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Research Paper

Environmentally clean technology transfer through CDM: From South Africa perspective

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ABSTRACT

Industrialized countries are responsible, both historically and currently, for the majority of greenhouse gas (GHG) emissions, but developing countries are increasingly contributing to the problem because of their rapid economic growth (IEA, 2007). Access to existing technologies and technological innovations is commonly seen as a prerequisite for the reduction of emissions in developing countries. Consequently, transfer of technology will be a key pillar in any agreement on a future regime to combat climate change through CDM (Clean Development Mechanism). CDM incentivizes in the private sector to finance emissions reduction projects and thereby potentially contributes to the transfer of technologies previously unavailable in developing countries. Hence, it is important to analyses the technology transfer contribution of the current CDM regime from SA (South Africa) perspective to see how SA can overcome negative factors affecting environmentally clean technology transfer from Annex I countries? SA generates its power from coal powered plant and this puts the country a foremost country in GHG emission in sub-Saharan Africa countries and makes the most eligible country to host CDM projects. However, the country still do not fully utilized its CDM potential due to lack of awareness and absences of political willingness of the government to confront the problem. Therefore, this study attempted to identify some factors affecting the environmentally clean technology transfer through CDM to SA. From literature review, interview conducted and questionnaires sent to project participants in SA, the author identified the following factors which are affecting technology transfer through CDM projects to SA and they are Eskom (National Utility Company) and Feed-in tariff policy, red-tape and corruption level, showhow transfer rather than know-how and Lack of incentives to investors involved in low carbon technology transfer though CDM. To demonstrate the case in question, the author employed two case studies of CDM projects from South Africa.

Key words: CDM, show-how technology transfer, know-how technology transfer, feed-in tariff, red tap.

INTRODUCTION

Global climate change threat

In the past, human interaction with nature had a disruptive effect on nature, but often also enriched the quality and variety of the living planet and its habitats. Today, however, human pressure on the natural environment is greater than before in terms of magnitude and efficiency in disrupting nature. Environmental effects from human interferences were mainly of local extent and predominantly of physical character, whereas a large portion of today 's environmental impacts are the result of emissions of chemical toxic to the environment (Wenzel et al., 1997).

The underlying reasons for the increasing environmental impacts are due to constantly growing human activity, use of many new chemicals foreign to the environment and use of increasingly larger part of the earth. The world 's human population growth is increasing exponentially as well as the material standard of living (UN, 1992). As the world 's population grows, improving material standards without putting the environment at risk is a global challenge.

According to Chertow (2001), to see this global challenge mathematically, IPAT equation is identified and it simply states that the Environmental Impact(I) is the product of Population (P), Affluence (A) and Technology (T) that is I=PAT, and it can be a starting point for investigating interaction of population growth, economic development and technological innovation. Thus, it is a formula used to demonstrate the impacts that a growing population imposes on the planet. For example, even if you cut human affluence (A) in half, a doubled population completely neutralizes any environmental impact reduction that this sacrifice would bring.

Industrial activities involving the use of foreign substances have magnified effects on the receiving environment in terms of air, water and soil contamination causing damage to ecosystems which is increasing progressively with time (Wenzel et al., 1997).

To this end, natural resources are under increasing stress, putting at risk public health and development. Water scarcity, loss of fertile soil and forests, air and water pollution, and degradation of coastlines affect many areas by flooding homes and destroying crops (Hinrichsen and Robey, 2008). These impacts can be categorized as global warming, ozone depletion, acidification, nutrient enrichment, smog, eco and human toxicity, resource depletion and others. These kinds of potential environmental impacts can be accessed through calculations carried out as part of the phase ‗life cycle impact assessment 'in short LCIA based on the inventory of exchanges and ultimately environmental exchanges.

Some of these human impacts have already reached such an extent that they are influencing all parts of the earth and can thus be regarded as global. This includes the exploitation of nonrenewable resources and chemical impacts on the environment from substances with the ability to spread to sensitive parts of the global ecosystems (Remmen and Lund, 2007)

For global environmental impacts, some of the major substances concerned include Carbon dioxide (CO2), Chlorofluorocarbons (CFCs), per fluorocarbons (PFCs) Nitrous oxides (N2O), Methane (CH4), and Sulphur hexafluoride (SHF6), which are collectively known as greenhouse gases (GHGs). These gases are believed to cause a global phenomenon known as global warming (Wenzel et al., 1997).

The term global warming is used to describe the rise in the earth's average surface temperature (King, 2005). It is mostly due to the release of anthropogenic greenhouse gases (GHGs) into the atmosphere. The gases in the atmosphere act like glass in a greenhouse, allowing sunlight through to heat the earth's surface but trapping the heat as it radiates back into space. As the greenhouse gases build up in the atmosphere, the Earth gets warmer. This warming of the Earth's troposphere is commonly known as the greenhouse effect (Benson and Rob, 2008). This confirms why the Earth 's average temperature has increased by approximately 0.740°C over the past century and Intergovernmental Panel on Climate Change (IPCC) has estimated a further temperature increase by 1.8 to 4% in this century (Chadwick and Hewehy, 2007).

At the end of the last ice age, the temperature rise is of the range 5 to 10°C. Importantly, it is possible to note that this increase is linked to an increase in carbon dioxide levels from 200 to 270 ppm. These are the measurements which represent the rise in carbon dioxide levels over the past 100 years. The current level of Carbon Dioxide is about 372 ppm. This massive and rapid rise in carbon dioxide levels is uncontroversial and attributed very largely to the burning of fossil fuels to generate energy (King, 2002)

The consequences of this warming include changes in the global and regional climates, sea-level rise, increasing intensity of heat weaves, storms, floods and droughts, spread of disease to new areas, conflict will increase and a lot of people will die and be uprooted or suffer in other ways, species will disappear and the whole ecosystems might be well destroyed. There are reported cases of increased intensity of tropical cyclones. Mountain glaciers, snow cover, and Arctic sea ice have also fallen. There are enormous harms before human being by the turn of the century calling for international response to set up global policy to mitigate the threat (IPCC, 2007).

IMPLICATION OF CLIMATE CHANGE TO SOUTH AFRICA

Sub-continental warming for Southern Africa is predicted to be greatest in the northern regions. Temperature increases between 10 and 30°C can be expected by the mid-21st century, with the highest rises in the most arid parts of the country (Gravey, 2008). In South Africa, as a semi-arid country, the predicted consequence is a broad reduction of rainfall in the range of 5 to 10%, and can be expected in the summer rainfall region. This will be accompanied by an increasing incidence of both droughts and floods, with prolonged dry season being followed by intense storms. A marginal increase in early winter rainfall is predicted for the winter rainfall region of the country. Therefore, today, a key concern is a climate change that has the potential to undermine the economic progress of South Africa, like other developing countries. Thus, the country faces the dual challenge of protecting the environment while pursuing economic growth in a sustainable manner. Hence, sustainable development that is appropriate and specific to the South African context should entail shared and accelerated growth, targeted interventions and community mobilization to eradicate poverty, and ensure the ecologically sustainable use of their natural resources and ecosystem services (DST, 2007)

KYOTO PROTOCOL AND ITS MARKET MECHANISM

The Kyoto Protocol, which was adopted in 1997 at the third conference of parties to the UNFCCC (COP3), and ratified by 2002 despite the US withdrawing, aims to provide means to achieve the climate change mitigation mechanisms. It brought about a new paradigm in international climate change politics by implementing legally binding GHG emission reduction commitments by Annex I countries (Grubb et al., 1999). The grounds for negotiating and ultimately adopting quantitative emission targets in the Kyoto Protocol had previously been laid out at COP1 meeting in 1995 within the Ad hoc Group on the Berlin Mandate (AGBM), which later become the Kyoto Protocol (Grubb et al., 1999; Luken and Michaelowa, 2008).

According to this protocol, developed countries, usually called Annex I countries, subsequently ratified the protocol thereby jointly committing themselves to reduce their aggregate greenhouse gases emission by at least 5.2% against 1990 levels within the period from 2008 to 2012 for five years, also called the first commitment period (UNFCCC, 1998). After long ups and downs, on the 16th of February 2005, the protocol entered legally into force after Russian federation ratification in 2004 that ensured at least 55 parties to the convention including the Annex I countries parties whose total GHG emission level represented 55% of the 1990 industrial countries emissions (Luken and Michaelowa, 2008). National limitations range from 8% reductions for the European Union and to 7% for the United States, 6% for Japan, and 0% for Russia has been fixed by the treaty. The treaty permitted GHG emission increases of 8% for Australia and 10% for Iceland. The emission reductions of GHG will be materialized through flexible market mechanisms of the Kyoto Protocol such as the International Emission Trading (IET) scheme, Joint Implementation (JI) and Clean Development Mechanism (CDM) to allow Annex I economies to meet their greenhouse gas (GHG) emission limitations by purchasing GHG emission reductions credits from elsewhere, through financial exchanges, projects that reduce emissions in non-Annex I economies, from other Annex I countries, or from Annex I countries with excess allowances (Table 1) (UNEP, 2004). In practice, this means that Non-Annex I economies have no GHG emission restrictions under the Kyoto protocol, but have financial incentives to develop GHG emission reduction projects to receive "carbon credits" that can then be sold to Annex I buyers, encouraging sustainable development objective of Non- Annex I countries. In addition, the flexible mechanisms allow Annex I nations with efficient, low GHG-emitting industries, and high prevailing environmental standards to purchase carbon credits on the world market instead of reducing greenhouse gas emissions domestically. Annex I entities typically will want to acquire carbon credits as cheaply as possible, while Non-Annex I entities want to maximize the value of carbon credits generated from their domestic Greenhouse Gas emission reduction Projects (Grubb et al., 1999) .

CDM MECHANISM DISCRIPTION

Moreover, the Mechanisms are intended to carry a strong financial incentive for the dissemination of environmentally clean technologies, including renewable energy technologies and especially technologies that increase the efficiency of energy transformation and consumption (Olsen et al., 2007)

The Clean Development Mechanism (CDM) is one of three ‗flexibility mechanisms ‘in the Protocol. These mechanisms allow flexibility for Annex I Parties (industrialized countries) to achieve reductions by extra-territorial as well as domestic activities. In ―flexibility mechanisms, the underlying concept is that trade and transfer of credits will allow emissions reductions in a cost-effective way. Since the atmosphere is a global, well-mixed system and greenhouse gas emission has a trans-boundary character, the rationale is that it does not matter where greenhouse gas emissions are reduced. Furthermore, the criteria are that Parties must participate voluntarily, that emissions reductions should be real, measurable and long-term ‘, and that they are additional to those that would have occurred anyway. The last requirement, that makes it an essential tool for emission mitigation, is defining an accurate baseline (Grubb et al., 1999). The Clean Development Mechanism (CDM) does not have an explicit technology transfer mandate under Kyoto Protocol (Dechezleprêtre et al., 2008a, b), but it contributes to technology transfer by financing emission reduction projects using technologies currently not available in the host countries (Hansen, 2008). However, there have been many concerns about CDM and some of the major concerns and criticism are explained hereafter.

Rich countries increase their emissions because the credits earned will allow them to emit more, thereby avoiding their responsibility to involve in more emission reduction projects at home, while developing countries are not tied to reduction at this stage because it is considered unfair to penalize them for what is internationally recognized as largely something caused by the rich countries DMG,2005. So this encouraged developing countries like countries in economic transition to continue emitting GHG while benefiting equally from CDM (Greiner and Michaelowa, 2002), CDM mechanism is also criticized

Table 1: CDM mechanism description.

Mechanism	Description
International emission trading	The International Emissions Trading under Article 17, is the ability of two entities that are subjected to emissions control to exchange part of their emission allowances, in order to redistribute the amount of allowed emissions between the parties involved or to sell the excess capacity of reduction to others who need it, at any period of time (Grubb, et al. 1999). This mechanism involves the direct transfer of —assigned amount units|| (AAU's) as ‗currency' of trade.
Joint implementation	In the other hand, Article 6 of the Protocol enables emission reduction or removal, from cross-border investment between Annex I Parties that can be transferred between them, this mechanism is known as Joint Implementation, which generates—emission reduction units (ERU's)
Clean development mechanism	Regarding CDM under Article 12, the Protocol enables Annex I country to invests money within a developing country to assist them with a project to reduce emissions, and in so doing buys the rights to the reductions (called certified emissions reductions (CER's))

that rather than empowering developing countries to produce clean technology by themselves (the topic of this thesis), instead it leads to further dependency on technology transfer through free-trade mechanism from multinational corporations that are criticized for being the heaviest polluters. It is also criticized for allowing the rich countries to continue using and burning fossil fuel while paying the third world not to use fossil fuel as mentioned above. One participant in Nairobi Climate change forum said, —...it is like rich person who wants to drive Hummer car and pays to his poor neighbor to ride a bicycle. Through CER, the structural inequity in commodity trading, in general, is feared to continue between North and South by treating emission credits the same way as other commodities. Because the price of carbon credit in Europe is quite different from developing countries. For example, one tone of carbon equivalent traded in European Union at US $ 26.7, whereas outside Europe CERs are traded at very low price and the advertised price by World Bank (WB) is only about US $ 5. Other deals are being made in the range of US $ 5-10, however, these range is also very low-price range as compared to EU. Although it is not known clearly why this price difference exists, but CERs are sold in deals where prices are not revealed immediately, so it is difficult to arrive at fair price (Shah, 2009). Another fear is emissions credits may be monopolized by many corporate ventures that might become eligible under CDM projects like nuclear power plants, so-called —clean coal|| plants, industrial agriculture and large-scale tree plantations which include genetically engineered varieties have extremely serious negative social and environmental impacts. Investments in —carbon sinks|| like large-scale tree plantations in the developing countries would result in land being used at the expense of local people, accelerate deforestation, deplete water resources and increase poverty. Entitling the North to buy cheap emission credits from the South, through projects of an often-exploitative nature, constitutes —carbon colonialism. Industrialized countries and their corporations will harvest the —low-hanging fruit called the cheapest credits, leaving developing countries with only expensive alternatives for any future reduction commitments they might be required to make. Many argue and criticize that CDM project additionality requirement has got flaws, that is, all CDM projects are required to ensure that they are additional, such that only that project which would not have happened without CDM can qualify (Lloyd and Subbarao, 2008). This all means that any climate change mitigation effort made by developing countries government— as a part of policy of the country — cannot qualify as CDM work. For example, if the developing country government put in place tough emission norms for buses, the public transport sector does not get credits under CDM. If a country has established specified standards for tighter emissions on all electric appliances, resulting in huge efficiency gains and lesser emissions, it cannot apply for CDM. These projects will not be additional, but —business as usual. The current design provides developed countries with carbon credit incentives to keep polluting as long as they have the money to pick up carbon credits (Shah, 2009).

The World Bank claimed that the CDM lacks a facility through which developing countries with —obvious energy needs can be rewarded for clean development. However, most African countries 'emissions are too low for them to qualify to earn credits for carbon reductions (CEO, 2001). Therefore, when geographical distribution of CDM project is assessed regionally, the majority of CDM projects are in ASP (Asia Pacific) of about 76.33% and LAC (Latin America Caribbean) of about 21.09% and Africa left only of about 1.99%. This immediately indicates that environmentally clean technology transfer through CDM project is very low in Africa. Hence, to make carbon market work better for Africa, various initiatives should be undertaken to amend the current rules so that it can foster African needs (UNFCCC).

CONCUPTUAL FRAMEWORK TECHNOLOGY TRANSFER

Definition of technology and the processes involved

According Molder's (2006), SCOT model (Social Construction of Technology), technologies are considered to be social constructions and this is equal to saying that technologies have given shape by demands of various social groups in the society. Although the concept of technology and the objective of technology transfer process have been defined in numerous ways, little agreement has been reached concerning the meaning, content and substance of the concept. However, conventional definition of technology can be grouped into three perspectives.1) technology from the transformer perspective, that is, machines and equipment's necessary to transform raw material into finished products, 2) technology from the interface perspective, that is, man-machine interrelations emphasizing more the associated, intangible factors like skills and methods, and 3) understanding technology from a specialized body of knowledge which can take certain forms, for example processes, technique, machines, materials, or procedures (Hansen, 2008).

The definition of technology is explicitly given by ranges of literatures as mentioned above, but to make more comprehensive and broader approach, the following discussion is made. According to Müller (2003), the development of technique can be elucidated by science of technique and in most cases the science of technique is taken as the common definition of technology, but this definition of technology is not believed to be encompassing the broader and in-depth concept of technology. Technology therefore understood as knowledge of a kind. But, when technology has grown to the point that it can able to destabilize the ecosystem and human being, then it can imply more than a mere knowledge. This means that the word technique does not yield itself to the knowledge that goes with it, the organizational structures that helps the normal function of the technique, and finally the practice that are resulting in the product will also be considered when technology defined. Therefore, it requires a broader approach than science of technique resulting in a comprehensive definition of technology. The political, socio-economic and ecological effect of the application of technology is becoming the most common discourse capturing broader meaning. Hence, to solve and identify problems related to technological transformation through inter-disciplinary methods, there is a common belief that an open-ended technological conception must be developed that makes the actors comprehend the relationship between technological and knowledge that goes with it, the organizational structures that helps the normal function of the social changes. Based on this a broader concept of technology, the following definition is given:

> "Technology is one of means by which mankind reproduces and expands its living conditions. It embraces a combination of four constituents: Technique, Knowledge, Organization and Product." (Müller, 2003)

To see the effect of four fields of constituents on technology transfer (Figure 3), each components of technology can be analyzed separately. Since four components of technology are the main interacting and valid variables, they make up the major portion of technology analysis. To demonstrate the definition of technology and its constituents and to argue the following sentence, all four components are depicted as pieces of a jigsaw puzzle.

> "A qualitative change in any one of the components will eventually result in supplementary, compensatory and /or retaliatory change in the other." (Müller, 2003)

According to Müller (2003), if this does not hold true, the initial change initiative will fail to succeed. He also stated that the relationship between each component variables involved cannot exhibit one-to-one deterministic matching. However, the actual changes occurring much depend on the external variables such as the socio-political, socio-economic, and cultural settings and on the internal variables.

To describe a given technology through its four constituting components and to drive the structure of a technology from a technology transfer process perspective, it is possible to scrutinize technology as consisting of several simultaneous and often contrasting processes.

Technology as technique: The structure of technique is made up of all the physical means of production or implements, hard-ware, involved in technical process in question. To this come the raw materials, components and energy inputs that are transformed or consumed in the same process; in this sense, the process is a transformation and consumption process. These processes are set in motion by physical labor; we thus have to do with a labor process as well.

Technology as knowledge: The knowledge component or soft-ware is structured according to empirically acquired skills, tacit knowledge and institution of the direct producers and the scientific insight and creativity of the technology designers. An increasing portion of the software is being built into the hard-ware as embodied knowledge. The processes involved are physical labor processes and searching-learning processes, which include all information in put processing.

Technology as organization: The internal division of labor and pattern of specialization are central to the structure, of the organization component, of technology. Sometimes this component is implied in the software concept. However, for the sake of arguments, we call this component the "org-ware". The counterpart to the division of labor is cooperation. This requires management and co-ordination and involves all kinds of communication processes which can also be embodied in the hard-ware and/or soft-ware, or disembodied, that is, person bound" (Müller, 2003)

There are very important, yet distinct divisions of labor called the vertical and horizontal division of labor that helps to see the technology transfer from another dimension. In case of vertical division of labor, numerous, largely unconnected and similar production processes characterize the final product. Whereas the horizontal division of labor characterized by backward and forward linkages between processes of production of components that ultimately result in finished product for consumption. Here, it is also very important to see the distinction between technically and socially determined divisions of labor. Technically determined division of labor gives very low chance for alternative management arrangement and differing organizational culture and is also pre-determined. In case of socially determined division of labor, the room for maneuver for alternative arrangement is very high (Müller, 2003)

Technology as product: The product component of technology stands for the immediate result of the combination of all the above-mentioned processes. The structure of product takes indefinitely different kinds of shapes. Here, we shall just mention a distinction between material objects and immaterial services (Müller, 2003). According to Hansen (2008), the production of goods and services therefore incorporates a technique, knowledge and an organization element, which together constitutes the producing technology.

Considering product as integral part of other three components of technology, the approach and the concept considered here is quite different from most other technology concepts. The major reason of this consideration is explained hereafter.

The approach here focuses on the fundamental concepts of components technology that enable one to make comprehensive, purpose-oriented application of technology. Others believe technology to earn a product. But the new approach considers technology including product and its other components to satisfy needs or help to solve problems.

The product cannot be taken as final destinations of the whole processes. Well-informed choice of product is the result of combined choice of technique, knowledge and organization. A key element here is the choice of products before combined choice of other components of the technology. The processes of production involving the technology usually result in product which has use value and later ultimately enters consumption process phase. Now, most consumption processes are new production processes. As result, the product bridges the gap between consecutive production processes (Müller, 2003).

IMPLICATION OF SOCIAL CARRIERS IN ENVIRONMENTALLY CLEAN TECHNOLOGY TRANSFER

The type of change occurring in the society put limits on social and cultural setting of technology receiver and technology supplier relationship which plays an important role in environmentally sound technology transformation under specific social formation. This is equal to saying; the social setting of the overall structure of the society is governed by the type of change occurring in the society. There are several social entities under changing institutional set ups, but acting within certain limits is called actors. The concept of social carriers of technology can be applied to this social set up when these actors are involved in processes of technology selection under actor-structure interrelation (Müller, 2003). The best practice to choose any technology including environmentally sound technology by social unites should consider the following six mandatory conditions. These steps are necessary but not enough:

1. Interest: Social unit should show motivation to apply and obtain the technology.
2. Power: The social unit must have a power of socio-political nature and economic means to materialize its interest.
3. Organization: The unit needs well established organization to exercise its power in the process of technology transfer.
4. Information: To meet its requirement, the social unit must have enough information to select cutting edge technology from different alternative.
5. Access: The unit must be able to obtain the required cutting-edge technology for predetermined purpose through procurement.
6. Knowledge: The know-how is another most important per condition to operate the technology at his disposal. Under the umbrella of a joint venture or any other deal structure, two or more than two different social unties should come together to exercise combined social carries of technology character. Depending on the institutional setting of the social unit and infrastructure at its disposal, the conditions elaborated above are divided into two, they are socially determined conditions from 1-3 and technological determined conditions that are from 4-6. Between these two conditions, the social division of labor is

found as determinant for both sets of conditions. The task network of the actors is used as a means through which actor-structure interactions take place. The technological capability of the society is measured by the aggregate of single, combined and linked carriers of technology.

This capability can manifest itself in quantitative and qualitative dimension. The degree of magnitude of the capability is demonstrated by the number and size of the actors of social carriers of technology, whereas the potential ability to satisfy human needs and solve social problem is measured by the content, range and level of technologies carried by unities (Müller, 2003). Therefore, to exploit this basic concept to the objective of this thesis, the development of societal and organizational structures that enable well-informed choices of technologies which promote climate stability, adaptation to the effects of climate change and SD is essential. To a large extent, the state of the environment today is the result of the technological choices of yesterday. Similarly, the state of the environment in the future will be determined largely by the technologies we choose today (Karakosta et al., 2010).

SOCIALLY SUSTAINABLE INTERNATIONAL TECHNOLOGY TRANSFER

Development assistance and international research cooperation have a role to play in encouraging the international transfer of clean 'technologies. Clearly, market factors are important and countries with close economic ties are most likely to transfer technologies between themselves. However, OECD analyses demonstrate that high technological capacity in the recipient country is a key factor in encouraging transfers. Countries that innovate themselves are more likely to benefit from innovations originating elsewhere. As such, actions by developing countries to put in place policies that constrain emissions and drive local innovation supported through capacity building will also be critical to encouraging more transfer of low-carbon technologies (OECD, 2009). According to Karakosta et al. (2010), at Global scale, Sustainable Development (SD) will require radical technological and related changes in both Annex I and Non-Annex I countries. In Non-Annex I countries like South Africa, the Economy is developing very fast, but it will not be sustainable if this country simply follows the old, historic polluting trends of industrialized countries. Rapid development with modern knowledge offers many opportunities to avoid bad past practices and moves countries towards more fascinating and better technologies, techniques and associated institutions. The literature indicates that to achieve this objective, developing countries require assistance with building strong and sustainable human capacity (knowledge, techniques and management skills), developing appropriate institutions and networks, and with acquiring and adapting specific hardware (Karakosta et al., 2010).

According to Müller (2003), based on the conceptual framework and models elaborated above, it is possible to make a comprehensive approach to deal with the most conspicuous features of such a technology transfer to achieve an anticipated objective. Technology transfer is a process by which expertise or knowledge related to some aspect of technology is passed from one user to another for economic gain. In the case of the transfer of low-carbon technology, the economic benefits include the mitigation of the future costs associated with climate change as well as any financial benefits to the companies involved in the transfer process (Karakosta et al., 2010). However, neither business nor the social problems of the developing countries have apparently been solved and their anticipated objectives are not achieved effectively through several projects implemented under international technology transfer processes (UNEP, 2004). These projects have mostly gone wrong somewhere during planning and implementing processes. To this end, here an outline of selected conceptual and methodological issues that help to understand the planning and implementation problems involved during international technology transfer will be seen (Müller, 2003). A technology package sent from the North to the South is transferred from one social setting to another and does not fit into the latter. This problem may be solved in 3 ways:

Option 1: The technology being supplied is fully adapted to the social setting of the receiver.
Option 2: The social setting of the receiver is fully adapted to fit the technology supplied.
Option 3: Both the technology supplied, and the social setting of the receiver are changed or "moved" to fit each other at some point, which hardly can be pre-determined (Müller, 2003) .

According to Mulder (2006), technologies are social constructions to which various groups of people have been shaped. In the 1970´s, Option 1 was a well-accepted transfer method. In this case, the technologies transferred to developing countries should be appropriate to the local conditions. However, this appropriate technology would already be there in developing country and at the end of the day this strategy consequently leads to stagnation. Therefore, new technology with corresponding process of adaptation and transformation should be introduced to cope up with this problem.

Option 2 is very similar to saying, bringing new technology from abroad and trying to adapt to very different societal setting and local conditions hopping to work accordingly will also not be feasible. This option to work on the real world would imply that the social setting of South Africa should be the same as the social setting of Denmark, this may take some centuries and even more.

Only by leaving the either-or notion and opting for something of both, that is option 3, where both the technology and the social setting are changed, a sustainable assimilation process may be set in motion. In general, there is no single way and clear-cut "recipe" for what must be done. Every possible case should be treated separately (Müller, 2003).

According to Müller (2003), there are different assumption made to reveal the possible barriers of effective technology transfer from supplier to receiver and they are: area of relative ignorance emanates from those features of social settings which are the most important steps for successful technological development, formation and application. These important preconditions are usually taken for granted by technology supplier that is they are not consciously considered by him. This equal to saying that the technology supplier has incomplete knowledge about social setting in which he has developed, formed and applied the technology in question. But technology supplier has complete knowledge about the technology he supplies. The technology receiver has at least complete knowledge about his social setting, but he has incomplete knowledge about the technology he wants to acquire and at the same time the technology supplier failed to consider all social settings that are crucial for effective technology transfer, then in most cases the receiver of technology left with passive knowledge. However, any efforts put in place before technology transfer to adopt new technology to the local social setting will be fruitless until both parties clearly understand that they have problem (Table 2). Usually, there is an assumption that the technology supplier has complete knowledge about what he put on sell.

However, the truth is different from what is usually assumed, and the technology supplier rarely has complete knowledge about the social conditions in which he has developed the technology in question and about his own social setting which made him to apply the technology effectively. Therefore, technologists who are supplying the technology have been used to describe the processes by which ideas, proofs-of concept, and prototypes move from research-related to production-related phases of product development (Bozeman, 2000).

According to Müller (2003), the social setting is a point where the incomplete knowledge of the supplier is manifested. As far as the supplier 's knowledge of the technology is concerned, only very small part of the supplier 's knowledge of technology consists of what usually called codified knowledge, but the major part of the knowledge of technology supplier is found in the knacks and bones of the person involved in that technology operation. This knowledge consists of tacit knowledge and mostly not easily available to the receiver even if the supplier is willing to transfer all the knowledge.

TECHNOLOGY TRANSFER AND DYNAMIC ASSIMILATION

Effective Technology with increased production capacity and long-lasting effect can be put in place, only if a dynamic assimilation process of the technology transfer is initiated in the receiving enterprise and society. To this end, more intensive interaction with technology suppliers, and their more active involvement in the project activities should be beneficial in delivering more knowledge and especially the tacit and sociocultural components of the technology which bridges the gap between two parties, clarifying, for the user, the potential of the technology, and facilitates the supplier's ability to provide the necessary inputs (Doranova, 2009). Considering five different options for various levels of technology transfer, it is possible to find the most common technology transfer mechanism from the consumption level that is the direct supply of the product of the technology in question. In this case it is also possible to consider a set of wind power plant equipment's sent to receiver country like South Africa from any one of Annex I countries. In this specific case the most important market assimilation takes place in such a way that some kind of ―know-who is transferred in the form of demand and market knowledge (Who will and can buy the product?). At the fourth level, which is called application level, it is possible to find what is usually conceived as technology transfer from supplier to receiver. In this case technology for the manufacturing of product can be transferred either in the form of a wind power plant equipment or a machine that can manufacture wind power plant equipment. In this specific case the most important technology transfer takes place in the form of ―Know-how which is crucial for operative assimilation processes. This transfer includes both the knowledge and skills required to run and maintain the equipment, and furthermore it involves the transfer of the most important part of dynamic assimilation of technology transfer processes comprised of increasing the capabilities to replicate the technology transferred. It consists more than a simple ―Show-how process which can be obtained from the operation and maintains manuals, as well as short lived instruction courses. This knowledge accumulates through experience including production, design, investment, improvement, etc. Thus, the broad view of technology which encompasses not only machines and equipment, but also the skills, abilities, knowledge, systems and processes are necessary to make things happen. Furthermore, technologies are meant to be composite systems that include know-how, procedures, goods and services, as well as organizational and operational measures (Doranova, 2009). Naturally, the conditions of social setting of the enterprise under which it is working are undergoing a constant change to make the enterprises to cope up with the circumstances it will able to transform and adapt its technology. In the medium-term perspective, enterprises can survive only by building capacity to enter an adaptive assimilation and this can hold true when the necessary ―Know-what ―knowledge of every in and out of the technology in question is acquired. In turn this knowledge gradually be obtained from the operative assimilation level or it can also be obtained through a

Table 2: Criteria for questionnaires design.

S/N	Country	Criteria	Indicator
1	South Africa	Economic	Feed-in-tariff (Renewable energy), investment policy (Subsides, incentives), infrastructure development (Road, Electricity, Air-transport, Internet, Telephone)
2	South Africa	Political	Political stability (Good governance), Environmental policies, Eskom and its regulatory influence
3	South Africa	Social	Crime and security, Red-tape and corruption
4	South Africa	Technological (Technology constituents its effect technology transfer)	Rather than Know-how skill, show- how skill transfer processes from capacity development perspective, Viability of technology to the local condition, from local cultural perspective and context

Source: DNA South Africa.

technology transfer directly aimed at the formation level. These transfer process comprised of the transfer of design out-line, preliminary prototype for testing and other engineering formation activities. This indicates that adaptation processes are usually undertaken in close cooperation between the supplier and the receiver on locality prior to operation. It is rare to see technology transfer at the development level. The in-depth —know-why —mostly presupposed by the initiation of an actual innovative assimilation processes and it is equivalent to say that applied research in products and processes helps to acquire knowledge of the totality of scientific principle on which the major technology based. This is equal to say the knowledge of the total scientific principle on which the major technological innovation established can be acquired through applied research in new products and processes. The whole idea is to promote the optimal level of effective transfer of technology based on well established strategic choice; every actor involved in technology transfer venture should preferably have an overview of the required dynamic assimilation processes. From figure it is possible to see the downward and upward development of adaptive assimilation level. In long run it is expected that the right side of dynamic assimilation entity would be equal to the left-hand side. The whole focus of the transfer processes goes to the right side of the model. To this end, the transfer process, which is considered as supplementary processes on the creation of technological capability and formation of technological dynamism, is on the receiver side (Müller, 2003).

CDM IN SOUTH AFRICA

According to United State of America, Department of State (US DS) (n.d) estimation, the population of SA(South Africa) is 47.5 million people which comprised Black 79.7%, White 9.1%, Colored 8.8% and Asian(Indian) 2.2%. South Africa is endowed with a spectrum of natural resources including minerals, ranging from precious metals to precious stones and coal (UNIDO, n.d). Natural resources comprise of almost all essential commodities for both export and local consumption, except petroleum products and bauxite. It is the only country in the world that manufactures fuel from coal (US DS, n.a).

The National Energy Regulator of South Africa (NERSA) granted licenses to ESKOM to operate legally, first under the Electricity Act number 41 of 1987, most lately under the Electricity Regulation Act number 4 of 2006, and by the National Nuclear Regulator in terms of the National Nuclear Regulatory Act number 47 of 1999. To meet the growing demand of electricity due to rapid industrialization, ESKOM is undertaking a massive building programme of $51 billion that is in nominal terms over the five years up to 2013. Since the building programme has started in 2005, additional capacity of 4, 454 MW has been commissioned up to 30 April 2009. The ESKOM Enterprises (Pty) Limited group, a wholly owned subsidiary of ESKOM Holdings, provides project lifecycle support and plant maintenance, network protection and support for the building programme for all ESKOM divisions. The ESCAP Limited and GALLIUM Insurance Company Limited subsidiaries are the two core ESKOM Enterprises (Pty) Limited business groups that have a major task which includes the granting of employee with home loan and the management and insurance of business risk (ESKOM, 2010).

CHALLENGES FROM A CENTURY-OLD LEGACY OF COAL BASED POWER SOURCE IN SA

In South Africa, due to low running costs of coal-fired power plant consisting of low fuel and labor costs, cheap electricity generation by ESKOM could continue to meet projected demand and remain stable and the position of ESKOM will be kept for time to come. Hence, because of very low unit cost of electricity due to very low generation cost by ESKOM, Independent Power Producers (IPPs) are kept away from entering the Energy production and distribution market to operate and make a reasonable return even with coal power plant which is much cheaper than renewable energy source. As coal is being extracted locally, there is absolute dependence on coal as a major fuel source for generating electricity. Therefore, ESKOM, as national utility, is responsible for consuming the bulk of domestic coal supply of the entire country. This national utility went far behind of offering electricity to all municipalities in the country at very low rates than the municipalities themselves were able to produce. For example, in the City of Cape Town, the Athlone power station used to provide some part of total electricity to the city using coal and the feedstock had to be transported into the power station by some means of transportation like road or rail from the mining centers in the North of the country. This added to the total cost of producing a unit of electricity and subsequently the City of Cape Town decided to shut down the Athlone power plant and started by power from national grid. Contrary to this, the majority of ESKOM's coal-fired power stations are located in Mpumalanga region where the coal mining fields are located and this gives ESKOM additional advantage to produce electricity very cheaply. As least cost supplier of electricity in the country, the National Utility ESKOM is not interested to enter into even off-take agreements with IPP because the power supplied by IPP would cost ESKOM more than what ESKOM could produce by its coal power plant (Tsikata and Sebitosi, 2009).

Furthermore, a considerable amount of government budget in SA comes from the premium paid from ESKOM revenue and this has strengthened the position of ESKOM by preventing the intention of the government to introduce IPP into the ESI sector despite the substantial amount of government efforts to diversify energy source through policy documents which helps the country to source up to 30% from non-traditional energy source like renewable energy source. The traditional power source in the South African context is coal-fired, dirty national grid. Although 30% of anticipated new energy generation capacity of the country is expected to emanate from the IPP sector, the requirement that the government put in place to make ESKOM as the only and the sole buyer of the power generated by IPP produced serious doubt with private investors to involve in the sector so ESKOM will remain a big challenge in future despite strong resistance from trade unions and costumers due to its double digit tariff increase for the new around (Tsikata and Sebitosi, 2009).

Thus, currently, South Africa is some way off from exploiting the diverse gains from renewable energy and from achieving a considerable market share in the renewable energy industry. South Africa's electricity supply remains heavily dominated by coal-based power generation, with the country's significant renewable energy potential largely untapped to date (NERSA, 2009).

The major reasons for a policy of security of energy supply dependence on one source called coal are the relative abundance of the source locally for the coming 300 years and having technology and appropriate skill to convert coal into fuel. This situation in the country brought about more consequences like exclusive dependence on century-old, centrally based power generation model from low-grade coal resulting in an extremely very low consumer tariff (Tsikata and Sebitosi, 2009)

On the other hand, exclusive study on Renewable Energy (RE) shows South Africa is blessed with high levels of renewable energy potential (Gaast et al., 2008), including an abundant wind resource (particularly strong along coastal areas), amongst the highest levels of solar radiation in the world and excellent potential for the use of pulp and paper, bagasse and other biomass by-products in energy generation. For example, it is estimated that biomass byproducts alone could provide more than 12,900 GWh of electricity per annum (NERSA, 2009).

Given the minerals-energy-complex as a prominent feature of the economy, the energy component comes under more attention and the possibilities for adapting to environmentally clean economy are greatly influenced by the type of energy sources used to generate power in South Africa (Painuly et al., 2007). More expected scenario is that demand for energy will continue to grow as South Africa continues to be located as an industrial cluster in SSA. As far as this demand is entirely dependent upon cheaply available power, the use of coal as the feedstock fuel for power generation within the current structure of the Electricity Supply Industry (ESI) is supported by the government (Tsikata and Sebitosi, 2009) 1600 MW, respectively. Industry is responsible for the biggest share of consumption and with the current macroeconomic strategies, this scenario is expected to continue (Tsikata and Sebitosi, 2009).

Therefore, even though more developed and emerging economies have shown willingness and some interest to make the systematic shift to environmentally clean economies, South Africa 's ability to undergo such a change to environmentally clean economies from traditional power source is not very clear as all possible evidence shows a continued dependence nearly on a single resource for energy security-coal fired plant. The prospect for renewable energy source to enter into such a competitive market equally with traditional energy source is questionable in the current working environment. At the end of the first quarter of 2009, the National Energy Regulator (NERSA) announced feed-in-tariffs (REFIT) for wind and concentrator solar power (CSP) generation (Tsikata and Sebitosi, 2009).

A renewable Energy Feed-In Tariff is a mechanism to promote the deployment of renewable energy that places an obligation on specific entities to purchase the output from qualifying renewable energy generators at pre-determined prices (NERSA, 2009).

The approved REFIT Guidelines will create an enabling environment for achieving Government's 10 000 GWh renewable energy target by 2013 and sustaining growth beyond the target (NERSA, 2009). However, investor 's response to the announcement would appear to be low tone. This lack of interest of investors emanates from expectation of very weak market environment (Tsikata and Sebitosi, 2009)

Generally, Renewable Energy (RE) could be defined as naturally occurring non- depletable sources of energy, such as solar, wind, biomass, hydro, tidal, wave, ocean current, and geothermal (NERSA, 2009). These sources can be harnessed to produce electricity, gaseous and liquid fuels, heat or a combination of these energy types. In South Africa, qualifying RE sectors defined as new investments in electricity generation sector using the following: Landfill gas power plant; Small hydro power plant (less than 10MW); Wind power plant and Concentrating Solar Power (CSP) plant (NERSA, 2009).

ESTABLISHMENT OF DNA AND CDM PROJECTS IN SOUTH AFRICA

In South Africa, Global climate change and greenhouse gas emissions are taking important place as a major issue in the country; however, the country has other pressing problems such as poverty, unemployment, HIV/AIDS and education/health as main priorities (Ameley, 2008). The CDM has great potential in SA as the country registered the highest and a foremost emitter of greenhouse gases in SSA (Sub-Saharan African countries) due to high dependence on coal-based energy (UNDIO, n.a). During the interview, one of the respondent from CDM Africa consultant company Mr. Johan also explained the reason why SA has large number of CDM projects in Africa, and he said he has two reasons for this and continued, —…the first reason is South Africa has very dirty baseline emission because South Africa uses coal dominated power generation and displacement in South Africa by renewable energy is very high and that is we get otherwise more than one kg carbon dioxide per every one KW power generation whereas in other neighboring African countries the baseline is hydropower and the baseline emission is almost zero and sometimes they are importing power from South Africa, and the CDM rule says there is no development of CDM project for emission zero baseline (Seres et al., 2008). Because of suppressed demand, many of South African country's electricity is very low grid connection from renewable sources for many people and it is difficult to show that you are displacing dirty power because you have hydroelectric power which has already emission factor that is almost negative or neutral. The other reason is the skill concentration in other African countries in CDM project is very low where as in South Africa is very high, I think these are two major reasons for uneven distribution of CDM in other African countries as compared to South Africa."

Projects submitted for initial review and approval by DNA belonged to the following sectors: Bio-fuel, Energy efficiency, Waste management, Cogeneration, Fuel switching, Hydropower, Manufacturing, Mining, Agriculture, Energy waste management, Housing, Transport and residential energy efficiency (DNA, 2010). In South Africa, the majority of the CDM projects are in landfill to Energy sector. However, in contrast to the fact that the country has long been the most attractive CDM host in Africa and given its strong dependence on coal which allows for many different CDM project types to be developed, the number of registered CDM projects are still very low in South Africa (GTZ, 2006).

As compared with countries like in ASP and LAC regions, since South Africa is within ‗others ‗in percentage registered project activities by host party, the percentage registered CDM projects distribution is very low. But out of 44 registered projects in Africa, 17 projects are in South Africa showing better performance as compared with other Africa countries in the world, with per capita emissions being higher than those of many European countries and more than 3.5 times higher than the average for developing countries (DST, 2007).

As mentioned above, South Africa joined most countries in the international community in ratifying UNFCCC convention in 1997 and to fulfill its obligation under the UNFCCC, a few projects related to climate change have since been undertaken by South Africa. These include the preparation of greenhouse gas (GHG) inventories, which comprises one of the inputs to the agreed National Communications (NC) to UNFCCC. Therefore, the first national GHG inventory in South Africa was prepared in 1998, using 1990 data. It was updated to include 1994 data and published in 2004. This was developed using the 1996 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories. The current report presents the third national estimation of greenhouse gases, using year 2000 as the base. This GHG inventories have been prepared using to a large extent the 20006 IPCC Guidelines for National Greenhouse Gas Inventories (DEAT, 2009).

ESTABLISHMENT OF DNA AND THE DNA COMMITTEE

On August 29, 1997 South Africa ratified the (UNFCCC) and acceded on July 31, 2002, the Protocol that was adopted on December 11, 1997 at the third Conference of Parties to the UNFCCC in Kyoto, Japan and the Protocol is referred to as Kyoto Protocol. To meet these requirements, the government of South Africa has appointed the Department of Minerals and Energy with the task of establishing and operating a Designated National Authority and mandated the establishment of the Designated National Authority committee (DME, 2004c).

In South Africa, DNA committee is responsible for overlooking the implementation of CDM projects including considering and reviewing projects and activities submitted to the committee by DNA. It supports, the DNA in its mandate responsibilities by providing advice to the Authority and will have an oversight role to ensure that DNA is fulfilling its mandate effectively. The committee comprised eight members representing the following departments: Mineral and Energy, Environmental Affairs and Tourism, Water Affairs and Forestry, Foreign Affairs, Trade and Industry, Agriculture and Land Affairs, Transport, The National Treasury.

The departments represented in the committee nominate the members of the committee and the major function of the committee includes: the consideration of CDM projects submitted to the DNA for approval; the development of the administrative guidelines and arrangement required for the effective functioning of the DNA; review of the DNA business plan and work programmes; the establishment of sub-committee for the coordination of CDM promotion in South Africa; making recommendation about the implementation of the CDM in South Africa to the Department of Minerals and Energy and appropriate cabinet; the preparation of such reports as may be required by government from time to time; the monitoring and evaluation of the DNA's performance and such other responsibilities as may be given to it by government

The representative of the Department of Minerals and Energy (DME) shall chair the committee and heads the committee and organize meeting (DME, 2004b).

CDM PROJECT CYCLE IN SOUTH AFRICA

As a rule, all Clean Development Mechanism (CDM) projects must go through a "project cycle". Some steps shown in this cycle are like any other investment project - such as raising finance and implementing the project. CDM projects are different from other development projects because CDM have got the special requirements of qualifying and overseeing the project as a true and genuine project, that is, the projects should be real, measurable and long-term environmental benefits. Each of the steps in the project cycle is explained in detail - particularly the various approval processes through which a project must pass before it can become an official CDM project. Furthermore, CDM projects must also involve specific elements of public consultation and information.

Step 1: Project identification and design

The first step of CDM project cycle is the project owner identifies an opportunity for a CDM project and develops a Project Design Document (PDD) that includes a baseline estimate and an analysis of the net carbon emissions reductions.

Step 2: Host country approval

This step handled by the Designated National Authority (DNA) of South Africa. In most cases the host country approval process can happen ―in parallel" with the validation process but it is required before a project can be submitted for registration to the Executive Board.

Step 3: Third-part validation of the project design document

In this step the responsible office is Designated Operational Entities (DOE). This is a third party, neither the project developer nor the DNA, accredited by the Executive Board of the CDM based on its technical expertise and experience with carbon mitigation and relevant technologies.

Step 4: Registration

Once a project is validated by DOE and approved by the host country DNA, it will be registered by the CDM Executive Board if it meets the requirement of the Board.

Step 5: Financial Facility and structuring

This step is associated with facilitating financial security. The investors provide capital for the implementation of project in the form of debt or equity. These investors may or may not be the carbon buyers who will pay for certified credits on delivery everything depends on the type of deal structure considered as indicated in methodology part in section 2.6. According to (UNEP, 2004) the project owner is the one who undertakes the specific CDM Project activity and he is the legal owner of any CERs produced and entitled to deal with them exclusively.

Step 6: Implementation and operation

After building the project, it will undergo commissioning and begin operation.

Step 7: Monitoring

Before it will be verified by DOE for certification, Project performance, including baseline conditions, is measured by the project developer in the commissioning process and during ongoing project operation.

Step 8: Third-part verification of project performance

To be sure that the project meets all requirements mentioned in PDD, an independent third party that is a

Designated Operational Entity (DOE) verifies project performance against the validated design and baseline to approve certification.

Step 9: Certification and issuance

This is the final step in which the generated carbon credits are issued. Depending on the host country approval, the validated project design and baseline, and the verified project performance, CERs are certified by a DOE and issued by the CDM Executive Board.

CDM PROJECT APPROVAL PROCEDURE IN SA

On 24 December 2004, the Minister of the Department of Environmental Affairs and Tourism of South African published a regulation, under Section 25 of the National Environmental Management Act (NEMA), establishing the DNA in an official newspaper (Government Newspaper). The DNA was established under this regulation within the Department of Minerals and Energy, and to oversee the activities of CDM in South Africa, the regulation provides the DNA with legal mandate (Goa and Martinez, 2010). To assess the voluntary participation in the CDM, the function of the DNA is very important because the rules which govern the CDM require a letter of approval of the project from the DNA of the host country. Sustainable Development (SD) criteria is one the binding criteria of CDM projects approval processes in South Africa. In approval processes, the projects that are creating local manufacturing capacity and brining substantial benefits to the local community have given high priority and well promoted. According to SA DNA, there are two possible staring points for a CDM project approval process: voluntary screening and mandatory submission. A project Identification Note (PIN) is submitted voluntarily in the first option and which gives an opportunity and an advantage to DNA to have an initial screening and to provide feedback to project developer whether a given project compiles CDM project approval criteria of the country or not, for example sustainable development criteria of South Africa. The initial screening result of the project will be informed to project developer within 30 days of the submission of the application form and PIN. The Project developer has every right to request and receive a letter of no objection from the DNA if the initial screening result is positive. The letter of the initial screening result of the project will be required to include the summary of the performance of the project against the sustainable development criterion. The provisional letter of the initial screening result of the project by DNA shall in no way compromise the opinion, independence or transparency of the DNA when subjecting the project to the formal evaluation process required for the granting of the formal approval letter required from the DNA well before submitted to CDM Executive Board (Goa and Martinez, 2010).

A detailed description of the Project Design Document (PDD) and its accompanying application form is submitted in the second option for final approval by DNA and this option is mandatory in both cases. PDD is posted by DNA on its website for public comments for a period of 45 days, and then the project is validated before final approval letter is issued. The advisory committee comprised of different ministerial offices will submit comments to the DNA on the project during the public consultation period before a final decision is made. Finally, the Director of the Department of Minerals and Energy will prepare a Letter of Approval (LoA), if the project is successful (DME, 2004c). Whenever DNA finds a project contrary to the objective of the Kyoto Protocol or contrary to the intention of stated government policy of the DNA, DNA reserves the right to refuse project approval until the project design document is changed to obey the rules and regulations established. However, the DNA must provide clear reasons and evidences for the rejection of a project as indicated in CDM project approval process (DME, 2004a).

CDM PROJECT APPROVAL CRITERIA OF SOUTH AFRICA

During the Marrakech conference15 in 2001 participants in CDM projects were agreed with procedures of CDM and accordingly they will have to provide ―written approval of the voluntary participation from the designated national authority of each party involved, including confirmation by the host party that the project activity assists it in achieving sustainable development. Project Design Document (PDD) is required and prepared by project developer for any type of CDM project activities to be approved by DNA well before registered by the CDM Executive Board. The registration of a potential CDM project with the United Nations Framework Convention on Climate Change Executive board requires approval of CDM project by host country DNA. The rules which govern the CDM require a letter from the DNA of the host country which confirms that the project activity assists it in achieving sustainable development. The CDM procedures leave the definition of what sustainable development means to project host country as it is a sovereign decision of each developing country. Therefore, for South Africa ‘s participation in the CDM, there has to be a procedure in place for deciding whether a proposed CDM project does assist the country in achieving sustainable development. The approval procedure to be followed is provided below. A companion document outlines the criteria to be used by the DNA in evaluating whether project ‘s support sustainable development. In the National Environmental Management Act (NEMA) of South Africa, sustainable development is defined as ―the integration of social, economic and environmental factors into planning, implementation and decision making to ensure that development serves present and future generations‖. This definition of sustainable development will inform the DNA to give due attention when it passes the decisions of the

CDM project approval (DME, 2004a).

SUSTAINABLE DEVELOPMENT CRITERIA OF SOUTH AFRICA

Three major criteria are used, according to the NEMA definition of sustainable development (SD), to assess the contribution of the proposed project to sustainable development in South Africa. These are supported by additional indicators to allow the DNA to effectively regulate CDM project activities in South Africa. To evaluate CDM projects submitted to the DNA, the DNA takes into consideration the following three major Sustainable development criteria: a). Economic: Economic aspect of sustainable development requires whether or not the project meets the national economic development of the country. b). Social: Social aspect demands the contribution of the project to social development in South Africa. c). Environmental: Whether the project really conforms to the NEMA principles of sustainable development (Goa and Martinez, 2010). These are the —SD criteria of CDM projects in South Africa and require the consideration of the following factors: 1). The first of the criteria stipulates that the disturbance of ecosystems and loss of biological diversity are avoided, or where they cannot be avoided, are minimized and remedied. 2). That pollution and degradation of the environment are avoided, or where they cannot be altogether avoided, are minimized and remedied. 3). That the disturbance of landscapes and sites that constitute the nation's cultural heritage is avoided, or where it cannot be altogether avoided, is minimized and remedied. 4). That waste is avoided, or where it cannot be altogether avoided, minimized and reused or recycled where possible and otherwise disposed of in a responsible manner. 5). That the use and exploitation of non-renewable resources is responsible and equitable and considers the consequences of the depletion of the resource. 6). That the development, use and exploitation of renewable resources and the ecosystems of which they are part do not exceed the level beyond which their integrity is jeopardized. 7). That a risk averse and cautious approach is applied, which considers the limits of current knowledge about the consequences of decisions and actions. 8). That negative impacts on the environment and on people 's environmental rights be anticipated and prevented, and where they cannot be altogether prevented, are minimized and remedied.

In determining the answers to questions 1-3 the DNA should be informed by consideration of the project indicators provided (DME, 2004a).

CRITERIA APPLICATION AND REASONS FOR THE DECISION

The DNA considers each project application against the three major criteria and will assess whether the project is in harmony to supports sustainable development objective in the country. There can also be possibility that projects will have adverse impact on one or more dimensions of sustainable development and a promising impact on the other dimensions. In such cases the DNA, in fulfillment of its regulatory role and with support from the inter-departmental advisory committee, will assess the overall contribution or otherwise of the project to sustainable development. The reasons for the decision should clearly be provided by the DNA by writing letter of decision in specified period. In these reasons the DNA will set out the analysis behind the decision and will note the expected performance of the project against the relevant indicators used. Since the numerically weighting indicators are highly complex, the DNA does not use a pre-defined formal scoring system to score and evaluate projects (DME, 2004a).

CASE STUDIES OF CDM PROJECT IN SOUTH AFRICA

Case study 1: PetroSA biogas to energy CDM project

Location of the project

The petroleum oil and gas corporation of South Africa (PetroSA) hosts the PetroSA CDM project activity within approximately 265 hectares of land. PetroSA plant is situated adjacent to the N2 highway at northern side of the farm Duinzicht, approximately 12 km from the town of Mossel Bay in the Southern Cape, some 360 km east of Cape Town. There are security measures in place and visitors need to be accompanied but PetroSA's Environmental Leader can be able to point out the exact project site within the facility– opposite to the anaerobic digesters (UNFCCC, 2005).

PetroSA biogas to energy cdm project description

PetroSA (The Petroleum Oil and Gas Corporation of South Africa) has been operating as a gas to liquid plant since 1987 at Duinzcht. It is a state-owned corporation that is situated at the town of Mossel Bay on the south coast of South Africa. The principal process of PetroSA refinery comprised of the conversion of natural gas produced offshore to synthetic liquid fuels via Fischer Tropsch GTL(Gas-To-Liquid) process. The refinery has a capacity of 36,000 bbl/day GTL, this is a crude oil equivalent capacity of 45,000 bbl/day.

The production process at Duinzicht leads to organic waste water that has been undergoing anaerobic digestion since the commencement of the Plant. The anaerobic digestion is continuous and a critical process for the operation of the PetroSA plant and care is thus taken by PetroSA to maintain the digester in a good working condition and monitors its performance. To monitor a performance, daily sample is taken and analyzed by PetroSA to establish the COD (—Chemical Oxygen Demand||) of the water going in and out of the digesters. The performance of the system is logged by a computer at PetroSA for further analysis. The gas normally collects in the tops of the digesters and rise up though the pipes to the flare. The gas flow rate is 1900 m3/h at 21°C. In the anaerobic digestion process, biogas is naturally generated. This biogas has been flared by flaring apparatus installed in the smokestack of the plant and over lifetime of the plant equivalent to at least 1300 GWh of gross heat value has been wasted this way (UNFCCC, 2005).

While PetroSA buys significant quantities of electricity from the national grid, the gas that was flared creates no energy benefit for the company within the last 15 years. If the GE Jenbacher engines are used to generate electricity from the gas that would otherwise have been flared, the CO_2 emissions from the project site will for practical purposes stay the same but there will be a displacement of grid electricity. At present the grid generates approximately 0.963 kg/kWh in CO_2 emissions and thus the approximately 31 631 MWh of electricity generated annually by the project activity will displace emissions from the grid of approximately 30 461 tons of CO_2 per annum. Over the lifetime of the project that is over the crediting period of 10 years, this figure will be an average of 29 933 per annum if 31 631 MWh of electricity is generated and this estimation was made considering the periodic PetroSA shutdowns for maintains (UNFCCC, 2009a). The MethCap SPV1 (Pty) Ltd is the project developer which owns, operates and maintains the plant as an Independent Power Producer (IPP) and the plant is financed from two essential revenue sources: Electricity sales to PetroSA and the sale of Certified Emissions Reductions through the CDM. The project was registered as CDM project by the UNFCCC under reference number 0446 on September 29, 2006 and crediting period started January 10, 2007. The project is not financially viable because both NPV (Net Present Value) and IRR (Internal Rate of Return) of the project are less than zero without carbon finance in the form of Certified Emissions Reductions and faces investment barriers, barriers of prevailing practice, barriers regarding capacity short-comings and other project)(UNFCCC, 2008) Case study I project stakeholders (UNFCCC, 2008), barriers confirming the project is additional. The additionality of the project was demonstrated by both investment analysis using financial indicators and barrier test. Regarding national policies/laws/regulations to establish the baseline emission projection of the Project Activity in this specific case study, what is however important is a discussion of the Demand Side Management (—DSM||) fund. The National Energy Regulator of SA (NERSA) put in place Energy Efficiency and Demand Side Management Regulatory Policy in May 2004 and is aimed in financing energy efficiency and renewable energy projects. Crucially, this policy was implemented after 11 November 2001, which means that it may not be considered in developing the baseline scenario (That is the baseline scenario should refer to the hypothetical situation where the DSM fund is not in place.) According to a CDM Executive Board 16 annex 3 decision17, this type of policy is classified as an —E-— policy as per paragraph 1(b) and (3) of the decision as follows: —if there is a national and/or sectoral policy that gives positive comparative advantages to less emissions-intensive technologies over more emissions intensive technologies (for example public subsidies to promote renewable energy or to finance energy efficiency programs) then, if the policy has been implemented after 11 November 2001 it may not be taken into account in developing the baseline scenario (that is, the baseline scenario should refer to a hypothetical situation without the national and/or sectoral policies or regulations being in place). Since the project activity is aimed at generating renewable electricity from biogas emanating from wastewater treatment, the project activity can be placed within the chosen category such as approved small-scale methodology AMS-I.D. In the baseline scenario methane is already recovered and flared and there is no methane recovery as envisioned by AMS-III.D thus AMS-III.D is inapplicable. Hence, the Project Activity complies in all respects with the requirements to use AMS-1.D18: Grid connected renewable electricity generation -version 9 (UNFCCC, 2005).

Contribution to sustainable development

Economic: The project adds to South Africa 's energy supply, adds an IPP, leads to energy diversification and creates a source of renewable energy. In the planning/construction phase,the project will create work for 60-100 people and long-term work for one or two people in the plant maintains and operation. Social: The project owner and developer MethCap SPV 1 makes a payment of $13,158 per annum to the local municipality called Eden District Municipality to support poverty alleviation social programme. The District Municipality will report back annually to the developer on how the funds were spent. Environmental: The environmental benefit from the project will be the more efficient use of energy and displacement of some grid emissions in South Africa (UNFCCC, 2005).

Technology selected, and monitoring method employed

According to UNFCCC decision 17/CP.7 paragraph 6 (c) (i)19 renewable energy project activities with a maximum output capacity equivalent up to 15 megawatts are small scale project activities and since this project will generate a maximum of 4.248 MW electricity from the combustion of methane generated from the PetroSA wastewater treatment, then it is grid connected small scale renewable energy project.

Technology selected and transferred

As far as technology concerned, three GE Jenbacher gas engines each will be used to generate electricity with 1.416 MW capacities were installed. These engines can be used not only in biogas applications but also in landfill gas applications. Jenbacher is arguably the foremost gas engine manufactured globally and has approximately 4 500 MW in installed capacity worldwide, the majority in the EU. The engine has not been used in South Africa successfully and not at all in the last two decades. The only known application in South Africa has been two previous generation engines at Sebokeng municipality, installed in 1983 and 1985 respectively. Because of the municipality failure to maintain the units by its own local engineers, these engines have fallen into a state of disrepair and did not work very well. Due to repeated operational and maintains problem observed with two previous generation engines, as part of the Project Activity, GE Jenbacher Engine company is now appointing local agents to service, operate and maintain the engines thereby creating local capacity in operation and maintenance. The project thus leads not only to the transfer of market leading,environmentally safe and sound technology to South Africa but also to capacity building in operations and maintenance (UNFCCC, 2005). Mr. Johan Van der Berg from CDM Africa Consultant Company is one of well-known CDM project developers in South Africa and he was the one who directly participated in this case study and the Kanhym landfill to energy projects as project developer. The Kanhym landfill to Energy project is not yet implemented and is in the technology selection phase. During an interview that was made with him he was asked to explain about the environmentally clean technology transferred through this case study to South Africa and he answered —…PetroAS Biogas-to- Energy project is one of the project using General Electric Jenbacher Engines, it is one of the best example of technology transfer in South Africa because that engine has not been used in SA before and the same landfill-to-energy project using the same technology is Kanhym Farm manure-to-Energy project that is also using certainly gas-to-energy technology but not yet implemented…"This confirms that there was a environmentally clean technology transfer from Annex I country to South Africa through this case study project but the question is to what extent did this transfer was made because as seen from case study the transfer of technology limited to transfer of equipment and building of a capacity of the host country employee so that they can undertake simple maintains and operation jobs by their own.

The other interviewee was Mr. Jacques Malan, Chief Technology Officer, AAP Carbon Company who has also involved in different CDM projects as project developer and investor in South Africa and answered to the question of how he sees environmentally clean technology transfer through CDM projects and he explained —it is quite interesting, I have already mentioned we have internal combustion engine from Austria, and the engine is very specialized for gas-to-energy conversation. The gas–to-energy conversation with General Electric Internal Combustion Engine Jenbacher is the most useful and widely distributed in South Africa landfill-to-energy conversation projects."This confirms that GE Jenbacher Engines have especial design characteristics which make it efficient, unique and state-of-the-art technology and this further tells that the hardware is perfect but the critical question comes when one is talking in terms of soft-ware that is the know-how transfer.

The third interviewee was Johan Myburgh,, Process Development Manager, Sappi Management Service in South Africa and he was also asked the same question of how he sees environmentally clean technology transfer from Annex I countries to South Africa and he answered —Energy cost is more than doubled in past two to three over the last ten years in South Africa. In the past we have been very relaxed or not using very efficient equipment's, so a lot of equipment's installed have very low efficiencies and there is very huge amount of potential to increase their efficiencies, with better design, technology and control, I mean from out of developed countries. "In this interview this interviewee has shown clearly that technology transfer in energy efficiency needed in South Africa and has been increasing from time to time more than ever. But the question is how one can make sustainable technology transfer through CDM so that country can benefit from sustainable technology transfer venture to meet its energy efficiency need in its industrial sector.

Monitoring method employed, and technology transferred

According to the first monitoring period final report version 3 of the project, from October 10 2007 up to September 30 2008, which was done by TUV SUED Industry service GmbH Consultant Company, monitoring consisting of metering the electricity generated by GE Jenbachaer Engines (UNFCCC, 2009). According to section D sub-section 4 of PDD of the project ,the meter measuring the electricity output was bought from Alstom Company which has quality management system and complies with ISO 9001.The meter is designed and manufactured in such a way that it does not need any maintenance intervention in the entire life time. However, the meter will be recalibrated at ten-year intervals which is the industry standard. The meter is designed for a 20-year lifetime at normal operating condition. The meter continuously records active energy and stores data accumulatively, stored data transmitted electronically, and readings are taken online.

The author has also learnt that the GE Jenbacher Engines are equipped with a remote monitoring DIA.NE.WIN system which takes real time reading directly on the DIA.NE screen or on the central site PC (Personal computer) linked to the DIA.NE system. For this purpose, GE Jenbacher Engine Company trained a local operator in Austria in June 2008 which allowed him to extended access to the DIA.NE WIN system and made him able to extract the required data for verification purpose (UNFCCC, 2009). According to UNFCCC (2005), DIA.NE.WIN is a new Window-based man/machine interface for GE Jenbacher gas engines. The system gives both for receiver and GE Jenbacher maintenance staff a wide range of supports during commissioning, monitoring, maintaining installations and for diagnostic purposes. A standard PC and Internet Explorer can be used to control and monitor the engines through DIA.NE.WIN system. The operating stations can be connected to the central on-site computer (server) via a local area network (LAN), a dial-in connection (modem) or via the Internet. It enables the user to operate different operating stations simultaneously and independent of one another. GE Jenbacher has used state-of-the-art technology to develop DIA.NE WIN. The system is built around a fast-industrial PC (server) which is integrated into the switch cabinet of the installation and which stores historical data and generates alarms. This computer also functions as a web server and modem server. The system is operated (by the customers) via ordinary PCs. Internet Explorer is used as an operating platform. From this explanation the author learnt that the technology with this project is not something which has been picked up from the shelf and put in operation instead huge technology transfer involved. Therefore, based on the analysis to transfer this sophisticated technology, the author critically suggest that the technology transfer must involve a basic know-how rather than simple show-how which is consisting of a short-term course and on job training.

Case study 2: Kanhym farm manure to energy project

Location of the project

Approximately 9,459 ha of land is allocated for the proposed development site which is located on the farm Driefontein. The site falls within the administration of the Steve Tshwete Local Municipality called Nkangala District Municipality and the farm is situated 32 km east of Witbank and 15 km south-south-east of the town of Middelburg in Mpumalanga region. According to the GPS (Global Positioning System), the co-ordinates of the farm are as follow: 25° 89‘ 50“ and 29° 54‘ 99“ E (See Map 13) (UNFCCC, 2006).

Being the home of pigs of more than 45,000 in number, Kanhym is the biggest pig farm in South Africa. The farm is designed for multiple purpose farming incorporating various other agricultural divisions in addition to the piggery farm, including maize farming and a mill where maize is milled. Eikeboom and Thokoza villages are the home of quite many workers and dependents. In Eikeboom there are 14 houses and in Thokoza 164 and on average each house is occupied by 4 people. As Kanhym Farm buys the electricity from the South African national grid, the inhabitants of the two villages get their electricity supply from Kanhym Farm manure to energy project for free. (UNFCCC, 2006). The design of the house of pigs are in the form of confined feeding lots accessed with a sewer system that drains animal waste into a large, three-staged anaerobic lagoon with a firm crust at the top. Concrete floors are built to take the defects and urinate of pigs and regularly washed with water that gravitate the manure into channels before discharged in to anaerobic lagoon. The main sewer channel terminates in to the anaerobic lagoon collecting all the manure in the channel. Currently this lagoon is not lined and covered and produces a mixture of gasses including CH_4 (60%), N_2O (1%) and CO_2 (38%), all of which are released into the atmosphere. The recent proposal is comprised of building a new lagoon upstream from the current one, then lining and sealing it with an impermeable membrane and an expandable membrane roof respectively. The project is expected to be executed in two phases and in Phase 1 of the project, the methane gas will be destroyed by flaring or burning in a boiler. The heat generated from the boiler will be used to maintain the temperature of the new digester at 37°C for effective biodegradation of organic materials by microorganisms. The best and safe enclosed flaring technology will be installed which ensures complete combustion, and the system has tried and tested to guarantee the safety of the operation. The monitoring system is installed to control the amount of methane produced. Phase 2 of the project will be commenced if enough gas is found to be produced and financial viability analysis allows the installation of a Jenbacher, Caterpillar, or Wartsila combustion gas engine. Annually, 3, 25 million m^3 of biogas yield is projected, which is enough to produce 1 MW of electricity continuously at an efficiency of 40%. To optimize the use of gas engine, as mentioned above waste heat from gas engine will be used for boiler to heat the digester to the required temperature of 37°C as mentioned above. As far as the technology of the Engines is concerned, they will be from different companies such as GE Jenbacher/Caterpillar/ Wartsila and are internationally tried and tested engines which all are expected to offer advanced and safe technology for converting methane rich gas into electricity. When the financial viability of the project estimated, and the production of gas is established, an appropriate internal combustion gas engine with the capacity of power in the range from 800 kW up to 1500 kW will be installed to run off the gas. The electricity produced will be fed into the national grid that presently supplies the farm or will probably be used to supply residents of both villages of Eikeboom and Thokoza or one village or the maize mill. If there is any surplus gas that is not utilized by the engine due to surges or the engine being off for overall maintains or for any other possible reason, will be flared. The end product out of the digester which usually called the sludge or digestate will be used as fertilizer or on soil enhancement in the area. During Phase 1 project period AMS III.D21 Methane recovery in agricultural and agro-industrial activities version 12 methodology used whereas in Phase 2 project period AMS I:.D22 Grid Connected Renewable Electricity Generation Version 11 methodology used to determine the baseline of the project. Both projects are small scale projects. (UNFCCC, 2006). Since the project comprised of methane recovery and destruction from manure from agricultural activities that would be decaying an aerobically in absence of the project, this methodology is appropriate methodology to be used. This project qualifies as type III small scale project activity because its annual emission reductions are less than 60 000 t CO_2.The project will be capable of generating 1 MW power in phase 2 project periods. Since the renewable power generation capability of the project is lower than 15 MW, the power generation component of the project qualifies as type I small scale project activity (UNCCC, 2007).

METHODOLOGY

The content of this paper is principally a reflection of the comments and opinions provided by interviewees, the answers to the questionnaires by informants, review of selected case studies of CDM projects and literature assessment of CDM project implementation processes and country profile of South Africa.Because both case studies have similar character, I have more focused on case study I for my discussion. The major work undertaken in composing this paper was the conduct of a series of interviews with and attempting to get answers from relevant South African stakeholders, seeking to explore perceptions of the country‘s clean/environmentally clean technology transfer needs and factors affecting clean technology transfer processes. A desk top review of relevant literature was also conducted to obtain inputs for the questions designed for an interviews and to formulate the questionnaires sent to the same experts who had interviewed, and to provide background information on issues raised during the interviews and in the questionnaires. The specific interview-methodology was followed by the author to collected relevant information from informants: 1) The author conducted a preliminary assessment to identify relevant individuals involved in CDM projects from website of Designated National Authority (DNA) of Clean Development Mechanism in South Africa; 2) The selection process for interviewees strove to ensure equity and parity in stakeholders‘ representation by including representatives from CDM project developers, project investors and consultants from private company; 3) The selection process aimed to select the most knowledgeable persons with proven involvement in clean technology transfer under CDM projects; 4) The author designed questions so that answer for his questions from informants help the author to answer his research question and sub-research questions; 5) Practically speaking, the questionnaire was used flexibly, with some questions being customized to the specific areas of expertise of the interviewee concerned and; 6) The average duration of an interview was twenty-six minutes, however, some were much shorter but not less than twenty minutes due to time constraints imposed by the interviewee and some were longer. The interview was transcribed directly on the basis of repeated and meticulous listening to the recorded interviews. On the other hand, after thorough review of literature, some criteria were established to design the questionnaires (See Table 3). Table 2 was drawn to guide the design of questionnaires as mentioned above based on economical, political, social and technological criteria with corresponding indicators in such a way that they can address the research question. The technological criteria were established based on Müller‘s sustainable technology transfer five models (Müller, 2003). These models are: 1) the technology transfer illustration model; 2) the actors and structure perspective model; 3) technology transfer symbolical illustration model; 4) area of relative ignorance matrix model; and 5) dynamic assimilation of technology transfer model. These five models are support each other to get enhanced insight of the social setting of two parties involved and their major role in sustainable technology transfer.

SOURCES OF DATA

In this thesis the attempt was made to collect the multiple sources of data to make a comprehensive approach to the research work. As a secondary source of data, PDD‘s (Project Design Documents) were assessed. PDD‘s are mandatory and standardized documents of about 50 pages submitted to the Executive Board by the project developers for registration. In the PDDs, it is possible to find information about the technology used, whether there is a transfer or not, the type of transfer, the estimated amount of the annual emission reductions, the cumulative emissions reductions to the end of the Kyoto period (31 December, 2012)and the countries that will buy the carbon credits generated by the project(if already available),the project implementer (name, business sector and name of the parent company) and every foreign partner involved (name, location). It also contains information on the role of the project partners: are they credit buyers, consulting companies, PDD consultants or equipment suppliers?

The author tried to read the documents carefully and thoroughly in order to understand the type of technology

Table 3: Criteria for questionnaires design (Source: DNA South Africa).

S/N	Country	Criteria	Indictor
1	South Africa	Economic	Feed-in-tariff (Renewable energy), investment policy (Subsides, incentives), infrastructure development (Road, Electricity, Air transport, Internet, Telephone)
2	South Africa	Political	Political stability (Good governance), Environmental policies, Eskom and its regulatory influence
3	South Africa	Social	Crime and security, Red-tape and corruption
4	South Africa	Technological (Technology constituents and its effect on technology transfer)	(Technology constituents and its effect on technology transfer) Rather than Know-how skill, show how skill transfer processes from capacity development perspective, Viability of technology to the local condition, from local cultural perspective and context

implemented in the CDM project in South Africa under this specific case study. And as an important step, more attention was paid on areas in which the intention, the objective and the formal and official claims was made by project developer regarding the environmentally sound technology transfer.

As the primary data collection processes, some interviews were conducted with selected companies involved in CDM projects as project developer, investor and consultant firms from South Africa. The major data source in this thesis clusters around on conducting interviews with key employees from companies that possess thorough and detailed knowledge regarding their respective company's interaction and involvement as CDM project developer, investor and consultant. As the other part of primary data collection processes, as mentioned above, questionnaires were sent to private companies involved in CDM projects both in South Africa and in Denmark. In this regard, the key informants identified have primarily been in higher and longer standing management positions in various companies in CDM projects which enabled them to provide information concerning the implementation processes of CDM projects in South Africa in general and environmentally clean technology transfer processes in particular.

DATA COLLECTION METHOD

Generally, data collection in empirical research methods are mostly divided into two categories namely: quantitative and qualitative. In this study, the method employed for the data collection is qualitative. Qualitative research methodologies refer to research procedures that produce descriptive data; that is written or spoken words of people and observable behavior (Bogdan and Taylor, 1975).

In this thesis work, both primary and secondary qualitative data have been used. The primary data consists of the answers to the qualitative questionnaires sent to CDM project participants in South Africa and telephone interviews made with project participants in South Africa. The secondary data include books, reports, journal, internet publications, PDDs and academic articles. This methodological technique has been selected based on the fact that *"multiple sources of evidence as the way to ensure construct validity"*. Furthermore, a qualitative approach is characterized by describing and understanding phenomena from a researcher's point of view. In this thesis, interviews were chosen as one of the qualitative data and they provide contexts where participants can ask for clarification, elaborate on ideas, and explain perspectives in their own words; the interviewer can use questioning to lead or manipulate interviewee responses. Due to the interpersonal nature of the interview context, participants may be more likely to respond in ways they deem socially desirable. (Harris and Brown, 2010).

According to Kvale (1996), the interview is the raw material for the later process of meaningful analysis. The quality of the original interview is decisive for the quality of the later analysis, verification and reporting of the interviews. In this regard the author used the semi-structured interview technique to collect the qualitative information to elaborate the analysis.

The questions put to the interviewees were open and loose and allowed for changes during the actual data collection process giving more room for flexibility. Comparatively this makes questionnaires appear more rigid and with no room for change. As such interview was feasible to obtain more detailed information because in this data collection process the telephone interview was conducted after the answers to the questionnaires were collected and the most important points missed from questionnaires were raised during interview processes.

Questionnaires and interviews are often used together in mixed method studies investigating in- depth assessment While questionnaires can provide evidence of patterns amongst large populations, qualitative interview data often gather more in-depth insights on participant attitudes, thoughts, and actions (Harris and Brown, 2010).

This allowed the researcher to obtain more condensed data, and to experience what the interviewees think about the subject in question. The interviews allowed the interviewees to provide information they would not have given during a questionnaire survey and this is an advantage that questionnaires will not provide.

The method adopted in this thesis report in data collection and processing also includes case studies focused on PDD documents of CDM projects.

DISCUSSION AND ANALYSIS BASED ON COLLECTED DATA

As mentioned in methodology part, there are two primary data which were collected through interview and questionnaires. The interviews were made with selected CDM project stakeholders in SA (South Africa). As far as literature review is concerned; out of the description of two case studies indicated above, they are also used for the following discussion and analysis.

The results from a set of interviews with interviewees, answers for questionnaires from the wide range of stakeholders involved in CDM projects in South Africa and analysis of selected case studies have indicated that clean technology transfer through CDM project with an optimal GHG emission reduction has not been promoted very well as it has done in other development sectors in South Africa in general.

So, after identifying a range of factors affecting environmentally clean technology transfer through CDM projects from Annex I countries to South Africa from literature reviews and from informants in SA in the form of interview and questionnaires , the author of this thesis has decided to discuss the first four factors as the major factors affecting technology transfer through CDM from the following lists: (a) lack of effective transfer of know-how to local people about environmentally clean technology, (b) the control of the generation and distribution of power by Eskom and Feed-in tariff (c) Red-tape and high level of corruption, (d) lack of incentives to investors involving in CDM Projects, (e) security and crime,(f) deal structure, (g) macroeconomic stability,(h) good governance (i) financial and credit policy of the country.

Objective: To identify the negative factors affecting the environmentally clean technology transfer through CDM projects from Annex I countries to South Africa and to discuss their effect in environmentally sound technology transfer from Annex I countries to South Africa.

To demonstrate the objective of this thesis mentioned above, one should consider thoroughly the area of sustainable development criteria in which environmentally clean technology transfer has exclusively been elaborated in the CDM project approval process in SA. So, there are three major sustainable development criteria are shown to assess the contribution of proposed CDM project to the sustainable development objective of South Africa, one of them being the economic criteria. Under economic criteria, appropriate technology transfer is considered as one of the major criteria and these criteria is supported by additional indicators to allow DNA to regulate CDM project contribution to sustainable development objective effectively when it approves the project and they are:

1) Positive or negative implications for the transfer of technology to South Africa arising from the project; 2) Impacts of the project on local skills development and; 3) Demonstration and replication potential of the project

These indicators can be used as a framework on which the analysis is based and specifically the second indicator that is ‗impact of the project on local skills development 'takes the lion share of the discussion part. In SA sustainable development criteria is one of the major tools for approval of CDM project by DNA.

ANALYSIS BASED ON CASE STUDY I

As far as this thesis case study I is concerned, the development and innovation regarding the engineering design of the major technological components in the internal combustion engine system was took place primarily in Austria and patented by the Austrian company (UNFCCC, 2005).

In South Africa, during the approval process of CDM projects by DNA, transfer of technology, development of local skill and replication potential of the projects are the major frameworks to be sure that appropriate technology under sustainable development criteria could be transferred through CDM projects. Therefore, the question has been, whether the technology transfer through CDM project involvement did enable or improve the capabilities technology receiver Company to undertake implementation, handling associated challenges and further replication or modification of Internal Combustion Engine (ICE)-the answer is no. Because, as mentioned below, it has found that the technology transfer in the specific case study to PetroSA Biogas to Energy Company enabled the company only to undertake basic operation and simple maintains of the technology.

To this end, regarding the know-how transfer, what is usually happening in South Africa is when the technology supplier left the company after transferring knowledge to the local engineers in the form of on job training or short term course, the local engineers are rarely doing the job in the absence of technology transferors (Suppliers) because the training they have given not enough to undertake the job alone and the host country company went back and calls foreign engineers from supplier company from time to time for overall maintains and operation. This is simply also because the knowledge transfer was not complete, and it was limited to show-how transfer rather than in-depth know-how transfer and in-depth knowhow transfer generally involves understanding of the basic conception of technology itself, transformation and innovation process of the technology in question. This kind of experience of calling back foreign engineers from time to time is very expensive and increases the overall transaction cost of the project to higher level because when they are called back, these experts are paid in foreign currency. During an interview with Mr. Johan Myburgh, process development manager from Sappi Management Service noted that when one company employs the knowledge (expert from abroad) directly from the developed countries, they have paid excessively in Euro rather than in local currency.

From analysis of case study, I, the author of this paper has learnt that GE Jenbacher Company technology transfer to local engineers of South Africa confirms what has said above. In this case study, the technology transfer is very limited, and it only includes short lived instruction courses and short term on job training. By making limited access to local engineers regarding the core technology and the design of the most important engine systems, GE Jenbacher Engines Company exercised a clear proactive strategy to hinder the know-how transfer from diffusing to local engineers and other operators. For example, in South Africa the first generation GE Jenbaher Engines which were installed in 1983 and 1985 by the Sebokeng municipality failed to function after some time because the Sebokeng municipality operators did not undertake proper maintenance to put the machine back into operation mainly due to lack of adequate skill of overall maintains of the engines this immediately indicates that the knowledge transfer by the company limited to simple show-how and it seems that this type of action was taken deliberately by the company to keep its importance with the technology receiver (See case study I).

From further analysis of the case study I, it is also evident that the technology supplier company, instead of building the capacity of the local engineers to a level that they will be able to take up the job by themselves, preferred to sign an overall maintenance and operation plan agreement contract with technology receiving company to be responsible for the overall maintenance and operation work periodically by itself. By doing this, local engineers were therefore kept away from gaining insight into the specific innovative applications and indepth knowledge about the technology in question. For example, the PetroSA Biogas to Energy CDM project 's PDD document, Validation Report, verification Report and certification Report analysis clearly indicates that the technology transfer in this project did not produce enhanced capability of the technology receiving company so that the technology receiver can able to replicate the engine by itself. In this project the training activities that GE Jenbacher have performed regarding the knowledge transfer to the end-use operators and local engineers about technological systems were undertaken to enable them to carry out simple operation and maintenance of the system so the major overall maintains and operation is deliberately left to the supplier company engineers.

As one of the interviewees called Johan clearly indicated in the interview confirming the above statement and said rather than giving intensive training to the local engineers, the company prefers to sign the operation and overall maintains plan contract agreement to undertake periodic overall maintains to keep the machine running. And that is what happened exactly between Austria Company, GE Jenbacher; technology supplier, and MethCap SPV1 (Pty) Ltd company of South Africa; technology receiver. He explained the reason for contract agreement and said‖… if you want to borrow money from the bank, then the bank always requires from you to put in place long term operation and overall maintains plan for specific period of time as one of the primary requirement to be sure that the project is running continuously and smoothly returning the money borrowed from the bank according to loan agreement put in place..‖, otherwise the bank will not borrow any initial capital to commence the project if the project developer didn't provide the bank with valid overall maintains plan.

Therefore, based on this contract agreement, as mentioned above the original equipment manufacturer and supplier GE Jenbacher Company undertakes periodic overall maintenance and operation of the engines according to the plan. The major problem with this type of technology supplier-receiver relation is the overall maintenance done by technology supplier makes local engineers unable to undertake the overall maintenance and operation by their own and produce entire dependency.

To overcome this problem, one possible way is the local engineers should be trained to a level that they can take up the job including overall maintains and operation, and moreover their capacity should be developed to a level that they can manage to replicate the technology by their own.

In addition, to make technology transfer more enhanced, an inter-cultural learning process must be exercised between the actors involved so that technology receivers will benefit from a sustainable technology transfer venture and access to comprehensive insight into fundamental aspects and principles of the technology in question whereas in this processes the technology supplier may be much better equipped by getting enhanced insight of his own social setting in which it has innovated the technology to keep continue his own technological development. If this strategy will be well followed and established by both parties involved, then this can at least minimize the area of relative ignorance of the knowledge of the technology identified, thereby helping both the technology receiver and technology supplier to see their problem clearly and solve through time.

Moreover, conceptual framework of technology transfer, this problem can also be solved to some extent only when operative assimilation process takes place through the know-how transfer including both the knowledge and skill needed to operate and maintain the equipment. The technology receiver not only learns how to maintain and operate but also, he must learn how to produce similar machine with better efficiency but more appropriate for the social setting of his own country. Such a transfer also needs innovative knowledge about the practicality of the technology to make it work under a range of circumstances.

In most cases this kind of knowledge transfer is impossible without the blessing of the technology supplier and the technology supplier is usually not willing to do this because as mentioned above they always want to keep their value high at receiver's side to be called from time to time by technology receiver, in general, technology providers have limited interest in the diffusion of their technology into the local economy because they want to avoid imitation. This is more of due to business-oriented relation than genuine technology transfer deal based on mutual benefit.

ANALYSIS BASED ON INTERVIEW AND ANSWERS TO QUESTIONNAIRES

One of interviewee Mr. Jacques Malan who is chief technology officer in AAPcarbon company in SA was asked to explain about his experience of the transfer of know-how especially the transfer of knowledge in the knacks and bones of the technology transferor and he answered —…the transfer of this kind of knowledge is rather difficult" and he continued saying," the technology transfer in this respect definitely required and necessary to secure and operate high technologies that are coming out of European countries." He gave an example and explained" if wind power plant introduced to SA and since these technologies are new to SA, we require huge amount of training to understand the system and able to operate them. This type of technology transfer usually will not be made instantaneously and mostly take very long training. There are some companies started to establish training center to train and support local people here in SA. For example, General Electric Jenbacher engine supplying company from Austria has opened a training center to train the local people to able to make them to operate and maintain the engine". From this interview it is possible to see that when technology transferred through an organization such as manufacturer there is a tacit knowledge involved and as mentioned above strong intercultural interaction should be exercised to transfer this knowledge. To tackle the problem the technology supplier company establishing a training center but its effect on increasing technological capability of receiver to a level of technological innovation is very low since this type of training usually involves short lived instruction courses to operators to handle simple operation of the machine, it is not enough to transfer required amount of skill which enable the local operators to undertake the overall maintains by their own. Local people should be trained so that they can be able to replicate the technology by their own.

Another respondent to electronic questionnaires from SA, who has involved in CDM projects as consultant from carbonstream Africa company, Mr Siphiwe Nhlapo explained his doubt about skill transfer through CDM in SA and said: "CDM skills, know-how and training of local people is a process that is still at infancy with a very low percentage of individuals involved in the development of renewable technology, and CDM at large. A strong involvement of the private sector is extremely important to facilitate the technology transfer process."This indicates that skill transfer through CDM projects still requires huge amount of work in SA.

The third interviewee called Mr. Johan Myburg, process development manager of sappi management service in South Africa, he has also had the experience of what was mentioned with others at the beginning of this discussion and he continued saying —we thought we could have transferred the know-how to local engineers during on job training by technology supplier but what usually happens is we could fall back from time to time to earlier supplier for maintenance and operation of the machine, in fact once your local engineer has given the required knowledge, still you will find lucrative opportunity in developing countries in running the business and to secure the continuity of the business you call the machine suppliers back for overall maintenance and operation, and that is also a problem and adds your overall running cost, I do not see that we overcome these type of know-how transfer problem totally and quickly, initially you find that you have to make a lot of views and attempt to transfer the know-how to local engineers eventually the some of the knowledge transferred by suppliers of the technology may not be transferred easily, it remains behind them-the individuals. To gain this knowledge, he concluded, the short-term cost is very high but long-term benefit is also very high and involves innovative training and we get it back." The whole knowledge transfer models examined in general and this interview clearly tells that at every cost the level of skill of local engineers and operators should be increased, so that the understanding of basic concepts and enhanced insight of the technology in question and its transformation and innovation processes must incorporate technology-society relations of the two parties involved to transfer the knowhow.

ANALYSIS BASED ON LITERATURE REVIEW

To reiterate the barriers of know-how transfer in this specific case study in more robust way, this sub-section attempts to use five very important and helpful conceptual framework models mentioned above. The author tries to adapt the selected concepts to demonstrate the idea with respect to South African case study. As far as the actors involved are concerned, as mentioned in mentioned above, the Case study 1 analysis focus more on the relationship between GE Jenbacher Company (technology supplier) and MathCap SPV1 (Pty) Ltd (that is called IPP, the owner and developer of PetroSA Biogas to Energy CDM project) and their relation is limited to equipment transfer and on job training. Furthermore, the relationship between these two companies is the major focus of this thesis because it involves environmentally clean technology transfer from Annex I country, Austria to South Africa.

In this case study, each actor involved had different roles and identifying the role played by each actor illustrate the significance of the project to this thesis. To this end, the more interesting part of this case study was involvement of two Annex I countries with different roles that were, as credit buyer and technology supplier, therefore, the generated CER (Carbon credit) was sold to Statraft Market GmbH German Company which is Annex I country and authorized by German DNA to get involved as CER buyer from Non-Annex I country South Africa. The electricity generated from PetroSA Biogas to Energy project is sold to PetroSA (Pty) Ltd Company by MathCap Pty Ltd Company according to PPA put in place.GE Jenbacher Company limited to transfer of the appropriate type of environmentally clean technology that internal combustion engine to South Africa according to the type of deal structure with project developer and owner that is with MathCap Pty Ltd Company. Interrelation and interaction between these companies plays an important role in transfer of environmentally clean technology from Annex I country to South Africa. Especially the interaction between technology supplier and receiver companies plays a crucial role and will be seen in detail how this interaction was managed so that environmentally clean technology selection and transfer was done.

This concept of social carriers of technology become very useful when the following six necessary conditions are fulfilled during the selection of a technology based on the actor-structure interrelations. And these six conditions are the interest and motivation of technology receiver (MathCap Pty Ltd Company) to apply the technology, power of the receiver to practice the interest that is having socio-political and economic power to influence others to act accordingly, organization to exert the power, information about various technologies available in the market, access to the technology being transferred for example GE ICE and knowledge about how to operate the technology transferred (Figure 1). The concept applies when actors decide to choose amongst suitable environmentally clean technologies in the market. These conditions are necessary conditions but not the enough conditions for appropriate technology selection. From analysis of this case study, the author learned that the missing part in GE ICE technology transfer process is the transfer of substantial amount of knowledge or especially know-how to receiver to operate the machine or possessing of the capability to handle the required technique and skill to undertook overall maintains and even further to replicate the machine locally. In Figure 2, different social carriers of technology are observed that are technology supplier and intermediaries (like brokers) and technology receiver.

This concept can also help to see the role of actors in the process of technology innovation steps of innovation processes in left hand side. If one carefully sees the case study I considered in this paper, as explained above, at different levels, there were different actors involved such as technology suppliers, project developers, consultants and technology operators. In this interaction, the road is not always smooth, and this is represented by barriers of technology transfer and in this case failing to transfer know-how properly to local operators was one of the barriers as mentioned above. To see the extent of this interaction in SA, respondents were asked about how they rate the interaction between public sectors, private sectors and research institutions in SA in technology transfer and almost all answered giving low rating and this indicates that in SA there is very weak network between actors involved for technology diffusion. Improvement in this area by concerned South African government office can make a difference.

The public or private intermediaries are involved to facilitate the transfer process by providing information, by consulting or planning to access capital (Example AfDB, WB). The second model is elaborated with open-ended jigsaw pieces about socially sustainable technology transfer and operates under three possible options. Out of these three options, according to this model, preferable option is the one in which the social setting of both the technology supplier and receiver should be changed or somehow moved to fit each other at some point. However, in most of the time, this is not the case because that is the social setting of the receiver mostly required to fit into and fully adapt to the social setting of the supplier and this result in failure and this is what exactly observed in South Africa.

The third model is the most important model and it deals with the area of relative ignorance of technology receiver like SA and technology supplier like Austria (typical Annex I country). The area of relative ignorance of the know-how transfer emanates from a characteristic feature of the social settings of the technology supplier, which are usually taken as important precondition for successful technology transfer, and they are called technological development, formation and application and usually they are not consciously considered by the individual technologists involved in technology transfer. The technology receiver has incomplete knowledge about the technology transferred. In South Africa, as repeatedly mentioned above, it is also possible to observe similar problems because according to interviewee involved in technology

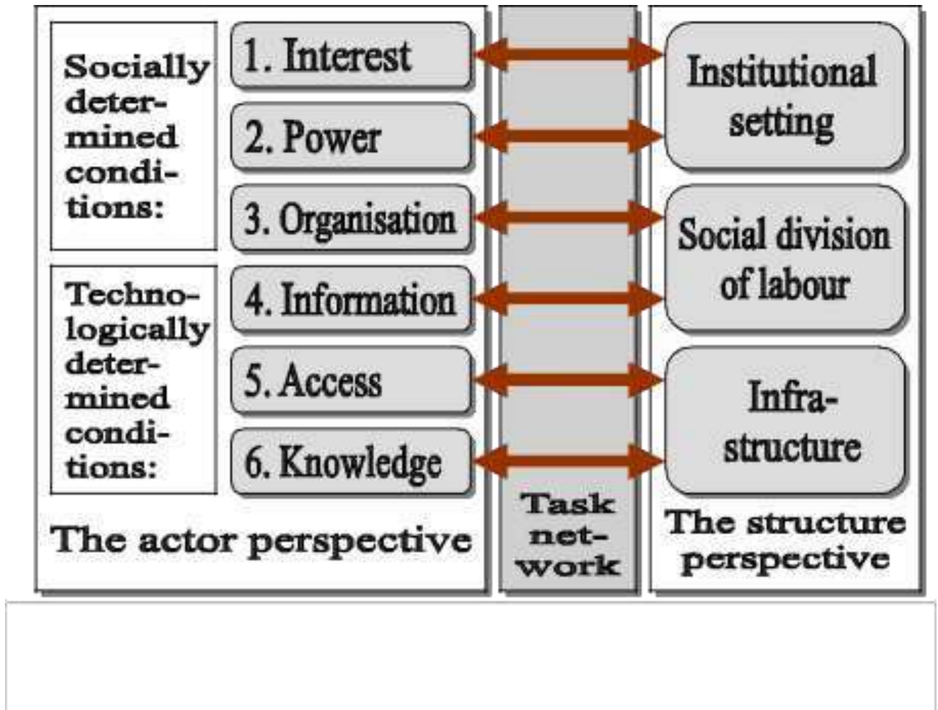

Figure 1: The relationship between the actor and structure perspective (Source: Müller, 2003).

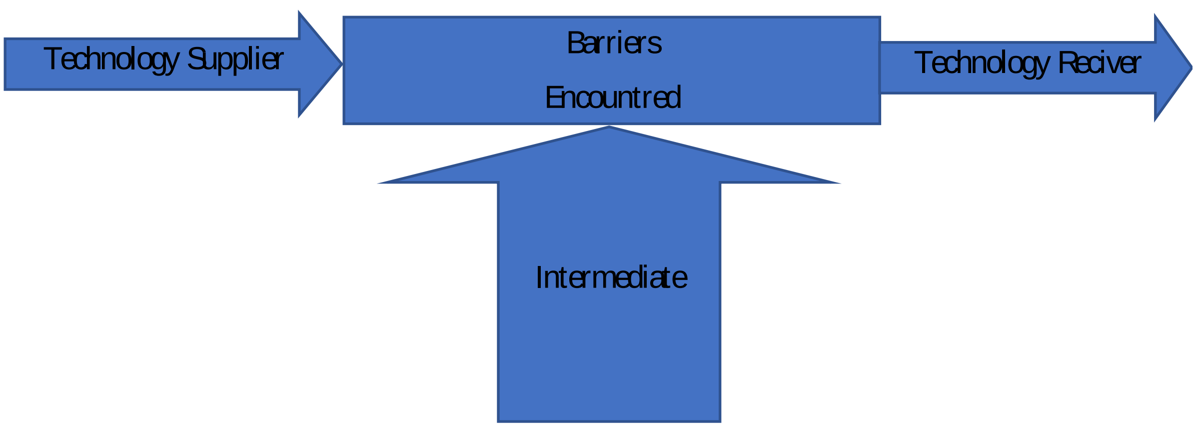

Figure 2: Main actors involved in technology transfer (by author).

transfer through CDM in the PetroSA Biogas to Energy project, the company which was transferred internal combustion engine from Austria went back to the supplier from time to time and call them for overall maintenance and operation instead of undertaking overall maintains by its own engineers due to incomplete knowledge about the technology.

As clearly shown above, this problem sometimes happens not intentionally because the supplier's knowledge about the technology itself is only partly consists of codified knowledge and the majority part is in the knacks and bones of the person involved in the technology transfer and usually called it is a tacit knowledge and it cannot immediately be transferred even if the technology supplier is willing to transfer it. It is also explained that technology as a knowledge possessed by individuals, firms, or organizations and has strong tacit elements that cannot explicitly be expressed or coded (Figure 3). For instance, in South Africa the local engineers underwent on job training and short-term courses by the technology supplier and yet they did not take over the job by their own. According to this literature review, this kind of technology transfer is

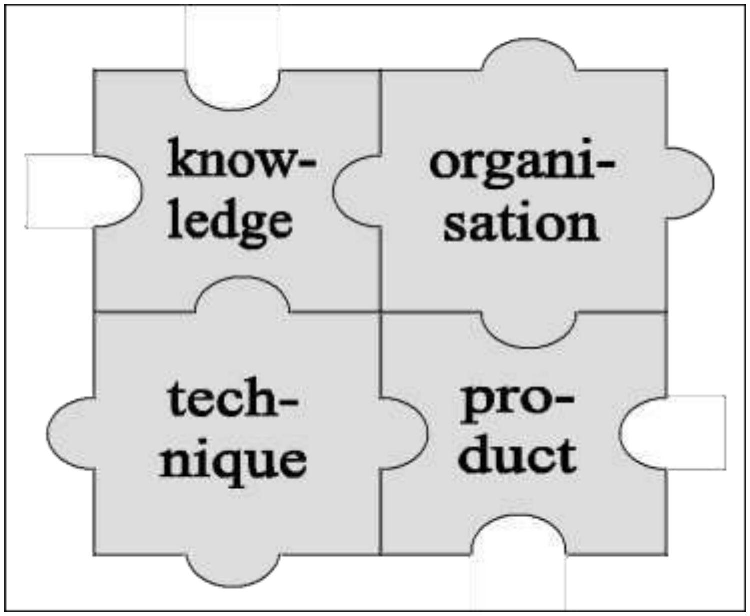

Figure 3: Four constituents of technology.

possible and successful only when the transfer process considers the social setting of both countries involved in the technology transfer process to adjust, to adapt and get used to each other to the new situation that is to the social setting both the technology supplier and technology receiver.

Therefore, the author firmly believe that the problem technology transfer in South Africa is related with show-how transfer instead of know-how transfer and can at least be tackled if the technology transfer could be defined as the degree to which the transfer raises the recipient's technological know-how and its capacity to use this knowledge to adopt and innovate new technologies, so that they can be able to make the machine which can make the internal combustion engine in South Africa. Furthermore, both the continuity and collaborative behavior should be developed between the technology receiver and supplier to increase the likelihood of transferring of the tacit knowledge in addition to the equipment thereby increasing the recipient 's capacity to adopt the technology. Therefore, short-term, one-time deals are less likely to contribute to high-quality technology transfer than long term, repetitive deals between the supplier and receiver of the technology.

SHOW-HOW RATHER THAN KNOW-HOW TRANSFER AND ITS EFFECT

In the above, two cases studies considered were described. Since the second case study is only registered by CDM Executive Board and in the process of equipment selection phase, it will not be discussed because the type of technology employed is not yet decided but the first case study will be discussed in detail.

The interviews which were one of important source of data for these case studies were conducted on March 29, 2010 through telephone with South Africa stakeholders. One of the interviewees was Mr. Adv Johan Van der Berg, the CDM project developer of PetroSA Biogas to Energy and Kanyhm Farm manure to Energy CDM projects.

ESKOM AND FEED-IN TARIFF IN ENVIRONMENTALLY CLEAN TECHNOLOGY DIFFUSION THROUGH CDM IN SA

According to the European Environment Agency (EEA), Feed-in Tariff (FiT) is defined as: "the price per unit of electricity that a utility or supplier has to pay for renewable Electricity from private generators" (EEA, 2009). According to EEDNA (2009), renewable energy sources comprised of the following power sources: wind, biomass, small hydro, solar and wave power. Renewable energy generating industry can be encouraged to grow only when sound policy instrument like a feed-in tariff is put in place to ensure those who are producing electricity from solar, wind and other renewable sources have a guaranteed market for the electricity they produce, and therefore a return from their investment. FiT forces the energy companies (or ‗utilities ') responsible for operating the national grid like ESKOM in SA to purchase electricity from renewable energy sources at a pre-determined price which is sufficiently attractive to stimulate new investment in the renewable sector. Feed-in tariff is an important policy incentive for promoting renewable energy since it enhances investor's confidence by removing uncertainties regarding the selling price of electricity to the national grid (EEDNA, 2009). One of the respondent to the questionnaires from SA, who has been involved in wide range of CDM projects as consultant from carbon stream Africa company, Mr Siphiwe Nhlapo was shared his experience about what REFIT mean and the present situation in South Africa, and explained "South Africa has developed a mechanism to promote the deployment of renewable energy that places an obligation on specific entities to purchase the output from qualifying renewable energy generators at pre-determined prices. This mechanism is called Feed-in Tariffs (FIT) – which is guaranteed prices for electricity supply rather than conventional consumer tariffs. The basic economic principle underpinning the FITs is the establishment of a tariff (price) that covers the cost of generation plus a "reasonable profit" to induce developers to invest. This is quite like the concept of cost recovery in utility rate regulation based on the costs of capital. "In South Africa very, good policies are put in place, but as the most of the respondents to this thesis questionnaires answered, they are not practiced on the ground. So the author of this paper firmly believe that not announcing good policy but exercising them practically is very important.

As stated above, in South Africa, at the end of the first quarter of 2009, the National Energy Regulator of South Africa (NERSA) announced feed-in-tariffs (REFIT) for wind and concentrator solar power (CSP) generation. The approved REFIT guidelines will be expected to create an enabling environment for achieving government ‘s 10, 000 GWh renewable energy target by 2013 and sustaining growth beyond the target. However, the investor ‘s response to the announcement of the REFIT by NERSA would appear to be weak. This lack of interest of the investors emanates from the expectation of very weak market environment due to dominance of the market by the national utility ESKOM.

This fear of dominance of the market by ESKOM was also expressed by CDM projects stakeholders in SA. For example, Mr. Jacques Malan Chief Technology Officer of APP carbon Company answered regarding Feed-in Tariff and said, in South Africa there is no sensible Feed-in Tariff as such for any clean power until recently. He continued and said the problem is related with ESKOM and that ESKOM refuses to buy power at Feed-in Tariff put in place by government, thereby keeping IPPs from developing clean technology projects. Another respondent from a joint venture company formed with a UK based clean technology company called the ENER-G Group who was also involved in implementing renewable electricity generation projects by using landfill gas as fuel source and registered the project with Executive Board; and answered to question and said Feed-in tariff is already put in place in SA, the problem is, he said there is a lack data on wind speed measurement and lack of issuing of PPAs due to the corruption.

The results from the set of interviews with a stakeholder in South Africa indicate that to fulfill host countries ‘energy service needs and priorities, all interviewee equally believe that the government of South Africa must change its position about the monopoly power generation and distribution of electricity by ESKOM to increase the ratio of power generated from renewable source to the national grid by IPPs. Respondents to questionnaires number also claimed that, currently the national grid is totally monopolized by ESKOM and if government of South Africa does not show its political willingness to change the current country forecasted demand of expected electricity source from where to come from and its position regarding the monopoly power of ESI by ESKOM-government utility company, it is difficult to boost a considerable renewable energy source projects through CDM in South Africa.

As indicated in interview, one of the respondent to questionnaires, Mr Jacques Malan,Chief Technology Officer from South Africa who has also involved as CDM project developer answered question and said, —…ESKOM (which has a monopoly in SA as the ONLY electricity provider) with one of the "dirtiest" Grids in the world and who is subsidized by Government to produce more "dirty" electricity. To my knowledge, there are Zero incentives (at this stage) for IPPs who want to produce cleaner energy in SA.Mr.Johan who is also involved as CDM project developer in South Africa, supported the idea given by pervious respondent in his answered to question and said, in South Africa ,there is no any power generated by IPP of any nature, either in the form of clean coal or wind power, most of the power is produced by the utility company ESKOM.

In interview made with Mr.Jacques Malan who is Chief Technology Officer of AAPCarbon Company in South Africa and he was also supported the answers given by previous respondents and he said, in the last five years the government officially decided to make ESKOM as only a single buyer of all power generated by IPPs, if investors want to involve in investment of any nature including renewable energy, the blessing and good will of ESKOM is very important and without it‘s good will it is difficult to enter into the sector. There is no law forcing ESKOM to buy power from any renewable sources generated by IPPs but there is a law which is forcing all power producers to sell their power to ESKOM and everything decided by ESKOM including the price. This idea repeatedly supported by all respondents indicating ESKOM is one of the major barriers in transfer of clean technology to South Africa through CDM projects. Under the topic of challenge from, a century-old legacy of coal-based power source in SA, a number of reasons are mentioned why coal powered plant is dominating in energy sector in SA. The first possible reason is a considerable amount of government budget in SA comes from the premium paid from ESKOM revenue so that the government is reluctant to change its position to allow more competitive IPPs to enter in to the market. As result of this, ESKOM has more encouraged pushing the government to prevent the entry of IPPs into the ESI sector despite the substantial amount of government efforts to diversify energy sources through policy documents which helps the country to source up to 30% from non-traditional energy source like renewable energy, but this is not more practical and one of the interviewees expressed his concern on the practicality of policies and said there are many policies, acts put in place in South Africa but when you see in terms of their actual application , it is not working well..

The other reason, as given by answers to questionnaires supporting the idea of the literature review stated above, the government put in place requirement that forces all IPPs to sell the power to ESKOM, and in SA ESKOM as the only and the sole buyer of the power generated by IPP and this has produced serious doubt with private investors to involve in the sector. Regarding this problem Mr Jacques Malan answered to questions in relation to Feed-in Tariff and said ―...The biggest problem however is that ESKOM has a monopoly and they are the "single buyer" of electricity from IPPs. They therefore refuse to buy power at the feed in tariffs, thereby keeping IPPs from developing projects. I believe this will change but it will still take some time (perhaps as much as 3-5 years.)

The other major reason for dominance ESKOM is the relative abundance of the source of big deposit of coal locally that is estimated to be enough for the coming 300 years and furthermore, it has already developed appropriate technology and skill to convert coal into liquid fuel. So, from this analysis the author of this paper learnt that otherwise unless the government changes its position regarding ESKOM monopoly power of energy sector as mentioned above it is impossible to assume the transfer of environmentally clean technology through CDM (especially like wind power plant) to South Africa. Therefore, ESKOM is at least can be guessed and taken as one of a big barrier for environmentally clean technology transfer through CDM projects to South Africa. Even if the country has big RE potential, it is clear from the analysis that opportunities to move to a low-carbon energy service supply is being missed due to this traditional source of energy.

RED –TAPE AND CORRUPTION AND ITS EFFECT

All respondents were highly concerned about the level of Red-tape and corruption effect on environmentally clean technology transfer through CDM projects in SA in their answers to questionnaires and all claimed that red-tape and corruption is one of the biggest problems in environmentally clean technology transfer through CDM projects in SA. In questionnaires the author asked the respondents UN Definition: Corruption could be said to constitute the combined effect of monopoly of power plus discretion in decision-making in the absence of accountability. This means that officials will have the opportunity to collect corrupt benefits as a function of their degree of monopoly over a service or activity, their discretion in deciding who should get how much, and the degree to which their activities are accountable. Source: http://www.uncjin.org/Documents/corrupt.htm select from a list of social factors that is most affecting environmentally clean technology transfer through CDM from Annex I countries to SA and all responded red-tape and corruption. For answers to questions regarding Red-Tap, respondents highly criticized how corruption is hindering the transfer of environmentally clean technology transfer through CDM to SA and expressed their concern about the difficulty of getting approved their projects due to high corruption level and mentioned some of serious corruption observed like lack of timely issuing of PPA(Power Purchase Agreement) and EIA(Environmental Impact Assessment) results, unpredictable public administration and extremely high corruption level among community leaders. For question to interview one of the respondents Mr. John Parkin, who is deputy head of Plant and Engineering of DSW eThekwini Municipality said SA has some of the lowest priced power in the world and he explained pathetic management of public utility and corruption in the department delaying feed-in tariff already approved thereby blocking the introduction of renewable energy projects to South Africa.

The author of this thesis believes that a high level of corruption complicates obtaining the right information at right time and thus raises transaction costs and becoming a big problem in exploiting the country 's renewable energy potential. So, the government should curb this problem in order to increase the transfer of environmentally sound technology through CDM projects to the country.

LACK OF INCENTIVES TO INVESTORS INVOLVING IN TECHNOLOGY TRANSFER THROUGH CDM

In another interview session, one of the respondent to questionnaires from PrEng Group, Energy Manager from Pretoria Portland Cement Company (Ltd) South Africa ,answered to question of how did he rate the incentives provided from government of SA to private investors involved in clean technology transfer through CDM and he answered very low incentive and he continued saying even though incentives are already on white paper; as far as they are not implemented, they are useless because administrative and policy support to strengthen technology transfer through CDM project is very poor in South Africa. This indicates that there is clear lack of commitment from government of SA to provide incentives to investors who want to involve in clean technology development sector through CDM. All ten respondents to this question shared the same view and rated in average very low incentive is provided for environmentally sound technology transfer through CDM in South Africa. Another respondent from SA, who has involved in wide range of CDM projects as consultant from carbon stream Africa company, Mr Siphiwe Nhlapo shared his long years of experience in the area about how he rate the possible incentive the government of SA offers to private investors involving in environmentally sound technology transfer through CDM projects and he answered LOW and explained some renewable energy project developers approached Department of Energy to provide them with incentives and due to limited resource at hand by Department of Energy to support project developers, they were not able to be assisted. He continued and explained this shows provision of low incentive by the government of South Africa to encourage private investors to engage in clean technology development sector. So, the author of this paper also wants to suggest that the government of South Africa should put in place practicable policy which promotes incentives to private investors involving in transfer of environmentally clean technology through CDM to maintain and strengthen the current move toward renewable energy sector.

CONCLUSION

Previously several studies were conducted in technology transfer through CDM focusing on PDD documents based on CDM project distribution globally, but the issue of low-carbon technology transfer to a specific country under CDM has not been well investigated (Doranova, 2009). The objective of this thesis is attempting to locate some of the major factors affecting environmentally clean technology transfer through CDM projects from Annex I countries to South Africa based on specific case studies to see the effect of these factors specifically focusing on know-how rather than show-how transfer, REFIT and ESKOM, Red-tape and corruption and Incentives to answer the following research question.

"How can South Africa overcome negative factors affecting environmentally clean technology transfer through the CDM projects from Annex I countries and what are the major factors affecting this transfer"?

As stated above, CDM does not have an explicit technology transfer mandate under Kyoto Protocol and sustainable development criteria for CDM projects is left to be defined by CDM project host countries. However, in Article 4 of UNFCC, transfer of clean technology from industrialized to developing countries is described above; however, under CDM project approval criteria of South Africa, the DNA has defined sustainable development criteria for CDM projects and has clearly stated that CDM projects should assist South Africa in reaching sustainable development objectives defined along its social, environmental and economic pillars. The economic criteria incorporated the transfer of appropriate technology through CDM as one of the mandatory indicators of SD criteria. This implies that the DNA has already put in place environmentally clean technology transfer as one of the requirements of CDM project approval criteria in SA, it is possible to see that there is insufficient information on what sustainability benefits can be delivered and how these may be achieved.

According to the author, SA should maintain well established interaction between the DNA, the technology supplier company, the technology receiver company and financial institutions in the technology transfer processes to reduce the possible barriers of environmentally clean technology transfer.

To this end, all actors including the South Africa DNA should work to reduce the barriers of information flow and difficulty of access to capital from financial institutions to make environmentally clean technology transfer much smooth. In discussion part above six necessary conditions are mentioned, that are supposed to be fulfilled to choose environmentally clean technologies. These are interest, power, organization, information, access and knowledge. As mentioned as mentioned above, different types of actors are involved in CDM projects in South Africa and each actor have different tasks and they are linked together in one way or another making a variety of what is called linked carriers of technology. In any country, including SA, there is no readymade technology for people to pick from the shelf and use it, so the carrier of technology should involve in technological innovation to transform the technology in question. But that is not the case in South Africa, for example in the electronic questionnaires sent to SA CDM project participants, in question number 15, the participants were asked how to do they rate the interactions between public agency, private agency and support research institutions (that is, education, training and technical assistance centers) in environmentally clean technology transfer and all answered LOW. This indicates that in South Africa, the government must pave the way for intensive involvement of research institutions in environmentally clean technology development and research. That is to make it clear that institution-industrial linkage must be created. On the other hand, as one important task, further reducing of the lack of information will minimize the barriers and one suggested way is through the DNA. The South African DNA could improve access to relevant information by generating data from the extensive number of projects presented to it. With this regard, more information requirement on the technological specification and the name of the technology supplier and/or technical project developer in the PDDs, as well as information on key problems occurring during CDM project approval processes, could be created by DNA as a unique database so that project developers can access these data when need comes. If this is coupled with data on project performance provided in terms of the type of the environmentally clean technology already implemented, proved and tested in South Africa, it could serve as valuable information for private actors to reduce search costs for choosing the proper technology and its provider. The information may equally be provided by CDM Executive Board but the information the South Africa looking for about environmentally clean technology entirely depends on the socio-political and economic context of the country, so the database generated by DNA based on South Africa context help the country more than any information source.

According to the first case study, the interaction between MathCap (Pty) Ltd Company as project developer and GE Jenbacher Company as technology supplier manifested in the supply and the implementation of technology as described above and it is a important interaction to demonstrate interrelations between actors involved during environmentally clean technology transfer in South Africa.

It appears evident from the PetroSA Biogas to Energy CDM project description of the technology that the technology transferred was characterized by the transfer of show-how of the knowledge of the technology. This was manifested in short term courses to the employees through on-the-job training in SA and in Austria instead of more intensive know-how transfer, limiting the local engineers and operators to perform simple operation only. This implies that the employees of the PetroSA Biogas to Energy Company did not gain extensive insights about the methods and procedures that have been applied in this technology transfer. The technology transfer did not increase the technological capabilities of the transferee to install, optimize, modify, and thereby effectively implement the complete system in the absence of technology suppliers as mentioned in the discussion part. Furthermore, a binding agreement and shared ownership nature of the deal structure was not put in place, which might have enhanced the willingness of the technology supplier to exchange valuable codified and tacit knowledge regarding the technology system. Instead they signed a contract agreement on operation and overall maintenance of the machine that allows technology supplier to undertake periodic overall maintains from time to time, rather than increasing the capacities of local engineers to take up all the jobs and even replicate the technology locally. Furthermore, the technology transfer should also to entail all aspects of overall maintenance and installation capacity of the system, including the transfer of enough knowledge so that local engineers are able to manufacture a machine which can make an internal combustion engine even with better efficiency and performance. In addition, to utilize this technology transfer system potentially, a policy framework should be designed so that it should regularly be monitored and evaluated by concerned government agency like DNA and NERSA to be sure that the effectiveness of implementation on technology transfer is properly practiced on the ground. In most cases in SA many policies are rarely applied according to interviewees answer. In general, in this technology transfer processes the most important thing is that both parties must show willingness to get prepared to change and move their technology and social setting to fit each other at some point thereby enhancing sustainable assimilation process put into motion, preferably at the development, formation and application level of the whole scheme of dynamic assimilations of technology transfer as discussed above, in contrary to this ,what generally understood from case study I analysis is that new technology from Annex I country, Austria, with quite different technological and social setting was transferred to South Africa so that South Africa setting was attempted to adapt to new technology and this resulted in failure.

Recently the government of South Africa has made a substantial amount of increase on Feed-in Tariff (called REFIT).One of interviewee Mr Johan Van der Berg was explained about what is exactly happing now in SA in this regard and said ‚‖…what is happening in SA is the government has announced REFIT that was approved in 2009 this wind power tariff is very good one and 25% increase of the tariff and if we think quickly, it is about € 20 Euro cents /KWH and this makes the tariff internationally very competitive price and at the moment public hearing on the rule of the tariff will be held and is going and one of the hearing will be held tomorrow. In two weeks', time the outcome of public hearing will be announced …. This step taken by the government of SA is to attract more investors on CDM project investment and to maintain long-term involvement of organizations that transfer knowledge, especially the private sector in industrialized countries. Since the national grid is still administrated by Eskom, without the blessing of Eskom it still remains difficult for private investor to involve as IPPs so the government must change its position on Eskom and must push in the area of energy source diversification by concentrating on renewable energy development.

The other problem which has to be addressed seriously in CDM project investment is inequity of carbon market, as mentioned in introduction part, the unit price of CER in Europe is 84.37% higher than in developing countries. For example, one of respondent to questionnaires Mr Jacques Malan from SA explained his feeling regarding CER price and said‖ Lack of financing available for CDM projects and the time it takes to reach financial close. I should also mention that greed by compliance buyers probably plays the biggest role. Typically, utilities in Europe, e.g. RWE, Vattenfal, ESBI, E. ON and others, all of whom we have had discussions with, are looking to get the lowest possible price for CERs. This may be acceptable business practice for them, but we as independent project developers feel that the deals they offer are "rip-offs" to put it bluntly. We have had offers for our CERs for around €2-€3 at a time when the spot prices were around €20 in European countries. This is insulting to say the least. To this end, it has already understood by CDM project developers that CDM increases the commercial viability of environmentally clean technology transfer by setting a price on carbon. Therefore, a high and stable carbon price would be desirable to increase the environmentally clean technology transfer under the CDM or a future similar mechanism. But, credit buyers are already aware that emissions reductions generated from CDM projects are sometimes untrustworthy, that is why, given a choice to ERU, and don 't offer the same price for CDM CER 's. Therefore, developing countries can also follow the same policy to make CER's price stable and high by introducing stringent checks and controls.

Therefore, it can be taken as one of the best incentives to local and private investors who want to involve in CDM project investment in SA. Furthermore, international and domestic policymakers need to complement the CDM by fostering host-country-specific improvements in investment conditions for key technologies.

In order to improve South African 'ability to involve more in environmentally clean technology transfer and host substantial amount of CDM projects, the country should fight red-tape and corruption putting in place appropriate anti-corruption policies. Furthermore, the country must incorporate anti-corruption education to support as one of a critical need of society to combat corruption and help to lay foundation for an ethical society and success. The society should commit themselves to the process of moral regeneration and sticking to a value system of ethical conduct.

In South Africa National Anti-corruption Forum (NACF) has already been established and in 2008 the third NACF summit took place in Johannesburg and adopted clear resolution to fight corruption (NACF, 2008) but the current corruption level indicates that South Africa must do more than this to eradicate the problem from root. As mentioned in discussion part, almost all CDM project participants who have responded to questionnaires and made an interview with author were found highly worried about corruption level in South Africa and suggested possible intervention from government too. In South Africa National Anti-corruption Forum (NACF) has already been established and in 2008 the third NACF summit took place in Johannesburg and adopted clear resolution to fight corruption (NACF, 2008) but the current corruption level indicates that South Africa must do more than this to eradicate the problem from root. As mentioned in discussion part, almost all CDM project participants who have responded to questionnaires and made an interview with author were found highly worried about corruption level in South Africa and suggested possible intervention from government to minimize the problem.

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ABBREVIATIONS: AAU, Assigned amount unit; **ADBM,** ad hoc group on Berlin mandate; **AfDB,** African development bank; **BEE,** black economic empowerment; **CDM,** clean development mechanism; **CERs,** certified emission reductions; **CIA,** central intelligent agency United State; **COP,** conference of parties; **CSP,** concentrator solar power; **DEAT,** department of environment affairs and tourism; **DME,** department of mining and energy of South Africa; **DNA,** designated national authority; **DNV,** Det Norske Veritas; **DOE,** designated operational entity; **DRC,** Democratic Republic of Congo; **DSA,** demand side abetment; **DSM,** demand side management; **DST,** department of science and technology; **ECTT,** environmentally clean technology transfer; ESI, electrical supply industry; **ERs,** emission reductions; **ERUs,** emission reduction unit; **ESKOM,** the national regulated electricity utility; **EU,** European Union; **FAR**, first assessment report; **GCI,** global competitiveness index; **GDP,** gross domestic product; **GE**, general electric; GE ICE, general electric internal combustion engine; **GHG,** green house gas; **GPS,** global positioning system; **GTZ,** Deutsch Technische Zusammenarbeit; **GWh,** Gigawatt hour; GWP, global warming potential; **HDI,** human development index; **HIV/ADIS,** human immunodeficiency virus; **IET,** international emission trading; **ISO,** international organization for standardization; **JI,** joint implementation; **IPCC,** intergovernmental panel on climate change; **IPP,** independent power producer; **IPAT,** impact population affluence technology; **IRR,** internal rate of return; **KWh,**

kilowatt hour; **LCIA,** life cycle impact assessment; **LULUCF,** land use, land use and forestry; **PC,** personal computer; **PPA,** power purchase agreement; **PDD,** project design document; **PPP,** purchasing power party; **FDI,** foreign direct investment; **FiT,** feed-in tariff; **ppm,** parts per million; **MNEs,** multinational enterprises; **NCCC,** national committee of climate change; **NEMA,** national environmental management act; **NERSA,** national energy regulator South Africa; **NPV,** net present value; **OECD,** organization of economic cooperation and development; **RE,** renewable energy; **REFIT,** renewable energy feed-in tariff; **SA,** South Africa; **SADC,** Southern African development community; **SCOT,** social construction of technology; **SD,** sustainable development; **SSA,** Sub-Sahara Africa; **UN,** United Nation; **UNEP** united nations environmental programme; **USDS,** United States Department of State; **US,** United States; **UNFCCC,** United Nation framework convention on climate change; **UNESCO,** United Nations educational, scientific and cultural organization; **WB,** World Bank; **WFCR,** world forum competitiveness report; **WMA,** world metrological agency.

REFERENCES

Ameley Ll (2008). Exploring the dynamics of the CDM in Africa: A South African case study. Master Thesis. Aalborg University, Department for Development and Planning Environmental Management.

Benson N, Rob P (2008). "Global Warming": Encyclopedia of Global Warming and Climate Change. SAGE Publications. 2: 456.

Bogdan R, Taylor SJ (1975). Introduction in qualitative Research. New York: John Whiley and Sons.

Bozeman B (2000). Technology transfer and public policy: a review of research and theory. http://calitc.pbworks.com/f/TechTransferStudy.pdf. (Accessed: March 24, 2010).

Bureau of Energy Efficiency (2007). India. http://www.bee-india.nic.in/. (Accessed. February 19,2010).

CEO (Corporate Europe Observatory).2001.'Saving' the Kyoto Protocol Means Ending the Market Mania. http://archive.corporateeurope.org/climate/bonnstatement.html.(Accessed:23 May, 2010).

Chadwick JM, Hewehy MAL (2007). Sate-and-Trends of The Environment: 1987-2007.

Chertow RM (2001). The IPAT Equation and its variant: Changes views of Technology and Environmental Impact. New Haven, US: Massachusetts Institute of Technology and Yale University.

CIA (Central Intelligence Agency) (n.a). The World FactBook. https://www.cia.gov/library/publications/the-world-factbook/geos/sf.html (Accessed: May 3, 2010)

Dechezlepre A, Glachant M, Me´nie Y (2008b). The Clean Development Mechanism and the international diffusion of technologies: An empirical study. Sciencedirect Publication. 36(4): 1273-1283.

Dechezleprêtre A, Glachant M, Ménière Y (2008a). Technology transfer by CDM projects: A comparison of Brazil, China, India and Mexico. Sciencedirect Publication. 37(2): 703-711.

DME (Department of Minerals and Energy) (2004a). Sustainable Development Criteria for Approval of Clean Development Mechanism Projects by the Designated National Authority of the CDM. http://www.dme.gov.za/dna/pdfs/sustainable_criteria.pdf.(Accessed: April 8, 2010)

DME (Department of Minerals and Energy) (2004b). Terms of Reference for the committee of the Designated National Authority of the Clean Development Mechanism. http://www.dme.gov.za/dna/pdfs/terms_of_ref.pdf(Accessed: April 19, 2010).

DME (Department of Minerals and Energy) (2004c). Project Approval Procedure of the Designated National Authority for Clean Development Mechanism. http://www.dme.gov.za/dna/pdfs/approval_process.pdf(Accessed: April 30, 2010).

DMG (Danish Management Group) (2005). http://www.danishmanagement.dk/latest-newsmainmenu-2/85-kyoto-protocol-enters-into-force (Accessed: March 2, 2010).

DNA (2010). South Africa's CDM project protifolio. http://www.energy.gov.za/dna/pdfs/South_Africa's_CDM_project_portfolio_up_to_25_Mar ch_2010.pdf (Accessed: May 23, 2010).

Dong Energy (2009). Annual Report. http://www.dongenergy.com/SiteCollectionDocuments/Koncernregnskab/2009/Q4/DONG_ ENERGY_UK_A4.PDF (Accessed: April 22, 2010).

Doranova A (2009). TECHNOLOGY TRANSFER AND LEARNING UNDER THE KYOTO REGIME: exploring the technological impact of CDM projects in developing countries. PhD Thesis. The Netherlands: Datawyse / Universities Pers Maastricht.

DST (Department of Science and Technology), Republic of South Africa (2007). SOUTH AFRICAN'S CLIMATE CHANGE TECHNOLOGY NEEDS ASSESSMENT SYNTHESIS REPORT.http://www.dst.gov.za/publications-policies/strategiesreports/SA%20climate%20change%20technology%20needs%20assessment.pdf.(Accessed: March 27, 2010).

EEA (European Energy Agency) (2009). Environmental Terminology and Discovery Service. http://glossary.eea.europa.eu/EEAGlossary (accessed 4 December 2009).

EEDNA (Energy, Environment and Development Network for Africa) (2009). The Role of Feed-in Tariff Policy in Renewable Energy Development in Developing Countries: A Toolkit for Parliamentarians. http://www.eparl.net/eparlimages/general/pdf/090911FITDevCountries.pdf (Accessed: May 19, 2010).

ESKOM (2010). http://www.eskom.co.za/live/content.php?Category_ID=14.Company Information (Accessed: April 18, 2010).

Gaast WV, Begg K, Flamos A (2008). Promoting sustainable energy technology transfers to developing countries through the CDM.Sciencedirect Publication.

Goa M, Martinez A (2010). CDM from China and South Africa perspective. Semester Project. Aalborg University, Department for Development and Planning Environmental Management.

Gravey J (2008). The ethics of climate change: Right and wrong in a warming world.London.MPG Books Ltd, Bodmin, cornwall.

Greiner S, Michaelowa A (2002). Defining Investment Additionality for CDM projects— practical approaches. Sciencedirect publication.

Grubb M, Vrolijk C, Brack D (1999). The Kyoto e and Protocol: A Guid and Assessment: Royal Institute of International Affairs. London.

GTZ (Deutsche Techische ZUsammenarbeit) (2006). Cpacity Development for the Clean development Mechanism: Lessons Learned in Ghana,India,Indonesia,South Africa and Tunsia.Berlin.W.B Druckerei GmBH Hochheim am Moin.

Hansen UE (2008). Technology and Knowledge Transfer from Annex I Countries to Non-Annex I Countries under Kyoto Protocol's Clean Development Mechanism (CDM): An empirical case study of CDM projects implemented in Malaysia. Master Thesis.UNEP RisØ Center.http://cd4cdm.org/Publications/TechnologyKnowledgeTransferCDMMalaysia.pdf.

Harris LR, Brown GTL (2010). Practical Assessment, Research and Evaluation. Mixing interview with questionnaires methods: Practical Problems in aligning data. http://pareonline.net/pdf/v15n1.pdf (Accessed: April 25,2010).

Hinrichsen D, Robey B (2008). Population and the Environment: The Global Challenge. Action. Bioscience.org http://www.actionbioscience.org/environment/hinrichsen_robey.html

IEA (2007). World Energy Outlook 2007—China and India Insights, Paris.

IPCC (2000). IPCC Special Report: Methodological and Technological Issues in Technology Transfer. Cambridge University Press, Cambridge.

IPCC (2007). Climate change 2007: Synthesis Report. Intergovernmental Panel on Climate change. Valencia, Spain.

Karakosta C, Doukas H, Psarras J (2010). Technology transfer through climate change: Setting a sustainable energy pattern. Sciencedirect Publication. 14(6): 1546-1557.
King D (2002). The science of climate change: Adapt Mitigate or Ignore. http://www.foundation.org.uk/events/pdf/20021031_King.pdf (Accessed: March 30, 2010).
King D (2005). Climate change: the science and the policy. http://www.ese.u-psud.fr/epc/conservation/PDFs/King.pdf: Journal of Applied Ecology .(Accessed: March 10, 2010).
Kvale S (1996). Interview: An introduction to qualitative research interviewing. Thousand Okas: Sage publication.
Lloyd B, Subbarao S (2008). Development challenges under the Clean Development Mechanism (CDM)—Can renewable energy initiatives be put in place before peak oil? Sciencedirect Publication.
Luken SE, Michaelowa A (2008). Coroperate strategies and the Clean Development Mechanism: Developing country financing for developed country commitments. The Lypiatts: Edward Elgar Publishing, Inc.
Mulder K (2006). Sustainable Development for Engineering: A Handbook and Research Guide. Delft University of Technology, The Netherlands: Greenleaf Publishing.
Müller J, Kuada J (2003). Culture and Technology Transformation in the South: Transfer of local Innovation. Denmark: Samfundslitteratur Press.
NACF (2008). The Third National Anti-Corruption Forum Summit Resolutions, South Africa. http://www.nacf.org.za/anti-corruption-summits/third_summit/index.html (Accessed: May 2, 2010).
NERSA (2009). NERSA decision on renewable energy feed-in tariff (REFIT). www.sessa.org.za/.../53-nersa-media-release-renewable-energy-feed-in-tariffrefit (Accessed: May 19, 2010).
http://www.unctad.org/en/docs/iteiit20051a1_en.pdf (Accessed: April 21, 2010).
OECD (2009). Financing Climate Change Action, Supporting Technology Transfer and Development: Key messages and recommendations from recent OECD work. http://www.oecd.org/dataoecd/60/1/44080723.pdf)
Olsen KH (2007). The clean development mechanism's contribution to sustainable development: a review of the literature. Springer Science. http://www.cd4cdm.org/Publications/CDM&SustainDevelop_literature .pdf (Accessed: March 2, 2010).
Painuly JP, Clausen N-E, Fenhann J, Kamel S, Pacudan R (2005). Wind Power and the CDM: Emerging practice in developing countries wind power project for the Clean Development Mechanism. Riso National Laboratory, Denmark.
Remmen A, Thrane M (2007). Life Cycle Thinking. In Kørnøv, L., Thrane, M., Remmen, A., and Lund, H.2007. Tools for Sustainable Development.AalborgUniversitetsforlag, aalborg, Denmark.
Schneider M, Holzer A, Hoffmann HV (2008). Understanding the CDM's contribution to technology transfer. Sciencedirect Publication.
Seres S, Haites E (2008). Analysis of Technology Transfer in CDM Projects. the UNFCCC Registration & Issuance Unit CDM/SDM. http://cdm.unfccc.int/Reference/Reports/TTreport/TTrep08.pdf (Accessed: March 19, 2010).
Shah A (2009). Climate Change flexibility Mechanism. http://www.globalissues.org/article/232/flexibility-mechanisms.(Accessed: May 12,1020).
Tsikata M, Sebitosi AB (2009). Struggling to wean a society away from a century-old legacy of coal based power: Challenges and possibilities for South African Electric supply future. Sci. Direct Public. 35(3): 1281-1288.
UNDSD (United Nations, Division for Sustainable Development).1992. Agenda 21: The Report of the United Nations Conference on Environment and Development, Chapter 34: Transfer of environmentally sound technology, cooperation & capacitybuilding. Rio de Janeiro: Earth Summit.
UNEP (n.d.). Technology Need Assessment (TNA): UNEP Project Document: Riskilde. Risoe National Labouratory, Denmark.
UNFCC (2010). Registred Project Activities by Host Party. http://cdm.unfccc.int/Statistics/Registration/NumOfRegisteredProjBy HostPartiesPieChart.ht ml (Accessed: April 19, 2010).
UNFCCC (2005). Clean Development Mechanism simplified Project Design Document for small-scale project activities (SSC-CDM-PDD): PetroSA Biogas to Energy project. http://cdm.unfccc.int/UserManagement/FileStorage/MVB35TXGKH9S 86MMWF1WMYV9LH QJC6 (Accessed: April 26, 2010).
UNFCCC (2006). Clean Development Mechanism Project Design Document form (CDM-ssc- pdd): Kanhym Farm Manure to Energy Project. http://cdm.unfccc.int/UserManagement/FileStorage/S8SF9ZW5RK08N FPWEK7PFHRS5JM7Z Y (Accessed: March 27, 2010).
UNFCCC (2007). Validation Report: Kanhym Farm manure to Energy project in SA. http://cdm.unfccc.int/UserManagement/FileStorage/OHGK0J445FRRS 9HLPZI9B7HSC8Z3F (Accessed: May 19,2010).
UNFCCC (2008). First Monitoring Report: PetroSA Biogas to Energy Project in SA. http://cdm.unfccc.int/UserManagement/FileStorage/0HMRYJXI819VZC 4KSBAOF7DWL3GPU 5.(Accessed: April 27,2010).
UNFCCC (2009a). Verification Report: PetroSA Biogas to Energy Project in SA. http://cdm.unfccc.int/UserManagement/FileStorage/Q32WIZDJRSHV0 YG7APOBT8LUN659X E.(Accessed: May 7, 2010).
UNFCCC (2009b). Certification Report: PetroSA Biogas to Energy Project in SA.http://cdm.unfccc.int/UserManagement/FileStorage/5OPCR9IL86F E2DQSBJ0Y4HV37GUK1Z (Accessed, May 12,2010).
UNFCCC (2010). Second Monitoring Report: PetroSA Biogas to Energy Project in SA.http://cdm.unfccc.int/UserManagement/FileStorage/13H2ZDXMKSI EFQU6ATYJCPRG94O B58. (Accessed:April 19,2010).
UNIDO (United Nations Industrial Development Organization) (n.d). CDM Investor GUIDE South Africa. http://www.dme.gov.za/dna/pdfs/unido_guide.pdf (Accessed: March 10, 2010).
US DS (United States Department of State) (n.a). Background Note: South Africa. Bureau of African Affairs. http://www.state.gov/r/pa/ei/bgn/2898.htm.(Accessed: April 16, 2010).
Wenzel H, Hauschild M, Alting L (1997). Environmental Assessment of Products. Volume I. ISBN: 0 412 80800 5. London UK: Chapman & Hall.

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