Programme of Activities: Will it break the ice for residential sector CDM projects?

India as case study

Gireesh.G.Nair

Supervisor
Luis Mundaca

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Abstract

The energy conservation measures in residential sector offers the dual benefits of green house gas emission mitigation and sustainable developments, which are in line with Clean Developments Mechanism (CDM) objective. However there are currently very few projects under CDM in residential sector mainly due to the higher transaction cost involved. Programme of Activities under clean development mechanism (PCDM) offers an opportunity to reduce the transaction cost by allowing several similar projects to register as a single CDM project. The thesis explores whether PCDM in residential sector in India would be possible by looking into the major enabling factors which are technical CDM requirements, financial benefits and project proponents capability.

The study revealed that PCDM might be highly beneficial to some of the technologies like solar cookers, biogas digesters and under favourable conditions deployments of such technologies can be done through Certified Emission Reduction (CER) revenue alone with out any external support. Since there exists lot of uncertainty regarding number of installations, CER prices etc CER revenue could be less than transaction cost for some of the technologies in a pessimistic scenario. Considering such an eventuality it would be better to launch a PCDM in residential sector under any of the ongoing nationally/internationally funded project. The programme may be gradually made independent depending on its effectiveness in terms of CER revenue realization. It was noted that for various technologies applicable in residential sector, it might be possible to prove additionality by meticulous efforts by the project proponents. However the stringent requirements regarding leakage, additionality, estimation of free riders etc make the procedure complicated for residential sector project thereby requiring sufficient expertise in CDM to handle PCDM project. In India the expertise is lacking for most of the potential project proponents of residential sector projects, which calls for capacity building measures. Further in order for the effective deployment of technologies in residential sector it is essential to have a coordinated action among various stakeholders and PCDM may act as a catalyst for such an initiative.

Key Words: Certified Emission reductions, Transaction cost, additionality
Executive Summary

The number of households in India is growing and as per the latest statistics available, there were 187 million houses in 2001 that was 2.35 times more compared to 1961. Further the housing shortage in the country is estimated to be 24.7 million. The colossal number provides significant opportunities for energy conservation measures in the sector, which is estimated to be 20% in India. However there exist quite a few bottlenecks regarding the diffusion of energy efficient technology in the sector like subsidized energy prices, higher initial cost, uncertainty regarding product quality etc. Clean Development Mechanism (CDM) with its objective of green house emission reduction and sustainable development could be an enabler for the technology diffusion in residential sector through the additional financial benefits it provides. However CDM being a financial mechanism, stakeholders are not interested to take up projects in residential sector that provides only a very limited Certified Emission Reductions (CERs) individually and thereby financially not attractive due to the transaction cost involved. Hence residential sector projects sparingly came under the radar of CDM. The concept of Programme of activities under Clean Development Mechanism (PCDM) was introduced in COP/MOP 1 (2005) wherein several individual projects in different locations can be bought together and registered under CDM gambit as programme of activities is expected to reduce the transaction cost involved in residential sector projects. However the rules and regulations regarding PCDM is not yet finalized and is to be seen whether PCDM may facilitate more CDM projects from residential sector.

The objective of the thesis is to find whether PCDM in residential sector would be possible in India by looking into the major enabling factors which are technical CDM requirements, financial benefits and project proponents capability. The following research questions will be addressed to achieve the objective.

a) Are there any major barriers for realizing energy conservation measures in residential sector in India? Can PCDM help to address any of these barriers and what are the critical technical challenges for implementing PCDM?

b) What is the impact of CER revenue under PCDM in the financial performance of technologies applicable in residential sector?

c) What are the strength and weakness of potential project proponents of PCDM in residential sector in India?

As a first step, existing literature were reviewed to understand the technical requirements of CDM in general and PCDM in particular. These requirements were studied in detail and barriers and opportunities for deployment of a set of technologies applicable in residential sector are analysed in the Indian context. Conducting a cost revenue analysis for all these technologies is done as a next step, wherein the financial implications of CER revenue in the deployment of the technologies are established. This is followed by conducting Strength Weakness Opportunity Threat (SWOT) analysis for a selected number of potential project proponents for PCDM in residential sector in India.

There are many barriers for energy conservation measures in the residential sector in India and some of them like financial barrier can be addressed through a PCDM project for many of the technologies considered. However there are a few challenges to effectively utilize PCDM in residential sector like lack of sufficient large-scale methodologies are one such issue. It is observed that for all the technologies considered in the analysis it might be possible to prove additionality by diligent effort of project proponents. However the stringent requirements regarding leakage, additionality, estimation of free riders etc make the procedure complicated.
and thereby requiring sufficient expertise in CDM to handle them. However many potential project proponents of residential sector projects in the country lacks the expertise to execute PCDM.

The cost revenue analysis made in the thesis revealed that for some of the technologies, CER revenue could support substantially the programme finance under optimistic scenario (higher CER price, more product deployment, lower transaction cost). In some cases CER revenue alone could be so attractive that it can support the programme with out any external support. However the analysis caution prospective project proponents that the transaction cost could be significantly high under pessimistic scenario and PCDM may not be worth to explore for many technologies in that situation.

Based on the analysis it is recommended to build on some of the existing programmes targeting the residential sector to initiate a PCDM project. The programme may be gradually made independent depending on the CER revenue realisation. The study revealed that many of the potential project proponents in this sector do not have enough expertise to handle PCDM projects, it is essential to conduct capacity building workshops as well as some pilot projects through PCDM. The SWOT analysis carried out for a select number of potential project proponents revealed that there exist strength and weakness in them and the benefits of PCDM can be better leveraged through a synergetic action.

In rural sector where almost 72 % of Indian lives the existing mechanism like Integrated Rural Energy Planning Cell (IREP) cells or the state level organizations responsible for energy/renewable energy may be used to launch a PCDM project. In order to effectively diffuse some of the technologies, the technological or logistical issues pertaining to them also need to be addressed. In order to achieve technology diffusion in residential sector concerted effort from all the stakeholders involved are needed and PCDM may augment such an initiative.
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1 Introduction

1.1 Background

Energy is the basic building block for socio-economic development and for any country, future economic growth crucially depends on the long-term availability of energy in increasing quantities from the sources that are dependable, safe and environmentally friendly. The Energy Information Administration data shows that world primary energy production is spiraling upwards and from 215 Quadrillion in 1970 it has grown to 443 Quadrillion BTU in 2004. As per Faith Biroal the chief economist of International Energy Agency (IEA) the cumulative energy investment requirement is estimated around $ 17 trillion over the year 2004-30 and half of these has to be in cash strived developing countries. It is imperative to judiciously use energy and end use energy efficiency measures as well as use of more renewable energy offers an attractive solution to address this situation.

The importance of energy efficiency is widely accepted and IEA in their statement on sustainable development considers further improvement of energy efficiency as one of the measures to encourage a more sustainable energy future. Further according the World Energy Outlook report the greatest GHG reduction in 2050 is projected to come from end use efficiency, power generation & carbon capture and storage (IEA 2006). The developed countries has benefited by adopting energy efficiency measures, wherein energy consumption pattern shows that one of the driving factors for decrease in energy intensity during the last three decades was through energy efficiency measures (IEA, 2005). The increased adaptation of renewable energy measures offer another option to reduce energy consumption and associated environmental and climate change problems. As per IEA study (2006) that if all the countries implement the policies that are under discussion towards renewable energy then the share of renewable energy will increase by a factor of two in power generations, industries and building by 2030 from the base year of 2004. In renewable energy sector also many developed countries have shown considerable initiatives and the recent EU decision to increase the share of renewable energy to 20 % by 2020 is considered as a major step in this direction.

The developing countries are fast catching with the developed countries in emissions and the share of world emissions from developing countries is expected to be more than half by 2030 from the current 39 %. (IEA, 2006). Hence these countries that uses predominately primary fuels like coal & oil need to learn from the experiences of developed countries in adopting energy efficiency measures and increasing the share of renewable energy in their energy mix.

Clean Development Mechanism (CDM) is one of the project based flexible mechanism tool under Kyoto Protocol by which Annexe B countries (developed countries that ratified Kyoto Protocol) can invest in projects in non Annexe I countries (developing countries) that can facilitate sustainable development in developing countries and claim the CO$_{2}$eq generated from the projects. The energy efficiency & renewable energy projects offer the potential to achieve the dual benefits of sustainability and mitigation of GHG emissions and hence could be an ideal choice to meet Kyoto objectives.
1.2 Problem Definition

As per the IEA report (2006) the building sector consumes 40% of the world’s total final energy and contributes to 24% of the total CO\textsubscript{2} emissions. The developing countries have witnessed a rapid increase in the CO\textsubscript{2} emission related to building, which stated to be around 3% year (IPCC special report, 2000) and the rapid economic growth of countries like India & China may likely to increase the emissions related to buildings further.

India is currently on a fast paced economic growth and primary energy requirement is expected to increase at 6% and as per projections the percapita primary energy consumption of India can increase up to 6 folds by 2030. The energy requirement of the country is predominately fossil fuel based and hence the GHG emission from the country is also expected to rise in future. Buoyed by the economic growth, construction sector is booming in the country as per Langdon (2005) the projected growth of the sector is over 10% during 2004-2008, and is highest in the world.

As per India’s initial communication to UNFCCC, the residential and commercial sector emits 0.065 Giga Tons of CO\textsubscript{2}eq, which accounts for around 5.2% of the total national GHG inventory. India’s construction industry is growing at a rapid rate and the urban building construction is worth around 1100 million USD (Environmental Valuation & Cost Benefit News, 2005). There exist lot of potential for energy conservation in buildings and as per the planning commission study the energy conservation potential in residential buildings in the country is around 20%. India has a strong presence in CDM projects and as of March 2007 has the maximum number of registered projects accounting to 33% of the total registered projects and 17% share in the total CERs. Further the renewable energy and energy efficiency has a significant share in the projects registered from India. However till March 2007 out of 421 host country approved projects, there was only two projects in residential sector which are renewable energy projects (www.cdmindia.nic.in). This is the general scenario with CDM projects in general wherein building sector projects accounts for a meager share of 0.75% in the total registered CDM projects.

According to experts one of the major barriers for such projects is their relatively lower certified emission reduction (CERs) generation potential thereby making them less attractive to prospective investors. In order to provide a thrust for these projects the concept of programme of activities under clean development mechanism (PCDM) was introduced wherein a programme involving several projects can be considered as a CDM project, which will reduce the transaction cost and providing larger volume of CERs. The COP/MOP1 has approved the acceptance programme of activities as a CDM project by its decision that project activities under a programme of activities can be registered as a single clean development mechanism project activity (Figueres, 2006). Though a local/regional/national policy or standard cannot be considered as a clean development mechanism project activity, the above decision is expected to be beneficial for energy efficiency & renewable energy projects in residential and building sector.

Since approval of PCDM in 2005 there has been a few projects registered with the EB that have the characteristics of PCDM. Till March, 2007 there are nine registered projects and
another four in the pipeline in the building sector, which represents around 0.15% of the total CERs generated (till 2012) by all the registered projects & those in pipeline. As PCDM is in the evolving stages, there exist lot of uncertainties and the rules are yet to be clearly defined.

The reasons attributing to the lower penetration of energy efficiency & renewable energy CDM projects may be valid for PCDM as well. One of the major barriers is the issue of additionality for energy efficiency projects and projects involving biomass. In case of energy efficiency projects many times it is likely that the projects become viable with out CER revenue and in case of renewable energy projects involving biomass, it is cumbersome to prove the biomass that are replaced are non renewable (Hernández, Pablo & Pelzer Michaelowa, 2005 & Gadha, 2007). The lack of enough methodologies, which is a prerequisite for submission of PDD, is another barrier as currently there is only two approved large-scale methodology “ distribution of efficient light bulbs to households” (AM0046) & “energy efficiency improvements carried out by an Energy Service Company (ESCO) through boiler rehabilitation or replacement” (AM0044) applicable for building sector. The transaction cost involved is an important aspect of CDM project (DTI, 2005) however as there is no experience regarding handling PCDM projects in residential sector the transaction cost involved is not known thus may create apprehension for project proponents.

Majority of Indian projects are unilateral and considering the financial additionality, a lot of upfront investment may be required to start up a PCDM in residential sector. In residential sector, the beneficiaries of energy efficiency/renewable energy measures are dispersed with small CER per household and hence it requires a project proponent to have an overall control in the execution of CDM activity and claim the CER revenue. According to Hayashia & Michaelowa (2007) PCDM may require complicated emission reduction calculations and the programme coordinator need to have the capability to carry out them successfully. Hence the success of the PCDM depends on the ability of the project proponent to handle the activity. In India organizations like NGOs, utilities, ESCOs, etc can initiate PCDM projects, however the complexity involved may make it difficult for them to develop and successfully manage a PCDM project in residential sector.

1.3 Research Objective & Methodology

1.3.1 Objective and Research Questions

The objective of the thesis is to find whether PCDM in residential sector would be possible in India by looking into the major enabling factors which are technical CDM requirements, financial benefits and project proponents capability. The following research questions will be addressed to achieve the objective.

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1 Based on registered projects list under CDM from UNFCCC site (www.unfccc.int)

2 As of December 2006 five methodologies for type 3 & 5 that are applicable to building sector were submitted for approval and two methodology got B rating, two C rating and one is pending for any decision (Hayashia, Michaelowa, 2007). This leaves only two new methodologies (NM0150 & NM0157) both dealing with energy light fittings a chance in near future.
a) Are there any major barriers for realizing energy conservation measures in residential sector in India? Can PCDM help to address any of these barriers and what are the critical technical challenges for implementing PCDM?

b) What is the impact of CER revenue under PCDM in the financial performance of technologies applicable in residential sector?

c) What are the strength and weakness of potential project proponents of PCDM in residential sector in India?

1.3.2 Research Methodology

The methodology adopted for the thesis is depicted below

**Literature Review**

The various available literatures which include peer reviewed articles, relevant official policy documents, project documents, internet based publications etc were reviewed to understand major issues that are related to PCDM like additionality, baseline, leakage, crediting period etc. The recent decisions of EB regarding PCDM were studied to get an idea about the latest development in the subject area. This is followed with literature review to critically analyse the status of energy efficiency and renewable energy projects being conducted in building/residential sector in India. The current policies in relation to energy efficiency/conservation & renewable energy were carried out from the published documents like integrated energy policy, energy conservation act, electricity act etc. The relevant literature were critically analysed to find the technical issues regarding PCDM in residential sector in the Indian context. A total of seven technologies were considered for the analysis, which include lighting, cooking and water heating application in households. The barriers and opportunities for PCDM in residential sector in India are elaborated based on the analysis.

**Cost Revenue Analysis**

The advantage of PCDM is it brings additional revenue through sale of CER arising from the technologies considered in the residential sector. However it incurs transaction cost as well and hence it is desirable to have a cost revenue analysis to find the benefits of opting for a PCDM. The cost revenue analysis to find the impact of CERs on the technologies selected is conducted through the following broad steps

- Collection of price details of the products considered for analysis directly from the manufacturers/suppliers in the country. The transaction cost for CDM were used based on secondary data available from literature as well as extrapolation of cost data available in other country to local currency using real exchange rate.
- As there is lack of experience regarding transaction cost involved as well as unpredictability involved in CER prices and products deployed different scenarios were created with range of transaction costs, CER prices and technologies deployed,
Calculation of GHG emission reduction potential under these scenarios and the financial implication of CER revenue.

The bank interest for different scheme were collected mainly from the latest update of respective financial institutions from their website. Apart from contacting the manufacturers/suppliers, existing literature and brochures of the products were also used to understand the product specification. The repayment for the loan for each technology under different scenario is calculated using the eazyloan software. The CER revenue as percentage of the annual repayment of loan is considered as an indicator to assess the effectiveness of PCDM in respective projects.

**SWOT Analysis**

For PCDM in residential sector, the role of project proponents is very important and select numbers of potential project proponents who can initiate a PCDM in residential sector were looked into to understand the challenges and opportunities for them to take up the PCDM. The Strength Weakness Opportunity Threat (SWOT) analysis is used to find out strategic alternatives based on the existing situation regarding project proponents. The energy conservation project involving residential sectors may be influenced by external factors like government policies and internal factors like technical capability of the organisation to handle the project. SWOT analysis is used for the analysis as it helps to develop a plan of action for the project proponents while considering the external and internal factors. Telephonic interviews as well as semi-structured questionnaire were used to collect information from a select number of potential project proponents like NGOs, builders, ESCOs etc to learn about their views on PCDM in residential sector in India. Semi structured questions were used in the interview as well as for questionnaire since PCDM is highly complex as well as new concept for many of the interviewees. Based on the interviews, questionnaire and official documents conducted SWOT analysis for the potential stakeholders with regard to handling of PCDM projects.

The possibilities of taking advantage of PCDM in reducing the energy consumption of residential sector were discussed based on the various inputs mentioned earlier.

**1.4 Scope & Limitations**

The scope of the thesis work is limited to the (i) cost revenue analysis in terms of impact of CERs revenue for the seven technologies that are applicable in residential sector under different scenarios and (ii) the barriers and opportunities related to PCDM for the technologies selected as well as the Institutions that can initiate PCDM in residential sector in India.

Though there could be many potential project proponent categories, in this thesis only Utility, NGOs, ESCOs and builders were considered taking into account their potential role in a PCDM involving the above technologies. The interviewed personnel from the various project proponent groups were limited and though it is likely to be the view of the respective groups in general, however the same may not be guaranteed. As the actual transaction cost detail and CER price were difficult to access due to its confidentiality nature, information available from existing literature were used and hence may vary depending on case basis.
Further the topic is currently in the evolving stage and discussions are still going on in many issues regarding PCDM so there could be a probability that some of the conditions considered in the thesis may not be valid when the final decisions are made on PCDM.

1.6 Thesis Outline
The chapter 1 highlights the problem, research objective, methodology scope and limitation of the thesis report. Chapter 2 provides an overview of clean development mechanism; status of energy efficiency and renewable energy CDM projects and barriers related to building sector CDM projects. Further it highlights the discussion regarding PCDM including the major issues. Chapter 3 highlights the energy efficiency and renewable energy potential in general in India. The energy conservation potential in buildings with focus on residential sector and the major barriers that prevent the realization of potential in the sector are discussed to understand the benefits of utilizing a programme of activities under CDM (PCDM) to address some of them. The above two chapters provide a theoretical framework for the subsequent chapters. Chapter 4 describes the PCDM related barriers and opportunity for taking up the select technologies suited to residential sector in Indian context. The Chapter 5 provides detailed cost revenue analysis regarding the impact of CER revenue in the financial performance of the technologies selected. Chapter 6 discusses the SWOT analysis of select stakeholders who can become project proponents of CDM project. The analysis is made within the context of handling PCDM projects. Finally the chapter 7 provides conclusion as well as recommendations to effectively utilize PCDM in residential sector in India.
2 Clean Development Mechanism & Programme of Activities under Clean Development Mechanism

2.1 Clean Development Mechanism

The Kyoto Protocol was the fall out of the undisputed scientific evidence of global warming and shares UNFCCC’s objective of reducing GHG emissions and has been ratified by 173 countries. Among the countries that ratified Kyoto Protocol, 35 countries and the economic integration organizations are legally bound to reduce greenhouse gas emissions below levels specified for each of them by the first commitment period (2008-12). The Kyoto Protocol, which came into force on 16th February 2005 has three “flexibility mechanism” namely Clean Development Mechanism, Joint Implementation and International Emissions Trading to lower the overall costs for achieving emission targets. The section briefly touches up on the various aspects related to CDM that are relevant to this thesis.

While the environmental benefit of reducing GHG emission is same anywhere, the cost of mitigation is much higher in some countries and this formed the basic idea behind Clean Development Mechanism. Under CDM which is defined in Article 12, Annexe I countries can implement GHG mitigation projects in developing countries and use CERs generated from the project to achieve compliance with their commitment targets. In order to be eligible to participate in CDM project, the host country as well as participating Annexe B country (developed country) has to ratify the Kyoto Protocol (UNEP, 2004).

The modalities and procedures for clean development mechanism were adopted in COP/MOP at Marrakech in 2001 and known as Marrakech Accords. The Marrakech accord has established certain guidelines for eligibility for CDM projects apart from the greenhouse gas emission reduction opportunities. The key features are as depicted below

**Additionality:** The anthropogenic emissions of GHGs by sources need to be reduced below the level that would have been happened with out the implementation of CDM project (UNEP, 2004). In order to register as a CDM project it is essential to demonstrate the additionality, which can be proved by using the additionality tool provided in the respective methodology (Michaelowa & Pelzer, 2005). The additionality tool provides general framework for demonstrating and assessing the additionality.

**Base Line:** Establishing the baseline is the most important step while designing a CDM activity as it will help in calculating the amount of GHG emission reduction achieved by a project activity (UNEP, 2005). Hence it is essential to estimate the baseline accurately and either approved methodologies may be used or new methodologies can be proposed for this. As of March 2007 there are 71 approved methodologies, which include 40 large scale, 21 small scale and 10 consolidated methodologies (www.unfccc.int).

**Sustainable Development:** CDM envisages (Article 12) sustainable development in host country through the CDM projects. It is the prerogative of host country to define sustainable development based on its national priorities (IGES, 2005). The DNAs based on its own set of criteria on sustainable development can accept or reject a CDM project.
The Project Model: CDM project are developed in any of the following ways

Unilateral Model: Under this model the host country project developers develop, finance & implement the project from their own equities and the CERs accrued from the projects will be sold to the market to the highest bidder (Philip, 2000).

Bilateral Model: In this model, an Annexe B entity will directly invest in non Annexe-I country in return of CER revenue, which may be used to meet the domestic commitment (Michaelowa, etal, 2004).

Multilateral Model: Here the investors are not directly involved in project financing instead a centrally managed fund (like World Bank’s Prototype carbon fund) will select the project on behalf of investors who will be issued CERs from the project as per their respective share in the fund (Michaelowa, etal, 2004).

Stages of CDM Cycle

There exist several stages in the CDM cycle before a project receives the certified emission reductions. The major stages in CDM cycle is as discussed below

Project Formulation: The initial step in the CDM project cycle is to identify a project that can be eligible for CDM considering the local DNA approval procedures.

Project Design Document: In order to register a project with CDM EB, the project proponents need to submit the documents in a specified format fulfilling the various eligibility criteria. The host country through its DNA has to approve the project and issue letter of approval confirming that the project assist in country’s sustainable development and also approving the voluntary participation of the host country in the project as CDM project.

Validation of the project: Validation is done to review independently whether the project meets the requirement of CDM. The validation can be conducted by an entity (DOE) accredited with the CDM EB. The DOE if satisfied with project will provide the validation report.

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3 As per Axel Michaelowa the unilateral project which involve late Emission Reduction Purchase Agreement (ERPA) can only be considered as “true unilateral project” since otherwise Annex B buyers will be sharing some of the risks in the project (Axel Michaelowa, 2006)

4 Some countries as well as major project developers require project concept note (PCN), which contains brief information about type of project, location, schedule, technical summary etc.
Registration of the project: Once the validation report is received, the project can be registered with CDM executive board. In order to register the PDD, validation report host country approval letter and also how the public comments about the project will be addressed has to be submitted to executive board. Registration will be usually done within 8 weeks of receipt of the PDD unless review of the project is required.

Monitoring of the project: After implementing the project, the project participant(s) has to monitor the emissions from the CDM project. The methodology adopted for monitoring must comply with the CDM rules, which needs to be confirmed by the DOE while validation. The emission details have to be reported in accordance with guidelines and the same needs to be verified by DOE.

Verification & Certification: The emission reductions achieved by the project for a stipulated time needs to be verified periodically by a DOE, which also certifies the project. The certification is the written assurance that project has resulted in real measurable emission reduction and is additional. The certification report has a request to EB to issue certified emission reduction (CERs) equivalent to the verified amount.

Issuance of CERs: The culmination of all the above activities will result in EB issuing the CERs. Prior to issuing CERs, the CDM registry administrator will keep a percentage of CER for administrative and adaptation costs and the remaining CER will be allocated to the project participants.

In order to facilitate small-scale projects, CDM has kept simpler requirement and have fast track approval for them. Small scale CDM projects are classified as following:

```
Type I: Small renewable energy activities up to 15 MW (or equivalent)
Type II: Small energy efficiency improvements which reduce energy consumption by up to 40 GWh per year
Type III: Other project activities that both reduce emissions caused by human activities and produce less than 50 kilotonnes of CO2 (or equivalent for other gases) annually
```

2.1.1 Certified Emission Reduction (CERs) market
The CDM through CERs constitutes around 10 % by value of total carbon market, which is around 21.5 billion USD in September 2006 (World Bank, 2006). The price depends on type of emission reduction purchase agreement, wherein the price can be €2 to €8 per CER if buyer takes the risk of non-delivery and €7 to €11 if seller takes the risk (carbonpositive, 2007). In terms of volume, European Union Allowance (EUA) share is close to 75% of the total CO$_2$eq in the market and hence the price of EUA can affect significantly the CER price.

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5 1 CER is equal to 1 Ton of CO$_2$eq
6 The limits for Type II & Type III were modified from 15 GWh to 40 GWh and 15 Kilotonnes of CO2 to 50 Kilotonnes CO2 respectively based on recommendations of SSC Working Group (SSCWG 7th meeting, Sep 2006)
7 As per Michaelowa A, the total demand for CERs will be worth 4.5 Billion € (Michaelowa A, 2006)
8 Emission reduction purchase agreement is an agreement between project developer and buyers, wherein the buyer commits to purchase certain quantities of CERs at a specific price.
Programme of Activities: Will it break the ice for residential sector CDM projects?

(World Bank, 2006). The CER price accordingly is expected to depend on rigidity of the EU national allocation plan for the second phase\(^9\) (2008-2012).

### 2.1.2 Transaction cost

Though the CER price is a revenue source for the project proponent from a CDM project, it is not possible to conduct the financial attractiveness of projects directly based on the final CER price. This is because the project proponent has to shell out additional cost for a CDM project or getting through the various stages mentioned earlier. The cost involved for this is referred transaction cost and include costs for various components like PDD development cost, Validation cost, verification cost, consultancy charges etc (Krey, 2004). According to Krey the transaction cost could range from 0.123 US$/ton CO\(_2\) for very large projects generating 0.5 million CERs/year to 212 US $/ton CO\(_2\) for micro projects generating only 100 CERs/year (Krey M, 2004). This shows that transaction cost could be a major barrier for projects involving lower CERs\(^{10}\). The cost incurred at various stages of a CDM project based on empirical analysis of a few projects from India are as given in Table 2-1.

#### Table 2-1 Transaction Cost involved in Clean Development Mechanism

<table>
<thead>
<tr>
<th>Total Cost (US $) (Min – Max)</th>
<th>Specific Cost (US $) (Min- Max)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Search Cost</td>
<td>19,000 - 29,000</td>
</tr>
<tr>
<td>Negotiation Cost</td>
<td>10,500</td>
</tr>
<tr>
<td>PDD Cost</td>
<td>6,500 - 120,000</td>
</tr>
<tr>
<td>Approval Cost(^{11})</td>
<td>-</td>
</tr>
<tr>
<td>Validation Cost</td>
<td>6,000 - 80,000</td>
</tr>
<tr>
<td>Registration Cost</td>
<td>5,000 - 30,000</td>
</tr>
<tr>
<td>Monitoring Cost(^{12})</td>
<td>-</td>
</tr>
<tr>
<td>Adaptation Fee(^{13})</td>
<td>10,193 - 212,349</td>
</tr>
<tr>
<td>TOTAL</td>
<td>57,193 – 481,849</td>
</tr>
</tbody>
</table>

Source: Krey M, 2004

### 2.1.3 Current Status of CDM Projects

As of March 2007, 547 projects are registered under CDM and CER issued so far is 28.2 million and the expected CERs from the registered project till 2012 is 790 Million. There are around 1200 more projects under validation and together with these projects the total CER generated is expected to be around 3100 million\(^{14}\) CERs (www.cd4cdm.org). HFCs project

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\(^9\) Near surplus allowance during the first phase of EU ETS resulted in reduced interest for CERs till 2007 and resulted in dropping of CER prices in April 2006 (carbonpositive, 2007).

\(^{10}\) Michaelowa et al in one of their article states that PCF considers project that generate less than 50000 CER/annum at a CER rate prevailing then (which was €1 to €5) are not viable (2003)

\(^{11}\) Indian DNA till now has no approval charges

\(^{12}\) The data was from 2004, and the project developers were not aware of the monitoring cost at that time.

\(^{13}\) The Adaptation Levy is 2% of CERs from all projects that are not located in a least developed country. Further an administration fee has to be paid (US$0.10/CER on the first 15,000 CERs per year and US$0.20 for each additional CER, up to a maximum of US$350,000) upon recovery of registration fee

\(^{14}\) Assuming full realization of CERs from these projects
have the maximum share in the total CERs generated from the projects, and the percentage break up of various categories of registered projects are as given figure 2-2

![Figure 2-2 Percentage Break Up of CER from registered CDM projects](image)

*Source: UNFCCC (March 2007) & self-calculation*

### 2.1.4 Energy Efficiency & Renewable energy projects under CDM in Building Sector

Energy efficiency & renewable energy projects may provide the dual benefits of sustainability and mitigation of GHG emissions and hence could meet the CDM goals. However as shown above, the energy efficiency projects and renewable energy projects accounts for only 4.4% and 10% of the total CERs generated respectively. There are several reasons attributed to lower penetration of energy efficiency and renewable energy projects under CDM and some of the barriers are as depicted below

*Table 2-2 Barriers for EE & RE projects under CDM*

<table>
<thead>
<tr>
<th>Energy Efficiency Projects</th>
<th>Renewable Energy Projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of sufficient methodologies &amp; difficulty in making an approved methodology&lt;sup&gt;15&lt;/sup&gt;</td>
<td>Higher upfront cost &amp; longer economic life span for many RE projects, however uncertainty regarding post 2012, makes the CERs generated from such projects after 2012 unattractive for investors</td>
</tr>
<tr>
<td>Challenges includes differentiating project gains from business as usual, efficiency changes due to load variation etc</td>
<td>Proactive policies in countries makes it difficult to prove additionality</td>
</tr>
<tr>
<td>Many energy efficiency measures are economically attractive making it difficult to prove financial additionality</td>
<td>Lower CER generated per project making it less attractive considering transaction cost&lt;sup&gt;16&lt;/sup&gt;</td>
</tr>
<tr>
<td>Establishment of baseline can be difficult especially when it is required to estimate the free riders/spillovers</td>
<td>Lower CER generated per project making it less attractive considering transaction cost</td>
</tr>
</tbody>
</table>

<sup>15</sup> As per Pelzer & Michaelowa energy efficiency methodologies suffers the maximum rejection (2005)
Lack of knowledge of financial institutions in EE projects makes it difficult to get finance  
Lack of knowledge of financial institutions in RE projects makes it difficult to get finance


Building sector offers excellent opportunities for CDM projects and as per an estimate, buildings along with energy efficient appliances can contribute to almost 32% of the total cost effective CDM projects (Margaree Consultants, 2004). However, the energy efficiency and renewable energy projects applicable to buildings are sparsely represented in CDM. The number of energy efficiency & renewable energy projects in building sector in the overall portfolio of CDM projects is only 0.75%. The majority of energy efficiency projects that are registered with CDM are for industrial energy efficiency that accounts for 95% of share of CERs, whereas building sector constitute 1% and energy efficiency measures in supply side accounts for the remaining share (www.unfccc.int). Similarly, the renewable energy projects are mainly for electricity production accounting 80% of the total CER generated under renewable energy category

**Reasons for Low penetration of CDM projects in Building sector**

Apart from the above mentioned constraints for the energy efficiency & renewable energy projects under CDM, these projects face further barriers in building sector. A single project in a building will often result in lower CERs \(^{18}\) compared to projects in other sectors. Further it is difficult to make bundled project in building sector owing to difficulties in meeting criteria like similar size, same stage of development etc and monitoring of these projects under different owners will be challenging (Diana etal, 2006). Another concern is the lack of sufficient methodologies for projects addressing the building sector. At present there are only three small scale methodologies targeting buildings which are energy efficiency & fuel switching measures for buildings (AMS II E), demand side energy efficiency programme for specific technologies (AMS IIC) and thermal energy for the user (AMS I C)\(^{19}\), Further there is a shortage of large scale methodologies as well with only two of them applicable to building sector namely, distribution of efficient light bulbs to households (AM0046) and “energy efficiency improvements carried out by an Energy Service Company (ESCO) through boiler rehabilitation or replacement\(^{20}\).

2.1.5 CDM Scenario in India

India ratified Kyoto Protocol in August 2002 and established National Clean Development Mechanism Authority (NCDMA), the Designated National Authority (DNA) in 2003 under Ministry of Environment & Forest. Senior officers from different ministries like Foreign Affairs, Finance, Power, Planning Commission, Industrial Policy & promotion, Environment & Forest constitutes the committee which is headed by secretary Ministry of Environment &

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\(^{16}\) Energy efficiency project in India (Ref No 0793) resulting 10627 CERs or a 12.3 MW Wind project in India (Ref No 0277) which generate 14416 CERs compared to the HFC –23 oxidation project in India (Ref No 0115) which resulted in 3.8 million CERs

\(^{17}\) From www.unfccc.int as of March 2007

\(^{18}\) Reducing energy consumption project in a hotel in India (Ref No 0686) resulted in 2987 CERs/year

\(^{19}\) Kuyasa low-cost urban housing upgrade project in Cape Town, South Africa used all these three methodologies in their project.

\(^{20}\) Based on the approved methodology list in unfccc website (www.unfccc.int)
Forest. India currently (March 2007) has the maximum number of registered projects accounting to 33% of the total registered projects and also has 17% share in the total CERs and as detailed in DNA website is moving ahead with 421 DNA approved projects.

Various international organizations have been helping the CDM capacity building in India notable being ADB funded Technical Assistance Programme, UNDP facilitating five states agencies in CDM project development and GTZ funded project for facilitating high quality CDM projects (cdmindia.nic.in). The country is rated highly for its conducive climate for CDM investment and as per DEG country analysis report (2006) the DNA receives 30-40 new applications every month. According to cdmindia India there are 18-consultancy organization in India doing consultancy services for CDM projects out of which nine have renewable energy and eight have energy efficiency as one of the main sector in their portfolio.

The share of various projects that are registered with EB from India is depicted below

% break up of CER generated

- Biogas: 1.2%
- Others: 1.5%
- Biomass: 12%
- EE: 23%
- Cement: 10%
- Wind: 4.7%
- Hydro: 3.1%
- HFC: 44%

% break up of projects

- Biogas: 33%
- Others: 3.4%
- Biomass: 33%
- EE: 28%
- Cement: 7.3%
- Wind: 10%
- Hydro: 10%
- HFC: 1.7%

Figure 2-3: Percentage Break Up of CERs and Project Type (India)

Source: www.cd4cdm.org (March 2007)

The projects approved by Indian DNA are characterized by the relatively high number of renewable energy projects & energy efficiency projects, which constitutes to 56% and 30% of total approved projects (cdmindia.nic.in). Though the renewable energy & energy efficiency projects have a lion’s share in the number of approved CDM projects, the building projects are conspicuous by their very limited presence. So far there are only four projects from India that can be considered to be addressing the building sector and are as given below

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21 www.cdmindia.nic.in
22 India with 350 projects has the maximum number of projects in validation stage (cd4cdm, March 2007)
23 Rating by point carbon is BBB+ and by DEG is 84.5%
24 From August 2005, the projects submitted for validation from India is growing and the period of 20 months since then 95% of the projects came into pipeline
25 cdmindia is a capacity building facility formed between German Technical Cooperation and Bureau of Energy Efficiency and the information is sourced from their website (www.cdmindia.com)
Table 2-3: CDM Projects in building sector in India

<table>
<thead>
<tr>
<th>Name of the project</th>
<th>CER generated/Year</th>
<th>Status</th>
<th>Issuance of CERs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy consumption project in a hotel</td>
<td>2987</td>
<td>Registered on 18th November 2006</td>
<td>Awaiting</td>
</tr>
<tr>
<td>Bagepalli Bio Gas Project</td>
<td>19553</td>
<td>Registered on 10th December 2005</td>
<td>Not yet</td>
</tr>
<tr>
<td>Bagepalli CDM Solar Hot Water Heating Programme,</td>
<td>662000</td>
<td>Validation stage</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Photovoltaic Lighting Programme</td>
<td>136000</td>
<td>Validation Stage</td>
<td>Not Applicable</td>
</tr>
</tbody>
</table>

Source: www.cd4cdm.org (March 2007)

The CDM National Strategy Plan by The Energy Research Institute (TERI) in 2005 has observed the under representation of CDM projects in sectors like residential sector and recommended that special focus need to be given to facilitate such projects. However two years down the line as seen from the projects approved by DNA there has not been much change in the statuesque.

2.2 Programme of Activities under Clean Development Mechanism

“Individual projects cannot contribute substantially to sustainable development, except from in tiny economies”

Christiana Figueres,

2.2.1 Background

The Programme of Activities under Clean Development Mechanism (hence forth also called as programmatic Clean Development mechanism in this thesis) has been in the forefront of discussion recently due to the realization that with the existing framework, the market based CDM will push projects in some sectors like residential & transport sector which have a wider sustainable development benefits to the background.

As mentioned earlier in the chapter, transactions cost will be prohibitive for small projects and in order to facilitate small scale projects under CDM the bundling concept were introduced wherein several small-scale project can be bundled together and considered as a single project. The Marrakech accord has made provision for bundling of small-scale projects with an objective to reduce the transaction cost27 thereby bringing small scale projects which otherwise do not have a chance on individual basis to be attractive to investors. The 20th EB meeting (6-8 July 2005) has made following general guidelines for bundling of project

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26 No monitoring report available yet.
27 Based on survey in 15 Indian projects Krey suggests that search cost (i.e cost to locate a buyer), negotiation cost & PDD cost is substantially higher for small scale projects, and the same can be reduced by bundling of projects (Krey, 2004)
Once a project activity becomes part of a bundle for a project cycle stage, it shall not be de-bundled for this stage.

The composition of bundles shall not change over time

All project activities in the bundle shall have the same crediting period

"EB of CDM 20th meeting report (www.unfccc.int)"

In case of bundling the projects should be of same size at the same stage of development and to be bundled by one organization (Diana et al., 2006). However Diana et al. argue (2006) that this will create problems for building projects and may not be sufficient to facilitate projects addressing building sector.

The debate on programmatic CDM was triggered by the methodology to address a mandatory energy efficiency standard for room air conditioners in Ghana in 2004 (OECD, 2006). The COP/MOP1 has approved the acceptance programme of activities as a CDM project by its decision that project activities under a programme of activities can be registered as a single clean development mechanism project activity (Figueres, 2006). However local/regional/national policy or standard cannot be considered as a clean development mechanism project activity28. The decision 4 CMP.1 further states that programme of activities can be considered as a CDM project provided they uses approved base line and methodologies while taking into account leakage and the emission reductions are real, measurable, verifiable as well as additional (Para 20, Decision 4 CMP.1, 2006).

The CDM Meth panel in its twenty-second meeting (September 2006) defined the programme of activities in the following ways

"Involves a bringing together of several project activities within a country29 to mitigate greenhouse gas emissions and all individual project activities are implemented as a result of a (coordinated) programme by way of technical/financial assistance.

Each individual project activity that involves GHG mitigation option is voluntary, i.e. not required by a national/regional/local government policy or standard.

Each individual project activity in a “programme of activities” has a direct, real and measurable impact on emission reductions and should be traceable, e.g. identified and localized at either the validation or verification stage of the “programme.

The coordinator/managing entity enters into agreements with the actors implementing the GHG-reducing activity to ensure that they will not claim credits for their action under another CDM project or programme of activities

All the project activities under the program of activities registered shall have the same or different crediting period.

"Methodology Panel report (UNFCCC)."

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28 Decision 4 CMP.1, 2006, The first methodology submitted by Ghana viz Energy efficiency through mandatory national-level appliance standards (AM 0072) was withdrawn and resubmitted as activities to increase market penetration of energy efficient appliances (NM 0159)

29 This has been changed and EB 28 gave guidance that PoA can be applicable in more than one country
The COP 11 decision on programmatic CDM brought into the forefront the concepts of sector, policy & private based initiatives in order to extend the scope of CDM from a project based approach. The programmatic CDM may facilitate in achieving the objectives of National technology deployment policies by involving the market-based instruments (Ueno, 2006). Though programmatic CDM is not explicitly envisaged for small-scale projects, the small-scale projects by means of aggregating several individual projects like replacement of inefficient bulbs, motors etc with energy efficient products can leverage the CDM benefits. It is likely that the emission reduction achieved through a PCDM can exceed limits of the present small-scale project threshold (UNDP, 2006).

The EB in its 28th meeting in December 2006 made some further clarification regarding programme of activities on issues like physical boundary, mandatory policies, crediting period etc. The table 2-4 provides the guidance on registration of project activities under a programme of activities as a single CDM project.

Table 2-4: Salient Points of the EB guidance (EB28) related to Programmatic of Activities

<table>
<thead>
<tr>
<th>Physical Boundary</th>
<th>“The physical boundary of a Program of Activities (PoA) may extend to more than one country provided that each participating non-annex I host Party provides confirmation that the PoA, and thereby all CDM Programme Activities (CPAs), assists it in achieving sustainable development”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mandatory policies/regulations</td>
<td>“PoA addressing mandatory local/regional/national policies and regulations are permissible provided it is demonstrated that these policies and regulations are not enforced as envisaged. If they are enforced, the effect of the PoA is to increase the enforcement beyond the mandatory level required.”</td>
</tr>
<tr>
<td>Base Line &amp; Methodology</td>
<td>“A PoA shall apply one approved baseline and monitoring methodology, involving one type of technology or measure applicable to all CPAs”</td>
</tr>
<tr>
<td>Emission reduction</td>
<td>“The PoA shall demonstrate that net reductions (removals) in anthropogenic emissions for each CPA under the PoA are real and measurable, are an accurate reflection of what has occurred within the project boundary, and are uniquely attributable to the PoA.”</td>
</tr>
<tr>
<td>Crediting period</td>
<td>“Each project activity shall be uniquely identified, defined and localized in an unambiguous manner including the exact start and end date of the crediting period, by providing, at the stage it is added to the registered PoA, information which is determined for the purpose in the registered PoA; Any project activity under program of activities can be added to the PoA at any time during the duration of the PoA by a coordinating/managing entity.”</td>
</tr>
<tr>
<td>Monitoring</td>
<td>“The emission reductions of each CPA shall be monitored as per the registered monitoring plan according to the methodology applied to the registered PoA. The method or approach used to verify emission reductions (that may include random sampling) shall ensure the accuracy of these emission reductions.”</td>
</tr>
</tbody>
</table>

Source: UNFCCC (December 2006)

The CDM secretariat is currently in the process of preparing draft procedures for registration of programme of activities and issuance of CERs as well as a draft programme of activities design document. The public inputs were called and EB 29 (14-16 Feb 2007) has directed the secretariat to review the draft based on the inputs received on this aspect.
2.2.2 Potential for Programmatic CDM

The programmatic CDM is expected to bring in wide range of emission reduction activities under the CDM. To provide a glimpse of potential, the CER generation potential from the energy up gradation programme in a million households\(^{30}\) in South Africa through measures like roof insulation, solar water heating and replacement of two incandescent bulbs in each household by CFLs will be roughly to the tune of 2.85 million CERs/year\(^{31}\). If such a project is implemented in the country or extended to other countries through programme of activities the saving will be quite substantial and the shear CER volume coupled with such a project being potentially eligible for gold standard\(^{32}\) will evoke interest of investors.

Projects in Programmatic CDM

Though many literature states that a handful projects have already been registered as programmatic CDM in building sector, however on closer examination till date there are no projects registered truly as PCDM in this sector. Most of those projects are registered as bundled projects but have the characteristic of PCDM\(^{33}\). The following table highlights the projects that are registered (they have used small scale methodologies) and also in the validation stage that has characteristic of PCDM in the building sector.

**Table 2-5: Projects that have characteristic of programmatic CDM in building sector**

<table>
<thead>
<tr>
<th>No</th>
<th>CDM Project</th>
<th>Annual CER generated (T CO(_2) eq/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bagepalli Bio Gas Project, India</td>
<td>19553</td>
</tr>
<tr>
<td>2</td>
<td>Biogas Support Program - Nepal (BSP-Nepal) Activity 1</td>
<td>46990</td>
</tr>
<tr>
<td>3</td>
<td>Biogas Support Program - Nepal (BSP-Nepal) Activity 2</td>
<td>46893</td>
</tr>
<tr>
<td>4</td>
<td>CDM Solar Cooker Project Aceh 1 Indonesia</td>
<td>3500</td>
</tr>
<tr>
<td>5</td>
<td>Kuyasa Housing Project, South Africa</td>
<td>6580</td>
</tr>
<tr>
<td>6</td>
<td>Moldova Biomass Heating in Rural Communities Project 1</td>
<td>17888</td>
</tr>
<tr>
<td>7</td>
<td>Moldova Biomass Heating in Rural Communities Project 2</td>
<td>17888</td>
</tr>
<tr>
<td>8</td>
<td>Moldova Energy conservation and greenhouse gases emissions</td>
<td>11567</td>
</tr>
<tr>
<td>9</td>
<td>Photovoltaic kits to light up rural households in Morocco</td>
<td>38636</td>
</tr>
<tr>
<td>10</td>
<td>Bagepalli CDM Solar Hot Water Heating Programme, India</td>
<td>662000</td>
</tr>
<tr>
<td>11</td>
<td>CDM Cook Stove Project Kupang 1, Indonesia</td>
<td>257000</td>
</tr>
<tr>
<td>12</td>
<td>Installation of 30,000 Solar Home Systems (30-75Wp) in Rural Households Bangladesh</td>
<td>94000</td>
</tr>
<tr>
<td>13</td>
<td>Karnataka CDM Photovoltaic Lighting Programme, India</td>
<td>136000</td>
</tr>
</tbody>
</table>

\(^{30}\) Under reconstruction & development programme South Africa envisaged to construct a million household by 2000 for households that have income below monthly income of 3500 R through a subsidy of 16000 R per beneficiary.

\(^{31}\) Average emission reductions by incorporating the above three measures in sample houses in Kuyasa, South Africa was 2.85 CO\(_2\) tonnes/hh/year

\(^{32}\) Gold standard is initiated by WWF & SSN & Helio International provides quality label for CDM projects (renewable energy & energy efficiency projects are eligible) fetches a premium price.

\(^{33}\) These projects can be replicated in a number of locations and can potentially exceed the SS project threshold.
2.2.3 Major Issues regarding Programmatic CDM

Though PCDM provides lot of potential, it throws immense challenges as well and this section discusses the major issues.

Methodological Issues

In order to successfully realize the potential offered by programmatic CDM it is imperative that approved large scale methodologies need to be in place. Though there are some large-scale methodologies for energy efficiency & renewable energy projects, most of them are industry specific and hence cannot be used in programmatic context. There are only a few large-scale methodologies applicable to programme of activities and further less in building sector. As mentioned earlier currently there are only two large-scale methodologies (AM0046 & AM 0044) applicable to building sector. The reasons attributed to low success rate of methodologies to be approved by the EB are the complications involved in developing the methodologies (Michaelowa & Pelzer, 2005). Some of the issues regarding the methodology formulation are discussed below.

Base Line

Even a single programme like changing of lighting to energy efficient lighting could have three different scenarios like discretionary retrofits, planned retrofits and new fittings. The baseline needs to establish in different ways, which include the existing/historical emission or emission arises with out the project by referring to common practices (Michaelowa & Hayashi, 2007).

The remaining life of the equipment can play an important role in the baseline estimation for programmes in building sector. Michaelowa and Pelzer argues that the remaining life of the equipment needs to be at least equal to the crediting period or changes in baseline equipment need to be considered in the methodology (Michaelowa & Pelzer, 2005). Another issue that may be considered for energy efficiency project in general is the endogenous energy efficiency improvement. Michaelowa & Hayashi suggests approach involving statistical sampling to effectively address this, which however is complicated (Michaelowa & Hayashi, 2007).

Additionality Assessment

There is limited exposure on additionality assessment for large scale programmatic CDM as earlier mentioned most of the CDM projects that have the characteristics of programme are bundled projects using the simplified guidelines applicable for small scale projects. In case of energy efficiency projects there is a tendency towards using barrier analysis and excluding the investment analysis (Michaelowa & Hayashi, 2007). Though it is not mandatory to use both analyses, Michaelowa & Hayashi (2007) demonstrates that EB prefer the use of both. As per Michaelowa & Hayashi the additionality can be assessed at two different levels in a programme of activities viz. at intermediary level who organizes the programme and at the actors who actually install the project. EB has to decide whether additionality is required at

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34 This is reduction in baseline emission due to modernization, better equipment etc happening over a time
both level and further. They argue that EB is not consistent in its decision like EB guidance states that additionality requirement at individual participant level, however in one of the methodology (NM 0150) which considers the additionality only on programme level, EB has not raised an issue (Michaelowa & Hayashi, 2007).

Free Riders & Spill Over
In a programmatic approach the free riders & spill over has a crucial role in establishing the emission reduction. Free riding occurs when emission credits are attributed to a particular project, even when that would have happened with out CDM incentive. The free riding arising due to lax methodology can inflate the emission credits from a project and stringent baseline estimation and additionality checks are suggested to overcome the free riders (Michaelowa & Hayashi, 2007).

The spill over has a positive influence as it can result in increase in the emission reduction by influencing the market. Michaelowa & Hayashi (2007) suggests the following three type of spill over:

- Spill over with in the project, wherein participants purchase/install equipment through the programme
- Spill over outside the programme, wherein participants purchase/install equipment outside the project participants
- Spill over due to non participant, wherein non participants were induced to purchase/install equipments through the influence of participants or greater availability of products in the market etc

It is suggested to compute the effect of free riders and spillovers through net to gross ratio (NTG), by using fraction of free riders and fraction of spill over in establishing the realistic emission reduction from a programme (Michaelowa & Hayashi, 2007). However usage of NTG is also a tricky as a national level study of CFL in US showed that the NTG can vary from 80-91% significantly affecting the emission reduction (Skumatz and Howlett 2006). Hence methodologies for establishing free riders and spillovers are complicated and thereby involving higher transaction cost (Michaelowa & Hayashi, 2007).

Leakage
Leakage is the net GHG emission change that will occur outside the project boundary but is attributable to the CDM project activity. In case of programmatic CDM Figueres and Bosi (2006) argues with reference to lighting replacement programme that leakage occurs when the still functioning old lighting device is re used and can be avoided by having a monitoring component for scrapping of equipments. However they further mentions that it is questionable to scrap functioning equipments in a resource scarce developing country (Figueres & Bosi, 2006).

2.3 Discussion
The buoyant economic growth in developing countries like India, which predominantly depends on fossil fuels, is expected to increase its GHG emissions in future. Further the climate change phenomenon may have significant impact in India like as per Kumar and Parikh (2001) a temperature change of +2°C with an accompanying precipitation change of
+7 %, farm level total net-revenue would fall by 9%. Parikh and Parikh in their paper (2002) refers from an ADB report which states that if a one-meter sea level rise were to take place today, it would displace 7 million people in India. Hence there are reasons for the country to initiate measures to reduce the GHG emissions and it is prudent to take action for India on all possible fronts to reduce the GHG emission and thereby reducing the impending threat of climate change. As mentioned earlier in the chapter since large potential exist in building sector, which include residential buildings, it is imperative that energy conservation measures may be targeted towards this sector. India has the maximum number of CDM registered projects and has conducive atmosphere for CDM investment. With the building construction activities growing in India, it should make sense for stakeholders to explore the additional benefits accruing from CDM revenue through PCDM to reduce the emissions from buildings.
3 Energy Efficiency and Renewable Energy Scenario in India- Focus on residential sector

3.1 General Introduction

India, with a population of over a billion, is on a fast track economic growth, with more than 7% GNP annual growth consistently since 2000\textsuperscript{35}. Though per capita primary energy consumption of India at 439 kgoe (2003) is lower compared to world average (1688 kgoe), India stands sixth in World in terms of total energy consumption (Planning Commission, 2006). Figure 3-1 indicates India’s share of energy sources for commercial purpose for the year 2004, which illustrates the dependence of India’s economy on conventional fossil fuels (coal and oil).

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{Figures3-1.png}
\caption{Primary Commercial Energy Consumption in India-2004}
\end{figure}

Source: Planning Commission: 2006

India with over 253 billion tones of coal reserves is self sufficient in terms this fossil fuel at least for the medium term. However India is highly dependent on foreign countries for its oil consumption and currently 76 % of its oil requirement is met through imports. The annual crude oil import during the year 2005-06 was 100 million Tons, which was 20 % more than the import figure of 2002-03, where as there was no increase in domestic crude oil production during the same period (MoPNG, 2006). If this situation prevails it is likely that the import dependence will increase further in future as Shahi\textsuperscript{36}, states that the requirement of primary commercial energy will likely grow at a rate of 6 % per year (Shahi, 2006). Further in order to sustain the present economic growth it is expected to add another 100 000 MW\textsuperscript{37} by the year 2012 from the current installed capacity of 128 432 MW. The financial outlay required to achieve the above capacity addition is around 180 billion USD including transmission & distribution assets (Sing A, 2006).

\textsuperscript{35} In current price terms (Union Budget, 2006-07)
\textsuperscript{36} R.V.Shahi was the secretary, Ministry of Power, Government of India till 31.01.2007
\textsuperscript{37} The installed capacity in India needs to be 800 000 MW in 2031-32 to maintain an economic growth of 8% till that period which is required to eradicate poverty and to meet its human development goal (Planning Commission, 2006)
According to India’s Initial National Communication to the UNFCCC, the annual anthropogenic GHG emission of India in 1994 was 1228 Million Ton and during 1990 – 2000, the compounded annual growth rate of GHG emission in the country was 4.2 % (MoEF, 2004). The National Communication reveals that CO2 emission accounts for the maximum share of total GHG emission at 63 %, CH4 accounts for 33% and the rest 4 % by N2O. The CO2 emission is expected to increase three fold from 1994 base line figure and reach 3000 million Tons by 2020 due to economic activities (Sharma et al, 2006). The energy use in residential buildings and commercial institutions results in 3.6 % and 1.7 % respectively of the total GHG emission and is considered among 15 sources that are classified as key source categories (Sharma et al, 2006).

Energy efficiency, conservation and promotion of renewable energy are some of the options to address the above concern to an extent. The chapter mainly deals with energy efficiency & renewable energy scenario in general and residential sector in particular. The energy conservation programmes targeting residential sector and barriers to realize the potential is also discussed.

3.2 Energy Efficiency & Conservation Scenario

Though as mentioned earlier the percapita energy consumption of India is lower than the world average, the energy intensity in terms of USD is higher than many countries. The energy intensity of the country has not changed much during the period 1980-2002 implying that the there was not much improvement in energy efficiency during that period (CPC, 2005). Several studies were conducted to understand the energy efficiency potential in the country and as per a study by planning commission the energy efficiency potential in industrial, commercial and residential sectors in the country is 25%, 20 % and 20% respectively (World Bank et al 2006). The following table provides the immediate energy efficiency market potential in different market categories.

<table>
<thead>
<tr>
<th>Market Category</th>
<th>Investment Potential (Billion USD)</th>
<th>Annual Energy Saving Potential (Million KWh)</th>
<th>Power Saving (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General Energy Efficiency</td>
<td>0.95</td>
<td>23827</td>
<td>3400</td>
</tr>
<tr>
<td>Process Energy Efficiency</td>
<td>1.8</td>
<td>25229</td>
<td>3600</td>
</tr>
<tr>
<td>Commercial</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.13</td>
<td>739</td>
<td>247</td>
</tr>
<tr>
<td>Government Owned</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Offices</td>
<td>0.077</td>
<td>345</td>
<td>160</td>
</tr>
<tr>
<td>Hospitals</td>
<td>0.02</td>
<td>210</td>
<td>34</td>
</tr>
<tr>
<td>Private Owned Hotels</td>
<td>0.03</td>
<td>184</td>
<td>53</td>
</tr>
<tr>
<td>Municipalities</td>
<td>0.3</td>
<td>3700</td>
<td>1688</td>
</tr>
</tbody>
</table>

38 In 2001, India’s energy intensity at 25,307 Btu per $1995 was highest in Asia surpassed only by China and Pakistan (EIA, 2001 however if energy intensity is considered in purchasing power parity, India consume 0.16 kgoe per dollar of GDP which is lower than the world average of 0.21kgoe (Shahi, 2006)

39 In 1980 India’s carbon intensity was 0.51 MMTC per 1000 USD 1995 at MER whereas in 2002 it was 0.52 MMTC per 1000 USD 1995 at MER (CPC, 2005), however when considered in
Programme of Activities: Will it break the ice for residential sector CDM projects?

| TOTAL | 3.2 | 53495 | 8935 |

*Source: Datta Roy, 2004*

The huge untapped potential in energy efficiency market can be observed from the energy efficiency consultancy market as well which is not encouraging at the moment. A consultancy market of 320 million USD is estimated at 10% of the above investment opportunity, against which the total current total consultancy market for energy efficiency including energy audit, performance contract, engineering etc is in the range of 12 to 22 million USD (Datta Roy, 2004).

In order to harness the energy efficiency market potential, government has introduced a few policy and regulatory instruments since the beginning of 21st century like energy conservation Act 2001, Electricity Act 2003, Electricity Policy 2005 etc.

### 3.3 Renewable Energy Scenario

India has huge potential of renewable energy and realizing the importance of non-conventional energy, in meeting India’s energy requirement, Government of India had created a Department of Non conventional Energy Sources way back in 1982, which was turned into a separate Ministry called Ministry of New and Renewable Energy in 1992. Upto March 2006 the total installed capacity based on the renewable energy sources was about 7169 MW consisting of 4434 MW of Wind, 1748 MW Small Hydro, 867 MW Biomass, 70.87 MW Gasifier, 2.74 MW Solar and 46 MW energy recovery from waste (MNES, 2006). As per MNES medium term assessment (2032) the renewable energy potential is 172000 MW shows tremendous potential to be harnessed (MNES, 2006). In order to realize the renewable energy potential Ministry of New and Renewable Energy introduced draft renewable energy policy in 2005, which is under the consideration of the government. The draft policy envisages achieving development of indigenous renewable and new energy technologies at par with international standards and to achieve optimal fuel mix to properly address the concern of the country. Ministry of New and Renewable Energy issued a set of guidelines to the states to promote renewable energy and currently fourteen states announced policy packages like wheeling, assured purchase etc for electricity generated from renewable sources.

There are economic incentives like accelerated depreciation, concession/exemption from custom and excise duty etc to promote renewable energy. India currently has one of the world’s largest programs for renewable energy and many of the programmes targets households, the brief details of which are provided in section 3.4.3.

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40 The erstwhile Ministry of Non Conventional Energy Sources

41 Like Karnataka state Electricity Regulatory Commission in 2004 instructed the distribution companies to purchase a minimum of 5% of electricity from renewable sources.
3.4 Building Sector Energy Scenario in India

3.4.1 The Scenario

India is witnessing a major boom in construction sector and the average growth projected during 2004-08 is over 10 %, which is highest in the world (Langdon, 2005). The construction sector is a very important economic driver for the country, and the sector accounts for 5.1% of GDP and is one of the largest employers in the country employing around 17.62 million people (Planning Commission, 2002). Under the construction sector, building construction is an important activity as noted from construction world news (2003) where in it was pointed out that during the period 1995-2000, construction in the household sector was increased from 44 % to 53 % of the total construction activity in the country. The figure shows the trend in number of houses constructed in the country.

![Figure 3-2 Growth of households in India](source: National Building Organization, GoI (2006))

The programme is aimed to provide construction assistance for dwelling units and upgradation of existing unserviceable kutch house for Scheduled Castes/Scheduled Tribes and non-SC/ST rural families who lives below the poverty line.

In terms of energy consumption, the building sector accounts for a major share and in India it is estimated that around 15% of the total energy demand is for meeting the operational energy requirement of buildings (WEEA, 2004). The residential households in India consume around 201,000 mtoe, which is around 11 % of the world residential household energy consumption (Earth Trends, 2003). The rural households account for around 75 % of the total energy consumed in the residential sector in the country (Michaelowa & Singh, 2004). In India firewood and chips constitutes the major share of energy in rural and urban households, figure 3-2 depicts the share of various fuels in total energy consumption of households in India.

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42 The Figureures are for the year 1999-2000
43 The programme is aimed to provide construction assistance for dwelling units and upgradation of existing unserviceable kutch house for Scheduled Castes/Scheduled Tribes and non-SC/ST rural families who lives below the poverty line.
Adalberth et al. (2001) demonstrates that operating energy constitutes the most significant component of the total energy consumption of the building during its life cycle. Hence it is quite logical to introduce energy efficiency and renewable energy measures for buildings to reduce the operating energy consumption because of the potential. There exist huge potential for energy efficiency in buildings and it has been estimated that for government buildings alone in 36 cities in the country, the overall energy saving potential is 760 GWh (Michaelowa & Singh, 2004). There has been some initiative from the government to harness the potential like Energy Conservation Act 2001 which was mentioned earlier stipulating mandatory energy audit for all buildings whose connected load is above 500 KW. Further realizing the importance of energy efficiency in buildings Bureau of Energy Efficiency (BEE) has considered the energy efficiency of buildings and establishment as one of their major area of activities (BEE website). Demonstration audits were conducted in selected buildings in New Delhi under the supervision of BEE with an objective towards capacity building for delivery mechanism of energy efficiency services. The energy audit conducted in nine government buildings in New Delhi showed a saving potential of around 25% to 46% (Michaelowa & Singh, 2004). It is likely that some of the state electricity boards will be taking a cue like the Maharashtra Energy Development Agency under their strategic energy conservation plan has multi pronged strategy to address building sector which include awareness programme, public building partnership programme through ESCOs, residential high efficiency lighting programme etc (MEDA, 2005). The newly launched ECO III project funded by USAID has components to facilitate energy conservation in building sector like conducting investment grade energy audit in select buildings in state and municipalities, promotion of green building certification etc (RFP ECO III, 2006).

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44 A Swedish study on life cycle assessment of residential buildings estimates the energy consumption during operational phase is more than 80% of the total energy consumption during the entire life cycle of buildings (Adalberth et al, 2001)
The National electricity policy (2005) suggests that energy conservation will be adopted in all government buildings for which the energy saving potential is estimated to be 30%. Another recent development in energy efficiency in building sector in the country is the release of draft energy conservation building code (ECBC) by BEE. The ECBC stipulates incorporation of energy efficiency measures for new buildings above stipulated parameters and also for old buildings under certain conditions (BEE, 2006). However all these initiatives are largely addressing the commercial building and not targeting the residential sector which as per Michaelowa & Singh (2004) cumulatively consumes almost four times more electricity than the commercial buildings in the country. A recent initiative to make household less energy intensive is taken at state level like that of West Bengal Renewable Energy Development Agency’s (WBREDA) solar housing complex and that of Mahrashtra’s\(^{45}\) eco housing programme. There exist some programmes that target the residential sector and the same is discussed below.

### 3.4.3 Programmes targeting residential sector

As mentioned earlier many of the programmes by MNRE targets households and brief details of some of those programmes are provided in the section\(^{46}\).

**Integrated Rural Energy Programme (IREP):** The programme aims to provide minimum domestic energy requirement for rural people in selected village clusters in each district with renewable energy as the focus. The programme envisages creating IREP cells in selected districts and making model projects integrating various rural energy programmes of MNRE.

**National Biogas and Manure Management Programme:** The objective of the programme includes providing fuel for cooking to rural households and organic manure through family type biogas plants. The government provide subsidies for the biogas plants which vary from 50 USD to 270 USD per equipment depending on location as well as capacity of equipment.

**Solar Photovoltaic Programme:** The programme is launched to promote the use of solar photovoltaic, which include solar home systems, solar street lighting, SPV power plants, and new application of SPVs. The programme during 2005-06 has provided incentives to solar home system for remote village electrification where electrification through other sources like biomass, biogas, small hydro or combination of all these are not feasible. The financial assistance of upto 90 % subject to a maximum ceiling are given to household for procuring solar home system.

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\(^{45}\) The WBREDA solar housing in Kolkata launched in 2006 was for independent bungalows priced at around 0.1 million USD for a bungalow (WBREDA website). The ecohousing programmes is supported by USAID and involves assessment criteria for new residential constructions with the thrust on energy efficient lighting, use of solar water heating and sustainable practices in architecture and building materials.

\(^{46}\) The information about the programme are sourced from the official website of MNRE (www.mnes.nic.in), refered on 01 March 2007
Promotion of Solar Buildings: The programme objective is to create awareness about solar energy application in buildings. The programme includes awareness campaign, orientation courses for architects, demonstration projects wherein the Ministry will bear 10% of the construction cost.

Solar Water Heating System Programme: The programme intends to promote widespread use of solar water heaters with help of financial incentives like soft loan and promotional activities.

Voluntary Initiatives: There are a few voluntary initiative for energy conservation in building sector in India like the Indian green building council which is part of CII - Godrej GBC is promoting green building concepts and provide LEED India certification to buildings. Another initiative is TERI Griha rating system by The Energy Research Institute, which evaluates the whole building during its entire life cycle on energy and environmental parameters (TERI n.d).

3.5 Barriers to residential sector energy conservation effort

Though there exist opportunities for energy conservation in residential buildings the sector offer significant challenges as well. The section highlights some of the major challenges to realize the energy conservation potential in residential sector in the country.

3.5.1 Subsidized electricity tariff

In India domestic consumers are provided with subsidized electricity tariffs and prices are below the marginal cost of supply (Reddy S, 2003). As observed from the annual report on working of state electricity board (2002), the combined subsidy offered by the state electricity board has increased to almost 6 fold during a ten year period of 1992-2002. The subsidy is reflected on reduced electricity price for the users and as seen from Figure 3-3 domestic consumers pay one of the lowest electricity tariffs among the various user groups (agricultural sector is the lowest). The lower electricity price makes more costly energy efficient/renewable energy products financially less attractive and could act as a disincentive for energy conservation measures among the domestic consumers.

47 The LEED India certification is awarded in recognition to sustainable site development, water savings, energy efficiency, materials selection and indoor environmental quality of a building
3.5.2 Higher initial cost of equipment

The capital cost of a product increases with increase in efficiency and generally the consumers’ choices are mainly dependent on capital cost of energy consuming equipment rather than minimising costs over the life of equipment (Reddy S, 2003). Some of the renewable energy products like PV system has a very long payback period whereas products like CFL cost almost 15 times more than the incandescent bulbs. According to Banerjee (2005) the residential consumer’s discount rate for energy investments is very high at 50 % and thus could be stumbling block for investing in energy efficient equipments.

3.5.3 Lack of Awareness

Consumer knowledge on energy efficient product and the cost advantages is important for its adaptation. However many consumers in the country which include the households are ignorant about the energy efficiency improvement potential (Reddy A, 1990). Even if consumer knows about a product they may not know about the benefits/disadvantages of using a product making it difficult to make an informed decision. This is reflected in a survey about barriers to diffusion of renewable energy technologies in Maharashtra state wherein majority of surveyed households were aware about solar water heaters but did not know that it cannot be used in winter (Reddy S, 2002).

3.5.4 Non Availability in the market

The non-availability or difficulty in accessing energy efficient/renewable energy products could be a barrier in adopting the technology by household consumers. Due to higher cost of many renewable energy or energy efficient products, they may not be easily available, like in case of LED bulbs they are available only through manufacturers/assemblers and the retail net working is yet to be established (Gupta V-personnel communication).

The DSM activity by utilities could be a possible solution involving some of the technologies. However transaction cost involved in managing such a programme in low energy use domestic consumers is high, making utilities less interested to address the sector (Banerjee, 2005). Further there are currently no regulations in place for energy conservation...
in households and even for commercial buildings which offer more saving per building, the capacity building exercise is only in the process.

3.5.5 Product Quality Issues
The consumer need to be sure about the technical soundness of product apart from the other issues mentioned earlier in order to have effective diffusion of the technology (Reddy S, 2003). There could a probability of lower quality products available among the energy efficient technologies in the market. To illustrate this with a case example, the testing of several brands of CFLs in India had shown that many failed to meet the standard life requirement (Consumer Voice, 2005). In developing countries apart from the product quality itself, external factors like voltage fluctuations can affect the life of the products (Meyers, 1998). The user friendliness of the technology is also important for the diffusion of technology as demonstrated by the survey conducted by Chandraskhar et al. (2007) which suggests products like solar cookers needs more technology innovations.

3.5.6 Lack of Incentive
According to Reddy S (2003) one of the major barrier that prevent the energy efficiency programmes in the country is the lack of financial incentive to state agencies like utilities. He argues that incentives make the energy efficiency programmes financially attractive as with incentive the return on investment increases. as these organization have to incur expenditure to operate such programmes. Reddy further argues that as the respective state agencies may incur expenditure to operate energy efficiency programmes, lack of government incentive may dishearten them in their endeavor.

3.6 Discussion
Energy efficiency and renewable energy provides the country good opportunities to reduce its dependence on fossil fuel and India with higher energy intensity per GDP in dollar terms along with demand and energy shortages need to tap them. As discussed earlier there has been renewed interest among the policy makers recently that can be interpreted from several policy measures in place as well as in negotiation in the last five years. However it is still early days to see the difference of these policy instruments. Though there has been an effort in the industrial sector to reduce energy consumption (some of the leading industries in specific industrial sector has its specific energy consumption comparable to the international standard\(^48\)) the building sector that has excellent potential for energy conservation was neglected till recently.

It is clear from the discussions in the chapter that there exist potential for energy conservation in residential sector. The barriers found in the literature survey were many fold and PCDM may be able to address some of them. Since one of the major barriers for the penetration of energy efficiency and renewable energy projects in residential sector are related to the concern regarding their financial attractiveness, PCDM provides an opportunity to address this issue to some extent. The CER revenues may be able to offset a portion of the higher cost of costly technologies making them more financially attractive. The project proponent of PCDM may be able to negotiate with supplier of the technology

\(^{48}\) Specific energy consumption in few of industries like cement, steel etc are comparable to the best in the world (EC Award documents of BEE, 2005)
regarding the quality and price since project proponent represents a larger customer base and may be able to influence the supplier in comparison to an individual customer. Further if the state agencies like utility initiate the programme, they may able to use a percentage of CER revenue as incentive for conducting energy conservation measures. However there exist several issues regarding implementation of PCDM and the major ones are addressed in subsequent chapters.
4 Barriers & Opportunity related to PCDM: Residential sector in India

4.1 Introduction
As mentioned earlier in section 2.2.3 there are quite a few issues related to PCDM. In this chapter a few technologies were chosen that are currently available/used in residential sector in India and are analysed to understand the major barriers and opportunities related to their deployment under programmatic CDM in India. The relevance of the technologies selected in Indian context is highlighted in section 4.2 and brief technical information about each of them is provided in Appendix 4.

4.2 Relevance of technologies/Products considered
The technologies considered are those required by households to meet their important requirements like lighting, cooking and water heating. Accordingly the technologies selected for the analysis are Compact Fluorescent Lamps, energy efficient tube lights, electronic ballast, LED with solar photovoltaic system, biogas digesters, solar cookers and heat pump for water heating application. Some of the technologies like energy efficient tubes and electronic ballast has predominant application in urban sector, while some other product like biogas digester, LEDs have application in rural sector.

Compact Fluorescent Lamps (CFL)
The lighting load accounts for 17% of the installed generating capacity of India and lighting industry is growing at a rate of around 20% per year (elcoma\(^{49}\)). The value of the lighting industry was approximately 1 billion USD in 2005 and CFL contributes to around 15% of the total market value of the industry\(^{50}\)(elcoma). As per the annual report (2005-06) of Ministry of Power the demand shortage in India is 10.5% and is prominent during the evening hours when the lighting loads are connected to the grid. CFL deployment will be beneficial to utility for customers whose peak demand coincides with the system demand like the residential sector\(^{51}\) (Rao N, 2005).

Energy Efficient (EE) tube lights
The Fluorescent tube lamp accounts for almost 25% market value of the total lighting industry (elcoma). The energy efficient tube lights considered in this analysis is the one with T5 tube and electronic ballast, which can replace an existing 40 W conventional tube light with electromagnetic choke. The energy saving potential by such a replacement could be around 45%\(^{52}\). There are a few major players in the country manufacturing such type of tube fittings. The technology however may find it difficult to penetrate the residential market due

\(^{49}\) elcoma is influential association of Electric Lamp & Component Manufacturers Association of India and the information is sourced from their website http://elcomaindia.com/ referenced on March 07th 2007
\(^{50}\) The lighting industry include lamps, luminaires, accessories etc.
\(^{51}\) Majority of respondents in CFL dissemination survey in India preferred CFLs installation scheme on easy credit through government or manufacturers (Kumar A, 2003). State Electricity Boards that are cash strapped for capacity addition and under the control of government can make the CFL implementation as a DSM activity, which provides one opportunity to address the demand supply gap.
\(^{52}\) Based on Asian Electronics Ltd, India Brochure
to the large price difference compared to conventional fluorescent tube light with electromagnetic ballast.

**Electronic Ballasts**
The ballast is a component in fluorescent tube fittings that controls current. In India the electromagnetic (conventional) ballasts dominates the market with a share of 66%. However the market share varies a lot in different cities like in Kolkata conventional ballast has share of 95 %, which may be attributed to strong presence of cheaper local brands (VOICE & SLEMA, 2003). The electronic ballast is energy efficient device that help to reduce 20 % of energy in comparison to the conventional magnetic ballast. Though the market price of magnetic ballast varies depending on manufacturer, a reputed brand would cost around 3 USD/equipment that is around 50 % cheaper than the electronic ballast. However the payback for investment for electronic ballast could be reasonably attractive depending on the number of hours of operation and electricity price.

**LED with solar photovoltaic system**
LED based solar home system (SHS) has application in remote villages where grid connected electricity is not feasible cost economically, which is estimated to be around 25000 villages. However Rajiv Gandhi Gramin Vidyutikaran Yojana (RGGVY) launched in 2005 by the central government targets providing lifeline energy of 1 KWh/day to all homes by 2009, and SHS is not capable to provide this amount of lifeline energy. Subsequently the villages that are not covered by the RGGVY initiative were revised to 10000 (MNRE, 2006). LED offers opportunity in remote villages considering its very low power consumption and very long operating life. The LED components are imported and assembled in the country and cost of the LED has seen a decreasing trend during the last few years (Gupta V, personal communication). In this analysis a cluster of LED (2.5 W x 5 Nos) along with solar recharging battery was considered as replacement for a 60 W incandescent bulb.

**Bio Gas Digesters**
In rural India, cooking accounts for a little over 80 % of the household energy consumption (Purohit etal, 2002). As mentioned in Figure 3-1 the major fuel sources for rural households are firewood and chip. Providing rural household with clean fuel like biogas will save women from drudgery associated with collection of these fuels and also beneficial to the health of users due to avoided indoor pollution. As per MNRE annual report (2005-06) the theoretical biogas plant potential in the country is around 12 million out of which around 3.5 million plants have been commissioned since the launch of biogas development programme in 1980-81. As per a sample survey conducted by National Council of Applied Economic Research during 1995, 87.5 % of the biogas plants were found to be in working condition, which shows a reasonable level of technology maturity in the country. In this analysis 2 m3 biogas digesters was considered, the estimated potential of which in the country is around 6 million (Purohit etal, 2002).

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53 With an assumption of 100 households in each of such remote villages, the total households that can be electrified by LED based SHS would be one million (author)
54 The price of a 1 W LED was approximately 6 US $ in 2004 and currently it is around 2 US $ (Gupta V – personnel communication). Further as per Gupta who has the pioneer manufacturing unit of LED in India the life of LED cannot be assured beyond 5 years
Solar Cookers
As per MNRE there exist a potential of around 10 million solar cookers in the country. However according to Purohit et al. (2002) the potential for solar cookers in the country is as high as 75 million, whereas the total cumulative number of solar cookers in the country as of 1999 was only 0.48 million (Purohit et al., 2002). Box type solar cooker is the most popular model for household application in India and there are around 30 manufacturers with a total installed capacity of 75000 units per year (MNRE, 2006).

Heat Pumps
In a typical middle class household almost 30 % of the energy is consumed by the electric water heater (BEE website). Air source heat pump for water heating for residential sector is a novel concept in India. One of the market segment considered for air source heat pump is the urban residential households and the product suited for the market is about to be launched. The heat pump considered in the analysis is air source heat pump used for water heating purpose and can replace electric water heater. The energy demand for heating water is likely to increase at a yearly rate of 13.65 % and 8.27% in rural and urban areas respectively from 2001-2031 for 8% annual GDP growth (TERI, 2006). However the prohibitive cost and untested technology could be barriers for heat pump based water heaters to create an impact in this market. In case heat pumps there currently there is no support from the government and hence it is felt worth to explore to what extent the CER revenue can support such a technology in terms of reducing the price barrier.

Existing Standards and Codes
There exist standards/codes for some of the products selected for the analysis and table 6-1 provides a brief overview of them.

Table 4-1 Performance Standards/Codes for the selected technologies in India

<table>
<thead>
<tr>
<th>Product</th>
<th>Standards/Codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>CFL</td>
<td>Performance requirement as per IS 15111: 2002 (Part 2) which stipulates the</td>
</tr>
<tr>
<td></td>
<td>energy, life, initial lumen etc.</td>
</tr>
<tr>
<td>EE Tube Lights</td>
<td>Currently there exist no National level performance standard specific to T5</td>
</tr>
<tr>
<td></td>
<td>tubes with electronic ballast</td>
</tr>
<tr>
<td>Electronic Ballast</td>
<td>IS 13021 : Part 2 : 1991</td>
</tr>
<tr>
<td>LED based SHS</td>
<td>MNRE has prepared the draft specification for LED based SHS which include</td>
</tr>
<tr>
<td></td>
<td>performance parameters (MNRE website)</td>
</tr>
<tr>
<td>Box type solar cookers</td>
<td>Manufacturing standard IS :13429; 2000</td>
</tr>
<tr>
<td>Bio Gas Digesters</td>
<td>IS 9478 : 1986 specifies requirements for design and installation of family size</td>
</tr>
<tr>
<td></td>
<td>bio-gas plants</td>
</tr>
<tr>
<td>Heat Pump</td>
<td>Currently there exist no national standard for heat pumps</td>
</tr>
</tbody>
</table>

Source: Bureau of Indian Standard

55 Anup N- personal communication
56 The Draft Energy Conservation Building Code specifies lighting power (W/ m²) for different areas in building and may act as a driver for energy efficient light fittings in buildings covered under the code.
57 State level organization when call for tenders for such fitting provide technical specification (eg, Gujarat Energy Development Agency, 2006). Further Bureau of Energy Efficiency has launched energy labeling scheme for fluorescent tube lamps upto 40 W
4.3 Barriers and Opportunities in PCDM

The section highlights the major issues related to CDM in general and PCDM in particular with reference to the above technologies.

4.3.1 Base Line Establishment

As mentioned in Chapter 3, in order to benefit from the PCDM it is desired to have large project using approved large-scale methodology. Further as per the EB 28 clarification on programmatic CDM specific methodologies may be used for each likely technology in a programmatic CDM. At present there is only one approved large-scale methodology for individual technology applicable to residential sector in India (AM 0046 – Distribution of efficient bulbs to households). Hence for technologies other than lighting that were considered in the analysis, large scale deployment under PCDM may not be possible as they will have to use small scale methodologies till somebody develops large scale methodologies pertaining to them. This situation provides an immediate challenge, since there are no incentives for development of methodologies for such applications (the beneficiaries are large numbers with small CER/participant) and involves significant time\(^{58}\) and money for to have an approved methodology.

In India average emission factor would vary in different part of the country. To illustrate this with an example in the case of power generation the maximum difference of emission factor is upto 45% (Refer table 5.3) and for a programmatic CDM activity that cut across different regions, the difference in emission factor need to be accounted. In India though Energy Conservation Building Code (ECBC) is in the final stages of preparation and electricity policy targets 30 % energy reduction in buildings, these are applicable only for commercial buildings which are above certain parameters and for government buildings respectively. The residential sector in general does not come under the purview of these standards/policies\(^{59}\). At present the policy that explicitly mentions about energy conservation in residential sector is the draft national housing policy (2005) aims to improve the energy efficiency in housing sector. The policy plans to introduce norms for energy consumption as well as to introduce laws for using renewable energy especially the solar water heaters in residential sector (MHUPA website). However as it the policy is still in the draft stage it may be unlikely that the baseline for any of the products mentioned in the thesis will have to consider these issue to prove additionality\(^{60}\) during the first commitment period. As discussed earlier most of the renewable energy products receive some sort of assistance from the government, which is type “E”, category and since these are in place before 11\(^{th}\) November 2001, its implication should be considered in the baseline scenario.

4.3.2 Leakage

Leakage can occur in the selected products under programmatic CDM like if the incandescent bulbs that were replaced by CFLs are used outside the project boundary resulting in additional emission. The CDM projects viability depends to an extent on how to minimize these leakages that could be significant for lighting products considered in this

\(^{58}\) On average the methodologies that were rated as “A” by EB at first consideration took 9 months for approval (ECON, 2005) and SSN received approximately 0.3 million USD for developing the methodology for housing sector (SSN website)

\(^{59}\) ECBC is applicable to buildings with conditioned area above 1000m\(^2\)

\(^{60}\) Even when the norms/standards are in place as per EB 28 the PoA of the technologies is valid if can be proved that the standards/norms are not enforced as envisaged.
thesis. It is important to provide methods to estimate the leakage in the baseline methodology. The large scale approved methodology for efficient lighting in household (AM 0046) stipulates that an independent monitoring of the scrapping of the lights returned by households need to be implemented and also to tally the number of lights that are scrapped with the new one implemented requiring the scrapped lights to be stored till cross checking is done. In PDD developed for green lighting projects in China, it is mentioned that leakage is zero since it will be ensured that incandescent lamps will be scrapped, however as per IISD report the PDD will need to revise the leakage calculation (IISD, 2006). In developing country like India, which has thriving second hand market avoidance or minimizing leakage pose significant challenges for the project proponent especially that involves product which has resale value like electric water heaters.

4.3.3 Double counting

It has to be ensured that double counting is not taking place in the CDM project. In the programmes like lighting products there exist probability of double counting due to presence of large number of stakeholders who can potentially claim CER revenue (Figuieres & Bosi, 2006). Further Bureau of Energy Efficiency has launched energy labelling for 4 feet fluorescent lamps of wattages upto 40 W in 2006 and can have a potential to cause double counting with the energy efficient tubes considered in the thesis. However no organization has currently launched a programme to utilize the CER revenue through programmatic CDM route for such products in the country. Hence the organization that start the CDM programme first may claim the CER benefits by bringing other stakeholders acceding this by entering into an agreement with them (Figuieres & Bosi, 2006). Already there exist business model in the country with utility and manufacturers for distribution of energy efficient technologies like BESCOM lighting programme. This type of agreement can be extended further to bring CDM concerns to facilitate launching of CDM programme targeting residential sector.

4.3.4 Additionality

As mentioned in chapter 3, additionality is a major hurdle for CDM projects especially that for energy efficiency projects. UNFCCC had developed additionality tool, which provides a framework comprising of steps for proving a project’s additionality (UNFCCC website). The illustrations of these steps as provided in EB 29 report are given in Appendix 3. The following sections details the screening steps involved and how the technologies considered in the thesis might be suitable for PCDM in the Indian context. As proving additionality could be very complex depending on specific cases, the description below would provide only an overview that indicates the opportunities and challenges.

Step 1: Identification of alternatives

The identification of realistic alternatives to provide the same quality of service is the first stage in the process. For the products considered in the thesis it could be different sources of lighting with same quality output, different methods of cooking and different methods for water heating etc. Further additionality tool developed by UNFCCC states that the

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61 The other products for which energy labeling are applicable currently are frost free refrigerators and room air conditioners (www.bee-india.nic.in)
alternatives considered shall be in compliance with all mandatory laws and regulations of the country. For the products considered there exist many alternatives that fully meet any such regulations and hence for all the products considered it will not be difficult to prove them as additional based on step 1 of the additionality tool.

**Step 2 or/and Step 3: Investment Analysis/Barrier Analysis**

The next step in additionality tool is investment analysis or barrier analysis or both together. In case projects like that are used for cooking, which does not have additional income other than CDM revenue a simple cost analysis is required. The PDD for *Bagepalli CDM Biogas programme* has used this type of analysis and it would be relatively easier to do the investment analysis compared to the project that incurs financial return. In case of projects like CFL, energy efficient tubes etc that result in monetary benefits due to energy saving, investment comparison or benchmark comparison analysis may be used. In case of CFL the IRR could be 100% at national average domestic electricity price of (at 0.045 $cent/KWh) for an individual buyer however for energy efficient tube, electronic ballast and heat pump, the IRR is negative for domestic application. Hence for all the products except CFL it would be possible to prove additionality by investment analysis. In case of CFL programme due to its financial attractiveness with out CDM benefits, in order to prove its additionality project proponent has to consider barrier analysis. The initial investment, which can be upto 15 times higher than the ordinary incandescent lamps, could be a barrier for CFL adaptation. However considering fast pace of growth in CFL industry in the country (75% growth for CFL in 2005 compared to 2004 as per elcoma), the project proponent may have to properly demonstrate that there exist sufficient barriers for the implementation of CFLs in residential sector.

**Step 4 Common Practice Analysis**

This step, which is a credibility check to complement the Step 2 and Step 3 is very important with respect to the product considered. In India as mentioned earlier there exist programmes like National Biogas and Manure Management Programme to promote biogas plants or interest free loan assistance for solar cookers. There exist programmes for energy efficient lighting as well like BESCOM lighting programme on CFL targeting residential sector. However as mentioned earlier in the chapter there still exist very huge potential markets for alternatives for conventional cooking or for energy efficient lightings (see section 4-2 for further reference). The PDD for *Bagepalli CDM Biogas programme* (project participants- Women for Sustainable Development and Agriculture Development and Training Society) demonstrated this by stating that the potential for biogas digesters in the project boundary is above 50000 but government programme could support only 500 biogas digesters. Similarly approximately 0.75 billion incandescent bulbs used every year in the country and accounts for 80 % of volume of sale of lights in the country (TERI, 2006). Hence it could be possible to establish additionality for all the products considered with the existing support. However careful analysis would be required to prove the additionality on this step especially because programmatic CDM can involve different regions wherein technology diffusion due to

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62 Many rural household in India collects wood chips/biomass for cooking free of cost (Sinha B 2002)
63 Authors calculation based on assumptions made in Chapter 5
64 Share of CFL is around 1-2% of the total lighting market (TERI, 2006)
existing programme could be different. To illustrate this point with an example as per MNES annual report (2005-06), in the state of Madhyapradesh till 2004-05, the biogas plants cumulative installation was only 16% of total potential, whereas the neighbouring state of Maharashtra achieved 79% of its commercial potential⁶⁵.

4.3.5 Free Riders
In programmatic CDM involving small products targeting residential sector, free riders are quite likely to be present. The additional emission reduction is that achieved after deducting emission reductions due to free riders and the challenge lies in quantifying the emission reduction attributed to free riders. The methodology submitted namely DSM program switching from incandescent lamps to CFLs (NM0157) uses the swapping of lights and as well as confirmation about the usability of lights replaced through survey in order to exclude free riders. However MP had raised issues about additionality owing to lack of check for authenticity of survey (Michelowa & Hayashi, 2007). Michelowa & Hayashi points out that these things make the emission calculations complicated and require the project proponent to have expertise to carry out such methods. As most of potential project proponents of programmatic CDM in residential sector in India like utilities, NGOs have insufficient expertise (Refer SWOT analysis in Chapter 6) in this field could be a stumbling block. An immediate way out could be involving the CDM consultants to help project proponent on a mutually agreeable term for a fixed duration and then continue the project themselves once capacity building is achieved. This will increase the transaction cost and further to facilitate this it is essential to have the confidence of CDM consultant especially since project proponent like utility in India are loss-making entity.

4.3.6 Transaction Cost Involved
As mentioned in section 2.1.2, the transaction cost is critical for the financial viability of a project under CDM. The CER revenue as a percentage of total investment for the projects considered can vary a lot depending on the different scenario like it can be as low as -ve in pessimistic case and can be as high as 113% in the optimistic case for a CFL programme. The same is reflected in the transaction cost wherein for some scenarios for a few of the technologies, the transaction cost is higher than the CER revenue. In relative terms it could deter the prospectus through PCDM for equipment requiring large investment. However for others it could provide incentive to the prospective project proponents to leverage the benefits in order to achieve their respective objectives. Higher the products installed lower would be the share of transaction cost, however the advantages of higher volume is limited to certain extent, above which the incremental benefits will be marginal. The next chapter provides more details regarding transaction cost involved in various technologies considered.

4.3.7 Discussion
There exist considerable challenges with regard to the technical issues of PCDM, which makes it difficult to achieve the objective of PCDM towards residential sector at least in

⁶⁵ The biogas plant diffusion in the country varies from region to region and reasons could be many which as Bhat etal (2001) points out with a case study in Sirsi, Karnataka are presence of multiple agencies in the dissemination network, participation of entrepreneurs competing to assist households in all aspects of biogas plant construction, subsidy, free servicing etc
short term. Further the stringent stipulations regarding leakage like that given in AM0046 would increase the transaction cost. The estimation of free riders also requires complicated process, which would make handling of PCDM project difficult to potential project proponents. As illustrated earlier all the products considered in this chapter may be able to clear the additionality test but may require stringent analysis for that.

Considering the deployment time required, leakage issues as well as the potential available\(^{66}\) for some of the projects even with in the state level, the author feels that it may be likely that PCDM involving the technologies considered may target a single region and may not be requiring multiple emission factor which however would be case specific.

The draft national housing policy may be a right step to provide the desired institutional framework for energy efficiency and renewable energy measures in housing sector. However it is not clear by what date the planned norms and laws will be formed and how these will be enforced. Judging by the time taken for the development of energy conservation building code, which took more than four years from the conceptual stage to the draft development stage\(^{67}\), energy norms and associated laws for reducing energy consumption in residential sector may not happen in the near future.

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\(^{66}\) For BESCOM lighting programme, the phase II targets 2.6 million customers for EE lighting with in a few districts of Karnataka

\(^{67}\) The energy conservation building code was considered as a thrust area in the action plan launched during the formation of Bureau of Energy Efficiency in 2002 and the draft energy conservation building code was prepared in 2006.
5 Impact of CER revenue in financial performance of technologies in residential sector

5.1 Introduction
The objective of this chapter is to understand the financial implication of CER revenue accrued by the deployment of the technology. As programmatic CDM is expected to assist projects involving low CER revenue by bringing many such projects under a programme of activities, the chapter depicts the financial performance from CER revenue for a range of products in each category.

In order to assess the impact of CER revenue from PCDM in residential sector, the set of technologies that are considered in Chapter 4 are used for the cost revenue analysis. The percentage share of CER revenue in the loan repayment is considered as a criterion to judge the PCDM contribution in the deployment of the respective technologies. In some of the technologies, like lighting products that can be deployed as a DSM activity involving utility, internal rate of return for the investment made to bear a part of the cost are also calculated.

5.2 Existing Scenario
Unlike other CDM projects it is not practical to estimate the contribution of CER revenue in the return of investment for technologies applicable in household as it saves marginal GHG emission in isolation. Hence it is assumed that there would be a project proponent who has interest in benefiting the CER revenue through programmatic CDM by clubbing together a number of such installations. The project proponent could be different depending upon the product category, like for lighting products utility could be a potential project proponent, whereas for biogas digesters, solar cookers etc NGOs can act as a project proponent. Without CDM in the existing situations nobody except manufacturers and utilities and government agencies like MNRE may be interested for deployments of the technologies considered on such large scale. The utilities are facing financial difficulties (refer 6-4) whereas manufacturers interest would be as usual driven by the objective of selling more products. Further except CFLs and energy efficient lights the manufacturers of other technologies considered in the analysis are small-scale players. The government organisations like MNRE that provide grants for renewable energy technologies are not involved in CDM projects. Hence financial baseline wherein the technologies would be deployed in large scale in absence of CDM is not considered.

5.2.1 Existing economic instruments that may facilitate the projects
There are some economic instruments in terms of reduced interest rate, subsidy etc from the government to facilitate the deployment of the technology considered in the analysis. It is prudent to assume that the parties implementing the technologies will utilize the available supports. A brief detail of the existing programmes supporting the technologies is provided in table 5-1.
Table 5-1 Existing programmes supporting the technologies considered

<table>
<thead>
<tr>
<th>Technology</th>
<th>Funding/programme</th>
</tr>
</thead>
<tbody>
<tr>
<td>CFL</td>
<td>If the utility takes up the project as a DSM project, interest rate(^68) of loan from Indian Renewable Energy Development Agency (IREDA) under Energy efficiency &amp; conservation programme will be 10.5% (<a href="http://www.ireda.in">www.ireda.in</a>). BESCOM Efficient Lighting Program a market based initiative under ECO-II project by USAID involving a utility the Bangalore Electricity Supply Company and CFL manufacturers. The households received the CFL from approved manufacturers on a monthly lease basis and received a discount of upto 20% of the market price.</td>
</tr>
<tr>
<td>EE Tube Lights</td>
<td>No Programmes for EE tube lights in building sector However If the utility takes up the project as a DSM project, interest rate of loan from Indian Renewable Energy Development Agency (IREDA) under Energy efficiency &amp; conservation programme will be 10.5% (<a href="http://www.ireda.in">www.ireda.in</a>).</td>
</tr>
<tr>
<td>Electronic Ballast</td>
<td>No Programmes for occupancy sensors However If the utility takes up the project as a DSM project, interest rate of loan from Indian Renewable Energy Development Agency (IREDA) under Energy efficiency &amp; conservation programme will be 10.5% (<a href="http://www.ireda.in">www.ireda.in</a>).</td>
</tr>
<tr>
<td>LED based SHS</td>
<td>Upto 90% grant subject to a higher sealing will be provided to various approved remote electrification projects. Solar home lighting systems for domestic lighting are eligible under the support where no other non-conventional energy technology is found to be feasible(^69) (MNRE, 2006). 9% interest through micro finance is possible if project is taken through NGOs.</td>
</tr>
<tr>
<td>Box type solar cookers</td>
<td>Incentive of 4.5 USD/solar cooker for state nodal agencies and 2.25 USD/solar cooker for promoters other than state nodal agencies. Interest free loan which has to be paid within one year (MNRE).</td>
</tr>
<tr>
<td>Bio Gas Digesters</td>
<td>Central subsidy of 48 US $ to 80 US $ per plant depending on the location and capacity of plant under National Biogas and Manure Management Programme (NBMMP)(^70). 18 US $ per plant for turnkey jobs to provide three years of free maintenance warranty (MNRE). 9% interest through micro finance is possible if project is taken through NGOs.</td>
</tr>
<tr>
<td>Heat Pump</td>
<td>Currently there exist no programme to support heat pumps</td>
</tr>
</tbody>
</table>

5.3 Key assumptions made for the analysis

In order to make the cost revenue analysis some assumptions were made and the major assumptions made for the calculations are provided in the subsequent sections

\(^{68}\) The interest rate of Power Finance Corporation Ltd (PFC) to State sector borrowers for schemes in transmission & distribution is 11.75% for reset after every 3 years (PFC circular, 2007)

\(^{69}\) LED system is not explicitly mentioned in the document however considering the latest development like prototype testing of LEDs, establishment of standards for LED lightings as well interest among policy makers about LED technology, it could be very likely that LED could also be covered by such scheme in near future (Gupta V, personnel communication)

\(^{70}\) The fund is allocated for a fixed target in each states and in 2004-05 the cumulative target was 100 000.
5.3.1 Operational Pattern
As the emission reduction by the deployment of the technologies considered is directly dependent on their operating pattern, assumptions based on published literature were made in this regard.

Table 5-2 Key Assumptions for the calculations

<table>
<thead>
<tr>
<th>Product</th>
<th>Key Assumptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>CFL</td>
<td>The 15 W CFL replaces a 60 W incandescent bulb. Daily working hours considered as 4 Hrs since average lighting hours in rural India is 4 hours (TERI, 2006) and substantial market for incandescent bulb which is being replaced exist in rural India. 20 % of the upfront cost of the equipment will be borne by the project proponent to promote energy conservation.</td>
</tr>
<tr>
<td>Energy Efficient (EE) Tube</td>
<td>28 W EE tube replaces a conventional 40 W FLT with electro magnetic ballast. Daily working hours considered as 5 Hrs since average lighting hours in cities in India is 5 hours (TERI, 2006) and the FTL market is predominant in cities. 20 % of the upfront cost of the equipment will be borne by the project proponent to promote energy conservation.</td>
</tr>
<tr>
<td>Electronic Ballast</td>
<td>Electronic ballast replaces a electro magnetic ballast. Daily hours as 5 Hrs since it is an accessory of tubes and the major market is in cities. 20 % of the upfront cost of the equipment will be borne by the project proponent to promote energy conservation.</td>
</tr>
<tr>
<td>LED based SHS</td>
<td>Daily hours considered is 4 Hrs as the product has application in villages and replaces 60 W incandescent bulbs.</td>
</tr>
<tr>
<td>Box type solar cooker</td>
<td>Replaces conventional wood stoves. The households use solar cooker for 60 % of its cooking requirement in sunny days (average sunny days in India is 275) and 70%71 biomass used is non renewable, which is the Indian average. Cooking requirement per household is for 5 members.</td>
</tr>
<tr>
<td>Bio Gas Digester</td>
<td>Replaces conventional wood stoves. The share of non-renewable biomass considered is 70%, which is whole India average and cooking requirement is for 5 member households.</td>
</tr>
<tr>
<td>Heat Pump</td>
<td>Replaces electric water heaters. The average annual electricity saving due to avoided use of electric water heater is 1075 KWh/equipment72.</td>
</tr>
</tbody>
</table>

5.3.2 GHG mitigation potential of the selected technologies
The GHG emission reduction potential of the technologies like CFLs, EE tube lights, heat pumps were calculated based on the energy saving potential as well as average usage and the

71 Sourced from PDD on Bagepalli CDM Biogas programme.
72 This Figure is the average electricity saving due to solar water heater with the average yearly number of days of operation is 225 days, in case of heat pump it will be higher but due to non availability of data regarding the number of hours of geyser operation in the country above Figure was considered which is a conservative estimate ( refer Appendix- for region wise break up)
average emission rate. In India, the emission rates in different regions are different due to the energy mix used for power generation. The weighted average emission rate in different location of the country is as given in table 5-3. In the analysis the average emission rate for the country is used.

**Table 5-3  Weighted average emission rate including imports ( t CO2/MWh)**

<table>
<thead>
<tr>
<th>Location</th>
<th>2004 –05</th>
</tr>
</thead>
<tbody>
<tr>
<td>North</td>
<td>0.72</td>
</tr>
<tr>
<td>East</td>
<td>1.05</td>
</tr>
<tr>
<td>South</td>
<td>0.79</td>
</tr>
<tr>
<td>West</td>
<td>0.92</td>
</tr>
<tr>
<td>North East</td>
<td>0.46</td>
</tr>
<tr>
<td>India</td>
<td>0.84</td>
</tr>
</tbody>
</table>

*Source: Central Electricity Authority, 2006*

In case of biogas digester annual CER generation is taken from the PDD developed for the registered CDM project *Bagepalli CDM Biogas programme*. Whereas for solar cooker the annual wood consumption per household for cooking is taken from the above PDD, however since the solar cookers cannot be used through out the year owing to non-availability of sunny days and also due to the fact that the households may not use solar cooker for all the cooking application, the CER generated from solar cookers were based on the assumption provided in table 5-2. The average annual CER generation potential for the equipment was estimated based on the calculation and depicted in table 5-4.

**Table 5-4  Average annual CER generation potential/product**

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Cost of one Equipment ( US $)</th>
<th>Annual generation/equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>CFL (15 W)</td>
<td>3.4</td>
<td>0.055</td>
</tr>
<tr>
<td>EE tube light (28 W)</td>
<td>20</td>
<td>0.037</td>
</tr>
<tr>
<td>Electronic Ballast</td>
<td>5.5</td>
<td>0.015</td>
</tr>
<tr>
<td>LED based SHS (12.5 W)</td>
<td>56</td>
<td>0.058</td>
</tr>
<tr>
<td>Box type solar cooker</td>
<td>45</td>
<td>1.85</td>
</tr>
<tr>
<td>Bio gas Digester (2 m³)</td>
<td>340</td>
<td>3.29</td>
</tr>
<tr>
<td>Heat Pump (Air source)</td>
<td>570</td>
<td>0.903</td>
</tr>
</tbody>
</table>

*Note: The budgetary price details of the product were collected from suppliers/manufacturers of the respective products in India.*

**5.3.3 Transaction Cost Involved**

The broad range of transaction cost involved where mentioned earlier in chapter 2, However for the analysis a more detailed calculation was adopted and as there is no experience in the transaction cost that will be incurred in a programmatic CDM, the minimum transaction and maximum transaction cost incurred for a CDM project established by Kray (2004) was
considered as key information source. The reasons for using Kray’s data was because it was based on an empirical study conducted in India and further it is widely referenced in other published literatures as well. Monitoring cost involved for products like solar cookers and biogas digesters is calculated based on the monitoring cost incurred for Kuyasa housing project\textsuperscript{73}. For products like technology retrofits like CFL & EE tubes monitoring cost was taken as around 8% of the transaction cost based on of SIPA (2005)\textsuperscript{74}. Further the sample size that was considered for monitoring was taken as 10 % of the household where the technology was installed. The adaptation levy and administration fee will change for different programmes based on the CERs generated. The transaction cost considered for the analysis (except the monitoring cost, adaptation levy, risk mitigation and administration fee which varies a lot for each product) is as given in table 5-5. The detailed transaction cost involved in a sample project is provided in Appendix 2.

Table 5-5 Transaction Cost

<table>
<thead>
<tr>
<th>Transaction Involved</th>
<th>Total Cost (US $) (Min – Max)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Search Cost</td>
<td>19,000 – 29,000</td>
</tr>
<tr>
<td>Negotiation Cost</td>
<td>10,500</td>
</tr>
<tr>
<td>PDD Cost</td>
<td>6,500 – 120,000</td>
</tr>
<tr>
<td>Validation Cost</td>
<td>6,000 – 80,000</td>
</tr>
<tr>
<td>Registration Cost</td>
<td>5,000 – 30,000</td>
</tr>
<tr>
<td>Verification Cost</td>
<td>8000 – 40000</td>
</tr>
<tr>
<td>Consultant Fee</td>
<td>10 % of first year CER price</td>
</tr>
</tbody>
</table>

\textit{Source: Krey M, 2004, SIPA, 2005}

5.3.4 CER Price and Crediting Period

The CER price that depends on various factors is highly fluctuating in nature and in the analysis a minimum and maximum values was considered, which was 6 Euro/CER and 10 Euro/CER respectively. As the actual CER price in a transaction is usually confidential in nature the above range is taken from the recent publication in Point Carbon\textsuperscript{75}. The CER revenue was limited to 5 years for the analysis considering the uncertainty that still exist regarding post 2012 Kyoto regime, which makes the CER purchasers reluctant to make binding commitments for CER purchase post 2012 (REIL, 2006). In case of CFL the crediting period is considered to be 4 years as the average operating life of CFL could be four years in India with four hours of daily operation (As per Indian standard IS 15111, the requirement of CFL life is 6000 Hrs). However for products like biogas digesters, solar cookers and heat pumps that have more than five years of useful life, the crediting period of

\textsuperscript{73} Monitoring expenses of 500 Rand for the first year and 250 Rand during subsequent years anticipated per household for the Kuyasa housing energy upgradation project was considered in the analysis. The above monitoring cost in South African currency was converted to Indian rupees by using the real exchange rate based on percapita GDP PPP for both countries and nominal exchange rates.

\textsuperscript{74} The percentage break up was for small scale project and according to the report for larger single project the % of transaction cost is lesser but considering the fact that PCDM involves more monitoring expenditure than a single large projects the higher value was considered for the analysis (author).

\textsuperscript{75} The rate is category 2 price of some of the CDM credit purchase done in February/March 2007 (Point Carbon, 2007)
seven years and ten years are also considered to depict the difference in impact of CER revenue in project deployment.

In order to evaluate the impact of CER revenue for each of the product through programmatic CDM a range of equipments installed are considered. The minimum number of equipment considered is based on the annual CO\textsubscript{2} saving potential of 15000 ton/year that was one of the earlier limiting value for small-scale CDM projects. There is no guidance yet from the EB regarding the limit on the PoA size and in the analysis the maximum value was limited to two million products or a total investment of 30 million USD which ever is lower for each product category. The two criteria is considered because of the cost difference among the technologies considered like a heat pump will be 150 times more costlier than CFLs and hence keeping the two criteria - absolute numbers and cost involved will help to have a upper limit more realistic. The limit of two million products is considered; as deployment could be possibly achieved in a year at least for some of the technologies by the project proponents and may provide significant CERs as well. The upper limit of 30 million USD is taken as a representative figure which was an equivalent funding India received from World Bank for DSM related activities\textsuperscript{77}. Based on the above cut off values, the minimum and maximum number of equipment considered for the analysis is as provided in table 5-6.

Table 5-6: Number of equipments considered for the analysis

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Minimum Equipment Considered</th>
<th>Maximum Equipment Considered</th>
</tr>
</thead>
<tbody>
<tr>
<td>CFL</td>
<td>275000</td>
<td>2000000</td>
</tr>
<tr>
<td>Energy Efficient light fitting</td>
<td>420000</td>
<td>1500000</td>
</tr>
<tr>
<td>Electronic Ballast*</td>
<td>1000000</td>
<td>5000000</td>
</tr>
<tr>
<td>LED based SHS</td>
<td>260000</td>
<td>5200000</td>
</tr>
<tr>
<td>Box type solar cooker</td>
<td>85000</td>
<td>600000</td>
</tr>
<tr>
<td>Bio gas Digester (2 m\textsuperscript{3})</td>
<td>5000</td>
<td>80000</td>
</tr>
<tr>
<td>Heat Pump</td>
<td>17000</td>
<td>510000</td>
</tr>
</tbody>
</table>

\* In electronic ballast the maximum numbers were based on 30 million USD since deployment of 2-million electronic ballast could result only around 30500 CER/annum.

5.4 Impact of CER revenue

As the CER price and also the number installation under PCDM is not known before hand, the percentage of transaction cost in total CER revenue and CER revenue as a percentage in total investment for all the products selected for minimum and maximum installation mentioned in table 5-6 were calculated for the following scenarios

- Lower transaction Cost and lower CER price
- Higher Transaction Cost and lower CER price

\textsuperscript{76} The BESCOM project mentioned earlier which was first of its kind in the country targeted 0.75 million CFL products in the phase I with in a six month period.

\textsuperscript{77} http://www.gefweb.org/wprogram/india.doc
A range of products in each category have been considered for the above scenarios which provides range of values for percentage of transaction cost in total CER revenue as well as CER revenue as percentage of total investment. In order for easier understanding the pessimistic scenario and optimistic scenario is highlighted in the text. A pessimistic scenario is where the number of product installed is lowest, the transaction cost higher and CER price lower whereas optimistic scenario is when the number of products installed is highest, transaction cost lower and CER price higher. The calculated values for the pessimistic and optimistic scenario are provided in table 5-7 and findings in graphical representation for all the scenarios are given in Appendix 1.

Table 5-7 Share of CER revenue in total investment & % of transaction cost

<table>
<thead>
<tr>
<th>Technology</th>
<th>Number of years considered for CER crediting</th>
<th>Investment envisaged/Ton of CO2 saved during the crediting period (USD)</th>
<th>% of transaction cost in total CER revenue</th>
<th>Transaction Cost €/CER</th>
<th>CER revenue as % in total investment</th>
</tr>
</thead>
<tbody>
<tr>
<td>CFL</td>
<td>4</td>
<td>15.5</td>
<td>8.6 to 113</td>
<td>1.07 – 6.8</td>
<td>-6.8 to 97</td>
</tr>
<tr>
<td>EE Tube Lights</td>
<td>5</td>
<td>108</td>
<td>11 to 100</td>
<td>1.78 – 6.02</td>
<td>0 to 11.1</td>
</tr>
<tr>
<td>Electronic Ballast</td>
<td>5</td>
<td>75</td>
<td>10.3 to 102</td>
<td>1.8 – 6.4</td>
<td>0 to 16</td>
</tr>
<tr>
<td>LED based SHS</td>
<td>5</td>
<td>193</td>
<td>35 to 121</td>
<td>3.45 – 7.24</td>
<td>-0.8 to 4.4</td>
</tr>
<tr>
<td>Box type solar cookers</td>
<td>5</td>
<td>5</td>
<td>9 to 80</td>
<td>1.5 – 4.8</td>
<td>32 to 244</td>
</tr>
<tr>
<td>Bio Gas Digesters</td>
<td>5</td>
<td>21</td>
<td>8 to 76</td>
<td>1.5 – 4.6</td>
<td>9.2 to 58</td>
</tr>
<tr>
<td>Heat Pump</td>
<td>5</td>
<td>126</td>
<td>17 to 84</td>
<td>1.71 – 5.1</td>
<td>1 to 9.2</td>
</tr>
</tbody>
</table>

As seen from the above table the annual CER revenue as percentage of total investment for the products like LED, heat pump and EE tubes are very low and the investment envisaged to mitigate 1 Ton of CO\textsubscript{2} saved for these products are higher than 100 USD\textsuperscript{78}. In case of CFLs, solar cookers and biogas digesters the share of annual CER in the total investment could be quite significant as in the case of optimistic scenario, which is an indication of the attractiveness of the project through CDM.

For all the products transaction cost is high in the pessimistic scenario and CDM is not worth exploring for all the products. However the transaction cost predictably comes down in other scenarios and in the optimistic scenario is less than 12% for all the cases except for LED based SHS.. A graph was plotted to find the trend of transaction cost as percentage of CER revenue above the maximum number of product considered in optimistic scenario. As

\textsuperscript{78} The penalty for non compliance under phase 2 EU ETS is € 100/Ton of CO\textsubscript{2}
per the graph it can be observed that there is noticeable decrease in incremental transaction cost reduction during the initial stage, however after that the curve is almost linear. As transaction cost is an important criteria in determining the financially additional CDM project’s attractiveness, the fact that it reduce only marginally after a certain number of installation, shows that unlimited number of installations through PCDM may not be more lucrative proposition for a project proponent.

One way of reducing the transaction cost could be to include more projects in each household. In order to find the effect of such a measure, among the projects considered LED lighting and biogas digesters are taken randomly. Here it is assumed that each household in which the biogas digester will be installed will also install two LED fittings (12.5 W x 2 each) and also the monitoring cost was assumed to be zero for the LED project. This assumption is made since the sample group will be same for both projects and hence monitoring cost of LED project may be covered under biogas digester project. The effect of clubbing these two projects and biogas digester and LED project alone is projected for the pessimistic and optimistic scenario in Figure 5-2.
From the above figure, it is clear that though for LED project, there is significant benefit in terms of reduction of transaction cost if its clubbed with biogas digester projects, there is no major benefits for biogas digester project. The reason attributed to this is the marginal share of LED project that is 3.4% in the total CER revenue. Hence for reducing transaction cost further in a programmatic CDM it may be prudent to involve technologies with almost similar CER share or to have many numbers of projects that could have the same sample group. However incorporating different type of technologies will create an issue under programmatic CDM as EB 28 guidance, which states “PoA shall apply one approved baseline and monitoring methodology, involving one type of technology or measure applicable to all CPA’s”. Hence it may be difficult to get the approval of EB for a programmatic CDM encompassing different technologies.

As the technologies considered in the analysis are purchased individually and also for renewable energy technologies targeting rural households does not result in cash inflow, the internal rate of return for the total investment envisaged in the project does not make much sense in most of the cases. Hence in order to find the impact of CDM project in the envisaged investments of the products considered, the share of CER revenue on average annual payment for the loan taken is calculated. The existing supports that are available (as mentioned in table 5-1) are taken into account in the calculation. The table 5-8 provides the effect of CER revenue in annual repayment with and with out the existing support.

**Table 5-8 Effect of CER revenue in repayment of loan**

<table>
<thead>
<tr>
<th>Technology</th>
<th>CER revenue as % of annual repayment with out any support*</th>
<th>CER revenue as % of annual repayment with the existing support</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Max</td>
<td>Min</td>
</tr>
<tr>
<td>CFL</td>
<td>322</td>
<td>-44</td>
</tr>
<tr>
<td>EE Tube Lights</td>
<td>45</td>
<td>0</td>
</tr>
<tr>
<td>Electronic Ballast</td>
<td>64</td>
<td>-1</td>
</tr>
</tbody>
</table>
As expected the share of CER revenue in repayment is maximum in the optimistic scenario and lowest in the pessimistic scenario. It can be seen that in case of solar cookers and CFL in the optimistic scenario CER revenue is very high and the project proponent can make good profit from the CER revenue itself. For other technologies except heat pump under optimistic scenario the share of CER revenue is significant which range from 38% to 66% of the annual repayment. However in case of the pessimistic scenario, the share of CER revenue is negative in most cases which shows that it will be too risky to take up a PCDM project in that case.

Further based on the above table in most cases share of CER revenue as a percentage of annual repayment do not change much even when there is no support. The reasons attributed to this is the lower support for the products considered. However in case of LED with SHS the difference is significant owing to the fact the potential support for that technology is very high.

For the above calculations due to reasons mentioned earlier, the 5-year crediting period was considered. However except the lighting products, all the other products have more than 5 years of life and CER revenue as percentage of annual repayment will increase if longer crediting period is considered. The graphs below provide the percentage of annual repayment for these products for a seven-year and ten year crediting period in an optimistic and pessimistic scenario.

* Interest rate for loan is that of commercial bank interest rate

<table>
<thead>
<tr>
<th>Technology</th>
<th>Average Life</th>
<th>CER revenue</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>LED with SHS</td>
<td>3</td>
<td>-40</td>
<td>38</td>
<td>-10.7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Box type solar cooker</td>
<td>192</td>
<td>25</td>
<td>222</td>
<td>29</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bio Gas Digesters</td>
<td>51</td>
<td>8</td>
<td>59</td>
<td>9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heat Pump</td>
<td>7</td>
<td>0.7</td>
<td>No support</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Assuming Bank will provide loan repayment of 7 years & 10 years respectively.
From the above graphs it can been observed that percentage share of CER revenue in annual repayment increases in the range of 31 – 67% in the pessimistic scenario and 120 – 230% in optimistic scenario for a 10 year crediting period in comparison to 5 year crediting period. For biogas project, CER revenue will support the entire loan repayment in an optimistic scenario, whereas the solar cooker projects can be fully supported through CER revenue even in a pessimistic scenario with a ten-year crediting period.

5.4.1 Internal rate of return (IRR)

Though as mentioned earlier, IRR do not make much sense for the products purchased individually, products like CFL and EE lights, electronic ballast offers opportunity for Demand Side Management (DSM) activities and hence IRR for the investment is considered for these products. In India one of the strategy adopted by utilities to tackle the demand supply gap, is load shedding, which can result in revenue loss especially if it includes the non-subsidized customers and DSM offers one opportunity in addressing this situation.

The IRR from investment for the utility assuming that they will bear 20 % cost of the products in order to reduce the cost barrier are as given in table 5-9.

<table>
<thead>
<tr>
<th>Product</th>
<th>Lower Transaction Cost &amp; Higher CER price (Only through CER revenue)</th>
<th>Higher Transaction Cost &amp; Lower CER price but with revenue generated by utility due to their increased capacity available from DSM activity*</th>
</tr>
</thead>
<tbody>
<tr>
<td>CFL (Deployment of 2 million products)</td>
<td>209%</td>
<td>1100%</td>
</tr>
<tr>
<td>EE Tube (Deployment of 2 million products)</td>
<td>-ve</td>
<td>144%</td>
</tr>
<tr>
<td>Electronic Ballast (Deployment of 9 million products)</td>
<td>-ve</td>
<td>212%</td>
</tr>
</tbody>
</table>

*The savings are based on engineering analysis. In reality the benefits of energy efficient lighting products for utility is difficult to estimate because as suggested in IIEC report (2006), common feeders cater to all kinds of loads which is a prevalent practice for all utilities in the country.

The above table shows that for CFL in the optimistic scenario, the IRR for utility investment (20 % of project cost) is highly attractive. In the pessimistic scenario, the IRR for the investment is negative, however if one consider the benefits to utility due to increased demand availability would be attractive. In case of energy efficient tube and electronic ballasts, the IRR through CER revenue in the both the case is negative, however as earlier if one considers the benefits to the utility as well then IRR would become attractive.

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79 Utilities are doing the load shedding while considering the conflicting interests like equitable distribution of shortages, paying culture etc (MSEB website)

80 The Electricity Regulatory Commission of the states of Maharashtra, AndhraPradesh, Karnataka, Delhi, MadhyaPradesh and UttarPradesh has issued orders to take up Demand Side Management measures (Prayas, 2005)
5.5 Discussion

The analysis shows that there exist multiple situations with reference to impact of CER revenue in the deployment of technologies. The analysis revealed that the transaction cost is significantly high in all the technologies considered under pessimistic scenario and PCDM may not be worth to explore in this situation as it can be seen that transaction cost in some cases are even higher than CER revenue from those projects. In some technologies like CFLs, solar cooker CER revenue is attractive in optimistic scenario, whereas for other technologies like heat pump and LED it is not attractive to initiate a CDM project involving these technologies. For those technologies that are attractive through CDM, CER revenue can support substantially the project finance under favourable situation. However considering the uncertainty of CER market, longer duration of installation (Bagepalli CDM Biogas programme in Karnataka, which till May 2007 could commission only 70 % of the total plants envisaged while registering it under CDM in December 200581) etc, that may make the programme unviable, associating with an existing programme like internationally funded project for rural development or DSM programme would be a possible way to operate PCDM involving the technologies considered in residential sector.

It is noticed that deployment of more and more projects may not reduce transaction cost proportionally as the reduction of transaction cost as percentage of CER revenue would be marginal above a certain limit. Further it was observed that if more than one project applicable to a particular residential sector could be clubbed together under programme of activities then the transaction cost can be brought down depending on the product selected. However incorporating more technologies in same building may raise issue in light of EB 28 guidance on PoA.

It has found that projects that generate lower CER per dollar of investment (like LED) are not attractive even in optimistic case with out the current support. However for other products the existing support does not make much difference in the contribution of CER revenue implying that even with out existing support CER revenue is attractive to take up PCDM projects under favourable conditions. Further it is observed that the increased crediting period can have significant effect on a project, like in solar cooker a increased crediting period of 10 years will support the entire programme only through CER revenue even in a pessimistic scenario.

In some of the technologies like CFLs, EE tubes etc utility may have interest to deploy them as part of the DSM activity. The deployment of these technologies will be beneficial to utility since it will lead to increased availability of demand with the utility that can be used to cater to unsubsidised sector like commercial establishments. However in India as mentioned earlier it is difficult to estimate the benefits due to such measure as common feeders cater to all type of loads. The CERs accrued through CDM project could act as incentive for the utility to initiate such projects and as seen table 5-9, for CFLs the IRR could be highly attractive in optimistic case even through CER revenue alone.

The CER price considered in the analysis were 6 €/CER and 10 €/CER, however if the buyer takes the risk there could be a probability that prices will go down further making the

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81 Source: Info needs, 2007
CER revenue not attractive in most cases. Hence it is essential to have a reasonable price and the fact that energy efficiency projects in residential sector may be able to fetch a premium compared to others through gold standard could be an incentive for project proponents.

The project proponents usually consider the life of the project for projecting the CERs, however investors may not be very much interested to procure CER generated post 2012 due to the current uncertainties regarding the fate of Kyoto Protocol after 2012. Crediting period of seven or ten years could further improve the attractiveness of PCDM projects involving relevant technologies. Hence as other CDM projects, PCDM would also benefit significantly by a positive signal from the world community in this direction especially since as shown in figure 5-4 some of the projects can be executed only with CER revenue even under a pessimistic scenario for a crediting period of ten years.
6 SWOT Analysis of Potential Project Proponents

6.1 Introduction

The beneficiaries of energy efficiency/renewable energy measures through PCDM in residential sector are dispersed with small CER per household and it is essential to have a project proponent to have an overall control in the execution of CDM activity and claim the CER revenue. The EB 28 states that programme of activities can be proposed by any entity public or private, and in this analysis the project proponent considered are those who have at least one of the following characteristics namely accessibility to the end users, technical competence, interest in regards to large scale adaptation of the products in the residential sector. This analysis is limited to ESCOs, NGOs, utilities and builders and the success of PCDM depends on the ability of these project proponents to handle them. Hence in this chapter SWOT analysis with in the context of the PCDM for these potential project proponents is conducted to understand whether PCDM in residential sector could be successful. The analysis was mainly through sample interviews and also through published documents.

6.2 Energy Service Companies (ESCOs)

Energy Service Companies with their expertise in energy conservation technologies can be a potential project proponent in CDM initiative. There are currently 12 ESCOs operating in the country\(^{82}\). A sample of four ESCOs who works in implementation of energy efficiency and renewable energy projects and located in different regions were interviewed to understand how they foresee the potential of programmatic CDM in residential sector. The interview was based on semi structured questionnaire (attached at Appendix 5) and the results are as discussed below

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge about CDM</td>
<td>25%</td>
</tr>
<tr>
<td>Knowledge about PCDM</td>
<td>25%</td>
</tr>
<tr>
<td>Whether tried to incorporate CDM in any of ongoing project</td>
<td>25%</td>
</tr>
<tr>
<td>Whether can handle CDM project independently</td>
<td>25%</td>
</tr>
<tr>
<td>Whether residential sector are clients</td>
<td>100%</td>
</tr>
<tr>
<td>Difficulty in collecting payment (100%)</td>
<td></td>
</tr>
<tr>
<td>Willingness to pay in the sector is not be attractive (100%)</td>
<td></td>
</tr>
<tr>
<td>Very low return with reference to the effort (100%) and financially not very strong to take such a risk</td>
<td></td>
</tr>
</tbody>
</table>

Possible Suggestions (mainly related to utility)

| More transparency, consistency and seriousness from utility |
| Requirement of an escrow account to facilitate payment |
| Government support – More Demonstration Projects |
| - Payment Guarantee |

\(^{82}\) An assessment of Energy Service Companies worldwide (forth coming report by CEU)
All the interviewed ESCOs mentioned difficulty in collecting the payment, very low return in comparison to the efforts as a barrier to consider residential sector as their clients. The SWOT analysis based on the discussion with the ESCO organizations is provided below

### Strength

The ESCOs have expertise in energy conservation as well as knowledge of monitoring and verification process of energy conservation projects, which will be beneficial to CDM projects that involve rigorous monitoring. One of the ESCOs interviewed has started CDM consultancy as an additional revenue generating activity.

### Weakness

The ESCOs discussed where small organizations with an average consultant strength of ten and financial constraint could be a stumbling block for them to execute large project like PCDM. Further based on discussions with the ESCOs it was revealed that most of them are not knowledgeable with CDM process. The ESCOs do not have residential sector as their client base and all the interviewed ESCO mentioned that they prefer industry, since as per them willingness to pay for their service is high in that sector.

### Opportunity

The cash starved utilities with peak demand shortage provide an opportunity for ESCOs who can associate with them to have DSM project that includes residential sectors. These projects in turn may be developed as a CDM project as well.

### Threat

ESCOs find it difficult to collect the payment from individual household. The above possible opportunity also provides the threat to ESCOs as they have apprehension regarding whether the utility would honour its commitment to wards payment. One of the ESCO interviewed pointed out about delay in getting the payment from a utility in spite of signed contract as well as satisfactory performance of their equipment. Some of the technologies applicable to the residential sector like CFLs are not very expensive and one of the interviewed ESCO mentioned that the users could purchase them directly from suppliers.

### 6.3 Non-Governmental Organizations (NGOs)

Some of the technologies considered like LED with SHS and biogas digesters have rural application. NGOs could be project proponents for the above-mentioned projects and in the country till date all the project proposal submitted to national DNA that has characteristic of PCDM was initiated by NGOs. A sample of five NGOs who works in implementation of energy efficiency and renewable energy projects were interviewed to understand how their views about programmatic CDM in residential sector and the result are as discussed below

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83 Another company (not the interviewed) with energy performance contract model has recently issued a legal notice to the utility after improper release of payment. (www.aelgroup.com)
Programme of Activities: Will it break the ice for residential sector CDM projects?

<table>
<thead>
<tr>
<th></th>
<th>Yes (%)</th>
<th>No (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge about CDM</td>
<td>80</td>
<td>20</td>
</tr>
<tr>
<td>Knowledge about PCDM</td>
<td>60</td>
<td>40</td>
</tr>
<tr>
<td>Whether tried to incorporate CDM in any of ongoing project</td>
<td>40</td>
<td>60</td>
</tr>
<tr>
<td>Whether can handle PCDM independently</td>
<td>20</td>
<td>80</td>
</tr>
<tr>
<td>Whether can handle CDM project</td>
<td>60</td>
<td>40</td>
</tr>
<tr>
<td>Whether residential sector are clients</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

Barrier to take up PCDM project

Non-clarity in rules related to PCDM (100%)
CDM is a cumbersome exercise requiring a lot of their limited resources and are uncertain about successful registration

Possible Suggestions

Government Support, Methodology needs to be simplified

The SWOT analysis for NGOs with reference to the PoA in residential sector is as given under

**Strength**

Many of the NGOs with their grass root level functioning and commitment towards the uplifitment of poor could act as a project proponent in residential sector projects especially in rural sector.

**Weakness**

Though majority of the interviewed personnel are aware about CDM and PCDM, the number of NGOs who have relevant expertise in environment and climate change issues are only few in numbers. Among the 420 reports submitted to Indian DNA for approval only eight numbers involve an NGO and out of which 50% are from state of Karnataka. The interviewed NGOs who have the capability to handle the PCDM also mentioned that generally there is lack of expertise among Indian NGOs to take up PCDM projects. Some of the NGOs interviewed also voiced opinion that the CDM process is very cumbersome and mentioned about monitoring difficulty and suggested to have grant from government as a prerequisite for starting such projects. One of the NGO pointed out the cost of monitoring instruments, which is almost equivalent to the cost of product thus making the CDM project unviable.

**Opportunity**

The government has various programme like that are mentioned earlier (RGGVY, Indira Awaas Yojana etc) for the uplifting poor in the villages and NGOs can do active role in these programmes. The NGOs can assist the self-help group (SHG) who are small

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84 There is no comprehensive published information about number of NGOs working in renewable energy and energy efficiency field with sufficient manpower, however based on NGO directory by TERI (http://edugreen.teri.res.in/explore/ngos.htm) author estimates the figure as less than twenty

85 ADATs, Karnataka, India

86 However this may be because of lack of knowledge of monitoring methodology

87 SHG manage and lend their accumulated saving and externally leveraged funds to their members and as of March 2002, SHG with bank linkage cover 7.8 million families in the country and the loan repayment is maximum of 5 years (Tankha A, 2002)
homogenous group of rural poor to avail micro finance from commercial banks. The commercial banks will give an interest rate upto 1.5 % lower through NGOs than if individuals approach the banks for loans under micro finance scheme. One of the NGO informed that PCDM may help them to negotiate with manufacturers regarding improvement of product quality.

**Threat**
Inadequate coordination between various stakeholders which can disrupt the execution of projects. Further NGOs work related to climate change issues will depend on the fund/grant they were able to generate and with out such support (which many times requires stringent conditions) they may not be able to take up such measures.

**6.4 Electricity Utilities**
As of 2006, there are 29 State Electricity Boards (SEBs) in the country providing electricity to respective states as well as a few private electricity utility companies. As there is quite large number of utility in the country and also since it was difficult to get the opinion from personnel who matter in the utility due to the prevalent bureaucratic system, author based the published documents to conduct the SWOT analysis with in the context of PCDM.

**Strength**
There exist large resource of manpower in all the state electricity boards of the country. According to CRISL report on rating of state power sectors almost all state electricity boards have surplus manpower in transmission and distribution (T & D) system. The CDM projects in residential sector may be clubbed with DSM activities and the surplus manpower available in T & D with their expertise in distribution system may be able to handle such projects. There has been recent initiative towards capacity building of utilities in DSM like BEE is in the process of facilitating five utilities to establish DSM cells. Further USAID is providing training to staff of utilities in technical and managerial aspects of electricity distribution and Demand Side Management module is one of the important components in the training programme. The situation offers state electricity boards with trained manpower who can handle DSM projects, and lighting projects discussed in the thesis qualifies as such projects.

The electricity boards has excellent reach to the households that are electrified, since in India the electricity consumption of individual houses are recorded by SEB staff or their appointed personnel on a monthly/bimonthly basis. This is an advantage for SEBs in CDM projects targeting residential sector in terms of reduced monitoring cost as they already have a system to visit all the electrically connected houses on a regular basis.

**Weakness**
The electricity utilities in the country which are predominately owned by government are loss making entities and as per Ministry of Power, financial losses of 12 major Indian utilities

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88 The CRISIL report (funded by Ministry of Power, GoI) had identified manpower rationalization of T & D system as an area of improvement in many state electricity boards (CRISIL, 2003).

89 Under DRUM Project by USAID, from October 2004 to March 2007, 424 training programmes were conducted and training were imparted to 7868 staffs in various utilities (personal communication Alok Mittal)
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is around 2.67 billion USD\textsuperscript{90} for the year 2002-03. This scenario will be a stumbling block for utilities to financially support DSM measures targeting residential sector.

The SEBs are conspicuous by their absence from CDM projects\textsuperscript{91} and only one utility in the country has till date submitted a CDM project proposal. Bangalore Electric Supply Company is the sole utility company who is a project proponent for a CDM project involving supply side and demand side energy efficiency intervention. Hence the electricity boards in general can be assumed to have insufficient exposure in CDM.

**Opportunity**

One of the peak load demand period in the country is the evening hours when residential lighting loads are connected to the grid and as mentioned earlier the country has a demand shortage of 10.5\% in 2006. As domestic consumers are subsidized sector promoting energy efficiency measures among household may help the utility to improve its bottom line\textsuperscript{92}. There has been some utility driven DSM programme recently initiated in the country like that of BESCOM lighting programme or BSES Delhi CFL scheme\textsuperscript{93}, and CDM provides an opportunity for utilities to augment such programmes. The working group\textsuperscript{94} on power for eleventh plan (2007-12) has recommended all SEB should set up DSM cells. Hence it is likely that DSM activity of SEBs may increase in the future. The CER revenue can be very attractive in some instances, like IRR from CFL lighting programme was calculated to be around 209 \% (refer table 5-9) for a 20 \% investment in an optimistic scenario only through CER revenue.

The electricity price in the country for domestic sector is showing an upward trend\textsuperscript{95} and more and more people are concerned about energy expenditure (inferred from increase in sale of CFL by 75 \% in 2005, whereas the growth of lighting industry in general was 20 \% during that period-elcoma website). The scenario might offers a receptive market for energy efficient products and SEBs through CDM revenue may help to reduce the major barrier, which is high initial cost for these equipment.

**Threat**

Domestic sector is subsidized and as shown in Figure 4.2, the total subsidy provided to domestic sector by all SEBs were around 2.78 billion Indian rupees and since electricity tariff is predominately state matter, it can be influenced by populist policies like free electricity to farmers or low income group etc.

\textsuperscript{90} Based on the information in the official website of Ministry of Power, Government of India (www.powermin.nic.in)

\textsuperscript{91} The author has checked available website of the utility companies in the country and could not find any information about CDM activities by them

\textsuperscript{92} Either through providing the available demand to nonsubsidised sector or if that is not the case the measure will reduce the technical transmission and distribution losses

\textsuperscript{93} Under this scheme launched in October 2006, BSES tied up with a private company and a regular customer buying one CFL will get another absolutely free.

\textsuperscript{94} This is very high profile committe consituted by planning commission with seceretary power as its chairman

\textsuperscript{95} As per the latest SEB performance report available with planning commission from 98 to 2002, every year average domestic electricity in whole India level has increased in the range of 6 to 16\% .
6.5 Builders
The real estate market in the country is dominated by large number of small players and only very few large organization have national presence (Planning Commission, 2002). However builders of houses could be a potential project proponent involving residential households and interview were conducted with five number of well known developers from different part of the country to understand their opinion about PCDM

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whether provides any energy efficient products as standard feature</td>
<td>25%</td>
<td>75%</td>
</tr>
<tr>
<td>Knowledge about CDM</td>
<td>25%</td>
<td>75%</td>
</tr>
<tr>
<td>Knowledge about PCDM</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>Whether tried to incorporate CDM in any of ongoing project</td>
<td></td>
<td>100%</td>
</tr>
<tr>
<td>Interested to learn about CDM</td>
<td>25%</td>
<td>75%</td>
</tr>
<tr>
<td>Whether can handle CDM project</td>
<td></td>
<td>100%</td>
</tr>
<tr>
<td>Whether residential sector are clients</td>
<td></td>
<td>100%</td>
</tr>
</tbody>
</table>

The SWOT analysis was based on the interview with five number of well known developers from different part of the country and is discussed below

**Strength**
Since builders are involved from the construction stage have the opportunity to incorporate energy conservation measure and also to influence the decision of prospective buyers.

**Weakness**
The builders have no expertise in executing CDM project and based on interview it was learned that CDM revenue is not at all a issue even for the organization who knows about CDM. Till date only one building developer has attempted to utilize the CDM revenue, which however was for a commercial building. There is no project submission for CDM in residential sector by the builders in the country.

**Opportunity**
One of the builders interviewed provides energy efficient equipments like CFL as a basic amenity to houses, which may be considered as an extra effort from the builder to make a lasting impression with customer and CDM revenue may augment such an initiative. Further the government is discussing about national housing plan that as mentioned earlier may mandate use of solar water heaters in residential sector. Since currently the implementation of law is not defined early movers may be able to clear additionality test by either justifying the laws (when ever it is implemented) are not enforced or by going for higher standard than stipulates that by the law. The better and more efficient technologies may be able to fetch a premium as well and can have a more satisfied customer.

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96 As per the author there is no comprehensive information regarding number of builders in India and author approached fifteen out of which five responded and those five builders are well known in the respective regions
97 Technopolis Building (6 75 000 sq ft) in Kolkata (Kolkata News line, Feb 06 2006)
Threat
The electricity cost of households is borne by the customers and majority of the interviewed builders currently do not provide energy consuming equipment as a standard fitting hence builders do not have any commercial interest for CDM projects. The energy bills of the amenities are also usually borne by the house owners through residential associations.

6.6 Summary of SWOT analysis

The summary of the above SWOT analysis is as provided in table

Table 6-1: Summary of SWOT analysis

<table>
<thead>
<tr>
<th>Organization</th>
<th>Strength</th>
<th>Weakness</th>
<th>Opportunity</th>
<th>Threat</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESCOs</td>
<td>Technical competence and expertise in monitoring and verification</td>
<td>Smaller organization with limitation in financial resources</td>
<td>Energy conservation opportunity through DSM measures</td>
<td>Difficulty in collecting payment from households. Apprehension regarding receipt of payment for their investment</td>
</tr>
<tr>
<td>NGOs</td>
<td>Grass root level reach</td>
<td>In sufficient expertise and financial constraints</td>
<td>Existing major programmes of government addressing the poor in villages. Assisting local poor through micro financing</td>
<td>Dependence on grant which could be very stringent for functioning. Inadequate coordination between various stakeholders</td>
</tr>
<tr>
<td>Utility</td>
<td>Large pool of man power resources and access to every electrified households</td>
<td>Lack of expertise in CDM and financial loss making entities</td>
<td>Demand deficit and some of the DSM measures targeting residential sector could be attractive financially and also can address the demand gap</td>
<td>Populist policies by the government that make electricity cheaper to a segment of society</td>
</tr>
<tr>
<td>Builders</td>
<td>As constructor have flexibility to some extent for incorporating energy conservation measures</td>
<td>Lack of knowledge about CDM and is not a priority area</td>
<td>To improve the image of the builders</td>
<td>Electricity Bills are paid by the owners of houses</td>
</tr>
</tbody>
</table>

6.7 Discussion

The SWOT analysis presented above discusses the potential project proponent's ability in taking up a programmatic CDM. Among the four discussed potential project proponents except builders due to their strong financial disincentive and relatively smaller scale of operation others may be able to take up programmatic CDM. However all these organization have strength and weakness and the opportunity provides a scenario for synergetic action. There is financial constraint for utility to take up DSM measure and ESCOs can take up the projects on behalf of them provided utility can assure the payment to ESCOs as per the performance of equipment. Similarly there is village electrification programme by government for which NGOS can play an active role. The programmatic CDM can act as an incentive for such measures. The association of NGO with regional SHG groups could be another possible strategy to take advantage of PCDM. As per Tanka (2002) the SHG bank
linkage is strong in two states in India (Tamil Nadu and Andhra Pradesh) and the repayment period of up to five years stipulated by banks could be a bottleneck for projects that have longer crediting period and are financially additional.
7. Conclusion

India’s increasing number of households offers potential for energy conservation however residential sector are generally passive recipients of technology and there are a number of barriers to achieve energy conservation in this sector. Some of the barriers identified are subsidized energy, higher initial cost of the product, lack of incentives, apprehension about the quality of products, lack of awareness of the energy efficient technologies etc. Programmatic CDM may be able to address some of these barriers. PCDM brings along additional financial resources and may be possible to overcome the financial barrier for some of the technologies applicable in residential sector. As PCDM involves several projects, the quality issue of products may be addressed to some extent depending on the negotiation ability of project proponents with manufacturers. Further CDM provides additional revenue to the project proponents to operate the energy conservation programme and thereby addressing the lack of incentive barrier to certain level.

The PCDM with the current requirements is complex and project proponents may likely to be apprehensive in taking up projects, for which additionality is difficult to prove or baseline establishment, monitoring requirements are cumbersome. However for all the products considered in this analysis it may be possible to prove additionality (though cannot be generalized for all circumstances) in Indian context by diligent efforts of project proponents. The uncertainties regarding the baseline estimation, monitoring requirements etc may change once sufficient approved large-scale methodologies relevant to technologies applicable in residential sector are available. The uncertainty regarding PCDM rules is a stumbling block in adaptation of PCDM in India and the situation may improve once draft guidance and procedure will be available to public after the 32nd EB meeting in June 2007 and if the same is approved by EB.

The cost revenue analysis made in the thesis revealed that for some of the technologies, CER revenue could support substantially the programme finance under optimistic scenario and in some cases CER revenue alone can support the programme without any external support. However as there are lots of unpredictability involved in CDM and technology deployment, it would be better to build on an existing programme targeting the residential sector. The project proponents considered in this analysis have strength and weakness and instead of operating independently it would be better if they cooperate and take advantages of others strength to handle PCDM project.

The deployment of many of the technologies considered in residential sector have added benefits like providing more time for productive work, better health due to reduced indoor pollution etc to the end users. However in order to achieve these social benefits it requires very close cooperation among various stakeholders to address the issues that may impede effective technology diffusion and PCDM may provide an impetus for such an action.
8. Recommendations

8.1 General
In order to realize the full potential of PCDM, it is desirable to have large-scale methodologies. This could be a major issue as except one large-scale methodology for lighting, there are no approved large-scale methodologies applicable to other technologies in residential sector in India. The situation is compounded by the fact that PCDM in residential sector is “nobody’s child” means no individual household/group of household will ever initiate a CDM project implying that methodology development will be through grant/funding agencies. Hence it is recommended that donor agencies may fund to formulate methodologies for a set of technologies applicable in the sector.

It has been observed that involving more than one technology in a single house may reduce the transaction cost in terms of monitoring and verification expenses. However the project proponents may be discretionary about clubbing the projects together. For example if the project proponents are interested to reduce the transaction cost of a biogas digester project, adding LED with SHS to the project may not serve the purpose (refer figure 5-2). It is preferable to have technologies that reduce the same GHGs or to incorporate many technologies together. However as per the guidance of EB 28 “PoA shall apply one approved baseline and monitoring methodology, involving one type of technology or measure applicable to all CPA” it may not be possible to get the approval of EB if more than one technology is clubbed together. Hence notwithstanding the issues related to baselines, methodology etc, EB may be flexible to allow the project proponents to have more than one type of technology under PCDM so as to reduce the transaction cost.

As demonstrated in chapter 5 (table 5-8) revenue through PCDM are very attractive for some of the technologies under favorable conditions, which if successfully operated can even result in non-requirement of the existing economic support by the government. As CDM offers an opportunity to remove the financial barrier, it is recommended that government may look into these technologies to find scope for any further improvement of the technology so that larger public may adopt the same. This may be achieved through providing more grants for research in these technologies.

8.2 Project proponents: Partnership and Capacity Building
As in any CDM project, there exist risks for PCDM but unlike conventional CDM projects wherein the emission reduction achievable could be known to a reasonable accuracy ex ante, in PCDM the estimation of emission reductions ex ante may be difficult. As shown in table 5-7, under pessimistic scenario, the transaction cost could be higher than CER revenue in some cases and hence offers a dicey proposition for project proponents to initiate PCDM projects. Further as the CER revenue will be received only after the project is implemented and emission reductions verified which might take considerable time depending on the project. Keeping in mind these potential situations it is recommended to build on other funded programmes like Indira Awaas Yojana/ internationally funded project for rural development or DSM programme etc as a possible way to operate a PCDM involving the
technologies considered in residential sector. The programme may be gradually made independent depending on the CER revenue realization.

The role of potential project proponents is very important in the success or failure of PCDM. The interviewed project proponents have strength and weakness and hence to realize the PCDM benefit a synergetic action among them would be required. In India for the products like lighting, electricity utilities could be a potential project proponent. Initiating DSM measures targeting residential sector may be one way of utilizing CDM benefits. However considering the weakness and threat as detailed in section 6-4, utilities may find it difficult to initiate a DSM programme in residential sector on their own. Instead they could initiate a project through ESCOs wherein ESCO may invest upfront on the technologies and utility can pay back to them from an escrow account from the payment collected from households. The payment can be made either through one time installment or from the monthly payment through the electricity bills. The ESCOs with their expertise on monitoring and verification may be able to take such projects under CDM. A business model (Energy Performance Contracting) is being evolved in the recently (2007) initiated REEEP project of street lighting in Madhyapradesh, where ESCO and municipality would share the benefits from CER revenue based on predetermined contract (REEEP 2006). It is recommended to learn from the experience of this project after its first year of implementation (which is likely to be in 2008) in order to target residential sector projects involving ESCOs. Some of the ESCOs interviewed were of the opinion that utilities losses focus in DSM activities involving ESCOs and also there exist uncertainty regarding the payment. The government assistance in terms of clear directions to the utilities to support ESCO activities is required to have more association of ESCOs in DSM and also to avoid possible litigations arising due to dishonoring of contracts. The above measures will increase the confidence in ESCOs in utility and they can build on their market from such associations.

As CDM may complement the DSM activities, it is recommended to have CDM activities as an additional responsibility for the proposed DSM cells of state electricity boards. The top management of state electricity boards may provide clear directions and guidance regarding the CDM activities under DSM cells. Further as shown in the SWOT analysis SEBs lack exposure in CDM and hence a select number of people(s) who may be involved in CDM activities may be trained in CDM procedures.

NGOs are one of the potential project proponents for technologies applicable in rural sector. However barring a few NGOs, there is a lack of capacity for NGOs in the country to take up the complex PCDM project. Hence it is essential to conduct capacity building programmes for NGOs to facilitate at least one NGO from each state to handle PCDM projects. The organizations like CDMIndia which is a capacity building facility for CDM in the country can organize such activities for potential project proponents with the help of state nodal centers of MNRE, CDM consultants etc. Indian National CDM authority needs to create awareness among various potential stakeholders through workshops when the forthcoming draft guidance’s regarding PCDM are approved by the EB. In order not to loose any further time in this front immediate response from DNA would be required.
8.3 Support from Banks
Another possible synergetic action to leverage the benefits of PCDM would be association of an NGO with several regional self-help groups (SHGs). As pointed out in section 6.3, SHGs can avail microfinance at reduced interest rate from commercial banks if NGOs apply for loan on their behalf. However the repayment period of five years could be a bottleneck as many of the renewable energy projects in residential sector can have more than five years crediting period. As demonstrated in the analysis (refer Figure 5-3 & 5-4) the CERs from some of the projects could be highly attractive for repayment of loan for a seven year or higher time frame. It would be beneficial to the projects, if commercial banks provide empowerment to their regional offices to approve a seven-year or higher repayment period for projects taken up by NGOs under PCDM. It is recommended to introduce such a provision in the two states of Andhra Pradesh and Tamilnadu that have strong SHG and bank linkage.

8.4 A workable model for Rural India
In case of some technologies applicable in rural sectors like solar cookers, biogas digesters as demonstrated in chapter 5 (refer figure 5-3), CER revenue alone would be able to finance the project under favourable conditions. However financial support may not be sufficient for the widespread adaptation of such technologies, which was highlighted by a survey conducted by Chandrashekar etal (2007) wherein it was inferred that more technological innovation, availability of spare parts etc considering the local conditions is required for effective diffusion of technology. It is essential to address the challenging issues like technological and logistical aspects related to these technologies in order to leverage the benefits of PCDM. This requires a more holistic approach involving more closer and effective interaction involving various stakeholders like government agencies, consultants, NGOs, research institutes, manufacturers etc. A model that could be adopted with some modifications for the purpose of taking the advantage of PCDM is that of Integrated Rural Energy Programme (IREP) cell in state of Karnataka, which as per Srinivasan etal (2007) became successful through effective interaction of various stakeholders. This model has not considered CDM benefits, however by incorporating CDM which complements IREP activities in rural sector into this model would be beneficial as CER revenue from projects could be an added incentive for operating such models.
Though till now no CDM project has been submitted under IREP activities, IREP cells with excellent grass root level reach (In Karnataka alone there are 48 IREP blocks spread across 27 districts) would be able to facilitate the monitoring requirement of the CDM projects. In Karnataka some of the actors involved in IREP activities have a good understanding of CDM (like the external consultant of the programme TERI is well regarded in the country for its work in CDM) and IREP state nodal agency with support from such actors can initiate programmatic CDM for projects beneficial to rural households and the revenues from CDM will further enhance the attractiveness of such projects. Hence it would be worthwhile to evolve such a model covering the whole state under the umbrella of IREP state nodal agencies in which at least one of the actors has a very good CDM handling expertise and take the responsibility of meeting the PCDM requirements. As a capacity building exercise it would be beneficial to start up a pilot PCDM involving residential sector through such a model.

“The new way of doing things may be hard, but continuing in the old way is certain to lead to an impasse”

Amulya Reddy
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S.K.Singh, Hindustan Construction Company, Mumbai, India (Questionnaire)

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**Abbreviations**

BEE - Bureau of Energy Efficiency  
CER - Certified Emissions Reductions  
COP - Conference of the Parties  
CPC - Climate Policy Center  
DNA - Designated National Authority  
EB - Executive Board  
ECBC – Energy Conservation Building Code  
ESCO - Energy Service Companies  
GHG - Greenhouse Gas  
GoI - Government of India  
IEA – International Energy Agency  
IISD – International Institute for Sustainable Development  
Meth Panel - Methodology Panel  
MHUPA - Ministry of Housing and Urban Poverty Alleviation  
MNRE - Ministry of New and Renewable Energy  
MoEF - Ministry of Environment & Forest  
MoP - Ministry of Power  
MoPNG - Ministry of Petroleum and Natural Gas  
MSEB - Maharashtra State Electricity Board  
NM - New Methodology  
PDD - Project Design Document  
PFC - Power Finance Corporation Ltd  
PoA – Programme of Activities  
REEEP- Renewable Energy and Energy Efficiency Partnership  
REIL - Renewable Energy and International Law Project  
SEBs – State Electricity Boards  
SSC - Small Scale CDM  
SSN – South South North Organisation  
STE - Science Tech Entrepreneur  
UNFCCC - United Nations Framework Convention on Climate Change
Appendix 1 Percentage transaction cost in total CER revenue and CER % in total investment under different scenario

**SCENARIO: 1 Lower Transaction Cost & Lower CER value (6 Euro/CER)**

**SCENARIO: 2 Higher Transaction Cost & Lower CER value (6 Euro/CER)**
Programme of Activities: Will it break the ice for residential sector CDM projects?

SCENARIO: 3 Lower Transaction Cost & Higher CER value (10 Euro/CER)

SCENARIO: 4 Higher Transaction Cost & Higher CER value (10 Euro/CER)
Programme of Activities: Will it break the ice for residential sector CDM projects?

SCENARIO: 1 Lower Transaction Cost & Lower CER value (6 Euro/CER)

SCENARIO: 2 Higher Transaction Cost & Lower CER value (6 Euro/CER)
Programme of Activities: Will it break the ice for residential sector CDM projects?

**SCENARIO: 4 Higher Transaction Cost & Higher CER value (10 Euro/CER)**

**SCENARIO: 3 Lower Transaction Cost & Higher CER value (10 Euro/CER)**
Appendix 2: Sample Transaction Cost Involved (Bio Gas Digester – Optimistic Scenario)

No of Installation: 80000  
Annual CER generation: 263200

<table>
<thead>
<tr>
<th>Title</th>
<th>Cost Involved (US $)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Search Cost</td>
<td>19 000</td>
</tr>
<tr>
<td>Negotiation Cost</td>
<td>10 500</td>
</tr>
<tr>
<td>PDD Cost</td>
<td>6500</td>
</tr>
<tr>
<td>Validation Cost</td>
<td>6000</td>
</tr>
<tr>
<td>Registration Cost</td>
<td>30000</td>
</tr>
<tr>
<td>Monitoring Cost*</td>
<td>147250 / 5 year</td>
</tr>
<tr>
<td>Verification Cost</td>
<td>40000 / 5 Year</td>
</tr>
<tr>
<td>Adaptation Levy</td>
<td>347000 / 5 year</td>
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<tr>
<td>Administrative Fee</td>
<td>255700 / 5 year</td>
</tr>
<tr>
<td>Consultancy Fee</td>
<td>346950</td>
</tr>
<tr>
<td>Miscellaneous Expenditure and legal charges</td>
<td>173500</td>
</tr>
</tbody>
</table>

* Monitoring expenses of 500 Rand for the first year and 250 Rand during subsequent years anticipated per household for the Kuyasa housing energy upgradation project was considered in the analysis. [The South African currency was converted to Indian rupees equivalent using the real exchange rate based on per capita GDP PPP for both countries and nominal exchange rates to estimate the monitoring expenditure in Indian condition], The consultancy charge is sourced from Rao. G.S (2005)

Source: Krey M, 2004, SIPA, 2005,
Appendix 3: Tool for Demonstration and assessment of Additionality

**Step 1:** Identification of alternatives to the project that are consistent with mandatory Laws and regulations

```
Yes
```

**Step 2:** Investment Analysis

As per the sensitivity analysis, whether the proposed CDM project activity is the most financially attractive or is unlikely to be financially attractive

```
No
```

**Step 3:** Barrier Analysis

Is at least one of the alternatives other than the proposed CDM project is not prevented by any of the identified barriers

```
Yes
```

**Step 4:** Common practice analysis

No similar activities are there and even such activities are present essential distinction between the proposed CDM activity and similar activities can be explained

```
No
```

**Project is Additional**

Source: UNFCCC, EB 29 Version 3
Appendix-4: Brief Information of Products considered

Compact Fluorescent Lamp
Compact Florescent lamps (CFL) are energy efficient lamps widely used as a replacement for incandescent bulbs. The CFLs are miniature fluorescent tube with inbuilt ballast. The CFLs are available in number of shape and wattage. In the analysis a 15 W CFL is considered which can replace a 60 W incandescent bulb.

Energy Efficient Tubes
The energy efficient (EE) tubes considered in the analysis is T5 triphosphor lamp with electronic ballast and can be retrofitted into the fixture of common 40 W T12 tubes. The EE tubes consume 28 W per fitting. As per the manufacturer the tube fittings have a power factor of 0.95 and provides 20 % more lux than conventional 40 W tubes (Asian Electronics Ltd).

Electronic Ballast
Ballast is a device that controls the amount of current and also assist in voltage built up required for starting of the tube. The electronic ballasts usually change the frequency of the power from the standard frequency to 20,000 Hz or higher, thereby reducing flicker associated with fluorescent lighting (Wikipedia)

LED Lamp with SHS
Light Emitting Diodes (LED) consists of a chip of semi conducting material impregnated with impurities to have a positive—negative junction (Wikipedia). In the analysis a cluster of White LED (5 x 2.5 W) is considered which can replace a 60 W incandescent bulb and provides 380-675 lumens. Solar photovoltaic panel along with battery backup powers the module.

Box Type Solar Cooker
Box Type Solar cooker (normal size -0.6 m x 0.6 m) consists of a insulated box, the inside of which is painted full black and is covered by one or more transparent covers, to trap heat inside the solar cooker but preventing it to come out of the box. The temperature inside can go upto 140°C which is sufficient for many cooking application.

BioGas Digester
Biogas Digester produces biogas, which is a mixture of CH₄ and CO₂ by anaerobic digestion of organic matter. The digester considered here is of 2m³ capacity and uses cow dung to produce biogas for cooking application and has a device efficiency of 55%.

Air Source Heat Pump
Air source heat pump uses small quantity of electricity to move heat from one place to another. The heat pump pulls heat from the surrounding air and dumps it at a higher temperature to tank in order to heat water (US Department of Energy). As per Anup .N of Nalamwar Energy Systems Pvt. Ltd. manufacturer of heat pump in India, the product suited to residential sector is about to be launched.
Appendix-5: Sample Questionnaire

1. Name of the Organization
2. Name & Designation
3. Number of Consultants
4. Are you knowledgeable about CDM
5. Have you handled CDM project independently
6. Are you aware about Programmatic CDM ☐ Yes ☐ No
7. If the answer is Yes, How do you envisage a take the benefits of a programmatic CDM
8. As per you what are the major difficulties with PCDM
9. Is residential sector your client ☐ Yes ☐ No
10. If the answer to above is No, Please provide the major reasons
    a. 
    b. 
    c. 
11. Have you undertaken projects in association with utility ☐ Yes ☐ No
12. As per you what are the major difficulties in associating with utilities
13. What are your suggestions for ESCOs to handle DSM projects effectively