Factors contributing to the proliferation of a native technology of a developing nation contributing towards the sustainable development :A Case study

Master Thesis

Priyanka Pasupuleti

Supervisor: Prof. Soren Lokke

Aalborg Universitet

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Abstract

Developing Nations like India have huge technical background and have the potential to develop newer technologies for sustainable development. Since they come under the category of developing nations, it is common that the infrastructure that contributes to the successful deployment of a technology will have many obstacles to overcome. However mechanisms like CDM can prove to an added advantage for a technology like this to flourish.

The thesis therefore focuses on studying different factors that affect technology developed for sustainable development in a country like India. Thus the case study Fal-G bricks and blocks project has been identified which is a native technology developed in India that contributes to the sustainable development.

The research questions are framed to identify the various actors that are involved in the project and also to identify the various factors that affect the project. Once the research questions are framed, the data is collected by various means and conducting interviews with major contributors of the project. Various theories are applied to perform the analysis on the collected empirical data to identify various actors and their roles, also the various factors that affect the project are identified, which in turn contribute to answer the sub research questions.

The results of the analysis showed that some of the identified actors play a positive role in the project while some play a negative role. However Few of the actors role remains to be analysed further as their role is ambiguous. The overall picture shows that the actors with ambiguous role have a major part to play in the project, and they need further analysis to conclude their final impact on the project which can be either positive or negative. Also the CDM has contributed in promotion of technology by providing the economic support.

Acknowledgement

It's never over till it's over; finally putting an end to the great journey of my Master's program by handing in the thesis. This is the time for me to say few but nice words to all the wonderful people in my life. To begin with, thank you Prof. Soren for being very patient and guiding me with your constructive comments throughout my thesis period. It was a very good experience to learn from you and I hope to be a master some day in social science's way of thinking! Secondly to Mr.N.Kalidas, Founder, Eco Carbon Private Limited and Mr.Brice Quesnel, Program Manager CDCF for sparing their precious time in sharing the smallest of details about the Fal-G Bricks and Blocks project which helped me a lot in completing my thesis.

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Abbreviations

C

CASH	Calcium Alumino-sulphate Hydrates
CDM	Clean Development Mechanism
CER	Certified Emission Reduction
CLC	Cellular Light Weight Concrete
COP	Conference Of Parties
CPWD	Central Public Works Department
CSH	Calcium Silicate Hydrates

E

ECPL	Eco Carbon Private Limited
ERU	Emission Reduction Units
EST	Environmentally Sound Technologies

G

GHG	Green House Gases

H

HFC	HydroFluorocarbons
HUDCO	Housing and Urban Development Corporation

I

IPCC	Intergovernmental Panel on Climate Change
INSWAREB	Institute of Solid Waste Research and Ecological Balance

J

JI	Joint Implementation

M

MoEF	Ministry of Environment and Forest
MRQ	Main Research Question

O

OPC	Ordinary Portland Cement
OECD	Organization for Economic Co-operation and Development

P

PFC	Perfluorocarbons
PDD	Project Development Designs
PIC	Product of Incomplete Combustion
PM	Particulate Matter

S

SPE	Sub-Project Entity
SRQ	Sub Research Question
SSCWG	Small Scale Working Group
SWOT	Strength Weakness Opportunities and Threats

T

TPP	Thermal Power Plants

U

UNFCC	United Nations Framework Convention on Climate change
UNEP	United Nations Environment Program

V

VAT	Value Added Tax
VSBK	Vertical Shaft Brick Kiln

1. Introduction

The inevitable change in the climate today is due to the result of emissions through one of the most prominent events that changed mankind which can be narrated as "less happened, less dramatically than was once thought", (Cannadine 1987) is the rapid industrialization from past 150 years. Global warming has gained its momentum having an undesirable effect on the "earth's natural systems", and in near future regardless of continuous efforts in reducing the Green House Gas (GHG) emissions, the earth will continue to have an adverse impact (UNFCCC, Essential Background 2010)

Current impact on the levels of climate change is due to the uncontrollable emissions by the industrialized nations and blame is put on the lifestyles of these developed nations that comprise minor part of the population around the world. However most of the damage is faced by poor nations, and is seen through their quest on enthusiastic rapid economic improvisation. With the limited availability of the resources and frequent encounters with natural calamities, developing nations are finding it difficult to cope up with the already damaged climate with developed nations as one of the root cause (UNFCCC 2010).

1.1. Call for Action

Climate change is a universal problem binding the world together. From the evidences of increase in the CO_2 levels in atmosphere in 1960s and 70s, as observed by the climatologists, necessity aroused in taking action to curb this problem and hence, establishment of an international panel named, Intergovernmental Panel on Climate Change (IPCC) was launched in the year 1988 by World Meteorological Organization and the United Nations Environment Program (UNEP) where board of 400 scientists "reflected their views" stating that global warming is the major problem to be solved immediately in the final assessment report in the year 1990 (UNFCCC 2010).

IPCC, states that global warming is "unequivocal" and this resulted in the increase of global temperature. These facts about the atmosphere, thus led to the establishment of United Nations Framework Convention on Climate Change (UNFCCC) in the year 1992 at Rio de Janeiro, at the "Earth's Summit" and entered into force on March 21, 1994 with signatories from 166 nations. UNFCCC was

established with the aim to alleviate GHG concentrations in the atmosphere at safe levels. Under UNFCCC, Annex I Nations[1] has agreed to reduce their emission levels to the year, 1990 levels by the year 2000 and monitoring of reduced emissions are observed by Conference Of Parties (COPs).

The Non Annex I[2] nations, on the other hand do not oblige with emission reduction rules unless Annex I nations supply enough funding and technology (UNEP Riso Centre on Energy, Climate and Sustainable Development 2004).

During COP 3 meeting, held in Kyoto on 11th December, 1997, a protocol was signed by the parties in the UNFCCC where 37 industrialized countries and the European community committed to reduce their GHG emissions to an average of 5% against the year 1990 levels within a period of 2008-2012. This protocol came into force on 16th February,2005 and detailed rules for implementing this protocol were established and adopted in COP 7 at Marrakesh in 2001((UNFCCC, Kyoto Protocol 2010).

1.2. Sustainable development

World Commission on Environment and Development (Brundtland Commission) in the year 1987 came up with a new concept known as "sustainable development", which gave world an outline towards economic, social and environmental progress. *Sustainable development* is defined as "development which meets the needs of current generations without compromising the ability of future generations to meet their own needs". This is one such concept that shore up strong economic and social development of people especially with low standards of living with an aim of protecting the natural resources as well as the environment (United Nations Economic Commission for Europe 2010). Figure 1 depicts various factors which contribute to the sustainable development.

[1] Industrialized Countries and the countries undergoing progression of transition to market economy committed to reduce their GHG emissions to year 1990 levels by the year 2000 according Article 4.2(a) and (b) (UNEP Riso Centre on Energy, Climate and Sustainable Development 2004)

[2] Countries which are developing or least developed (UNEP Riso Centre on Energy, Climate and Sustainable Development 2004)

Figure 1: Sustainable development

1.3. Measures Taken

In response to climate change measures with aim of the Kyoto Protocol as mentioned above is the reduction of the GHGs by the Annex I nations, the measures taken are either adaptation techniques, reducing the vulnerabilities to the climate change or developing mitigation techniques, which not only reduce GHGs but also give way towards sustainable development of the nations as such. With global response in resolving climate change problems, necessity to opt for the mitigation measures have been considered a better option due its long term benefits, and hence the establishment of "international carbon market" and "new institutional mechanisms" all over the world has initiated in laying the foundation stone for the future mitigation measures (Intergovernmental Panel on Climate Change 2007). The market based mechanisms established are Emission trading, Joint implementation (JI) and Clean Development Mechanism (CDM). Figure 1Figure 2 explains how the market based mechanisms contribute for the sustainable development.

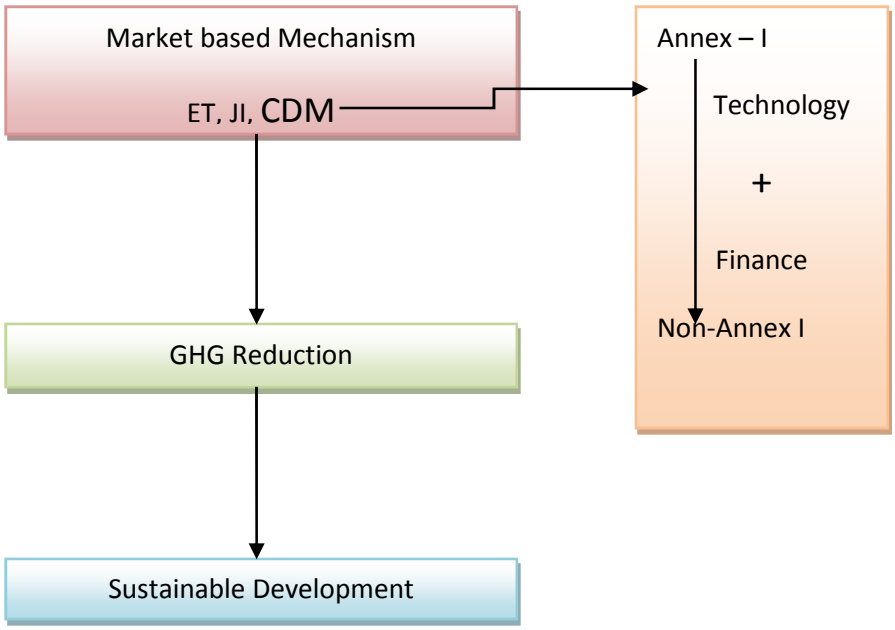

Figure 2: Market based mechanisms for sustainable development

Emission trading under the Article 17 of Kyoto Protocol is established with a view of controlling pollution by endowing financial incentives, for attaining emission reductions in the of the pollutants while CDM and JI are the "project based mechanisms". (UNFCCC, The Mechanisms under the Kyoto Protocol: Emission trading, the Clean Development Mechanism and Joint Implementation 2010).

Joint Implementation, JI is the mechanism under Article 6 of Kyoto Protocol allowing the project between Annex B [3]countries with emission reduction commitment to earn Emission Reduction Units[4] (ERUs) from a country with emission reduction project, i.e. the Non Annex I nations as such (UNFCCC 2010).

1.4. Introduction to CDM

CDM, a market based mechanism, under Article 12 of the Kyoto Protocol allows for the "carbon offset" projects in the Non Annex I or developing nations, hence useful for the emission reduction by the Annex I nations thereby enabling them in earning Certified Emission Reduction (CER)credits. Each credit is in turn equivalent to one tone of CO_2 (UNEP Riso Centre on Energy, Climate and

[3] Annex B Parties: countries that have committed for emission reduction quantitatively under Article 3.1 of Kyoto Protocol

[4] ERUs: Unit of JI mechanism under the Article 6 of Kyoto Protocol equal to one metric ton of CO_2 equivalent

Sustainable Development 2004). CDM is the only market based mechanism developed in the Kyoto Protocol, with the joint collaboration between the developed as well as the developing nations existing (Japan International Corporation Agency 2006).

1.4.1. Aim of CDM

1. Help in mitigating the change in the climate
2. Assisting developing nations to achieve sustainable development
3. To assist Annex I nations to reach target in the cost effective manner

CDM projects are done on the voluntary basis with aim to show long term benefits via climate change mitigation measures. The projects under CDM should be attaining the emission reductions even after the completion of the project.

1.4.2. Importance of CDM:

The reason why the CDM is in game is due to the fact that the projects under this market based mechanisms aims for the emission reduction and in a "carbon constrained scenario", authorization for emitting carbon is considered as an important product which can be traded. Figure 3: Actors in CDM shows the list of actors participating in the CDM and their role in bringing this project to success.

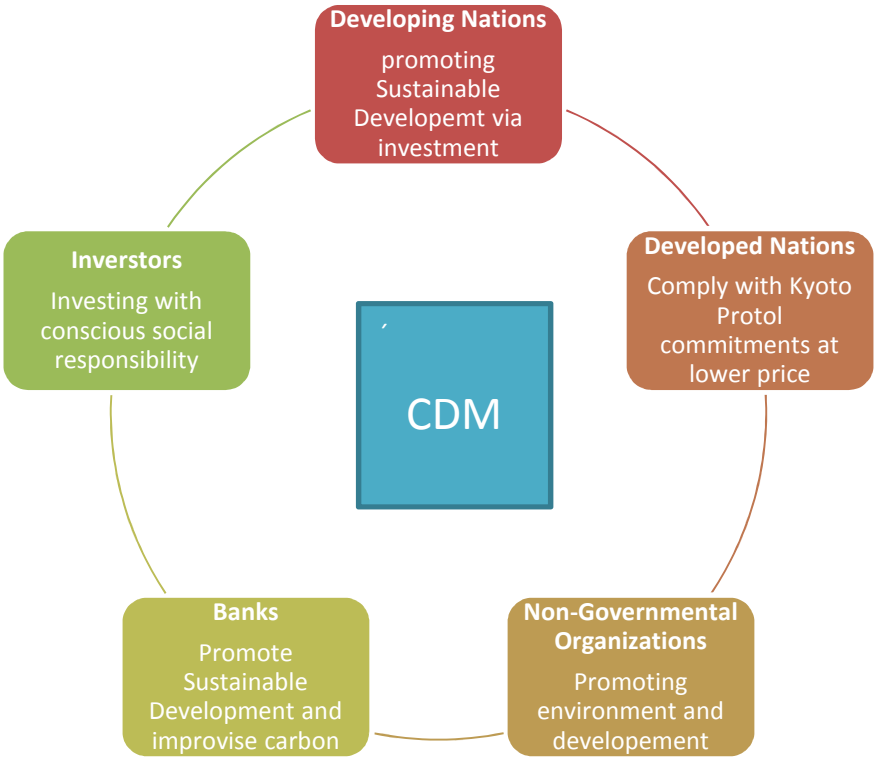

Figure 3: Actors in CDM

1.4.3. Benefits of participating in CDM:

CDM was 1st proposed by Brazil and as mentioned above, it's a market based mechanism for the Non Annex I nations to promote environmentally friendly investments of Annex I nations, in turn promoting sustainable development while contributing to the reduction of GHG emissions globally. For a nation that hosts CDM projects, it's a means for gaining foreign investments. Apart from this, it also benefits the host country to get cleaner air and water and environmental friendly foreign technologies, which sums up in contributing towards sustainable development which is the aim at the end of these projects (United Nations Conference on Trade and Development 2002).

For the nation which is on the investor's side, the benefits of being under CDM project is that these nations comply with the emission reduction objective that are attained from the emission reduction credits generated as a result of the CDM projects. The Annex I nations can invest in the CDM projects when their quota of commitment period is calculated and that they have a system of accounting of GHGs in the national level. The Annex I nations should also submit the appropriate GHG inventory prepared at the national level and that they are complying with Kyoto protocol. The developing as well the developed nations via these CDM projects contribute in the reduction of the GHGs and for this reason, the CDM is regarded as one of the better mechanisms striving to save the planet (United Nations Conference on Trade and Development 2002).

1.4.4. Eligibility as CDM participants:

CDM project involves participants from all the sectors of the society, which includes government, NGOs, business as well as the citizens in cooperation with both developing and the developed nations. It is seen that the private sector plays an important role as the CDM project participant since the emission reductions are contributed by this sector and also the private sector receives the investment flows that are associated with CDM projects. Thus, CDM projects are the combination of both public and private sectors with additional participation from the local communities where the project is taking place (United Nations Conference on Trade and Development 2002).

1.4.5. Criteria for choosing the host nation for the CDM project

The CDM projects takes place in the developing nations. The reason for choosing a particular host country depends on the following criteria's:

a. Cost associated with technological upgrading
b. Potential return on investment
c. Tax scenario
d. Openness towards foreign investment
e. Availability of finance and labor
f. Cooperation by the government

A CDM project can commence any a time in the year after the investor country ratifies the Kyoto Protocol (United Nations Conference on Trade and Development 2002).

1.4.6. Steps for Implementation of CDM project:

Table 1 gives five steps, the checklist for implementing CDM projects. The project design evolves from the host nation, and might be in cooperation with other unit. The local condition of the area in which the project is undertaken has to be studied and assessed. There should be approval from the host country government for project commencement. Validation of the project by the operational unit could take place in the same area where the operational units are present. These can be located anywhere and are valid as long as they qualify. The next step is to pass the validation report to the Executive Board for registration of the project. The participants of the CDM projects monitor the project which is in accordance to the monitoring plan which is approved in the validation as well as the registration stages.

The operational entity in turn reviews the GHG reductions. This step is followed with issuance of report to the Executive Board that certifies the reduction of the GHGs (United Nations Conference on Trade and Development 2002).

Step	Definition	Responsible Entity
1. Project Design	A document with the information needed about the proposed CDM project.	Project participants
2. Validation and Registration (G.35-52)	Validation is the process of independent evaluation of a CDM project (Annex G35). Registration is the formal acceptance of a validated project (Annex G36).	Operational Entity Executive Board
3. Monitoring (H53-60)	The collection and archiving of all relevant data necessary for establishing GHG emissions by sources occurring within the project boundary during the crediting period.	
4. Verification and certification (I61-63)	Verification is the periodic independent review and determination of the GHG reductions that have occurred as a result of a registered CDM project activity during the verification period. Certification is the written assurance that a project activity achieved the GHG reductions during the specified time period.	Operational entity Operational entity
5. Issuance (I64-66)	Certified emission reductions (CERs) are issued to the parties account.	Executive board

Table 1: Checklist in the CDM process under Marrakech Accords (United Nations Conference on Trade and Development 2002)

Technology input plays a key role in achieving the sustainable development which is the essence of CDM. In CDM projects there is a necessity to incorporate and transfer technologies that are environmentally sound, known as Environmentally Sound Technologies (EST) to Non -Annex I nations. The role of the Annex I nations according to the Agenda 21 of UNFCCC, is to support developing nations in providing necessary "technological know-how" and guiding them with "economical, technical as well as managerial capabilities" for the competent use of the transferred technology as well as in further development of the technology that has been transferred. (UNFCCC 2010)

According to Soren E.Lutken, currently there is a non-availability of the exact statistics on the "involvement of bilateral[5] investment in CDM projects". The Project Development Designs (PDDs) of most of the CDM projects shows no technology transfer but presents the fact that the technology is developed natively. Survey done on the 628 registered CDM projects show that "projects are generally unilaterally[6] financed" (Lutken 2008). Apart from that in larger countries like India and China, keeping in view of the per capita as well as the policies of these countries, it is indicated that these nations have a "large technological base" and hence they do not have the necessity for the transfer of technology in accordance with CDM. (Haites, Duan e Seres 2006).

Promoting new low- carbon technologies and their global application is a major challenge in balancing the GHG emissions. Bali Road Map of the year 2007 indicates that technology development and diffusion are the two strategic objectives for mitigating the climate change and helping the developing nations economically as well as in providing other incentives. However the barriers faced by the developing countries in importing the technologies from the developed nations are many such as tarrifs, adaptation of the technology, protection of intellectual property rights etc (United Nations Department of Economic and Social Affair 2008).

[5] Bilateral projects: CDM projects done with investment from the Annex I nation's government or from the private companies (TFS Green 2010)

[6] Unilateral projects: CDM projects with no involvement of Annex I nations but only the host nations ((CDM Rulebook 2010)

In a country like India, there is a least scope of transfer of technology from the developed countries due to its "large technology base". It is noted that out of 329 projects in India only 5 projects are involved in the technology transfer from the developed countries. The ratio of the projects involved with technology transfer is only 7.3% of the total projects with annual emission reductions of upto 34.4%. Therefore it can be said that India has a lower rate of international technology transfer when measured in terms of "number of projects" or "annual emission reductions" (Haites, Duan e Seres 2006). (Lutken 2008).

For a CDM project to be eligible in India, the Government of India establishes that a CDM project can be approved if the project comprises of transfer of technologies which are environmentally safe and that the transfer of technologies can be within the country as well as from the other developing nations (Haites, Duan e Seres 2006). However the focus of thesis is on seeing various factors affecting the technology developed natively by Non Annex I nation like India contributing towards sustainable development and what role does CDM play in this aspect.

2. Research Framework

In this chapter aim of the project along with the justification for selection of the topic is explained in detail. In order to fulfill the objectives of the thesis, a main research question and associated sub-research questions are formulated thereby forming a base for rest of the thesis.

Aim: The Thesis focuses on studying what factors affect the new technology developed natively by the Non Annex I nations which contribute for the sustainable development. Also the role of CDM in promoting this technology is analyzed. This includes analyzing the technology as well as the conditions associated in implementing newer technology in the host nation. Also the role of foreign investments such as World Bank via CDM will be studied.

Justification: To study about the technology that has been developed by the developing nation is an interesting case to study. The main reason for this is to see how the new technology works and how well can it merges in terms of social, cultural political and economic conditions. Also to see how the new technology could prove its mettle than the technology of similar kind, already well established and simultaneously attracting the foreign investments in the project. This in turn rises to question of how does this technology opens up gate for the developing nations to develop greener technology, contributing in turn to reduce GHG emissions as well for the sustainable development of their nation on their own under CDM projects.

Direction of the thesis: Analyze the case study of the existing CDM project that involves newer technology developed by Non-Annex I country and assessing the potential of this new technology in the political, social, cultural and economic aspects with a detailed description about the existing technology so as to see the difference between the two technologies as such. This is followed by assessing the role played by the foreign investments in improvising and supporting the newly developed technology by the developing nations which in turn would lead to answering the main research question as mentioned below.

Case study: To fulfill the aim of the project a case study is chosen which is given below

India-Fal-G Brick and Blocks Project No.1

Main Research Question:

What are the various factors that affect the development of newer indigenous technologies which contributes to the sustainable development of a country like India and what role does CDM play in this aspect?

Sub Research Questions

The Main Research Question is sub divided into two Sub Research Questions answering the main research question. They are:

1. **How do different actors look upon the new technology as a breaking path for the penetration of this technology into the market**
2. **How is the new technology being looked upon from the cultural, economic as well as the institutional point of view in India in turn contributing to sustainable development via the CDM project?**

3. Case Study

The current chapter gives an overview on the background information in relation with clay bricks and bricks made up of fly ash in India with latest innovations in this field. It also gives the overview of the case study chosen for the thesis and the factors responsible for it to get registered as CDM project.

The history of Bricks in the world can be traced back to 7,500 B.C in the regions of upper Tigris, Antarctica and South East Anatolia. The most primitive bricks discovered were the mud bricks, found around the Middle East region 10,000 years ago which were hand molded and sun dried (Ireland Brick Suppliers 2010). Discoveries from the ruins of Mohenjo-daro shows that more than five thousand years ago the ancient Indus Valley civilization have used mud bricks extensively and interesting facts about these bricks reveals that they were prepared with a perfect ratio of 4:2:1, which is till date considered to be "optimal ratio of brick dimension for effective bonding" (Global Oneness 2010).

The oldest building material to be manufactured is the brick. The improvisation in the clay bricks progressed around 5000 years, with the adaption of "pottery manufacturing methods" in order to enhance its strength as well as sturdiness. Ranging from some of the ancient monuments to the latest buildings, clay bricks hold a very important role in the construction field providing protection with additionalties including comfort, durability, safety as well as beautification to the buildings (Portland Cement Association 2010). Current methods used in the brick production are much similar to what was done way back during 3000 B.C. Firing is considered to be as the widely used method for the brick production from ages with difference lying in usage of basic materials used varying from "shale, clay and water" and the efficiency and speed with which the bricks are prepared today. Figure 4 depicts the stepwise procedure of making bricks (Portland Cement Association 2010).

a. Extruding a brick column

b. Brick stacks ready for fire

c. Firing bricks in kiln

Figure 4: Brick Manufacturing Procedure

3.1. Indian Brick Scenario

Brick masonry in India holds one of the most prominent roles in the construction area from the prehistoric era (Gumaste, et al. 2004). Today India stands as the second largest brick producer in the world, with an estimated production of approximately 150 billion bricks. The production figure is confined to be just an approximation as most of the brick industry in India come under the "unorganised sector", where large number of units are managed and operated by small scale family units categorised under "cottage industry" in the rural and semi-urban areas of the country (India Bart 2008). The practice of the clay brick production is carried from generations which indicates its strength of this industry however these bricks do not qualify the required ISO standards. Despite of bricks with low standards, yet they hold a major share in the brick market due to their strong socio-political strength due to their strong roots in the villages where this industry thrives from in majority (K. N 2010). The rough figure of clay bricks available from the brick industry in India conveys that 100,000 kilns produces approximately 80 to 110 billion bricks produced per year (Maithel and R 2000).

The brick kilns are categorized into three divisions based on the production capacity, with small brick kilns producing < 1 million bricks per year, medium kilns with 1-2.5 million bricks per year while large bricks annually produces > 2.5 millions bricks per year. Small kilns are called as clamp kilns, located mostly in the rural areas, the medium and large kilns are called Bull's trench kiln (BTK) with their locations near urban and more populated rural areas. The brick making is a

process involved with high energy intensity, with energy consumption of 1.2 to 1.75 MJ/Kg by Bull trench Kilns for producing fired bricks and 1.5 to 3.0 MJ/Kg by clamp kilns (Maithel and R 2000).

The major fuel used for firing the bricks is coal, and an estimation of 15 million tons of coal annually is utilized for producing the cooked bricks. The efficiency of the brick firing usually in Indian scenario is low and the result is the high amounts of Product of Incomplete Combustion (PIC) emissions. Apart from these emissions derived due to combustion, the "life cycle of brick making" also generates "fugitive" emissions. The emissions from the brick kilns consists mostly of "coal fines, dust particles, organic matter and small amounts of gases with acid deposition such as SO_2, NO_2, H_2S and CO. Emissions from the burning of 15 million tones of coal per year is expected to emit out 6.7 million tones of CO_2. (Maithel and R 2000)

Figure 5 Explains the making of the clay bricks using the mud and how these mud bricks are dried by burning them using coal as the material for this purpose (New York Times 2007).

a. Preparing clay bricks

b. Conversion of raw bricks to dry bricks

Figure 5: Clay Bricks in making

The ever growing population and the demand for the construction material also have resulted in more production of the bricks. In a study done by the "Structural Transformation Governing Sustainability of Building Materials", there exists an increasing gap between "demand and supply" of important building materials

which are cement, steel, bricks and lime accounting for more than 80% of the emission towards the construction. The Contribution of burnt bricks to the Indian economy is very significant as it accounts 27% of the emission resulting due to the production of the materials used for construction. If the rate of production of burnt bricks is permitted to meet the demands of housing, the result would be increase in energy, twice the amount by the year 2020 and this would result in doubling of CO_2 levels from 1990-2020, due to the prolongation of the brick firing technologies existing today (VSBK India 2010). Apart from the significant air pollution, the clay bricks also cause "resurfacing" of the soil for its production which in turn affects the soil fertility (Lal 1998). There has been improvisation in the clay bricks in terms of firing of the bricks in the form of Vertical Shaft Brick Kiln (VSBK) which is useful for burning of green bricks. Despite of claiming to be advantageous due to its higher efficiency in burning of raw bricks and less usage of land and is fetching a good business in the clay brick market. However, the major flaw of VSBK is that it still uses the natural resource, the firewood for the initial burning of the kiln and in long run, materials like saw dust, rubber tyres etc are used which are rated as a heavy polluters, polluting the atmosphere. (Development Alternative 2010)

3.2. Innovation in the construction industry

Like every industry, the construction industry was also developing new technologies to meet its ever growing demands. The innovations in the construction industry have led to the development of various forms of usage of fly ash.

Fly ash is one of the waste or by products generated during the combustion of coal. Fly ash which is in general a waste product derived from the burning of the coal in thermal power plants, and is ash is very difficult to discard this bulk waste.

On the other hand fly ash can be considered as par over different construction materials since it can be molded to useful reserve with least amount of investment. Another quality associated with fly ash is that it enhances the "speed and quality" of the structures thereby contributing to the increased effectiveness in the construction of buildings and houses in general (Fly Ash Information 2010).

In India about 65% of the total electricity generated is from thermal power installations which use coal for production. Based on the ever growing energy demand of the nation, these coal based power plants are anticipated to play a vital role in the future which is supported with the fact that the coal reserves in India are expected to sustain for more than 100 years. The ash content in the Indian coals diverge between 25 to 45% but most predominant form of coal used in the generation of power in the thermal power plants in India contains around 40% ash (Bhattacharjee and Kandpal 2002). The current annual generation of fly ash is close to 45 million tons per year which is supposedly be increased to 70 million tons per year by the year 2010 (Arora 2001). India uses only about 3-4% of the total fly ash generated when compared to Europe, USA, China etc, where the utility of fly ash is about 40% (Arora 2001).

The regulation passed by the Ministry of Environment and Forests (MINISTRY OF ENVIRONMENT AND FORESTS) in the year 1999, stating the 100% utilization of the fly ash is a must by all the newly established coal plants, within the first nine years of their operation and for the existing power plants, a time period of 15 years is given from the date of issue of this Governmental Order.

The availability and the advantages in the construction industry have led to the boost in innovation in the development of various technologies for utilization of fly ash as construction material.

3.2.1. Application of fly-ash in construction

Fly ash is used in manufacturing cement and asbestos, in road construction as well in back filling and land development. However the main usage of fly ash is in the construction field i.e. making bricks and block (Bhattacharjee and Kandpal 2002) with mix of both low cost procedures as well as the processes involving large investments used for attaining superior quality "walling material". Current state of art in utilization of fly ash is summarized as follows:

a. **Stabilized Mud Fly Ash Bricks:** these are the bricks made up of compacted mud fly ash blocks that are made into firm structure with addition of lime, cement or other chemicals. However this form of bricks are not so popular in usage since availability of dry fly ash onsite is a difficult process since in India the fly ash is

available in the wet form which leads to the decrease in the pozzolanic characteristics of ash, which is a key ingredient for many ash-based materials (Fly Ash Information 2010).

b. **Cellular Light Weight Concrete (CLC):** bricks with ingredients as flyash, cement, coarse sand , fine sand. A binding agent is added so as to form a thin slurry, which is decanted into molds allowing it to set and are sprayed with water for curing. The density of these blocks differs from 400 to 1800 kg/m^3. This variety of flyash bricks are used for big buildings, i.e high rise constructions in order to reduce the "dead weight" of the buildings. Compressive strength of these blocks is based on their density. Preparation of these bricks is not a cost effective technique and the blocks produced onsite requires few lakhs of Rupees (Fly Ash Information 2010).

c. **Flyash-Limestone-Gypsum, product named Fal-G:** Combination of flyash, limestone and gypsum, is known as Fal-G. This technique uses phosphogypsum, waste material dervied from fertilizer plant, which is washed and undergoes calcination[7]. The combination of flyash lime mix,in an appropriate quantity, when mixed with gypsum that is calcined, produces Fal-G and when this is mixed with sand which can be useful to produce blocks of high strength. The combination of flyash, lime and calcined gypsum produces cement having high binding quality (Fly Ash Information 2010). Substitution of lime, a by-product can be done with Ordinary Portland Cement (OPC) without any change in the quality of bricks and blocks (Eco Carbon Private Limited 2006).

The thesis focuses on the last mentioned application of the fly ash FAL-G, with a complete analysis from social, financial, economic, and political aspects.

3.3. Overview of the case study

In India there are many techiques for producing flyash bricks however, the most widely used technique is the Fal-G technology. The development and marketing of this technology is done by Institure of Solid Waste Research and Ecological Balance

[7] Calcination is defined as continuous heating of any mineral for a long duration at high temperatures so as to remove water which in turn increases the "hardness, physical stability as well as absorbent properties of the material" undergoing calcinations (About.com 2010).

(INSWAREB). Key ingredients used in the preparation of Fal-G are shown in the Figure 6.

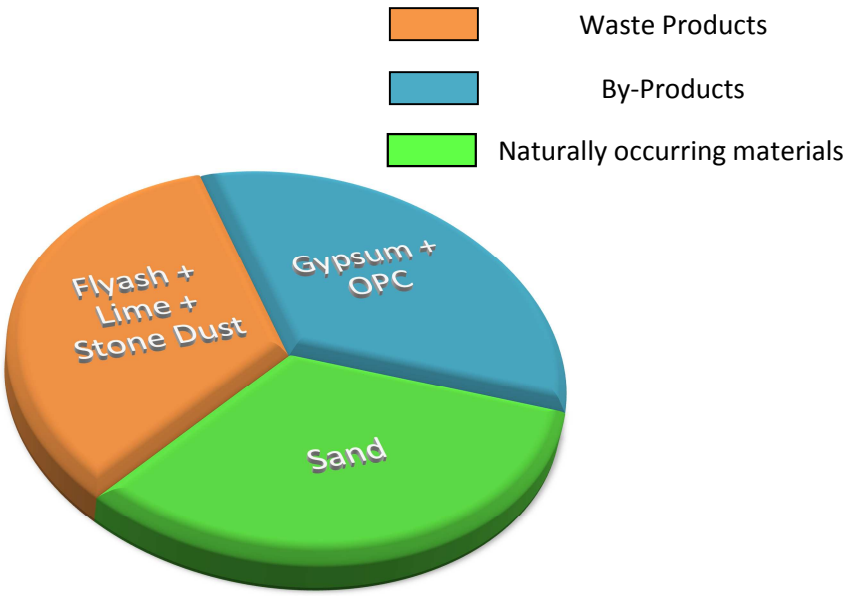

Figure 6: Key Ingredients of FAL-G technology

The raw materials used in the production of Fal-G are 85-100% either waste products or by- products except sand, thus conserving fertile soil as well as coal. Fly ash is a waste material from coal based power plant. Lime is a waste material from paper and other industries; stone dust is a waste material from stone crushers. Gypsum is a by-product from fertilizers and aluminum plants, OPC is product derived from cement plant (proxy for lime stone). Sand is derived from the river bed (Eco Carbon Private Limited 2006).

The technology is gaining popularity with establishment of more than 200 units running, utilizing this technology, with Central Public Works Department (CPWD), the nodal Government of India organization in the building industry taking interest in this technology for production. World Bank has also shown its keen interest in this innovative technology. The Kyoto Protocol with its market based mechanism, CDM provides a very good opportunity for the developing nations to improve eco-friendly technologies with the investment from OECD nations who are committed to reduce GHG emissions through these market based mechanisms (Fly Ash Information 2010).

3.3.1. Fal-G bricks into CDM project

In India, bricks produced from the Fal-G technology hold a small portion amongst the total brick production from clay. It is assumed that 4 billions of Fal-G bricks produced per year has to compete with the hundreds of billions of clay bricks every year (World Bank 2006). Inspite of the heavy competition in the market, Fal-G has established a niche for itself in attracting World Bank's Community Development Carbon Fund (CDCF) with CDM playing an intrinsic role in improvising the environmental as well as social conditions in the India with reduction of GHGs as well as by implementing various schemes on health and accident insurance, which is in compliance with terms of CDCF through this project thus giving a way for sustainable development (UNFCCC 2006).

3.3.2. Description of the project

The project is entitled as "India-Fal-G Brick and Block Project No.1". The project is set up due to the factors that the bricks produced by using Fal-G mechanism reduce GHG emissions and also in reducing air pollution since there is a very minimal usage of fossil fuel and to facilitate the usage of fly ash, as a key ingredient for building material. The Project Design Document, an important document in CDM project is applicable to 14 Fal-G plants set up and they are categorized into small scale CDM project. However these projects are grouped under "Bundled CDM Projects" in order to reduce transaction costs (UNFCCC 2006), a device as per UNFCCC facilitated to earn carbon credits in smaller amounts (N and N n.d.).

Bundling is defined as grouping of numerous small scale CDM projects of similar kind so as to form into a single CDM Project action without losing the specific characteristics of individual project activity in compliance to the CDM Executive Board (N and N n.d.)

3.3.3. Project Partners

The primary participants in this CDM project are identified to be two. They are:

a. **Eco Carbon Pvt. Ltd. (ECPL):** This is a primary company which is encouraging Fal-G technology as CDM project adding commercial elements into it. This company provides the technological as well as the operational support to the entrepreneurs who are single handedly running the Fal-G

plants. Another important role of it is organizing the entrepreneurs so as to "promote project for carbon transactions" (World Bank 2006).

b. **The Community Development Carbon Fund (CDCF):** World Bank is responsible for maintenance and operations of this trust fund on behalf of both public as well the private participants. The role of CDCF is to buy the emission reductions that derive by the project done under ECPL and administer the execution of programs developed for community development. Any official communication with regards to the CDM project is CDCF of the World Bank (World Bank 2006).

3.3.4. Environmental and Social Impacts of FaL-G bricks

The Fal-G brick project is based on the environmental friendly technique used as the alternatives for building materials. This project contributes in the conservation of fossil fuels as well as the energy by avoiding the usage of the fossil fuels in the production process. Also it contributes in the reduction of the land degradation and the air pollution since it avoids the usage of the clay as the raw material. Another added advantage of this project is that since it uses industrial waste and the by-products as the raw materials, the environmental impact associated with the inappropriate disposal of the industrial wastes are considered to be proper mitigation measures of this project. Social conditions of this project on the other front, creates business prospective to the small and micro entrepreneurs. Unlike the "seasonal production operations" as in the clay brick industry, Fal-G brick plants operate continuously, therefore providing employment opportunity for the skilled laborers year wide thereby helping to create self-livelihood facilities for the poor artisans.

Following is the list of the environmental and social impacts associated with Fal-G bricks project

Environmental impacts:

a. **Waste material/ By-Products:** main impact of the Fal-G bricks project is the usage of waste materials and the by-products obtained from the industries. Fly ash disposal, which is generally a difficult process in the thermal power plant, is utilized as a main ingredient. Same is in the case of

lime, a waste product from paper and other industry also faces the problem for disposal is utilized as the one of the ingredients for the manufacture of these bricks. Another advantage of Fal-G bricks is that waste materials from the breakage of the bricks are utilized through recycling process (Eco Carbon Private Limited 2006).

b. **Water usage:** in the Fal-G bricks, the water requirement is approximately 500- 1000m^3 per million of bricks per unit. Although the source of the water is groundwater, however the usage of water depends on the water balance of the region where the project is being undertaken (Eco Carbon Private Limited 2006).

c. **Air pollution:** the estimated main GHG, CO_2 is emitted from generators using diesel as the fuel during the non-availability of grid power. Other sources are machinery run by diesel and vehicles. Utmost precaution is taken by the units during the operation, even though precautionary measures have to be improved in the handling and storage of the materials avoiding dispersion of fine dust from the atmosphere (Eco Carbon Private Limited 2006).

d. **Noise levels:** the level of noise generated from the operational unit based on the grid power is negligible. However from the mobile sources like the generators form the diesel and engines, pumps and motors etc produce noise of around 90-100 dB which is below the ambient noise level, ranging within 200-300 m from the source (Eco Carbon Private Limited 2006).

e. **Soil:** the soil contamination from the Fal-G plants is mainly done if there is an accidental oil spill from the diesel engines during operation; however the impact is restricted to the surroundings of the unit. At present, there is no system found to avoid accidental oil spill, if any. For the storage of fly ash or lime or gypsum, empty bags are utilized or are sold in the market (Eco Carbon Private Limited 2006).

f. **Land ecology:** the terrestrial ecology might be affected due to the Fal-G plants, due to the settlement of the suspended dust particles, carried by air. They have impact on the fertility of soil as well growth of plants. However, it

is proved that the fly ash can be utilized as fertilizers to enhance crop production especially, rice, wheat and cereals (Eco Carbon Private Limited 2006).

Social impacts: It was found that following areas had to be improvised:

There have been no reports on the ill-health of the workers in the Fal-G plants over last decade, although the health of the workers is the point of concern especially during the handling of the raw materials and exposure to the dust. Other aspects on the social side are:

a. **Worker's housing:** the worker's housing in Fal-G plant are classified to three categories. They are : 1. Who come from their homes to work in the unit,2. Who come and reside in the area near to unit as bachelors, 3. Who come with their families and stay near the work place. The first category workers do not require any housing facility and the 2nd category workers are provided with dormitories at work site. However for the 3rd category workers, the employers facilitate them with the accommodation at an extent of over 8 m^2.

b. **HIV/AIDS:** most of the Fal-G brick workers are migrants and are single. The risk of getting infected with HIV/AIDS is very high among such workers and cannot be neglected. Hence, utmost attention is paid in during the project to avoid such mishaps (Eco Carbon Private Limited 2006).

c. **Child labor employment:** the employment of children in the clay brick industry is a common sight. However, this is not the same in case of Fal-G brick units, since specific provisions are followed by the entrepreneurs so that they do not employ children for work (Eco Carbon Private Limited 2006).

d. **Wage payment:** it is a very common sight in India, to find the differences of wages between male and female labors, in the informal sectors but, since the Fal-G units are associated to production, thus this issue is not a problem.

e. **Locality:** the Fal-G bricks project is based on the locality where it is established. It has no competence with the local resources other than the ground water. However, land might be considered as one of the source for competence but in most of the case, Fal-G entrepreneurs either own the land or buy the land from the private parties. Hence the impact on the "local assets" of the area where the project is conducted is not considered to be a major issue (Eco Carbon Private Limited 2006).

3.3.5. Host nation and the location of the project

The host nation is India with project in several districts in the State of

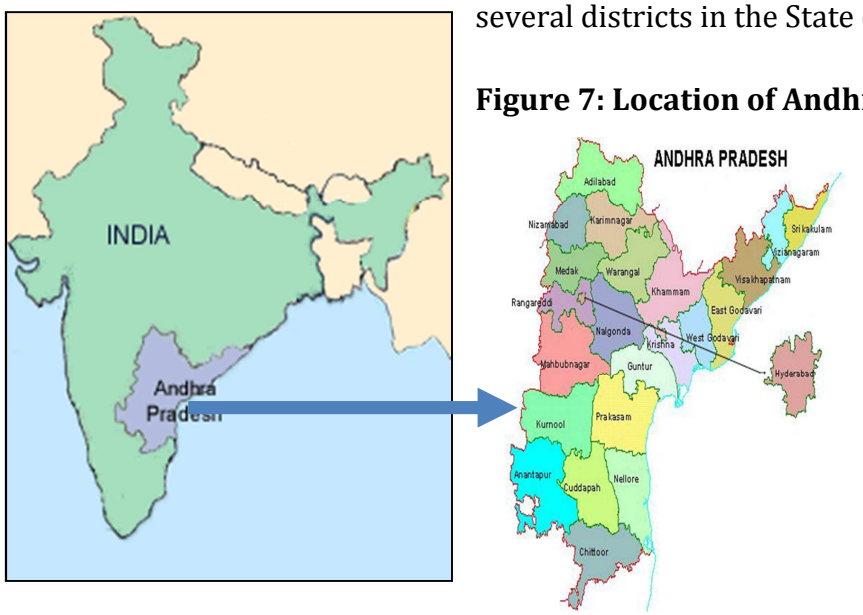

Figure 7: Location of Andhra Pradesh in India

Andhra Pradesh, India. Shown in Figure 7. The area is chosen by the easy availability of the chief raw ingredients like flyash, gypsum as well as stone dust. The location is also selected with the availability of brick markets in the vicinity. Characteristic Fal-G plant is established in general in the urban area where there is demand for bricks. Area required for a single plant is approximately 200 square meters. The distinction between each plants is done through allotting of unique code or serial number which is even convenient for records as well as for administrative purpose. Coding for each plant contains state in which this project is ongoing, followed by identification of district, Numbering of Bundle is done in Roman numeral and then followed by Serial Number of the plant in bundle. A typical example of one such code where there is eigth Plant in bundle No.I in the state of Andhra Pradesh in Vishakhapatnam district is give the code as: AP/VSP/I/8 (N and N n.d).

3.3.6. Categorization of Fal-G project

The proposed project comes under the category of type II by CDM which are Energy Efficiency Improvement Projects. Since Fal-G projects fully avoids the process of sintering[8] and coal consumption as such. Although there is a consumption of either electricity or diesel for the machines to function, but the amount of usage of these kind of energy sources is very low when compared to the thermal energy which is used for manufacturing burnt clay bricks. Therefore this project is categorized under Type II.D, which is "Energy efficiency and fuel switching measures for industrial facilities" that is confirmed by the Small Scale Working Group (SSCWG) in response to the project participant's offer to bring up new category named category III (UNFCCC 2006)

The total amount of energy saving targeted for this project is calculated as the "difference between the energy consumed for the production of fixed volume (m^3) of bricks and blocks produced in the project and the energy that would have been consumed for production of an equal volume of clay bricks". It is estimated that the aggregation of energy saving done by 14 Fal-G plants with a total production capacity of 61200 m^3 bricks per year is estimated to be 44.37 GWh_{th} per year. This saving of energy is below the "45 GWh_{th} threshold for savings in thermal energy inputs" considered for small scale projects that fall under II.D category (UNFCCC 2006).

3.3.7. Mechanism of Fal-G technology

The invention of Fal-G technology for producing bricks and blocks is invented in India by the Institute of Solid Waste Research and Ecological Balance (INSWAREB), that works by considering chemistry of strengths present in flyash, lime and gypsum. The chemistry of fly ash and lime is exercised by capturing ettringite[9] phase towards its threshold levels by addition of adequate quantity of gypsum. This is the main reason why the Fal-G bricks skips the energy intensive machines like heavy duty press or autoclave, which on the other hand are required for bricks

[8] Sintering: This process is used in the production of clay bricks. Clay bricks undergo two important phases. 1. Production of Green Bricks (clay bricks before firing are called "green bricks" and 2. Firing green bricks in a kiln also called as sintering which uses thermal energy inputs (World Bank 2006).

[9] Ettringite: is calcium sulfoaluminate, present in the portland cement concretes. Sources like these are mixed with portland cement in order to avoid rapid setting up as well as for developing the strength of the cement (Portland Cement Association 2010)

prepared from fly ash and lime. Figure 8 shows various stages of FAL-G brick production and Figure 9 shows the summary of FAL-G bricks and blocks production.

a. Workers working in a Fal-G plant

b. Fal-G blocks casting

c. Fal-G blocks

d. Fal-G bricks with no sintering process

Figure 8: Various stages of FAL-G brick production

Fal-G project does contribute to the reduction of CO_2 emissions; however there are no specific rules by the Government of India which makes the production and usage of Fal-G bricks and blocks in construction a mandatory. Thus, this technology of Fal-G bricks is yet to make its mark in the brick market. Estimations made for the energy reductions achieved by promoting the usage of Fal-G bricks at 14 various locations is about 14162.3 tones of CO_2 equivalent per year. Figure 9 explains the process of Fal-G brick making (UNFCCC 2006).

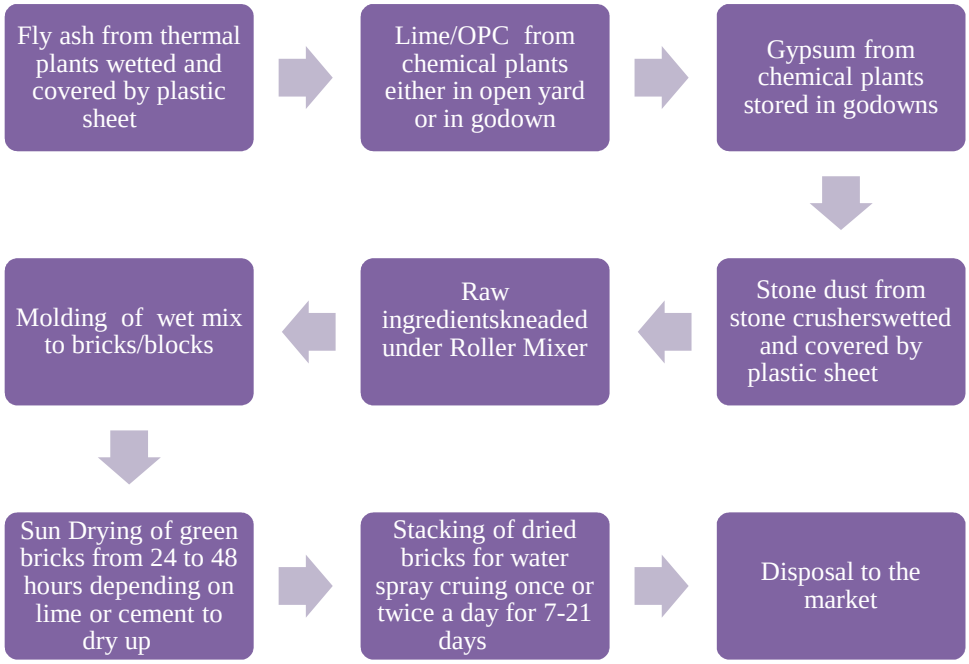

Figure 9: Summary of Fal-G bricks and blocks preparation

3.3.8. Characteristics of Fal-G Project:

Fal-G bricks and blocks project falls under the category of "Bundled project". However it is to be noted that all the Fal-G projects are dealt independently and maintained by individual entrepreneurs, who are noted down as project participants in this project. The main characteristics (Scheemer 1999) of this project are:

1. There is an independent ownership of each Fal-G plant
2. The technology used in the Fal-G plants is provided by INSWAREB, with an intermediary role to perform but at the same time, each plant by signing contract with INSWAREB is in collaboration with it for gaining technical support.
3. There exists no individual contract amidst bundled Fal-G plants and each plant caters to various market segments, like transportation and other logistics. Each plant has delineated boundary with specific physical and geographical area as well as equipments employed (UNFCCC 2006)

4. Theories and Empirical Data collection

The current chapter introduces the theories used in this thesis. The theories are chosen based on the qualitative information gathered by the author. They are the bridges guiding the author to utilize the collected empirical data and adapt to the essence of selected theories to be used for analyzing and placing the information in the right area so that it becomes the pathway towards answering the questions which would help in finding the solution to the problem identified in the thesis. The following theories chosen for the thesis are mentioned below. Apart from this, the methods for collecting the empirical data are also mentioned to give the reader clarity of how the data is collected.

4.1. Stakeholder Analysis

A process of analyses that involves collecting and evaluating qualitative information, which that determines the rate of interests of stakeholders taken into consideration during the developmental and implementation stage of a project or program (Scheemer 1999). Stakeholders, on the other hand are defined as the actors (individuals or organizations) playing an important role in order to reach the project goals and whose participation plays a major role in the success of the project. Thus the identification of stakeholders in a given project plays an important role in the success of project (Hut 2008). This analysis gives the clear picture about who the key players are, their knowledge, interests, alliances as well as their priority towards the project and this in turn plays an important role in structuring as well as making the project to reach its goal. Stakeholder analysis, when combined with another important tool for analyzing a project as a whole gives better success to the project.

Stakeholder analysis signifies stakeholders in terms of legitimacy, urgency and power. The legitimacy attributes towards actions of the actors within "socially constructed" values or norms. Urgency on the other hand is the extent to which the actors pay immediate attention on to the project or organization while power is the capability to control the type of decisions made as well as in facilitation of implementing the decisions. It is very important however to make a note that the "legitimate stakeholder with urgent interests" might not have power to influence

the project and that not every powerful actor has an urgent and legitimate state in the project (Hatcher and Ashton 2002).

The following steps are adapted based on the requirement of the project:

a. Identification of the stakeholders
b. Assessment and analyzing stakeholders
c. Role played by each stakeholder at stages of the project
d. Development of strategic actions and analysis of risk in the project during planning stage of the project (Hut 2008)

In the project stakeholder analysis is one of the key tools in answering the Main Research Question. As mentioned above, the current thesis aims at identifying the stakeholders and their role in the project. To sum up, the initial analysis on the stakeholder relations provides the basic information on the interest of each actor seen as well as unseen in the Fal-G project.

4.2. SWOT Analysis

To analyze the situation of the product or the company, it is necessary to follow a simple framework in order to develop "strategic alternatives" via analyzing the situation. For this purpose it is obligatory to dissect the product in all possible ways, in short analyzing the SWOT meaning the Strength, Weakness, Opportunities and Threats of the respective product or the firm that the subject is looking at (Valentin 2001). This is a traditional mode of identification for insights through the desired arrangement. Hence the SWOT analysis offers "conceptual foundations" for better insight into the desired subject under study (Valentin 2001)

SWOT analysis mostly includes checklists that are towards the identification of the "SWOTs" and it is an essential step to identify and evaluate the schematic factors assisting or deterring the product in reaching "its full potential", with list of various factors being utilized as a starting point within an enterprise (Houben, Lenie and Vanhoof 1999. The conventional checklists according to Thompson and Strickland include the "powerful strategy" and "attractive consumer base" comprising the strengths and threats as "vulnerability towards industry driving forces" (Valentin 2001).

As it is a flexible tool, the advantage with this is to inspect the management areas thereby gaining insight into the importance of the framework of the company with

initiation of suitable actions. For a successful company or product it is essential to have a better environment, which includes both external as well internal factors, playing a key role. While it is important to contemplate the product's or company's future goals towards strengths, avoiding predisposition in relation to the weakness, which form the essential internal elements, the success can only be achieved with familiarization of opportunities and threats that form the external environment. The identification of the internal strengths and weakness as well as the external opportunities and threats is therefore a key component for any company or product to flourish and the study of this sort is termed as SWOT analysis (Valentin 2001).

In the current thesis, author adopts the "knowledge-based SWOT analysis system" with background information and the static knowledge from the Bontje Model primarily used to develop a business plan along with the resource based SWOT analysis that alleviates not only the short comings of the traditional SWOT analysis but also focuses on the more methodical concern with an insight towards perceptive, reliable and actionable features of the product.

Figure 10: Knowledge based SWOT analysis system

Based on this plan, there are five management areas to be focused. They are: the market, finance, production, people and the environment and these areas are analyzed by the means of checklist that helps the author to look into the following points like gathering historical evidences related to the topic and looking into every possible details of the product independently of author's knowledge about the subject and the awareness of the problems occurring, hence concentrating on the strengths and the weakness as shown in Figure 10. Resource based analysis on the other hand is based on the context of viewing resources of a product or company that determines which external situation provides the opportunities as well as the threats for the subject chosen. Hence the resources in **Table 2** are looked upon

Types of Tangible and intangible resources
Financial – e.g., cash and access to financial markets physical – e.g., facilities, equipment, configurations, and raw materials
Intellectual – e.g., expertise, formulas, and discoveries
Legal – e.g., patents, trademarks, and contracts that protect intellectual capital
Human – e.g., employees' individual expertise and skills
Organizational – e.g., culture, customs, shared visions and values, routines, and working relationships
Informational – e.g., customer and competitor intelligence
Relational – e.g, strategic alliances; relations with customers, vendors, and other stake holders, which often are affected by bargaining power and switching costs
Reputational – e.g, brand names that reduce perceived risk or have symbolic value

Table 2 : Types of Tangible and Intangible Resources (Valentin 2001)

Once an analysis is started considering the above mentioned parameters, the results shall be -based on the following:

1. Focused SWOTs which concentrates on the market-product parameters, pricing and distribution policy of the product in the market (Piercy and Giles 2007).

2. Customer orientation seeing what the customers require based on how they value the product and drawing the balance between what the company think is important while promoting the product and what customer think is important (Piercy and Giles 2007).

3. Socio-cultural mode giving importance to the cultural background which will be seen as a key factor for the success of the product in the market.

4.3. Barrier Analysis

Barrier analysis is defined to be a research or design method involving detection of "pathways" by which a given objective or project is affected by a hazard, and it also includes the recognition of any "failed or missing countermeasures" which should or must have prevented the undesired consequences. Major focus of barrier analysis is the target which exists under specific range of conditions. A target can be either a person or collection of data or project etc.

Analyzing the adverse effect of target refers to observing the target out of its required range of conditions and the cause behind it is called as the hazard, which has to be defined along with the target so as to identify barriers. The barriers are used to cutoff pathway by which hazard can affect the target. Hence the barrier analysis is used for the identification of pathways related to the specific project. Advantages of using the barrier analysis are that it is simple to understand and in usage, with easy application requiring minimal resources. In combination with the other theories it works well and the results attained from the barrier analysis turn out to be rather a recommendation sources for improving the project.

As mentioned above that barrier analysis along with other tools contributes in the success of the projects, the CDM projects are no exception. The additional

CDM which has five steps in general, with inclusion of barrier analysis turns to play a major role in giving project a success. Barrier analysis is a check to see the presence of atleast one barriers which prevent from the implementing of the proposed project without CDM activity and to see whether one substitute scenario

apart from the proposed CDM project is not prevented by the identified barriers (CDM Rulebook 2010).

Fal-G bricks and blocks project is said to be an "Additional CDM project" meaning that this project contributes in the reduction of the GHGs released due to the anthropogenic emissions along with other sources thereby minimizing the GHGs as such. Hence, the barrier analysis is a useful tool for an additional CDM project and following steps are used to demonstrate and assess additionality:

- **Step 1:** Identification of alternatives to the project activity
- **Step 2:** Investment analysis to determine that the proposed project activity is either (a) not the most economically or financially attractive or (b) not economically or financially feasible;
- **Step 3:** Barrier analysis
- **Step 4:** Common practice analysis

The Government of India has made no mandatory statement with regards to fly ash bricks as a compulsion in the construction business in the production as well as in the usage of these bricks, even though as mentioned in Chapter 4 that all the new and the old thermal power plants has to utilize the fly ash within a period of five to fifteen years of their operation respectively. Hence it is common for projects like these to face barriers in order to establish a niche for themselves which through the barrier analysis will easily sort out and solve the identified barriers thus giving way to further investigation in this project In the CDM projects, barrier analysis plays a major role in identification of the problem areas which slow down the project. This proves be advantageous for the project planners since it gives a way to solve the problems expected in the project, which in due course of time helps in the smooth running of the project.

4.4. Institutional Theories

Institutions as by the definition are the flexible structures of society which are more enduring, giving firmness to the society in due course of time. Institutions reflects several types of carriers including systems that are symbolic with routines as well as the artifacts, being operated at several levels of "jurisdiction" ranging from world to the "localized interpersonal relationships". The institutions define

the boundaries that are legal, moral as well as cultural, hence distinguishing between "legitimate and illegitimate activities". An essential criterion of these institutions is that they should support and strengthen the actors as well as the behavior of these actors. By definition, the institutions are stable orderliness. However these institutions are subjected to change, which are either revolutionary as well as incremental in nature (Scott 2001)

The institutional theory in the modern era stresses on the point that the social reality emerged out based on the interactions between human beings and hence the term "institutionalization" is defined as procedure with repetitive actions, resulting in arriving at the same meaning of an action by different people (Institutional Theory n.d.).

An institution demonstrates these traits due to the processes which flow in motion by regulative, normative and cultural cognitive elements. They are the firm building blocks of the institutional structures providing institutions elasticity that are resistant in general. Although the key ingredients of institutions are the rules, norms as well as the cultural beliefs it has to abide by the behavior as well the "material resources" associated to it. The three pillars are explained below:

1. The Regulative Pillar: emphasizes on the behavior that involves the rules establishment, monitoring and granting of the rules. It has the capacity to form rules, check over other's acceptance towards these established rules and to maneuver rewards as well as punishments in order to persuade future behavior. These process may function either through shunning activities or can be done formally via laws, courts etc.

2. The Normative Pillar: includes values and norms which emphasizes on the prescriptive, evaluative and obligatory forming the basis of a steady social life. The "Values" are defined as conceptions of the preferred or the desirable, together with the construction of standards which existing structures or behaviour can be compared and assessed. "Norms" specify how things should be done; they legitimize means to pursue valued ends. However what is critical here is that although normative forces inflict constraints on social behaviour but they also authorize as well as enable social action.

3. The Culture-Cognitive Pillar: emphasizes that through external cultural framework, shapes the socially mediated framework of understanding. They emerge out as the mixed conceptions, comprising of the nature of social reality and the frames through which meaning is made (Scott 2001). The important feature here is that routines are followed because they are taken for granted as "the way we do these things".

In the current thesis, the focus is on how the various factors play an important role in defining the sustainable development with institutions running in function providing stability and order and simultaneously undergoing change, both revolutionary as well as incremental. To define it, the support of three institutional pillars is a must.

The regulative pillar identifies the influence of the regulations issued by the actors like Ministry of Environment and Forests on the actors who follow the regulations like ECPL, INSWAREB etc. and also the implementation of the regulations is analyzed. The normative pillar identifies the different norms the various actors follow and also identifies the voluntary actions that define the values of the actors. The cultural cognitive pillar identifies the cultural effects on the various actors and the level of influence of the cultural issues is analyzed.

4.5. Data Collection

In any scientific report, it is very essential to collect the data and utilizing them to full extent. Also the important factor is to balance the usage of both primary as well as the secondary data collected by the author. While the primary data involves the material collected by the author, that includes results from interviews and questionnaires, systematic observational data etc. The secondary data on the other hand includes the collection of the data, mainly utilizing the data from others that are widely accepted (The National Counselling Institute of Ireland 2010). These data are mostly grouped under literature review. A detailed description about how both primary and secondary data are collected is given below:

4.5.1. Interview Guidelines

Assessment of this thesis is widely based on the information obtained from the interviews taken from the identified actors of the case study chosen. A qualitative research interview portrays the topic chosen from the interviewee point of view,

deciphering the meaning of their experiences prior to the scientific explanations. Constructing an arena of knowledge is the essence of the qualitative research interview (Kvale 1996). In the current thesis, the research interview is about extracting qualitative texts than quantitative data, reflecting the subject's point of view towards the theme of the thesis.

4.5.2. Interviewees selection

Through the literature review, the actors were identified who hold an important role in the case study chosen. Also the actors were categorized under developers and investors. The interview has given the key information which plays an important role in the thesis since they are exclusive piece of information derived, in turn providing a more clear view about the case study and the problems associated with it. This gives the author in more having multi dimensional approach thinking towards finding the solution to the research questions.

4.5.2.1. Interview pattern

The questions from the interview falls under two categories. The 1st category is the set of questions that were framed after the actors were identified based on their role in the Fal-G bricks project. The 2nd category of questions are the questions framed on spot following the continuity of the answers given by the interviewee which in turn has helped the author in getting useful information that is not available in the web pages or books.

4.5.3. Literature Review

The starting point in the scientific studies starts with examining the data from various resources available. A literature review is well described as the "discursive prose" but not a collection of summary of various pieces of literature organized (Texas A&M University n.d.) one after another (University Of TORONTO 2010). It as the name suggests gives in detail about the work that has been accounted on a given topic or field. It forms the core of thesis and the reason behind it is that the research of any thesis or report should be able to merge the gap in "what is known about topic". Therefore it is important that after the introduction of the topic to the readers, it is followed by describing the appropriate research on the topic chosen which inturn indicates the readers that the research going on for the topic chosen fits within the existing studies as such (Texas A&M University n.d.).

In the thesis author has extensively done research on the various literature works, related to the topic chosen, thereby giving the research an extensive theoretical support. This is done by selecting the data ranging from published document, to journal to the information present in the websites as well as the books. However, all these information reflects the information from the material used with focus on the key points to author's arguments (Boote and Beile 2005)

In the current thesis, the literature review consists of information which forms a pathway for the analytical research to be followed in the next chapters as well as act as the information guide to the topic chosen for analysis i.e. fly ash bricks and CDM. The collected literature is obtained from internet where the key words chosen are "CDM, FAL-G Bricks, WORLD BANK, CDCF". Apart from this, personal communication was done by the author to get the qualitative information from the selected stakeholders. The material as well as the information obtained are studied and revised thus playing an essential role in framing of the storyline for the current thesis. The literature ranges widely with subjects covering from social science to chemistry, political science to the management tools. Source of these wide ranges of literature shall be found under the reference, thus guiding the reader to find and look through the material used for solving the problems as such.

4.6. Framework of Research

The overall thesis shall be analyzed on the basis of qualitative information derived from the interviews of the identified stakeholders and literature reviews.

The pattern of the thesis is designed as follows:

1. **Stakeholder Analysis:** this theory will be used for identifying all the possible actors in the case study chosen. All the stakeholders have to be identified including the actors that have been shadowed, and here the traditional clay brick workers have been identified. Learning the perspective of different actors towards the project is what stakeholder analysis would help in.
2. **SWOT Analysis**: it is important to have a very good knowledge about the product to be analyzed. This theory will be helping to analyze the SWOT of the Fal-G bricks as such which in turn would help the author to see where is the strong

hold about the product and where the opportunities are for the penetration of this product by identifying the weakness as well the threats to the product.

3. **Barrier Analysis:** after identifying the SWOTs of the product, it will be clear for the identification of the barriers for the implementation of the CDM project in India. Here the stakeholder analysis and SWOT analysis comes in handy since it's through their finding results it will be useful to see what are the barriers that are preventing the project as a whole from being implemented and also it will give the breakthrough that gives us the actors and the causes for the negativities in the project and thereby helping for giving the suggestion for improving the CDM project.

4. **Institutional Analysis:** identify the factors that are actually playing a key role in the project. Three factors have been identified, the Indian governance, climate change and economic perspective. The reason for choosing these factors are that they are intertwined with each other and go hand in hand because the chosen case study is a CDM project with native technology in its side claiming to reduce GHGs and hence enabling in answering how is sustainable development in India defined. Under the three pillars namely the regulative, the normative and the cultural cognitive identified factors will be analyzed. The results shall be integrated with the other identified factors to see which direction is this project going and if this direction is really beneficial or not at the end both to the climate as well as to the workers. However the cliché is on the cultural conditions, since in India the brick industry is a traditional source of employment carried from generations and has a strong cultural impact. Therefore cultural factors will be highlighted taking the results obtained from the three pillar analysis. This will give insight to the author to see how the brick industry is being run under with cultural factor as the key role and how this factor can be studied under keeping in view the fly ash brick industry since they are not bound by any caste system or other social condition and that they are actually independent of this issues. The cultural system has to be highlighted although it has an indirect impact on the climate and thus are benefactorier for the workers since they are in easy access with the CDM to get credit money and get benefit irrespective of caste etc

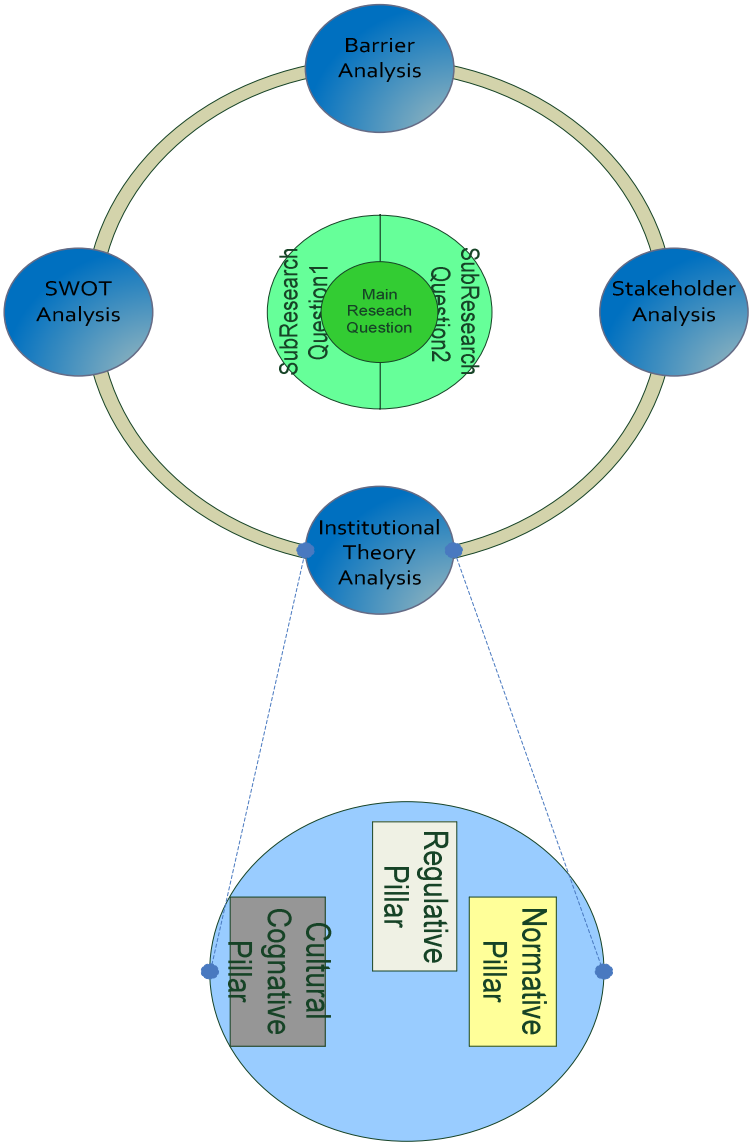

Figure 11 : Answering Main Research Question using Analysis

5. Overview of Empirical data

In the current chapter, the analysis of the empirical data is done based on the theories selected as seen in chapter five. Structural procedure for analysis begins with identification of actors and pre-determining their roles based on the literature analysis as well as semi structured interviews. This is followed by analyzing the qualitative data by incorporating them in the selected theories.

5.1. Stakeholder Analysis

The stakeholder analysis emphasizes on collecting and evaluating qualitative information, which determines the rate of interests of stakeholders taken into consideration during the developmental and implementation stage of a project which in turn plays an important role in the success of project. Stakeholders shall be identified, followed by defining the role played by each actor.

5.1.1. Identification of actors

Based on the literature review, the following actors were identified for the Fal-G Brick and Blocks Project No.1. Stakeholders identified are listed in Table 3. In this analysis, some of the identified actors are visible during entire project, while other actors are hidden. From the stakeholder analysis, the role of visible and hidden actors in the Fal-G project will be determined to see whether they are useful in project improvisation or are a major obstacle in the path of improvisation based on the case study chosen.

Serial number	Actors identified
1.	INSWAREB
2.	ECPL
3.	CDCF
4.	Micro Enterprises
5.	Fal-G project workers
6.	Clay brick industry
7.	Ministry of Environment and Forests
8.	Raw material suppliers
9.	Brick consumers
10.	Local residents

Table 3 : Identified Stakeholders in the Fal-G bricks and blocks project

Role played by each stakeholder in Fal-G projects:

a. Institute of Solid Waste Research and Ecological Balance (INSWAREB): It is Non Governmental Organization (NGO) established with a non-profit motive and is located at Vishakhapatnam in the state of Andhra Pradesh of India (World Bank 2006). The founders of Fal-G technology started this NGO because they thought that the technology that they developed is a "junta" technology, meaning common man's technology, and the Chairman of Housing and Urban Development Corporation (HUDCO), believed that this technology has a breakthrough path in the clay brick industry, hence encouraging the founders of Fal-G technology to start a building sector that has to be governed by a Non- Profit Organization. Thus, NGO INSWAREB started with its role as R&D body. In 1990, INSWAREB, being NGO, was accredited as an observer organization for COP (N 2010).

Role played: INSWAREB is the inventor and promoter of Fal-G technology. This technology was developed because of urge to contribute for sustainable development. Founders of INSWAREB are primarily the building material technologist, with focus on industrial solid waste utilization, which is around 240 - 50 million tones every year with fly ash occupying 70% of the total solid waste output and fly ash incidentally happen to fit into developers building material technology due to its pozzolanic nature. This is how the technology development took place. Apart from holding the special role of inventors of this technology, INSWAREB is concerned in providing "technology know-how", Operations and Maintenance (O&M) and the logistical support to the micro entrepreneurs related to this project. It also act as the market facilitator, conducting workshops and awareness programs, encouraging entrepreneurs and the consumers using Fal-G bricks (N 2010).

b. Eco Carbon Private Limited (ECPL): A commercial body involved in research, development and commercial operation of planted technologies, utilizing mineral constituents from the industrial by-products such as fly ash, slag, gypsum, line sludge etc. Based on Hyderabad, in the state of Andhra Pradesh, India, it is responsible for finding buyers to buy the carbon credits generated from the project and transferring on the benefits to the micro entrepreneurs who are engaged with the project (World Bank 2006). Founders of Fal-G technology approached World

Bank via INSWAREB offering Fal-G as CDM project however the World Bank expressed comfort level to sign the deal with corporate rather than a NGO due to its less accountability. Hence, Eco-Carbon Pvt. Ltd (ECPL) was started as corporate outfit (N 2010).

Role played:

ECPL acts as the "bundling agency" on behalf of individual micro entrepreneurs to find buyers for the generated carbon credits in the international arena and pass on the profits to these entrepreneurs using Fal-G technology. ECPL along with INSWAREB intends in bundling of production plants with additional roles including the supervision of the plant's operations hence coordinating the monitoring and verification processes with the accredited agency, helping the micro enterprises in transferring the Emission Reductions (ERs) to the buyer. In order to obtain the rights to the generated ERs and to act as bundling agency, ECPL has proposed a legal agreement with the individual entrepreneurs as such (N 2010).

c. Community Development Carbon Fund (CDCF): CDCF, a very specific carbon fund set up by World Bank in the year 2003 has a specific objective of developing small scale projects in the poorest countries benefitting the poor communities. CDCF, purchases credits from the projects that do not necessarily have to be financed by World Bank through loans. CDCF also purchase credits from projects which are completely independently financed (Quesnel 2010).

Role played: CDCF participates in the project right from a very early stage, i.e. at the time of preparation of PDD followed by project entity going through validation, registration and then up to CERs issuance An agreement, named Emission Reductions Purchase Agreement or an ERPA a typical contract defined in the CDM world is signed with project entity where CDCF specifies on how many emissions reductions they are going to purchase, the date of delivery of the emissions reductions, calendar of delivery which and then the price. Apart from this, the project owner Eco Carbon Private Limited (ECPL) has agreed to include in the contract they have with various brick factories a number of provisions to improve the working conditions of workers there, like health benefits and better working equipment and working conditions etc. The community benefit plan has been

discussed with ECPL and agreement has been made and is now implemented in various brick factories and this plan is financed out of a small premium in the price of carbon that the investors in the CDCF have agreed to pay. CDCF collaborates with the CDM Executive Board thus registering for the project (Quesnel 2010).

d. Micro Enterprises: they are the ones selling the Fal-G bricks in the brick market.

Role played: they are responsible for organizing the essential resources for setting up the individual Fal-G project along with marketing of manufactured Fal-G bricks. Maintenance of the required data and the records as per the CDM monitoring requirements are managed by these enterprises. They also should implement the community development and environment management programs in compliance with ECPL and CDCF (World Bank 2006).

e. Fal-G project workers: In the Fal-G plant, the workers are classified into three categories. They are: 1. one who those who travel to the work place from their residences located nearby. 2. Bachelors who come and stay at the work place and 3. The families moved to work place (Eco Carbon Private Limited 2006).

Role played: they are the beneficiaries of the agreement between Fal-G technology promoters and the CDCF.

f. Clay brick industry: they are the major competitors of the Fal-G project. They are considered as the big bulls with many families practising the tradition of brick making from generations, hence holding a strong forte in the Indian society.

Role played: since they are the big bulls of the construction business in India, with 20 billion clay bricks kilns spread all over the country, they have a strong market hold and are the main competitors for Fal-G bricks. They also hold a major place in the lower sections of the Indian society and hence are considered a strong base for the vote by the politicians in India (N 2010).

g. Ministry of Environment and Forests: In India the environment falls under the portfolio named Ministry of Environment and Forests (Ministry of Environment and Forests).

Role played: all the major decisions with regards to selling of raw materials, to paying of taxes are dealt by the Ministry of Environment and Forests. Apart from this the issuance of regulations in usage of fly ash in the vicinity of Thermal Power

Plants (TPPs) is regulated by this ministry. Hence it is very important to study the view of government regarding greener technologies and their role in promoting it.

h. Raw material suppliers: the key ingredients in the preparation of Fal-G bricks are fly ash, lime stone and gypsum. Fly ash is generated as the waste material from the coal based Thermal Power Plants, while the other raw materials like gypsum, lime stone for the preparation of Fal-G bricks are supplied from other industries where they are by-products.

Role played: They are crucial as well since they are the ones that actually help in producing the bricks made out of these materials.

i. Brick Consumers: they are the major stakeholders on whom the success of the project depends ultimately. In order to make the Fal-G project a success, it is the responsibility of the government of India as well as the entrepreneurs to endorse the advantages of the engineered product i.e. the Fal-G bricks over the clay bricks in various aspects.

j. Local residents: these are the people residing near the plants.

Role played: they are the ones who are directly affected from the hazards that are released due from the Fal-G plants and hence they have a right to file a case against plants stating the factors hampering their health as well as the lands. Apart from this they also look upon the Fal-G plants as the source of employment.

Each identified actors have a different role in the improvisation of the project. Based on the literature review, following actors are identified that contribute primarily in the initiation and developmental phase of the project as such.

a. Eco Carbon Private Limited (ECPL)

b. Institute of Solid Waste Research and Ecological Balance (INSWAREB)

c. Community Development Carbon Fund (CDCF) of World Bank

d. Fal-G Bricks entrepreneurs

e. Ministry of Environment and Forests

There are other actors whose role would play a major role in the thesis, since a lot of factors regarding improvisation of the project are dependent on them. Their decision would be playing a key role in understanding of the project and looking

the case study in multi dimensions. Other actors, like the clay brick workers, consumers, Fal-G project workers, raw material suppliers and local residents are those actors who are affected from the decision taken by the stakeholders whose primary functions is the initiation and development of the Fal-G project that are identified by the stake holder analysis.

The Table 4 depicts the summary of the roles of the various stake holders identified in the thesis.

Stakeholder	INSWAREB	ECPL	CDCF	Micro Enterprises	Clay brick workers	Ministry of Environment and Forest (Govt. of India)	Raw material suppliers	The brick consumers	Local residents
Areas I	Provides technology and Facilitating the market	Coordinating Carbon Transaction	Buying Emission Reductions	Setting up and operating Fal-G plants	Strong competitors	Policy makers	Primary Entrepreneurs	Consumers	Consumers +
Specific Roles	Know how of the technology Providing details and support with equipment, machinery and raw materials Guarantee to the enterprises on failure of technology Conducting workshops and programs for brick owners and brick workers	Enrolment of micro enterprises under the Fal-G project Searching for the potential buyer of ERs with appropriate price Negotiations between the buyer and the CDM Executive Board regarding Carbon Transactions Monitoring under CDM and World Bank requirements Providing the benefits generated to the micro enterprises according to the agreement	Coordinating and registering the project with the CDM Executive Board Payments to ECPL as according to the agreement Monitoring the implementation of community development programs by ECPL	Resources mobilizing Equipment and machinery procurement and marketing the products Maintenance of data and records according to requirements of CDM Implementation of community development programs as in accordance with ECPL and CDCF	Age old tradition Strong hold on the market Strong socio-political background in the Indian society	Promoting greener technologies Price fixation of the raw materials Taxes, CEZs are decided by the government	Key ingredients are supplied by them	Major actors deciding the future of the product	They suffer the most if any leakage happens

Table 4 : Summary of the roles of each stakeholder identified

5.2. Barrier Analysis:

This analysis is an important step especially when a project like Fal-G, falls under "additional" CDM project" category. As mentioned in the previous chapters, there is no compulsion by the Government of India to utilize fly ash bricks as the construction materials throughout country, and that the clay brick has a strong hold in the Indian construction market. Hence, it is very necessary to analyze Fal-G bricks project with regards to the barriers they face right from the initial stages of its production to selling of bricks in the market, thus giving the developers a chance to improve the products based on the identified barriers.

Based on the literature review as well as the empirical data collected from the interviews, the barriers are identified and have been grouped under the following categories. They are:

1. **Market Penetration:** In the Indian market of construction clay bricks are utilized at a larger scale since they very popular among the consumers but they are also low in cost. There also exists a concept that the clay bricks are the most suitable as the construction materials for buildings in India. In the recent time, even though there are new alternative building materials made up of materials like cement concrete block and fly ash, yet the clay brick materials enjoy the advantage of being used as the most widely used material for constructing the buildings. Clay bricks accounts for more than 95% of the total walling material market in India while fly ash bricks including the Fal-G brick's market share is just 1.4% reflecting consumers' choice of bricks, making them as less popular among the consumers in India. Market share of various bricks in India can be seen below in the Table 5 based on the studies on "Cost Effective Building Materials and Technologies" and the data was collected by the Holtec Consulting Private Limited, in the year 2004 on behalf of Building Materials Technology Promotion Council, a Government of India undertaking (UNFCCC 2006).

Type of walling material	Market size (Rs. Crores[10])	% of total market
Burnt clay bricks	32825	95.3
Cement Concrete Blocks	1135	3.3
Fly ash bricks incl. Fal-G	485	1.4
Total	34445	100

Table 5 : Different walling material's market share (UNFCCC 2006)

2. Technical skill of Workers: It is noticed that the production of these bricks actually requires training of artisans from the process of starting towards maintaining the production process, which therefore are looked upon as the barriers for the workers.

3. Sourcing of raw materials: unlike the clay bricks where the raw material is the soil having availability at larger scale in and around the production areas, the Fal-G brick materials does not fall under this category. All the materials that goes in for producing the bricks first need to be tested, selected and have to be sourced from the industries from which these materials are produced. Therefore, the barrier faced here is that, it becomes very evident for the producers to choose carefully the places with availability of the required materials unlike clay brick plants, which require only the ample amount of soil for production.

4. Barriers in operational and handling of materials: the chemical composition of Fal-G bricks is made with a control recipe of three ingredients as mentioned above. However, a slight change in the composition of materials while producing the bricks, would lead to a change in the chemistry. This would in turn lead to the re-doing of the whole recipe in preparing the Fal-G bricks. A slight change in the composition hence is looked upon as the interruption in the functioning and operating the plants hence causing considerable amount of production loss (UNFCCC 2006).

[10] 1 crore = 10 million

5. Market acceptance of Fal-G bricks, a barrier: it is a known fact that the ingredients with which Fal-G bricks are made up of, produces bricks of a very high as well as superior quality bricks. However, market surveys conducted by various Fal-G brick promoters reveal that consumers do not get attracted to these bricks due to the grey color which is due to the fact that Fal-G bricks are made up of fly ash and that the fly ash imparts its color onto the bricks. Apart from it, the consumers also hesitate in buying the Fal-G bricks because of the presence of ash in it which creates a negative impression on the quality of the product (UNFCCC 2006). Apart from this the consumers also lack information about the renewable technologies as well its advantages in association with economic and financial cost benefits and its capability to reduce the GHGs.

6. Government Regulations as barrier: the producers of the Fal-G claims that a major hindrance for improving and promoting this product comes in the form of Indian government's bizarre rules on the fly ash. In the interview, Mr. N.Kalidas of ECPL states that the Government of India imposes sales and excise tax on green technologies and collects money on purchasing the fly ash. He quotes that, "The government has achieved 10-15% penetration in the sale of fly ash and they are trying to make money out of them. These are the things that prove counter-productive to the product proliferation." (N 2010).

7. Socio-Political Conditions as barrier: Clay bricks manufacturing is termed as small scale cottage industry and is practiced as a family tradition, passing from one generation to another generation (UNFCCC 2006). Clay bricks workers have a strong hold in the Indian society and this is supported by statement from the Fal-G promoter in his interview where he states that "**c**lay brick has a very strong socio-political hold making them to proliferate even in the remote areas of country (N 2010)." Mr. N. Kalidas also points out that even though Fal-G has its own technological strength; it has to compete with the clay brick industries in India which is very much in the un-organized sector, with no tax payment as well as CEZs. However, on the other hand, fly ash brick industry has to compete with such an un-organized product keeping itself in the organized sector facing lot of competition, particularly on the price front of the clay brick industry (N 2010).

Summary:

The Fal-G bricks and blocks project has been identified with various barriers and are classified under various categories mentioned above. To summarize the barriers, the technological barrier states that performance of the new project activity would increase the emission rates due to the low market share. From the barriers arising due to the existing practices, it can be seen that unless there is a strict policy with regards to implementing the project, the emission rates would be higher. Apart from this other barriers like institutional, managerial and organizational would also lead to the increase in the emissions if proper action is not taken to remove the barriers in the identified categories as such (N and N 2009).

5.3. SWOT Analysis

In order to analyze any product, the SWOT analysis is an apt tool since it gives reader a chance to see various dimensions of a given product. Identification of the strength and weakness of a product, the opportunities that product is capable of achieving and threats the product faces gives analyzer an idea about how does the product succeed in the market as well how much would it be in reach of the customers, when introduced. The SWOT analysis therefore plays a key role in knowing the product thick and thin helping the producers as well as the readers to understand about the chosen products advantages and disadvantages. To start off the analysis, the author would go in the order of S, W, O and T and they are categorized according to the hierarchy of the product, covering all the important aspects that play a key role in the life cycle of Fal-G bricks..

5.3.1. Strengths

Following the analysis, strengths of the case study chosen have been identified.

5.3.1.1 Manufacturing and Processing

1. Availability of its raw material: as the name goes, the main ingredients used in preparing the Fal-G bricks are: Fly ash, lime stone, gypsum. These minerals are widely used in industries and are well known. The major advantage of these minerals is that they are available widely in the form of wastes as well as by-products derived from the industrial activities. The availability of these products is

in adequate quantity at the vicinity of the areas where the projects are being carried on (UNFCCC 2006).

2. Durability of bricks: the Fal-G bricks are known for their strength. Due to the presence of fly ash, gypsum and limestone, the strength of these bricks arises from calcium alumino-sulphate hydrates (CASH) in the early stages, which is in turn complimented with calcium silicate hydrates (CSH) which is due to the mixing between fly ash and lime, for the ultimate strengths. As a result, the Fal-G bricks strength increases to 200-250-350 kg/cm$^{2.}$, from the range of 60-80-120 kg/cm^2. Due to the immense strengths of these bricks, it is sufficient to handle the products for stacking (World Bank 2006).

3. Developers from the background of brick manufacturing industry: the developers of this technology, Mr.N.Kalidas in the interview taken by the author stated that, it is due to their background as the building material technologists and that their focus is towards the industrial solid waste utilization. They being the technocrats identified that fly ash constituted of about 70% of the total solid wastes that they identified during their research on the solid wastes. Fly ash incidentally happens to fit into their building material technology due to its Pozzolanic nature. This is how their interest on this technology started leading to framing of their initial aim (N 2010).

4. No Intellectual Property right involved: ECPL, the founder of the Fal-G technology are the holders of patent for this technology as such. However, Mr.N.Kalidas says that it was out of their passion to share their knowledge, that they have not confined their innovation to laboratory or to themselves but has shifted their stream towards land and "resorted to entrepreneurial development". He further stated that, although they own a patent on this technology, yet they do not invoke these patents right on to the small scale entrepreneurs so that "the small scale industries should not be shackled with obligation" thereby helping in the rapid proliferation of industry. He further quotes that, they have "resisted from collecting any royalty and it's more like Microsoft Windows path", getting royalty, if there exists such a condition, otherwise they do not bother about the pirated versions of their technology, since ultimately it proves to be "beneficial to the country" (N 2010).

5. Less space consumption for the production: As an answer to the question about how much the Fal-G technology is in reach of the common man, Mr. N.Kalidas replied that the bricks can be made at any free space available, for example, the road side in a forum, in an agricultural land and even on the foot path (K. N 2010). The report from the World Bank states that the Fal-G brick production requires a minimum land of 0.5 acres (World Bank 2006).

6. Cheap Equipment for manufacturing: In the recent times, in the production of Fal-G bricks, machines are used for better finishing and beautification of the product,. Mr.N.Kalidas, Fal-G technology promoter in the interview quotes that, "in 10,000 units, about 6 to 7 thousand units do use a molding machine at a cost of only Rs.60, 000. Starting capital today is about 3.5to 4 Lakhs towards plant and machinery and a bit extra for infrastructure etc". (N 2010).

7. Less Time of Production: production of Fal-G bricks according to the producer is an easy process. Mr.N.Kalidas quotes that the masons has switched over this technology. It is a technology where, the brick has gestation period of 10-15 days unlike the clay bricks with 40-45 days period of gestation and skill there is no much skill involved and it is the machine that does the operation (N 2010).

5.3.1.2 Financial

Returns of investments due to selling of Carbon credits: based on estimation, it is believed that each Fal-G plant on an average, having the capacity to produce 2 million bricks per year is expected to bring in carbon revenue of approximately US$ 3,500–4,000 annually solely, which excludes the transaction costs (World Bank 2006). In an interview with the representative of CDCF, World Bank, by the author, Mr. Brice Quinsel quotes that, "this is a project that has been already delivering a number of CERs on the fund so certainly that's of the on the success stories so far on the fund" (Quesnel 2010).

5.3.1.3 Environmental

1. Lower emission of GHGs: The Fal-G bricks project is an energy efficient project. Since the only source of CO_2 emission is associated with the usage of diesel, in the mechanical equipments run by it. For eg: the pan mixer, where the diesel is burnt directly in the engine (not converted to electricity) to run the

mechanical equipments. Electricity is also used to run the run the equipments. Therefore, the emissions associated with the consumption of diesel and electricity is accounted for while estimating the emission reductions. Another activity outside the project boundary with CO2 emissions is the transport of raw materials to the FaL-G plants. Thus to sum up, there doesn't exists a massive emission of the GHGs in the atmosphere by this project (UNFCCC 2006).

2. Utilization of those waste materials (flyash): as mentioned previously, out of the waste materials that are being utilized in the Fal-G project, fly ash comprises of 70% of the total waste. The main advantage of using fly ash is that it would in turn reduce the potential environmental threat that is associated with this waste product whose disposal is a big problem to the thermal power plants (INO). Hence one of effective way to curb the disposal problem of the fly ash is by converting it into bricks mixing with other products, that comprises of the Fal-G bricks as the name goes by, thus reducing the potential environmental threat and contributing in reducing the waste disposal in the form of bricks (UNFCCC 2006).

3. No top soil erosion: the clay brick industries prime ingredient is the soil. However they utilize highly fertile top soil in the production of the bricks. There exists estimation that clay brick industry degrades the fertile top soil at the rate of 50,000 acres every year in India, thereby causing severe land degradation. Also that soil is a source that is scarce at present; hence the utilization of Fal-G bricks can serve the purpose of mitigating this problem of disposal at larger extent, thus reducing the pressure on the fertile land that could be used for cultivation instead of producing bricks (Khaturia 2006).

4. Energy efficient: it is noticed that in the production of Fal-G bricks at an equivalent rate of the clay bricks, there exists the usage of lower amount of energy, thus contributing to energy saving. The Fal-G technology is rated as "appropriate, advanced, energy efficient, eco-friendly, and above all it is the carbon saving technology" with another advantage being that is the "cost reducing technology". Since the FaL-G brick/block plant completely avoids the sintering process thereby no coal consumption is also seen. Although some of the machines in a FaL-G plant utilizes either electricity or diesel for their operation, however this usage is much lower when compared to the thermal energy consumed for production of burnt

clay bricks. Thus even under the CDM, this project activity thus falls under Type II.D "Energy efficiency and fuel switching measures for industrial facilities" (UNFCCC 2006).

5.3.2. Weakness

5.3.2.1. Manufacturing & Processing

1. Storage of raw materials at longer tenure is a problem: long term storage of the main ingredients used for producing the Fal-G bricks leads to the degradation of ambient air quality due to the emission of particulates. Apart from that there is also a threat of increased exposure to dust by the workers while unloading the raw materials as well as to the public with an occasional dust nuisance (Eco Carbon Private Limited 2006).

2. Transportation required for raw materials (fly ash): For transporting the raw materials, the cost has to be managed by the entrepreneurs, which is a loss to them since the area of availability of these raw materials is very far from the actual site of production (Eco Carbon Private Limited 2006).

5.3.2.2. Financial

1. Marketing is weak: Although, there are many advantages in utilizing Fal-G bricks, however the penetration of this technology in the market is significantly low, which is less than 1% of the total market share. Mr.N.Kalidas of ECPL quotes that, "we are hitting the bull, i.e. 200 billion clay brick industry and to cover a country like India, meeting a 200 billion market of clay brick, requires lot of effort from every quarter of project" (K. N 2010).

2. Not popular amongst common man (relation with customers): Despite of the advantages the Fal-G bricks has in terms of reducing GHGs and being energy efficient, yet the usage of these bricks has not picked up at a very considerable amount. In India, there are big MNCs like Aditya Birla groups that are customers of Fal-G, yet the major reason behind this situation is said to be an increased production costs, which in turn has resulted in the raise of the finished Fal-G bricks (Khaturia 2006).

3. Misconception of the bricks (poor man's brick): another major flaw which is hampering the way to use Fal-G bricks is the color of the bricks. Due to the presence of fly ash in the bricks the bricks are usually in the grey color hence creating a barrier in terms of fewer acceptances from the customers. Apart from the colour, the existence of fly ash in the product also creates negative perception upon the quality of the product thus hampering its sales in the market (UNFCCC 2006).

5.3.2.3. Cultural and Social

As mentioned in the earlier parts of the thesis, the brick production in India is a family business and that generations after generations are involved in this business. The clay brick workers have integrated in the society. Due to their age old existence in the society, it is easier for the clay bricks owners to sell their products in the market based on the trust that they have gained for so many years. However that is not the case of Fal-G bricks. Even Mr.N.Kalidas accepts the existing fact and quotes, "Clay brick has a very strong socio-political strength and if you ask me who is responsible for this, I can't say anything as they are located like Indian water, in villages, the remote areas, working without recognition (N 2010)."

5.3.2.4. Political

Clay brick has a strong hold in the society. In the clay brick industry, although there are no big MNCs involved, yet it is considered as a bull because of the mightiness of the people's strength. So many families are practicing the clay brick technology for last several centuries, thus depicting the strength of clay brick industry (N 2010), thereby occupying an important position amongst the working section of the Indian society. Due to their strong position, a major role is played by them during the elections where their votes are cashed based on the caste. Thus the caste based system plays a very important role as well in the non-proliferation of Fal-G bricks in the Indian market.

Tax imposing on flyash in turn raising the cost of raw material: this is another weak point of the Fal-G which disinterests the entrepreneurs in producing these bricks. The Government of India has imposed sales tax and excise tax on the greener technology and that thermal power plants are trying to collect money on

the fly ash which is a waste material generated from the thermal power plants (TPPs). Mr.Kalidas says that, "Fly ash should be made available as easy as clay and I appeal to government but they never bother to listen to us. They achieved 10-15% penetration in the sale of flyash and they are trying to make money out of them. These are the things that prove counter-productive to the product proliferation (N 2010).

5.3.2.5. Environment

Fuel usage during transportation: The Fal-G units operated based on grid power do not emit any dangerous gases. However the units depending on diesel engines to run their machinery certainly emit particulate matter (PM) , SO2, NOx & CO. The Quantity of NOx and CO emitted from the machinery depends upon the temperature and efficiency of diesel-operated generator and machinery for producing the bricks as such (Eco Carbon Private Limited 2006).

Fly ash: as mentioned earlier, it is the waste material derived from the thermal power plant. The radio activity limits of the fly ash generated from the Indian coals is within the limits however it causes irritation to the workers on the prolonged exposure (Eco Carbon Private Limited 2006).

Limestone: lime is produced by the acetylene industry where it exists in the form of calcium hydroxide sludge. When the lime is in contact with the skin directly, it causes irritation on the skin, while the quick lime causes blisters leading to burns at the later stage (Eco Carbon Private Limited 2006).

Gypsum: gypsum is the by-product generated from the aluminum fluoride industry in the form of anhydrite. The usage of anhydrite is done in the fertilizer industries with a considerable amount of radium concentration. However in India, the concentration levels are low thus are in safe limits and is not considered to be a major threat (Eco Carbon Private Limited 2006).

Stone dust: the stone dusts are the rejects derived from the stone crushers. These lead to congestion as well as irritation in the nasal and respiratory passages. The prolong exposure of this dust in an extended period of time results in the development of pulmonary disease as well (Eco Carbon Private Limited 2006).

5.3.3. Opportunities

1. Backing of World Bank:

Major advantage of the Fal-G bricks project is that it comes under the CDCF program of the World Bank. Mr.N.Kalidas in the interview quotes that their commitment towards sustainable development was much earlier than the era of Kyoto Protocol that started in the period of 1990 to 2000. In the year 2002, World Bank launched CDCF and they realized that Fal-G technology provides lots of service to the common man and for the society and it's the fittest concept for community development. Hence Fal-G bricks project under CDM was launched complying with all the rules of CDM and CDCF. Mr.N.Kalidas quotes that, "our's is the first project signed under CDCF" (N 2010).

2. Advantage of INSWAREB and ECPL: INSWAREB as well as ECPL are the Fal-G technology producers with strong background as building technologist. (N 2010).

3. CDM project: Inspite of the heavy competition from the clay brick industry yet the entrepreneurs are able to survive and sell their products at the lower price due to the utilization of the CDM revenues to save the market competition. Hence CDM provides great service to the industry in the name of CDM (N 2010).

4. Loans by bank at lesser interest: Fal-G project helps the entrepreneurs to get the bank loans at a faster rate. Although it is the responsibility of the individual entrepreneurs to mobilize the loans to set up the plant, but the technology provider, ECPL helps arranging the finance, providing with the feasibility report, giving necessary information to the bank queries and sharing the correct information regarding the carbon transaction arrangements as well as agreements hence assisting an individual entrepreneur to gain the loans from the bank (World Bank 2006).

5. Transparency in selling of credits: The CDCF, signs an Emission Reductions Purchase Agreement or an ERPA with ECPL, a typical contract defined in the CDM. This is negotiated with project entity and signed usually at after the validation is advanced enough so that CDCF have some confidence that the project will indeed be validated. This is when they start this contract and it has provisions and in the contract we specify usually specify how many emissions reductions CDCF are going to purchase, the date of delivery of the emissions reductions, calendar of delivery and then

the price and there are some provisions that would be present in the contract (Quesnel 2010).

7. better conditions for the workers in terms of houses, hospitals and schools for the children: In the interview, Mr.Quinsel quotes that the Fal-G project owner Eco Carbon Private Limited, "has agreed to include in the contract they have with various brick factories, a number of provisions to improve the working conditions of workers there, like health benefits and better working equipment and working conditions and so forth. There is a plan which is called the community benefit plan that has been discussed and agreed and now implemented in various brick factories and this plan is financed out of a small premium in the price of carbon that the investors in the CDCF have agreed to pay" (Quesnel 2010).

8. Chances for expanding the market share is more, provided there's proper backing up of government: Mr.N.Kalidas says that, "If the government continues to give the support and this is one of the common man's technology and people love to buy this product, people love to manufacture this product because of various academic logistics and once the availability penetration would be fast and CDM is a added advantage to increase the proliferation (N 2010).

10. Working conditions: due to the better working condition to the workers, more people will be interested in taking up this field of construction and more environmental concern would also drive people to buy the fal-g bricks.

5.3.4. Threats

1.No support from the government: the technology providers claims that when they are offering technology to the people, free of cost or at a nominal price without invoking patent how can government and thermal plants try to make money out of it? In the interview, Mr.N.Kalidas states that, "One side leaders talk about the national agenda and national climate change, while on the other side they are panelizing the green technology with unwanted taxes" (N 2010)

2.Greener tech. are not supported unlike clay bricks who do not even pay taxes: Fal-G bricks have to compete with the unorganized clay bricks sector who are exempted from tax payment, CEZs , but at the same time it has to keep itself under the organized sector. This is a threat for the project since taxes are imposed on the greener technologies

3. Other assumed threats are:

1. Raw material competition would lead to the threat for the production of the bricks

2. In case of the fuel charge increasing there will be threat to the decrease in the production

3. Complete failure of fal-g can be possible due to the aggressive marketing by the competitors

4. Financial options are limited for the establishment of the fal-g bricks

5. Threat to the very roots of the clay bricks if fal-g is hit, which might cause a problem in the Indian society

6. There is no political back up for the fal-g due to the less strength in terms of vote bank

7. Bureaucracy

8. Fuel leakage from the equipment would lead to the pollution

9. Loose disposal of fly ash- a major pollution to the soil

5.4. Institutional Analysis

The three pillars of institutional theory regulative, normative, and cultural cognitive have different attributes emphasizing on rules, norms and values, and shared conceptions. Based on the literature review and empirical data, climate change, Indian political scenario and economic feasibility in India are identified as the essential components to do the Institutional analysis of case study, Fal-G bricks and blocks in India. The analysis is done where each component is looked under three pillars, thereby giving clear view on how are the identified factors playing a role with regards to improvement or declining the Fal-G bricks project taking into consideration.

5.4.1. Analysis of Climate change

In the global arena, climate change is considered to be one of the most important problems to be sorted out. In the year 2007, the Fourth Assessment Report of IPCC highlighted the grim view of the earth's future with reports about how the global

warming would have a devastating impact on the earth's climate. This in turn has resulted in slowing down the pace of advancement towards sustainable development through various factors like increased exposure, leading towards adverse impacts (Ministry of Envrionment and Forestry 2010). However, concrete plans to curb the climate change in the future have been executed by establishing UNFCCC by the IPCC and UNEP and adopting it in the year 1992 as the means of taking global responsibility towards climate change. The convention has a "near universal membership" with 192 parties as its members, with an ultimate objective of stabilizing the concentration of GHGs in the atmosphere at a level of preventing dangerous human intervention with the nature (UNFCCC 2010). In order to give more boost to the climate change programs, members of UNFCCC in the year 1997 adopted Kyoto Protocol in the year 1997, with main motive to strengthen the commitments of developed nations as well as the countries with economies in transition towards reducing emissions of GHGs by an average of 5.2% below 1990 levels within a period of 2008-2012. The Kyoto Protocol came into action on 16th February, 2005 (Ministry of Environment and Forestry 2010). Convention gave the industrialized nations to stabilize their GHGs giving them the norms to reduce the gases while the Protocol on other hand has made these nations in committing towards reduction of GHGs with issuance of regulations.

The countries abiding by the rules of the Kyoto Protocol must have to meet their targets through reformative which are market oriented mechanisms. These are: Emission Trading, Clean Development Mechanism (CDM) and Joint Implementation (JI). While JI and emission trading are one sided mechanisms, CDM projects on the other hand are those projects where a developed nation takes up a GHG reduction projects in the developing nations where the amount of GHG reduction project activities are way lower in cost and simultaneously assisting the developing nations towards achieving sustainable development. This way the developed nations abide by the regulations of the protocol in achieving the "emission limitations and reduction commitments" as well as in helping developing nation to attain development in a sustainable way (CDM India Designated National Authority 2005).

India is one of the parties to the UNFCCC and has agreed to comply with Kyoto Protocol in August, 2002. CDM projects are done in the field of Biomass based cogeneration, energy efficiency, Municipal solid waste, renewable energy such as wind, mini hydro projects etc. It is estimated that by the year 2012, all the registered CDM projects in India would generate 433 million certified emission reductions (CERs) (National Portal Content Management Team 2010). Out of many registered CDM projects, the case study for this thesis is the Fal-G bricks and blocks project. Since the FAL-G project uses one of the small scale methodologies in CDM, i.e. the manufacturing of Fal-G bricks do not involve the usage of coal for baking the raw bricks to cooked ones like the clay bricks but instead needs just air/ sun drying to harden, the usage of thermal energy from the fossil fuels is evaded. The energy efficiency of the 14 Fal-G brick units is about 43.73 GWh_{th} by energy saving which is less than the threshold of 45 GWh_{th} per year as defined in chapter 4(UNFCCC 2006). This energy saving therefore allowed Fal-G to qualify for being a CDM project that is capable of generating CERs. FAL-G has become a part of CDCF port folio a community development program by World Bank, by complying with regulations of CDM, and CDCF where the project owner Eco Carbon Private Limited has agreed to include in the contract they have with various brick factories a number of provisions to improve the working conditions of workers there, like health benefits and better working equipment and working conditions and so forth. There is a plan which is called the community benefit plan that has been discussed and agreed and now implemented in various brick factories and this plan is financed out of a small premium in the price of carbon that the investors in the CDCF have agreed to pay (Quesnel 2010). Since Fal-G project is in compliance to the rules of CDCF, therefore CDCF plays a regulative role for the chosen case study.

Climatic wise, the fly ash bricks are superior than the clay bricks in terms of raw material, especially the fly ash which is 130 million tons from the TPP and difficult to dispose off (Ministry of Environment and Forest, Government of India 2010). Also these bricks do not produce GHGs at a very large scale than the clay bricks as mentioned above and eroding the top soil as raw material.

The report by the Ministry of Environment and Forests to the People on Environment and Forests 2009-10, it is stated that due to the notification issued in

the year 1999 and 2009, the usage of fly ash has increased considerably at around 66.64 million tons per annum (Ministry of Environment and Forest, Government of India 2010), yet consumer's choice is towards clay bricks due to various factors and misconceptions like color, strength, socio-political conditions and the economic conditions mentioned previously, thus depicting the cultural cognitive factors for less utilization of the bricks made up of fly ash and in turn encouraging more drastic climate change due to clay bricks usage as such.

5.4.2. Institution for the Economic feasibility

The CDM gives a chance for the developing nation to host a project being funded by the developed nation not with its commitments towards emission reduction or emission limitations with Kyoto Protocol. Such projects can earn "saleable" credits (CERs) generated from this project in turn benefitting the developing nation leading towards sustainability (UNFCCC 2010).

The CDM projects can be both unilateral and bilateral as explained in chapter 1. CDM projects which are unilateral, i.e. the Fal-G bricks and blocks project are funded by the CDCF of World Bank sell the generated CERs to the world bank, which are is shared among the members of CDCF is proportions, and these CERs cannot be sold to anyone other than the members of the CDCF, 16 nations and 9 companies (Quesnel 2010). Apart from this small premium in the price of the CERs generated are utilized under the Community Benefit Plan towards better health and working conditions. Thus the unilateral gives norms to the Fal-G bricks project in selling the generated CERs to Annex I nations, in turn complying to the rules of CDCF in generation and selling of the credits and utilizing the small amount from the money gained due to sale of CERs in an additional benefit named community development planning benefitting the workers (Quesnel 2010).

Due to the consistent efforts of several programs as well as notifications from the year 1999 to 2009 there has been a considerable increase in the utilization of fly ash and unlike earlier where Thermal Power Plants would charge the producers in pick-up of the fly ash generated as waste, now the Thermal Power Plants in turn are gaining revenues for giving away the fly ash to various users in need (Ministry of Environment and Forest, Government of India 2010). Thus with the combination of rules through notification and giving the fly ash to the users and

gaining money in return by the TPPs is a cultural progress towards making fly ash bricks economic feasible to the producers.

Report from the North Techno Projects on the usage of Fal-G bricks states that for a Fal-G brick with a composition of 55% fly ash, 25% of sand, 15% of lime and 5% gypsum of weight in total of 3.2 kg, with VAT@ 4% of Rs. 0.11, the selling price of the brick is Rs.2.90. The direct profit attained is 1.20 and indirect profit attained through Carbon Credit is 0.08.The percentage of both direct and indirect profits are70.99% and 4.72% respectively. Therefore the total percentage of the profit comes to 75.71% (NORTH TECHNO PROJECTS 2010). The indirect profit through CERs is an extra benefit to use Fal-G bricks financially than the clay bricks, with increase in the usage of these type of bricks as mentioned above, thus giving more scope for attracting producers as well as consumers at cultural conditions.

However, in spite of the profits seen as above, yet there are factors like taxes and CEZs as mentioned by Mr.N.Kalidas in his interview and also the transportation cost for the raw materials that make Fal-G bricks costlier than the clay bricks. Also due to the heavy competition from the clay brick industry, which have a strong hold in the society forces the Fal-G brick industries sell their bricks at cheaper rate (N 2010). The cultural factors have thus been a hamper to the Fal-G bricks in the society economically.

5.4.3. Institution for Indian Governance

India gave its consent to the Kyoto Protocol in August, 2002 with one of its aim in fulfilling the fundamental rules for implementing of CDM projects with respect to "national sustainable priorities" whereby the Annex I nation would set up GHG reduction project in the Non Annex I nation since the cost of GHG reducing project activities are much lower and complying with the rules of the Kyoto Protocol for the limiting and reducing the emission commitments and helping the Non Annex I nations to achieve sustainable development (CDM India Designated National Authority 2005). Thus, the Indian Government exhibits the regulative approach being in compliance with Kyoto Protocol.

In India, periodic meeting of the National CDM Authority is held whereby CDM projects are granted the Host Country approval. The Ministry of Environment and Forests states that till December, 2007, the National CDM Authority has granted its approval for 772 projects in various fields such as Energy Efficiency, Municipal

Solid Waste, Renewable energies etc. As mentioned under the climate perspective, if all the projects are successfully registered with CDM Executive Board, fulfilling the norms of the Kyoto Protocol, then the resultant CERs generated will be 433 million (Ministry of Envrionment and Forestry 2010).

In case of Fal-G bricks and blocks project that fall under unilateral CDM project, Ex Indian Prime Minister, Mr.P.V.Narasimha Rao, framed a high power committee to explore the scope of implementing Fal-G project as a national program after receiving letter from the developers of this technology. Mr.N.Kalidas, the developer of Fal-G technology quoted in his interview that, "Incidentally by the time the report had come, he was out of the power and the high power committee report did not get into action". Thus culturally Indian politicians could be sensitized towards the benefits of using Fal-G bricks, taking its positive aspects. The Ex-Chief Minister of Andhra Pradesh, Mr.N.Chandra Babu Naidu, with an interest in the Fal-G technology for its contribution in attaining the sustainable development has ordered the issuance of 8 Governmental Orders (G.O) during his time promoting this technology in the Andhra Pradesh Government which is in the year 1999. Thus at the state level, regulations were made to use the Fal-G bricks (N 2010).

Issuance of notification by Ministry of Environment and Forestry (Ministry of Environment and Forests) for usage of Fly ash bricks in the year 1999, amended in the year 2003, at a ratio of 1:3 with soil for clay brick producers, provided the brick kiln is located within a ratio of 50 km (100 Km amended) of coal based thermal power plants (TPPs) (Khaturia 2006). In the year 2008 6th of November, Ministry of Environment and Forests amended the notification stating that the Central Government shall put into effect its power on or after a tenure of 60 days from the date of notification published and issued to the public to implement the notification (05 February, 2009). The notification will be valid to all the construction agencies, both public and private sectors and that it will be the responsibility of the agencies that are either undertaking any construction or approving the design. Thus the notification gives the brick manufactures a regulative to use the Fal-G bricks that are beneficial to the environment. The stricter rules from the year 2009 states the mandatory utilization of the fly ash within a radius of 100 km of TPP for both public and private buildings and shall be

under the supervision of agencies who are either undertaking any construction or approving the design of the building (NORTH TECHNO PROJECTS 2010).

With several rules passed by the government, yet the Fal-G bricks have a weak hold culturally since they are not well backed up by the politicians. The clay bricks sector does not have to pay to the government since they are a much unorganized sector. Their strong hold in the lower section of the Indian society makes their very important as a vote bank to the Indian politicians (N 2010). Apart from this, there are no price regulations over the clay bricks which in turn are affecting the sales of the fly ash bricks. Also no proper endorsement is done by the government in promoting this technology as such. One side leaders talk about the national agenda and national climate change, while on the other side they are panelizing the green technology with unwanted taxes which at the regulative level curbs the growth of Fal-G bricks into the Indian market (N 2010).

6. Discussion

The thesis aims at studying various factors that affect the development of newer indigenous technology, developed in a developing nation and its contribution towards sustainable development of the nation. Fal-G bricks and blocks project was selected as the case study for this thesis as the technology for this project is developed in India, with patent rights being held by the promoters of Fal-G technology. As the project is capable of reducing GHGs which is the basis for generating a CER the project is qualified for being a CDM project.

In this chapter we discuss the life cycle so far of the Fal-G bricks and blocks project with the support of the various analyses done in the chapter 6. Each stage of project is looked under SWOT, barrier, and Institutional analyses by identifying the stake holders. Though the project is a success today in terms of generating CERs under World Bank's perspective (Quesnel 2010), it is not the beginning of the journey and definitely not the end as each stage of a journey has its own ups and downs which we discuss in detail below.

The technology behind the Fal-G project was started as an initiative by Mr.N.Kalidas and his partner, the founders of INSWAREB and ECPL and was identified as stakeholders during analysis as present in chapter 6 of the thesis. As explained in the SWOT Analysis the technical background of the developers helped them in establishing initial framework for the project. This in turn has been qualified as the major strength for the technology to develop with utilization of fly ash. Initial cost of the development of technology was from the creators own earning as the consultants for the multi-national companies in the field of brick manufacture. This definitely shows that the promoters were independent in financial aspect during the initial development of the technology, and this option might not be feasible for everyone particularly when the creator of a technology is not financially strong enough to invest in development.

The key ingredients used in the preparation of Fal-G bricks are fly ash, lime and gypsum. Ordinary Portland cement and sand are other ingredients utilized in the production. As the name suggests, major advantage of these bricks is the availability of the main materials that is either in the form of waste or by-products from various industrial activities. According to the producers of the Fal-G bricks,

the gestation period ranges between 10-15 days where the raw bricks are sun or air dried depending on the ambience of the plant unlike the clay bricks where the gestation period is between 40-45 days and uses coal for firing the raw bricks (K. N 2010) with reports from CDCF stating that for every 1 million tons of bricks to fry, it requires 200 tons of coal for burning (The World Bank Carbon Finance Unit 2010). Despite of the advantages with respect to availability of raw materials, its strength and its climatic advantages, yet Fal-G bricks have a disadvantage where any slight change in the composition of raw material can disturb its functionality thereby changing the chemistry of the bricks as such (UNFCCC 2006). The availability of the raw materials at a larger scale is also not possible and problems with storing and transportation of raw materials at longer tenure being an evident weakness of this technology.

Realizing the social and environmental advantages of the technology, the promoters approached World Bank for support and promotion of the technology explaining its potential in the year 2000. World Bank convinced by the potential of the technology proceeded to sign a deal at which point the ECPL was created as the World Bank was concerned with the accountability of the INSWAREB as a NGO to overcome the initial barrier being an NGO. Further progress in the deal was blocked as India was not a signatory of the Kyoto Protocol as the host country approval is very important for a project to be hosted under CDM rules (K. N 2010). This was the initial major barrier that was faced by the FAL-G project to be setup as a CDM project. To overcome the barrier the project promoters made an approach to the Indian parliamentarians by addressing 540 letters. Fortunately in 2002 India has acceded to the Kyoto protocol which allowed FAL-G project to overcome its initial barrier. In the same year World Bank launched CDCF which aims at the community development through CDM projects and Fal-G project was the first project to be signed under the CDCF (K. N 2010) giving the technology and the project economical strength and opportunity to expand further. Analyzing the above events it can be clearly seen that Fal-G bricks project which can contribute to the sustainable development with its environmental strengths such as lower emission of GHGs, utilization of waste products from the Thermal Power Plants etc was denied a major opportunity to be a CDM project because of lack of initiative from the Government of India. The future of the technologies like Fal-G is directly

related to the government policies, and that these technologies cannot proceed independently in certain areas of development. If the Government was proactive to the requests of Fal-G promoters, or if the government had a foresight on the greener technologies, there by playing a important role in the international scenario of environmental issues it could have helped in the promotion of technologies like Fal-G.

The period between the years 1999 to 2002 saw the issuance of the Government Orders with regards to promoting fly ash as a raw material in the building construction and manufacture of bricks and blocks. On September 19th 1999, the Ministry of Environment and Forest issued Notification on the utilization of fly ash at a radius of 100 Km of the coal based Thermal Power Plants. In the year 2002, all the Governmental agencies including the Central Public Works Department as well as the State governments were asked to utilize the fly ash based bricks or blocks as the building materials and provisions with regards to fixing of rates for fly ash and soil borrow areas were made (MINISTRY OF ENVIRONMENT AND FORESTS 1999). In the same year, 31st January, 2002 Government of Andhra Pradesh issued notification to all the municipalities of the state to use fly ash as their building construction material (GOVERNMENT OF ANDHRA PRADESH 2002). Issuance of Government Orders mentioned above must have improved the overall usage of fly ash as a construction raw material, causing a major breakthrough for the related technologies like Fal-G. However in reality the improvement in the usage of the fly ash related construction materials was not seen as expected, as the Government Orders were not strictly followed up on. This shows that there is a difference between what is seen at the institutional level is not same at the ground level and the companies like Fal-G fall prey for such inconsistencies. This also demands a more active follow up on the Government Orders that are being issued by the Government.

The CDCF has been setup with a very specific objective to develop small scale projects in the poorest countries or small scale projects that can bring measurable benefits to the poor communities. (Quesnel 2010). The fund consists of 25 fixed participants out of which 9 are governments and 16 are the private sector

companies. The credits purchased by the CDCF are sold only to the 25 participants mentioned in proportion to their share in the fund (Quesnel 2010).

CDM is the only market based mechanism defined in Kyoto protocol with joint collaboration between the Annex I and non Annex I countries. Unilateral CDM projects are those projects that do not have the Annex I party "letter of approval" at the time of registration of CDM project. FAL-G bricks and blocks project falls under the unilateral CDM projects. FAL-G was registered as a CDM project in the year 2004. The five step process under Marrakech Accords as mentioned in chapter 1 results in the issuance of the CERs to the parties concerned. The energy efficiency of the Fal-G bricks has placed it under type II.D CDM project due to its non coal consumption as well as sintering technique, in turn contributing to the lower emission of GHGs into the atmosphere.

The energy efficiency of the 14 Fal-G brick units with a total production capacity of 61200 m^3 bricks per year is estimated to be 44.37 GWh_{th} per year. This saving of energy is below the "45 GWh_{th} threshold for savings in thermal energy inputs" considered for small scale projects that fall under II.D category (UNFCCC 2006). Since the Fal-G uses small scale methodologies in CDM, it in turns complies with CDCF objective for funding the CDM project. Apart from this, the "community benefit plan" is implemented by the ECPL as a part of its agreement with CDCF, whereby utilization of small premium in the price of carbon is made for various social causes such as health conditions, better work equipments and working conditions (Quesnel 2010), for the FAL-G workers who can be classified as, the ones who travel to work from nearby places, bachelors who stay at work place and the families who stay at the work place (N 2010). The Fal-G agreement for the regulations of CDCF regarding the social responsibility has benefitted both the Fal-G entrepreneurs and their workers.

The Fal-G project is one of the success stories and has started delivering a number of CERs. As the project is successful, based on the estimation that each FAL-G plant on an average approximately produces about 2 million bricks per year and the carbon revenue generated out of this is US $3500-$4000 annually excluding the transaction costs (World Bank 2006). Fal-G bricks with a with a composition of 55% fly ash, 25% of sand, 15% of lime and 5% gypsum of weight in total of 3.2 kg,

with VAT@ 4% of Rs 0.11, has the selling price of the brick for Rs.2.90 according to the report from the North Techno Projects. The direct profit attained is 1.20 and indirect profit attained through Carbon Credit is 0.08. The percentage of both direct and indirect profits are70.99% and 4.72% respectively. Therefore the total percentage of the profit comes to 75.71% (NORTH TECHNO PROJECTS 2010). The indirect profit through CERs as mentioned above is an extra benefit to use Fal-G bricks financially and according to Mr.N.Kalidas, CDM is helping some of entrepreneurs to lower their price in order to compete with the clay brick industry, thereby utilizing CDM revenues to save the market competition from the clay brick industry. Despite the advantages as seen above, factors like taxes and CEZs as mentioned by Mr.N.Kalidas in his interview and also the transportation cost for the raw materials, make Fal-G bricks costlier than the clay brick (K. N 2010).

Many of the entrepreneurs complain about the stiff competition they face from the clay brick industry, a highly unorganized sector that hold a strong position in the Indian society, particularly from the price front of the clay brick industry. Consumers in India to certain aspect look for price but not for the engineered property. Fal-G brick industry thus has to compete with such an un-organized product keeping itself in the organized sector. Although big MNCs utilizes the Fal-G bricks yet among the common man, the misconception of Fal-G bricks being dull in color and not attractive in addition to the price results in its lower market penetration (K. N 2010). Apart from it, the consumers also hesitate in buying the Fal-G bricks because of the presence of ash in it which creates a negative impression on the quality of the product (UNFCCC 2006). As mentioned, the clay brick industries in India are very much in the un-organized sector, which means that they do not pay taxes. No taxes are bound on the clay brick industry. They utilize highly fertile top soil in the production of the bricks. There exists estimation that clay brick industry degrades the fertile top soil at the rate of 50,000 acres every year in India, thereby causing severe land degradation (Khaturia 2006). Apart from this, the burning of clay bricks uses coal for sintering process leading to the emission of GHGs at a higher rate. Inspite of these negativities, integration of the clay brick workers in the Indian society, it is easier for the clay bricks owners to sell their products in the market, based on the trust that they have gained for so

many years due to their age old existence in the society. However that is not the case of Fal-G bricks. Even Mr.N.Kalidas accepts the existing fact and quotes, “Clay brick has a very strong socio-political strength in villages, the remote areas, working without recognition (N 2010).”

The above scenario could have been different if the promotion of Fal-G bricks was aimed at distancing the concerns of the consumer like coloring the Fal-G bricks, explaining the strength and advantages of the bricks by presenting the proper facts that can overcome the existing misconceptions. Also Fal-G entrepreneurs should have taken a proactive role by endorsing the product to the big customers like the contractors and construction companies that would have made some positive impact on the small customers in long term.

The political conditions play a major role in hampering the penetration of the Fal-G bricks into the market. With imposed sales tax and excise tax and thermal power plants trying to collect money on this fly ash, the government has achieved 10-15% penetration in the sale of fly ash. These are the factors that prove counter-productive to the product proliferation (N 2010). Another barrier according to ECPL’s founder Mr. .N.Kalidas is that “when the technology to the people is offered either at free of cost or at a nominal price without invoking patent why is it that government and thermal plants try to make money out of it? Leaders talk about the national agenda and national climate change, while on the other side they are panelizing the green technology with unwanted taxes.” (N 2010). Due to the strong position of clay brick workers in the lower section of the Indian society, a major role is played by them during the elections where their votes are cashed based on the caste based system plays a very important role. . Thus the caste based system plays a very important role as well in the non-proliferation of Fal-G bricks in the Indian market. The role of government in promoting the fly ash based construction materials need to shift from current mode of small term profits towards long term goals and benefits. Also it has to be clarified to the all sections of people that technology is for everyone when it can do good to the environment as well as the society instead of going by caste based politics.

Even with its own weaknesses and threats from other, Fal-G bricks and blocks project has proved its mark with its survival and according to CDCF, it is one of the

“very successful projects” since they think that technology providers have done a fantastic job not only by complying to the CDCF rules but at the same time have been delivering successfully a number of CERs on the fund. In an interview with CDCF, Mr.Quinsel stated that buying additional CERs from Fal-G bricks by CDCF fund would be mostly limited due to the already determined target of CDCF to the year 2012. Since the year 2012 is approaching sooner, any credit purchasing by the fund will be looked upon as one of the last operation by the CDCF but after the given time it will not be in a position to purchase the credits anymore from the project (Quesnel 2010). As Mr.N.Kalidas mentioned in his interview that it is due to the additional source of revenue from CDM that some of Fal-G entrepreneurs are able to lower their price in order to compete with the clay brick industry by utilizing the CDM revenues to save from the market competition (K. N 2010). Hence, it is evident that Fal-G bricks and blocks producers have to find another potential buyer to purchase the generated CERs to continue competitive pricing for the bricks in future.

Issuance of GO by the Ministry of Environment and Forestry in the year 2009 states the mandatory utilization of the fly ash within a radius of 100 km of TPP for both public and private buildings and that it shall be under the supervision of agencies who are either undertaking any construction or approving the design of the building to see that all the buildings are constructed with fly ash. (NORTH TECHNO PROJECTS 2010). Also the report by the Ministry of Environment and Forests to the People on Environment and Forests 2009-10, states that due to the notification issued in the year 1999 and 2009, the usage of fly ash has increased considerably at around 66.64 million tons per annum (Ministry of Environment and Forest, Government of India 2010). However taking into account the previous issuance of Government Orders by the Ministry of Environment and Forests and their follow up it is very difficult to come to a conclusion that these Government Orders would do any good to the market penetration of fly ash based bricks. Also the Fal-G bricks are highly dependent on the generation of fly ash in the Thermal power plants and its availability at a cheaper price which would not be true if the demand goes high as a result of steps taken by the government to promote the fly ash utilization.

As identified in the SWOT Analysis, the weakness of the Fal-G bricks and blocks projects in future perspective are high transportation costs for transporting raw materials, low market penetration and less popularity of the Fal-G bricks among consumers due to the misconception about the bricks with socio-cultural and political factors. Weaknesses in combination with no government support and charging taxes on the green technology, complaints by the local residents, increased fuel charge, limited financial options and bureaucracy will prove to be potential threats to the Fal-G technology in future if no steps are taken to overcome these. However abundant availability of raw material for the production of bricks with no patent right on the technology by the technology providers and availability of equipments at a cheaper rate with low space consumption for the brick production would strengthen the Fal-G technology. The lower emissions of GHGs and utilization of the waste and by-products as the raw materials and being energy efficient should be considered as a strong points of opportunities for the proliferation of this technology into the Indian brick market even in the future.

After analyzing the life cycle so far of the Fal-G project it can be said that the project has faced initial threats from various actors identified such as Indian Government, clay brick industry, which has hindered the penetration of the Fal-G technology as expected based on its potential of being a sustainable technology with many advantages. At later stages of the project support from CDCF and CDM gave considerable strength to the Fal-G technology in a variety of aspects like economical, moral, and social elements. However the initial threats and inherent weaknesses of the Fal-G technology need to be overcome in order to have a future that suits the actual potential of the technology. Actors like the Government of India need to be proactive in supporting the sustainable technologies and need to follow up on the regulations issued by it. The society needs to be educated regarding the advantages of the technologies like Fal-G and they should be made a part of the revolution towards the sustainable technologies.

7. Conclusions

The discussion in the chapter 6 gives extensive insight into the life cycle of Fal-G bricks project with rest of the chapters providing base for the discussion. The current chapter concludes the thesis by answering the sub research questions which will answer the main research question.

Sub Research Question 1

How do different actors look upon the new technology as a breaking path for the penetration of this technology into the market?

Answer to Sub Research Question 1

To answer the 1st sub research question, stakeholder analysis was performed and ten actors were identified. Out of which INSWAREB and ECPL are the promoters of the technology and they heavily support the implementation of the Fal-G technology as a sustainable development alternative for the traditional clay bricks. CDCF in this thesis has been identified as the main financial supporter and it shares the promoter's enthusiasm regarding the contribution to the sustainable development. The entrepreneurs and workers of Fal-G bricks and blocks project are the actors present in the front line of manufacturing and selling of the Fal-G bricks. They have taken upon their respective roles based on the technological, social and economical promises of Fal-G technology. Ministry of Environment and Forestry (Ministry of Environment and Forests) shares the idea of fly ash being an environmentally friendly alternative in the construction industry. It also is responsible for issuing regulations regarding the usage of fly ash within the vicinities of Thermal Power Plants run by coal but their active participation is not as enthusiastic as it looks on the regulations. Clay brick industry is the main competitor for the Fal-G bricks and blocks project. The clay brick industry, having its social and cultural roots deep inside Indian society, looks upon the Fal-G technology as a threat; though in reality it is not. Among the raw material suppliers, the fly ash suppliers see Fal-G technology as a means to get rid of the waste produced in their power plant during the initial stages of the technology,

later this has become an extra source of revenue for the TPPs. The raw material suppliers of other key ingredients used in the preparation of Fal-G bricks are the standard industrial suppliers. The brick consumers are the key players who decide the fate of Fal-G technology by utilizing the Fal-G bricks. They perceive Fal-G bricks as costly engineered designer product while in the looks they assume the Fal-G bricks to be poor man's brick. They also have misconceptions with regards to the strength of these bricks. The local residents are the ones who get affected by the minor side effects of Fal-G brick manufacturing plants. They perceive it as an opportunity for getting employment. They only see Fal-G establishment as a threat when the side effects hampering their health conditions starts showing up.

Sub Research Question 2

How is the new technology being looked upon from the cultural, economic as well as the institutional point of view in India in turn contributing to sustainable development?

Answer to Sub Research Question 2

The new Fal-G technology uses fly ash as its key ingredient to manufacture the fly ash bricks. This competes with the traditional clay bricks for market penetration. These traditional clay bricks have a strong roots associated with the Indian culture and society as they are mostly a "family run businesses" and the bricks are perceived to be part of culture that are reflected in the modern Indian architecture. The Fal-G bricks which have no cultural roots are looked upon as the poor man's brick look wise and costly engineered designer products. The clay brick industry is a big bull which has huge market capture in India when compared to Fal-G bricks. One of the reasons is due to the lower price of the clay bricks when compared to the Fal-G bricks. This is due to the high raw material costs and being organized sectors they pay taxes which in turn affects the total production costs and this is reflected in the price of Fal-G bricks. However they are competing in price with the clay bricks due to the revenues generated by the sale of CERs. The Government of India is promoting usage of fly ash by the issuance of Government Orders from the year 1999 and various amendments have taken place with latest being in the year 2009 where the Ministry of Environment and Forests made it mandatory for the users present within the radius of 100 Km of TPPs to use fly ash as the construction material for the buildings. However, due to the strong hold of clay

brick sector in the lower section of the Indian society, forming them a strong vote bank; the Indian politicians are backing off from taking a strong step towards strict implementation of the Government Orders issued regarding the usage of fly ash bricks. Though the Indian Government appreciates the contribution of Fal-G bricks to the sustainable development, they are still taking decisions that are counter - productive like increasing the fuel costs, charging for the fly ash which is supposed to be a free product from TPPs and imposing taxes on the greener technologies while the clay brick workers gets away without paying taxes just because they are an unorganized sector. The demand from the Fal-G brick industry is that fly ash should be made available on par with the soil.

Main Research Question

What are the various factors that affect the development of newer indigenous technologies which contributes to the sustainable development of a country like India and what role does CDM play in this aspect?

Answer to Main Research Question

As sub research questions 1 and 2 are answered, we can clearly see that there are cultural, institutional and economic factors that are affecting the penetration of the Fal-G technology while as answered in sub research question no.1, some actors like INSWAREB, ECPL, CDCF, Ministry of Environment and Forests, Fal-G entrepreneurs and workers contribute positively to the success of the technology while actors like clay brick industry, raw material suppliers and brick consumers have a negative impact on the technology. The Ministry of Environment and Forests has both positive contributions as well as the negative effects in the Fal-G project which leaves a open question if it has a positive or negative impact on the project, to answer this it requires further investigation. The local residents play a neutral role and are only affected by this technology. These actors as well as the factors mentioned in the sub research question no.2 give rise to the various strengths and opportunities and at the same time weaknesses and threats and barriers to the Fal-G technology. The CDM plays a substantial role in the economics of the technology by giving the financial support by purchasing the generated CERs which act as an additional income to the Fal-G technology.

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Appendices -Interviews

Appendix I - Interview with Eco Carbon Private Limited (Mr.N.Kalidas)

1. *What is Motivation of developing Fal-G technique?*

This technology is developed because of urge to do something for sustainable development. We being the building material technologist, we thought of focusing towards industrial solid waste utilization, which is 150 million tons per year and now at present it happens to be around 240 -50 million tones every year. This means that when we focused our attention on the solid waste utilization, it means that we are conserving equal quantities of minerals and the energy that gets into the processing of the minerals. So that is how our interest started and our initial aim is also coined. We identified that fly ash is 70% of the total solid waste output and fly ash is incidentally happen to fit into our building material technology as it happens to be pozzolanic material. So that is how this technology development took place and we being the technocrats, we have not confined our innovation to laboratory, we immediately shifted to land and then resorted to entrepreneurial development and we were so passionate in our entrepreneurial development programme that we hold the patent on this and we are not invoking this patent rights on the small scale entrepreneurs' specifically to ensure that, the small scale industries should not be shackled with obligations……which has helped in the rapid proliferation of the industry and today more than 10,000 units are working throughout the country. We resisted from collecting any royalty. it's something like Microsoft Windows. We follow Bill Gates in this, where we get the official royalty, we get it otherwise we are not bothered for the pirated approach which is ultimately beneficial to the country.

2. *How did you succeed in getting the financial aid for Fal-G project?*

We were doing consultancy earlier for multi-nationals like …… of Germany and we were doing some corporate consultancies. So initially we were earning out of that and were spending for this and when this technology dissemination started, it started receiving nominal amount of, one time consultancy fee for the entrepreneur and this was utilized for market development and market awareness, market awareness structuralisation program etc. if you look at our website, we do multi-fallacious approach in order to consolidate the technology promotion. This means that we do entrepreneurial development, market development, market awareness program and we are interacting with government and sensitizing them about their accountability towards sustainable development. Also we have dropped a couple of notifications in order to drive the government on what they have

to do about this particular sector. So our approach is multi-fallacious and ultimate goal is for the promotion of sustainable development.

3. *How exactly is your company dealing with the Indian government with respect to bureaucracy?*

We have bad beauracrats and bad politicians and at the same time we have good beaurecrats and good politicians. We are fortunate to get access to good people. One such example when P.V.Narasimha Rao, the EX-Prime Minister of India, when returned back from his visit from Singapore, had issued a statement praising the technology over there. Immediately a fax was issued to him stating that "you politicians have time to praise the foreign technology but not the native" and he at the Prime Minister level constituted a high power committee to explore the scope of implementing this is a national program. Incidentally by the time the report had come, he was out of the power and the high power committee report did not get into action, but the point here is this is how we sensitize the people. Earlier the Ex-Chief Minister of Andhra Pradesh, Mr.N.Chandra Babu Naidu, has taken a lot of interest in this technology because he understood the contribution of this technology for the sustainable development and during his time he has issued 8 Governmental Orders (G.O) for promotion of this technology in the AP government. Ministry of Environment keep drafting the GOs for the promotion of fly ash utilization and they default certain data and that's where again we guide them and very recently, we have re-drafted their draft notification and many of our implementations have taken under consideration and final notification had come in November,2009. Now we are interacting with government.

4. *Based on all this bureaucracy, in the present scenario, how do you actually think CDM based on the Fal-G technology a worthy project for the sustainable development?*

The point here is that Fal-G has its own technological strength. It has to compete with the clay brick industries in India which is very much in the un-organized sector, which means that they don't pay tax, CEZs. No tax regimes are binding on the clay brick industry and fly ash brick industry has to compete with such an un-organized product keeping itself in the organized sector. Many of our entrepreneurs say that there is a lot of competition, particularly on the price front of the clay brick industry and consumers in India to certain aspect look for price but not for the engineered property. They like the engineered property if the price is same. So this CDM is helping some of entrepreneurs to lower their price in order to compete with the clay brick industry. They are utilizing the CDM

revenues to save the market competition. Hence great service to the concept of CDM to this industry.

5. *Based on the project development design, how is INSWAREB associated with you? Is it a joint venture of your company or is it independent organization tied up with you?*

You must have read about our activities. Basically the whole activity is engineered by me and Dr.N.Bhanumati Das who happens to be my spouse as well as the working partner. Initially we started NGO because we thought that the technology we developed is a "junta" technology, meaning common man's technology, which needs lots of …. And the chairman of HUDCO, believed our technology has a breakthrough path in the clay brick industry. So he supported us initially encouraging us to set up a building sector and this sector has to be governed by a Non- Profit Organization and that is how NGO has been started with INSWAREB as R&D body and associated body, i.e. INSWAREB Building sector that focuses on the free demonstration of building energy technology. So initially the INSWAREB approached World Bank offering Fal-G as CDM project but it came to the level of signing vesta, i.e. a commercial deal, and so World Bank expressed comfort level to deal with corporate rather than a NGO because NGO is a non-profit organization and accountability is not more. So in order to satisfy their comfort level, Eco-Carbon Pvt. Ltd was started as corporate outfit. So it's even it's the INSWAREB or ECPL we are together.

6. *How did you start up with your shift with CDM and how did you deal with World Bank?*

If you look at Kyoto Protocol, they are all in the era of 1990 to 2000 but we started our commitment towards sustainable development much earlier. So when we have seen this Kyoto Protocol and the development, we thought that this is a development falling in line with our objective of sustainable development so we started taking interest on the Kyoto Protocol. In 1990, we have been appointed as an observer organization for COP. INSWAREB, being NGO, it has been accredited as an observer organization for COP. So we started reading more and more about Emission Trading etc etc, and we realized that our technology is the fittest technology for this. So in the year 2000, we have undertaken an independent tour of US and Europe and tried promoting our concept in the international market and in the process of this tour, we happen to meet the world bank, so our 1st dialogue with world bank started in the year 2000 but incidentally at that time India was not a signatory so the world bank said if you can convince your government we can give you 10 million dollars for this project. We realized that host country approval is very

important to take the program and India was not the signatory. So we 1st made an approach to our Parliament and we addressed 540 letters to all the parliamentarians (can be seen in our website). Fortunately in the year 2002, world bank launched CDCF and they realized that our technology provides lots of service to the common man and for the society and it's the fittest concept for community development and ours is the first project signed under CDCF.

7. *When you talk about common man, how much do you think that your technology has reached common man as such, because according to the report by UNFCCC, market penetration of this technology is less than 1%.*

There are 2 issues, qualification of technology for common man and taking this technology in the service of common man is the 2nd stage. If you see the parameters of this technology, this had all the compliances for sustainable development and we made a challenge in one of the forums stating that "you can't show one more technology of this nature which has compliance to so many parameters." When I say "so many parameters", I insist now, saying that, "it is the appropriate technology, it is the advanced technology, it is the energy efficient technology, it is the eco-friendly technology, and above all it is the carbon saving technology and also it is the cost reducing technology.

If you increase the efficiency of a carburetor of a car, no doubt you will increase the fuel efficiency of the car but cost will go high. So if you look at the technology scenario on various products, one way or the other its….. . if you increase the efficiency….. this is one such technology which fulfills the parameters and we have an award to people who can show a technology which is much better than our technology, and this challenge is to you as well. So what I want to say is that, many of the clay brick producers, the masons has switched over this technology. It is a technology that can be practiced on foot path, road side in a forum, in an agricultural yard and ADITYA BIRLA GROUP is my client and have set up a scale of large scale projects in order to promote the scale of ……. it has a cross section of entrepreneurs, thereby lot of flexibility in the investment requirements is available and coming to project, the brick has 40-45 days period of gestation and skill is required to manufacture clay bricks whereas Fal-G takes gestation 10-15 days, there is no much skill involved and it is the machine that does the operation. So in a way it is much easier technology to be practiced comparing to the base line product, i.e. the clay brick. If you look at the clients, round the earth various entrepreneurs have joined to take up this program and it has motivated clay brick producers as well to shift to this technology. Earlier I missed this point, when you said government, it means implementation of policies and these policies are implemented only if it is accepted by the people and

definitely people will not accept the policy until they enjoy the comfort level. When people enjoy the comfort level, no government is required, no policy is required and this is what fly ash brick activity is bringing the comfort level but looking at the dimension of India and looking at the dimension towards hundred million clay brick market, the rate of penetration should be rapid than what is achieved today.

Indian government has imposed sales tax and excise tax and now the thermal power plants are trying to collect money on this fly ash. Fly ash should be made available as easy as clay this is the punch line and I appeal to government but they never bother to listen to us. They achieved 10-15% penetration in the sale of fly ash and they are trying to make money out of them. These are the things that prove counter-productive to the product proliferation.

If the government continues to give the support and this is one of the common man's technology and people love to buy this product, people love to manufacture this product because of various academic logistics and once the availability penetration would be fast and CDM is a added advantage to increase the proliferation.

8. *When you say that clay brick people also can utilizes this technology, then how do you support them financially?*

First of all I have to clarify that the cost of plant and machinery has nothing to do with quality. When we launched the technology we have picked up the moulds from the clay brick industry and we made them to use in the Fal-G bricks instead of clay to manufacture bricks and those bricks they weigh 120 to 150 Kg per square meter against to 30 to 50 cms of Clay bricks. So I want to clarify here that the quality of Fal-G or Fly ash bricks which is a reflection of pozzolanic chemistry, has nothing to do with machinery.

Role of Machinery is that it helps in production made and helps for giving sort of finishing to the product to give it a better cottage or finishing touch and hence is used in the beautification of the product but has nothing to do with compressive strength and water absorption. When we started this, it was started as a cottage industry and today out of my 10,000 units, I may say about 6 to 7 thousand units do use a moulding machine which costs only Rs.60,000. The mixer costs about Rs.2 Lakhs and on those days it was around 1Lakh. So all in all the starting capital today is about 3.5to 4 Lakhs towards plant and machinery and a bit extra for infrastructure etc. which is the starting capital and if one wants to manufacture brick in the lines of clay brick using the same wooden mould, that is also possible.

9. *As of now, how much do you think your technology has really been penetrated into the market?*

Today it is the technology of the people. People realized what the product is and what the comfort of practicing is but the question is how much of penetration do we need today or we have achieved today. We are hitting the bull, i.e. 200 billion clay brick industry. So the point here is people are aware of product technology and the comfort level but to cover a country like India, and to meet a 200 billion market of clay brick lot of effort is required from every quarter of project. So how far this can be achieved is one question. We are in the path of achieving this but how rapidly can we achieve this, is the question that I am not in a position to answer today and this criticism cropped up purely due to the government's negative attitude and I should say they just sign off with no sense of responsibility. You can put it in your thesis.

When the technology developer is offering technology to the people, free of cost or at a nominal price without invoking patent how can government and thermal plants try to make money out of it? Is it not shame on their path?

One side leaders talk about the national agenda and national climate change, while on the other side he is panelizing the green technology with unwanted taxes. Is it not a crime, mistake of lopsided policy which only is meant to kill the concept and I am very unhappy for this.

10. How do you face restrains from the giant bulls the brick market?

If you look at the clay brick industry, there are no big MNCs involved there but still it is considered as a bull because of the mightiness of the people's strength. So many families are practicing the clay brick technology for last several centuries, so that's the strength of the clay brick industry. Today if you look at the clay brick quality in India, 70 to 80% of the bricks do not qualify ISO standards. Can you imagine a country like India using a product which hasn't qualified ISO standards at such a large volumes? Clay brick has a very strong socio-political strength and if you ask me who is responsible for this, I can't say anything as they are located like Indian water, in villages, the remote areas, working without recognition. I told you earlier that they do not bother to pay taxes but their strength is making them to proliferate even in the remote areas making it possible that clay brick is available at every nook and corner of country. So can we make fly ash available at such ease is one question. At one point we need to…… the government. Once the goal is to halt the plant, the same should be implemented to halt the fly ash ……. and we should encourage fly ash depot at every urban sector. Unless we make the fly ash logistics

comparable to the brick or over power that of clay brick industry, our efforts remain as only efforts but do not get into reality.

11. How are you planning to endorse your product?

We are not deterred by any government policy. Whatever opportunities we get in our way, we take it and at one point of time, we got the opportunity of HUDCO and we utilized it another time we got the opportunity of Mr.N.Chandra Babu.Naidu, the Ex Chief Minister of Andhra Pradesh, we utilized it. Now we got the opportunity of CDM revenue we are utilizing it. So to promote the fly ash bricks into the clay brick market, continuous efforts are required for which we are trying to take advantage of every tool. Today CDM revenue is such tool and we are sure that tomorrow another government may come and pay more attention to sustainable development. So we work and as the opportunity comes we take the advantage of it and try to promote our technology.

Appendix II - Interview with Community Development Carbon Fund (Mr. Brice Quesnel)

1. *What are the factors that are considered for investment in a CDM project like Fal-G Bricks and Blocks?*

The fund that is purchasing the emissions reductions from this project is one of the world bank carbon funded community development carbon fund and The community development carbon fund has been setup with a very specific objective which is to give priority and try to develop small scale projects in the poorest countries or small scale projects that benefits you know poor communities and can bring measurable benefits to the poor communities, so that is a very specific carbon fund that was setup by the world bank in 2003 and it is in these context the project FAL-G has been selected and is now part of CDCF port folio, this is a project that uses one of the small scale methodologies in CDM so it is considered to be objective of the fund and it is also the project where the project owner eco carbon limited has agreed to include in the contract they have with various brick factories a number of provisions to improve the working conditions of workers there, like health benefits and better working equipment and working conditions and so forth. There is a plan which is called the community benefit plan that has been discussed and agreed and now implemented in various brick factories and this plan is financed out of a small premium in the price of carbon that the investors in the CDCF have agreed to pay.

2. *What are the parameters actually setup by CDCF in investing in the new technology, because this is a technology which is developed natively so do you have any specific parameters given to the ECPL when you actually funded this?*

In case of this particular fund CDCF we don't have technology guidelines or preferences, but obviously because of the objective of the fund itself which has to again provide poverty reduction and other kinds of benefits to communities, naturally there are certain kinds of technology that don't lend themselves well to these kind of projects so for instance you will not find any projects in industrial gases for instance but we have a number of projects in renewable energy, energy efficiency and landfill for instance. But again technology is not one of the parameters, we focusing on when identifying the projects.

3. *How did you actually choose FAL-G to be invested by CDCF? is there any procedure?*

Yes again this was quite some time ago but the project was a small scale project, which was one of the criteria for the fund and it was the project where there was a potential to bring valuable and measurable benefits to the poor workers who are working in the brick factory in India and most importantly the project owner Eco carbon was willing and very interested in doing just that we have asked. The CDCF is a very specific fund in this respect, and again the objective is primarily to do carbon and development jointly and to demonstrate that there is possibility to find carbon projects that also have poverty reduction and other benefits for the poor in the poor countries.

4. *How do you take risk analysis in a country like India?*

The project screened or analyzed in terms of risks they have both in terms of the project risks themselves, financial closure, capacity of the project entity and so forth but also in terms of the CDM risks, risks for the process being validated, for proper generation of the emissions reductions and this is you know we have good CDM process that review the project documents, and the dig process review the project as well.

5. *Do you really think that this project i.e, FAL-G is really complying with CDM projects, since it is an unilateral project so how do you look in that perspective?*

The unilateral projects are certainly allowed by the Kyoto protocol and by all the rules of the CDM there is nothing against that what has to and it is perfectly allowed and indeed has long been very active in the unilateral CDM market which is specificity of India compared to many other countries, so there is nothing wrong with and on the contrary it is quite very good. Annex I country involvement comes in the form of purchasing of the CERs in this case through a fund administered by the world bank

6. *When you say that the CERs are actually administered by the world bank to be transferred into developed country, how do you negotiate with a country like developed countries to transfer credits?*

This is consistent with the rules of Kyoto protocol and the regulations that have been set in place by the executive board of the CDM so the thing that you have to get in order to be able to register the project with the executive board is a letter from what is called the designated national authority, India in this case which is part of which ministry of environment which is confirms that India basically is ok with the project approves the project of the CDM project and once you have that then everything is dealt with the executive board and the UNFCCC secretariat and the host country is no directly involved in the transfer and generation and transfer of the CERs, the only point of involvement is through letter of approval that you must present in order for the project to be registered

7. *When you say that unilateral projects are actually good can you just be specific like why did you say the statement that they are actually good?*

Well I think it shows entrepreneurship and the creativity from the point of the country its nothing wrong with. On the contrary, so you know there is no formal requirement that an annex I country or private entity from an annex I country should be directly involved in helping prepare the project, in managing project or whatever.. The only requirement is that at some point there will be one of the actors there to purchase the credits. But if you have an entrepreneur in India or in other developing countries you know who is capable and is able to raise the required financing to develop renewable energy project there should be no obstacle from this person to able then to benefit CDM as well even if there is no annex I involvement in the beginning, but this of course to begin with countries where access to local finance so forth is well developed which is case in India not in many other developing countries.

8. *If in a case where local investment is not possible, then how do you actually take up a project like it?*

There has to be a financing package in place, and that's one of the things that we look at. But the fund is not directly contributing to that other than through the purchase of the credits which is one of the things that the other financiers may look at when discussing and agreeing on their own participation through loans or otherwise but the CDCF is not directly contributing to that and the CDCF like other World Bank fund is purchasing credits from the projects that do not that are not necessarily financed by world bank through loans or whatever. We also purchase credits from projects which are completely independently financed.

9. *In a project like FaL-G at what point of time do you start investing?*

No we pick the project at a very early stage, at the time of preparation of PDD actually and then we with the project entity we go all the way through validation, registration and then upto CER issuance.

10. *Apart from FaL-G, what is the success rate that you find in a project that is funded by CDCF?*

Well its variable. We have good and bad stories. On the stray project that fail to deliver for number of reasons either they are not able to close their financing or there are issues during project implementation or validation is much longer or even fails, where as sometimes we are not able to get project validated so you have all sorts of issues that can happen. But it's a bit too soon to have real statistics on success rates because number of our projects are still not registered and there is few of them have actually started issuing CERs even though that are registered are in still in process and of having that verified that CERs issued

11. *Since this is your direct involvement with a project like Fal-G, how do you actually take the CERs, do you have any direct things or do you send people?*

Yeah we have regular site visits to the project site to supervise the project or to you know help in validation or monitoring and verification process for instance when the designated operational entity visits the project for the validation site visit we usually are here as well to help with questions and present anything for verification emissions usually we have to visit the site as well or directly work with the project owner to prepare for the validation or to make sure that the monitoring system is well in place and so forth

12. *What about the sustainable development at the end of the day when you have purchased the CERs?*

At the beginning we have the Community benefit plans that is part of the project that we finance where we make sure that the project have a measurable impact on community so either the impact is intrinsic to the project. For instance we are financing a large biogas, house hold biogas program in Nepal and in that case it has intrinsic benefits to the communities who, where the biogas bio digester is implemented or like in FaL-G we discuss and agree with the project owner specific additional measures that would bring

benefits to community in that case poor workers in the brick factories and then we monitor that these benefits are indeed put in place implemented regularly.

13. *Does CDCF make a strong impact by purchasing the CERs which in turn is actually benefitting the poor communities?*

It depends on the project that's one thing the impact the size of the, material or…… of the impact certainly depends on the project you are looking at but in any case the CDM is supposed to help overcome barriers for certain types of technologies or kinds of projects that are difficult to implement in the particular country and so we are supposed to be here at the beginning of something at the beginning of the transition to certain other forms of technology or electricity generation or whatever so the transformation of the impact is supposed to come later on if it is successful then the buyers will have come forward/… more projects will be able to happen with this technology or you know that's what the CDM is supposed to be doing but it takes time to be able to look at that to check to what extent it has happened

14. *When I look at a project like this a unilateral since you said that it is good but for me in my personal view I find this to be beneficial only for the developed nations because the success of a CDM would be in a long term and it's not clearly seen on spot but CERs are generated and they are purchased by the developed nations and they get profit there*

Well I think this is something that you should ask to the project owner himself, he will tell you what he thinks I mean in this particular case he is extremely happy to have the source of revenue from the CDM which really helps him to implement, develop and spread his technology so I see that as a very interesting case where you have actually a technology that has been developed in a developing country by developing country themselves but there are obstacles to actual diffusion of this technology and its use for number of reasons and here comes the CDM who helps support that I mean supports diffusion and implementation of this technology I mean this is a very interesting example.

15. *How do Governments of the developed nations and the companies approach you for purchase of CERs?*

The Credits are not sold by the nations themselves. It's a project based mechanism the CDM so you always have to have a project owner, an entity in the country which can be anything like an industrial factory can be a electricity utility can be a municipality and has various forms and this is where the project is going to be implemented and this is this entity which is going to sell the credits to the buyer. In this case a carbon fund and the relationship we have with government is different. We have very different and separated from the carbon fund, we have capacity building programs where we provide training and technical assistance to the DNAs participant in the country you know the program to be able internally reveal their country to help develop the CDM you know by opening this information to project owners and so forth that's separate from the project themselves

16. *Again another question don't you think it would make a difference if developed nations are directly involved in a project like this than actually approaching through a source like CDCF or world bank I mean this would actually increase the interactions between the nations*

Well I think again the CDM is supposed to be or has been designed to be a Project based mechanism so by definition the involvement of governments is relatively limited in that case limited to the issuance letter of approvals both by the host country government and by the investor country government, and that was made on purpose, its not supposed to be a public mechanism state to state relationship kind of mechanism but it's really, mostly targeting the private sector, so there are other ways, other channels and ways to for rich countries, developed countries to support developing countries in terms of climate change mitigations financing its taking other channels, other tools. The CDM is mostly a private sector driven mechanism by construction

17. *So how exactly you find in a present, in a reality when you take the FaL-G project what is your perception about this as CDCF unit*

This is one of the very successful projects in CDCF certainly, we are fortunate to work with an extremely committed and very competent project owner eco carbon and Mr.N.Kalidas who is doing I think is doing a fantastic job with this technology and so we are very, we are happy to be able to support him through this project and this is a project that has been already delivering a number of CERs on the fund so certainly that's of the on the success stories so far on the fund.

18. *I think this is one of the most initial projects of CDCF because it was also started in 2003,*

Yes

19. *Do you have any kind of certain tenure of where of funding a project like this, because now that it is successful and so do you have any specific tenure or you just keep funding or how is it? Because I know that its till 2016*

No we have a purchase agreement with the project owner for certain number of years and so we agreed, we agreed already to purchase a certain volume of CERs upto certain end date of the contract and then that's it and after that if the project continues and if they are still CDM it will be time for the project owner to go and look for other buyers

20. *And when you initially started this funding, what kind of problems did you face from the institutional sectors in India?*

I must say that I am not fully aware of that because I was not with the fund at the time the project was at the time the project started but I haven't seen or read anywhere we particular difficulties~

21. *When I took interview with Mr. Kalidas like he told me that you know the Beaurocracy exists a lot in India and so he did certainly face problem because this is a competition between the clay bricks vs and FAL-G bricks so I was just curious of just like how did you how did CDCF find out the problem*

A: May be I am not aware enough of all these details especially since I wasn't there when the project started so I may not be the best qualified to answer that question

22. *If a project which is funded by CDCF and it turns out to be a failure, then how do you actually deal with a project like that?*

Well you know we have a contract with the project, and so we basically we enforce the contract, and when there is a failure the contract has provisions to deal with that and most likely it will end up with the termination of the contract and freeing each party of its obligation and I mean that's usually the way it works

23. *Do you have kind of any insurance to the companies with you or how is it?*

No We don't have any particular insurance no any kind of insurance but you know these contracts are contracts with payments on delivery so we actually transfer the funds at the time of delivery of emissions reductions so there no or very limited financial risk from the fund

24. *Are you planning to support in future any more projects with FaL-G India*

Actually that may be possible Mr.N.Kalidas has informed that he might be interested in selling us some additional you know credits from similar project that could be in any case very limited because the CDCF fund mostly target pre 2012 credits and 2012 is coming very fast so if there is something additional it will be one of operation and a setup CDCF will not be there in a position to purchase anymore from the project

25. *Can you explain the process of investment by CDCF in general once the PDD is developed and then how exactly do you negotiate*

Well so we usually we sign the what is called an Emission Reductions Purchase Agreement or an ERPA which is the typical contract defined in the CDM world and this is negotiated with project entity and signed usually at after the validation is advanced enough so that we have some confidence that the project the will indeed be validated so this is when we start this contract and it has provisions and in the contract we specify usually specify how many emissions reductions we are going to purchase, the date of delivery of the emissions reductions, calendar of delivery and then the price and there are provisions also, also some provisions and they are what would be the main elements of the contract

26. *In a project like Fal-G which is a CDM Project your role is to buy the CERs from the CDM project that is generated right*

Yeah, yes

27. *You sell this to developed nations but my question is that do you have any specific criteria designed for a developed nation? For example I stay in Denmark and I know that Danish carbon Agency is a part of CDCF so do you have any specific parameters setup for an agency like this? Or they just come and buy it and go away?*

So we have actually fixed and certain number of participants in our fund 25 participants, 9 public that is government participants and 16 private sector you may have found this information already so these are the participants in the fund, and we don't sell the credits anybody but these participants they get their share the credits purchased fund by the for the prorate to the participation in the fund and we didn't have any in terms of criteria for accepting the participants when we created the fund and I think we think a due diligence which was really to see what kind of the business the companies were doing and their credit worthiness as well but again I don't have all the details of that I could try and then find information if you are interested but it is indeed a criteria is due diligence from the bank before accepting an entity as a participant in these funds