GENERIC FINANCIAL VALUATION OF METHANE EXTRACTION FROM SOUTH AFRICAN COALMINES WITH REGARD TO THE CLEAN DEVELOPMENT MECHANISM OF THE KYOTO PROTOCOL

G.F. LINDE **MAGISTER SCIENTAE**

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Supervisor: **Prof. A.B. de Villiers**

Co-Supervisor: **Prof. T. Eloff**

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Abstract

During December 1997, 160 countries reached a historical agreement on limiting greenhouse gas (GHG) emissions in Kyoto Japan. In comparison with the United Nations Framework Convention on Climate Change (UNFCCC) at the Earth Summit in June 1992 that only committed Annex I countries to "aim" to stabilise emissions of carbon dioxide and other GHG's at 10 % below their 1990 levels by 2012.

The Clean Development Mechanism (CDM) was developed to include developing countries in the final convention while protecting their potential for economic growth and enabling them to commit themselves to emissions reductions on a voluntary basis. The CDM is a clean technology or financial transfer to a developing country. An international institution must validate this transfer, linked to a project contributing to the global effort, in order to obtain emission reduction credits in exchange.

One of the main purposes of the CDM is to assist developing countries in sustainable development.

The importance of the South African coal industry is unquestionable. Not only does the South African coal mining industry provide South Africa with a core energy source but also with important externally gained revenues. Coal is becoming a less accepted form of energy due to its impact on the environment.

The coal mining industry in South Africa could offer Annex I countries and companies a cost effective way of achieving certified emission targets (CER's) by investing in coal bed methane abatement projects. This will bring to South Africa cleaner technologies and financial support with the main focus on environmental improvement. It will also improve the environmental reputation of the coal mining industry in South Africa that might have added financial benefits for the industry.

A number of variables influence the viability of methane extraction from South African coalmines. This can be expected as the economics of climate change is still evolving.

The most influencing variables on the viability of methane extraction are risk based. Political and financial risk will always influence decision-making on CDM investment in Non-annex I countries.

Putting a price on greenhouse emissions will put more of a focus on energy input into processes. Those who are inefficient in energy use will pay more, those who are efficient in energy use will save.

The price on methane emissions from coalmines will tend to favour those producers who tend to have a more holistic view to the resources they are exploiting. Financial costs of recovering coal bed methane might be problem today, but keep an open mind because the situation is likely to change rapidly in coming years.

Advise to the coalmine industry in South Africa is to see the opportunities of the Kyoto Protocol as a "No Regret" option. South African coalmines should assess their potential methane volumes that can be extracted, the potential value and cost of capturing methane and coalmines should follow market trends in GHG trading.

As the CDM develops, a number of major projects will probably proof especially profitable, but only the first Annex I investors will be able to take advantage of them. These opportunities will have to be snatched up quickly. A "jam effect" may develop thereafter, once the use of this mechanism (theoretically the most beneficial) has become widespread. Methane emission CDM projects on South African coalmines offer opportunities for Annex I countries in achieving CER's.

GHG's as a commodity will change the way that we think about business.

List of Abbreviations

CDM	Clean Development Mechanism
CER	Certified Emission Reduction
COP	Conference of Parties
ER	Emission Reduction
ERU	Emission Reduction Unit
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GWP	Global Warming Potential
IPCC	International Panel on Climate Change
JI	Joint Implementation
NEPA	National Environmental Protection Agency
OECD	Organisation for Economic Co-Operation and Development
UNFCCC	United Nations Framework Convention on Climate Change
U.S.	United States

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1 Introduction

The United Nations Framework Convention on Climate Change (UNFCCC) 1992 came into force in 1994. The Parties to the Convention were divided into two groups, namely Annex I Parties (also known as Annex B parties), and non-Annex I Parties. The Annex I Parties include the countries that were members of the Organisation for Economic Co-Operation and Development (OECD) at the time they signed the Convention, as well as countries that were classified as having economies in transition at the time, countries such as Russia, other Eastern and Central European countries. The remaining Parties to the Convention are then classified as Non-Annex I Parties, basically all of them developing countries like South Africa (Hasselknippe and Hoibye, 2001:4).

"During December 1997, 160 countries reached a historical agreement on limiting greenhouse gas emissions in Kyoto Japan. In comparison with the UNFCCC at the Earth Summit in June 1992 that only committed Annex 1 Parties to "aim" to stabilise emissions of carbon dioxide and other greenhouse gases at 10% below their 1990 levels by 2012, the so-called Kyoto Protocol sets legally binding emissions targets and timetables for these countries. Together they must reduce their emissions of six greenhouse gases by at least 5% below 1990 levels over the commitment period 2008-2012" (Zhang, 1998:2).

Article 3 and Annex A of the Protocol specify its coverage in terms of different gases. In 1990 the total greenhouse gas (GHG) emissions from Annex I countries was given to be about 18 billion tons CO_2 equivalents (United Nations FCCC/CP/1998/11/Add.2). This means that the overall Annex I commitment according to the Kyoto Protocol (i.e. the total annual average for the period 2008-2012) is about 17 billion tons CO_2 equivalents. The CO_2 equivalents are calculated from the emissions of the six main greenhouse gases: *carbon dioxide* (CO_2), *methane* (CH_4), *nitrous oxide* (N_2O), *hydro-fluorocarbons* (HFCs), *per-fluorcarbons* (PFCs), and *sulphur hexafluoride* (SF_6). To each greenhouse gas there is a conversion factor that is used to convert to CO_2 equivalents.

The Clean Development Mechanism (CDM) was developed to include developing countries in the final convention while protecting their potential for economic growth and enabling them to commit themselves to emissions reductions on a voluntary basis. The CDM entails a clean technology or financial transfer to a developing country. An international institution must validate this transfer, linked to a project contributing to the global effort, in order to obtain emission reduction credits in exchange.

South Africa is sensitive to climate change, and contributed about 1.2% to global warming in 1990 (Scholes *et al,* --).

South Africa has an energy intensive economy. Our economy is dependent on the mining and manufacturing industries. The environmental impact of secondary economic activities such as mining and manufacturing is usually more significant than the impacts of tertiary economic activities such as the financial services industry.

Although South Africa has been classified, as a Non-Annex I Party, our atmospheric emission to the atmosphere is comparative with that of the Annex I grouped Parties. This reconfirms how energy intensive the South African economy is.

A global awareness of environmental protection has emerged over the past few decades. Sampson (2000:1-3) states that the concentrated development of environmental laws over the past ten years has placed South Africa arguably on par with many developed countries. It is the opinion of these authors that growth in corporate governance has also increased the awareness of environmental protection within companies. The Intergovernmental Panel on Climate Change (IPCC) has reported that the balance of evidence suggests a discernible human influence on global climate and as such has called on countries to ratify the Kyoto Protocol.

Coal and coal mining has recently come under the spotlight of the global community as coal is said to be one of the dirtiest forms of energy. Dunn (1999:16) states that while the market price for coal was $32 per ton in 1998, when environmental and health disruptions are factored into the equation, coal is not as cheap as it may seem. It is true that a number of people are questioning coal, as a solution to the world's future energy needs.

With the emergence of the Kyoto Protocol, coal mines has even come more under environmental pressure due to methane releases (during mining) and carbon emitted from the combustion of coal.

International environmental pressure on coal as one of the most environmental destructive forms of energy is growing to make coal a less acceptable form of energy. Mbendi, (2002) suggests that South Africa is the world's third largest exporter of coal, mainly to Europe, which is the world's biggest supporter of the Kyoto Protocol. The coal mining industry in South Africa could face a difficult financial future because countries that have ratified the Kyoto Protocol could decide to import coal from "environmental friendlier" suppliers or to minimise the use of coal. This will influence the South African economy because the coal industry in South Africa contributes significantly to the Gross Domestic Product (GDP) of South Africa.

Cantor Fitzgerald and PricewaterhouseCoopers (2002) describe a number of steps that could be followed by a company interested in emission trading. The steps proposed by Cantor Fitzgerald and PricewaterhouseCoopers are:

- Determine emission baselines based on 1990 emissions. The amount of emission released into the atmosphere should be reduced by 10% based on the 1990 emission benchmark of the company. This is only applicable to Annex 1 countries and companies. Non- annex 1 countries that get involved in emission trading through the CDM should also determine their emission baseline as improvements in emission releases should be measurable and verifiable before CER's can be awarded and verified;
- Understand the industry in which the investing company would like to invest by doing an economic and social overview of the industry and identify potential

environmental improvements that could yield CER's. It is important to remember that one of the main objectives of the CDM is to help foster sustainable development in the host country;

- Understand the emission trading principles;
- Define the emission management strategy;
- Develop a emission reduction strategy in the Non-annex I country/company (for CDM projects);
- Monitor and verify emission reductions. An external party should verify emission reductions achieved in the Non-annex I company (CDM project) before the Annex 1 company can be entitled for CER's;
- Register emission reductions;
- Obtain financial, and legal advice and get insurance on the proposed emissions trading; and
- Enter the market of emissions trading.

The financial valuation of methane extraction in this study is based on a generic, non-site specific investigation. The main contributing factor for this decision is the uncertainty in respect of methane emission factors in geographical areas in South Africa and the lack of emission trading research in the South African context. As at 2000, "a South African paper showed that the bulk of the research on global warming has concerned vulnerability and adaptability to climate change. Although 22% of research into global warming has ostensibly involved policy, only 1% of total research has been economic in focus!" (Leiman, 2000:3).

Coal mining in South Africa in 2001 took place at 26 underground and 15 surface mines.

This study focussed on methane extraction from underground coalmines.

Emission factors (where available) from coalmines are not always published and are in most cases kept confidential.

1.1 Problem Statement

Does the CDM of the Kyoto Protocol hold any viable opportunities for Annex I investors in the South African coal mining industry in the form of viable certified emission reductions (CER's)?

The following specific problem statement questions have been set:

- What is emissions trading, how does the CDM of the Kyoto Protocol enable emission trading between an Annex I party country and an Non-annex I party;
- What CDM design issues should be taken into consideration for selection of CDM projects;
- What is the social and financial value of coal mines in South Africa and why is it important that the life span of South African coal mines be stretched as long as possible to entertain sustainable development;
- What is methane, how is it formed, released into the environment and how does it contribute to global warming;
- How can methane be extracted from coalmines (coal bed methane recovery);
- Is it a viable option for Annex 1 parties to invest in methane mitigation projects in South African coalmines to achieve CER's; and
- What are the risks and consequences for the South African coalmining industry that are interested in engaging in GHG emission trading?

1.2 Objectives

This paper, in general aim to investigate the viability of CDM projects that is focussed on the mitigation (financial or technological transfer) of methane emissions from South African coal mines to achieve CER's.

The following specific objectives are set:

- To give a description of what emission trading is, how the CDM of the Kyoto Protocol enables emission trading between a developed country (Annex 1) and a Non-annex I country;
- To indicate what CDM design issues should be taken into consideration for selection of CDM projects;
- To indicate the what the financial and social importance of the South African coalmining industry is in respect of sustainable development;
- To give a description of what methane is, how it is formed and released into the environment, and why methane emission is an environmental problem;
- To indicate potential methods of methane extraction (coal bed methane drainage) from underground coal mines;
- To indicate what the importance and process of emission data verification is in the whole emission trading concept;
- To give viability opinion on methane abatement cost in South Africa and potential benefits and viability for an Annex 1 country in investing in a South African CDM project; and
- To give an overview of the risks and consequences that the South African coal mining industry faces in respect of emission trading.

1.3 Hypotheses

Methane has been seen in the past as a worse than useless State resource (Latten, 2001: 7). Except for safety purposes, methane emission has not received much research attention until the issue of climate change came to the forefront. However, in South Africa a number of coalmines are still in non-compliance with basic environmental legislation. The viability and opportunities of complex trading systems like the CDM of the Kyoto Protocol is in the opinion of this author not well researched or known by South

African coalmines as most coal mines struggle on a day-to-day basis just complying with basic environmental legislation.

Capital expenditure for methane capturing could be a problem for a number of mines, as methane abatement is not seen as a priority environmental management issue for most coalmines.

1.4 Methodology

A desktop study was performed for all aspects of this study. The majority of documents evaluated and considered for this study were those that were available electronically, and as such presents the latest information on the economic aspects of climate change.

1.5 The Controversy

The Kyoto Protocol has been receiving vast amounts of attention in the past few years especially from the U.S. and Europe.

Politicians, businesses, industries, interest groups and organisations raised their voices for or against the Kyoto Protocol. This is because the Protocol has implications for each of the aforementioned groups. There is a general consensus that limits on greenhouse gas emissions will impact domestic trade, jobs, and consumers. Specifically, the agreement is expected to have significant effects on the mining, chemicals, petroleum refining, paper, iron and steel, aluminium and cement industries (Manne and Richels, 2001).

The impact of the U.S. deciding not to ratify the Kyoto Protocol will mainly affect emission trading in two ways, namely:

- Large reduction of the greenhouse gas market demand, the U.S. had approximately 60% of the greenhouse gas market demand for international reductions. The demand reduction leads to a significant fall in expected market price; and

- The withdrawal of the U.S. increases the market and negotiating power of Russia. Russia now has a market share of more than 50% and can now lead as "price leader" by maximizing revenues and increasing prices significantly (Grutter Consulting, 2002).

2 Emission Trading:

Both Anon (1999:7) and Anon (2001:2) agree that the international emission trading concept is the mechanism introduced by the Kyoto Protocol that permits countries to buy and sell a portion of their designated GHG emissions among themselves or internationally. This mechanism allows countries that have reduced their emissions more than their target, to sell the resulting 'emission credits' to other countries who need them to achieve their target. Its purpose is to help achieve the net global reduction in emissions agreed under the Kyoto Protocol. It is therefore possible for companies, which are allocated allowances for their emissions of greenhouse gases, according to the overall environmental ambitions of their government, to trade with each other in order to meet their commitments. The emission allowances are sometimes called quotas, permits or caps. The total of all these allowances allocated to all the companies included in the scheme represents the overall limit on emissions allowed by the scheme. It is this overall limit that provides the environmental benefit of the scheme. One main attraction of emission trading is that it provides certainty of environmental outcome.

According to the above principle it becomes possible for individual companies to emit more emissions than their allowance. This enables both companies to benefit from the flexibility offered by trading, without disadvantage to the environment (Anon, 1999).

In addition to international emissions trading, emission reduction trading systems can be used within countries to help them meet their targets under the Kyoto Protocol. Such a national trading system would allow industry, governments and organisations to buy and sell emission reductions to help achieve the national target.

Michaels (2001) argues that emission trading is a concept understood in varying agrees among all sectors participating in the climate change negotiations. The goal of emission trading is however simple: Maximise emissions reduction costs efficiently while lowering total emission reductions by a set percentage. Anon (2001:1) describe emission trading as a process when a source of air pollution reduces its emissions and then transfers ownership of the emission reduction to another party. Markets for emission reductions can be created by regulation or voluntary.

Grubb *et al.* (1999:19) argues that the case for a tradable entitlements system is based on the advantages that it would offer over other politically feasible alternatives. In the short term, it offers the possibility of reaching the environmental goals at a lower cost than would be possible if each country were limited to reduction options within its own borders. Making it easier to reach the goals may encourage more countries to sign the Kyoto Protocol and would probably increase compliance with those goals. Because it separates the issue of who pays for control from who implements control, it facilitates trans-boundary cost sharing, an item of particular importance of the developing countries.

Grubb *et al.* (1999:19) argue that tradable entitlements facilitate the development and implementation of innovative approaches to climate change control. It offers greater flexibility in how the emission reductions are achieved (as well as by providing economic incentives for the adoption and use of unconventional approaches). Tradable entitlements can significantly lower the long-term costs. Lower long-term costs may be an important element in gaining greater international acceptance for the idea of emission limits and in reducing the difficulties associated with ensuring compliance. Furthermore, if it becomes desirable to ensure that participants cover the administrative costs of running the system, levying a low annual fee on each entitlement could raise revenue. This revenue could be used for financing technology transfers or for other worthy purpose without jeopardising the cost-effectiveness of the system.

The Kyoto Protocol also accepts the concept of emissions trading under article 17, under which Non-Annex I country is allowed to purchase the rights to emit greenhouse gases from Annex I countries that are able to cut greenhouse gas emissions below their assigned amounts. Although Annex B to the Kyoto Protocol and Annex I to the Convention are now identical in nature, this change from Non- annex I into Annex I potentially allows a developing country to engage in emissions trading if it voluntarily adopts an emissions target and is inscribed in Annex I.

The design of a workable emission-trading scheme is essential to the success of emissions trading. A market-based emissions trading approach can only achieve significant cost reductions in cutting greenhouse gas emissions while also allowing flexibility for reaching compliance if it is structured effectively.

2.1 The Case for Emissions Trading

Emissions trading transforms the "right to emit a pollutant" into a scarce resource by limiting the total allowable emissions of that pollutant. Trading of emission credits can only occur once the environmental goals are met, since penalties for non-compliance are generally more severe than the cost of complying. Enforcement of the legislation is the backbone of any successful GHG market, creating economic incentive for industry to reduce its emissions of a GHG.

Environmental issues are pervading into the scope of business operations with increasing frequency. Clean up expenses, emission reductions, and other compliance issues are cost factors that impact balance sheets across all industries. To stay competitive, individual companies must not only incorporate current environmental standards into their business plans, but also anticipate how future regulations will affect their bottom line.

Pressing into the next century, global warming is potentially the farthest-reaching environmental issue ever debated. Implementation of greenhouse gas legislation will have international impacts. Compliance with greenhouse gas legislation will affect the competitiveness of every energy intensive sector of the world's economy. As a result, a company's ability to comply in a greenhouse gas confined world will be either a competitive advantage or a liability. Those companies that can comply at lower costs will have an operating advantage over those that may have higher compliance costs.

There is much uncertainty regarding greenhouse gas legislation. However, the potential economic risks associated with being unprepared for such legislation are too immense to be ignored. Therefore, acting today to mitigate potential risks associated with greenhouse gas legislation could be a necessary part of a company's operations.

Mandatory reductions in greenhouse gas emissions for Annex 1 companies will come at a price. The ability to emit greenhouse gases would then become a scarce resource, to be managed like all other costs. This potential environmental regulation will undoubtedly change the landscape of international industry. Companies that are able to anticipate the effects of this change will have a competitive advantage over those that fail to adequately prepare. Mitigating some of these risks now will result in reduced liabilities in the future, reducing the impacts of potential greenhouse gas legislation on a company's bottom line.

It is widely accepted that trading emissions should allow an environmental target to be achieved at the least cost to the economy. PricewaterhouseCoopers (1999:9) indicates that the flexibility mechanisms of the Kyoto Protocol could lower the overall cost GHG abatement measures taken. Firms, for whom emissions reductions are cheap, can reduce their emissions and sell those emissions rights to firms who would have to pay more to reduce their greenhouse gas emissions. Trading should be a better way of achieving the world's objectives. Command and control regulation which imposes the same standard on everyone, regardless of the cost they face, or taxation, which just raises the price to everyone, irrespective of whether they have a cheap alternative or not, will not last.

Emission trading will become a precision tool. It is less prescriptive in the methods employed to achieve reductions – but it is underwritten by an obligation to reduce emissions which neither regulations nor taxation can deliver.

Trading is a market mechanism that has considerable appeal because it forces companies to look at what options they have available to reduce their emissions, in a very quantitative way. When markets exist, it makes companies ask themselves why competitors are finding lower cost options than they have found themselves. Trading is a stimulus to bring new technology into practice, because it sets a real cost on emissions and provides market incentives to reduce that cost.

GHG's are particularly appropriate for trading. Unlike other pollutants, where the local impact matters, the impact of greenhouse gases is felt globally and it is the global concentrations of GHG's that must be reduced.

Competition and innovation are promoted by emissions trading markets to develop more efficient, lower cost technologies that reduce emissions. As a result, all known information is reflected in the market price for tradable emission credits, including: fuel switching costs, cost of alternative technologies, internal cost for making reductions, anticipation of additional regulations, etc. The price signals from emissions trading markets allow companies to make better resource planning decisions while promoting economic efficiency.

Emissions trading adjust an industry's economic burden of compliance to the business cycle, while ensuring the desired environmental protection. During a period of economic expansion and increased production, emissions can be expected to rise. As a result, demand for tradable emission credits will increase as will the price for tradable emission credits, since the supply is fixed. Emission trading promotes rational investment decisions in emissions abatement at a time when industry can best afford it. Conversely, periods of economic slowdown result in lower emissions, lower demand for tradable emission credits, lower prices, and lower the economic burden on affected industries.

2.2 Joint Implementation

This possibility was named "joint implementation" (JI) in the negotiations leading to the Rio Conference. JI is currently the most relevant concerning worldwide cost minimisation project-oriented emission reduction credited to the investing country. In 1995, the Berlin Conference of the Parties decided on a pilot phase for JI without crediting called "activities implemented jointly". In 2000, it was decided that actvities implemented jointly would be followed by JI with crediting. The Kyoto Protocol allows JI between Annex I countries (article 6) (Kyoto Protocol: 1997).

JI projects shall be approved by all involved Parties and shall be "supplemental" to domestic actions (article 6 (1d)). The Meeting of the Parties shall define guidelines, verifications and reporting rules (article 6 (1c)). Emission reduction units (ERU's) created through joint implementation under article 6 are treated in the same way as those from emission trading under article 17 (article 3 (10, 11)). Emission reduction units from JI do not accrue if inventories are not submitted annually or do not use the agreed guidelines (article 5 and 7). Emission reduction units questioned through expert teams may be transferred but are "frozen" until the question is resolve (article 6 (4)) (Kyoto Protocol: 1997).

2.3 Clean Development Mechanism

The CDM is one of several "flexibility mechanisms" authorized in the December 1997 Kyoto Protocol to the 1992 UNFCCC, signed at the Rio de Janeiro "Earth Summit".

Article 12 of the Kyoto Protocol identifies three specific goals for the CDM:

- To assist in the achievement of sustainable development;
- To contribute to the attainment of the environmental goals of the Framework Convention; and
- To assist Annex B (Annex 1) parties in complying with their emissions reduction commitments (Kyoto Protocol, 1997).

In particular, Article 12 specifies that developing countries are to benefit from CDM projects resulting in and that industrialised countries may use CER's to comply with their quantified emissions reduction commitments under the Kyoto Protocol. Essentially, this allows for voluntary projects similar to previous JI projects between Annex 1 and non-Annex 1 parties. The difference is that unlike previous JI projects, CER's are specifically authorised to apply to Annex I emissions reduction targets.

The CDM leads to the creation of "certified emission reductions" (CER's) (article 3 (12)). Article 12 (3) states that countries that fund projects through the CDM get credit for certified emission reductions from these projects provided benefits accrue to the host country (article 12 (3a)). Crediting shall be only allowed until a certain percentage of the emission target, which remains to be defined, is reached (article 12 (3b)). It is unclear whether crediting up to this quota is in full or only partial. Besides countries, companies are allowed to invest in, and execute projects (article 12 (9)). In contrast to the other flexibility mechanisms, CER's accrue for the whole period 2000-2012, not just for the commitment period (article 12 (10)). The CDM should cover its administrative budget through project revenues. Moreover, a part of these revenues shall be used "to assist developing country Parties that are particularly vulnerable to the adverse effects of climate change to meet the costs of adoption" (article 12 (8)). It remains open as to who carries out certification of emission reductions but independent bodies shall be responsible for carrying out verification (article 12 (7)). The project criteria remain the same as for activities implemented jointly (article 12 (5)) (Kyoto Protocol, 1997).

The CDM is also intended to be an opportunity for developing countries that did not accept binding emissions reductions at Kyoto to be involved in greenhouse gas mitigation.

Article 12 establishes three bodies to oversee the CDM:

- The representatives of the Conference of Parties (COP);
- An executive board established by the COP; and
- Independent auditors to verify project activities (Kyoto Protocol, 1997).

2.4 CDM Design Issues

Toman and Cazorla (2000) give a comprehensive overview and argument on CDM design issues. The authors stipulate that in order for CER's to be created from CDM projects, a number of overlapping technical, regulatory, project finance and administrative functions must be performed. Before any CDM project can be established, there must be demand for CDM projects and CER's. Specific concern is raised about developing countries' uneven bargaining positions during project contract negotiations, and this issue must be addressed; liability must be assigned, insurance procured; project financing must be obtained; and the benefits of projects must be allocated among participants. It is important to bear in mind that the CDM is a form of market, one in which valuable goods and services are to be bought and sold. Private markets could most effectively undertake most of these functions or existing international institutions. Montgomery *et al* (1999:32) is less opportunistic about the CDM, indicating that the CDM is likely to have few of the benefits of global trading because it fails to correct price distortions and trade impacts and imposes large transaction costs and fees.

2.4.1 Criteria for selection of projects.

CDM projects must fulfil certain criteria in order to be certified upon completion. Possible criteria include:

- The method or extent of technology transfer;
- Specific performance or design standards for transferred technology;
- Capacity and willingness of both national and local governments to host the project;
- Existence and nature of agreements for sharing project benefits (CER's and financial returns) and project liability between investor and host; and
- Limits on local environmental or other social impacts such as employment.

A particularly important question is what criteria might be established for determining sustainable development and other benefits for host countries, as this is one of the most important objectives of the Kyoto (Toman and Cazorla, 2000).

2.4.2 Project review and CER calculation (before implementation).

The baseline or previous amount of carbon emissions from the project facility or area in question must be established before project initiation. The baseline is used to show that purported greenhouse gas reductions are "additional" to what otherwise would have occurred. One practical question that arises in assessing additionality is the issue of "project leakage" – when a particular project lowers emissions, but emissions rise in other parts of the host country economy (or elsewhere).

A variety of options for defining project-level baselines to assess additionality exist. These include detailed project-level review of projected emissions with and without the project, and streamlined formula-based approaches that estimate emission reductions based on easily observed project characteristics (for example, conversion of a coal power plant to natural gas). Another approach would involve the host country establishing and enforcing "top-down" national or sectoral baselines in an effort to limit leakage, and then assigning shares of the baseline to different emission sources much as emission allowances are allocated in the U.S. program for sulphur dioxide trading among power plants. In this case the validity of the CER's generated from a specific project would depend in part on overall sectoral emissions (Toman and Carzola, 2000).

2.4.3 Project monitoring and CER assessment (after implementation).

Toman and Carzola (2000) raises a concern regarding the issue of additionality as technical questions arise on how to measure, monitor and verify the outcomes of individual projects. Both emission reduction and carbon sequestration projects pose their own measurement and monitoring challenges. Some independent entity must intermittently monitor the emissions or sequestration of the project in order to ensure that the benefits of the project accrue over time as represented by project participants. In turn, standards for the accreditation of the certifiers are needed in order to ensure certifier objectivity and credibility. The verification of achieved emission reductions is critical in the GHG trading process, as this will ensure credibility.

2.4.4 Rules for CER validity and project liability.

Montgomery *et al,* (1999:33) provides a risky scenario indicating that participants to the CDM projects should demonstrate that their projects will lead to emission reductions that would not otherwise occur. Limits on the information available to administrators to enforce this requirement may lead them to reject projects that would be pursued under full emissions trading or accept projects that would be pursued even under business-as-usual conditions. It is therefore important that rules be put in place to ensure project validity. To ensure that CER's are credible, there must be rules defining when CER's can be used and assigning legal responsibility in the event that a CDM project is found not to generate the amount of emission reduction promised (either because of misrepresentation before the fact or less than expected performance after the fact). Liability is of less concern if CER's can be used only after an independent (and honest) auditor has certified their existence. If this were the case, prospective credits would be held in abeyance between certifications; the project participants would have to trade off the value of more rapid certification against the cost. If, however, credits can be used in advance of certification, as is the case in some U.S. emission credit trading programs, then questions of after-the-fact liability do arise. Under the Kyoto Protocol, Annex I countries have ultimate responsibility for non-compliance if credits are disallowed. In practice, the assignment of liability to Annex I investors/CER buyers is likely to be efficient since buyers have a financial and reputation stake in CDM projects, possess the resources for effective project oversight, and face enforceable emission ceilings in their own countries. CER's could be transferred to subsequent purchasers without reassignment of liability in order to protect incentives for trading (Toman and Cazorla, 2000).

2.4.5 Marketing, information, financing, and insurance services.

Montgomery *et al*, (1999:10) argue that the potential distortions in international trade that could result from attempts to meet the Kyoto Protocol targets without a comprehensive, global emission trading system are significant, due to the growing interdependence of among the world's economies. This opinion is confirmed by Toman and Cazorla (2000), if the CER market is designed reasonably well, most prospective investors are likely and will be able to have access to market financing for well-designed CDM projects. In some cases, however, institutions like the World Bank will have to provide assistance in identifying and providing financing. Insurance against project failure is another important financial or brokerage service due to associated risk in the project, which again could be provided by the private sector or in some cases by multilateral institutions. Market institutions need to be developed for facilitating transactions in CER's as well as "derivative" transactions, such as options to buy or sell CER's in the future. These institutions would serve as a clearinghouse for secondary trades by matching buyers and sellers, and could also be a repository for "banked" or unused CER's. Such institutions would also facilitate exchanges between CER's and emission permits emerging from Annex I trading (Toman and Carzola, 2000).

2.4.6 Providing negotiating support for Non-annex I countries.

Toman and Carzola (2000) indicates that some developing countries might avoid participation in CDM projects out of fear of possible exploitation by investors due to lack of capacity to negotiate fair contracts. These countries are concerned about the relationship between the CDM and international development assistance, the under-development of the private sector in some developing countries, the lack of developing country capacity to monitor and verify projects independently, and the possibility that investors will take advantage of their lack of technical expertise in project evaluation. The CDM or other institutions could assist by providing access to experienced negotiators and offering training or capacity-building services. However, undertaking these tasks requires a resolution of potential conflicts of interest among the roles of project promoter, host country advocate, and neutral market supporter.

2.4.7 CDM fund administration.

Article 12(8) stipulates that "a share of proceeds from certified project activities [should be] used to cover administrative expenses as well as to assist developing country Parties that are particularly vulnerable to the adverse effects of climate change to meet the costs of adaptation" (Kyoto Protocol, 1997).

It is uncertain how funds will be raised and is of particular interest. If the funding mechanism is based on the proceeds of the project (either direct financial payment or diversion of a share of CER's to a central fund), then in negotiation investors will reduce their willingness to provide benefits to the host country accordingly in order to ensure that the net return on the project remains commensurate with other rates of return throughout the global capital market. In this case the CDM fund would simply be redistributing proceeds among Non-annex I countries. An alternative would be to levy a fixed annual registration fee on any investor interested in being eligible for participation in the CDM.

2.4.8 Key Decisions on CDM Structure and Function

Toman and Corzola, (2000) indicates that there are several ways that the CDM could be structured to address project selection, finance and implementation. The CDM could be more centralised and active in CER market operation, playing a role similar to that of the World Bank or the Global Environment Facility (GEF) in screening, selecting, financing, and assisting in implementation of projects. The CDM also could be a market maker, seeking out host countries from whom to acquire credits and reselling them. However, a key question with a more centralised alternative is the extent to which the CDM would have a comparative advantage in carrying out all these functions, especially if by international agreement it became the only entity eligible to carry out these various.

Another alternative would be very similar to JI, in which an industrialised country and a developing country agree to collaborate on a CDM project, which is later, certified by an independent auditor. This arrangement would imply a much smaller role for the CDM, one mostly involving definition of basic criteria for project selection and implementation, general oversight of audits and recording of CER exchanges. This system likely is the most dynamic and flexible, with individual actors in the market (investors, financiers, and others) defining the functioning of the CER market through "learning by doing." How successful this approach would be in terms of accountability would depend on the criteria used for project selection and implementation and the quality of oversight applied.

"There is a broad debate over the issue of "supplementarity." The Kyoto Protocol refers to the use of international emissions trading (and by extension the CDM) as being "supplemental" to domestic actions. Supplementarity constraints reflect a concern by some Annex I countries that participation in international flexibility mechanisms will limit the scope and stringency of domestic policies, thus retarding the long-term development of technology and improved energy efficiency needed to achieve and go beyond the Kyoto goals. The other side of that argument is that limits on trading and CDM are blunt instruments to improve the credibility of a nation's commitment to the Kyoto Protocol, and that by increasing the overall cost of compliance with the Protocol the restrictions also contribute to lack of willingness to achieve the target reductions" (Toman and Cazorla, 2000).

Montgomery *et al* (1999:32), describe that one of the obstacles of the CDM could be the CDM itself because the CDM's presence can be used as an excuse to avoid commitments to global trading system. There will be strong political forces in play that could cause siphoning of the benefits of projects or distribution of funds based not on cost effectiveness of projects but on which nations feel they deserve a share of the funds. The risk is that political, rather than economic, forces will govern most of the CDM projects.

2.5 General Rules on Emission Targets

Grubb (1999:20) states that the 1992 UNFCCC recognises the principle of global cost-effectiveness of emission reduction in article 3 and has thus opened the way for flexibility. As it did not fix a binding emission target for any country, the need to invest in emission reduction either at home or abroad was not pressing.

In December 1997, industrial countries and countries with economies in transition agreed to legally binding emission targets at the Kyoto Conference and negotiated a legal framework as a protocol to the Convention- the Kyoto Protocol (Grubb, 1999:20). Article 3 of the Kyoto Protocol defines the five-year commitment period (2008-2012) in which the emission targets that are set out in Annex I for individual countries have to be reached. Article 3 of the Kyoto Protocol also stipulates that by 2005, Annex I Parties "shall have made demonstrable progress in achieving its commitments". Together, Annex I countries must reduce their emissions of six greenhouse gases by at least 5 per cent below 1990 level's over the commitment period. The cover a basket of six greenhouse gases by at greenhouse gases listed in Annex A: carbon dioxide, methane, nitrous oxide, hydro fluorocarbons, per fluorocarbons and sulphur hexafluoride (Kyoto Protocol, 1997).

If emissions during the commitment period are lower than the target, the difference may be banked for the next commitment period (article 3 (13)).

3 An overview of the Social and Economic Importance of South African Coal Mining Industry

The importance of the South African coal industry is unquestionable. Not only does the South African coal mining industry provide South Africa with a core energy source but also with important externally gained revenues. South Africa has been identified as the country most dependent on coal for its energy (78%) and electricity needs (93%) in comparison with all other countries in the world (Dunn, 1999:12). The coal mining industry in South Africa is one of the pillars of the South African economy. "South Africa's coal industry is the second biggest mining sector after gold" (Mbendi, 2002). In recent times the global coal industry globally has had it difficult with trading. Environmental matters contributed to this reduction in the demand of coal. Kilani (2001:6) classified "The future of coal as a major fuel source" as a potential challenge and threat for South Africa as environmental pressure is mounting to ban the use of coal due to its severe environmental impacts.

It is the opinion of this author that coal should be optimally used in South Africa, converting the negative environmental reputation that coal has into a reputation as a cleaner energy source on which our economy and energy needs are dependent.

The South African community and economy cannot afford the South African coal industry to gain an even worse reputation in respect of its environmental responsibilities. All viable options to improve the well-being of South African coal mines should be investigated to ensure that South Africa can gain as much as possible financially from coal mining. The CDM might benefit the minimisation of environmental pollution, the CDM might have hidden benefits for the South African economy in that it might enhance the environmental reputation of South African coalmines and therefore might become (or stay) a first choice supplier to environmentally aware countries such as Europe. Financial and technological benefits could also flow out of the CDM emission trading.

In order to transform the reputation of the coal mining industry, coal-mining leaders should strategically introduce cleaner technologies and expand and investigate opportunities such as methane extraction and containment that might have financial value under the CDM of the Kyoto Protocol.

3.1 The Financial Importance of the Coal Mining Industry in South Africa

Anon (2000:1) confirms that the coal mining industry is South Africa's second-largest mining sector, with total sales value exceeding R17, 5 billion in the fiscal year of 1999. In 2000 with sales contributed 20% (R20 billion in 2000) to South Africa's mineral sales and 4% to the GDP (Mbendi, 2002).

This author also states that if compared to the gold industry, coalmines increased their importance within the mining industry, especially in terms of its contribution to the GDP. Saleable coal production increased by almost 4 percent a year since 1990 to 225 million tons in 1998

"South Africa is said to be the world's second largest coal exporter, after Australia, as well as second lowest cost producer, after Indonesia. Approximately 69 Mt of coal was exported in 2000 out of a total production of 225 Mt. Bituminous or steam coal remains South Africa's main export coal (at 69 Mt in 2000), with anthracite having to be imported, due to diminishing reserves" (Mbendi 2002). Export volumes of coal showed a strong upward trend with exports exceeding 66 million tons in 1998, compared to only 31 million tons in 1983. The price of coal has however declined significantly during the past few years. This is forcing the coal mining industry to focus on improved and more cost effective mining methods.

“60% of South Africa's coal exports are currently destined for the European market. Most of the coal produced is consumed locally, with the power generation using 41% of total production” (Mbendi, 2002).

“South African exports grew over the last few years due to new markets being established in Argentina and Brazil” (Mbendi, 2002)

Kilani (20--: 6) identified South Africa as being the country second most dependent on coal for electricity generation. South Africa has a dependency of 93% on coal for electricity generation while Poland has a 95% dependency on coal for electricity generation. Kilani (20--: 7) also state South Africa (59.5 Mt) to be the third largest exporter of coal after Australia (140.4 Mt) and the U.S. (83.0 Mt) during 1996.

If compared to the gold industry, coalmines increased their importance within the mining industry, especially in terms of its contribution to the GDP.

3.2 The Social Importance of the Coal Mining Industry in South Africa

The coal-mining sector employed more than 60 000 employees for the year 1998. Within the mining industry coalmines contributed some 22% to the gross domestic product (GDP), 16,5% to mineral exports and 13% to job creation during 1998. The total remuneration for employees at coal mines amounted to R3,5 billion in 1998 (Anon, 2001:1).

“Due to the strong linkages with suppliers of goods and services, the coal industry sustains more than 165 000 indirect job opportunities in the South African economy” (Anon, 2000:1). Anon (2001:1) states that the decline in the number of employees between 1990 and 1994 was largely a result of the industry’s continued shift to increased mine mechanisation, skills development and opencast mining operations entailing higher capital intensity.

3.3 Potential Challenges and Threats for the Coalmining Industry

"Those who advocate increasing the use of coal to replace dwindling oil supplies must note that its use will either increase pollution or result in vastly increased costs in future" (Anon, 2001:2).

Dunn (1999:11) argues the fuel (coal) that ushered in the industrial revolution still burns, but that a new era beckons in energy choices. Anon (2000:3) is of the opinion that coal reserves of South Africa are only expected to last 40 to 50 years – not even considering the implication that coal could become so environmentally unpopular in the coming years that its life expectancy might even more decrease the lifetime of the coal reserves.

Dunn (1999:10) states that on February 28, 1998 officials in Beijing and 32 other Chinese cities were forced by the National Environmental Protection Agency (NEPA) to release pollution records that had been suppressed for almost 20 years. The pollution reports revealed that the air outside "Beijing's Gate of Heavenly Peace had become hellish". Prolonged exposure to the air posed serious health risks and had increased the city's death rate by 4%. Citizens were angry – only discovering that the haze hovering over the city with its related health problems was almost entirely the result of coal mining and coal combustion for electricity generation.

Auken (1999:2) states that "The climate system is so complex that it may not be possible for scientists to fully determine which of the many possible surprises can definitely be ruled out, and which we must take into account, and it may be even more difficult to assess risks and probabilities. Considering the described upheavals triggered by past natural climate changes, It seems risky to enter into large anthropogenic perturbations.

The reputation of the coal industry has taken a serious setback. "The reign of King Coal has not been without heavy costs: Its use has left a legacy of human and environmental damage that we have only begun to assess. At the close of the twentieth century, coal's smog-choked cityscapes are no longer the symbol of industrial opportunities and the wealth they were 100 years ago. Instead, coal is increasingly recognised as a leading threat to human health and one of the most environmentally disruptive human activities" (Dunn, 1999:12).

The FCCC and international agreement reached by the United Nations in 1992 at an International Earth Summit in Rio de Janeiro called for substantial reductions in the release of man made greenhouse gases which are considered a significant cause of global warming.

Anon (2001:3) indicates that there is roughly 200 billion tons of carbon dioxide emitted each year. 190 Billion tons are naturally occurring and 10 billion tons are from man-made sources. Such warning attributable to human activity is likely to cause significant climate change and a resultant rise in sea levels. The first goal is said to be the stabilisation of atmospheric greenhouse gases which requires that fossil fuel use be cut and other emissions such as methane release managed to as low as possible.

According to Anon (2001:3) fossil fuel use will need be cut by 60% to 80% world wide just to stabilise the emission of greenhouse gases to the atmosphere. Drastic control policies including the imposition of a carbon tax might have to be exercised to achieve this. A 10% fossil fuel levy has already been imposed on electricity bills in UK. But this may also pose a great threat to the growth of coal mining industry, especially in developed countries like U.S., resulting in significant increase in costs with corresponding decreases in the output of coal mines and/or possible shutdown of many coal mines.

The Danish Minister for Environment and Energy, Mr. Svend Auken mobilised his country for the action required against global climate change by publishing an article in the leading Danish newspapers. He stated that they have embarked on an unpredictable global experiment with the climate, an experiment that has just started, but which could end up having consequences which are much more serious than we can imagine. The danger posed by climatic changes is becoming widely accepted. However, the full scope of the problem is hardly recognised. Many people imagine that temperatures will just rise slowly, which might not be too bad. However, scientists are increasingly reminding us of the possibility that the global climate can exhibit instabilities (Auken, 1999:1).

According to Auken (1999:1) the evidences of past rapid climate changes are piling up, and should not be ignored. Natural climate changes have, in the past, caused effects, that we would not like see repeated, through anthropogenic interference with the climate.

Auken (1999:2) states that in political terms it is rather obvious what is required to stabilise greenhouse emissions "The use of fossil fuels must be phased out as quickly as possible". Auken (1999:2) also clearly present his frustrations: "It is obvious that the ambition level of the Kyoto Protocol is quite inadequate compared to the actual challenge. Therefore, it troubles me that the international community have pent almost 10 years negotiating the terms for a binding climate agreement, and still have not managed to close the deal. This is primarily due to the resistance from those parties that who would be most affected by a change from fossil energy sources to alternatives: oil producers, the car industry etc., who still seem to be very influential in political decision-making".

Another major concern for South African coal producers is dwindling reserves. South Africa's on the site mineable reserves has decreased from 58 billion tons in 1982 to an estimated 33,48 billion tons in 1998. At the present production rate South Africa has sufficient mineable reserves to last the next 40 to 50 years, provided the production rate is decreased from 6 percent to 3 percent per annum. An estimated 34 billion tons of coal remain, and based on present consumption rates, South Africa could have a mere 7 billion tons remaining by 2040. In 1982, reserves were estimated at 50 billion tons (Mbendi, 2002).

A significant decrease in the saleable production of anthracite is mainly attributed to the exhaustion of anthracite reserves in the country. Most of the mines are old, some have closed down and country has already started to import anthracite. However, production of bituminous coal is increasing.

The coal market is also said to be in oversupply. New competition such as Indonesia and Colombia increased exports during 1998, impacting negatively on South Africa's coal share of the world market. These low-cost producers such as Colombia and Indonesia are of great concern for South African producers.

South Africa's domestic resources offer limited growth potential and low-cost transport and productivity management will remain important to ensure competitiveness. Large capital investment for expansion and new mines planned for the next few years is on hold as a result of current oversupply in world markets and low coal prices. Highly developed technological processes, especially for beneficiation, are an important competitive advantage for South African producers.

The domestic coal market grew marginally since 1990 to 1998. Electricity generation by export is by far the largest consumer of coal in the domestic market, using 93,26 million tons in 1998.

Despite these negative threats impacting on the coal industry, South African producers are focusing on increasing their competitiveness. This is not done only through more efficient operations and increased labour productivity, but also through a repositioning and reorganising of the industry and looking at opportunities to implement cleaner technologies.

Table 1: Coal production and Consumption in South Africa 1990-2000 (in million tons).

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Production	247.6	256.2	247.3	258.4	272.3	288.39	297.1	324.6	322.0	320.2	326.1
Anthracite	*6.1*	*4.9*	*6.1*	*5.7*	*4.5*	*3.6*	*3.9*	*4.4*	*2.9*	*2.7*	*3.4*
Bituminous	*241.5*	*251.3*	*241.2*	*252.7*	*267.9*	*284.8*	*293.2*	*320.1*	*319.1*	*317.7*	*322.7*
Lignite	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*
Consumption	193.5	153.1	151.8	156.2	158.1	172.8	165.7	178.1	187.0	174.6	176.3

(An energy overview of South Africa, 2000)

4 Methane's Origin and Properties

Methane is a naturally occurring, flammable gas. Methane is naturally caused by the decomposition of organic matter during the formation of geological coal formations. The decomposition of organic matter, wetlands and animal digestive processes are also sources of methane emissions (Anon, 2000:2). "Methane is a colourless and odourless gas with a wide distribution in nature. The firedamp of coalmines is mainly methane. Methane is combustible and mixtures of about 5-15% in air are explosive" (Anon, 2001:1).

Riemer and Freund (19--:1) state that methane is the second most important of the anthropogenic greenhouse gases after carbon dioxide. According to Anon (1996) methane is a radioactively and chemically active trace greenhouse gas. By being radioactively active, methane is said to trap infrared radiation or heat and contributes to the warming of the earth. Being chemically active methane enters into complex chemical reactions in the atmosphere.

The presence of methane is naturally removed by the radical hydroxyl whose concentration is however continuously depleting, this increases not only the abundance of atmospheric methane but also atmospheric concentrations of ozone and stratospheric concentrations of water vapour, which are stated to be both greenhouse gases.

Increasing atmospheric methane concentrations is said to account for eighteen percent of the global greenhouse effect compared to approximately 66% for carbon dioxide (Anon, 1996). Because methane has a relatively short atmospheric lifetime compared to the major greenhouse gases, reductions in methane emissions will help to ameliorate global warming relatively quickly (methane has an average residence time of 12-17 years in the atmosphere, whereas for carbon dioxide it is 50-200 years) (Anon, 1996).

4.1 Methane Originating from Coalmines

Anon (1996) describes that methane is produced during coalification (the process of coal formation). The produced methane remains trapped under pressure in the coal seam and the surrounding rock strata. This trapped methane is only released when the coal seam is fractured and will eventually be emitted into the atmosphere or will seep back into the mine workings as the coal is mined.

One of the most important characteristics of mined coal is its coal rank, which determines the gas content per unit of mass (e.g. lignite versus anthracite) (Anon, 1996).

Lloyd *et al* (1997:73) mention that methane is present in coal mainly as an adsorbed species. Methane typically obeys adsorption laws. Methane content furthermore varies close to reversibly with pressure, increasing as pressure increases.

Underground mines use ventilation systems to ensure that methane remains within safe tolerances within the coal mining working environment. Methane is explosive in concentrations of 5 – 15% in air (De Pasquale and Pollard, 1998:11). Methane has gained a reputation as a "killer" gas since the beginning of the underground coal-mining era. The reason for this reputation is borne out of the fact that methane is explosive. Mine air containing methane is removed from the mine workings and is generally vented directly into the atmosphere (Anon, 1996). It therefore follows that methane in the mining environment has been one of the most adequately addressed occupational health and safety issues.

Ventilation systems pump large volumes of air through the mine to dilute and remove in mine methane. The ventilations systems then extract and exhaust the diluted methane to the atmosphere. Methane concentration in vented air is often less than 1% (De Pasquale and Pollard, 1998:7).

4.2 Other Sources of Methane

According to the Environmental Protection Agency (EPA), methane emissions in the U.S. mostly occur from landfills, enteric fermentation, gas and petroleum systems, agricultural activities, coal mining, stationary and mobile combustion, wastewater treatment and a number of industrial processes (Anon, 2001).

Sources of methane emissions have been identified and quantified in the U.S.. The following table represents total calculated methane emissions in the U.S. for the year 1999.

Table 2: U.S. Sources of methane emissions for 1999 (Unit: Carbon Dioxide Equivalent)

Source	1999 Emissions
Landfills	214.6
Enteric Fermentation	127.2
Natural Gas Systems	121.8
Coal Mining	*61.8*
Manure Management	34.4
Petroleum Systems	21.9
Wastewater Treatment	12.2
Rice Cultivation	10.7
Stationary Combustion	8.1
Mobile Combustion	4.5
Petrochemical Production	1.7
Agricultural Residue Burning	0.6
Cilicon Carbide Production	< 0.05
International Bunker Fuels	<0.05
TOTAL	**619.6**

(Anon, 2001:2)

It is clear from the sources and quantities of methane emissions in the U.S. that there is a definite influence by coalmining in the quantity of methane emissions.

Methane emissions from coal mining accounts for almost a quarter of the methane landfill emissions. Methane emissions ranks as the fourth highest of all emissions in the U.S.

4.3 Atmospheric Concentrations of Methane

Anon (1996) argues that atmospheric concentrations of methane are increasing. The increase in methane concentrations is said to be due to human-related activities that release methane to the atmosphere and in the opinion of this author, mainly due to human population growth. In 1990 the methane concentration level was approximately 1.72 parts per million (ppm) – nearly double the level estimated for the beginning of this century (Anon, 1996). Analysis of infrared solar spectra has shown that the atmospheric concentration of methane increased by about 30 percent over the last 40 years.

Anon (1996) suggests that variations in methane's atmospheric level over the previous hundred and fifty thousand years could be largely attributed to changes in methane emissions from natural systems, and in particular wetlands which is of course an outflow of increased human population.

This suggests that there is a risk for increased methane emissions from natural sources as and might contribute to climate change in the future. The emissions from several of the natural sources, in particular, wetlands, gas hydrates, and permafrost, are strongly governed by environmental variables such as temperature and precipitation. Therefore, climate change induced by humans could actually trigger the release of more greenhouse gases from natural systems and magnitude of future climate change could increase consequently (Anon, 1996).

The atmospheric concentration of methane in 1996 was approximately 4850 Mt3. "This amount is thought to be increasing by about 30 Mt per year. Atmospheric methane concentrations are expected to continue to increase, although global measurement programs indicate that the rate of increase appears have slowed in the last several years" (Anon, 1996).

Anon (1996:6) estimate that the current annual rate of increase of atmospheric methane is about 0.0115 ppm.

4.4 Methane and Global Climate Change

"Methane's increasing concentration in the atmosphere has important implications for global climate change. Methane is very effective in absorbing infrared radiation or heat given off by the earth's surface. By absorbing infrared radiation and inhibiting its release into space, the presence of methane contributes to increased atmospheric and surface temperatures, and thus to the greenhouse effect" (Anon, 1996).

Anon (1996) states that its Global Warming Potential (GWP) expresses the intensity by which a greenhouse gas contributes to global warming. The GWP reflects how more powerful a substance is than the standard substance which is carbon dioxide and that by definition has a GWP equal to 1. The author also mentions that there is no simple way of calculating the GWP of a certain substance in comparison to carbon dioxide, partly because substances have direct and indirect effects. Takle (1997:1) define the GWP as the total impact over time of adding a unit of a greenhouse gas to the atmosphere. It is calculated by multiplying effect of the instantaneous radiative forcing by the concentration of gas added and integrating over time from 0 to some arbitrary time period, defined only as time (T). "Carbon dioxide, for instance, has relatively low radiative forcing but a very high volume of gas annually added to the atmosphere and a long atmospheric lifetime, so it has a very high GWP" (Takle, 1997:1).

According to Anon (1996:6) the GWP of methane is 62 times higher than the GWP of carbon dioxide.

The IPCC has recommended using a GWP of 62 that reflects both direct and indirect effects over a time horizon of 20 years. This means that the impact of on global warming of 1 ton of methane is 62 times higher than the impact of 1-ton carbon dioxide over a time period of 20 years. "If one considers the same effects over a 100 years time horizon, the GWP will be about 25" (Anon, 1996). The more recent accepted GWP of methane for a 100-year period is 21 and is the prescribed figure used by the IPCC (Anon, 2001:2).

Anon (1996) state that an important parameter is the time which methane stays in the atmosphere namely 12-17 years against 50-200 years for carbon dioxide. This should mean that the implementation of a strategy to reduce methane emissions would have a more immediate impact on the global greenhouse effect compared to carbon dioxide where the benefit of initiatives would only be perceptible in the medium or long term.

Methane indirectly contributes to global warming by influencing the concentration of ozone in the troposphere, stratosphere, the amount of hydroxyl in troposphere and the amount of water vapour in the troposphere and stratosphere. Methane's indirect effect on warming resulting from these chemical reactions could be comparable in magnitude to its direct effect, although considerable uncertainty remains on this issue.

Another interesting factor to take into consideration is when methane is captured and combusted; it transforms methane into carbon dioxide and eliminates 95% of its GWP (Anon, 1996).

4.5 Stabilisation and Reduction of Global Methane Emissions

Analysis of gases trapped in ice indicates that the amount of atmospheric methane has more than doubled over the past three centuries and that it has increased at the rate of 1 percent per year during the past 15 years (Rice, 1997:2). Atmospheric methane has been increasing at a rate of about 30 Mt per year, stabilizing global methane concentrations at current levels would require reductions in methane emissions by approximately the same amount. Such a reduction represents less than 10 percent of current anthropogenic emissions. This reduction is much less than the percentage reduction necessary to stabilize the other major greenhouse gases. Carbon dioxide requires approximately a 60 percent reduction while other gases such as nitrous oxide requires a 70 to 80% reduction. Analysis of gases trapped in ice indicates that the amount of atmospheric methane has more than doubled over the past three centuries and that it has increased at the rate of 1 percent per year during the past 15 years.

Natural systems such as wetlands and decomposing forested areas account for about 40 percent of the methane released to the atmosphere. Significantly, the balance is largely the result of human activities such as rice cultivation (19 percent), livestock (11.5 percent), landfills (8 percent), biomass burning (11.5 percent), venting from oil and gas wells (4 percent), and coal mining (6 percent). Most experts agree that little reduction can be gained from altering livestock and rice cultivation methods; however, some important reductions can be achieved by improving techniques for recovery and utilisation of methane from coalmines (Rice, 1997:2).

Methane reduction strategies therefore offer an effective means of slowing global warming in the short term. On the other hand, because of the relatively high increase in yearly concentration of methane, a continuation of present trends may have a long-term impact on the global temperature, which could be almost as dramatic as that foreseen for continued increases of carbon dioxide concentrations.

The reduction of methane emissions is not only an attractive option in the short term but also a necessary commitment for the long term.

4.6 Elimination of Methane Emissions: Combustion with/without Energy Recovery

Anon, (1996) argues that methane combustion gives rise to a release of energy followed by emissions of carbon dioxide and water vapour. During combustion one ton of methane is converted into 2.75 tons of carbon dioxide, this means that if compared on a equal basis the GWP values (before and after combustion), the pre-combustion GWP value of 21 (for methane in a 20 year period) ends-up as a post-combustion GWP value of 2.75 (2.75* GWP1 of carbon dioxide).

By converting methane into carbon dioxide in the combustion process, one eliminates 95% of the greenhouse gas effect problem since the carbon dioxide generated during the combustion will only represent 5% of the original methane global warming potential.

The extent that avoidance of methane emissions can be done through collection of methane and subsequent combustion with energy utilisation, means in short that the potential exist to achieve a double bonus. In the ideal case there will be no net greenhouse emissions at all because the saving of fuel that would otherwise have been used to cover the energy production will counterbalance the resulting carbon dioxide from the combustion process.

The use of flares (simple combustion without energy recovery) is recommended by the author for eliminating methane emission and their associated harmful atmospheric impacts but energy recovery system should be referred, if they are economically justified.

The complete elimination of recovered methane's contribution to global warming, 95 percent is linked to the combustion of methane into carbon dioxide and only the 5 percent is due to the energy saving resulting from utilizing the recovered methane's energy content. In other words, from a climate point of view, the importance of methane recovery lies in the elimination of the methane molecules much more than in the use of the energy release during the combustion (Anon, 1996).

4.7 The Recovery of Coal Bed Methane

Methane is said to be removed from underground coal mines either in advance of mining, during mining activities, or after mining has occurred, exiting the mine through degasification systems or mine ventilation systems.

Degasification systems are also commonly referred to as drainage systems. When removed in advance of mining, the methane is drained through vertical boreholes drilled into the coal seam. This type of methane recovery often occurs years ahead of the mining activity. This is similar in concept to conventional natural gas drilling and production. The methane that is removed in advance of mining is often very high quality, and acceptable for injection into natural gas pipelines. In addition to vertical wells, horizontal boreholes can be drilled into the coal seam in the underground mine before mining occurs. This process also produces high-quality gas.

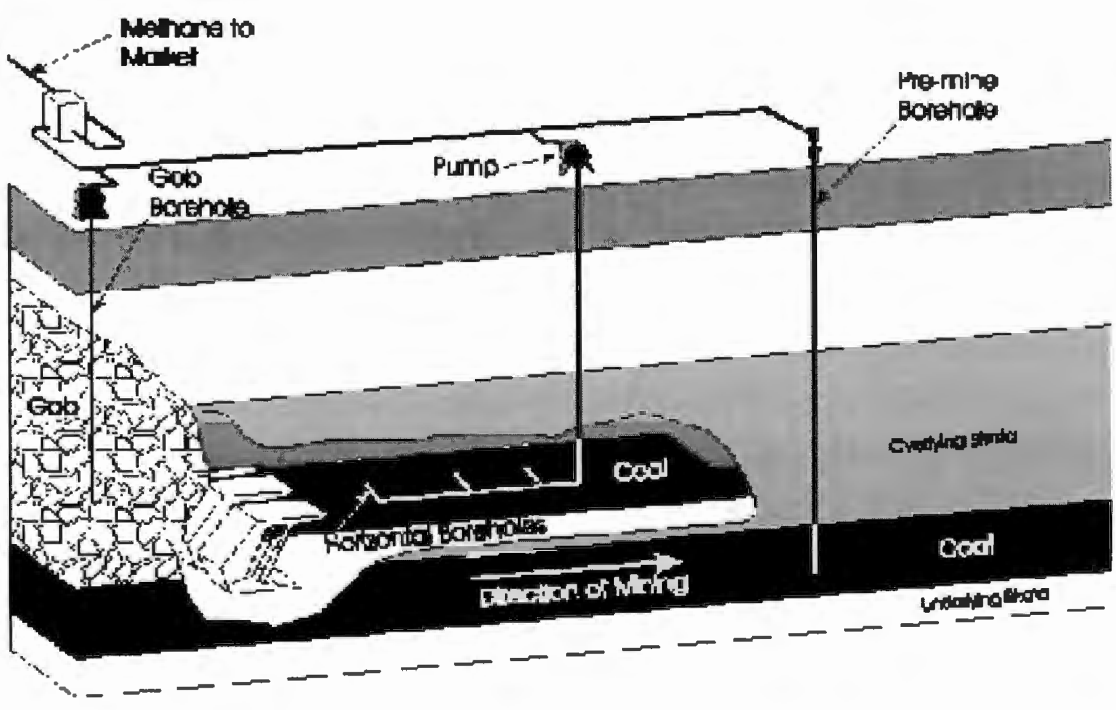
Once coal is removed in an underground mine, the resulting void cannot support the strata above it without supports. The roof and walls collapse and the debris fills the void after the supports is removed. This debris is referred to as the "gob," and the methane, referred to as "gob gas," is released into the mine. Both vertical and horizontal wells are used to recover the “gob” gas.

Gob gas is initially high quality (more than 95% pure methane); however, over time its quality declines as the methane mixes with air. In ideal cases, gob gas can be injected directly into pipelines, but in other cases it must be processed to remove contaminants. It is said that gob gas is a good choice for power production and heating applications because these uses allow for more variation in the methane quality compared to pipelines.

Ventilation air is the other source of methane emissions from underground coalmines. Mine operators must move massive quantities of air through their mines to regulate temperature and humidity, to ensure a fresh source of air, and to maintain methane concentrations at or near 1% of volume in working areas. As air moves through the mine, methane from the fractured coal seams mixes with the ventilation air and is carried out of the mine with the ventilation air through the exhaust system (Anon, 2002).

The diagram below depicts the degasification and ventilation systems described above.

Figure 1: An illustrated example of coal bed methane extraction.



(Anon, 2002).

Coal bed methane extraction and commercialisation is being widely developed around the world as several countries mine deeper seams and strive to supplement their domestic energy reserves. Recent technological advances have stimulated seam gas exploration and development to reach record levels. A number of coalmines in the U.S. and Australia are collecting methane from seam drainage operations and selling electricity produced by natural gas powered generators sets. Ambitious investment efforts are on in many other countries like China, Poland and South Africa and the activities are going to expand rapidly to many other countries in near future. The platform is growing in strength and competitive gains are expected. The repositioning of the industry, further global integration and technology enhancements mainly in the beneficiation process strengthened the platform for future competitiveness. The recovery of coal-bed methane is said to have been successfully undertaken since the early 1970's in the U.S. (Anon, 1994).

4.8 Alternative Applications for Coal Bed Methane

Anon (2001) indicates that there are a number of alternative applications for coal bed methane. These include but are not limited to:

Commercial and industrial options

- Heating greenhouses;
- Co-firing methane in coal- fired industrial and utility boilers;
- Enriching medium- quality gas for pipeline injection; and
- Co-generating with methane to produce electricity and heat.

Developing technologies

- Power generation using micro turbines or very low- emission fuel cells;
- Methanol production;
- Supplemental fuel for blast furnaces;
- Small-scale liquefied natural gas production; and
- Brine water treatment.

Ventilation air methane

- Supplement primary fuels in power generations or boilers/ furnaces; and
- Heat recovery using thermal oxidizers and catalytic processes.

Mine-site uses

- Facility, water, and ventilation air heating; and
- Coal drying.

4.9 Emission Data – Measurement and Verification

The primary objective of a CER audit is to provide and independent opinion on emissions data of the coalmine or other entity. This audit process will include the identification of weaknesses and deficiencies in the entity's internal emission data control, management and reporting systems that could affect the reliability of data.

The purpose for emissions data verification is simple in the sense that it should provide assurance through external verification that the stated emission reduction stated is true and correct prior to finalising the transaction with the buyer.

The audit methodology used for the verification of emissions, features both environmental and financial audit standards and principles. This provides a balance of skills and capabilities because the audit team needs a workable knowledge of climate change issues, technical processes, financial audit and environmental audit techniques. A risk-based approach is usually followed, i.e., one that draws upon an understanding of the entity's risks and controls as they relate to emission information.

Table 3: Stages in the CER audit and verification.

1. Scoping and positioning	Understanding the business of the coal mine or entity and also the scope of work to be performed
2. Evaluation of emission trading protocols of the entity	Evaluation of the specific coal mine's or entity's climate change protocols and data collection system against international standards and industry norms
3. Engineering of the audit process	Developing the procedures and tools to be used by the auditors for the effective completion of the audit
4. Audit and verification	Preparation of the audit report and verification statement

(DNV *et al*, 2000:4).

It should be remembered that even when the best financial and environmental audit techniques is applied, the result could never be absolute in accuracy, but only provides a high level of assurance.

It is important that the verification statement is in conformity with the International Standard on Auditing (ISA) 100 and 920.

The following assertions are understood within the context of ISAs and are used where applicable to define the framework of procedures necessary to issue a verification statement:

- ***Completeness***: All relevant information and data related to the parameters reported are disclosed;
- ***Existence***: All events and emissions disclosed should actually occurred;
- ***Accuracy***: All data and information should be accurate with regard to date, description and quantity;

- ***Valuation***: All the measurements, calculations and estimates used to report emission data and information should be based on an acceptable methodology; and
- ***Documentation***: Based on ISA suitably adapted.

The verification reports or statements usually will include:

- An identification of the subject matter about which the verifier is providing assurance, as well as the title and date of the report or other medium (e.g., website) that contains the subject matter;
- An acknowledgement that the reported subject matter is the responsibility of the organisation's management and that the verification statement is the responsibility of the verifier;
- The purpose of carrying out the verification;
- The nature and source of criteria used in evaluating the subject matter, developing findings, and reaching conclusions; if the purpose of the verification is to provide assurance about the extent to which the sustainability report complies with the GRI Guidelines, these should be referred to in the verifier's conclusion or opinion;
- The procedures carried out and any standards followed in the course of the verification, including the extent to which stakeholders were involved in planning and participating in the verification process;
- An identification of the party or parties responsible for the verification, as well as an indication of the relevant qualifications or competencies of those who carried out the work and their relationship to the compotators of the report;
- A statement or opinion as to the conclusions reached and an indication of the level of assurance provided about the subject matter, including any reservations or limitations; and
- The date and place of issuing the verification statement or report.

5. Costing Methodology and Viability Assessment

Understanding and quantifying methane emission abatement costs is vital for coalmines and Annex I that are interested getting involved in emissions trading.

There are two general modelling approaches to estimating the cost of pollution abatement strategies namely, top-down models and bottom-up models. The former are macroeconomic models that attempt to capture the overall economic impact of an abatement strategy. They tend to analyse aggregate behaviour based on economic indices and elasticises. With top-down models, the overall cost of a pollution abatement strategy is normally expressed in terms of change in GDP.

In contrast, bottom-up models look at the microeconomic costs of individual mitigation options. Bottom-up models rely on the detailed analyses of technical potential, focusing on the integration of engineering costs and environmental performance data. With bottom-up models, the overall cost of a pollution abatement strategy includes, for example, investment, operation and maintenance, and energy costs.

Past experience has shown that bottom-up models have problems accounting for consumer behaviour and administration costs, were as top-down models have problems accounting for different rates of technical change. Essentially, top-down models are better at predicting wider economic effects and bottom-up models are better at stimulating detailed technological substitution potential (Hendriks and de Jager, 2001).

5.1 Annex I Financial/Cleaner Technology Investment Viability

The first viability assessment considers a clean technology or financial transfer to a South African coalmine. The Annex I company will consider the cost of the cleaner technology or financial transfer to a South African coal mine in comparison with the Non-compliance costs it will have to pay when not meeting (exceeding) its allocated and enforced emission limits. It's CER's achieved by investing in a CDM project should compensate for that amount of emissions that the company is in non-compliance with.

A cleaner technology transfer or financial transfer will be viable for the Annex I company if that cost is lower than the emission non-compliance fines and the company achieves its (verified) CER's.

The sample mines shown in the tables 4, 5, and 6 are hypothetical. However, while the mines are hypothetical, their defining characteristics (emissions, coal production, etc.) are representative, where possible of the relevant characteristics of gassy South African coalmines.

The price per ton of carbon dioxide equivalent is irregular. In recent times it has been as high as U.S. $28 and as low as U.S. $1.33 per ton carbon dioxide equivalent (Anon, 2002:1).

For the purpose of this assessment the hypothetical price of U.S. $12 for a metric ton carbon equivalent emissions will be used.

a) Characteristics of mining activities, emission factors and emission volumes

The most important information when an Annex I investor considers getting involved with emission trading in a Non-annex I company is to know what the target coalmine's total methane emission was in the previous year. This can be calculated by measuring the volume or mass of methane released per ton coal mined. A methane emission factor for the specific region or mine then needs to be determined. This methane emission factor usually differs from mine- to-mine, geographical-to-geographical area and continent-to-continent.

To estimate emissions from coal mining, the following steps are performed:

- Obtain required data of coal production from the targeted coalmine in the previous year;
- Calculate methane emissions from the mining activities;
- Calculate post-mining emissions; and
- Calculate total mining emissions.

The data required to estimate methane emissions from coal mining are annual coal production from surface mines and underground mines.

Emissions estimates are accomplished by:

- Multiplying the appropriate amount of specific mine coal production by the estimated emission factors for methane of that mine or geographical area;
- Determining the median of the high and low totals, and
- Converting cubic meters of methane to tons of methane.

Table 4: A hypothetical potential of emission abatement for two South African coalmines.

GENERAL INFORMATION	MINE A	MINE B
Mining method	Longwall	Longwall
Remaining Lifetime	20 Years	20 Years
Annual Coal Production	2 Million tons	3 Million tons
METHANE EMISSIONS		
Emissions Per Ton (Methane Emission Factor)	28.57 Cubic meters	57.14 Cubic metres
Total Annual Methane Emissions	57.14 Million Cubic meters	171.43 Million Cubic metres
Annual Ventilation Emissions	40.00 Million Cubic metres	85.72 Million Cubic meters
Annual Degasification Emissions	17.14 Million Cubic metres	85.71 Million Cubic metres
Degasification Method Employed	Gob Wells	Gob Wells and Horizontal Boreholes
Degasification System Recovery Efficiency	30%	50%
% of Degasification Emissions that is Pipeline Quality Gas (>95%)	5%	30% (70% from in-mine boreholes, 30% from gob wells)

(Schultz, 1995:3)

b) Emission abatement capital and annual operating costs

The abatement of methane emissions will have capital and annual operating costs. The CDM makes provision for an Annex I country/company that does not meet its emission limits to invest cleaner technologies or financially in a Non-annex I country/company. These investments should lead to emission reductions in the Non-annex I country/company before it can be eligible as an acceptable CER programme, which is the main purpose of the project for the Annex I country/company. The costs and/or cleaner technology benefits (return on investment) should be identified and assessed before CDM project implementation. It is also important to take into consideration that emission abatement could have annual recurring costs, as the CDM investment is not always a once-off project, but could last years.

The effectiveness of the degasification and capturing system that is intended to be implemented should also be taken into consideration, as this will determine the amount and effectiveness by which methane can be captured.

All these costs should be taken into consideration as the abatement costs could strongly influence the viability for the investing company. The investing country should have the assurance that the "clean technological or financial transfer" they make to abate emissions in the Non – Annex I country will yield the expected CER's.

The following table sets out a framework for calculating the cost of a methane abatement project.

Table 5: A checklist of capital and yearly operating costs.

NON RECURRING CAPITAL COSTS		MINE A	MINE B
Total Direct Non-Recurring Costs		**MINE A**	**MINE B**
Purchased Equipment Costs	Primary control device		
	Auxilary equipment		
	Intrumentation		
	VAT/sales taxes on equiment		
	Freight		
	Modifications to other equipment		
Buildings			
Direct Installation Costs	Foundations and supports		
	Handling and erection		
	Electrical		
	Piping		
	Insulation		
	Painting		
Site Preparation			
Total Indirect Non-recurring Costs			
Indirect Installation Costs	Engineering		
	Construction and field expenses		
	Contractor fees		
	Start-up		
	Performance testing		
	Contingencies		
Other Non-recurring Costs			
Working Capital			
Off-site Facilities			
ANNUAL RECURRING COSTS			
Variable (Direct) Costs			
Non-fuel Operating Costs	Maintenance materials		
	Operating, supervisory and maintenance labour		
	Staff training		
	Replacement parts		
	Waste treatment and disposal		
Fuel Operating Costs	Electricity, oil, gas etc.		
Fixed Operating Costs			
Overheads			
Rates			
Insurance			
Administrative Charges			
	TOTAL (Capital and Recurring Cost)	**R AB**	**R BB**
	TOTAL (Recurring Cost)	**R AC**	**R BC**

Now that the potential methane extraction volume has been determined, the infrastructure and capital investment and annual recurring costs have been estimated (see table 4), the Annex I company could do a viability assessment on the possibility of achieving CER's at a lower cost than the standing non-compliance penalty in its Annex I country.

If found viable, the Annex I company could continue with the project. The methane captured through the project should be eliminated to ensure that the methane molecules do not end up in the atmosphere. Independent auditors will verify this before issuing a statement on the achieved CER's.

The following are used as examples:

Mine A:

Mine A is the smaller of the two coalmines in terms of annual coal production, 2 million tons and annual methane emissions of 57.14 Million Cubic metres. The gob wells employed for methane capturing at the mine will account for a 30% capturing effectiveness of methane emissions.

The total capital and recurring cost for mine A in the first year of operation is estimated at R AB. The methane capturing system put in place for mine A is 30% efficient, which mean that 17.14 million cubic metres methane will be captured.

The emission reduction (ER) for mine A will be 21 (GWP for methane)* XX tons of methane captured.

If the ER cost is lower than the Annex I non-compliance penalty, the CDM project is viable for the Annex I investor company.

Mine B:

Mine B is the larger of the two coalmines in terms of annual coal production, 3 million tons and has the highest methane emissions of the two mines, 171.43 Million cubic metres. Horizontal boreholes and gob wells will be used to remove large quantities of methane from the mine. Emissions from these degasification system accounts for 50% of total methane emitted from the mine.

The total capital and recurring cost for mine B in the first year of operation is estimated at R BB. The methane capturing system put in place for mine B is 50% efficient, which mean that 85.71 Million cubic metres will be captured.

The emission reduction (ER) for mine B will be 21 (GWP for methane)* XX tons of methane captured.

If the ER cost is lower than the Annex I non-compliance penalty, the CDM project is viable for the Annex I investor company.

5.2 Non-Annex I, Voluntary Emission Reduction Program

The second viability assessment considers that South Africa has ratified the Kyoto Protocol and has implemented a voluntary emission reduction program whereby industry was allocated emission caps. This will enable a South African coalmine to trade with emission reductions achieved below the set limit (recognised as an Annex I party).

The same hypothetical coalmines are used as above. The scenario change is that mine A and B are themselves responsible for the implementation of the emission mitigation systems, because the emission reductions achieved can now be transformed into a financial value.

The price per ton of carbon dioxide equivalent is irregular. In recent times it has been as high as U.S. $28 and as low as U.S. $1.33 per ton carbon dioxide equivalent (Anon, 2002:1).

For the purpose of this assessment the hypothetical price of U.S. $12 for a metric ton carbon equivalent emissions will be used.

All these costs should be taken into consideration as the abatement costs could strongly influence the viability for the investing company. The investing country should have the assurance that the "clean technological or financial transfer" they make to abate emissions in the Non –annex I country will yield the expected CER's.

Now that the potential methane extraction volume has been calculated (see table 4), the infrastructure and capital investment and annual recurring costs have been estimated, the coalmine could do a viability assessment on the amount of methane captured versus the price of carbon dioxide per ton * 21 (Methane GWP).

The coalmine should also assess and investigate opportunities for the alternative use of methane as this could be of financial benefit to the mine. It is important to remember that methane is a source of energy and methane could be sold or used as an alternative source of energy.

Using or selling the captured methane as an energy resource could have two fold benefits for a coalmine. A coalmine could have a reduction in virgin energy consumption if the coalmine decides to use its own captured methane. This could lead to a reduction in the coal mine's energy consumption bill. By selling the captured methane to a buyer the coalmine would receive remuneration for capturing that methane that would have been released into the environment and have been captured.

Table 6: A methodology on the calculation of methane utilisation value.

UTILISATION INFORMATION	MINE A	MINE B
Distance to Pipeline	5Km	1Km
Wellhead Gas Price	R350.00/Cubic metre	R350.00/Cubic metre
Mine Electricity Price	R4.00/Kwh	R4.00/Kwh
Utility Avoided Cost	R0.00/kwh	R6.00/kwh
Nearby Industry or Institution with Large Natural Gas Needs?	No	Yes
Local Industrial End-user Gas Price	N/A	R800.00/Cubic metre
Distance to Nearby Industry or Institution	N/A	5Km
Annual Demand for Gas by Nearby Industry or Institution	N/A	300 000 Cubic metres
Coal-fired Thermal Dryer Used On-Site?	No	No
Current Price Received for Coal	N/A	N/A

(Schultz; 1995:3)

If the financial value of the captured methane is more than the mitigation investment cost, the coalmine can "sell" the independently verified CER's to an Annex I company for an amount lower than the non-compliance penalty in the specific Annex I country or to a price that is determined by the open market.

Mine A:

Mine A has very little or no potential for internal usage of its captured methane. No additional financial benefits will accrue from the captured methane.

The ER for mine A will be 95% (effectiveness of methane flaring to demolish methane molecules)* 21 (GWP for methane)* XX tons of methane captured * U.S $ 12 (assumed price per ton CO2 equivalent).

Mine B:

Mine B has a significant opportunity for selling 300 000 cubic metres of pipeline quality (>95% Methane concentration) to a nearby industry. The price for wellhead methane is assumed at R 350.00 per cubic metre. The direct potential selling cost of the 10.30 million cubic feet methane adds thus value of (300 000 cubic metres * R350.00 = R 105m).

The emission reduction (ER) for mine B will 95% (effectiveness of methane flaring to demolish methane molecules)* 21 (GWP for methane)* XX tons of methane captured * U.S $ 12 (assumed price per ton CO2 equivalent) + R105 million (pipeline quality methane sold to client).

5.3 Other Risks and Consequences for the South African Coalmining Industry Engaging in Emission Trading

The viability calculation of an Annex I company interested in CDM project should take into consideration a number of other factors during decision-making.

The following risks should be taken into consideration:

- ***Political Risk:*** No legislation is ever adopted requiring greenhouse gas emission reductions;

- ***Country Risk:*** Greenhouse gas reduction project is recognised as creditable toward compliance, but not for country in which investment was made;

- ***Qualification Risk:*** Greenhouse gas reduction project does not qualify for early action credit or cannot be applied for compliance;

- ***Producer Risk:*** Greenhouse gas reduction project qualifies as creditable, but seller fails to produce or deliver reductions; and

- ***Contract Risk:*** Greenhouse gas reduction project contract does not properly establish the buyers' title to any resulting greenhouse gas reduction (Cantor Fitzgerald and PricewaterhouseCoopers, 2002).

Anon (2000:4) mention that the commoditisation of greenhouse gas emissions will introduce two things:

- The risk of added cost for those companies producing greenhouse gases in excess of any reduction commitments; and
- The opportunity for added revenues for those companies producing greenhouse gas below any reduction commitments.

General assumptions currently undertaken in emissions trading are:

- Emissions trading is most likely central to domestic implementation;
- Trading among Annex I nations is likely to occur; and
- CDM and JI are currently problematic (Cantor Fitzgerald and PricewaterhouseCoopers, 2002).

Without legislation to define which investments will yield creditable results, much uncertainty exists.

In a study entitled *Impacts of the Kyoto Protocol on U.S. Energy Markets and Economic Activity*, the Energy Information Administration (EIA), an independent statistical and analytical agency in the U.S. Department of Energy, has projected that meeting the U.S. targets under the Protocol will call for significant market adjustments, which will include:

- "Reductions in CO_2 emissions will result in between 18 and 77 percent less coal use than projected in the EIA Reference Case in 2010, particularly affecting electricity generation, and between 2 and 13 percent less petroleum use, mainly affecting transportation;
- Energy consumers will need to use between 2 and 12 percent more natural gas in 2010 and between 2 and 16 percent more renewable energy, and extend the operating life of existing nuclear units; and
- To achieve these ends via market-based means, average delivered energy costs (in inflation-adjusted 1996 dollars) must be between 17 and 83 percent higher than projected in 2010" (Anon, 1998:2).

It is obvious from the above-mentioned items that the demand for coal might decrease over the long term. This will influence South African coalmines negatively as well as the South African economy.

Anon, (2001:3) states that apart from the direct loss of coal production there are numerous other costs for the coal sector associated with mitigation. These costs relate mainly to the impact of the long-term reduction in coal consumption and hence coal production. In the short to medium term, these impacts will be moderate as global coal consumption is anticipated to continue to increase, but it is said to be at a lower rate.

Macro economic impacts on coalmines have been identified by (Anon, 2001:3) as:

- Lowered economic activity in coal-producing countries due to potentially reduced coal sales;
- Job losses in the coal mining, coal transport, and coal processing sectors – especially in developing countries (like South Africa) with high employment per unit of output;
- The potential for the "stranding" of coal mining assets as well as coal processing assets;
- Closure of coal mines, which are very expensive to re-open if ever;
- Higher trade deficits caused by reductions in coal exports from developing countries;

- Reduction in national energy security resulting from an increased reliance on imported energy sources where local energy options are primarily coal based;
- Negative social impacts of mine closure on communities where the mine is the major employer; and
- Possible slowdown of economic growth during the transition from coal to other energy sources in countries with a heavy reliance on coal (PricewaterhouseCoopers, 1999:17).

Achieving significant reductions of greenhouse gas emissions will be expensive. These costs will be borne, directly and indirectly, in large part by today's biggest emitters and energy users.

Market mechanisms (e.g., emissions trading) are employed to decrease the overall cost of achieving national reduction targets. Intelligent use of current and near-term market opportunities may greatly enhance a company's strategic and tactical position to compete in a greenhouse gas constrained business environment.

5.4 Approaches for Annex I Companies

Given this new implicit challenge of climate change and it's consequences, the economic impact of these stakes on companies future shareholder value will depend largely on decisions made in the next few years.

Annex 1 companies can opt for several different responses. The three approaches and their consequences are outlined as follows:

- In the case of a *wait-and-see attitude*, the company lags behind both in mastering the Kyoto mechanisms and in understanding its own internal situation. Management is left unprepared for regulatory changes and falls behind its competitors;
- In the *reactive strategy,* the company waits for the Kyoto mechanisms to become effective before making the requisite investments. By optimising recourse to the tools

available in 2008, they do limit the compliance costs incurred to stay below the allowance ceilings, but miss numerous opportunities. The most profitable CDM-type projects are already funded, leaving only the smaller scale CDM projects. This is also known as the "jam-effect";

- The *forward thinking strategy,* aims at taking the stakes in stride immediately, participating in negotiations and developing expertise and experience. Companies already known for their commitment are Royal Dutch Shell and BP Amoco.

Implementing this forward thinking strategy requires a conjunction of several factors:

- Determined commitment by top management, taken up by the main operational divisions;
- Setting up a supervisory body with an array of technical and financial expertise;
- Monitoring trends in both national and international negotiations;
- Intelligence watch on actions led internationally such as competitor projects;
- Cost assessment for meeting voluntary or imposed objectives;
- Acquisition of technical and financial proficiency in analysing opportunity thresholds for CDM projects;
- Negotiation with the relevant authorities regarding sector specific objectives and/or internal permit allocations;
- Accelerated development of technological innovations (e.g. alternative energy); and
- Taking the initiative regarding CDM-related opportunities (PricewaterhouseCoopers, 1999:18).

6 Conclusion

Emission trading is a regulatory program that allows firms the flexibility to select cost-effective solutions to achieve established environmental goals. The Kyoto Protocol offers companies a number of mechanisms to achieve emission reductions. Emission trading encourages compliance and financial managers to pursue cost-effective emission reduction strategies and give value to emitting entrepreneurs to develop the means by which emissions can inexpensively be reduced.

A number of variables influence the viability of methane extraction from South African coalmines. This can be expected as the economics of GHG trading is still evolving. One of these factors is CDM design issue, which will influence the effectiveness of CDM projects, however the most influencing variables on the viability of methane extraction are risk based. Political and financial risk will always influence decision-making on CDM investment in Non-Annex I countries.

The social and financial importance of coalmining in South Africa is indispensable and adds to sustainable development in South Africa. Coal is likely to be a dominant primary energy source, however signs are there that we will use it more efficiently. Putting a price on greenhouse emissions will put more of a focus on energy input into processes. Those who are inefficient in energy use will pay more, those who are efficient in energy use will save.

Methane is a potent GHG and is released during coalmining operations. Methane emission abatement could lead to short term climate change mitigation. A number of methane emission extraction options exist. Financial costs of recovering coal bed methane might be a problem today, but keep an open mind because the situation is likely to change rapidly in coming years.

The price on methane emissions from coalmines will tend to favour those producers who tend to have a more holistic view to the resources they are exploiting. Financial costs of recovering coal bed methane might be a problem today, but keep an open mind because the situation is likely to change rapidly in coming years.

A critical step in the achieving CER's is the verification of ER's by independent parties.

Methane is most likely the lowest risk-trading commodity if compared to other GHG's. By simply combusting methane, 95% of its GWP is eliminated. The time which methane stays in the atmosphere is 12-17 years against 50-200 years for carbon dioxide. This mean that the implementation of a strategy to reduce methane emissions would have a more immediate impact on the global greenhouse effect compared to carbon dioxide where the benefit of initiatives would only be perceptible in the medium or long term.

Advise to the coalmine industry in South Africa will be to see the opportunities of the Kyoto Protocol as a "No Regret" option. South African coalmines should assess their potential methane volumes that can be extracted, the potential value and cost of capturing methane and follow market trends of GHG trading.

The final point is crucial. As the CDM develops, a number of major projects will probably proof especially profitable, but only the first Annex I investors will be able to take advantage of them. These opportunities will have to be snatched up quickly. A "jam effect" may develop thereafter, once the use of this mechanism (theoretically the most beneficial) has become widespread. Methane emission CDM projects on South African coalmines offer opportunities for Annex I countries in achieving CER's.

GHG's as a commodity will change the way that we think about business.

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