ASSESSING A PROSPECTIVE LANDFILL GAS TO ENERGY PROJECT IN AGADIR, MOROCCO

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ABSTRACT

The aim of this study is to appraise and to establish an actual and concrete business opportunity in the field of MSW management, utilizing Landfill Gas and generating green energy in Morocco, in particular in Greater Agadir City and in the perspective of technology transfer. A special focus is on the LFGTE technology and expertise available in Scandinavia, represented by a selected Swedish company Biogas Systems Ab, pioneers in Converting Landfill Methane to Electricity. One part of the Author's activities is to interview the company and take into account their special needs in respect of the market in such emerging market.

The study will use deductive method and qualitative design. The desk research was conducted through literature review, books, journals and internet resources. Tools utilized on the field study included: maket and sites visits, interviews with local authorities, government officials, energy producer and technology providers. In order to investigate the target market as well as the technology in more depth, structured interviews will be used to obtain valid and reliable empirical results.

Based on the stakeholders-analysis and the result of interviews with different decision makers, substantial opportunities exist across the country to harness this energy resource and turn what would otherwise be a liability into an asset. The comments received from all stakeholders were all favourable to the project.

The landfill gas recovery project represents the low hanging fruit for carbon credits trading in the developing countries. The sale of CERs earned by implementing the project will generate a substantial flow in foreign currency. This project will adopt a three-pronged strategy of business viability, social integration and environmental protection. Recommendations were made for both municipalities and foreign prospectives companies. Once up and running, this project will become the standard model that will be reapplied in other similar sites across the nation.

There is a lot of scope for further research on the subject matter of this thesis. The study proposes a business model. However, the financial aspect is not discussed and would be subject to a company intending to penetrate the market with its technology solution in reality.

Key words: Landfill Gas-To-Energy, Biogas, transfert technology, Greater Agadir, Morocco, Ansoff Growth Strategy Matrix, CERs, Clean Development Mechanism

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Helsinki, 20 November 2011 Ahmed Sabri

Abbreviations

ADEREE Agency for Development of Renewable Energy and Energy Efficiency

CO2 Carbon dioxide

CO2eq Carbon dioxide equivalent

CH4 Methane

CLD Causal Loop Diagrams

CDM Clean Development Mechanism

CDER Center for Development of Renewable Energy

CER Certified Emission Reduction

DNA Designated National Authority

DH Moroccan currency Dirham (MAD)

Euro United States Dollars (1 Euro = 10 DH) Aprroximately

EU European Union

FDI Foreign Direct Investment

GDP Gross domestic product

GHG Greenhouse Gas

GWP Global Warming Potential

GWh Gigawatt hour

IRR Internal Rate of Return

JI Joint Implementation

LFG Landfill Gas

LFGTE Landfill Gas- to- Energy

MSWM Municipal Solid Waste Management (also MWM)

NPV Net Present Value

MEMEE Ministry of Energy, Mining, Water and Environment

MW Megawatt

ONE National Electric Power Authority

PDD Project Design Document

T CO2e Tonne of carbon dioxide equivalent

PNDM Household Waste Management National Program

WFOEs Wholly Foreign Owned Enterprises WFOEs

UN United Nations

UNFCCC United Nations Framework Convention on Climate Change

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1 INTRODUCTION

This chapter is an introduction to the thesis with an explanation of the problem area, the research questions, aim and scope of the project.It introduces the theoretical framework, the research approach and the structure of the report.

1.1 Background

Morocco produces about 5 million tons of municipal waste per year and could reach 6.2 million tons in 2020 and the contribution of poor SWM to the cost of environmental degradation is estimated at 0.5% of GDP. The rate of waste production now stands at 0.75 kg/inhabitant /day. The waste management industry in Morocco is undergoing a number of changes that place emphasis on energy recovery and recycling. Paradigms are shifting towards closed-loop systems that minimize environmental damage and extract value from landfills.

Morocco is limited in its fossil energy resources and is therefore very much dependant on importations of carbon, petrol and even electricity. The dependency on fossil energies is constantly rising, from 93% in 1994 to 97% today. The electricity consumption increases at 8 % growth rate a year. The energy sector in Morocco is today in a position where the need for new investments and maintenance have a significant impact on the energy consumption and the security of energy supply.

With the increasing global focus of energy conservation and stress on clean generation, Landfill Gas (LFG) has emerged as a source which is available backdoor, is proven to be economical in cost perspective and is a growing energy resource in the modern world. LFG is a byproduct of the decay process of organic matter in municipal solid waste (MSW) landfills. The gas typically contains approximately 50% methane and 50% carbon dioxide, with some additional trace compounds. The heat value of LFG ranges from 400 to 600 British thermal units (Btu) per cu-

bic foot and can burn in virtually any application with minor adjustments to air/fuel ratios.

The use of LFG provides environmental and economic benefits, and users of LFG have achieved significant cost savings compared to traditional fuel usage due primarily to the fact that LFG costs are consistently lower than the cost of natural gas. Additionally, because LFG is comprised of approximately 50% methane, a major greenhouse gas, reducing landfill methane emissions by utilizing it as a fuel helps businesses, energy providers, and communities protect the environment and build a more sustainable energy future. Progress in lowering GHG emissions is best achieved by a concerted, integrated approach that employs all available technologies and methods, including landfilling of municipal solid wastes (MSW) with capture and use of landfill gas (LFG). This "hierarchy" of waste management is illustrated in Figure 1.1 (Kaufman and Themelis, 2009).

Figure 1: The Hierarchy of Waste Management (Kaufman and Themelis, 2009)

The enactment of the Kyoto Protocol has provided a new stimulus for commercial landfill gas recovery projects in developing countries through the Clean Development Mechanism (CDM). The CDM is an enabling mechanism through which developed countries can invest in sustainable projects, such as landfill gas projects, in the developing world through the purchase of Certified Emission Reductions (CERs). Landfill gas projects have a major role in Kyoto

trading because emission reductions can be readily quantified and the technology has been fully commercial for three decades. There is now a window of opportunity to develop landfill gas recovery projects in developing countries to contribute to cost-effective global climate change mitigation.

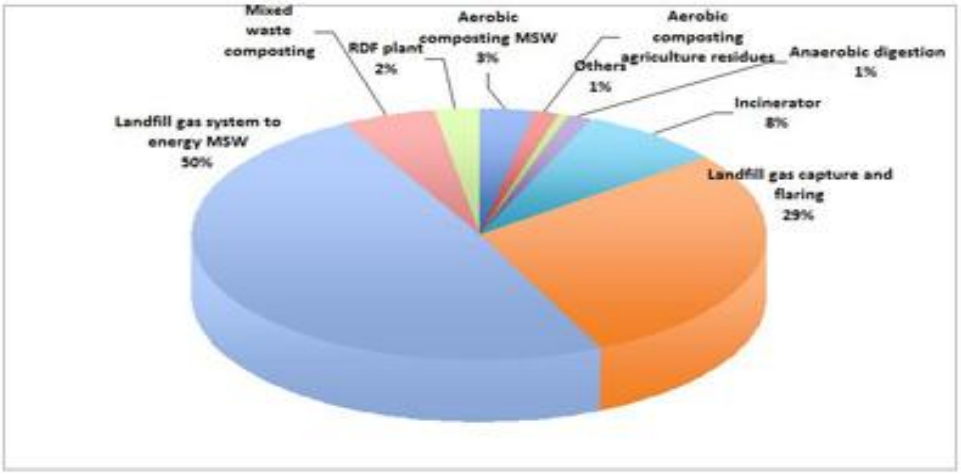

Figure 2 : Type of technologies supported by CDM

Studies have shown that harvesting landfill gas to recover energy is viable in USA and Europe. Some plants are able to recover investment cost at 3-4 years with better rate offered for the sales of electricity and with support from the government. A landfill gas plant consists of an extraction system and a utilization system. The whole recovery system can be made for different types of extraction and utilization systems. The most common use of gas is as fuel in a gas engine running an electric generator. The gas can also be used in a gas boiler for production of hot water for heating or process heating.

Back home, Morocco understood early on that the CDM could provide good opportunity to attract investments in clean tecnologies. Accordingly, the country was one of the first developing countries that ratified the Kyoto Protocol and designed a national authority in charge of the CDM. LFG technology is new and still untested. Morocco has expressed interest in exploring landfill gas use at landfills facilities in the biggest cities, and secondly in other Moroccan towns. A robust CDM business has arisen to support methane capture.

As the dominating source for energy in Agadir and Morocco in general, is imported fossil, an effective way to reduce the use of fossil for electricity and thermal energy production would be to use LFG with energy recovery. Therefore, the goal with this thesis is to evaluate the possibility to establish a power plant in Agadir landfills. To reach this goal the situation in Agadir was studied on site for more than three months, waste management and energy demand, laws, incentives were investigated.

Effective environmentally and sustainable solutions of solid waste services constitute a fundamental need for the local authorities. The Municipality of Greater Agadir is very interested in using of gas from its landfills to fuel engines to generate electricity for its facilities and public lighting.When landfill gas is productively used to power generating units, instead of just flaring the collected gas, greenhouse gases are reduced. Beside the business, landfill gas- to- energy project will be a win-win opportunity to both the City and the community. The project will generate cost effective renewable. Converting the landfill gas into reusable energy instead of being wasted by flaring has been recently a high priority goal of the Bureau. The city is seeking foreign partners for the utilization of LFG.

This thesis proposes to supply a power plant to Agadir landfill and try to assess the viability of the project through a prospective foreign company. A case company is selected for technology and strategic analysis purposes. The special focus is on the LFGTE technology and expertise available in Scandinavia, represented by a Swedish company Biogas Systems Ab from Sweden, pioneers in converting landfill methane to electricity. One part of the Author’s activities is to interview the company and take into account their special needs in such emerging market.

Beside the municipalities, local governments, researchers, prospective investors and foreign companies interested in entering Moroccan market to meet this business opportunity are the audience of this research project.

1.2 Research questions, objectives and limitations

The research dilemma is the concern that triggers the investigation. The dilemma investigated here is viewed from a market analyst's point of view and is related to the potential of LFG technology in the Moroccan market with particular focus on Agadir city. In this case the research dilemma is: Is LFG-to-Energy (LFGTE) project a viable business opportunity in Agadir, Morocco? To answer this question, exploration was carried out to identify stakeholders in the market to under stand their perceived value of the business.

The key objectives of the research are to analyse the potential of a business opportunity for LFGTE technology in the Moroccan market with focus on electricity generation in Agadir landfills and to propose a business model for prospective companies who specialize in LFG management technology.

The research questions are thus defined as:

Is there business potential for LFGTE in Agadir, Morocco and what operational business model could be initiated in such a new market by the prospective foreign company?

The investigative questions seek to answer the research question narrowing down the areas of interest throughout the research. The relevant sub-questions are:

-What is the current situation of MWM and energy in the target market?
-What are the main demand drivers for Landfill gas utilization?

- What is the suitable solution to the local context?

-Who are the most important stakeholders for supplying a LFG facility in Agadir?
-What are the expected benefits for sustainable development?
-What is the operational business model for the project?
- Which is the appropriate entry strategy model to use? What kind of challenges will a foreign company come across when penetrating the Moroccan market?

For the purpose of this research, certain limitations are imposed to the content. These limitations related to choice of case company, competing technology and geographical location.

Morocco is chosen as the geographical location as great attention has been given to alternative energy sources and as it was chosen as a test market for Biogas Systems in MENA region. The country has a reputation of being environmental concerned and already hosting the UN Climate Change Conference. At the same time access to knowledge and research is easier as the author originate from Morocco.

In this study the focus will be on appraising the emerging business opportunity in MSW sector in Morocco, with particular regard to the potential in LFGTE within Agadir. Taking Agadir as a case study, this research provides a useful basis for the evaluation of LFGTE market potential for other cities in Morocco with similar conditions. Morocco has dozen of cities with a population of one million or more plus numerous other larger urban areas.

Biogas Systems Ab, located in Sweden, was chosen as the case company to analyze the technology and its internal capabilitities to enter the Moroccan market. It offers a fully funded, integrated and commercially attractive solution for LFG management and utilisation for landfill owners, including the process of qualifying carbon credits.

The study proposes a business model. However, the financial aspect will not be discussed and would be subject to a company intending to penetrate the market with its technology solution in reality.

1.3 Theoretical Framework

The theoretical background includes strategy concepts and marketings models. Through the value chain analysis, the relevance of technology for the competitive advantage of individual firms was highlighted. Different choices of market entry modes, as channels for technology transfer, were presented. The importance of foreign direct investment for technology transfer will be explained.Pestel, stakeholders-analysis and growth strategy were also introduced.

1.4 Research approach

The study uses deductive method design. The researcher has chosen a qualitative research and conducted both desk and filed research. The desk research was conducted through literature review, books, journals and internet resources. A three month training at ADEREE and field trip was conducted to Agadir in the Kingdom of Morocco. The study was conducted on literature in the subject area. Some literature was provided by ADEREE.

Tools utilized in the field study included: site visits, interviews of local authorities, technology providers, and government officials. Structured interviews will be used to obtain valid and reliable empirical results. Market visits were conducted to investigate the target market in more depth, so more detailed information were gathered. Sites visits were made to two different landfill power plants in Finland in addition to those visited in the target market Morocco.

Interviews with stakeholders and on-the ground assessment in Agadir, as standard model of Morocco, are designed to understand the national enabling environment and the industry‘s supply chain.With the help from the contacts provided by the ADEREE, the municipality and others, interviews were conducted in Agadir and other cities including the capital, with concerned parties, institutions and decision makers in ministries regarding information about the municipal waste and energy situation in the region, laws and legislations and plan for the future.

Moreover, due to the topic of sustainable LFG management, one case company was contacted for technology and corporate strategy analysis. Since the study is initiated in Finland, a visit was made to a Finnish leading company Sarlin. However, LFG technology is more developed in Sweden and then the study was done through the Swedish company Biogas systems Ab.

1.5 Structure of the research report

The first chapter introduces the problem area, aim and scope of the project, describes the structure of the whole paper. In the second chapter, the theoretical tools applyed in the research were described. Chapter three presents the methodological practices utilised throughout the research process. In chapter four, the macro-environmental analysis of the target market, as well as a strategic analysis of a case company are discussed. Findings are analysed and possible scenario is created for the future prospect project and recommendations are provided for both the foreign investors as well as the municipalities. Finally, in chapter six the author states his conclusions concerning the potential and opportunity for a prospective foreign company concerning the proposed project as a pilot project for the whole targeted country.

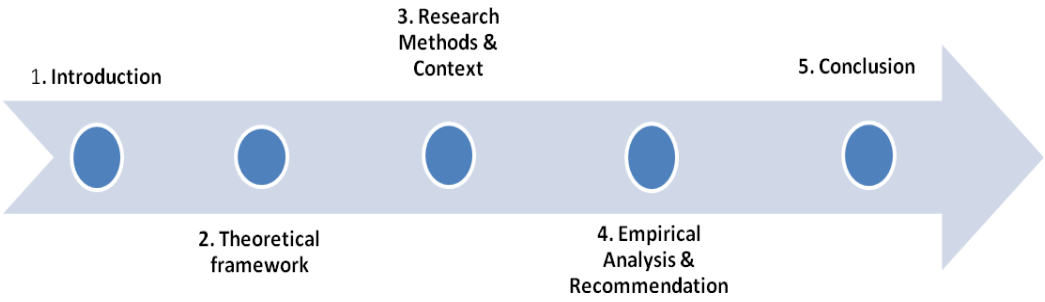

Figure 3: Structure of the research

2 MARKET & STRATEGIC ANALYSIS THEORIES

In order to create a valuable result, suitable methods and theories are important for the investigation to find an answer to the thesis question. In this chapter the relevant business models and frameworks that are used in this paper are introduced. This chapter discusses the importance of FDI as a channel for the technology transfer, how the technology affects competitive advantage and the growth strategy of the company and takes a look at the relevance of the stakeholder-analysis in relation to busniss models. Pestel, value chain analysis, entry modes, technology transfer channels and Ansoff Growth Strategy Matrix are described.

2.1 Macro-environment analysis: PESTEL framework

The PEST analysis is an acronym for the four key strategic areas of change: Political factors, Economic factors, Social factors and Technological factors. Each area has the potential to fundamentally change the competitive environment where the company is operating. A definition, according to Grant, is "environmental influences" that "can be classified by source (for example into political, economic, social and technological factors ("PEST analysis"))" (Grant, p.68).

The following parameters need to be evaluated in the PEST analysis extended as PESTEL analysis (Carpenter and Sandler, 2007, p.91 – 94) with Environmental factors and Legal factors.

The values in each of the factors involved in PESTEL are:

-**Political**: Refers to war, terrorism, inter-country relationships, international trade regions (Eriksson, et. al., 2004, p.22), political trends, governmental leadership, government structures, taxes, elections, employment law, consumer protection, environmental regulations, competitive regulations, and industry-specific regulations.

− **Economic**: Refers to economic growth trends, taxation, government spending levels, disposable income, job growth, unemployment, exchange rates, tariffs,

inflation, consumer confidence index, import ratios, export ratios and production levels.

− **Social:** Refers to demographics (age, gender, race, family size), education, life-style changes, living standards, population shifts, trends, housing trends, fashion, attitudes toward work, fads, diversity, immigration, emigration, health, leisure activities, occupations, and earning capacity (Kotler & Keller 2005, Chapter 8).

− **Technological**: Refers to inventions, manufacturing advances, information technology, internet, communications, transportation, new discoveries, research, energy uses, energy sources, new fuels, rates of obsolescence, health, bio-tech, genetics, agro-tech, waste removal and recycling.

− **Environmental**: Consists of direct and indirect costs as access to raw materials, waste, pollutions, etc.

− **Legal**: Consists of laws and regulations in the region and within the organisation.

PESTEL analysis is a good tool for putting the right amount of effort into strategic planning process that focus on outside environments and for identifying core strategic issues needed to focus on providing a better mid-term and long-term horizon in the strategic plan. It is also applicable to different market sizes as for local as PESTEL is able to adapt to the request of analysis (Kotler et al., 1996, p.26).

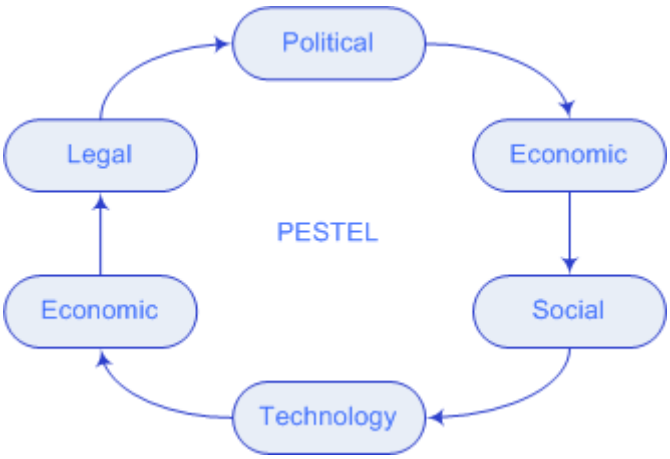

Figure 4: Pestel Model

The purpose of environmental analysis is to find out the strategic position of a company; one aspect of it is to identify the impact on external strategy which address the environmental opportunities and threats on the organization.

2.2 Value Chain Analysis: Firms and Technology

In today's environment, it is becoming ever more critical for firms to develop sustainable competitive advantages. In order for decision makers to develop this advantage, they must also understand their own firm's resources and capabilities, as well as be able to evaluate these strengths and weaknesses in terms of competitive advantage. Value chain analysis provides strategic decision makers a systematic technique for scanning their internal organizations. By focusing on competitively relevant strengths and weakness, decision makers can better see the potential of these resources and capabilities for adding or subtracting value to the firm's processes. This understanding can then lead to generic strategies that will most likely lead to sustained competitive advantage.

Few practicing managers will doubt the importance of technology for their company. In management science, Michael Porter intensively analyses the relation between technological change and competitive advantage. He states that "of all the things that can change the rules of competition, technological changes are among the most prominent" (Porter 1985: 164).

To understand the role of technology for competitive advantage, we first need to examine the determinents of competitive advantage. Competitive advantage stems from the various discrete activities a firm performs in designing, producing, marketing, delivering, and supporting its product. These activities can be systemized in Porter's concept of the value chain illustrated in figure 5.

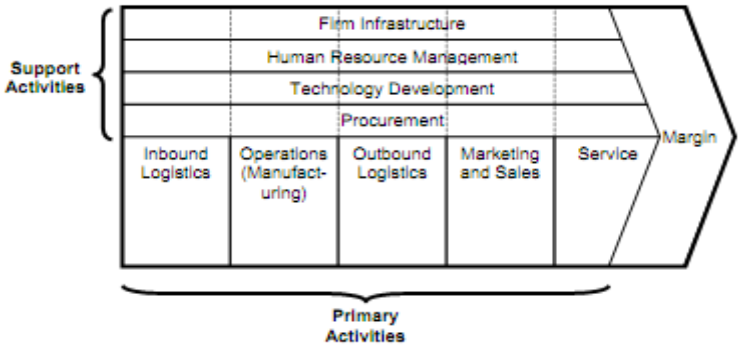

Figure 5: Value Chain (adopted from Porter 1985: 37)

The value chain divides all activities into primary and support activities. Primary activitie are the activities involved in the physical creation of a product, its sale and transfer to the buyer, and the after sale assistance. Support activities support the primary activities and each other by providing purchased inputs, technology, human resources, and various companywide functions. Each of these activities influences competitive advantage by contributing to a firm's relative cost position and creating a basis for differentiation.

As activities and technologies in firms are linked to each other, a technological choice in one part of the value chain can have implications to other parts of the chain. Therefore, a firm cannot only be understood as a collection of value activities but also as a chain of linked technologies. Technology affects competitive advantage if it has a significant role in determining the relative cost or differentiation position.

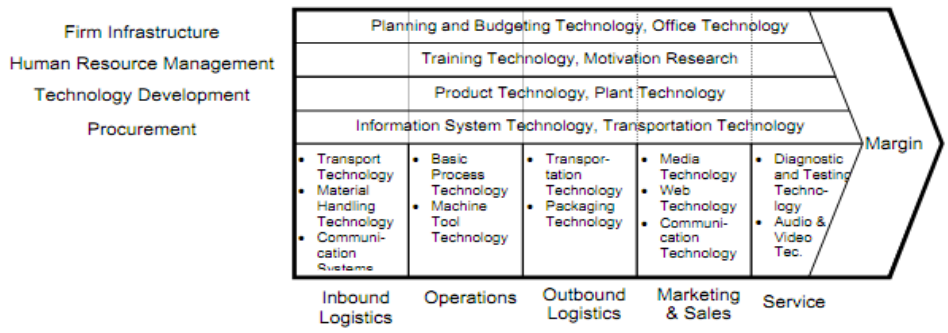

Figure 6: Technologies in a Firm's Value Chain (adopted from Porter 1985: 167)

2.3 Corporate strategy: Ansoff Growth Strategy Matrix

Corporate strategic decisions are usually based on the methods through which an organization could leverage its existing competitive advantage in promoting value and ensuring growth (Lynch, 2009), while sustainable competitive advantage depends largely on how well a company performs these actions. The need for companies to grow and expand has been known to drive product and marketing innovation, which in turn prompts them into adopting different organisational strategies, based on the products they sell and markets they target (Ansoff, 1984).

The matrix presents four main strategic choices, ranging from an incremental strategy in which current products are sold to existing customers to a revolutionary strategy in which new products are sold to new customers.

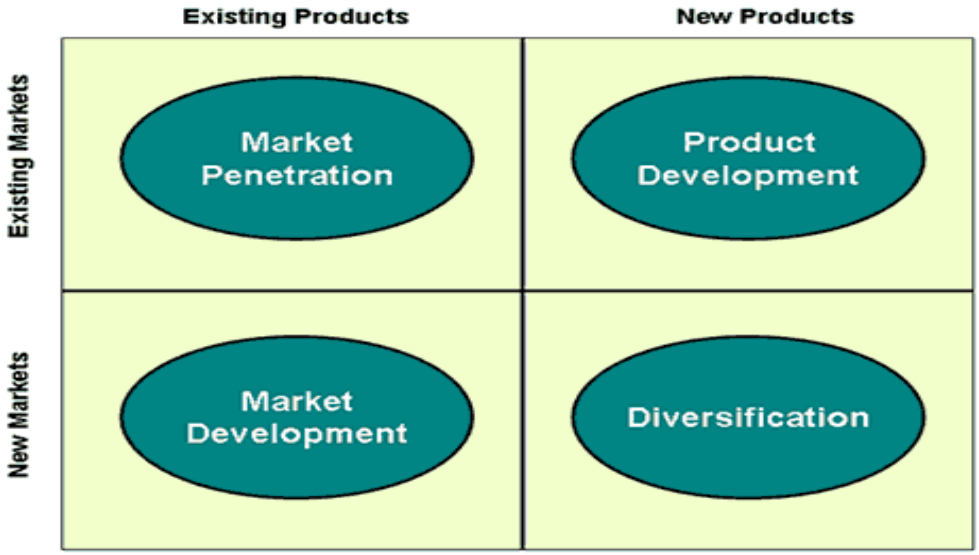

Figure 7 : Ansoff Growth Strategy Matrix

-**Market penetration**: In this quadrant, the company markets existing products to existing customers. The products remain unchanged and no new customer segments are pursued; instead, the company repositions the brand, launches new promotions or otherwise tries to gain market share and accordingly, increase revenue.

-**Market development**: Here, the company markets existing products to one or more new customer segments. These customers could represent untapped verticals, virgin geographies or other new opportunities.
-Product development: This quadrant involves marketing new products to existing customers. The company grows by innovating, gradually replacing old products with new ones.
-Diversification. This quadrant entails the greatest risk; here, the company markets new products to new customers. There are two types of diversification: related and unrelated. In related diversification, the company enters a related market or industry. In unrelated diversification, the company enters a market or industry in which it has no relevant experience.

These quadrants represent varying degrees of risk. Assuming that the more a business knows about its market, the more likely it will be to succeed; the market penetration strategy entails the least risk, while the diversification strategy entails the most. In fact, consultants often refer to the diversification cell as the 'suicide cell'.

To explore the growth strategy of the case company, the Ansoff's matrix is adopted in this research.

2.4 Entry strategy modes: Technology Transfer Channels

Generally, technology transfer means the use of equipment and/or knowledge not previously available in the host country by the project. There are several channels through which technologies may be transferred. The commercial transfer of technology at the international level largely takes place through *trade, FDI, and licensing agreements.*

Still, foreign direct investment is considered as one of the major sources of international technology transfer. Nevertheless, what makes FDI so important for technology transfer is that FDI, unlike trade in goods, involves explicit trade in technology. Foreign direct investment is defined as an investment involving a long-

term relationship. It reflects a lasting interest and control by a resident entity in one economy in an enterprise resident in an economy other than that of the foreign direct investor (UNCTAD 2005: 297, 298). FDI implies that the investor exerts a significant degree of influence on the management of the enterprise resident in the other economy. In other words, foreign direct investment is defined as an investment by a resident entity in an enterprise resident in an economy other than that of the foreign direct investor. Other than portfolio investment, FDI grants the investor a certain degree of control over the management and the activities of the enterprise. Basically, two different types of FDI exist:

• *Greenfield investment* refers to the direct investment in new facilities or the expansion of existing facilities. Greenfield investments are the primary target of a host nation's promotional efforts because they create new production capacity, jobs and transfer technology and know-how.

• *Mergers and acquisitions* occur when a transfer of existing assets from local firms to foreign firms takes place. Cross-border mergers occur when the assets and operation of firms from different countries are combined to establish a new legal entity. Cross-border acquisitions take place when the control of assets and operations is transferred from a local to a foreign company, with the local company becoming an affiliate of the foreign company.

As green-field investment is the type of FDI bringing new production and technological capabilities, focus is done on this type of FDI. There are two basic structures in which green-field investment may occur (Cohen 2004: 127):
• *A wholly owned subsidiary (WOS)* is a company controlled by another company or corporation. Subsidiaries are separate, distinct legal entities for the purposes of taxation and regulation. They are distinct from divisions, which are entities fully integrated within the main company, and not legally or otherwise distinct from it.
• *A joint venture (JV)* is a strategic alliance between two or more parties to undertake economic activity together. The parties agree to create a new entity together by both contributing equity, and then share in the revenues, expenses, and control

of the enterprise. The venture can be for one specific project only, or a continuing business relationship.

A firm or joint venture needs to market an absorbed technology or technology-based product in order to externally commercialize it. Two components are required:

• The marketing strategy consists of market segmentation as well as the selection of a target market and focuses on the long-term positioning of a product/ technology in the market.

Figure 8 : Marketing Process

• The tactical marketing refers to the actual marketing mix consisting of activities such as price, promotion, distribution channels (place) and product characteristics.

Figure 9 : Marketing-Mix

2.5 Stakeholders identification

Examining stakeholder theory in relation to business models is very important because it helps to bring greater clarity to the variety and types of actors operating within a firm's external environment. Moreover, by applying stakeholder theory, it helps firms to understand (1) the business implications that stakeholders have upon their business model; (2) the feasibility in business models when catered to different stakeholder groups; and (3) provide the possibility of gaining a better knowledge in the power balance between business models and stakeholders.

Stakeholder theory, defined by Freeman (2010, p. 48), is seen as "those groups who can affect or are affected by the achievements of an organization's purpose". It is important to understand how these three different stakeholder groups can potentially influence a business. Freeman (2010) classifies these influences by a stakeholder as economic, technological, social, political, and managerial.

3 RESEARCH METHODS AND CONTEXT

The chapter will start by presenting the research approach, followed by selection of case company, data collection and analysis, and reliability and validity. Also the research context will be discussed in this chapter.

3.1 Research Method

The study uses deductive method and qualitative design.The deductive research process starts with a strong theoretical footing (Danermark, 2001; Hyde, 2000), its aim is to test theoretical knowledge (Johnson, 1996) that has been developed prior to empirical research.As defined by Sharan B.Merriam (1998, p. 5) qualitative research can be considered an "umbrella concept covering several forms of inquiry that help us understand and explain the meaning of social phenomena". In this study the researcher is investigating a social phenomenon: He aims to investigate business potential of LFGTE in Agadir as pilot project for the whole country, Morocco.

The author of this research will use an exploratory method. According to Fisher (2007, p.166), this includes interviews, observation, documents and other forms to give an insight into the situation on the ground. Yin (1994), explains that research work involves defining and designing stages where theories are studied, cases selected and methods on how to conduct the cases are studied. A case company is selected is studied in this research.

Generalization of Case Study

Yin (1994) argued a case study is an empirical inquiry that: Investigates a phenomenon within its real-life context where the boundaries between the phenomenon and the context are not clearly evident and uses multiple sources of evidence. "Case studies take as their subject selected examples of a social entity, which are studied using a variety of data collection techniques". According to Hakim (2000)

He argued, "*Case study is a research strategy that pay most attention to understanding the dynamics present within single settings*".

It is easy to understand that a selection has to be large enough to be generalizable. This is an issue for case studies where the selection often is relatively small, which makes generalizations of case studies easy to question. The following questions are commonly asked in those situations (Denscombe, 2000):

• How representative is the case?
• Are not the results specific for this particular case and its circumstances?
• How can a generalization be done based on a small selection of units?

Case studies, as opposed to survey research, are not statistically generalizable, but analytically generalizable. It means that a case study is compared to compiled theories and when a similarity is found, the results are analytically generalizable (Yin, R. K., 1994). Taking Agadir as a case study, the research provides a useful basis for the evaluation of LFGTE market potential for other cities in Morocco with similar conditions.

Selection of case company

The method of selection used in this thesis is subjective selection, which according to Denscombe (2000) can be defined as when the units are picked by hand based on what is known about the target population. These units are considered to be the one that can contribute the most valuable information and are seen as relevant for the research topic.

Due to the topic of sustainable LFG management, one case company was contacted for the technology analysis. The company should be provider of environmentally sound solutions for LFG utilization with the right technology and competitive solutions appropriate to the Moroccan context.

Since the study was initiated in Finland, first a visit was made to a Finnish leading company, Sarlin. However, LFG technology is more developed in Sweden; and then the study was done through the prospective Swedish company Biogas sys-

tems AB, pioneers in converting landfill methane to electricity. Expert in LFGTE technology, the firm provides a complete solution covering whole process and value chain. One part of the Author's activities is to interview the company and take into account their special needs in respect of the market in emerging market like Morocco.

3.2 Data collection and Analysis

Both primary and secondary sources of information have been used in the thesis for the purpose of collection of data. The secondary sources have been used to establish the relevant theoretical framework for the thesis which discusses the relevant literature to the research area and similarly case company website and other industrial sources have been used for collecting information on industry and the case company.The primary sources of data collection have been used in form of interviews and questionnaire survey through the meetings, the electronic means, telephone and email. A combination of structured, semi-structured questions have been asked to the respondents, while a general discussion over the research topic has also been done on few instances where respondents were free to share their views besides the set questions.

The data for the confirmation of findings has mainly been obtained through visiting the markets.The research is based on primary data gathered through a meeting with Biogas Systems's General Manager, in order to create a deeper and more in-depth understanding of the company's technology including its unique systems. Since LFG technology is a rather complex subject, Tony Zetterfeldt the CEO wanted to have personal meeting with the author and invited the author the visit the company located in Sunne, Sweden, to make sure that he had sufficient information about the company and its products, as well as giving him opportunity to ask any questions that had emerged during the research.

Information has also been gathered through direct inquiries and vists to two Finnish landfill managing companies´ headquarters: Päijät-Häme Waste Disposal Ltd

(PHJ) in Lahti and Helsinki Region Environmental Services Authority (HSY) and to the respective landfills. The studies on the LFG plants were conducted to give the author a clearer picture over the whole technology process from the gas capture until the production or electricity and heat.
Sites visits were made to different landfill power plants. In Helsinki area, a visit was made to the newly operational power plant in Ämmässuo Landfill located in Espoo. The landfill is one the biggest in Europe and the largest in Scandinavia.The researche has also visited the biogas station in Kujala Landfill in Lahti region. Both power plants were equipped by Sarlin, the leading company in Finland.

Three month training at ADEREE and a field trip was conducted to Agadir in Morocco. The study was conducted on literature in the subject area. Some literature were provides by ADEREE. With the help from the contacts provided by the ADEREE, the municipality and others, a set of meetings and interviews were conducted in Agadir and other cities including the capital, with concerned parties, institutions and decision makers in ministries regarding information about the municipal waste and energy situation in the region, laws and legislations and plan for the future.

In order to better understand the issues involved with a market and a proposed business model in the target market a series of unstructured interviews was conducted with stakeholders in the industry value chain. The views captured are intended to be representative attitudes of competitors and customers.

Finally, the author has attended a seminar in Oujda city on the potential of biogas. The city located in North East Morocco, is where a Renewable and clean energy industrial area was created (Technopole Kyoto Park-East-Oujda). All the stakeholders were invited, including ministerial, provincial and municipal representatives, press, academic community, provincial and municipal legislators and neighbors. A visit to the landfill was also organized on the same day and the case company equipped the landfill by its unique collection systems.

3.3 Validity and Reliability of the Thesis

The validity and reliability of the thesis has been insured by firstly establishing a mutual understanding of the research topic among the researcher and respondents through frequent communication with them i.e. building the construct validity. Similarly the questions have been designed and discussions conducted such that the objective information is being collected.

The respondents were also chosen on the basis of those who are closely linked with the areas of the research and who have the real insight to the topic. The right people and mutual understand helped in generating the most relevant questions and relevant discussion over the subject area.

To insure internal validity, the researcher was objective in his approach with no personal inclination towards a possible answer to the research question. The data was collected as per the answers given by the interviewees, and justification was sought in light of practice and experience as well as common prudence.

As regards to external validity, the findings from Agadir case study can be generalized to similar cities in the targeted country. To ensure reliability of the thesis, information was collected from concerned people and many differnts decision makers and authorities. Companies were also contacted and landfill powerplants were visited to ensure that the information provided by the case company is actual and reliable.

3.4 Research Conext

This thesis is submitted in partial fulfillment of the requirements for the Master´s Degree Programme in International Business Management at the Faculty of Business Studies, Lahti University of Applied Sciences. This sustainability-focused programme aims to create new business and find sustainability oriented business opportunities between Finland and emerging markets.

Therefore the author found a suitable three month training position in Marrakech, Morocco from June to August. The National Agency for Development of Renewable Energy and Energy Efficiency (ADEREE) gave the author this opportunity to conduct research for his thesis research. ADEREE is playing a pioneering role in the promotion of studies, evaluations and project feasibility in this field.

First created in 1982 under the name of The Center for Development of Renewable Energy (CDER),ADEREE is a public institution with commercial and industrial characters, attached to the Ministry of Energy and Mining. According to its missions and objectives, it contributed to the development, at large scale of renewable energies targeting the important energetic, economic and environmental stakes with the strategic use of this type of energy. The agency has developed its activities, including research studies, publications and awareness campaigns, training courses, conception and execution of projects. It provided technical expertise and assistance for the realization of technical, economic and financial feasibility studies. ADEREE and given the strategic mission of drawing up programs to increase the use of renewable energy up to 20 % of total energy consumption and 12% energy efficiency by year 2020, as well as develop local skill sets and establish national standards (certification).

With the help from the contacts provided by the ADEREE, the author gained accees to the information and to visit ministries, sites and attend seminars.

4 EMPIRICAL ANALYSIS AND RECOMMENDATIONS

This chapter provides a deeper analysis of a prospecive foreign investor´s future business environment. A brief presentation of the target market is given. Both profile of waste and electric sector in Morocco and in the target city Greater Agadir, are discussed. PESTEL framework is used to analyze the macro-environment and its impact on the prospective company.Then the demand drivers and incentives for LFG utisation are discussed. At the corprate strategy-level, Ansoff matix provide a detailed look into the Growth Strategy of the case company. To analyse the LFG technology, value chain analysis shows the separate activities that add value to the product, the process and how to manage the linkages of technologies among the company´s activities. A business model is described and summarized by using a related canvas. Recommendations are provided. After describing the advantages for the municipality to follow PPP route, a possible entry strategies for the new company that will be set up in Morocco are discussed.

4.1 Status of MWM & Energy and Climate Change policy in Agadir, Morocco

This paper focuses on the potential for a realistic business opportunity in MWM in Morocco, with particular regard to the recovery of energy from Landfill gas in Agadir.

4.1.1 About Target Market

Breif description of Morocco

Morocco is situated in the north west of Africa and has a unique and strategic position. The kingdom currently has approximately more than 36 million inhabitants, of whom 56 per cent live in urban areas. The urbanization rate rose from 51.4% in 1994 to 62% in 2010.

Morocco enjoys financial stability and economic reform is firmly on the Government’s agenda. On October 13, 2008, the European Union granted Morocco "ad-

vanced status", which is reflecting the EU's decision to strengthen trade and political ties as well as to reward Morocco for its economic and democratic reform process.

Morocco is currently witnessing a strong development in vital economic sectors, including agriculture, industry, fisheries, urban development, infrastructure and tourism.This development has induced negative repercussions on the quality of the environment. The environmental degradation trends in Morocco are currently estimated at 13 billion dirhams per year, or 3.7% of GDP. The share related to the inadequacies in solid waste management is 0.5% of GDP.

Morocco is a land of opportunity in all sectors. Among sectors where Scandinavian or international expertise and transfer technology is particularly suitable to meet Moroccan demand are energy and environment, development of renewable energy resources.Waste management improvements are a key national objective. Many concessions are being awarded to private companies including international firms to develop sustainable waste management systems.

Therefore, there is a significant potential for similar LFG capture and electricity generation projects in Morocco, and such projects represent an important part of Morocco’s efforts to reduce GHG emissions.

Breif description of Greater Agadir Municipality

Greater Agadir refers to the conurbation around Agadir City. Greater Agadir has a population of 900 000 inhabitants (figures for the agglomeration include the nearby cities of Inezgane and Aït Melloul). The population of the city proper (the urban community of Agadir) is estimated at 450,000 inhabitants is a fast-growing city and a seaside resort whose population increases twofold in the summer.

Figure 10: Agadir Beach

The city is located on the shore of the Atlantic Ocean, near the foot of the Atlas Mountains in south east of Morocco.The region is an important economic hub of the country. Main industries in Agadir are agriculture, fishery and tourism. Agadir had been accorded an important position as a tourist city representative of the country .Agadir is one of the favorite European beach tourist destinations with a long sandy beach and the base of the fishing and agricultural industry. Agadir harbor is the first sardine fishing harbor in the world with exports of citrus fruits and vegetables.

Figure 11: Map of Morocco with Agadir marked out in the red circle. Agadir is situated in Soth western Morocco and is the capital of the Souss.Massa-Daraa Region.

Taking Agadir as a case study, the research provides a useful basis for the evaluation of LFGTE market potential for other cities in Morocco with similar conditions. Morocco has couple of cities with a population of one million or more plus numerous other larger urban areas.

Figure 12: Agadir new Marina complex.

4.1.2 Macro-Environment Analysis: The Pestel Framework

In this case study, the research dilemma is: Is LFG-to-Energy (LFGTE) project a viable business opportunity in Agadir, Morocco? To answer this question exploration was carried out to identify the key factors influencing the related industry. Here the materials and data collected from interviews, government reports and personal observations from field visits are presented in a descriptive form.The following section presents the results of the analysis of data collected from the visits to the field. The main thrust of the analysis is the assessment of the viability of the LFGTE plant project in Agadir Landfills.This is done in two stages. First an analysis of the technical viability as determined by the availability of the methane resource is confirmed by the flaring system existing already in the old site, followed by a socio-economic analysis of the project's survivability. Relevant factors and their interactions in each of these stages are first depicted in Causal Loop Diagrams (CLD).

The economic viability of the proposed project is governed by policies in three different sectors; the MSW, energy and climate or emissions trading sectors. MSW policy and practices especially regarding, MSW collection efficiencies, choice of disposal method and so on are crucial to the waste stream which in turn

forms the resource for LFG and electricity production. Energy policies relevant to the electricity prices and the level of regulation of electricity sales will to a large extent will ascertain how much income is to be expected from electricity generated from the site. Furthermore, the existence or not of a climate policy is important to determine if CER's can be sold as. For instance CDM regulations require that parties must have ratified the Kyoto protocol and set up DNAs in order to take part in its emissions market. Some of these issues as they affect the viability of the proposed LFGTE projects and their interactions are represented in the CLD below.

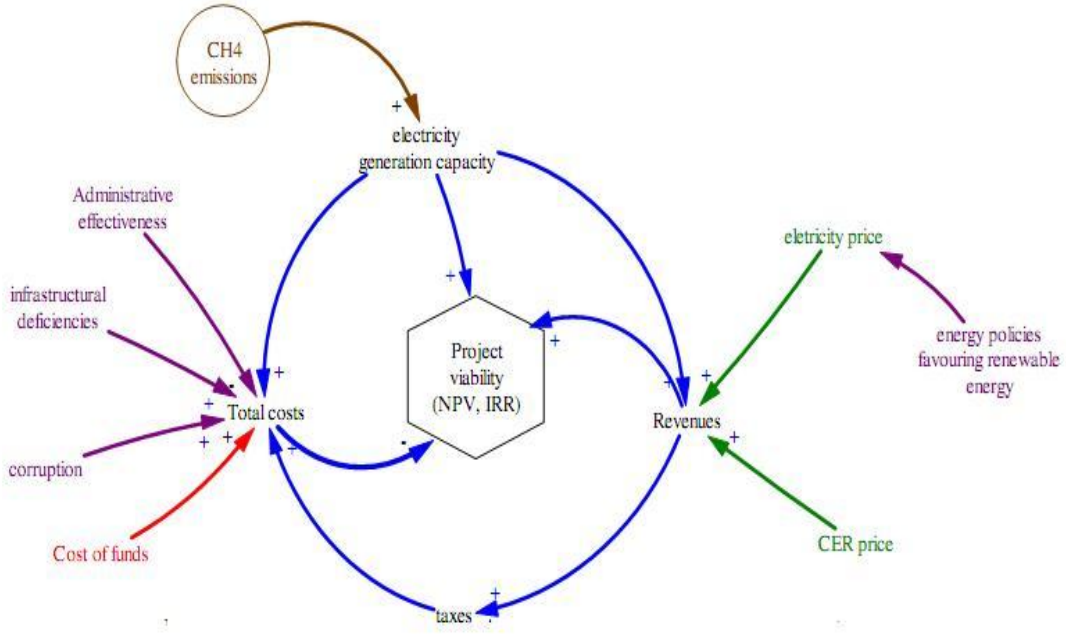

Figure 13: CLD showing influence of Macro-environmental factors

The CLD shows that these socio-economic factors impact on the projects viability by influencing the projects costs and revenues. Larger socio economic trends such as corruption, level of infrastructure and so on also have implications for the economic viability of any project (Barish, 1962). The impacts of corruption, especially on the transaction costs, while clearly perceptible are rather very difficult to measure. Corruption, bureaucracy, state of infrastructure and so on not only directly increases the projects costs as shown in the CLD, but also and equally importantly, reduces the country's credibility, there by affecting FDI and other funding inflows.

Actual empirical analysis of the data needed to evaluate the cost of the project that could be relevant to this study could not be found. However, the financial aspect is not discussed and would be a subject for a company intending to penetrate the market with its technology solution in reality.

The PESTEL framework can help to identify factors that influence the LFG industry and point to future trends in the political, economic, social, technological, environmental and legal environments that might impinge on the foreign company entending to enter the Moroccan market.

Political factors

The attitudes and reactions of people, social critics, and governments all affect the political environment. The political environment can also have a dramatic effect on opportunities at a local and international level. Some business managers have become very successful by studying the political environment and developing strategies that take advantage of opportunities related to changing political dimensions. In the waste management sector in Morocco, government influence plays a critical role in the success of foreign firms due to its unique social and political systems. First, because the waste management sector is a relatively long-term investment, stable government and consecutive policy is important for such investment. Second, many businesses require government permission. Third, the Moroccan government is encouraging foreign investment in environmental protection sectors through tax reduction and other incentives.

Morocco has launched and elaborated an ambitious upgrading program in the area of MWM with cost of 40 billion DH.The program aims to develop and reform the sector.Dependence on energy imports is an important reason why renewables are accorded key status in official plans for the energy sector. A national strategy foresees increasing their share in Moroccan energy supply to 20 % by 2020.

Morocco has taken significant steps towards developing CDM projects. The CDM DNA (Designed National Authority), is striving to identify and facilitate any opportunity likely to attract investments which would help to realize projects

aimed at the reduction of greenhouse gas emissions, while fully adhering to the goal of sustainable development.

The CDM Investment Climate Index (CDM ICI) measures the investment climate for CDM projects. It can range between 100 points(highest) and 0 points (lowest). Altogether, the climate is rated as 'satisfactory' in Morocco. In Africa, the country thus ranks the second. The inferior ranking to South Africa is primarily attributable to Morocco's less favourable rating for general investment climate and the corruption index.

CDM investment climate index (CDM ICI), Africa April 2006 (excerpt)

Rank	Country	CDM ICI (max. 100 pts.)	Regional classification
1	South Africa	76.4	Good climate
2	Morocco	70.9	Satisfactory climate
3	Tunisia	52.6	Adequate climate
4	Mauritius	52.2	Adequate climate
5	Uganda	49.7	Adequate climate
...	...	...	...
52	Central African Republic	5.6	Unsatisfactory climate

Source: DEG - Deutsche Investitions - und Entwicklungsgesellschaft mbH
(For calculation method see www.kyoto-coaching-cologne.net)

Figure 14: CDM investment climate index: regional comparison

Biogas is of special interest for CDM projects. Several cities are reportedly seeking foreign partners for the utilization of landfill gas. However incentives and financing tools have to be improved and energy market liberalization process must continue.

Economic factors

The current pursued economical policy has brought Morocco´s economical stability, an increased financial performance and developments in the service and industry sector. With a gross domestic product of 109,2 billion Euros, Morocco developed to be the 58th biggest economy in the world - two places behind Finland. A closer look on the GDP real growth rate identifies a continuously growing economy. Even in the year of the financial crisis, the economy growth was 5.6 percent (2008) and remained high in 2009 (4.9%). Morocco's market economy benefits from the country's relatively low labor costs and proximity to Europe, which aid key areas of the economy. According to the World Bank, Morocco is the fifth largest economy in Africa.

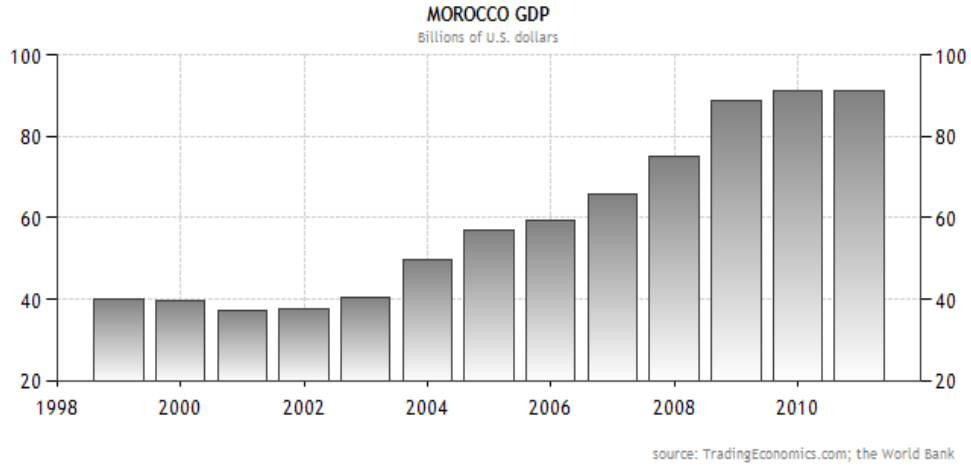

Figure 15: Moroccan GDP Growth

In addition Morocco has deep foreign relations with the EU and the US. With both economic zones free trade agreements are arranged. Furthermore the Moroccan currency dirham shows stability. This reduces the potential danger for foreign investment caused by volatile currencies.

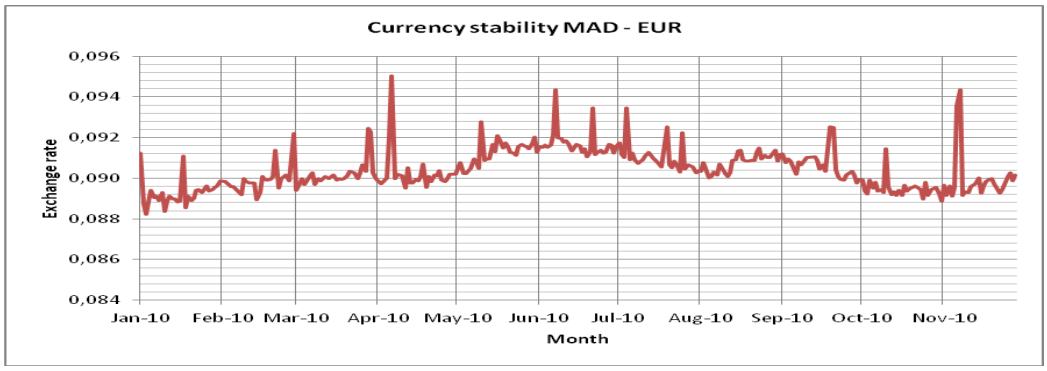

Figure 16: Stability of the Moroccan Dirham

Socio-cultural Factors

Morocco provides a competitive income distribution and low labor. Also the educational level and the skill set of the labor force should be enough to implement LFG technology in anyway in this market. Additionally, a foreign investment is welcome in Morocco to decrease the unemployment. It is obvious that the implementation of any technology will create jobs and income for the country. For example, local communities will benefit by the implementation of LFG plants. New jobs are created and increased tax revenues produce an income.

Morocco’s municipal solid waste services continue to be conceived and defined only in terms of “cleansing” with the main focus on waste collection and limited attention and resource allocation to waste disposal, which leads to significant major environmental and social impacts. However, People's attitudes towards waste treatment have changed in recent years. With increasing levels of education and awareness of the environmental problems around them, Moroccan people are now more willing to do something to protect their environment.

Municipal solid waste management has become one of the most serious environmental concerns in urban areas, especially in view of its adverse effects on quality of life, human health, natural resources and environment, and economic and social development. The country is seeking foreign expertise to increase public awareness towards environment protection.

Technological Factors

From the technological point of view several points must be considered. A main issue is the availability of infrastructure. Especially the electricity grid infrastructure is important. The Moroccan electricity grid connects the countries’ biggest cities along the coastline.Furthermore the access to technological know-how and the technology itself is considered.

Investigating a business opportunity in Morocco in sustainable technology poses the question, if the required technological know-how is ensured and access to technology is provided. Normally, higher education, research and development institutes and know-how transfer from other countries create technical know-how. In the case of Morocco a long-term national research and development strategy as well short-term actions plans were implemented in 2006. Energy and environment are two of seven priority areas. To ensure technical progress and development the strategy highlights the empowerment of the current Moroccan science and technology landscape. National supporting agencies, like the National Centre for Scientific and Technological Research or the Moroccan Association for Research

and Development get the mission to improve technological know-how through research. Besides this pillar, higher education institutions (universities) and semi-public research institutes like the ADEREE spur technological progress (Boshoff 2006, p.9ff). Besides domestic knowledge, contracting foreign companies boost the technological development. Free trade agreements with Europe Union and United States make this possible. (Kirémidjian 2009, p.45ff)

However, the technology of LFG revovery and electricity generation is new in Morocco. Project required equipments are not available locally and have to be imported. The project participant and the landfill operator are not familiar with LFG based power generation station and they lack technical know-how to operate the project. Hiring of highly specialized engineers (probably expatriates) is needed. Capacity building and know how transfer is as well needed for local technical staff. The lack of availability of equipment and local specialized technical staff are important barriers for the project implementation for the municipality,so there is an opportunity for foreign investors. It is worth mentioning that the project activity was at the time of the CDM consideration a first of its kind in Morocco. The only other landfills in Morocco currently capturing, flaring biogas are Fez and Oujda landfills. The first started the flaring as CDM activity in December 2009 and the second is equipped by Biogas Systems AB which is the company case of this research. It is worth mentioning that the Agadir Municipality is considering CDM development for the Bikarane landfill and a PIN for the landfill has been developed and registered since 2005(Only rehabilitation of the site including only flaring activities and not LFG utilisation).

Environmental factors

There are no restrictions from the related environmental protection laws on the LFG technology and solutions this project is planning to promote in Morocco. But it is necessary to know the environmental laws and regulations related to MSWM, renewable energy and climate change before entering the Moroccan market. In December 2006, Morocco enacted its first law on solid waste management, as well as laws on environmental protection and Environmental Impact Assessments.

In Morocco, the environmental Impact Assessment (EIA) is required in the case of construction of new landfill site or construction of electricity generation facility. The EIA have to be submitted to the local government.

Finally, CDM registration has a positive impact.There are a large number of open dumping landfill sites in Morocco site. Appropriate closure treatment and valid use of collected biogas from landfill sites will contribute to not only preventing global warming but also improving local environment. Moreover, spread of this kind of project will contribute to technological sustainability as well as environmental sustainability is among the Moroccan environmental policy.

Legal Factors

Aware of the fact that investment is a key factor to ensure sustainable and sustained economic growth, Morocco has liberalized its economy by easing procedures, providing better protection to private operators through introducing new laws aiming at improving investment conditions and, thus, acquiring significant flow of domestic and foreign private capital, including labor code, copyrights, industrial property, freedom of pricing and competition,personal data protection, arbitration and mediation.

There is no law in Morocco requiring landfill biogas collection and flaring or use. However, it is likely that the laws and regulations regarding municipal waste managemnt in Morocco will become increasingly strict, presenting opportunities for foreign companies that can provide cost-efficient and reliable products (The decree on the administrative procedures and technical requirements relating to controlled landfills is promulged on 7 January 2010). Even if progressive liberalization on the electricity market eases market access for private investors, the main constraint on the sector is the lack of legislation or its inadequate scope. There is no supporting law to date to regulate mains feeding of renewable electric power in detail.

The new SWM law requires that municipalities improve their sanitary services and their waste disposal practices, rehabilitate/close open dump sites and promote the construction of sanitary landfills but does not enforce the LFG extraction, incineration or use for electricity production.

Summary of macro-environmental analysis

The overall macro-environment in Morocco for the LFG industry is attractive. The economic growth and deteriorating environment have presented business opportunities in the waste industry. LFG technology is considered a "sunrise sector" in Morocco due to its huge market potential in the near future. Among all six factors, the prospective foreign investor should pay significant attention to government influence. A foreign prospective company should build a good relationship with government officials, gain a deep understanding of the related regulations and policies, and evaluate the impact of policy changes responding quickly to seize new business opportunities created by these changes.

4.1.3 Demand drivers for LFG utilization

Municipal Waste development and trends in Morocco and Agadir

Policy, legal and institutional framework

In Morocco, 391 urban localities were identified in 2004, 55 of which had more than 100,000 inhabitants representing approximately 68% of the urban population. Most of these cities have delegated cleaning services to the private sector.With a ratio per capita of 0.76 kg/day, the amount of municipal solid waste may be estimated at 5 million tons per year in urban areas.In 2006, the collection rate was estimated at 70% in urban centers, whereas landfilling was only 13%.The MSW quantities generated are expected to reach 8.68 MT by 2030.

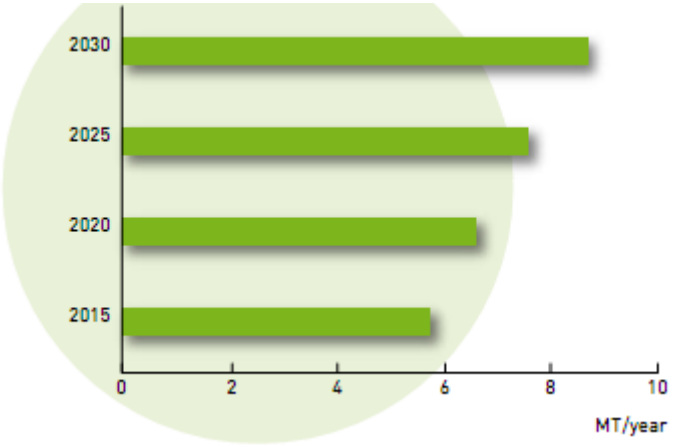

Figure 17: Projected MSW production

The Solid Waste Managemenet (SWM) infrastructure may be summarized as follows:

Landfill status	Number of landfills
Controlled landfills built	10
Controlled landfills under construction	3
Rehabilitated or closed dumps	15

Table 1: The SWM infrastructure

The domestic waste production in urban areas is about 11 000 tons/day (about 0.75 Kg/inhab/day). This kind of waste is characterised by the presence of a lot of organic substance (65 – 70 %), soft and hard paper (8 –10 %), plastics (8- 10 %), metal (1 – 4 %) and glass waste (1 – 2 %).

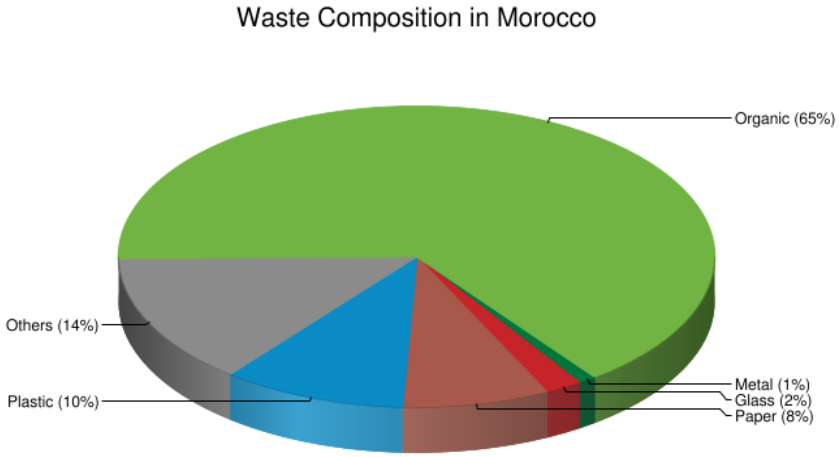

Figure 18: waste composition in Morocco

The general legal framework for waste management includes essentially the following elements:

•LawNo.28-00 on Solid waste management, whose main guidelines and implementation decrees are given in Annex 2;

•The decree of 7 January 2010 on the administrative procedures and technical requirements relating to controlled landfills.

The law on the Municipal Charter confers jurisdiction upon the municipalities relative to the creation and management of local public services Landfill management. The municipalities may manage their services directly in direct or standalone governance, or by entrusting them to professional operators through delegated management.

The Government has recently undertaken vigorous actions toward the development and the reform of the solid waste sector, including the preparation of an ambitious national program on Municipal Solid Waste. The Household Waste Management National Program (PNDM) covers a wide range of institutional, financial, environmental and social upgrading actions in order to achieve an acceptable coverage of sustainable municipal solid waste services in all urban areas.This program also covers the whole chain, from collection to treatment. The total cost of the program has been estimated at 40 billion DH over a period of 15 years.

SWM Actions	Billion DH
Improvement of collection and cleaning services	26.5
Creation and operation of controlled landfills	7.4
Rehabilitation of existing dumps	3.3
Studies, project management, control and monitoring	1.3
Development of the sector "Sorting-Recycling-Valorization"	0.7
Communication, awareness raising and training	0.7

Figure 19: SWM investment projects

Private sector participation is currently marked by the presence of a dozen private operators, among whom about ten are active in the collection market, and about ten in the transfer and landfilling market.The main operators are Moroccan subsidiaries of internationally known European companies and big groups. Nearly 80%

of the current market (collection and landfilling) is controlled by four subsidiaries of international groups. Seven companies control nearly 96% of the current maket as shown in the figure below.

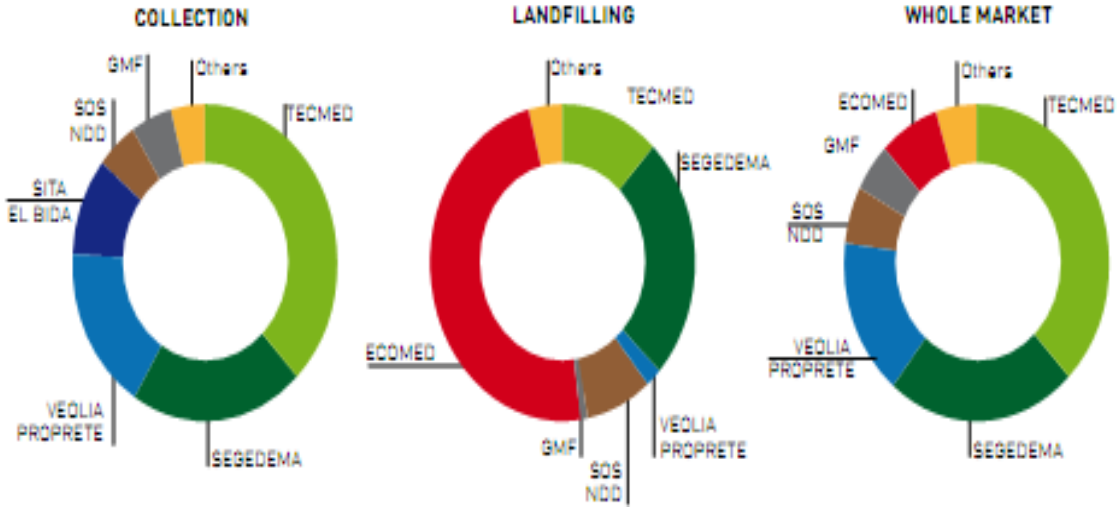

Figure 20: Market shares by operator

Snapshot of Municipal waste Management in AGADIR

The collection and cleaning service of the city of Agadir is the responsibility of the municipality. The tonnage landfilled is between 600 and 800 tons per day. The delegated management agreement was signed in 2006 between the Urban Municipality of Agadir and seven other municipalities in the Greater Agadir (including 3 urban municipalities).

Table 2: Volume of MSW production in Temlast Landfill (Source Agadir City)

Year	Real tonnage (tonnes)
2008	**187 664,238**
2009	**213 262,240**
2010	**235 977,773**

Greater Agadir with a population of 900 000 inhabitants, has two landfills. The old one Bekarane site was opened in 1978 and closed in 2010. The land fill is located about next to the new Footbal Stadium, and about 1 km from the university. Collection and flaring systems already exist. According to a pre-feasibility study report, the biogas (methane) is tested and evaluated at 50 %. The report addresses

the potential implementation of a landfill gas (LFG) collection, control and utilization project at the Bekarane site. The potential to generate energy is confirmed by the the flare installed.

Figure 21: Flaring and collection systems in Bekarane site confirming biogas potential

The new Metropolitan Sanitary Landfill Tamlast CET is located not far from the old one. In Agadir, the organic component, paper fiber, wood and plastic of MSW are representing about 90 percent of the biodegradable portion of the MSW. When MSW is buried in a landfill, a complex series of reactions occur in which anaerobic microorganisms decompose a portion of the organic fraction of the waste to carbon dioxide (CO2) and methane (CH4).

Energy Demand, Renewable Energy and Energy Efficiency Promotion

Over last two decades the risk and reality of environmental degradation have become more apparent with increasing economic development and population growth. Solving the current environmental problems, while addressing issues related to electricity generation and solid wastes problems, requires long-term potential actions for sustainable development. In this regard, renewable energy resources are recognised as one of the most efficient and effective solutions. Therefore, there is a need to expand the production of electricity from various forms of renewable energy. A review of the present energy situation in Morocco is pre-

sented in this paper to show that using landfill gas for energy is a viable source of electricity for the country.

Electricity demand

Energy demand in Morocco is rising steadily (see figure below), in particular the demand for electric power. The causes driving such development include economic growth, advancing industrialisation, greater prosperity among Moroccans and a number of demographic factors. Since 2004, annual growth rates in electricity consumption have averaged seven percent. Power generation is primarily fuelled by fossil energy sources such as coal, natural gas and heavy fuel oils.

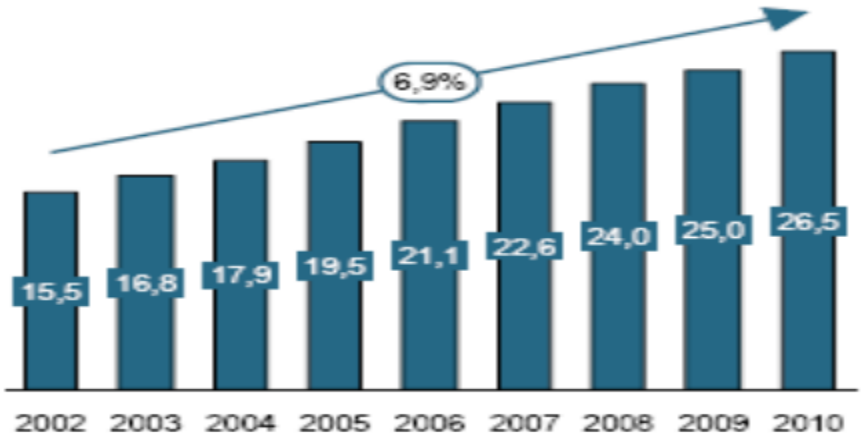

Figure 22 : Evolution of Electricity Demand in Morocco

The country possesses virtually no fossil energy sources of its own and must therefore import its fuel supply. Both in absolute and relative terms, Morocco's high fuel import rate in excess of 97 percent makes it North Africa's largest energy importer. Energy subsidies have become a significant burden on the nation's budget and trade balance. Forecasted demand will cause Moroccan greenhouse gas emissions, currently still low, to rise considerably. Nevertheless, the nation can succeed in reducing its dependence on energy imports and fostering a more sustainable energy supply by tapping into its enormous potential for renewable energy sources and targeting greater energy efficiency.

Electricity Prices

Electricity prices in Morocco are, by regional standards, relatively high. The price of electricity for final consumers is fixed by decree from the Prime Minister of Morocco. Subsidies on electricity prices have been phased out in recent years, leading to a steady but moderate price increase. (See figure below)

Table 3: Electricity prices in Morocco

ELECTRICITY PRICES IN MOROCCO 2009				
		€/kVA*a	€/kWh	
(Very) High Voltage	general	33.5	0.05-0.12	depends on time of the day and annual hours of consumption
	optional	26.1-145.7	0.05-0.16	depends on voltage level, time of the day and annual hours of consumption
Medium Voltage	general	34.3	0.05-0.11	depends on time of day
	optional	31.14-155.6	0.04-0.14	depends on time of the day and annual hours of consumption
	agriculture	38.1-190.5	0.04-0.16	depends on annual hours of consumption and time of the year
Low Voltage	households	-	0.08-0.13	depends on monthly consumption
	rural households	-	0.1-0.13	depends on capacity of connection

Source: Arrêté no. 528-09, 2009

The Electricity Grid

In 2006, the transmission grid was owned by the state power utility ONE and consisted of 18 920 km of 400 kV, 225 kV, 150 kV and 60 kV lines.In 2007, the distribution network, belonging to ONE, consisted of 55 103 km of medium voltage lines and 149 795 km of low voltage lines. The retail of electricity to the final consumers is in the responsibility of ONE (for most of the country), seven local municipal authorities (»Régies«) (Marrakech, Fès, Meknes Tétouan Safi, El Jadida-Azemmour and Larache-Ksar El Kébir) and four private companies (gestion délégué), using ONE's grid Casablanca, Rabat-Salé, Tanger Kénitra). The losses in the network accounted for 4.7 % in 2007(ONE 2009). ONE aims at strengthening and extending their grid. According to ONE, the grid in the south is not sufficient for new (renewable) capacities, ONE aims at building 650 km of 400 kV lines between Agadir and Laâyoune ; this 400 kV line to the South is supposed to be in operation by 2012.

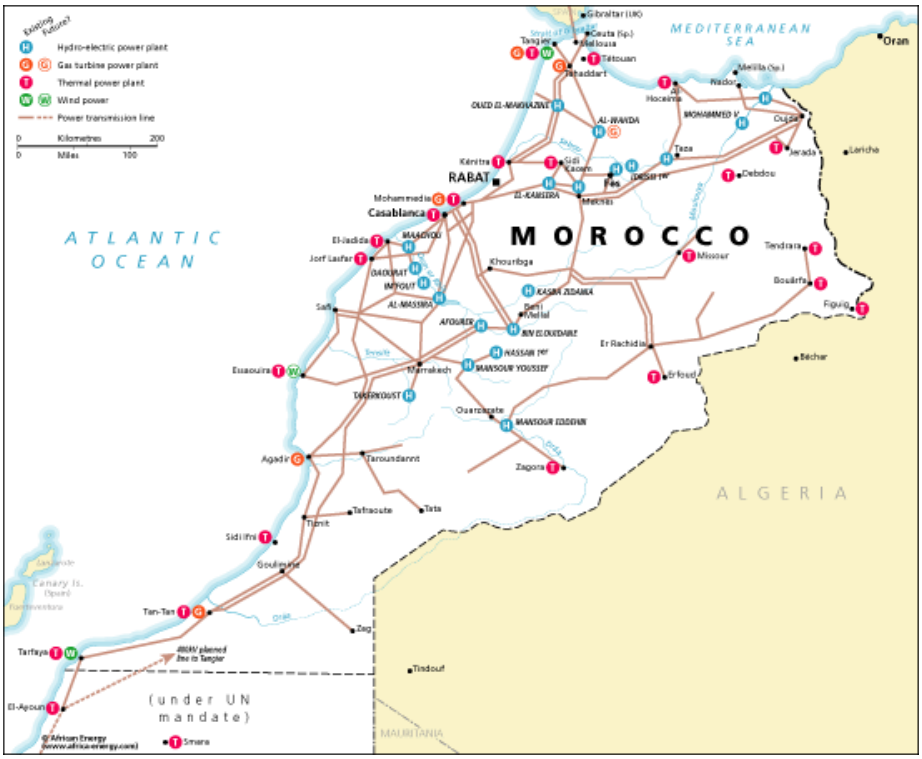

Figure 23: Moroccan electricity grid

Competition

Generation is controlled by ONE and private concessionaires (JLEC, CED, and EET); transport is the exclusive responsibility of ONE. Where private concessions are concerned, ONE gives a purchase guarantee. Electricity is distributed by ONE (45% of the domestic market), the municipal electricity boards like the case of Agadir region and private distribution companies. The retail sale of electricity to the final consumers is responsibility of ONE (for most of the country), seven local municipal authorities ("Régies") (Marrakech, Fès, Meknes Tétouan Safi, El Jadida-Azemmour and Larache-Ksar El Kébir) and four private companies ("gestion déléguée"), using ONE's grid.

The state's share of power generation has fallen to about 35%. Law No. 16-08, enacted in late 2008, raised the self-generation threshold from 10 to 50 MW. ONE still has a monopoly on electricity generation with a capacity of more than 50 MW. However, it is authorised to conclude agreements with private operators for power generation in excess of 50 MW under concession, provided that the generator supplies the generated electricity only to ONE and the economic balance claus-

es in the agreement are respected. In such cases, competitive tendering is compulsory. ONE is also authorised to enter into private contracts with producers for the concession of electricity generation from domestic energy sources (fossil or renewable) for their own use, any surplus being sold to ONE.

Assessment of Biogas Resource Potential

Residual, urban, agricultural or industrial biomasses represent an untapped potential for energy production reaching 950 MW. This potential is not actually very developed in Morocco but local businesses fully understand its value. Biogases are naturally produced by the fermentation of organic refuse accumulated in garbage dumps. These gases have a sufficiently high concentration of Methane (at least 40%) to be transformed into steam or electricity. Public dumps in all the bigger cities in Morocco are now tightly supervised and represent an interesting potential waiting to be developed.Electricity production using processing plant biogas represents a promising potential.

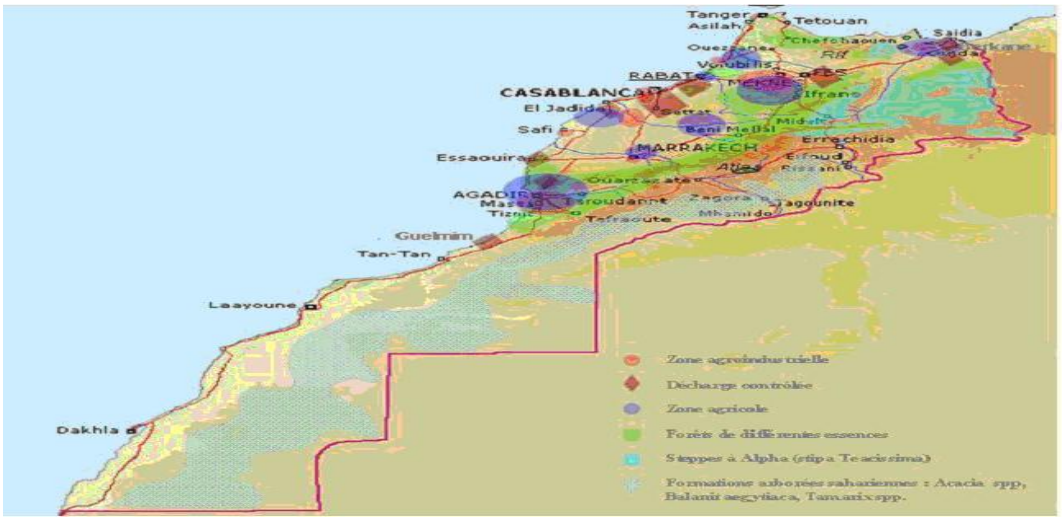

Figure 24: Map of Biomass Energy in Morocco

The availability of methane resource in sufficient quantities is essential to the project's success are confirmed in the Agadir landfill.

Agadir: Electricity Consumption profile

In Agadir, there was sharp increase in electricity consumption from 2009 in Agadir.The layout of new development will cause automatic future increases in energy demand in public lighting. Therefore, Agadir is steadily increasing its

capacity of hospitality reception and will grow in supply of services and activities related to tourism such development of the beach, festivals and events. Therefore, significant increase consumption in public lighting is expected.

Figure 25 : Agadir beach side in night time

Energy recovery from waste will greatly exceed the total coverage of public lighting needs of the city. Any further energy produced could then be injected into the national grid and then resold. The lighting is controlled by counters that start and stop all at once. There are no areas with extinction depending on the time of the night.

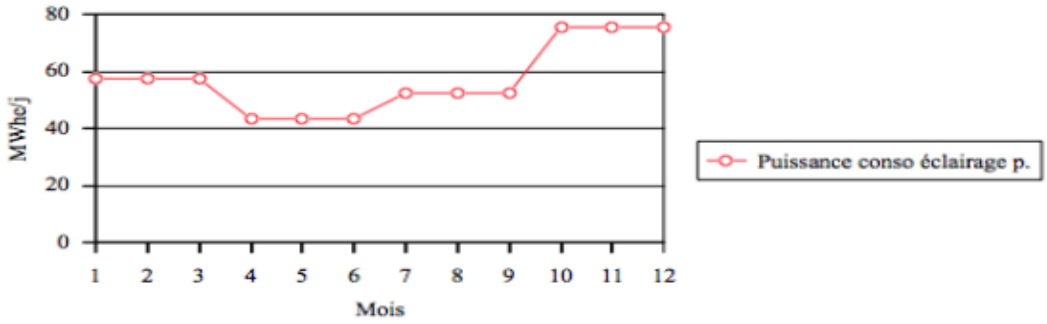

Figure 26: Public lighting consumption in Agadir

The potential utilization of landfill gas at Agadir facilities can provide significant economic, environmental, and energy security benefits while contributing to the achievement of the city ´s stated goals and objectives for implementing renewable domestic energy production.According to pre-feasibility conducted by Energy Investments Company (SIE), it is evaluated and confirmed that energy recovery from LFG, only in the old landfill, will exceed largely the total coverage of public lighting needs of the city.

Incentives for LFG project in Morocco: RE & CDM

Renewable Energy Law

Due to large energy imports, the higher international prices place an increasing burden on Morocco's foreign exchange reserves and may hamper general national development. With the continuing growth in energy needs (lastly about 7% to 8% a year in the electricity sector) and the exceptionally heavy dependence on fossil fuel imports, Morocco is under considerable pressure to promote efficient energy use and expand renewable energies.

Morocco has put in place a voluntary legislative framework aimed to support the national energy strategy, to promote renewable energy development, increase energy supply, improve the energy structure, guarantee energy safety, protect environment and realize the sustainable development. **Law 13-09 referring to renewable energy** was promulged in 2009. This law encompasses production of electricity from renewable sources and introduces 4 major innovations:

1. Free competition in the production of electricity from renewable sources.
2. Access to the national power grid (Medium, High and Very High Tension) for all producers of electricity originating from renewable sources.
3. The use of the power grid and interconnections to export electricity produced from renewable sources.
4. The option for a developer to build a direct transport line in the case of insufficiency of the power grid and/or interconnections.

Dependence on energy imports is an important reason why renewables are accorded key status in official plans for the energy sector. A national strategy foresees increasing their share in Moroccan energy supply to 20 % by 2020. The country is basically very well suited for the use of renewable energies. The conditions for biogas energy are also extraordinarily favourable. Furthermore, LFG utilisation is of special interest for CDM projects. Several cities are reportedly seeking partners for the utilization of landfill gas.

Clean Development Mechanism (CDM)

Waste management opens many opportunities to implement CDM projects in non-industrialized nations. Furthermore, Morocco, as a developing country (non-Annex B Party) that has ratified the Kyoto Protocol in 2002 is eligible to participate in the flexible mechanisms enabled under the Kyoto Protocol, such as the Clean Development Mechanism (CDM). Waste disposed in landfills generates gases typically composed of 50% methane (GHG) that can be captured and flared or used to produce electricity. Those Emission Reductions can be sold to Part 1 country entities to generate for the improvement of current SWM practices.

A part flaring activities ,there is at present no LFG utilisation in place in Morocco, which results not only in global environmental impacts linked to the emission of greenhouse gases, but also in financial losses, in terms of foregone revenues from the sale of carbon emissions reductions under the CDM. The potential of landfills where projects are underway is estimated at about *1.571.200 TECO per year.* Several projects intended for the management of waste have been initiated in other cities throughout the Kingdom. Altogether these projects offer a potential for methane emission reduction estihated at *600 000 TEco/per* year.

Table 4: Portfolio of Solid waste Project under CDM

Portfolio of « solid-waste » project

Project title	Developer	(kTECO2/an)	stage	Contact
		Public landfill		
Biogas recovery and flaring/valorization in Akreuch (Rabat)	The Rabat Urban Commune	76	PDD	M.Mohamed Hassan Elhouti mhlhouty@menara.ma
Recuperation and bio-gas burning in Fez	The Fez Urban Commune	75	PIN	Mr Larbi Fakhiri Flarbi@hotmail.com
Biogas recovery and flaring/valorization in Marrakch	The Marrakech Urban Commune	169,4	PIN	Mme Khadija Al Feddy kh_alfeddy@hotmail.com
Biogas recovery and flaring/valorization: in Oujda	The Oujda Urban Commune	28,5	PIN	Adnane El Ghazi cu-oujda@menara.ma
Biogas recovery and flaring/valorization in Agadir	The Agadir Urban Commune	17,7	PIN	Fatima EL BAZ Cu-agadir@menara.ma
Biogas recovery and flaring/valorization in Kenitra	The Kenitra Urban Commune	54,6	PIN	Abdelaziz FKYRAT courkenitra@menara.ma
Biogas recovery and flaring/valorization at the new inter-communal dump of Rabat, Sale et Temara (Rabat, Sale, Temara)	Group of communes	250	Under development	M. Mohamed Hassan ELHOUTY mhlhouty@menara.ma
Biogas recovery and flaring/valorization Casablanca (Mediouna)	Casablanca commune	400	Under development	Commune urbaine de Casablanca
Biogas recovery and flaring/valorization at the new Casablanca landfill	Casablanca Commune	500	Under development	Commune urbaine de Casablanca

In a feasibility study of CDM projects related to waste sector, it is invaluable to assess the capacity of different waste management alternatives in terms of

GHG emission reduction.Having higher potential to reduce GHG emissions gives more CERs which mean that the CDM project can generate bigger profit from sell ing CERs. All the LFG capture projects in Morocco which have been undertaken have considered the CDM. There is nothing suggest that a similar project has been or being carried out without the CDM incentive. Four landfill projects that flare biogas or envision currently the LFG capture and elimination are either already registered as CDM projects (Oulja landfill), under validation (Fès landfill project), under development (Oujda andfill) or under consideration (Bikarane landfill).

Attractive Investment Incentives for LFG projects

In addition to the tax exemptions granted under the common law, Moroccan law provides specific financial, tax and customs advantages to investors, as part of agreements or investment contracts to be concluded with the State, provided that they meet the required criteria.(See Apendices: Investment Incentives).This concerns:

•The contribution of the state to certain investment expenses: Investment Promotion Fund;

•The contribution of the state to certain expenses for the promotion of investment in specific industrial sectors and the development of modern technologies: the Hassan II Fund for Economic and Social Development;

•Exemption from customs duties under Article 7.I of the Finance Act No. 12/98;

•Exemption from import VAT under Section 123-22 °-b of the General Tax Code.

These four advantages can be benefited from in a single investment project.

Analysis of secondary research indicates that there is a huge potential for the new and untested LFG technology in the country. Untapped potential of biogas produced in landfills, increasing electricity demand and energy dependency, renewable energy, investiment and CDM incentives are the main key market drivers for LFG utilization.

4.2 Case company: Strategic Analysis

4.2.1 Biogas Systems Ab: Brief History

Biogas Systems has its roots in Sunne, in mid-west Sweden. For the first 25 years the firm operated under the name Värmekollektor AB. It acquired its present name, Biogas Systems AB, in 2010.The business was founded in 1985 and has concentrated on building landfill gas plants ever since, thus acquiring extensive experience that benefits its customers. Biogas Systems AB is an international clean energy and climate change mitigation company that specialises in converting harmful methane emissions from landfill sites into clean energy and valuable carbon credits.

The company has combined more than 26 years of international experience to enable it to provide world-class fully-integrated solutions for landfill gas projects.It aims to reach around the world. It currently operates around plenty of projects worldwide.Its customers are mainly found in the energy sector and among municipal and independent waste management companies. AB is currently active throughout Scandinavia and parts of Europe and North Africa.

4.2.2 Technology & Value Chain Analysis

The value chain describes the activities within and around an organization, which eventually create a product or service. It includes primary activities that are directly concerned with the creation or delivery of a product or service; and support activities, which can improve the effectiveness or efficiency of primary activities. Managers should understand how these separate activities add value to the final product, and how these separate activities can be linked effectively and efficiently.

Biogas Systems Ab's business model consists of LFGTE plant planning and construction, sales of LFG management solutions, biogas facility maintenance, and technology transfer.

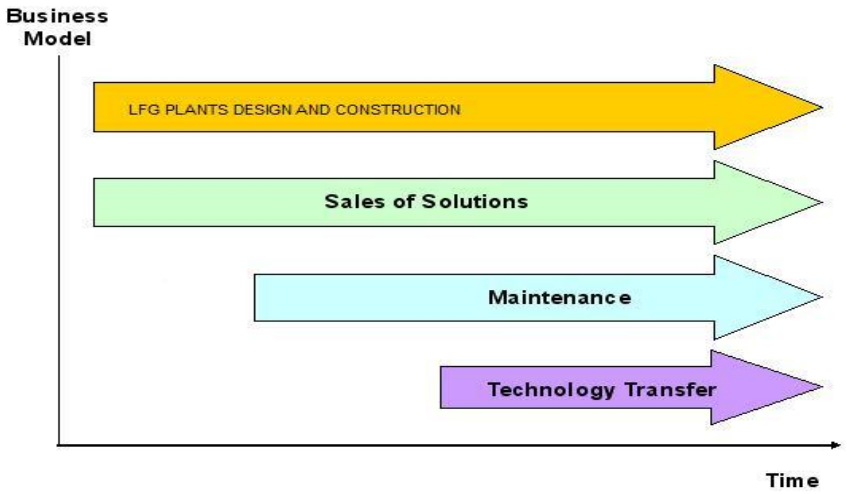

Figure 27 : Transfert technology within Business Model

Biogas Systems develops environmentally sound and financially profitable solutions for energy and biogas. The company takes a complete approach and has full control over the whole landfill gas process, from analysis and trial pumping, design and engineering, to manufacturing and installation of turnkey plants, including equipment for generating electricity and heat.

The firm´s involvement does not end with final delivery. They are on hand throughout the life of the plant to provide the ongoing service and support that are needed for effective operation.Its solutions are based on its own technology, combining specially developed components and subsystems to create complete systems.

The company provides complete packages for optimised gas extraction .Biogas Systems AB supplies all the equipment that is needed for a working landfill gas plant. This includes *gas engines, gas turbines* and *gas boilers* for producing electricity and heat from biogas, as well as *gas flares*. These complete systems also include the control system, cooling system and other peripheral equipment, as well as service agreements for economical operation.

Figure 28: Biogas Systems´Products

Concerning Landfill gas system, the whole process is important to the company.They like to be involved at an early stage so that they can work closely with the customer to develop solutions that maximise the customer´s environmental benefit and financial return.

A key part of what it offers is a unique gas collection system for landfill sites. It is tailored to suit each customer's particular requirements. The systems components are manufactured and pre-assembled in the firm´s own facility and installed at the landfill site. They take complete responsibility for the full installation, from groundwork to commissioning.

Figure 29 : Biogas Systems Ab ´s unique collection system

By providing an integrated solution, Biogas Systems Ab captures methane that would otherwise have been emitted to the atmosphere, thereby eliminating a potent greenhouse gas whilst providing a clean energy substitute to conventional fossil fuels, in a commercially attractive way.The company is committed to providing the best solution to its partners with the focus on delivery.

The best and suitable solution for methane management for the proposed project in Morocco should cover the whole value chain, from landfill gas drainage and gas collection to selling the heat, power and carbon credits.The technology should also be appropriate and adaptable to the local context. In Morocco, there is more need for electricity than heat. The figure below shows that with the fully and integrated solution the value is added to the final product as well as to the future business.

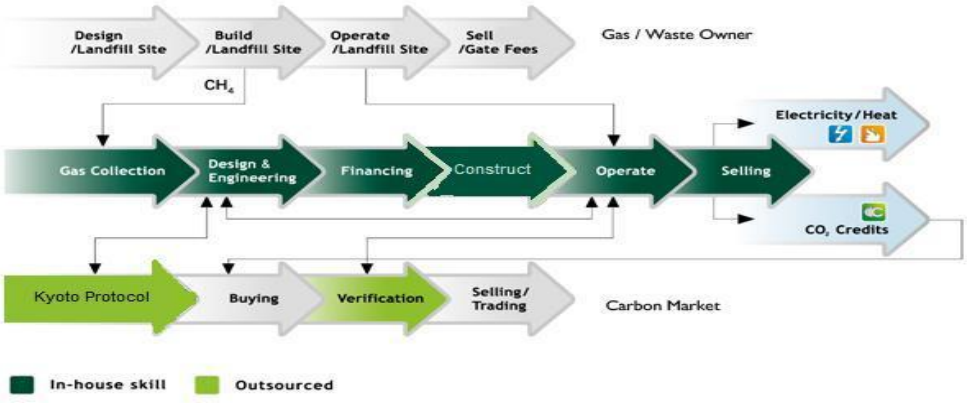

Figure 30 : Integrated solution covering whole process and value chain.

4.2.3 Corporate strategy analysis: Ansoff's Growth Matrix

Ansoff's Growth Matrix has been chosen to establish what kind of product and growth strategies Biogas Systems is following. Biogas Systems has with Tony Zetterfeldt as CEO changed its strategy in relation to product portfolio as well as with which markets will have increased investments in terms of expanding in new markets.

Market Penetration

Biogas Systems is not using market penetration (existing markets and existing products) as a growth method. A reason for this is that the European markets in which the firm has its highest sales are at the best case lagging in the current economic market and at worst in recessions, hence growth requires competing on prices, which the firm is very reluctant to do, or by aggressive advertising. Furthermore the comapny is in the high-end segment, where exclusivity and signalling value are important factors, thus it has to keep up with those values and remain on the cutting edge, which makes market penetration a bad strategy.

Market Development

With big share of Biogas System´s sales coming from exports, it is important for the company to keep investing in foreign markets to push up the growth rates. Geographically, the company is strongest in Scandinavia but has also spread in many parts of Europe as well as to North Africa. In trying to grow further and take advantage of the high growth that has taken place in recent years in Russia and China, and thus place itself in the market development area in the Ansoff's Matrix.

Biogas Systems Ab is also planning to expand on other emerging markets and increase its presence in those geographical areas. Though not specifically mentioned, a likely area is India, which is experiencing high growth and increasing wealth. Moreover, the firm is trying to grow by increasing the number of distribution channels.

Growth in new markets is appropriate for a business like Biogas Systems as its core competencies are related to products and not to geographic areas. Thus it can carry on its expertise into new markets. There are however still some drawbacks as moving into new markets is generally associated with higher risks than if market penetration, as a strategy, had been chosen.

Growth in new markets is especially important for Biogas Systems as it has most of its sales in only European countries and it is thus largely affected by the fluctuations in those markets.

Product Development

At the same time, the comapny has focused on the product development side as it aims to launch new products and have most of sales coming from newly launched products .This strategy entails developing new products to launch in existing markets. The strategy is necessary if the company wants to uphold its position as a high quality technology, as remaining on the cutting edge of technology along-side keeping up with modern design is the only valid foundation for charging premium prices.

Diversification

This strategy of growth is the most risky of the four possibilities given in Ansoff's growth matrix. Biogas Systems Ab does not use to the full extent this method. However when it enters a new market, it is likely to enter it with its entire portfolio of products, including new ones. Still Biogas systems Ab can not be said to use the diversification growth strategy in the same sense as described in the Ansoff's Growth Matrix.

Analysis on Growth Strategy

The growth strategy chosen by Biogas System Ab fits with its niche industry where growth in the saturated western market requires either price cuts or launching new products. Biogas Systems however, can not just make advanced versions of already existing products every year as that will make its products loose value. The reason for this is that the company´s brands itself on making long lasting products which have a long life and should not need replacement for many years. Furthermore, the growth strategy for new markets also fits with firm's niche industry as presence in high growth areas is important to have a growing turnover.

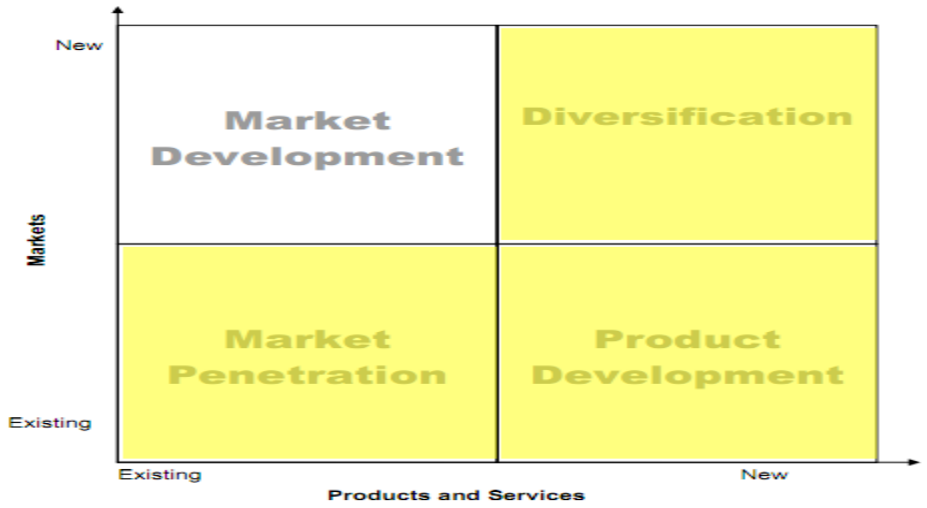

Figure 31 : The growth strategy chosen by Biogas System Ab: Market Development (Ansoff's Growth Matrix)

This strategy choice is explained by the fact that the landfilling is the most commonly adopted technology in developping countries for Municipal Solid Waste (MSW) disposal as an alternative to waste burning and composting. Landfills, although profitable, are no longer the preferred end disposal method in Europe. Amount of landfilled waste must be reduced. That what explain that the company has interest to expand their busnisses outside Europe to new markets in Developing countries such as Morocco.

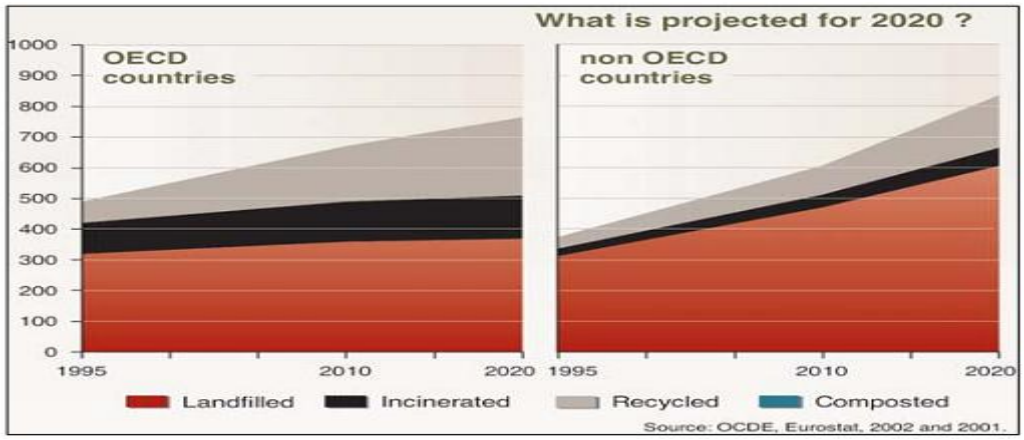

Figure 32: Evolution of waste landfilled

4.3 Business case: LFGTE Power Plant project in Agadir

Proposed Project description

The Agdir City owns Tamlast landfill, the new municipal solid waste landfill for Greater Agadir, which services about 900,000 people. With over million tonnes of refuse in place, Tamlast landfill receives approximately 240,000 tonnes of refuse each year and is expected to operate until 2040.

The Agadir city has an overall landfill gas (LFG) management strategy for the old site Bikarane landfill.The original LFG collection and flaring system was installed recently. The next step was to utilize the energy in the collected LFG rather than continuing to flare the gas. This would continue to reduce Greenhouse Gas (GHG) emissions from the site and create green power rather than wasting a valuable resource. The municipality plans to enter into a private/public partnership with a partner to co-own a Landfill Gas Utilization Facility.

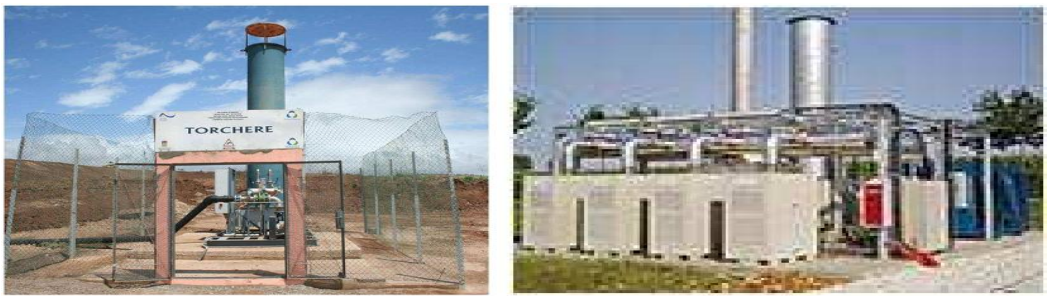

Figure 33 : Actual flaring and future proposed power plant

While the municipality operates the landfill including collection and transportation of municipal solid waste, daily management of the landfill site is committed to Tecmed until 2017, and then the proposed private company funded both by a prospective foreign company and by the Agadir City is expected to be responsible for operating a power plant. The old site is already full and has already been closed.The waste management department of Agadir has continued the operation in new landfill Tamlest.

Location

In the beginning, the project activity will be located at Bekarane old site and will extend to the the new Landfill in Tamlast. There is already biogas capture and destruction activity in Bekarane site before the project activity. The technical po-

tential is then already confirmed by flaring. As and when the new landfill starts producing enough gas to produce enough electricity for on-site consumption and/or export to the grid another facility will be installed.

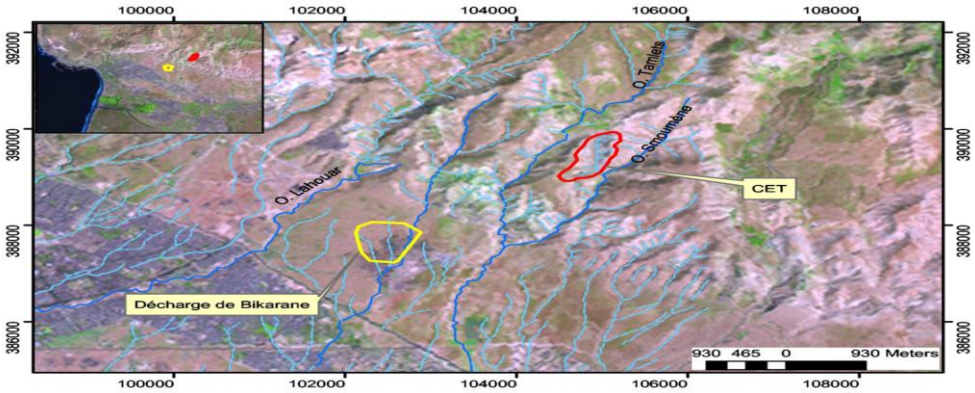

Figure 34: Map of the proposed project pocation in both Bekarane old site marked out in the yellow circle and new landfill Temlast CET marked out in red circle.

Description of the technology to be employed in the Project:

This thesis has as objective to propose to transfer LFG technology to both Agadir landfills. For Bikarane site the project aim to supply Power plan in order to generate electricity.For the new site a landfill gas collection system, flaring and LFG-To-Electricity facility will be provided.The project activity involves the installation of state of the art LFG collection technology with electricity generation through which emission reductions are facilitated.

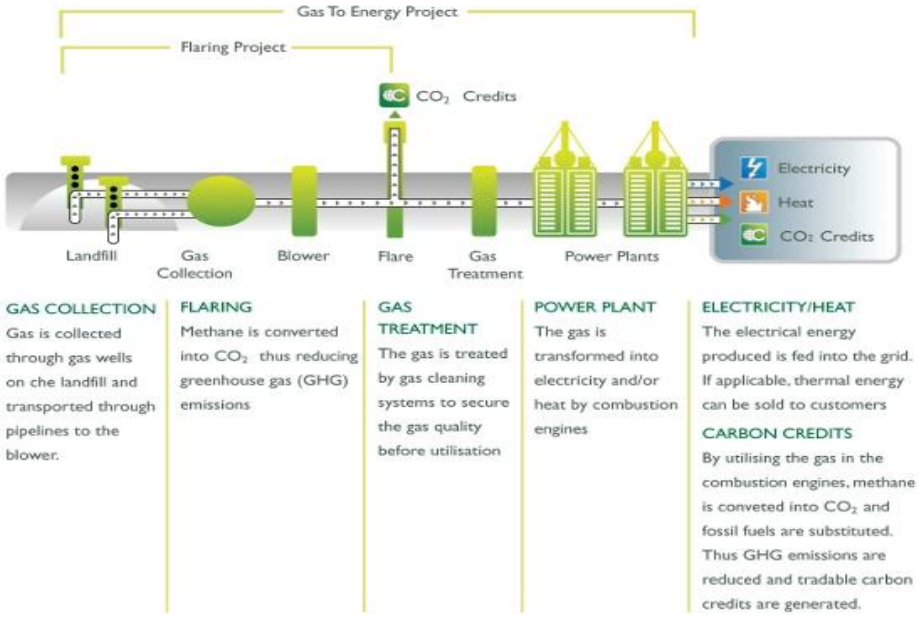

Figure 35: Technology solution to be employed in Agadir

Project Activities and objectives

The proposed project activity involves producing electricity from the biogas captured and injecting it to the national grid .The main objective of the project is to avoid methane emissions from municipal waste landfills in Morocco by promoting landfill gas (LFG) utilization projects. Furthermore, carbon dioxide emissions will be reduced from utilisation projects, consisting in the substitution of the national grid electricity with electricity produced with the biogas. The proposed project will contribute to reduce GHG emissions, mitigate the nuisances associated with the LFG emissions and improve the air quality. It will help streamline sound environmental practices in the Solid Waste Management sector in Morocco.

Local legal requirements for CDM projects and taxation aspects

The Moroccan National Designed Authority (DNA) was established by ministerial decree. No specific CDM law has been adopted as yet. Three new environmental laws are, however, in force as of 2003, one on environmental impact studies that are also required for CDM projects (some implementation regulations with obligatory standards are still missing, however). All laws, decrees and ordinances to do with the environment can be read on the website of the ministry responsible (www.matee.gov.ma).

Foreign investments are promoted in different ways in Morocco. Information on legislation and associated links can be found on the DNA website. In the environment sector in general, there are no restrictions for foreign investors. The ceiling is upgraded from10 to 50 MW for the private operation of power stations which are supposed to be run as independent power projects (IPPs) outside the ONE grid.

According to the Moroccan DNA, CDM income is generally taxed like export earnings. There is no separate fiscal legislation on the sale of emission reduction certificates (CERs) or other aspects of CDM projects in Morocco. Nor are there any special tax incentives for projects in renewable energy. Plant and machinery

imported for an investment in a CDM project are usually subject to a preferential customs duty of 2.5% unless the requisite goods are also produced in Morocco itself. As a rule they are exempt from all other import charges. The practical application of customs and tax provisions is not generally regarded as a serious problem in Morocco.

Carrying out a CDM project and receiving final registration by the CDM Executive Board requires multiple steps. These steps are regarded as the CDM project cycle, and are put in place in order to to safeguard the actual climate benefits of CDM project activities. The project cycle can be seen in the figure below:

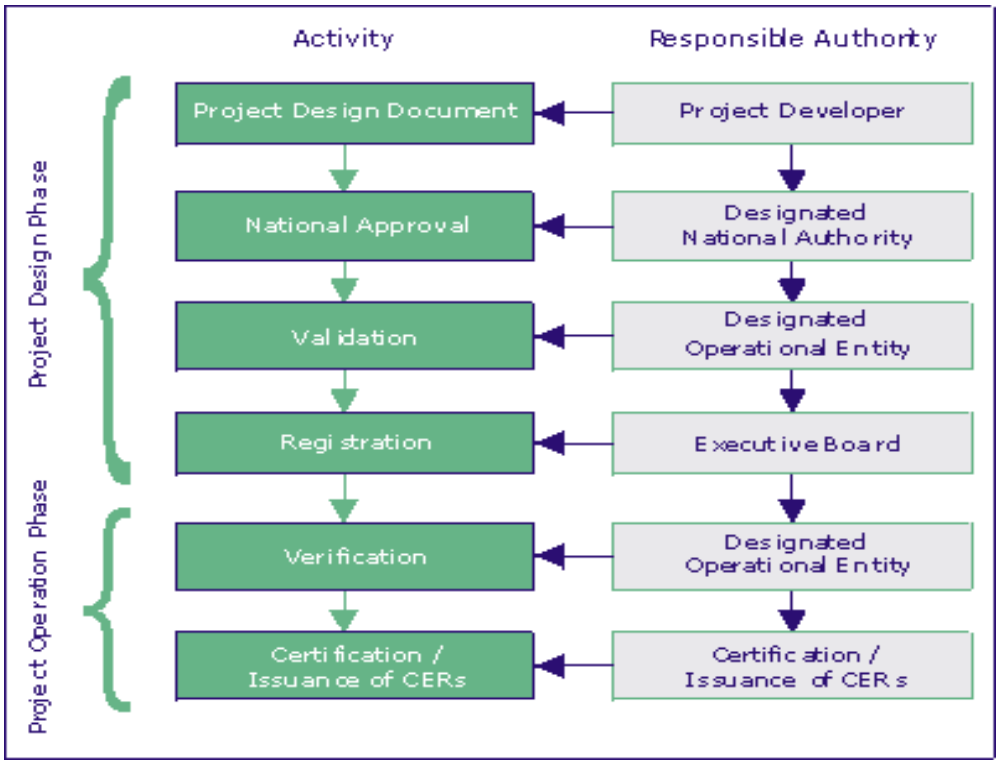

Figure 36 : CDM project cycle

Source: Adapted from "Using the CDM into energy planning – A case study from South Africa", James-Smith, E.

4.4 Stakeholders Analysis

The following key stakeholders related to the project are identified:

4.4.1 Agadir Municipality

The Land to be used for the Project is owned by the the City of Agadir. An agreement will be established between the future company and the city. The municipality is the partner and the first potential client for the future business. Energy generated can be used to cover public lighting and for other uses.

The potential utilization of landfill gas at Agadir facilities can provide significant economic, environmental, and energy security benefits while contributing to the achievement of the city ´s stated goals and objectives for implementing renewable domestic energy production.

4.4.2 ONE

Morocco's electricity utility, Office National d'Electricite (ONE), was established as a legally and financially autonomous public entity, responsible for electricity provision in Morocco in 1963. It operates as a single buyer, and owns the entirety of the transmission network, and the majority of the distribution grid. The power market was opened to IPPs in 1994, and by 2002, ONE began restructuring that allowed subsidiaries to be formed. Much of the initial power sector development therefore occurred under ONE as a public monopoly. Although ONE was financially autonomous at inception, the government has traditionally used subsidies to absorb fluctuations in energy prices and shield consumers from electricity tariff increases, and to expand the distribution network to reach rural populations. However by 2008, ONE has problems related to transmission and distribution system overload, resulting from rapid demand growth and increased electrification rates, which quickly outpaced the growth in sector infrastructure investments. It is estimated that demand will grow at an annual rate of 8% until 2015, threatening

the long term security and reliability of electricity supply. To address this challenge, ONE is preparing to operate in an increasingly liberalised market, as called for by a draft law under discussion, and in line with the plans to increase regional market integration with the Maghreb and the EU.

The proposed project activity will be connected to the national grid of Office National d'Electricité ONE. As a public utility ONE has the monopoly of electricity transport and it manages the unique national grid in Morocco. The national grid is well identified and is referred to in all ONE official annual report activities.

The generated electricity is to be sold to the national utility ONE and be injected in the national grid.

4.4.3 Landfill management company TECMED

While the municipality operates the landfill including collection and transportation of municipal solid waste, daily management of the landfill site is committed to Tecmed until 2017. During the research it is reported that the company has a problem related to leachate (waste water from landfill). The landfill biogas can be used to power the leachate treatment facilities and for landfill on-site uses. So, Tecmed is considered as a potential customer. The operator of the Agadir landfill has continuously interacted with local stakeholders, both for the dissemination of information associated to the management plan of the landfill, and for different improvement projects involved in such plan, especially the project reviewed herein.

4.4.4 Other concerned Government Offices and Administrations:

Several ministries are involved and active in the sector of Municipal waste and Renewable Energy:

• The Ministry of the Interior/ the General directorate of Local Authorities (DGCL)/the Water and Sanitation Directorate, as the ministry supervising the lo-

cal authorities, supply the necessary technical and financial support to the municipalities;

•The Ministry of Energy, Mines,Water and the Environment,through the Secretariat of State in charge of Water and the Environment Department for its coordination and planning role.

•The Ministry in charge of Finance, through the Municipal Receiver,intervenes in almost all thestages of the delegating process: from the study of tender documents to the launching of these tenders, the opening of bids, and the awarding of management delegation contracts.

•ADEREE is a public institution with commercial and industrial characters, attached to the Ministry of Energy and Mining. According to its missions and objectives, it contributed to the development, at large scale of renewable energies targeting the important energetic, economic and environmental stakes with the strategic use of this type of energy.

4.4.5 CERs purchasers

The Landfill gas recovery project represents the low hanging fruit for carbon credits trading in the developing countries. The CERs can be used by the developed countries to help meet their Kyoto greenhouse gas reduction targets. According to Kyoto protocol Those Emission Reductions can be sold to Part 1 country entities to generate revenue for the improvement of current SWM practices.

Therefore, the sale of CERs, also known as carbon credits, can significantly increase the financial viability of landfill gas-recovery projects in developing countries.

4.4.6 Funders:

Consultations with officials from the state ministry of energy and environment revealed that the government is investigating the possibilities of handing over operation of the landfills to private interests. In addition to local funding there is also foreign funding scenario.

Foreign Funding

In general, the cost of funds from foreign sources is cheaper than that from local sources especially in Morocco where interest rates are generally on the high side. This is especially true when the sources of the funds are public or non-profit institutions or specialized funds like the **World Bank's Carbon Fund**.World Bank has signed a partnership agreement on municipal solid waste sector development, which includes a carbon finance CDM component.

International Bank for Reconstruction and Development (IBRD) acting as the Trustee of the Carbon Partnership Facility (CPF) can participate in financing this kind of project.

Local Funding

Energy Investments Company (SIE)

Created in February 2010, the Energy Investments Company (SIE) operates in the energy field, and more specifically in the field of renewable energy and energy efficiency. Public corporation with a starting capital of 1 billion Dirhams, the SIE is undertaking the mission of supporting the national program working to develop renewable energy with high environmental compliance. The SIE is therefore expected to take the lead in investment into projects aiming to increase energy production capabilities, reinforce renewable energy resources and strengthen energy efficiency.The SIE will prioritize its investments in projects acting in the field of renewable energy including biogas.

Among its strategic goals is to reinforce local energy resources. Through this angle, the SIE works to promote and finance biomass programs, notably projects invested in the field of biogas capture in public garbage dumps and the direct appreciation of waste products.

The SIE has already entered into a partnership with both the Bouregreg Valley Authority and Sale City in order to form a new entity whose objective will be the appreciation and exploitation of clean energy sources (biogas) from the Oulja public dump that is under the purview of these agencies. The company created would supply, amongst others, the Potter's Town site.

The Municipal Development Bank in Morocco (FIC)

FIC (Fonds 'Equipement Communal) will be the Coordinating/Managing Entity for the Project of Activities. FEC is a state-owned Moroccan Bank created in 1959 and is specialized in the financing of local investment projects of municipalities and local public institutions. FEC's mission is to support the implementation of national policies for local development with the provision of loans and technical assistance to municipalities. Many programs are undertaken, developed and managed by the FEC to promote sustainable practices in the MSW sector in Morocco.

FEC will provide technical assistance for the development of individual CDM projects activities, manage the programme of activity POA and sell the resulting CERs on behalf of the municipalities and/or private sector landfill operators. Accordingly, agreements for sharing the financial benefits resulting from the sale of emission reductions will be signed with the FEC and the municipalities and/or the private sector operators. These agreements will include the definition of the roles and responsibilities of all Parties involved in the implementation of the CDM Program of Activities and individual CDM projects (CPA).

Energy Development Fund is created by ADEREE to put into practice its commitment to support energy efficiency programs and renewable energy development.

4.5 Summury of the interviews: Stakeholders' comments

Interviews with stakeholders are designed on-the ground assessment in different parts of Morocco and to understand the national enabling environment and the industry's supply chain. In Agadir, field study was also conducted at the city land-fill. Key stakeholders involved in the interviews include: Agadir City Council, Governmental offices, State Energy utility ONE and landfill managing company.A visit was done to the concerned ministries located in the capital, Rabat. In this report, the comments of local stakeholders were analysed and compiled through interview survey in three categories summarized in the table below:

Table 5:Stakeholders categories summary

Category		Stakeholders	Status	Survey Period
1. Governmental organization	Central Government	a.Ministry of Interior (DGCL)	Responsible ministry of MSWM policy	27th June 2011
		b.Ministry of Energy and Mineral Resouces (MEMEE)	Responsible ministry of renewable energy policy and development	27th June 2011
		c. Ministry of energy & environment	ADREE	June,July & August 2011 (training)
	Local Government	Agadir city, El Baz, Akhdaich, ELhlaisi	Counsil vice president Landfill Responsible	June,July and August 2011
		Sami Khadijah Environment Agency	Responsible regional environment	13th June 2011
2.Private enitities	ONE (Ofiice National d'Electricite) Societe d'Investment Energitique (SIE)		National Electric Company Energy Investment Company	20 & 27th June 2011
	TECMED		Local enterprises Landfill operating Company	25th and 30th May 2011
3.Comunity	a. Resident Associations		Community Residents	12th August 2011

In the interview survey the proposed project was discussed with the explanation of the economic, environmental and social impacts of the construction and operation of the project. The comments received were all favourable comments to the project. The salient points of those conversations are received and summarized as follows:

From governmental organizations:

• *Local governments of Greater Agadir* who dispose their municipal waste at Tamlest site and Agadir City Council who governs the landfill as an administrative office of the area also accepted the project. In addition to the adavantages and the reasons mentioned along this research, they support this project because they expect the post-closure utilization of the old and extend the operation to the new landfill site after the acceleration of landfill stabilisation by extracting methane gas by the project.

According to the the municipal council president and the vice president in charge of environment and responsible of the landfill, Agadir city has opted for setting of a local development company (Societe de Development Locale SDL) for better management of certain activities. They are entities of partnership between the municipality and a public or private enterprise for the management of a given urban services including energy production from biogas in the former landfill is the activity of the one company in the local development program.

•Central government organizations of The Ministry of the Interior (the General directorate of Local Authorities (DGCL)/the Water and Sanitation Directorate) as responsible ministry of solid waste management policy, The Ministry of Energy, Mines, Water and the Environment (MEMEE) as responsible ministry of renewable energy policy and environmental conservation have welcomed the project in that the government is encouraging the development of renewable energy projects for diversifying the source of energy and that the project will environmentally contribute to the safety closure of urban solid waste landfill site.

DGCL stated that they do not have the policy to enforce the LFG collection and utilization of the existing or closing municipal solid waste landfill sites.

•*Energy Investments Company (SIE),* located in the capital Rabat, was visited by the author and responsables confirmed that they are interested in financing the project. A pre-feasibility study have already conducted by SIE and confirmed the technical potential.

•*Environment Department of Agadir City* confirmed that the preparation of DEIA, Detailed Environmental Impact Assessment will be required for the proposed project.

From private entities:

•*ONE*, the national electric company, has agreed to receive the electricity generated by the project as a small renewable energy resource at a designated point in their distribution grid lines.

•*TECMED*, the operator of the existing new Landfill site, declared a strong interest in this project. They can buy energy produced to power the leachate (waste water from landfill) treatment facilities.

There are also many potential costumers such as the university, provincial hospital, Olympic football and many businesses and institutions that are very interested in this green local and low cost energy.

From Community residents:

Community residents are strongly interested in this project. Because, they hope this project contributes to the improvement of the environmental condition in landfill site.

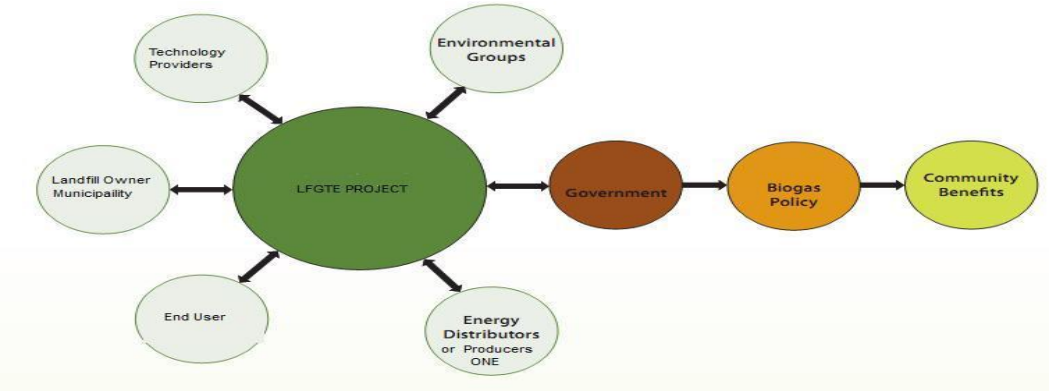

Figure 37 :Stakeholders communities

4.6 Business model canvas

A business model describes the rationale of how an organization creates, delivers, and captures value. To describe a business model a concept containing all the necessary elements is necessary. In order to get a common description framework, it is tried to describe tie business model with the same concept. The concept of

choice is the business model canvas. Within this concept the business model gets described by 9 different blocks, which are explained hereinafter.

Customer segments

There are two customers segments.The first one is energy consumers. Primary customers of this business model are the municipality of Agdir, TECMED as the landfill managing company, the local Electricity Utility ONE or other end user. Furthermore, provincial hospital, the university, new olympic football stadium (for both electricity and heat for showers) and schools and plenty of homes and institutions located in the nearest villages, are additional potential customers. According to Law 13-09 on renewable energy, the electricity generated could be consumed by the municipality (Landfill-on-site use, public light, etc), sold to the ONE or other end-users. The nearest institutions and the stadium and others can be feeded by electricity as well as heat. These potential customers have the interest in buying electricity as low cost and green and low cost energy.The second customer segment is CERs purchasers in the intenationl CDM carbon market.

Value propositions

The value propositions describe what the company offers to the customer to satisfy his needs. Landfill-gas-to-energy (LFGTE) is a renewable energy solution that lowers energy risk and costs.In this business model, a sustainable, green, low cost energy is sold to satisfy the need for reduced electricity bills and to be less reliable on fossil fuels. The contribution to sustainable development is another value proposed by this project. Thereby eliminating a potent greenhouse gas whilst providing a clean energy substitute to conventional fossil fuels and in a commercially attractive way is considered as adding value.

Channels

Channels describe the way in which a company communicates with its customer in order to make the value propositions. In the case of this model the customer could be reached on several ways. One channel is to make agreement with the customer for example ONE and local governments.This channel might ensure the

connection to prospect organizational and institutional customers. In fact this business model is new on the market and not yet applied by any competitor.

Customer Relationships

Building up a competence of solutions is essential in creating the best solution for the customers. The most suitable customer relationship for this business model is a dedicated beneficial partnership. The benefits of reduced energy cost and the provision of green electricity are strongly demanded. Furthermore, after conclusion of a contract or agreement .Therefore a specific contact person is necessary to provide and establish a customer service satisfying relationship. Expertise will combined with service in this business which is considered as win-win opportunity for the company as well as its customers.

The future business will develop long-term and mutually beneficial relationships, which the firm achieves by working in partnership with its customers and their communities

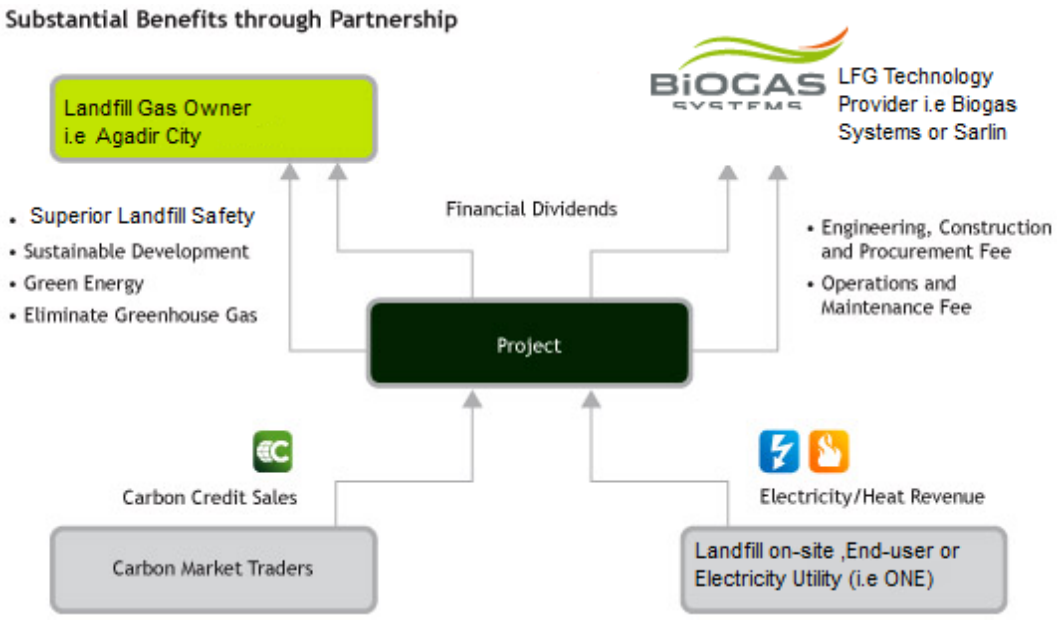

Figure 38: Model of the proposed LFG facility

Revenue streams

The revenue stream describes how the company makes cash and income. The company's success is based on two revenue streams.The revenue stream derives mainly from green energy (electricity and heat) and CERs sales (carbon financ-

ing). In general it is assumed that the electricity generated from the project would be sold to the municipality for street lighting. The project is financially sustainable because it generates revenues from two sources: the sale of electricity to ONE or end-user and the sale of CERs.

The sale of CERs earned by implementing the project will generate a substantial flow in foreign currency to the business. This income will be shared with the Commune and can be used for the research and promotion of new sustainable-development projects.

Key resources

The key resources a company needs are of physical, financial, intellectual and human nature. One office, vehicles and tools are necessary if installations are to be offered, but vehicles can be leased and local firms, such as electricians and constructor, can be used to handle the major installation services.
Financial resources are needed to cover the cost, if there is not a sufficient income stream. Moreover the company offers financial services to customer; therefore key partnerships with banks and financial resources are necessary.

Intellectual resources are brands, proprietary knowledge, patents and copyrights. During investigation and examination no need for special intellectual resources was discovered. Human resources are the necessary staff. The company requires people for management and maintenance.

Key activities

The key activities of the project are capturing and combusting methane, and selling generated electricity or heat and carbon credit in the international market.

Key partnerships

To run this business model successfully two key partnerships are required. In this case, it is very important to have partnership with the municipality, ONE and other potential customers.

Cost structure

Costs estimates for this business model are both capital and operational.
This business model is designed as a service model. Therefore the business is more value-driven than cost-driven by offering services and selling energy. The focus in this model lays in satisfying customer needs. Costs estimates for this business model are both capital costs (taxes, financial dividends) and operational costs (salaries, fee for maintenance). CDM income is generally taxed like export earnings.

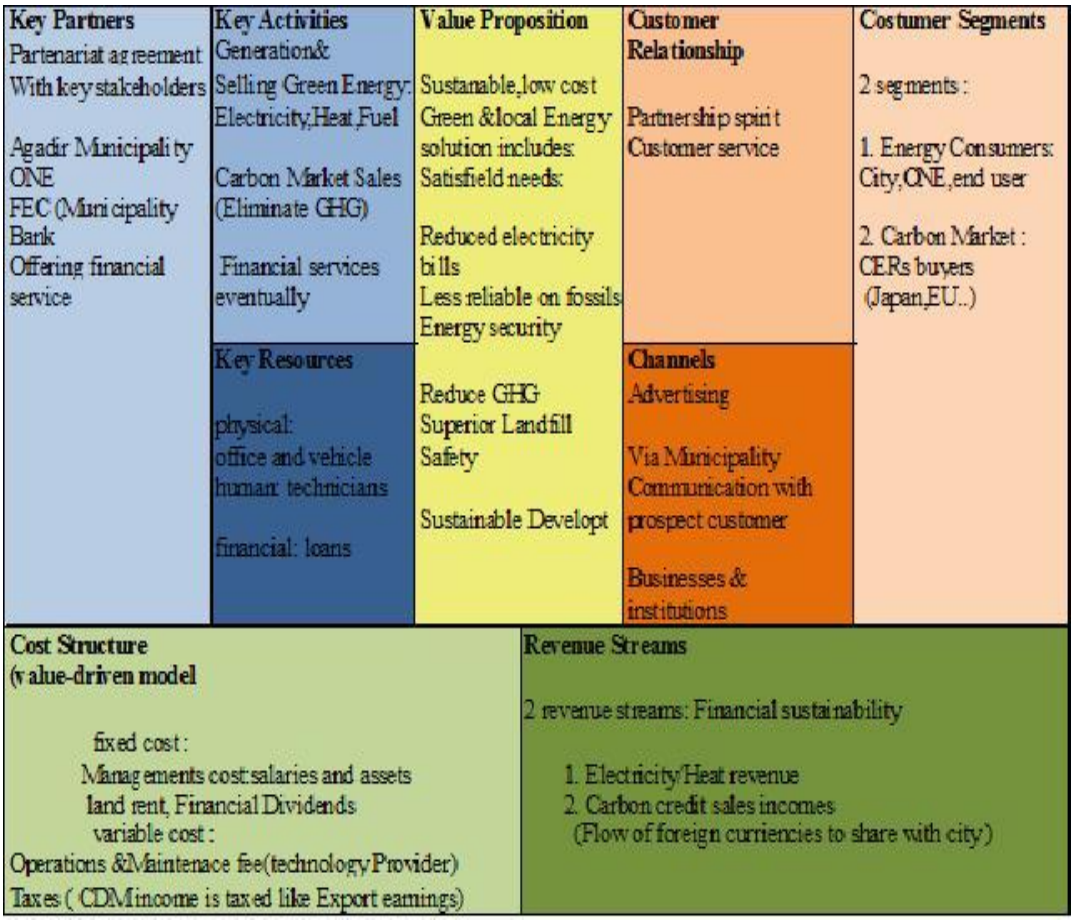

Figure 39: Business model canvas

4.7 Contribution to Sustainability

Besides the stakeholder analysis, the business model gets analyzed towards sustainability and responsibility. A common definition for sustainability is exclusive and therefore the sustainability of the business model is difficult to assess. A poss-

ible way to attempt an evaluation is by using the triple bottom line as analyzing framework. The triple bottom line is based on the three pillars "economical, social and environmental". Hereinafter, the relation of the business model to each of this pillar is described. This will help us to get an understanding about the sustainability of the business model.

Social

The business model has social impacts. Even before LFG energy project produce profits from the sale or use of electricity; it produces a related benefit for communities: jobs. LFG energy projects involve engineers, construction firms, equipment vendors, and utilities or end users of the power produced. Much of this cost is spent locally for drilling, piping, construction, and operational personnel, providing additional economic benefits to the community through increased employment and local sales. Moreover, economical activities create social benefits and welfare. Not only job creation is a benefit. Sourcing parts from local suppliers and working together with local banks enable economic growth and related social welfare.

Environment

Besides this, the technology provides environmental friendly energy without any noxious emissions. Converting LFG to energy offsets the need for non-renewable resources such as coal and oil, and reduces emissions of air pollutants that contribute to local smog and acid rain. In addition, LFG energy projects help curtail global climate change, because they reduce emissions of methane, a greenhouse gas more potent than CO_2. LFG energy projects go hand–in–hand with community commitments to cleaner air and reductions in greenhouse gases that cause global climate change.

Economical Benefits

LFG energy projects are a win-win opportunity for all parties involved, whether

they are the landfill owner/operators, the local utility, the local government, or the surrounding community. Once the LFG system is in place, the captured gas can be sold for use as heat or fuel or be converted and sold on the energy market as renewable "green" power. In so doing, the community can turn a financial liability into an asset.

The project will be a vehicle for technological development in the Province, and will permit the engagement and formation of specialists and new projects in the field of the capture of the Landfill gas, so as to overcome the technological barriers presented by this type of project.

Financial Sustainability, Transferability, and Scalability

Financial Sustainability: The project is financially sustainable because it generates revenues from two sources, the sale of electricity to ONE or end-user and the sale of CERs. The total revenues exceed the total expenses for operation, maintenance and local taxes, thereby providing a profit for the project. Unless there is an unexpected reduction in emission reductions and thus CER payments, the project should be financially sustainable.

Transferability and Scalability: Currently Agadir has a new landfill in operation, in addition to the Bikarane landfill. None of the Landfills located in the region have an LFG utilization system yet, and the success of this project is likely to be replicated at the new landfill by the Agadir Municipal Government and other cities of the region in their respective landfills.Morocco has a couple of cities with a population of one million or more plus numerous other larger urban areas. Therefore, there is a significant potential for similar LFG capture and electricity generation projects in Morocco, and such projects represent an important part of Morocco’s efforts to reduce GHG emissions. The innovative elements of this project, particularly the carbon financing, can be readily transferred to the other Moroccan cities to scale up Morocco’s efforts to reduce GHG emissions

4.8 Recommendations for Municipalities& foreign prospective investors

4.8.1 PPP CDM project Model for the Municipalities

Public-Private Partnership (PPP) is considered the best model to develop a CDM landfill gas project**.**To date there are no internationally registered landfill gas CDM projects in Morocco although two are close to achieving that milestone and Agadir project is one of them.

Landfill	Status	Flaring start date	CDM status
Fès	In operation	December 2009	PDD under validation
Agadir/Bikarane	Closed in 2010	November 2009	PIN developed in 2005 – PDD development under consideration
Oujda	In operation	Early January 2009	PDD submitted to the DNA
Oulja	Closed since December 2006	No flaring activity	CDM project registered under N° 1192 on November 6, 2008.

Figure 40: list of LFG project under CDM approval process

CDM projects have significant environmental and economic benefits and the potential for these projects in Morocco is enormous. However, the projects tend to be complex and have been slow to gain momentum.

The project owner has to learn through its project how to manage the development of a landfill gas CDM project, where to find the appropriate technical, legal and commercial expertise, how to negotiate a carbon credit contract and how to move a CDM project expeditiously through the various steps in the approval processes. It is previous experience that made many appreciate that a Public Private Partnership (PPP) could work very well for municipal CDM projects.

In terms of the Kyoto Protocol, municipalities in Morocco can make a positive impact on the environment by contributing to an overall reduction in greenhouse gasses. In addition, the Protocol ensures that credit buyers in the EU, Japan and Canada pay relatively high prices for carbon credits. Many municipalities still have the opportunity to develop landfill gas projects under the Kyoto Protocol but only if they act quickly and choose the right structure for their projects. CDM projects are more complex than the projects that municipalities regularly undertake. They require international and Moroccan approvals and must be closely

coordinated and efficiently pursued. Most importantly, these projects are time sensitive. The first commitment period of the Kyoto Protocol ends on 31 December 2012.

PPP's offer a structure and process that have significant advantages for local authorities that they want to develop CDM projects for environmental and economic benefits. National government has expressed support for PPP's and the CDM lends itself to such an approach. However, finding the appropriate private partner and ensuring that responsibilities are correctly allocated between the municipality and the private partner are important factors contributing to the success of a PPP.

-A PPP CDM project will not burden a municipality's resources

Municipalities are under pressure to address a wide array of municipal needs. Under current law a municipality is not obliged to capture landfill gas or to undertake a CDM project as there are many other high priority projects competing for the municipality's scarce resources.

A PPP CDM project allows the municipality to get the benefit of the CDM revenue without investing its own precious capital into the project.

-A PPP CDM project will enable a municipality to limit its risk:

CDM projects are new to Morocco and while municipal officials have an excellent understanding of the waste side of landfill gas projects, most municipalities lack experience when it comes to landfill gas collection, flaring and utilisation, and lack capacity in the technicalities of the CDM international registration process. Undertaking a CDM project in-house carries with it a wide range of specific risks that are unfamiliar to municipalities. The following figure illustrates some of the CDM project risks.

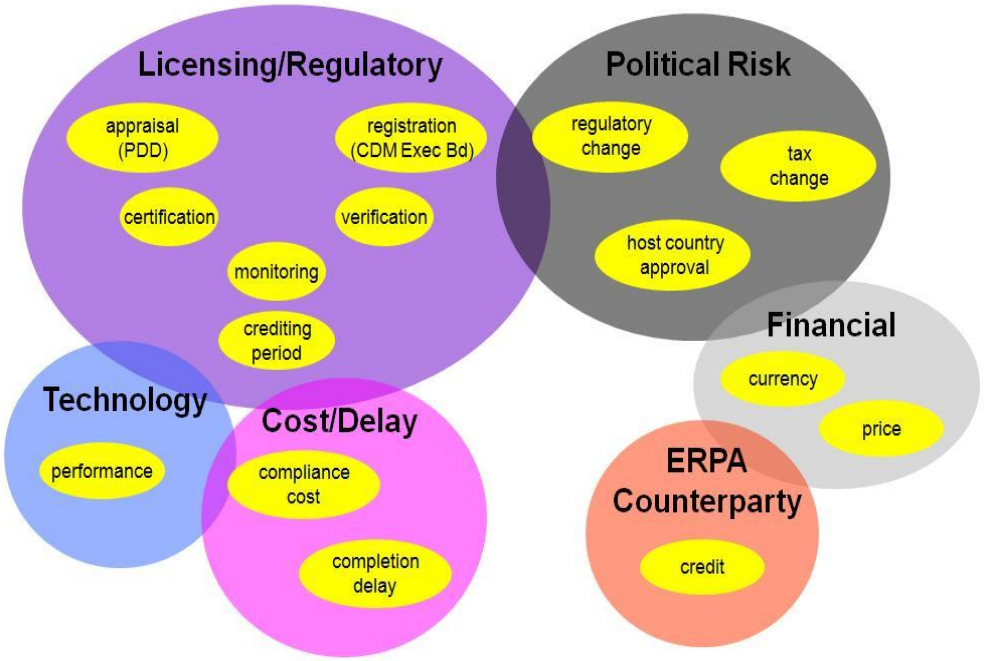

Figure 41 : CDM project Risks (Some..) (ERPA: Emission Reduction Purchase Agareement)

Following the PPP route allows a municipality to get the benefit of the private partner's ability and willingness to take on risks. It is certainly prudent from a risk management perspective for a municipality to appoint a private partner to undertake the project, with appropriate transfer of risk to that partner, in return for a low-risk and predictable income stream for the municipality. A PPP CDM project will allow a municipality to rely on the experience and expertise of those who have demonstrated success with the CDM.

Most municipalities do not have practical experience in the development of CDM projects or in the selling of carbon credits. It is not realistic to expect a municipality to monitor and maintain connections to the international CDM market or to be experts in landfill gas collection and utilisation. However, these factors are keys to getting the most out of a CDM project opportunity.

Following a PPP route allows a municipality to have instant access to and the benefit of the private partner's experienced CDM team, which will have ongoing interaction with the market, an understanding of market trends and prices, and technical landfill gas expertise of the highest quality.

These are only a few of the reasons why municipalities should consider using a public-private partnership to develop a CDM landfill gas project.It is also good opportunity for a foreign company who own technology and expertise in CDM.

4.8.2 Entry Strategy Modes for Prospective Foreign Company

While attraction and absorption are necessary elements of technology transfer, they do not yet guarantee the application of the acquired technology. The application of new technologies in developing countries determines the degree to which the transfer of a particular technology is successful. Besides the internal usage of technologies, firms are required to manage the external application of technologies. Governmental organizations or consultants may assist firms in this process.

Barriers and Success Factors

Morocco presents opportunities for foreign companies with environmental protection technology and know-how, especially in the field of LFG management. Morocco is looking at developing its domestic industry and therefore prefers technology transfer to pure imports. The common barrier for foreign environmental technology in Morocco is the price. Those foreign companies that are more likely to succeed are those with a price vs. technology offering that is well matched to the state of development of the market.

A key success factor for most foreign companies is the demonstration of a long-term perspective and commitment. Furthermore, gaining access to potential customers may depend upon relationships, and these take time to develop. Working with an intermediary can often help accelerate this process. Moroccans are increasingly interested in joint venture business opportunities with foreign partners as a way to modernize Moroccan factories or license technology.

Another barrier faced by smaller foreign companies is the interest of Moroccan customers in having packages combining technology and financing, often in the

form of BOT. For the smalle or companies which don't cover the whole value chain, may consider forming supplier groups and thereby offer integrated solutions.

The following options for the external usage of absorbed technologies exist:

Licencing:

A firm may sell the absorbed technology to others, for example in the form of licenses. Licensing may occur because firms lack capital for marketing a technology, want to avoid risks, or are not in possession of a distribution network. Licensing a technology to another firm includes the commercialization of documents and know-how and can involve the training of other firm's experts. It has the disadvantage that a firm has less control over the licensee than if it had set up its own production and sales facilities. Furthermore, if the licensee is very successful, the firm has given away the profits, and when the contract ends, the company might find that it has created a competitor (Kotler 2000: 377).

Joint Venture

Another possibility for commercializing a foreign technology consists in the foundation of a joint venture with a partner firm. As mentioned in the second chapter, a joint venture is a strategic alliance between two or more parties to undertake economic activity together. A firm in a developing country may search for another party, create a new entity, contribute equity, and share revenues, expenses, and control of the enterprise. Such a venture may be suitable if the firms does not have the necessary capital, marketing experience or lacks a distribution network for the new technology. However, a joint venture bears the risk that partners might disagree over investment, marketing, and other policies (Kotler 2000: 377).

Finally, the firm may make direct investments and introduce the new technology alone in the market. This way a firm can fully exploit the rents deriving from its technology. However, firms should know their target customer, have experience in

the market and be able to find distribution channels to bring their products to their customer.Firms also need to develop an adequate market strategy and marketing-mix to be successful.

The most effective mechanism for accessing Morocco's LFGTE market is joint venture model. A Joint Venture (JV) is a business arrangement in which the Joint Venture partners create a new business entity or official contractual relationship, and share the investment and operational costs, management responsibilities, and profits & losses.

At this time, the Government used JVs as a vehicle to transfer advanced technology and management techniques from foreign companies to state owned enterprises. In return, foreign investors benefited from access to markets and suppliers, as well as lower investment and operational costs. Although liberalisation of foreign investment has led to alternative investment vehicles, such as Wholly Foreign Owned Enterprises WFOEs, this proposed project still require the involvement of Moroccan partners especially municipalitiesas the landfills owners, thus forbidding WFOEs and limiting foreign investors to establishing JVs. Furthermore, Joint Ventures are worth considering. Cooperation with a Moroccan company would open many doors to government bids and large projects.

Build-Operate-Transfer (BOT)

At present, the BOT model is the most popular investment model in the Moroccan environmental protection market. By encouraging the BOT investment mode, the Moroccan government intends to absorb foreign capital, as well as advanced technology and equipment.

In a BOT arrangement, the government awards operational authority for the project to companies or investment agencies. The authorized party is responsible for the financing, design, construction, operation, maintenance, and management of the project during the contracted period. The BOT investment must simultaneously achieve return and profit during the operation period. At the end of the con-

tracted operation period, the facility is returned in good condition and working order (as prescribed in the contract) to the government.

The most significant issue for BOT project negotiations is the investment return. Previously, the government promised a fixed and relatively high payback, which provided the foreign investor with security and stability. However, because of an increasingly mature financial market, the government can no longer agree to fixed paybacks. Experience shows that flexible negotiation strategies need to be applied to secure BOT projects.

5 CONCLUSIONS &SUGGESTIONS FOR FURTHER RESEARCH

The chapter gives a conclusion to the research questions in light of the relevant literature, empirical findings and analysis conducted in earlier sections in this study. The section briefs the important elements that the analysis has highlighted and helped in answering the research questions. At the end criticism on the thesis has been presented along with future research direction.

The aim of this study is to establish the actual and concrete business opportunity in the field of MSW management, utilizing Landfill Gas and generating green energy in Morocco, in particular in Greater Agadir City and in the context of technology transfer. The research has been also conducted as through training at National Agency for Development of Renewable Energy and Energy Efficiency (ADEREE) in the target market .All empirical studies have been made within an actual research and development project.This business idea is a result of a three month investigation, along the training, of the development of biogas energy in Morocco. Exploring business opportunities in municipal waste management and with rising concern about energy sources, landfill gas (LFG) has emerged as an easily available, economically competitive, and proven energy resource.

The study uses deductive method and qualitative design.The desk research was conducted through literature review, books, journals and internet resources. Tools utilized on the field study included: market and site visits and interviews.

There is a huge potential for new and untested LFG technology in the country. Untapped potential of biogas from waste, increasing electricity demand and energy dependency, renewable energy and CDM incentives are the main key market drivers for LFG utilization. The waste management industry in Morocco is undergoing a number of changes that place emphasis on energy recovery and recycling. Paradigms are shifting towards closed-loop systems that minimize environmental damage and extract value from landfilled municipal waste.

As the dominating source for energy in Agadir and in Morocco in general, is imported fossil fuel, an effective way to reduce the use of this non clean energy resource for electricity and thermal energy production would be to use LFG with energy recovery. Therefore, the goal with this thesis is to evaluate the possibility to establish a power plant in Agadir landfills. To reach this goal the situation in Agadir was studied on site for more than three months, waste management and energy demand, laws, incentives were investigated.

Based on the stakeholders analysis and the result of interviews with different decision makers, substantial opportunities exist across the country to harness this energy resource and turn what would otherwise be a liability into an asset .The Municipality of Greater Agadir is very interested in using gas from its landfills to fuel engines to generate electricity for its facilities. This evidence reinforces the idea that the city wants new solutions to old waste management problems. Interviews conducted with many stakeholders highlighted the necessity for a sustainability-focused project. This landfill gas-to-energy (LFGE) project will provide a valuable service to the environment and a potentially profitable business venture, while contributing a new energy resource to local and regional communities.

Taking Agadir as a case study, the research provides a useful basis for the evaluation of LFGTE market potential for other cities in Morocco with similar condi-

tions .Morocco has a dozen of cities with a population of one million or more plus numerous other larger urban areas. Therefore, there is a significant potential for similar LFG capture and electricity generation projects in Morocco, and such projects represent an important part of Morocco's efforts to reduce GHG emissions. The innovative elements of this project, particularly the carbon financing, can be readily transferred to the other Moroccan cities to scale up Morocco's efforts to reduce GHG emissions.

Moreover, the research found that the CDM project will ensure transfer of technology from a developed country to enhance the utilization of LFG for energy recovery from landfill. The government can support the renewable energy development by setting policy like having a pricing law or offering better rate to encourage potential investors to invest in CDM projects, which reduce CO2 emissions and environmental pollution due to accumulation and migration of LFG in the landfill.

The special focus is on the LFGTE technology and expertise available in Scandinavia, represented by a selected company, Biogas Systems Ab from Sweden. One part of the Author's activities is to interview the company and take into account their special needs in respect of the market in emerging markets such as Morocco. Based on the corporate strategy analysis of this company, the researcher found out the western market is saturated. The strategy for new markets in developing countries such as Morocco is vital for the growth of European companies. Such strategy fits with the firm ´s niche industry as presence in high growth areas is important to have a growing turnover.

Based on the data gathered a suitable and operational business model for the future LFGTE plant is proposed. The model should be a CDM project. The sale of carbon credits through CDM projects may help to encourage more investors to consider harvesting LFG to generate electricity. Landfill gas is a low-cost, local, renewable energy resource, thereby eliminating a potent greenhouse gas whilst providing a clean energy substitute to conventional fossil fuels and in a commercially attractive way and is considered as adding value. Two distinct activities and

related customers segments are identified. Incomes from energy sales and credit carbon revenues will be the low hanging fruit for the future business.

Based upon this analysis, the author recommends that Agadir city and municipalities in general as landfills owners, adopt a focused-PPP strategy and via CDM project model, set up a new company with a foreign partner with technical landfill gas expertise of the highest quality such as the case company with a competitive solution which covers the whole value chain.
CDM, if well structured, could be a vehicle for promoting benign technology transfers. The clean development mechanism invites Annex I Parties to work with developing countries to further sustainable development and the overall objectives of the Climate Convention and acheive their emission reduction obligations through a transfer of "credits" .Through CDM certified emission reductions can be generated through the investment in concrete projects and based on measurable, certifiable emission performance.
The private-sector pathway is one of the key channels for technology transfer. Public-private partnerships are increasingly seen as an effective way in which the public sector can achieve public policy objectives by working with the private sector. For the public sector they have the potential of harnessing the efficiency of the private sector, as well as overcoming budget restrictions and leveraging limited public funds. For the private sector, they aim to help overcome some of the internal and external barriers, which prevent appropriate technology transfer from taking place, and to create interesting business opportunities.

The researcher has also made a recommendation for a prospective foreign company intending to enter the Moroccan market to meet this emerging opportunity. Joint Venture and BOT are two effective implementation models. Moroccans are increasingly interested in joint venture business opportunities with foreign partners as a vehicle to transfer advanced technology and management techniques from foreign companies to state owned enterprises.In return, foreign investors benefit from access to markets and suppliers, as well as lower investment and operational costs. Cooperation with a Moroccan company would open many doors to government bids and large projects. There is also an interest of Moroccan custom-

ers in having packages combining technology and financing, often in the form of BOT.

Finally, the prospective LFGTE facility represents the right opportunity at the right time.The project is a long term, lucrative, sustainable win-win opportunity. The project is financially sustainable, transferrable and scalable.

Thesis Criticism & Future Research

There is a lot of scope for further research on the subject matter of this thesis. The study proposes a business model. However, the financial aspect is not discussed and would be a subject for a company intending to penetrate the market with its technology solution in reality. In order to substantiate the results; an empirical study can be conducted in a more extensive way to identify the extent of support in numeric and quantitative terms. Even if a LFGTE plant sounds like a good investment, it is a long time before a plant could be operational. Furthermore, the data regarding the quantities and further studies in affected areas are necessary before a power plant can be established. An in-depth operational model merits further investigation. There could be further dimensions added in the research such as the investment costs and an indepth corporate-level strategic analysis of case company.

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APPENDICES

Appendice 1: Carbone Finance

What are carbon markets?

Most industrialised countries have committed themselves to reduce their greenhouse gas emissions through international negotiations and treaties. Individual national targets have been set to meet this collective commitment. The European Union and other states put legally binding obligations on their biggest industries to reduce their emissions. Firms with high emissions need to pay a price for each tonne of CO2 which they are emitting – called the 'carbon price'.

Attaching a price to carbon emissions and creating markets to trade them is thought to provide financial incentives to encourage emitters to undertake emission reduction efforts. If a company wants to emit more than it is allowed to, it can buy credits from those who have reduced their emissions below the target level, or from a project in a developing country which has certified emission reduction credit to sell. This trading forms the basis of the carbon market. Emission reductions certificates or colloquially 'carbon credits' are the currency of these markets. So carbon finance is a payment to a project in order to purchase its emissions reductions – just like a commercial transaction.

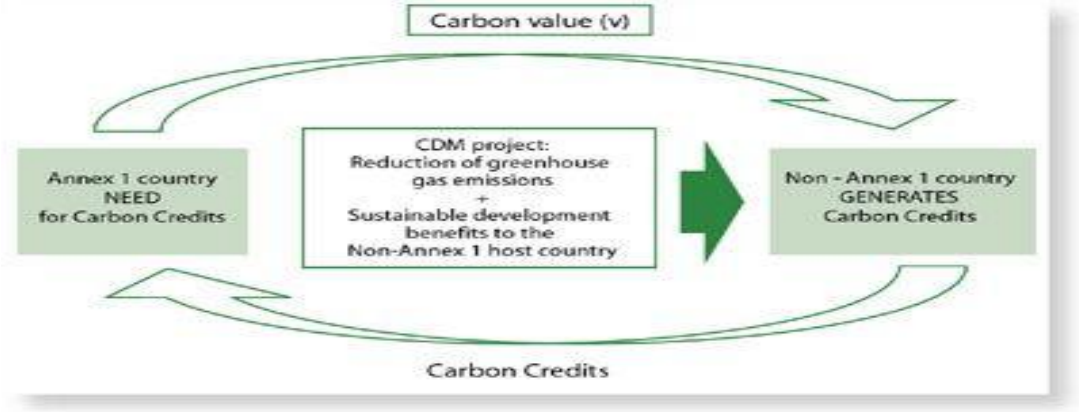


Figure: Clean Development Mechanism framework

http://www.aweimagazine.com/article.php?article_id=48

Approval and Evaluation Procedure of CDM Projects

As far as CDM approval procedures are concerned, a two-step decision-making has been adopted at national level. First, the project developers submit the Project Identification Note (PIN) with standardised contents to the SP MDP. The submitted project is assessed against national CDM requirements and decision on acceptance or rejection of the project is made within two weeks. Second, the project is checked for conformity with the Kyoto Protocol requirements. As the Moroccan national regulation requires an environmental impact assessment, this is done before a Host Country Approval (HCA) is delivered. This second assessment phase is not allowed to exceed four weeks.

National Sustainable Development Criteria in Morocco

A set of sustainable development criteria exists and a sustainability assessment procedure is set up:

• The project must respond to National priorities of Sustainable Development.

• The project must comply with the current country laws and in particular those related to the environment and its preservation.

It is particularly essential that an environmental impact study be realized in conformity with the national regulations on environmental impact studies.

• The project must aim to enhance the national potential of energy and/or its diversification, and to optimize its different usages. The project must use clean and confirmed technologies and avoid any importation of out-dated technologies.

• The project must have a tangible positive impact on local populations: creating jobs; creatingwealth; increasingquality of life, and building capacity on clean development and environment.

• The project must enhance the competitiveness of the enterprises.

•The project would also be able to develop the country's capacity to combat the adverse effect of Climate Change and adaptation to Climate Change

http://www.econstor.eu/bitstream/10419/19383/1/354.pdf

CDM Designated National Authority

Morocco has established its CDM DNA in 2002. It consists of a CDM National Council and a Permanent Secretariat which is ensured by the direction of Partnership, Communication and Cooperation.

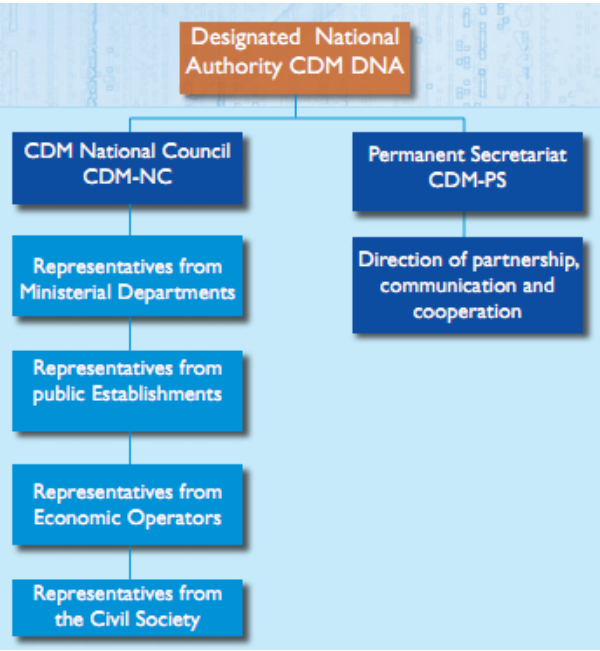


Figure: CDM DNA composition

CDM DNA missions

• To deliver the letter of approval to the promoters of projects according to National Sustainable Development Criteria;

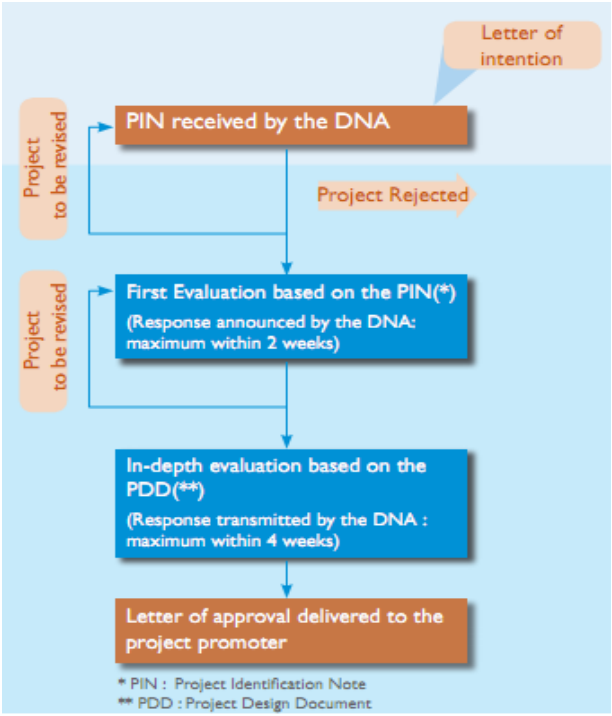
• To promote the MDP among policy makers, economic operators, financial operators, consultants and NGOs;

• To promote CDM national potential by acting at the international level throughthe signatureof memorandum of understanding, and participation in international fora etc;

• To establishNational Sustainable Development Criteria;

• To build the capacities ofthe national actors.

Approval and Evaluation Procedure of CDM Projects



(Source: CDM DNA Morocco)

http://www.cdmmorocco.ma/download/pub/Depliant-AND-ang-1-.pdf

Appendice 2: The project boundary and the monitoring plan

The project boundary

A full flow diagram of the proposed project and system boundaries is presented in the following figure. The flow diagram comprises all possible elements of the LFG collection system and the equipment for electricity generation.

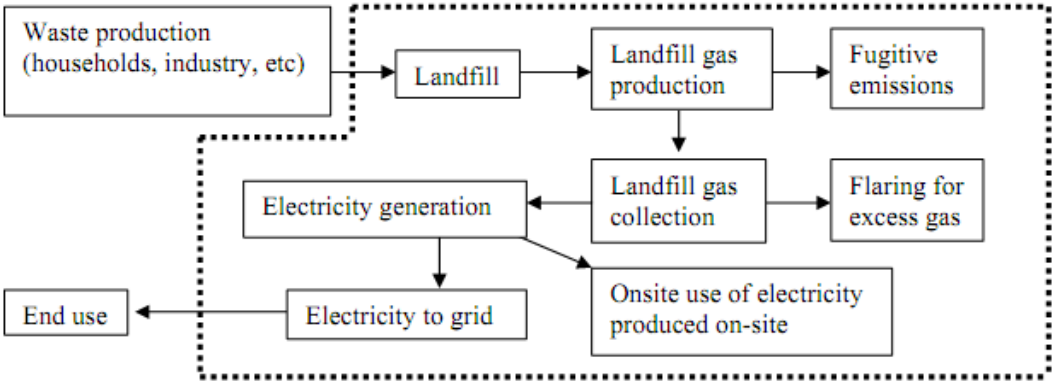


Figure: Flow chart of system boundaries

The monitoring plan

The following figure shows the main components, measuring points and measuring parameters included in the monitoring plan of the present project activity.

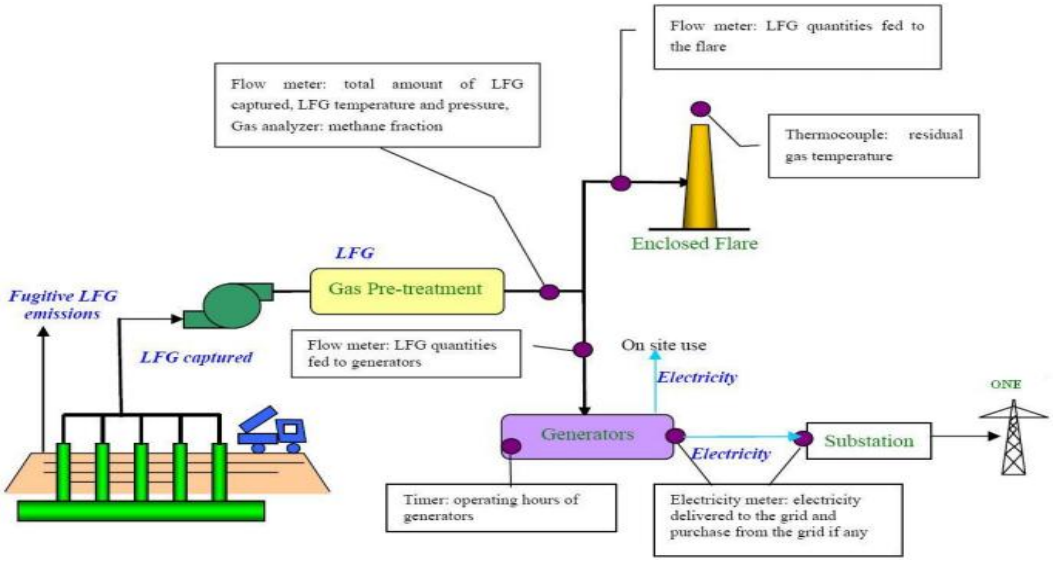


Figure: Monitoring data and instruments installation location

APPENDICE 3: Landfill Gaz Utilization Options

A landfill gas plant consists of an extraction system and a utilization system. The whole recovery system can be made for different types of extraction and utilization systems. In figure 1 a wide range of different applications is shown.
The extraction system can for example consist of vertical perforated pipes, horizontal perforated pipes or ditches, and in some cases a membrane covering, under which the produced gas is collected.The gas is sucked out of the landfill by means of a pump or a compressor leading the gas into the production system. The most common use of gas is as fuel in a gas engine running an electric generator. The gas can also be used in a gas boiler for production of hot water for heating or process heating. Under normal circumstances it will not be necessary to purify the gas, except from removal of impurities (particles), if the gas is to be used in a gas boiler or gas engine. In some cases the gas is upgraded to almost pure methane, after which it can be used in the natural gas network. In figure below the principle of a typical landfill gas plant is shown.

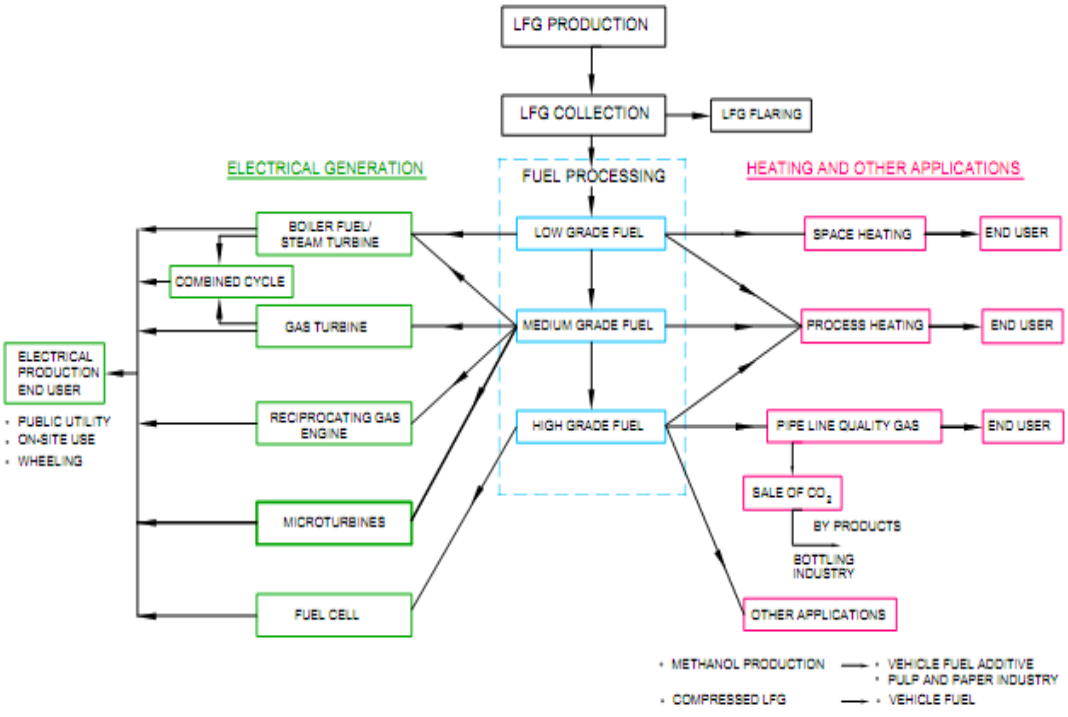


Figure: Landfill Gaz Utilization Options (Source: Conestoga-Rovers & Associate)

Appendice 4: ADEREE Training Certificate

ADEREE

Réf. N° 00763 SG/DCM

Marrakech, le 16 JUIN 2011

ATTESTATION

Monsieur **Ahmed SABRI**, étudiant en Master à l'Université Lahti des Sciences Appliquées en Finlande, poursuit son stage de trois mois (juin - août 2011) au sein de l'Agence Nationale pour le Développement des Energies Renouvelables et de l'Efficacité Energétique sur le thème « Opportunités d'Affaires du Biogaz -Valorisation des Déchets Solides dans la Région d'Agadir ».

Cette attestation est délivrée à l'intéressé suite à sa demande pour servir et valoir ce que de droit.

Le Directeur Général
Said MOULINE

مراكش : زنقة المشعر الحرام، إسيل، ص.ب : 509 ، الهاتف: 0524.30.98.14 /22 - فاكس: 0524.30.97.95
Marrakech : Rue El Machaar El haram, issil, BP: 509- Tél : 0524.30.98.14/22- Fax : 0524.30.97.95

Appendice 5: Renewable Energy Law *(source Ministry of Energy, Mines, Water and Environment)*

I-Introduction

Law No. 13-091 on Renewable Energy sets the regulatory framework for the production of electricity from a renewable source.

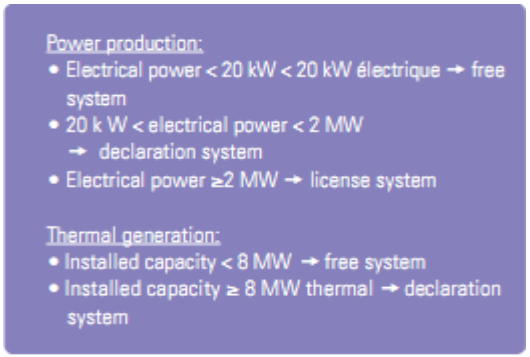
This law allows 4 major advances:

1. The opening to competition of the production of electricity from renewable sources.
2. The access to the medium voltage, high voltage and very high voltage national electricity grid to any power producer from renewable sources.
3. The possibility to export electricity produced from a renewable source by using the national electricity grid and the interconnections.
4. The possibility given to any developer to build a direct transport line if the national electricity grid or of the transport interconnections is not enough.

II-Generals

Rules about declarations and licenses:

• For any installation, modification or operation of a power plant from renewable energy, the following rules will be applied:

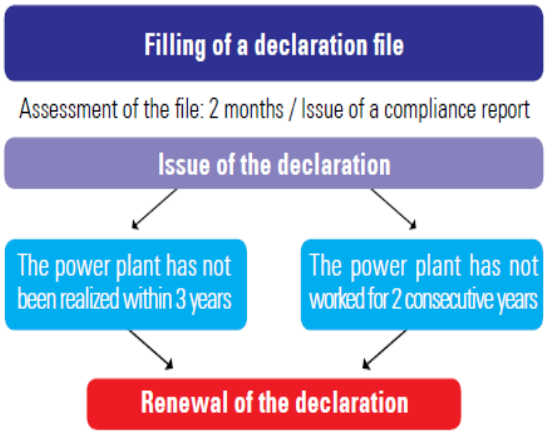


• Power plants from renewable sources can be connected only to the medium voltage, high voltage or very high voltage national electricity grid.

• Power plants of 2 Megawatts or more from solar or wind energy should be realized in dedicated areas defined by the administration.

III-Declaration

Process:

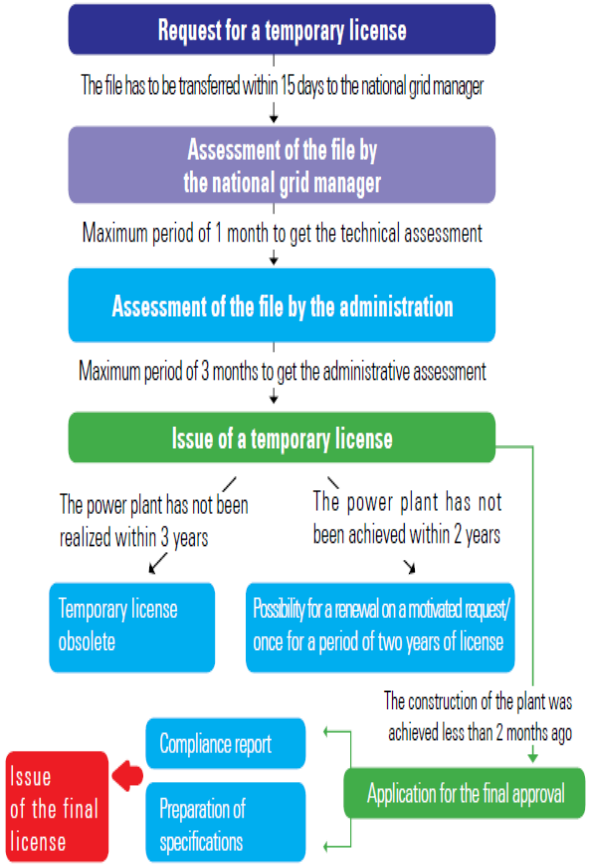


• The declaration is delivered after the assessment of both the administrative and the technical files; specifications about these files will be detailed in an application decree.

• Every modification concerning the plant should be first notified to the administration.

IV-License

Process:



Final approval:

• The license is delivered following the rules defined in the articles 8 to 12 of the law 13-09 and in its application decree.

• The final approval is given for a duration of 25 years, renewable once for the same duration.

• Details for filling the application for the building of a power plant will be specified in an application decree.

V- Connection to the national electricity grid and to the interconnections

Request for the connection to the national grid:

• The request for the connection to the national high voltage, very high voltage and medium voltage is mandatory for any installation or modification.

• This request must be done to the manager of the national grid.

Access agreement to the electricity national grid:

• Technical and commercial specifications for the access to the high voltage, very high voltage and medium voltage electricity grid will be detailed in an agreement between the operator and the grid manager.

Building of a new transport line:

• If the electric capacity of the grid is not enough, the operator can be allowed, through an agreement between the operator and the national grid manager, to build and to use for its own needs a direct transport line.

VI-Marketing

The developers who get a license can sell electricity to:

• To the State or to the agency delegated by it through an agreement,

• to a consumer or a group of consumers connected to the national electricity grid,

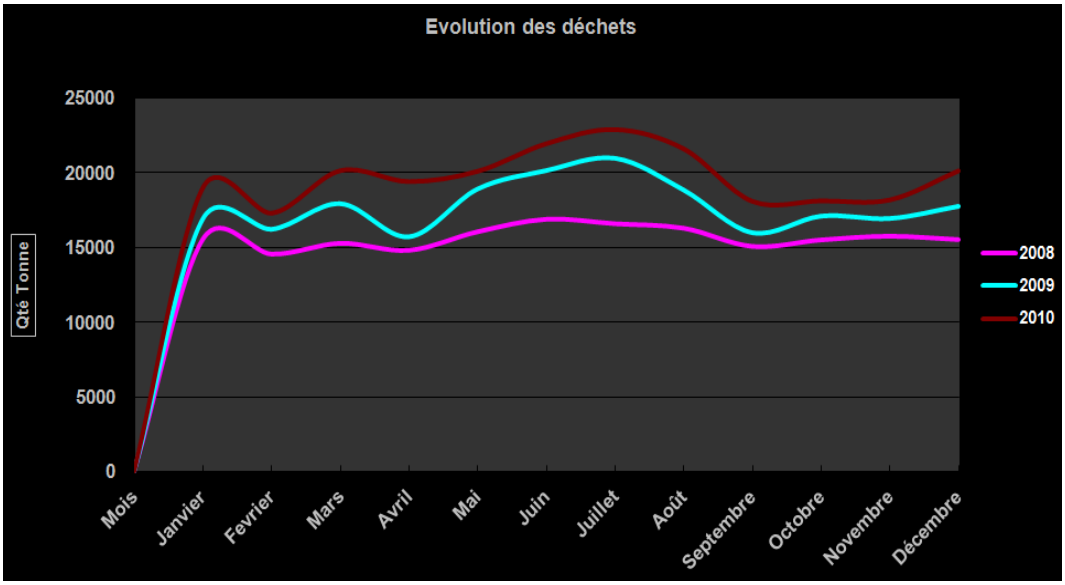
• To a consumer located abroad.

The export of electricity from a renewable source generates an annual fee on the operation of the plant; this fee is calculated on the basis of the part of the electricity from a renewable source exported.

Appendice 6: **Evolution of monthly waste production during years 2008, 2009 & 2010**

Tecmed Maroc

Month	Tonnage 2008 (tonne)	Tonnage 2009 (tonne)	Tonnage 2010 (tonne)
January	15,545.467	16,911.390	18,987.290
Febrary	14,536.580	16,198.390	17,274.060
March	15,260.510	17,917.200	20,119.390
April	14,790.330	15,698.950	19,387.090
May	16,034.710	18,904.910	20,080.530
June	16,872.160	20,134.040	21,930.435
July	16,571.760	20,958.390	22,876.780
August	16,271.280	18,827.540	21,578.750
September	15,052.990	15,967.450	18,066.760
October	15,487.160	17,081.990	18,102.660
November	15,735.160	16,923.230	18,162.570
December	15,506.131	17,738.760	20,108.440
Yearly Total	187,664.238	213,262.240	236,674.757

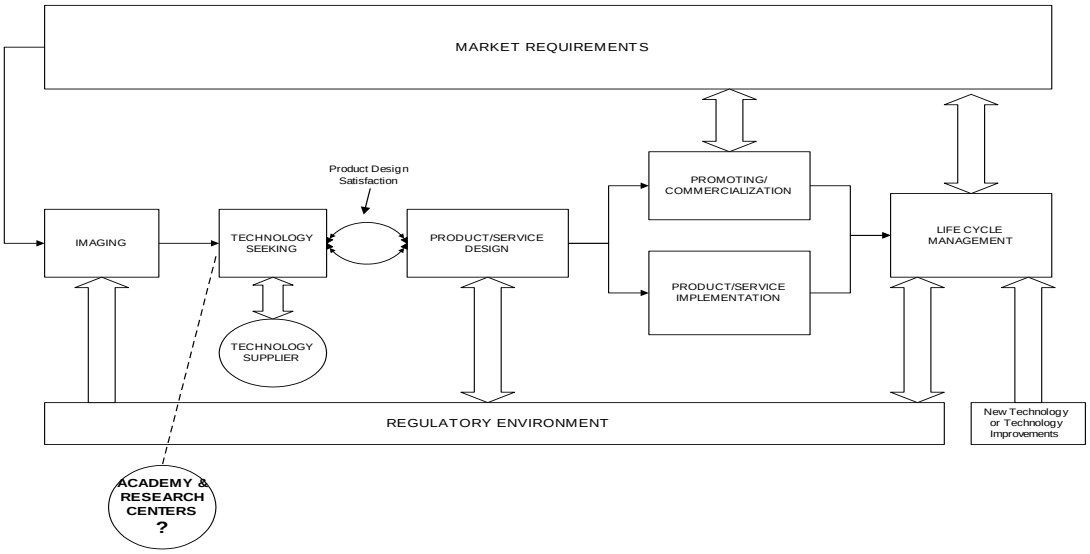


Source: TECMED (Agadir Landfill managing company)

Appendice 7: Technology Transfer Model

As seen from the point of view of a technology importer, Morocco.

This appendice presents a technology transfer model seen from the point of view of most technology receivers in Morocco.The model represents the author´s interpretation of LFG industry ´s reality. At the same time, the model pretends to show opportunities to create a proper technology transfer environment for innovation. The typical technology transfer model which we think applies for the proposed propject in Agadir (and probably for many Moroccan cities) is graphically shown in the next figure:



1) Market: As in many TT models (Transfer Technology), the point of entrance is lead and defined by the Market. The unsatisfied needs represent a lot of opportunities for entrepreneurs and innovators. In some cases, those needs could be very basic (e.g. there may be a need for modern and efficient public services like landfill management), but also, in high technology markets, the needs might be so complex and sophisticated as those the industry has in any developed country.

A good understanding of the Moroccan market is necessary when a foreign company is trying to introduce new products or technologies. It is frequent to find business cases which are not based on the Mexican reality but they are based on figures and facts in developed countries.

2) The next step of the model is the “Imaging phase”. Here is when a solution and process is developed. In this phase, not only market needs should be considered but also it is important to look at the political and economical environment in order to foresee the actual viability of the product introduction.

3) Once a solution has been created and documented, starts the seeking of available technologies. A common practice in Morocco is the creation of joint ventures between Morocco and foreign companies. A Moroccan compan, having the idea and a business case, typically starts to look to developed countries trying to find available technologies that may satisfy the needs. The other way around starts to grow as well, i.e. foreign companies looking for Moroccan partners.In those ventures, the foreign partner typically provides the technology and “know-how” of the core business while the Moroccan partner provides the know how on administrative tasks (accounting, human resources, taxes, etc.). We see the Moroccan need as input for those TT models where the market is the input.

4) One important point to consider is that, a “tropicalization” of the technology is frequently needed. Here we see a very important loop going back and forth until the technology is ready for the Morrocan conditions. The chosen technology must be adapted to fulfill not only market needs, but also regulatory aspects such as technical specifications and security norms.

5) When the technology is ready, starts the implementations phase.If the technology is a final product, i.e. it goes to a consumer, the implementation phase may be the commercialization and consequently the logistics period for importation, delivery and so on.

If the technology has to be deployed is part of a manufacturing process or infrastructure of a venture, the implementation phase exactly that, deploying the technology up to the point it is ready to produce the final products.

Since this technology is either a final product or part of the production chain of a

final product, the feedback from the market is very important. It is necessary to evaluate if the needs are being satisfied or a modification is needed. When needs are not being satisfied, a loop back to step 4 should be considered.

6) The final step in our model is the "life cycle management". Here, we mean that the product, the market, the process should be constantly evaluated. If needed, a loop back to the adaptation step may be considered, but if needs are dramatically changed or if new opportunities are detected, a loop back to start the cycle should be considered. A good opportunity to adapt existing technologies to new processes or products is there available for the implementation step.

As it can be observed in the model, the academy, i.e. Universities, research centers, etc. are normally not involved in this process. Industry is not accustomed to looking to neither the universities nor the research centers to develop "in-country" technology. Although institutions, like ADEREE, are implementing collaboration programs with the industry, it is not enough. There is a large walk between the industry and investigation centers. This line needs to be shortened.

However it is not only the education and research centers that need to accelerate their activities. The government has a key role to promote LFG utilization technology and the creation of innovation centers where industry and researchers can work in pro of developing "in-country" technology and knowledge.

Appendice 8: Interview Questionnaire for City Personnel

City Name: CU d´Agadir Interviewee: Dr El Baz Fatima

Title: Consielliere du Mr le Maire Chargee de l ´Environnement et les Risques Urbains

Questionnaire relatif au projet de recherche sur la valorisation du biogaz dans le cadre de la gestion des déchets menagers

1. Quelle est la situation actuelle du secteur des déchets ménagers dans la ville d´Agadir ?
2. Quelles sont les activités économiques principales et autres génératrices des déchets?

3. Discuter les aspects de la gestion des déchets et des décharges au niveau de la ville d´Agadir. (gestion déléguée ou non et pourquoi?)
4. Le cadre légal, réglementaire et institutionnel de la gestion des déchets et des décharges.
5. Quel est le volume (capacité) des déchets générés au niveau du Grand Agadir? Evolution et prévisions pour les années à venir?
6. Quelles sont les caractéristiques et la composition des déchets de la ville/région?
7. Quels genres de dispositions prises par la commune en vue d´éliminer toutes les nuisances dont souffre la population et tous les risques écologiques liés à la gestion des déchets et qui menace la ville?
8. Quelle solution environnementale? Si elle est intégrée pour l´eau, l´air, les déchets et l´énergie renouvelable ou non?
9. Y a-t- il identification d´une technologie spécifique et appropriée au contexte local? Types et dimensions des moteurs adoptés ou à installer?
10. Quel sont les avantages d´un tel choix de technologie en terme du niveau des émissions traitées et en terme de de besoin de maintenance.(haut/bas)?
11. Faisabilite en function des systeme de dégazage déjà inslalles? ou conception d´autres systems dans le future? l´étude sur quantification du methane?
12. Potentiel technique de valorization energetique du biogas: energie thermique/électricité (Estimations).
13. Accesibilite au reseau ONE? Quelle est sa reaction:s´ interesse et suit?
14. Y´a il des contraintes, obstacles d´ordre technique, juridique et operationnel?
15. Quels genre d´encouragements reservé a ce genre d´investissement?
16. Quel sera l´impact de ce projet de valorisation sur l ´environnement?
17. Qu ´il est l´état d´avancement du dossier MDP lie au projet?
18. Quel genre de model d´affaire adopté par la commune pour l ´exploitation du biogas(production et commercialisation)
19. Sur quelle base le conseil communal a adopté ce model d´investissement? les avantages et partenariat ?
20. Quelle sont les formalités et le cadre du montage d´une Société de Developement Locale ou autre model prevu dans la charte communale?

Appendice 9: Investment Incentives in Morocco

	Eligibility criteria	Benefits					
		Land	Infrastructure	Training	VAT	Customs	Equipment
Investment Promotion Funds «IPF»	Investment exceeds Dh 200 Million • Creation of at least 250 jobs • Project in the "priority" provinces or prefectures • Technology transfer • Protection of the environment	Contribution of the state in the cost of land acquisition (up to 20% of the cost of the land)	State contribution to the infrastructure expenses within the limit of 5% of the investment, 10% spinning industry, the weaving or the textiles	Contribution of the state in the cost of vocational training (up to 20% of the cost of the vocational training)			
Hassan II Fund	• Sectors : - Equipment manufacturing for the automotive industry - Manufacture of electronic components- Equipment manufacturing for aerospace industry - Manufacturing related to nanotechnology, microtechnology And biotechnology • Investment exceeds Dh 5 Millions (without import duties and taxes) • Equipment investment exceeds Dh 2,5 Millions (without import duties and taxes). • Setting in one of five free-trade Zones	Contribution of the state in the cost of land acquisition (up to 30% of the cost of the land) + buildings based on a unit cost of 2000Dh /m² HT					Contribution of the state in 10% of the cost of acquisition of new capital goods (without import duties and taxes)
Tax incentives in the Tax Code	Investment exceeds Dh 200 Million • Signing of an investment agreement with the State that is approved by the Investment Commission				VAT exemption for imports of capital goods, materials and tools for 36 months at the Beginning activity of the company	Exemption from the duty on imports of capital goods, materials and tools for 36 months at the beginning activity of the company	

	Eligibility criteria	Benefits		
		Customs	Taxation	Exchange
Free-trade Zones	Setting in one of five free-trade Zones	• Unlimited exemption from duties • Simplified customs Procedures	• Exemption from license and business tax for 15 years • Unlimited exemption from VAT • **Corporate Tax:** 0% for 5 years, and 8.75% for 20 years • **Income Tax:** 0% for 5 years, and 80 % allowance for 20 years.	No restrictions on capital repatriation and convertibility • Free foreign currency transactions

PHOTOGRAPHS

Appendice 10: Photographs of Sites and markets visited by the researcher

Biogas Systems HQ- Sunne, Sweden

Meeting with the company CEO

Construction and assembling Facility

Inside biogas plant

Ammässuo Landfill Power plant

Power plant at Ammässuo, Espoo

Sarlin Headquarter in Vanta

MWM Engin in Ammässuo LFGTE

Power plant and biogas station in Kujala Landfill Lahti equiped by Sarlin

Oujda Landfill, Morocco equiped by Biogas Systems´unique collection systems

New landfill at Tamlast in Agadir

Full Leachate basins need treatment and to be powered by future energy & Biogas detection tests at the old site at Bikarane in Agadir