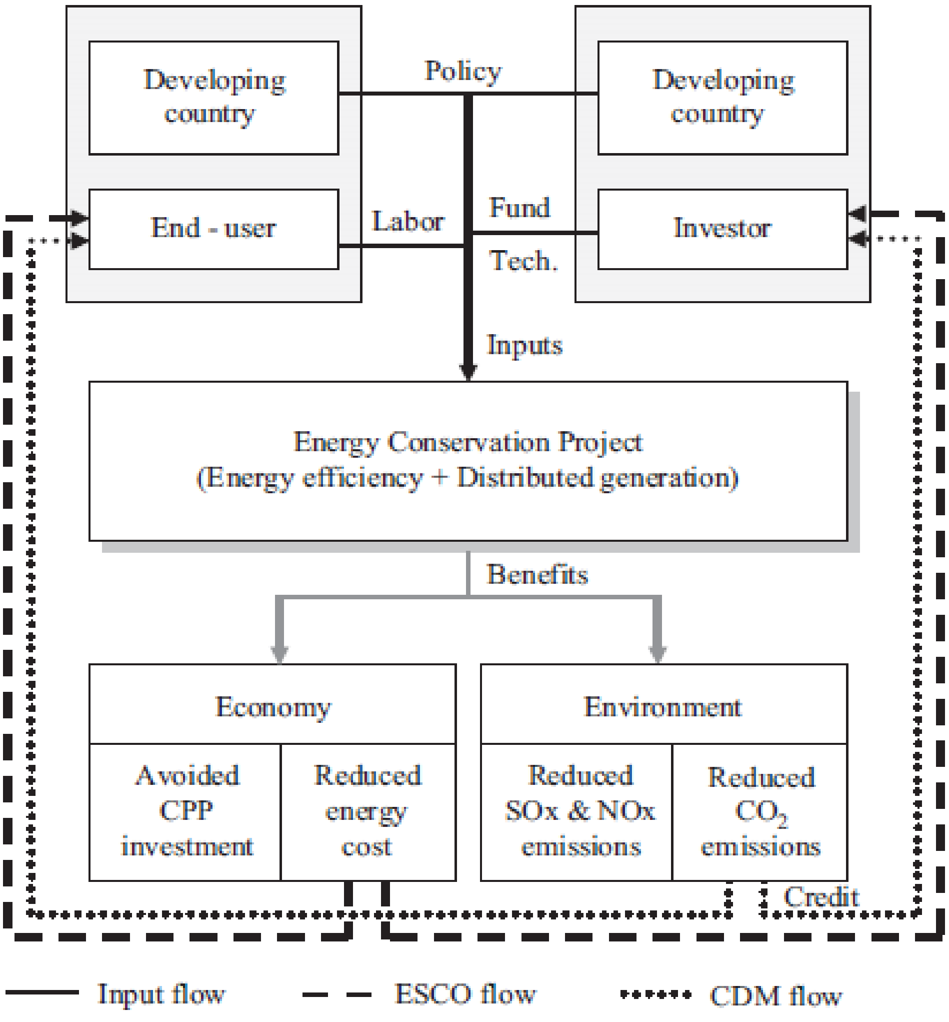


Fig. 1. Conceptual diagram of the combination between an ESCO and a CDM.

Source: Okay *et al.*(2008:1823)

3.7 CLEAN DEVELOPMENT MECHANISM (CDM)

3.7.1 CDM project

The Clean Development Mechanism (CDM), defined in article 12 of the Kyoto Protocol, provides countries with emission limitations or emission reductions. Opportunities to implement emission-reduction projects in developing countries are therefore created. These projects can earn saleable certified emission reduction (CER) credits with each credit equivalent to one tonne of CO_2. These credits can be used to meet the Kyoto targets. The CDM provides an opportunity for sustainable development and emission reduction, while providing industrialised countries flexibility in how they can meet their emission reduction (limitation) targets (Anon, 2012b).

The operational detail of a CDM project indicates that the project must provide emission reductions that are (i) additional to what would have occurred, (ii) it must be measurable, and (iii) lead to long-term reduction. The project's approval will be provided by the Designated National Authorities (DNA). This is a body granted the responsibility by a party to authorise and approve participation in CDM projects. Establishing a DNA is one of the requirements for a party if they want to participate in the CDM. The most important task of the DNA is assessing potential CDM projects to make sure that they will assist the host country in achieving its sustainable development targets and they must provide a letter of approval to the project participants in the CDM projects. This letter of approval must indicate that the project activities will make a contribution to the sustainable development in the country. It is then submitted to the CDM Executive Board to support the registration of the project (Anon, 2012c).

3.7.2 South Africa's DNA

South Africa's DNA was established in 2004 and currently they are focusing on the approval process for potential CDM projects. They will also provide support to project developers as well as promoting South Africa as an attractive location for potential CDM investors. All the responsibilities of the DNA in SA are allocated to the Director-General of the Department of Mineral and Energy (located in the Department of Minerals and Energy). They have

(i) developed an approval procedure to follow during the evaluation of a project to see whether the project meets the sustainable development requirements for South Africa in terms of the Kyoto Protocol, and (ii) they have set sustainable development criteria to be used as guideline in the evaluation (Anon, 2012d).

The sustainable Development Criteria are defined in the National Environmental Management Act 108 of 1998 as an integration of social, economic and environmental factors into planning, implementation and decision-making so as to ensure that the development serves present and future generations (Anon, 2012c). A summary of the sustainable development project indicators are listed in Table 3.3.

Table 3.3: The sustainable development project indicators

	Criteria	Indicator
Environment	Impact on local environment quality	• Impacts of the project on air quality • Impact of the project on water quality • Impact of the project on the generation or disposal of solid waste • Any other positive or negative environmental impacts of the project (Such as impact on noise, safety, visual impact, or traffic
	Change is usage of natural resources	• Impact of the project on community access to natural resources • Impacts of the project on the sustainability of use of water, minerals or other non-renewable natural resources • Impact of the project on the efficiency of resources
	Impact on biodiversity and ecosystems	• Change in local or regional bio-diversity
Economic	Economic impacts	• Impacts of the project on foreign exchange requirements • Impacts of the project on existing economic activity in the area • Impact of the project on the cost of energy • Impact of the project on foreign direct investments
	Appropriate technology transfer	• Positive or negative implications for the transfer of technology to South Africa arising from the project • Impacts of the project on local skills development • Demonstration and replication potential of the project
Social	Alignment with national, provincial and local priorities	• How the project is aligned with national provincial, local government objectives (access to basic services) • Impact of the project on local skills development • Contribution of the project to any specific sectoral-specific objectives
	Social equity and poverty alleviation	• Impact of the project on employment levels? (Specific number of jobs created/lost, duration of employment, distribution of employment opportunities, type of employment.) • Impact of the project on community social structures and heritage. Contribution of the project to the development of previously underdeveloped areas
General	General project acceptability	• Are the distributions of project benefits reasonable and fair?

Source: Adapted from Anon (2012c)

3.7.3 Duties of the DNA

The other duties of the DNA are:

The DNA must (in consultation with the steering committee):

a) apply and establish an approval procedure for a CDM project;

b) consider applications by project proponents for endorsement that the project complies with the international and national criteria of the CDM project and, where appropriate, comment on project design documentation;

c) issue the letter of approval to project proponents in respect of CDM projects meeting the international and the national sustainable development criteria approved by the Minster of Minerals and Energy;

d) facilitate the effective and beneficial participation of South Africa and South African public and private sector entities in the activities of the CDM;

e) promote the establishment of CDM projects in SA in co-operation with other government agencies with the same responsibilities;

f) monitor and report to the Minister of Minerals and Energy from time to time on the CDM projects and the activities in SA; and

g) declare all the donations they receive in accordance with the provisions of the Public Finance Management Act (Act No. 1 of 1999) (Anon, 2012c).

3.7.4 CDM in developing countries

South Africa is classified as a developing country for the purposes of the UNFCCC and the CDM. The CDM offers the following opportunities for developing countries:

a) It can attract capital for projects that are assisting a shift to a more prosperous but less carbon-intensive economy;

b) It encourages and permits the active participation of private and public sector;

c) It can be used as an effective technology transferring tool if investments are channelled into projects that can replace old and ineffective fossil fuel technology or it can create new industries in environmentally sustainable technologies; and

d) It can assist developing countries to define investment priorities in projects that meet their sustainable development goals.

3.7.5 Administration of CDM

Under the rules of the Kyoto Protocol, two bodies are responsible for the administration of the CDM, namely (i) Conference of Parties (COP) (serving as the Meeting of Parties (MOP)), and (ii) the CDM Executive Board. The COP/MOP is the supreme body of the CDM and consists of those parties that have ratified the protocol. It is responsible for the provision of guidance to the executive board and elaborates modalities and procedures with the objective to ensure transparency, efficiency and accountability. They are also responsible to review the regional distribution of designated operational entities to promote equitable distribution (Anon, 2012c).

The CDM Executive Board (EB) has the duty to supervise all the operations of the CDM. They work under the authority and guidance of COP/MOP and they consist of the following members from parties of the Kyoto Protocol: (i) one member from each of the five United Nations regions, (ii) two other members from parties included in the Annex 1 countries of the protocol, (iii) two members from parties not included in Annex 1 countries and (iv) one representative from the small island developing states.

- The EB has the following responsibilities: Approval of new baseline and monitoring methodologies;
- Approval and registration of CDM projects;
- Issuance of CERs;
- Development and maintenance of the CDM registry;
- Accreditation of Designated Operational Entities (DOEs); and
- Making recommendations to the COP/MOP on further modalities and procedures for the CDM.

Designated Operational Entities (DOE) are an independent third party that has the responsibility to check whether the project and related documentation meet all the requirements for registering as a CDM project. They must also verify the actual emission reduction of registered CDM projects and request the EB to issue CERs accordingly. The EB has the responsibility to accredit the DOEs separately for validation and verification (Anon, 2012c).

In the case of SA, the CDM has the ability to provide additional investment for the development of activities that can reduce the combustion of (i) fossil fuels (coal, oil, gas and paraffin), (ii) reduce methane emission (e.g. landfill sites), and (iii) they can help to improve land use patterns (e.g. reforestation). Investments (directly related to emission reduction) could make some businesses in SA more viable (Anon, 2012c).

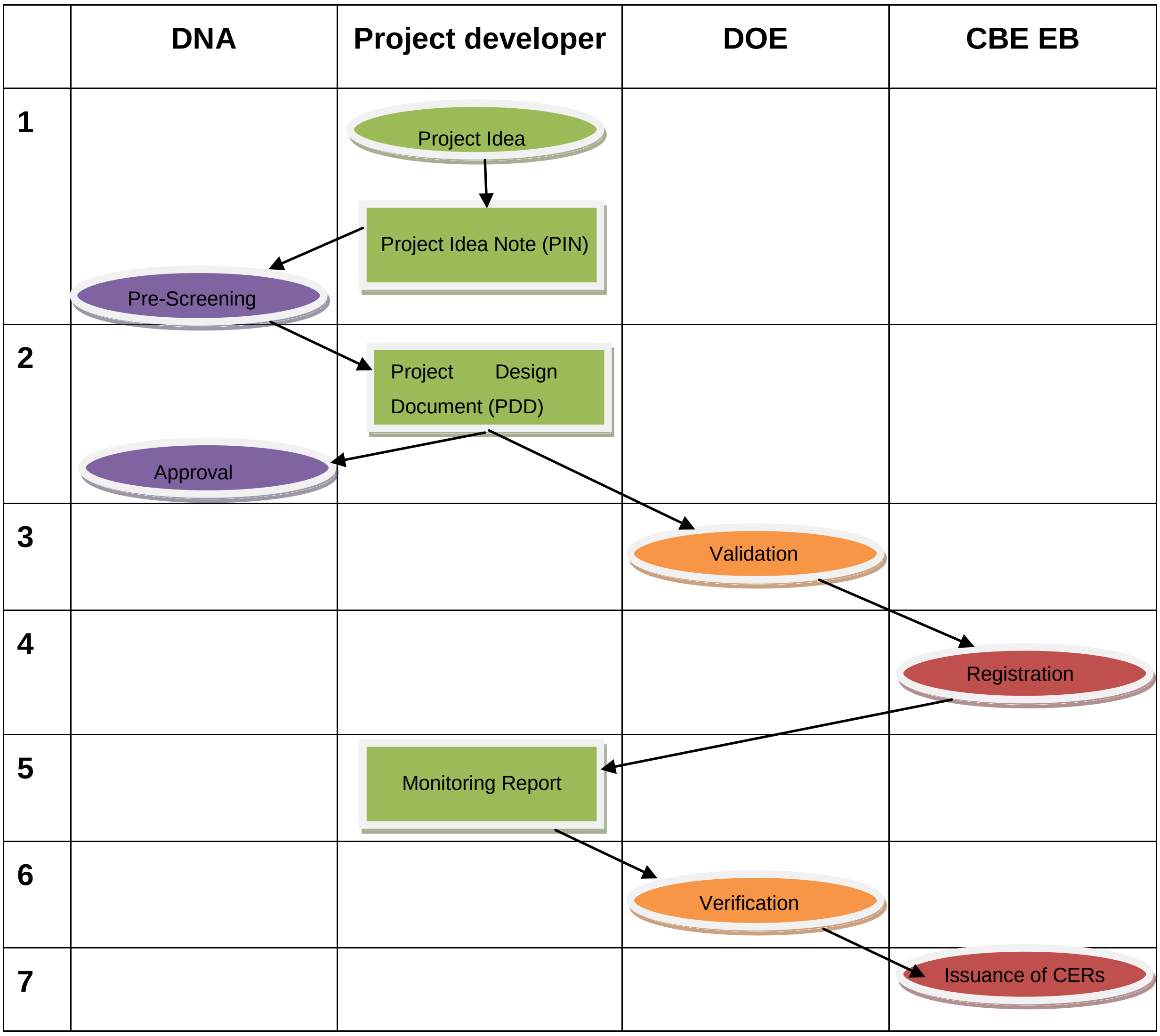
3.7.6 CDM project cycle

Starting a project requires a **Project Idea Note (PIN)** created by the project developer. This document provides an overview of the project, including information on anticipated emission reductions, the project's contribution to sustainable development and it must provide a preliminary overview of the financials of the project. A PIN is not an obligatory step for the CDM or for the CDM project cycle, but it is useful for the presentation of the project to the host (DNA and potential investors) (Anon, 2012c).

After the PIN is completed, a **Project Design Document (PDD)** must be developed. Included in the PDD must be a detailed description of the proposed project, an approved baseline with monitoring methodology as well as the project application. Additional information to be included includes the duration of the project and the crediting period, selected information on environmental impacts and stakeholder comments. The PDD is the key document for the validation of the project, host country approval, registration and verification of the CDM project (Anon, 2012c). After the host country has approved the PDD, the project needs to be evaluated by the Designated Operational Entity and after this valuation, the project is registered by the CDM Executive Board.

After the project approval, it needs to be financed (either through debt or equity). After the financing is obtained, the project can commence, be implemented and get operational. Monitoring the project as it progresses is important, because the DOE will verify the project performance against the validated design and baseline in order to approve certification. The certification is the process whereby the DOE certifies CERs that are being used by die CDM Executive Board based on the validation of the project design and baseline as well as the project performance. Figure 3.5 schematically shows the CDM project cycle.

Figure 3.5: The CDM project cycle



Source: Adapted from Anon (2012c)

3.7.7 CDM projects in South Africa

Up to 19 June 2012, SA had the following CDM project profile:

- 326 CDM projects submitted to the DNA;
- 228 Project Idea Notes (PINs); and
- 98 Project Design Documentation (PDDs).

Of the 98 PDDs, only 21 have been registered by the CDM Executive Board as CDM projects (nine issued with CERs). 77 projects are at different stages of the project cycle. Examples of projects submitted to the DNA include: bio-fuel, energy efficiency, waste management, cogeneration, fuel switching and hydro-power and other sectors such as manufacturing, mining, agriculture, energy, housing, transport and residential (Anon, 2012c). Specific processes need to be followed when registering a project as an official CDM project (Figure 3.5 shows the CDM project cycle).

In South Africa, the energy sector is our key source of GHG emissions. In 2000, it contributed 82.6% of the country's GHG emissions. The industrial processes contributed 7%, agriculture, forestry and land use 8.4% and wasted emissions contributed 2% (Anon, 2012c).

Opportunities in the energy industry that have good potential for emission reductions in SA include the following:

- Electricity generation from renewable energy sources and biomass;
- Fuel switching for thermal energy supply;
- Energy efficiency improvements in steam and thermal energy supply systems; and
- Energy management in the following areas: variable speed drive, electrical motors, lighting and compressed air systems.

Potential for CDM projects in other SA sectors:

- Agriculture: Afforestation and reforestation, fire controls, improved management of woodlands and biofuel production;

- Transport and automotive sectors: Improved public transport, urban planning and traffic management, vehicle fuel switch, vehicle efficiency and road to rail transport;
- Manufacturing: Industrial energy efficiency, structural changes to less energy and emission-intensive, boiler conversion to gas;
- Residential, public and commercial buildings: Solar water heating, energy management, energy efficient building designs and appliances;
- Waste sector: Composting, gas to energy generation; and
- Mining: Improve energy efficiency (Anon, 2012b).

Table 3.4 lists the CERs already issued to SA projects.

Table 3.4: CERs already issued to SA projects

Name of project	1st Issuance	2nd Issuance	3rd Issuance	Total CERs per project
Omnia Fertilizer Limited Nitrous Oxide Reduction	26 276	157 352	321 234	504 862
Transalloys Manganese Alloy Smelter EE	223 073	112 292		335 365
Sasol Nitrous Oxide Abatement	259 537	543 502		803 039
PetroSA Biogas to Energy	32 730			3 2730
Enveroserv Chloorkop Landfill Gas Recover	83 135			83 135
Lawley Fuel Switch	18 098	17 032		35 130
Total	**642 849**	**830 178**	**321 234**	**1 794 261**

Source: Adapted from Anon (2012c)

Figure 3.6 Emission reductions by project

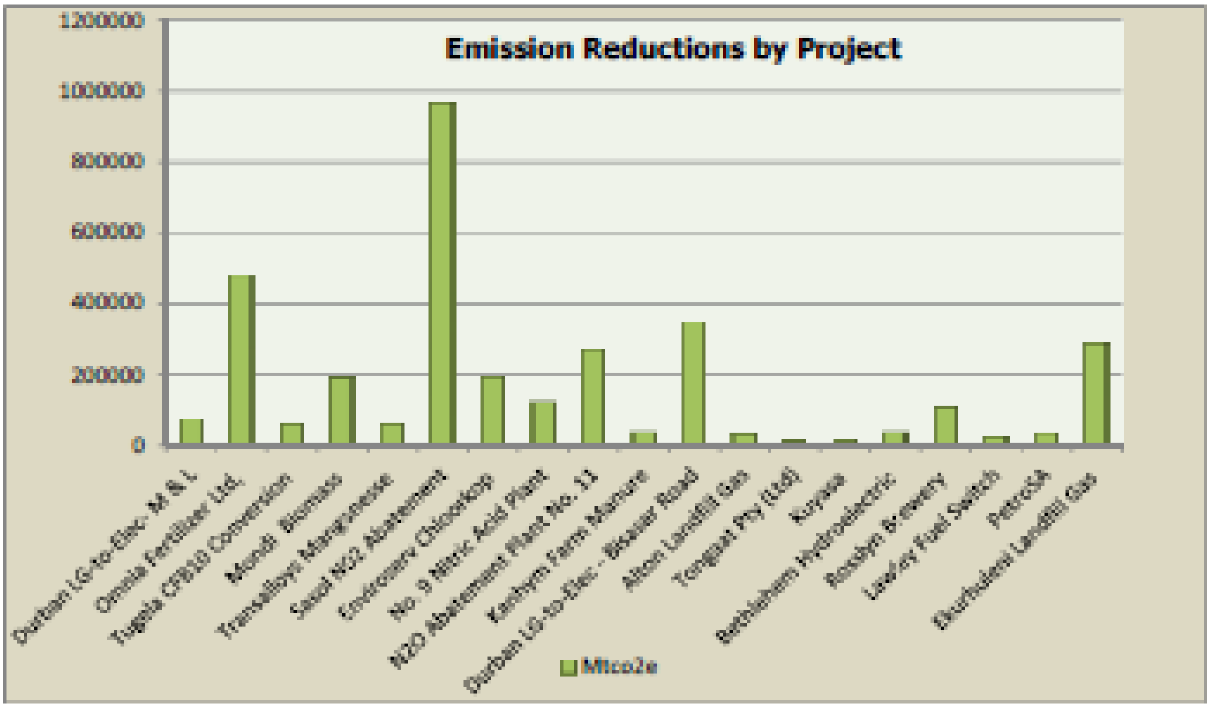


Figure 3: Annual GHG Emission Reductions for Registered Projects

Source: Anon (2012c)

3.7.8 Approval of CDM project

There are two ways to obtain approval of a CDM project, namely voluntary screening and mandatory submission.

1. Voluntary screening: Voluntary screening occurs when you submit a PIN application form to the DNA. This is voluntary, but it provides the DNA with an opportunity for initial screening of the project. The DNA then provides feedback to the developer on the likely performance of the project against sustainable development approval criteria. The results of the initial screening must be made available within 30 days of submitting the PIN.

2. Mandatory submission: All the mandatory submissions must include a more detailed description of the project via a project design document (PDD). After the PDD is submitted, it is published on the DNA website for public consultation (for a period of 30 days) and the PDD will be available

to any interested parties. The DNA will evaluate the project on the basis of the information provided in the PDD and comments received during the consultation period. If required, they will ask for more supplementary information. A recommendation will then be sent to the DNA steering committee members for consideration and the steering committee's comments and recommendations will then be sent back to the DNA. On the basis of the comments received from the steering committee, the DNA will make its final recommendation to the Director General for approval of the project. After submitting the PDD, it should take no longer than 45 working days before the DNA gives its decision of approval (Anon, 2012c).

3.7.9 Stakeholders of CDM project

There are various stakeholders taking part in the process of a CDM project. As mentioned earlier, we have the DOE, which includes the following in SA:

- Det Norske Veritas Certification Ltd;
- Dureau Veritas Quality International Holding SA;
- SGS United Kingdom Ltd;
- ERM Certification; and
- Verification Services Ltd and Carbon Check (Pty) Ltd.

Secondly, investors and CER buyers can be parties from developed (Annex 1) countries or private sectors, NGOs (Non-Government Organisation), Government or multilateral funds (Anon, 2012c).

A project such as the Landfill-Gas-to-Energy project has promoted the use of new renewable energy technology and has provided opportunities for job creation.

3.7.10 Trading of CERs

After successful registration of a project as a CDM project and being rewarded with CERs, you can trade the CERs. Emission trading enables Annex 1 parties to achieve emission reductions and it is commonly known as Cap and Trade. Cap and Trade provide parties with the opportunity to buy emission permits for GHG from other countries. The government of a country or an international body sets a limit or cap for the amount of GHGs that a country can emit and the total amount of the country's emissions cannot exceed its emission cap. If a country or entities (examples are manufacturing firms) exceed their emission caps, they are faced with either penalties or they need to buy credits from other firms that have not exceeded their emission allowance.

To elaborate on emission trading: Annex 1 parties may transfer Kyoto units to or acquire units from another Annex 1 party. Emission trading does not affect the total assigned amount of Annex 1 parties collectively, it rather re-distributes the assigned amount among them. The number of units that parties may transfer to other parties is limited by the parties' commitment period reserve (CPR). This is the minimum level of units that a party must hold in its national registry at all times preventing parties from over-trading units and thereby impair its ability to meet their commitment (Kyoto Protocol Reference Manual, 2008:16).

Two market-base mechanisms for trading are (i) joint implementation, and (ii) CDM (Anon, 2012c).

- Joint implementation (JI): providing one Annex 1 party the opportunity to invest in a project to reduce emissions or enhance sequestration in another Annex 1 party and then receiving credits for the emission reduction or removals achieved through the project. These units are called emission reduction units (ERU). The ERU also has no effect on the total assigned amount of Annex 1 parties collectively. It rather redistributes the assigned amount among them (Kyoto Protocol Reference manual, 2008:17).
- The Clean Development Mechanism (CDM): CDM credits may be generated from emission reduction projects or from afforestation and reforestation projects in non-Annex 1 parties. Unlike the emission trading or the JI, the CDM creates new Kyoto units and their acquisition by Annex 1 parties increases both the total assigned amount available for those Annex 1 parties collectively and their allowable level of emission. A CDM

project must meet specific requirements and follow the correct procedures to validate and register a project and to also verify and certify the emission reductions and removals. CDM projects have three different types of Kyoto units, i.e. i) certified emission reductions (CERs) that are issued for projects that reduce emissions, ii) temporary CERs (tCERs) and iii) long-term CERs (ICERs) that may be issued for projects that enhance the removal through afforestation and reforestation projects (Kyoto Protocol Reference Manual, 2008:18).

3.8 CARBON CREDITS

In 2005, a global carbon market was established with the purpose of facilitating the trade in carbon credits and helps to mitigate climate change in a cost-effective way. By the end of 2009, the total market value was US$144 billion with 8.7 billion tCO_2 traded (Anon, 2012c).

There are a few carbon markets, but the two main markets currently used are:

(i) The regulated carbon market: This market is regulated by international rules (Defined by Kyoto Protocol and Marrakech Accord) and the market includes carbon credits created through CDM projects; and

(ii) The voluntary carbon market: This market is unregulated and includes a range of different trading relationships and voluntary project standards.

The tabulation below indicates the key differences between the Regulated (CDM) market and the Voluntary carbon market (Anon, 2012c).

Table 3.5: Compliance versus voluntary markets

Compliance market (e.g. CER)	Voluntary market (VER)
Compliance markets generate and trade GHG emission reductions known as Certified Emission Reductions (CERs) that are regulated and directly initiated under the Kyoto Protocol's Clean Development Mechanism (CDM).	Voluntary markets generate and trade GHG emission reductions that are not regulated or directly initiated by the Kyoto Protocol and known as Verified Emission Reduction or (VERs).
Certified Emission Reductions (CERs): GHG reduction of any CDM project is measured according to internationally agreed methods and is quantified in standard units called Certified Emission Reduction (CERs). These are expressed in tons of carbon dioxide (CO_2) equivalents.	Verified Emission Reductions (VERs): GHG reductions outside Kyoto Protocol are measured according to internationally agreed methods and are quantified in standard units called Verified Emission Reduction (VERs). These are also expressed in tons of carbon dioxide (CO_2) equivalents.

Source: Adapted from Anon (2012c)

Carbon credits can only be traded after they meet the specific criteria that help to ensure that the emission reductions or removals have, or will, actually occur and that this will only be due to a carbon offset project. No single global price exists for carbon due to the different commodities and types of carbon credits that exist in the carbon market. The two types of markets are:

(i) The **primary market** that refers to the initial transaction between the project developer and the investor. This is a transaction that will carry the CER (the commodity in question) from the project in the developing country to the international market. The Primary CER Purchase includes no guaranteed volumes of CERs, because the purchase depends on the performance of a specific CDM project or portfolio of projects.

(ii) The **secondary market** is any further transaction after the primary transaction. This is the onward sale of CERs until it is bought by the final consumer who will submit it to meet their target. These CERs are linked to a spot market price.

AngloGold Ashanti (a gold mine in SA) will have the option to trade their carbon credits on a primary or secondary market. The following section will provide a brief introduction about gold mining.

3.9 GOLD MINING

The main gold reef in South Africa was discovered on the Langlaagte farm near Johannesburg in 1866. Diamonds were already discovered in Kimberley by then, so a number of investors were already in SA and it was therefore easy to attract investors to invest in the large newly-found gold reef.

For a while, mercury was the principal agent used to dissolve gold from crushed ore, but it only has an effective gold extraction rate of about 65%. This is not enough to make it viable compared to the high cost associated with gold mining. After the new technology and the new gold extraction reagent (called cyanide) were used, gold mining in SA became viable.

In 1898, SA produced 118 tonnes (3.8 million oz) of gold, making it the leading gold producer and by 1913 it produced approximately 280 tonnes (9 million oz). Due to the high cost and time of sinking a new shaft compared to an open pit mine, SA became less competitive and gold production dropped to only 605 tonnes (19.5 million oz) by 1990 after its peak of 700 tonnes (22.5 million oz) in 1977 (Anon, 2012d). This still, however, left SA to produce nearly 40% of the world’s gold on the export market. Gold mining in SA employs nearly 500 000 people. The gold-mining industry accounts for roughly 18% of SA’s annual Gross Domestic Product. The export value of SA gold is valued at $3.8 billion (Anon, 2012e).

In SA, all gold mines are sunken shafts, where ore is transferred from the underground to the surface. The ore is initially grounded down by means of semi-autogenous milling, after which a conventional gold leach process, incorporating a liquid oxygen injection, is applied. The gold is then extracted by means of carbon-in-pulp (CIP) technology. The plant makes use of conductions of electro-winning and smelting to extract gold (Anon, 2012f).

3.10 SUMMARY

South Africa has a large part to play in reducing carbon dioxide emissions, thereby reducing the effect of global warming. SA is not one of the Annex 1 countries and has no carbon emission reduction targets under the Kyoto Protocol, but still has a part to play in reducing the effect of global warming. Therefore, the SA government proposed a carbon tax policy that will most likely be implemented at the end of 2014. The impact on SA businesses needs to be considered so that the most effective carbon tax policy for all will be implemented. To reduce the effect of carbon tax on businesses, companies can make use of ESCOs and they have the option to register projects as CDM projects. The criteria for registering a project as a CDM project are disclosed in section 3.7. After registration, carbon credits can be earned and sold. One fact will not change, and this is that everyone has a role to play in reducing carbon emissions and saving our planet from disaster, which includes gold mines in South Africa.

The next chapter will conceptualise capital investment techniques from the literature.

CHAPTER 4

4 CAPITAL INVESTMENT APPRAISAL TECHNIQUES

4.1 INTRODUCTION

This chapter address the secondary objective of conceptualising capital investment appraisal techniques from the literature. Capital budgeting is described as the "analysis and evaluation of investment projects that normally produce benefits over a number of years" (Correia, Flynn, Uliana & Wormald, 2007:8-3). Companies must remain competitive in national and international markets, and for this reason they need to expand current projects or develop and invest in new projects. Optimal investment decision-making can determine the success of a project.

Qualitative aspects of an investment project are important, leading us to the data content needed to evaluate any project effectively. Keep in mind that cash inflows and cash outflows are only the numbers used to do the calculations, forming the basis for the decision-making. The quantitative and qualitative assumptions are the real determinants of any project's viability. The assumptions regarding cash outflows must be carefully considered before cost can be included in the project cash flow (Ogilvie, 2008:312).

There are a number of capital investment appraisal techniques, which include: (i) Accounting rate of return (ARR), (ii) payback method, (iii) net present value (NPV), and (iv) internal rate of return (IRR).

To investigate whether to register the Vaal River compressed air energy efficiency improvement project as a CDM project, AGA has to utilise the right investment techniques.

In this chapter, we will discuss each capital investment appraisal technique. Firstly, an accounting rate of return is calculated, followed by the payback technique. The last two sections of this chapter will discuss the net present value and internal rate of return techniques.

The aim of this chapter is to conceptualise capital investment appraisal techniques from the literature.

4.2 ACCOUNTING RATE OF RETURN

The return on assets (ROA) or return on investment (ROI) is used in measuring the effectiveness with which the company's assets are utilised by management. This ratio is often used to evaluate management and the ratio is then based on the book value of assets. Therefore, it may be important, for any project to be accepted, to meet a certain accounting rate of return (ARR). The ARR must have a favourable effect on the return on investment of the company.

The accounting rate of return (ARR) is defined as follows:

$$ARR = \frac{\text{Average incremental net income}}{\text{Average investment}}$$

Average incremental net income will be the increase in the average net income of the company if the project is accepted. This is calculated by dividing the total net income received from the project by the economic useful life of the project. The difference between net income and cash flow will be related to depreciation and other non-cash flow items. The net income is defined as the income after depreciation and non-cash flow expenses are deducted (Correia *et al*., 2007:8-11). It is important to consider the advantages and disadvantages of ARR.

The advantages of ARR include:

- The calculation is simple; and
- The total life of the project is considered

The disadvantages of ARR include that:

- No tax or capital allowances are taken into consideration;
- The timing of the cash flows is not accounted for; and
- Profit instead of cash flow is used (Ogilvie, 2008:312).

4.3 PAYBACK PERIOD

The payback technique is used to measure the time it will take a company to recover the cost that they have invested in a project. This cost will have to be recovered from the cash flows generated by the project. It may be used as a crude indicator of risk, because it indicates for how long the funds will be at risk (Correia *et al*., 2007:8-10).

The advantages of payback period include:

- Decision-makers can easily understand the information presented to them; and
- The calculations are simple and likely to be error-free.

On the other hand, the disadvantages of the payback period include:

- All project cash flows within the project are weighted equally;
- Cash flows outside the payback period are not accounted for; and
- It is not easy to do an accurate determination of how long the payback should be.

Taking the disadvantages into consideration, it may seem that the payback method is not often issued; however, in practice, it is used extensively (Ogilvie, 2008:314).

4.4 NET PRESENT VALUE

The net present value (NPV) technique takes into account the time value of money. It involves estimating a project's future cashflows, and then the cashflows are discounted at the company's required rate of return (cost of capital). After the cashflows are discounted, the cost of the investment is subtracted from the present value.

This technique is a popular capital investment technique because it is a financial measure that takes cognisance of the time value of money invested in a business (Diacogiannis, 2008:89). Furthermore, by empowering investors with an understanding of the different capital investment techniques, they are handed a valuable tool for determining which project, if any, should be accepted or rejected (Gowthrope, 2005:497). The NPV technique can therefore be defined as the process of evaluating an investment by projecting the future net income thereof (Clasen, 2011).

The net present value technique is an indicator which determines the value that an investment will add to an organisation (Drury, 2011:58) If the present value is positive, it is an indication that the project will result in an increase in the value of the firm due to the project earning more than the required rate of return (Correia *et al*., 2007:8-6). If the present value is negative, the project will be lead to a net cash outflow, i.e. making a loss. Therefore, in theory, if the investment project's net present value is positive, the project should be accepted. However, this does not indicate that investments should be made in all projects with a positive net present value as the cost of capital may not always account for the opportunity cost, e.g. in comparison with other profitable investments. Therefore, if there is a choice between two equally limited alternatives, the one providing the highest net present value will be selected (Drury, 2011:58). Table4.1 highlights the various outcomes of the net present value calculations and the reaction that an organisation should have in terms of the investment decision.

Table 4.1: Different net present value outcomes

Net present value outcomes If...	**It means…**	**Then…**
Net present value >0	The investment would add value to the firm	The investment project may be accepted
Net present value <0	The investment would deduct value from the organisation	The project should be abandoned
Net present value = 0	The investment would neither increase or decrease value for the organisation	There is thus indifference in the decision whether to accept or abandoned the project. This project adds no financial value. Decision should be based on additional criteria, e.g. strategic positioning or additional factors with no factors explicitly incorporated in the estimates.

(Source: Drury, 2011:156)NPV formula:

$$NPV = \sum_{t=1}^{n} \frac{C_t}{(1 + K)^t} - I$$

C_t = net cashflow at time t

I = cost of the investment

K = cost of capital

The advantages of NPV include:

- The calculation of NPV, before and after cashflow, over the lifetime of the project is considered;
- The profitability and risk of the project are given high priority; and
- NPV calculations help to maximise the firm's value.

The disadvantages of NPV include:

- It is difficult to use; and
- Difficulty is experienced in calculating an accurate discount rate (Anon, 2013).

4.5 INTERNAL RATE OF RETURN

Internal rate of return (IRR) is the discount rate that causes the present value of net future cashflows to equal the cost of the investment (Correia *et al.*, 2007:8-7).

IRR formula:

$$\sum_{t=1}^{n} \frac{c_t}{(I + r)^t} - I = 0$$

r = internal rate of return

In the case of IRR, the rule is to accept the project if the IRR is greater than the cost of capital and rejected if it is less than the cost of capital (Ogilvie, 2008:317).

The advantages of IRR include:

- Time value of money is considered;
- It discloses the maximum rate of return the project can provide; and
- Cash flows of the entire project are considered and analysed.

The disadvantage of IRR is:

- It is difficult to understand (Anon, 2013).

4.6 SUMMARY

Capital investment decision-making is a complicated task. A company must use the most reliable information to perform the correct calculations in order to make the right decisions. All four the techniques mentioned in Chapter 3 have different risks associated with them.

In order to account for risk, theory suggests the following:

1. If payback is used, reduce the required payback period.
2. If IRR is used, increase the required 'cut-off' rate.
3. If NPV is used, increase the discount rate, to account for the 'risk' associated with the project (Ogilvie, 2008:321).

Any of the three capital investment appraisal techniques mentioned above, could be utilised to evaluate the feasibility of the Vaal River compressed air energy efficiency improvement project. However, by using the ARR technique the impact of taxation and the timing of the cashflows are not considered. Furthermore, when using the payback period as an investment appraisal technique, cashflows occurring after the payback period are ignored and therefore an accurate payback period is difficult to determine. IRR is however easy to understand and uses the same information used by the NPV calculation.

Therefore, taking cognisance of all the above, the most appropriate capital investment appraisal technique to use for the Vaal River compressed air energy efficiency improvement project, will be the NPV technique. The NPV technique assigns a high priority to both the profitability and risk of a project. The technique takes the impact of taxation into account as well as the cashflows for the entire project period.

The next chapter will provide an overview of the case study utilised.

CHAPTER 5

5 CASE STUDY

5.1 INTRODUCTION

In June 1998, AngloGold Limited was formed. This was in consolidation with the gold-mining interests of Anglo America. AngloGold Ashanti, as it stands now, was formed in April 2004 as a result of a business combination between AngloGold and Ashanti Goldfields Company Limited and AngloGold Ashanti.

AngloGold Ashanti Limited with its headquarters in Johannesburg (SA) is a global gold-mining company with a profile of long life, relatively low-cost assets and differing ore body types in key gold-producing regions. The Company has 20 operations that are located in 10 countries (Argentina, Brazil, Australia, Ghana, Mali, Guinea, Namibia, Tanzania, South Africa and US) with an ore reserve of 75.6Moz of gold as at 31 December 2011 (Anon, 2012g).

AngloGold Ashanti is primarily listed on the Johannesburg Stock Exchange Limited (JSE) Ltd, but it is also listed on the London Stock Exchange (LSE), Ghana Stock Exchange (GhSE), New York Stock Exchange (NYSE) and the Australia Securities Exchange (ASX). During December 2011, the group had 382 242 243 ordinary shares in issue, with a market capitalisation of $16.2bn, with 98% of the ordinary shares being free floated, while 1.67% is held by the Government of Ghana (Anon, 2012g).

Currently, the company is the third largest gold-mining company in the world, with a net debt of $610m by 31 December 2011 and an EBITDA of $3.014m. They employ 61 242 people (including contractors) and produce 4.33Moz of gold, generating a $6.6bn gold income (excluding joint ventures) (Anon, 2012h).

AngloGold Ashanti (AGA) has six deep-level mines in South Africa; three of the mines are located in the Vaal River area (Moab Khotsong, Great Noligwa and Kopanang), while the other three are located in West Wits (Mponeng, Savuka and TauTona), as well as a surface operation. A surface operation is a plant that is located above ground. Here, the rock that is mined underground is crushed and transferred into gold. The South African region produced 37% of the company's gold (1.63Moz) in 2011, and employed 32 082 people. Uranium is also produced in the South African Region (Vaal River side) and they produced 1.38Mlb of uranium in 2011. Uranium is a by-product of gold in the Vaal River area (Anon, 2012i).

AGA (SA Region) consumes large amounts of electricity to produce gold. Electricity is in direct correlation with carbon dioxide emission, therefore directly related to carbon tax. Carbon tax will have a big impact on AGA's cash cost as well as their cashflow. Due to the high cost of underground mining, it puts more pressure on AGA (SA regions) to produce gold at a competitive cost in comparison with their open-pit mines. ESCOs will help AGA to save electricity and therefore to reduce the carbon tax bill. The Vaal River Compressed air energy efficiency improvement project will also contribute to a reduction in production cost (due to electricity saving) and carbon credit sales will help to reduce the higher cost associated with carbon tax. For the Vaal River compressed air energy efficiency improvement project to be registered as a CDM project, the project will have to meet the registration criteria as set out in Chapter 3, section 7. AGA has different financing options when registering the project and the best option will have to be used.

Secondary objectives discussed in Chapter 5 will comprise (i) investigating whether the Vaal River compressed air energy efficiency improvement project will meet the CDM registration criteria, (ii) investigating what the best financing option for AGA to use in the registration will be, (iii) a comparison will be done of the different trading options for selling carbon credits, and (iv) investigating whether carbon credits' sale revenue is optimised.

The layout of this chapter is as follows: Firstly, the effect that the proposed carbon tax policy for SA will have on AGA will be discussed, followed by a consideration of an ESCO project for AGA. The third and fourth sections will investigate the Vaal River compressed air energy efficiency improvement project and the cost to register a project as a CDM project. The last section will focus on the financing options for a CDM project and the chapter will conclude with a summary.

5.2 CARBON TAX

The proposed carbon tax policy that was introduced by the SA government (February 2012) raised some concerns about (i) the impact on the income distribution, and (ii) the international industrial competitiveness of mines in SA (De Wet, 2012b). Taking only the latter into consideration, AGA will have to carefully consider the effect that carbon tax will have on their competitiveness. The outcome of the SA carbon tax has been highlighted as levelling the playing field between carbon-intensive and low carbon-emitting sectors (De Wet, 2012b). Companies will have to take preventive measures to minimise the effect that carbon tax will have on their profits. The impact of carbon tax could have some dramatic consequences on a company such as AGA by not just lowering their profit, but also their competitiveness to gold mines outside SA. Gold mining in SA is already much more expensive in comparison with open-pit mines, globally. AGA will have to consider all possible options to reduce the effect that carbon tax will have on the SA operations. Considering the capital investment appraisal techniques discussed in Chapter 4, the best technique to use to evaluate the impact of carbon tax on AGA will be an NPV calculation over the expected life of a mine.

5.2.1 Net Present Value (NPV) on the carbon tax effect

The effect of carbon tax on the SA Region of AGA using the NPV technique has been calculated using three different scenarios. The NPV calculations were performed by the long-term financing department in AGA's SA regional offices at West Wits. However, as the SA government has not yet announced the emission thresholds (stipulated in Table 3.2 under section 3.5.1) for gold mines in SA, three different scenarios (based on assumptions from prior data provided to AGA) were used. In all three scenarios, a rate of R120 per carbon ton and 10% discount rate (used only for the carbon tax calculations) were used to calculate the NPV effect in real terms. The useful life of a mine from 2012 until 2059 was used. Useful life, at the time of these calculations, was estimated to end by 2059 (estimations done by AGA's production departments).

In scenario 1, an emission threshold of 50% was used and results in an NPV of R1 145 million. In scenario 2, using a 60% threshold, a R916 million NPV was calculated, while if a threshold of 70% was calculated, an NPV of R687 million was obtained (Fulat, 2012a). Even if the best case scenario of a carbon tax threshold of 70% is considered, AGA SA Region will still have a negative impact on their cashflow of R687 million over the useful life of the mine. This is equal to 1591 kg of gold (gold price at R431 692/Kg – gold price on 21 August 2012) (AngloGold Ashanti, 2012).

5.2.2 Reducing the carbon tax effect

As mentioned in Chapter 3 (section 3.1, page 19), there are different measures that can be introduced to reduce the effect of carbon tax. Probably the most effective measure will be to improve energy consumption and thereby reduce carbon emissions. This is easier said than done. Replacing equipment with more energy efficient equipment is expensive and other factors, apart from energy use, have to be considered, such as the maintenance of the new equipment and whether maintenance support is available in SA should the equipment be imported.

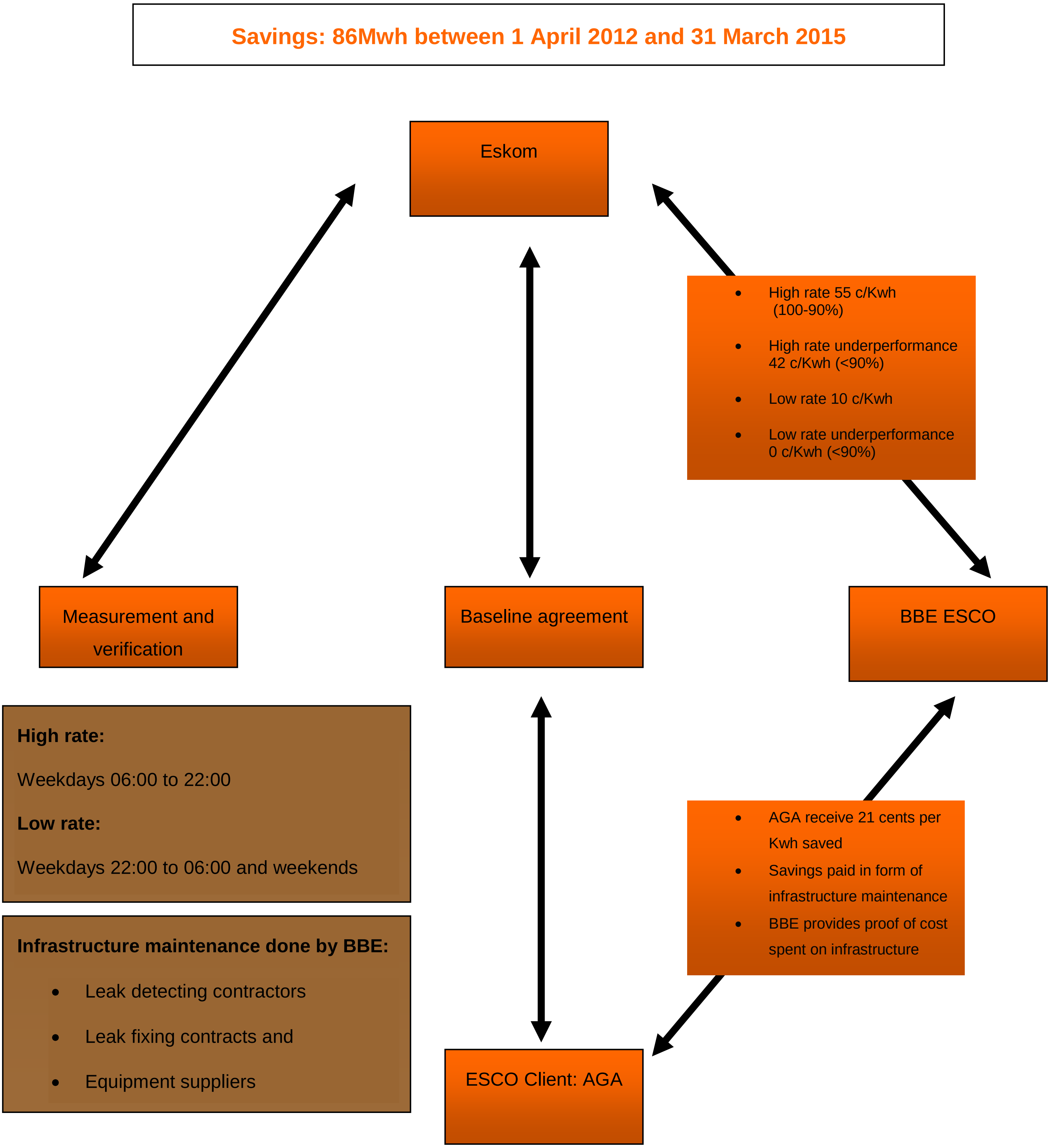
One of the other options that can be used to reduce the carbon tax effect will be to make use of ESCOs. In the following section, we will discuss the ESCO project considered by AGA.

5.3 ENERGY SERVICE COMPANY (ESCO)

One other option available to AGA is to make use of an Energy Service Company (ESCO) to improve energy efficiency.

AGA SA Region has opted to enter into an ESCO contract with Bluhm Burton Engineering (BBE). BBE, in turn, will enter into a contract with Eskom. Refer to Figure 5.1 for the structuring of the contract:

Figure 5.1 Contract structure between BBE and AGA



Source: Fulat (2012b)

The details (summarised in Figure 5.1) of the contract with BBE will include the following:

- BBE has to achieve 86Mwh of savings between AGA over 36 months starting 1 April 2012;
- BBE must repair all electricity leaks to ensure the saving of electricity;
- BBE will give AGA 21 cents per kilowatt hours saved (irrespective of what Eskom pays them) in the form of infrastructure related to compressed air, leak fixing and other related aspects; and
- Provide AGA with proof of 21c of this portion that was spent on infrastructure.

Eskom will pay (BBE) for measured and verified savings as follows:

- High rate, which falls on weekdays between 06:00 and 22:00: 55c/kWh,
- Low rate which falls on weekday between 22:00 and 06:00 and weekends: 10c/kWh (Fulat, 2012b).

The contracts commenced 1 April 2012 and the targeted savings have to be achieved by 31 March 2015. Of the 86MWh that need to be saved over the three years, 21c/kWh saved (payable from BBE to AGA) will be for Kwh saved between 06:00 and 22:00 on weekdays and it will be classified as direct and open external expenses on this project. These may include the following: (i) Leak detecting contracts, and (ii) Leak fixing contracts and equipment suppliers. All the expenses will be open book so that anyone can see that these funds are being spent on infrastructure maintenance (Fulat, 2012c).

The benefits of the above agreement for AGA will be (i) that they will have 21c per Kwh for infrastructure, and (ii) they will save electricity costs (Kwh) and (iii) they will have to pay less carbon tax due to lower electricity usage (CO_2 indirectly) (Fulat, 2012b).

Making use of the contract with BBE will be one option for AGA to reduce their electricity cost and to reduce the negative effect of carbon tax. They will have to carefully consider each opportunity to improve their electricity efficiency.

An ESCO is only one option to reduce the effect of carbon tax. Another option is to register a project as a CDM project. The project can then, after registration, earn carbon credits. Such a project considered by AGA is the Vaal River compressed air energy efficiency improvement project that will be investigated in the next section.

5.4 VAAL RIVER COMPRESSED AIR ENERGY EFFICIENCY IMPROVEMENT PROJECT

The project that AGA is considering to register as a CDM project is called the Vaal River Compressed Air Energy Efficiency Improvement Project.

5.4.1 Promethium

AGA has made use of Promethium (an outside consulting firm) to assist in the consultation of the project. The price forecast used by Promethium was based on the Prospective Outlook for the Long-term Energy System (POLES) model. This is a global sectoral simulation model used for the development of energy scenarios that can sketch scenarios up to until 2050. The dynamics used by the model are based on a recursive (year by year) simulation process of energy demand and supply with lagged adjustment to prices and a feedback loop through international energy prices. POLES provides a valuable tool to address the long-term energy, technology and climate changes issues. The model is already simulating energy demand and supply for 32 countries and 18 world regions (Promethium, 2011b).

POLES is aligning the cost of energy produced from fossil fuels with the cost of renewable energy by adding the price of carbon to the cost of fossil fuels. Renewable energy is currently more expensive than energy produced from fossil fuels. The low cost of fossil fuels therefore supports a high carbon price (Promethium, 2011b).

5.4.1.1 Different price scenarios

The different price scenarios of carbon are built around the modelling done by the European Union (EU) for the following four scenarios, namely: (i) Base case, (ii) No global carbon market, (iii) Perfect global carbon market, and (iv) Repeat of 2008 collapse in 2012 (Refer to Table 5.1).

The model presented by the EU sets the price of the European Union Allocated Unit (EUA) required to achieve the 20% commitment made by the EU (Promethium, 2011b).

Estimating a CER price from the projected EUA price, Promethium has analysed the spread between the CER price and the EUA price from 2008 to 2010 (Promethium, 2011b). Refer to Table 5.2 for the carbon prices calculated in €/carbon credit.

Table 5.1: Summary of different CER price scenarios (€ per carbon credit)

Scenario	Basis of modelling
Base case	This case assumes a gradual carbon market
No global carbon market	This case assumes that developed countries will reach their reduction targets of 30% internally, with the absence of international trade in carbon offsets
Perfect global carbon market	This case assumes that there is a global carbon market encompassing all sectors in both the developed and developing world. This ensures a single equalised carbon price
Repeat of 2008 collapse	This case assumes that financial markets could experience another collapse with a similar magnitude to the 2008 meltdown

Source: Adapted from Promethium (2011b)

Table 5.2: Prices modelled (€ per carbon credit)

	Base case	No global carbon market	Perfect global carbon market	Repeat of 2008 collapse
2010	€10.65	€10.65	€10.65	€10.65
2011	€12.99	€15.24	€11.43	€12.99
2012	€15.33	€19.82	€12.21	€7.80
2013	€17.66	€24.40	€12.99	€7.80
2014	€20.00	€28.98	€13.77	€11.54
2015	€22.34	€33.56	€14.54	€15.29
2016	€24.67	€38.14	€15.32	€19.03
2017	€27.01	€42.73	€16.10	€22.78
2018	€29.34	€47.31	€16.88	€26.52
2019	€31.68	€51.89	€17.66	€30.27
2020	€34.03	€56.47	€18.43	€34.02

Source: Adapted from Promethium (2011b)

5.4.2 Terms of the project

AGA aims to register The Vaal River compressed air energy efficiency improvement project as a CDM project under the Kyoto Protocol in order to earn carbon credits from the project. After successful registration, the project can earn tradable carbon credits. Revenue generated from the carbon sales will be used to fund more electricity efficiency improvement projects (Promethium, 2011a).

The aim of the Vaal River compressed air energy efficiency improvement project is to increase the energy efficiency on both the demand and supply side of the Vaal River compressed air ring. In this study, the focus will be on the supply side of the project due to the demand side that still needs to be finalised. Justification for this project will be on the basis that the capital will be paid for in the electricity savings that will be generated by the project (Promethium, 2011a).

Promethium has suggested that AGA should develop this project under a Small Scale Methodology CDM project, meaning that it would be saving less than 60 000 MWh per year. Indications are that the project will be saving 55 000 tons of CO_2 (per year) in the initial years of the project (Promethium, 2011a).

On the supply side of the project, three energy efficiency activities of the ring will be used, i.e. (i) re-allocation of the VK100 compressor, (ii) improving the compressed air control, and (iii) dropping the pressure in the ring itself.

(i) **VK100 Compressor Re-allocation:** AGA moved a used VK100 compressor from Tau Lekoa (a mine that was sold in 2010) to Moab Khotsong, where it was installed and commissioned. It replaced two 3.73MW inefficient compressors. The 3.73MW compressors were only used in emergencies when the base load compressors tripped. An additional two 15MW compressors at Kopanang will also be upgraded and incorporated into the control system of the Vaal River compressed air ring. After the VK100 is installed at Moab Khotsong, only one of the 15MW compressors from Kopanang will be in use in emergency situations, and the other compressor will be used as a standby in the unlikely event of emergency situations. This results in a 4.7MW energy saving as the 15MW compressors at Kopanang are replaced with a 10.3MW VK100 compressor (installed at Moab Khotsong, but used by Kopanang). The two 3.73MW compressors at Moab Khotsong will be excluded from the power saving, as they are seldom used. When the additional 15MW compressor is run in emergency situations, the power will have to be subtracted from the emission reduction of the project (Promethium, 2011a).

(ii) **Compressed Air Control Improvement Project:** The control system on the Vaal River compressed air ring will be upgraded in line with the work performed by a DSM consultant, HVAC and AGA. Improvements will involve lowering the base load on the ring with the VK 100 compressor that was moved and the installation of valves on the compressed air pipes at the working surfaces to shut off air supply when no one is working. Moving the VK 100 is part of a strategy to keep the most efficient machines running for the base load and to only add the less efficient machines when necessary. The isolation valves are part of a control strategy to limit the compressed air usage, which includes throttling the base load machines during low demand times to reduce unnecessary blow off. Compressed air shut-off valves will shut down the air supply if the mine is emptied for several hours after blasting or during off-shift periods. Shutting off the valves will mean that power will be saved on the entire compressed air ring. Estimates done by HVAC on the savings of the first phase of the control project are 2.20MW, averaged over a 24-hour weekday. Other alternatives that can be considered for power savings include (i) the installation of variable speed drives on the motors of the compressors, and (ii) a centralised control unit for the whole compressed air ring (Promethium, 2011a).

(iii) **Compressed Air Ring Pressure Reduction Project:** By lowering the air pressure in the ring, energy can be saved. The lowering can only be done if all the mining equipment that draws air from the ring can operate at the lower ring pressure; also keeping in mind that some equipment may need replacement. The project has the potential to create large emission reductions, but the reduction is not quantified as yet. Therefore, this supply side energy efficiency project should not be overlooked if a decision to proceed with this project is taken (Promethium, 2011a).

5.4.3 Criteria for eligibility

The Vaal River compressed air energy efficiency improvement project will be approved under the Small Scale Methodology (AMS II.D – version 2) (Defined as energy efficiency and fuel switching measures for industrial facilities). The table below sets out the criteria for the methodology (Promethium, 2011a).

Table 5.3: Comparison of AMS IID requirements and supply side energy efficiency project detail

Eligibility criteria of AMS IID	AngloGold Ashanti project
This category comprises any energy efficiency and fuel switching measures implemented at a single or several industrial or mining and mineral production facility(ies).	The project is an energy efficiency project implemented at a mining facility.
This category covers project activities aimed primarily at energy efficiency.	The project is an energy efficiency project.
A project activity that involves primarily fuel switching falls into category III.B.	The project does not involve fuel switching.
The measures may replace, modify or retrofit existing facilities or be installed in a new facility.	The project involves the retrofit of an existing facility.
This category is applicable to project activities where it is possible to directly measure and record the energy use within the project boundary (e.g. electricity and/or fossil fuel consumption).	The power used by the Vaal River compressed air ring can be directly measured.
This category is applicable to project activities where the impact of the measures implemented (improvements in energy efficiency) by the project activity can be clearly distinguished from changes in energy use due to other variables not influenced by the project activity (signal to noise ratio).	The compressed air ring is currently being monitored. The project expects a power saving of 18% against the historic energy consumption of all the compressor houses on the ring.
The aggregate energy savings of a single project (inclusive of a single facility or several facilities) may not exceed the equivalent of 60 GWh_e *per year. A total saving of 60* GWh_e *per year is equivalent to a maximal saving of 180* GWh_{th} *per year in fuel input.*	The energy saving of the project will be 6.9 MW, resulting in an annual reduction of 54 GWh_e.

Source: Adapted from Promethium (2011a)

The analysis above indicates that the proposed methodology can be used in the development of the project, provided that the energy savings are below 60GWh/year and that the energy savings can be directly measured as a fraction of the electricity consumption of the entire compressed air system.

5.4.4 Project boundaries

The boundaries of the project will be drawn around all the compressor houses in the Vaal river compressed air ring. This will ensure that power savings of the compressed air supply improvements in the project are measured accurately.

5.4.5 Leakage of emissions

Leakage of emissions will occur when energy efficient equipment is transferred to or from another activity. A clear demonstration will be required to prove that the move of the VK100 compressor does not cause any additional emissions at Tau Lekoa where the compressor is currently held. The valves that will be installed as part of the project activity will be purchased for this application and therefore no leakage is anticipated.

5.4.6 Common practice analysis

Significant technological and prevailing practice barriers are not foreseen, as the technology that will be used in this project has been tested and it is not the first project of its kind in South Africa. However, in addition, a common practice analysis must be completed. A common practice assessment is required as part of a CDM project. This would include a high-level review of compressed air supply side energy efficiency improvements throughout South Africa. A high-level investment analysis of the VK 100 compressor re-allocation is highlighted in Table 5.4. These calculations are a requirement under the criteria set by the UNFCCC. The cost and savings from the project are also highlighted in Table 5.5. From Table 5.4, it can be concluded that the payback on the project is six years.

Table 5.4: Payback period of the VK100 relocation project

Cost and Savings	**Rand amount**
Capital cost	R20,806,000
VK100 cost	R38,000,000[2]
Total project cost without DSM consultant	**R58,806,000**
Annual savings	R8,009,089
Payback without DSM consultant (years)	**7.34**
DSM consultant funding[3]	R10, 403,000
Total project cost with DSM consultant	**R48,403,000**
Payback with DSM consultant (years)	**6.04**

Source: Adapted from Promethium (2011a)

A preliminary overall project common practice analysis study is indicated in Table 5.5 below.

Table 5.5: Payback period of the Supply side energy efficiency project

Cost and savings	Rand amount
Capital cost of VK100 move	R20,806,000
VK100 costs	R38,000,000[4]
Cost of HVAC control project	R13, 734,000
Total project cost without DSM consultant	**R75,540,000**
Annual savings	R18,130,000
Payback (years)	**4.17**

Source: Adapted from Promethium (2011a)

[2] This value is based on the assumption that if AGA did not use the compressor in this installation it could have sold it at 40% of the value of a new machine. The value of the new machine is taken as R95 million.

[3] We have assumed that Eskom contributed 50% of the capital expenditure as part of the DSM Consultant programme.

[4] This value is based on the assumption that if AGA did not use the compressor in this installation it could have sold it at 40% of the value of a new machine. The value of the new machine is taken as R95 million.

For the project to be registered as a CDM project, the requirements in Table 5.3 need to be met; however, there is still documentation that needs to be validated before the project can be registered. The required documentation for validation will be discussed in the next section.

5.4.7 Validation requirements

The following documents/information must be available at validation:

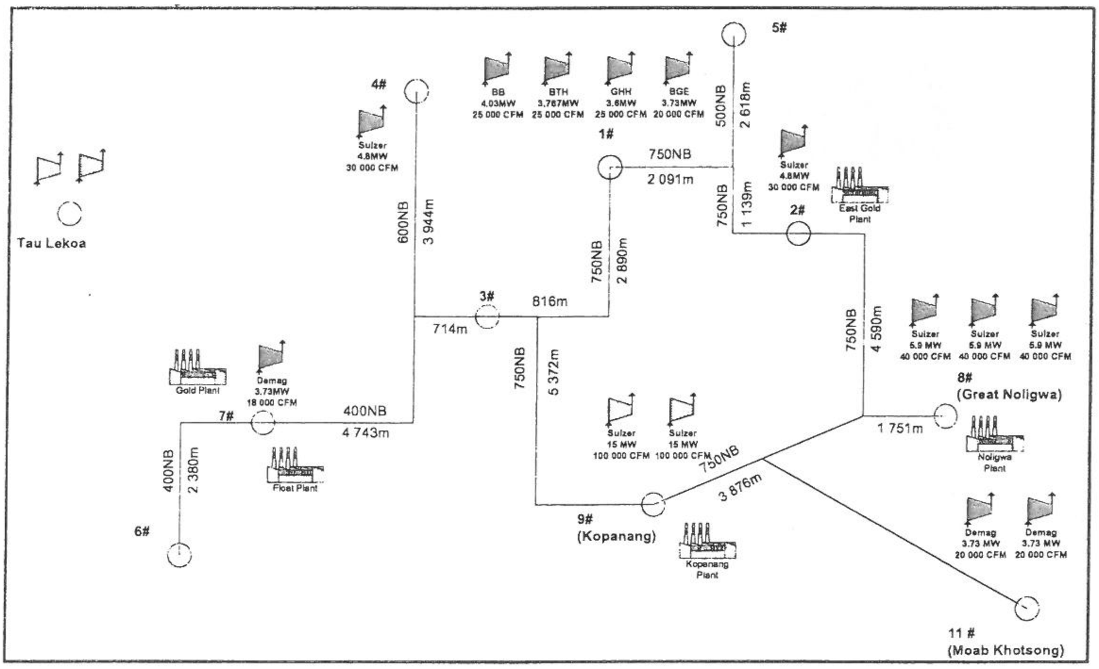
- Remaining life of mine for all the mines on the compressed air ring;
- Pressure and temperature profiles for the air leaving the compressor houses on the compressed air ring;
- Historic electricity consumption and air production data for all the compressors attached on the ring;
- Information on the electricity metering system;
- Expected life/retrofit dates/decommissioning dates for all compressors on the ring;
- Decommissioning reports of the VK100 from Tau Lekoa;
- Compressed air control and management plans and estimated power savings;
- Technical design information on all the interventions;
- Project financial information and AGA financial decision criteria;
- Any environmental approvals required; and
- All documentation related to the sustainable development aspect of the project (Promethium, 2011a).

5.4.8 Monitoring plan

The compressor housed on the Vaal River compressed air ring will have to be monitored to observe the effect of the compressor relocation and the control improvements. The power consumption and compressed air production of all the compressors on the ring will be monitored and a compressed air emission coefficient for the ring will be calculated. The power saved by the VK 100 move and the control improvements will then be calculated with the use of the emission coefficient and an electricity emission factor.

The total power of all the compressors in the ring, excluding the compressor at Tau Lekoa, is 83.6 MW. The layout of the compressed air ring is shown in Figure 5.2 below. The saving of 6.9MW from this project is 8.3% of the name plate capacity of the ring and can be directly measured (Promethium, 2011a).

Figure 5.2 Layout of the Vaal River compressed air ring



Source: Promethium (2011a)

5.5 COST TO REGISTER A CDM PROJECT

Registering an energy savings project as a CDM project is costly if taking into account all the registration fees and other funding required (refer to Table 5.6) (Promethium, 2011a).

Table 5.6: Registration cost

	Contracting party	Comments	Cost
PDD	Promethium	This step involves the writhing of the PDD according to the guidelines provide	R350,000
Validation	Designated Operational Entity (DOE)	This involves the auditing of the project by auditors accredited by the UN	Varies between €30,000 and €40,000
Registration fee	Executive board of the CDM	Depends on the size of the project	US$9,500[1]

Source: Author

[1] Based on 55,000 CERs in the first year and $0.10 per CER up to 15,000 CERs and $0.2 per CER for those above 15,000 CERs

5.6 FINANCING THE PROJECT

There are three different options for AGA to finance the Vaal River compressed air energy efficiency improvement project, namely:

(i) Fund the project internally and then they will have to solely carry all the risk associated with the project; or

(ii) EDF (the French equivalent of South Africa's Eskom) pays for the CDM registration; or

(iii) Nedbank pays the CDM registration as an upfront payment (Fulat, 2012c).

The following information was also taken into account in making a decision on the optimal option to utilise:

Table 5.7: The different options

CDM development fees	Pricing structure	Risk
Nedbank offers to pay for CDM development and registration, as well as to provide an advance payment for carbon credits. The cost towards CDM development will be deducted from the advance payment towards AGA.	Floor price €8,50, and 65% participation in difference between market price and floor price.	AGA guarantees to repay the upfront payment if no CERs delivered, and cannot sell CERs to other buyers.
EDF Trading offers to pay for CDM development and registration. These costs will be deducted from the payment made to AGA for the delivery of CERs on the first issuance.	88% of market price.	AGA cannot sell CERs to another buyer for a better price.
AGA pays for registration, validation and PDD development cost.	100% of market price, less 5% commission.	AGA carries the risk of the CDM project not being registered.

Source: Adapted from Fulat (2012c)

As mentioned in section 5.4.1.1, we do have four different scenarios that were used for the NPV calculations on the Vaal River compressed air project, i.e.:

(i) The base case;

(ii) No global carbon market;

(iii) A perfect global carbon market; and

(iv) Repeat of 2008 collapse.

In each of the four scenarios, the following PDD, validation and registration costs were used, as well as a discount rate of 15% (as advised by Promethium).

Table 5.8: CDM registration, variable cost

Variables		
Discount rate		15%
PDD drafting scenario		R350 000
Validation cost	€35 000	R 41 863
Registration cost	$9 500	R66 500
Contingency		R41 637
Registration, validation and PDD cost		R800 000

Source: Fulat (2012c)

The useful life for the Vaal River compressed air energy efficiency improvement project was estimated by Promethium as 10 years (2011 to 2020). Carbon credits will only be sold from 2013 onwards and no sales will be made in 2011 and 2012. In 2013, only half of the CERs will be issued for sale (55 000/2 = 27 500), from 2014 to 2020 the full 55 000 CER will be up for sale. This is the case in all four scenarios and for all three financing options.

The prices and exchange rates provided in Table 5.9 will be used in each of the three financing options when describing the different scenarios.

Table 5.9: Exchange rates, prices and amount of CER sold

	CER sold per year	Exchange rate	Base Case	No global carbon market	Perfect global carbon market	Repeat of 2008 collapse
2011		R 9.77	€12.99	€15.24	€11.43	€12.99
2012		R10.01	€15.33	€19.82	€12.21	€7.80
2013	27 500	R10.26	€17.66	€24.40	€12.99	€7.80
2014	55 000	R10.52	€20.00	€28.98	€13.77	€11.54
2015	55 000	R10.78	€22.34	€ 33.56	€14.54	€15.29
2016	55 000	R11.05	€24.67	€2 38.14	€15.32	€19.03
2017	55 000	R11.33	€27.01	€42.73	€16.10	€22.78
2018	55 000	R11.61	€29.34	€47.31	€16.88	€26.52
2019	55 000	R11.90	€31.68	€51.89	€17.66	€30.27
2020	55 000	R12.20	€34.02	€56.47	€18.43	€34.02

Source: Adapted from Fulat (2011)

All three financing options will now be discussed. The first financing option to evaluate will be if AGA provides internal funding for the Vaal River compressed air energy efficiency improvement project.

5.6.1 Internal funding

If AGA provides internal funding, the registration and validation costs will be R800 000, of which the first half will be paid in 2011 and the second half will be paid in 2012. As disclosed in Table 5.7, AGA will receive 100% of the CER price for CER sales, but they have to pay Promethium a commission of 5%. Therefore, AGA receives 95% of the price provided for each scenario in Table 5.9. The revenue is calculated as follows:

Revenue = (CER price (at 95%) x exchange rate) x amount of CER sold

In Table 5.9, all the prices are also disclosed, as well as the revenue per scenario. The revenue provided is then used for the NPV calculations. The revenue is calculated as follows:

Revenue = (CER price (at 95%) x exchange rate) x CER sold

Table 5.10: AGA option: Price and revenue

	Base case price	Base case revenue	No global carbon market price	No global carbon market revenue	Perfect global carbon market price	Perfect global carbon market revenue	Repeat of 2008 collapse price	Repeat of 2008 collapse revenue
2011	R120.54	-R400 000	R141.37	-R400 000	R106.08	-R400 000	R120.54	-R400 000
2012	R145.77	-R400 000	R188.48	-R400 000	R116.13	-R400 000	R74.14	-R400 000
2013	R172.19	R4 735 262	R237.86	R6 541 177	R126.62	R3 481 957	R75.99	R2 089 850
2014	R199.84	R10 991 259	R289.59	R15 927 425	R137.56	R7 565 559	R115.33	R6 432 892
2015	R228.77	R12 582 111	R343.76	R18 906 573	R148.96	R8 192 933	R156.58	R8 611 631
2016	R259.01	R14 582 111	R400.45	R22 024 725	R160.85	R8 846 947	R199.82	R10 989 842
2017	R290.63	R15 984 473	R459.76	R25 286 967	R173.25	R9 528 541	R245.12	R13 481 582
2018	R323.66	R17 801 349	R521.79	R28 698 967	R186.16	R10 238 686	R292.56	R16 091 040
2019	R358.17	R19 699 078	R586.63	R32 264 920	R199.61	R10 978 382	R342.23	R18 822 545
2020	R394.19	R21 680 568	R654.39	R35 991 666	R213.61	R11 748 664	R394.19	R21 680 568

Source: Adapted from Fulat (2012c)

5.6.2 EDF pays for the CDM registration

The R800 000 registration and validation cost will be paid upfront by EDF. AGA will still have to pay 40% of the cost as per agreement with EDF. This cost is payable in 2013. 40% of the registration cost of R800 000 is R320 000 that will have to be paid by AGA in 2013. As disclosed in Table 5.7, AGA will receive 88% of the CER price for CER sales. The revenue is calculated as follows:

Revenue = (CER price (at 88%) x exchange rate) x CER sold

Table 5.11: EDF option: Price and revenue

	Base case price	Base case revenue	No global carbon market price	No global carbon market revenue	Perfect global carbon market price	Perfect global carbon market revenue	Repeat of 2008 collapse price	Repeat of 2008 collapse revenue
2011	R111.66	R0	R130.96	R0	R98.26	R0	R111.66	R0
2012	R135.03	R0	R174.60	R0	R107.57	R0	R68.68	R0
2013	R159.50	R4 066 348	R220.33	R5 739 195	R117.29	R2 905 392	R70.39	R1 615 861
2014	R185.12	R10 181 377	R268.25	R14 753 825	R127.42	R7 008 097	R106.83	R5 875 521
2015	R211.91	R11 655 008	R318.43	R17 513 457	R137.99	R7 589 243	R145.04	R7 977 089
2016	R239.93	R13 195 957	R370.94	R20 401 850	R149.00	R8 195 067	R185.09	R10 180 064
2017	R269.21	R14 806 670	R425.89	R23 423 717	R160.48	R8 826 438	R227.06	R12 488 202
2018	R299.82	R16 489 671	R483.34	R26 583 926	R172.44	R9 484 256	R271.01	R14 905 384
2019	R331.77	R18 247 567	R543.41	R29 887 505	R184.90	R10 169 449	R317.01	R17 435 620
2020	R365.15	R20 083 052	R606.18	R33 339 648	R197.87	R10 882 973	R365.15	R20 083 052

Source: Adapted from Fulat (2011)

5.6.3 Nedbank pays CDM registration as an upfront payment

The agreement with Nedbank is that they will pay the CDM registration cost and they will do an upfront advance payment to help AGA to finance the Vaal River compressed air energy efficiency improvement project. The combined upfront payment will be R11 415 789, including the R800 000 registration cost (This cost information was provided by Promethium). Therefore, AGA will receive a net advance payment of R10 615 789 in 2011. The rest of the agreement includes that the advance payment will be repaid with €8.50 (named floor price) per CER sold up to 2015. In 2013 to 2015, AGA will receive 65% of the CER price after the floor price (€ 8.50) is deducted. After 2015, AGA will receive 65% of the CER price participating above the floor price. Revenue (2013 & 2014) = ((CER price - € 8.50) x 65%) x exchange rate x CER sold.

Revenue (2015 – 2012) = (((CER price - € 8.50) x 65%) + € 8.50)) x exchange rate x CER sold.

Table 5.12: Nedbank options: Price and revenue

	Base case price	Base case revenue	No global carbon market price	No global carbon market revenue	Perfect global carbon market price	Perfect global carbon market revenue	Repeat of 2008 collapse price	Repeat of 2008 collapse revenue
2011	R28.51	R10 615 789	R42.76	R10 615 789	R18.61	R10 615 789	R28.51	R10 615 789
2012	R44.42	R0	R73.65	R0	R24.14	R0	-R4.59	R0
2013	R61.12	R1 680 764	R106.05	R2 916 359	R29.93	R823 209	-R4.70	-R129 285
2014	R78.62	R4 324 010	R140.03	R7 701 387	R36.00	R1 980 110	R20.79	R1 143 549
2015	R96.96	R5 332 580	R175.63	R9 659 844	R42.35	R2 329 458	R47.56	R2 615 936
2016	R210.10	R11 555 242	R306.87	R16 877 777	R142.93	R7 861 403	R169.59	R9 327 594
2017	R232.55	R12 790 179	R348.27	R19 155 043	R152.24	R8 372 962	R201.41	R11 077 674
2018	R255.99	R14 079 640	R391.56	R21 535 624	R161.91	R8 905 186	R234.72	R12 909 429
2019	R280.47	R15425 581	R436.79	R24 023 262	R171.98	R9 458 789	R269.56	R14 825 847
2020	R306.00	R16 830 019	R484.03	R26 621 823	R182.45	R10 034 505	R306.00	R16 830 019

Source: Adapted from Fulat (2011)

After all the revenue was calculated for all three financing options, Promethium performed NPV calculations for each scenario and financing option.

Table 5.13: NPV values

	AGA option	EDF option	Nedbank option
Base case	R43 949 090	R41 102 699	R38 411 379
No global carbon market	R68 635 218	R63 969 849	R55 301 888
Perfect global carbon market	R26 816 915	R25 232 895	R26 689 365
Repeat of 2008 collapse	R34 421 172	R32 276 838	R31 892 278

Source: Adapted from Fulat (2011)

From the information in Table 5.13, it can be concluded that the highest NPV value is under the AGA financing option with the no global carbon market scenario. We know that a carbon market does exist. It is also known that it is unlikely that developed countries will reach their reduction targets of 30% internally with the absence of international trade in carbon offsets. Due to these facts, it will not be the best scenario to use. The second highest NPV value was for AGA to do an internal funding under the base case scenario. If AGA does choose this option, the whole risk associated with the project and registering it as a CDM project will be carried by AGA. If the project is not registered, it is a loss of capital. The next option will be to make use of EDF funding. Promethium recommended that AGA goes with this option (base case scenario with EDF funding), because the risk is partly on the shoulders of EDF. AGA also has no experience in carbon trading, whereas it will then be contracted with EDF and this will reduce the risk associated with the project.

5.7 SUMMARY

It this chapter, we have taken into account the effect that carbon tax, ESCO and carbon credits will have on AGA, a mining company. It is clear that carbon tax will put more pressure on a mining company. The additional cost added to production cost by additional carbon tax will have a negative effect on AGA's comparability to other AGA operations outside SA. Additionally, it will make the current production cost between deep-level mining and open-pit mining even bigger. This may result in AGA closing or selling its SA operations in the future.

ESCO and carbon credits that are sold will help AGA to reduce the effect that carbon tax will have on the company. ESCO will improve the electricity efficiency and in doing that the electricity cost will be reduced leading to a reduction in carbon tax.

The Vaal River compressed air energy efficiency improvement project will also help to improve energy efficiency. By reducing the energy consumption, it will also participate in the carbon tax reduction. This project will do more than just help to improve energy efficiency and reduce carbon tax; it will also bring in money. The money generated from the selling of the carbon credits will be utilised towards more energy saving projects (Greyling, 2011). The next chapter will present the conclusions and recommendations of the study.

CHAPTER 6

6 CONCLUSIONS AND RECOMMENDATIONS

6.1 INTRODUCTION

The aim of this case study was to evaluate the feasibility of a carbon reduction project in the mining industry.

The secondary objectives as provided in Chapter 1 (section 1.3, p. 5) were as follows:

- To discuss the history behind carbon reducing projects and the earning of carbon credits. Furthermore, to identify the criteria to register a project as a CDM project;
- To conceptualise capital investment appraisal techniques from the literature;
- To ascertain whether the Vaal River compressed air energy efficiency improvement project meets the registration criteria as set by the CDM;
- To investigate whether the best financing option is utilised by AGA to finance the registration of the project;
- To compare the methods of trading carbon credits to determine the most beneficial method; and
- To investigate how the funds earned through the carbon trading by AGA can be optimised.

The conclusions and recommendations provided in this chapter are based on the literature reviewed in Chapter 3 and 4 and the data analysed in Chapter 5, in order to meet the objectives set out in Chapter 1 (section 1.3, p.5). Furthermore, recommendations will be made on the feasibility of a carbon reduction project, namely the Vaal River compressed air energy efficiency improvement project in the mining industry.

This chapter will draw conclusions on each secondary objective set and recommendations will be made. The chapter will conclude with the limitations of the study as well as highlighting areas for further research.

6.2 SUMMARY OF RESEARCH CONCLUSIONS AND RECOMMENDATIONS

Each of the secondary objectives and the conclusions and recommendations thereof will now be discussed.

6.2.1 The history of CDM projects and the criteria to register a project as a CDM project

In registering a project as an official CDM project, the following process needs to be followed:

1. A PIN (Project Idea Note) must be created. This document provides an overview of the project, including information on anticipated emission reduction, the project's contribution to the sustainable development as well as the provision of a preliminary overview of the financials of the project.
2. The PDD (Project Design Document) must be developed. This document must include a detailed description of the proposed project, an approved baseline and a project application. The PDD must then be submitted for approval at the Designated National Authority (in South Africa).
3. AGA will be registering the project under the Small Scale Methodology (AMS II.D – Version 2) and, for this registration, the following criteria need to be met:
   - (a) This category comprises any energy efficiency and fuel switching measures implemented at a single or several industrial or mining and mineral production facility(ies).
   - (b) This category covers project activities aimed primarily at energy efficiency.
   - (c) A project activity that involves primarily fuel switching falls into category III.B.
   - (d) The measures may replace, modify or retrofit existing facilities or be installed in a new facility.

(e) This category is applicable to project activities where it is possible to directly measure and record the energy use within the project boundary (e.g. electricity and/or fossil fuel consumption).

(f) This category is applicable to project activities where the impact of the measures implemented (improvements in energy efficiency) by the project activity can be clearly distinguished from changes in energy use due to other variables not influenced by the project activity (signal-to-noise ratio).

(g) The aggregate energy savings of a single project (inclusive of a single facility or several facilities) may not exceed the equivalent of $60GWh_e$ per year. A total saving of $60GWh_e$ per year is equivalent to a maximal saving of $180GWh_{th}$ per year in fuel input.

6.2.2 Ascertaining whether the Vaal River compressed air energy efficiency improvement project will meet the registration criteria

This conclusion will be discussed in the same sequence as section 6.2.1.

1. Is the **PIN document** completed? The Vaal River compressed air energy efficiency improvement project does have a complete set of documentation stating the overview of the project. This document provides an overview of the emission reduction targets (55 000 tons of CO_2). The contribution that the project will make towards sustainable development will be to relocate the VK100 compressor providing AGA the opportunity to have more control over the capacity of the ring, resulting in fewer compressors used.
2. A document with a detailed description of the Vaal River compressed air energy efficiency improvement project, including the baseline, was provided. These documents can be handed in as part of AGA's application for the project to be registered as a CDM project.
3. Small Scale Methodology includes:

(a) The project is an energy efficiency project implemented at a mining facility.

(b) The project is an energy efficiency project.

(c) The project does not involve fuel switching.

(d) The project involves the retrofit of an existing facility.

(e) The power used by the Vaal River compressed air ring can be directly measured.

(f) The compressed air ring is currently being monitored. The project expects a power saving of 18% against the historic energy consumption of all the compressor houses on the ring.

(g) The energy saving of the project will be 6.9MW, resulting in an annual reduction of 54GWh_e.

The recommendation therefore is, taking all of the above into consideration, that it is clear that all the information for a PIN and PDD document is provided and that the project does meet the criteria and requirements to be registered as a Small Scale Methodology CDM project.

6.2.3 Investigating the best financing option to register the project

The third objective was to investigate the best financing option when registering the project.

The VK100 compressor relocation cost and the installation of the VK100 compressor will be for AGA's account. AGA will also be responsible for the upgrading of the two 15MW compressors at Kopanang.

Registering the project as a CDM Project will include the following cost:

PDD cost	R350 000
Validation cost	R341 863
Registration fee	R66 500
Contingency cost	R41 637
Total cost	R800 000

R800 000 is the cost that will have to be financed. AGA has three options for financing this cost: (a) Fund the project internally and then take all the risk associated with the project on themselves, (b) EDF pays for the CDM registration, or (c) Nedbank pays the CDM registration as an upfront payment. The detailed NPV calculations with four different scenarios on all three the options were shown in Chapter 5. The four scenarios used were: (i) Base case, (ii) no global carbon market, (iii) perfect global carbon market, and (iv) repeat of 2008 financial collapse in 2012. Detail of all four scenarios can be found in Chapter 5.

The option described as no global carbon market has the highest NPV calculation result, but the "no global carbon market option" is defined as the case where the assumption is made that the developed countries will reach their reduction targets of 30% internally, with the absence of international trade in carbon offsets. This is very unlikely to happen and for this reason it is not the best scenario to use. Therefore, the second highest NPV resulted out of the base case, providing a more realistic picture of the project.

In the base case calculations, the following NPVs were calculated:

- AGA funds the project internally: R43 949 090
- EDF pays CDM registration: R41 102 699
- Nedbank pays CDM registration: R38 411 379

From the NPV calculations performed, the highest value results were from the AGA self-funding option. However, if AGA makes use of the self-funding option, the total risk will be with AGA. The NPV calculated for AGA internally funding the project is R43 949 090. This result is only R2,8 million more than the NPV calculated making use of the EDF option (R41 102 699).

It would therefore be recommended that AGA should make use of the EDF option, leaving the risk with EDF while AGA will receive 88% of the market price for their CERs.

6.2.4 Determining the most beneficial carbon credit trading method

If AGA makes use of the self-funding option mentioned in 6.2.3, they have the option to sell the carbon credits to any party at the price determined by them. If making use of any of the other two options (i) EDF pays for the CDM registrations, or (ii) Nedbank pays the CDM registration as an upfront payment, with the funding contract including the carbon credit sale. The recommendation can be made that, because AGA has not previously been exposed to carbon credits, sales are still unknown to AGA and, for this reason, it may be a better option to make use of the EDF funding option; in other words, selling the carbon credits to EDF.

6.2.5 Optimising funds earned from carbon trading

After the carbon credits are sold and AGA receives the revenue for the sale, the funds will be available to invest in more energy efficiency improvement projects.

6.3 LIMITATIONS AND SHORTCOMINGS OF THE STUDY

Most of the information used in the case study was collected during interviews conducted with key AGA personnel involved in the project. Information collected during interviews is likely to contain opinions and therefore may not be the most accurate data collection method. Due to this study being a case study, not all the recommendations can be generalised. However, the literature collected in Chapter 3 can be used by any mining company interested in registering carbon reducing projects.

Taking the shortcomings into account, consideration will be given to areas identified for further research.

6.4 AREAS OF FURTHER RESEARCH

Results from this study were from the gold-mining industry. Similar studies can be performed on other mining sectors (platinum, coal etc.). This may also be a worthwhile study to conduct on other industries in the production sector.

6.5 SUMMARY

The main research objective was to evaluate the feasibility of a carbon reduction project in the mining industry. The aim was to meet the main objective by firstly drawing conclusions on the secondary objectives as set out in sections 6.2.1 to 6.2.5. After considering both the literature review presented in Chapters 3 and 4 and the case study presented in Chapter 5, the conclusion can be reached that a carbon reduction project is feasible in the mining industry.

As mentioned in Chapter 1 (section 1.1.1, p. 3), global warming (an increase in the average temperature of the earth's lower atmosphere) is a result of human intervention. Human intervention has led to the increase in GHG emissions. Limiting the emissions will reduce the effect of global warming. In 1992 (at the UNFCCC), all the Annex 1 countries committed to a stabilisation target for carbon dioxide and other GHG emissions. Even though, South Africa is not part of the Annex 1 countries, it still has its role to play in limiting the impact of global warming by reducing GHG emissions. The South African government is in the process of implementing carbon tax to try and reduce the carbon emissions in SA. They have also implemented ESCOs as well as carbon credits.

The carbon credits that were implemented by the CDM under the Kyoto Protocol can be sold to other countries or companies, as discussed in Chapter 5 (section 5.4, p. 58). From the empirical study, it is clear that AGA will be able to register the Vaal River compressed air energy efficiency improvement project as a CDM project and the project will be able to earn carbon credits.

AGA has three different financing options. The financing of the project registration will be combined with the sale of the carbon credits. A portion of the profit on the carbon credit sale will be used to repay the financing of the project. The three financing options as mentioned in Chapter 5 (section 5.6, p. 68) are (i) AGA funds the project internally, (ii) EDF pays for the CDM registration, and (iii) Nedbank pays the CDM registration as an upfront payment. Options (ii) and (iii) are only for the registration cost of the project. Promethium has made use of four scenarios for each of the three financing options, i.e. (i) the base case (using carbon credit market price as at the time of the NPV calculations), (ii) no global carbon market, (iii) the perfect global carbon market, and (iv) repeat of the 2008 collapse (the collapse in the international economy).

From of the information presented in Chapter 5, it was evident that the highest NPV is with the option of AGA internally funding the project. If AGA does an internal funding, the total risk associated with the project stays with AGA. If the project is not registered, it is capital that is lost.

Taking this into consideration, the recommendation was made that AGA should make use of the option that EDF pays the CDM registration. The risk associated with the project will be with EDF, and AGA will only lose 40% of the registration cost if the project is not registered and they will still receive 88% of the CER price per CER sold.

Carbon tax will also contribute to an increase in production cost; with a carbon reduction project such as the Vaal River compressed air energy efficiency improvement project, you will also reduce your carbon tax, thereby reducing the effect that carbon tax will have on your costs.

It can therefore be concluded that a carbon reduction project is feasible in the mining industry and thereby the main and secondary objectives of the study were reached.

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