August 2008

Feasibility Study for Developing Proposal under Clean Development Mechanism (CDM) for ClaimingCarbon Credits for Leach Pit Toilets & Toilet Linked Bio Gas Plants

FINAL REPORT

Submitted by

Winrock International India

Contents

List of Tables

List of Figures

1.0 INTRODUCTION

The Total Sanitation Campaign launched by the Rajiv Gandhi Drinking Water Mission, Ministry of Rural Development, Government of India has played a major role in reversing the trend of open defecation by increasing the sanitation coverage from 36.4% in 2001 to 38% in 2006 using environment friendly technologies such as leach pits (LPTs) and toilet linked bio-gas plants (TLBs). It has also helped in increased coverage of school and aganwadi toilets and community toilets using the above technologies. Total Sanitation Campaign has now been scaled up in the entire country and is under implementation in 254 districts with an outlay of Rs. 1665 crore. Of the 138.2 million rural households in India (Census, 2001), nearly 24 million have constructed household toilets with support from the TSC. Besides, 250,000 school toilets, 69,000 Anganwadi toilets, 7,400 community complexes, and 6,925 production centers/ rural sanitary marts (RSMs) have been set up. In addition, Govt of India has launched an incentive scheme (Nirmal Gram Puruskar) for villages, blocks, and districts achieving the open defection free status. Close to 559 districts have already been awarded for ensuring sanitation facilities in all households, schools and aganwadis and also for clean and green environment using solid and liquid waste management technologies that includes composting, vermi composting, bio- gas plants and waste water reuse.

The promotion of LPTs, TLBs and solid and liquid waste management technologies implemented under the Total Sanitation Campaign reduces emission of green house gases to the atmosphere. With the above background, this report examines whether the Total Sanitation Campaign program qualifies for CDM benefits, which will greatly help in financing further sanitation related initiatives at national level. The present study attempts the problem by; (i) Designing special experiments to establish and quantify GHG emission reductions by avoiding open defecation, and (ii) Propose the most appropriate approach to package these initiatives as a CDM project.

2.0 ASSESSMENT OF CDMABILITY OF THE PROJECTS IMPLEMENTED UNDER THE TOTAL SANITATION CAMPAIGN

In order to assess the CDM ability of the various activities carried out under Total Sanitation Campaign, a 10 step screening criterion is used, as shown in Figure 1.

In this section, each of the steps is explained along with the guidelines to follow and the projects implemented under the Total Sanitation Campaign (TSC) are screened for their CDM ability against these guidelines.

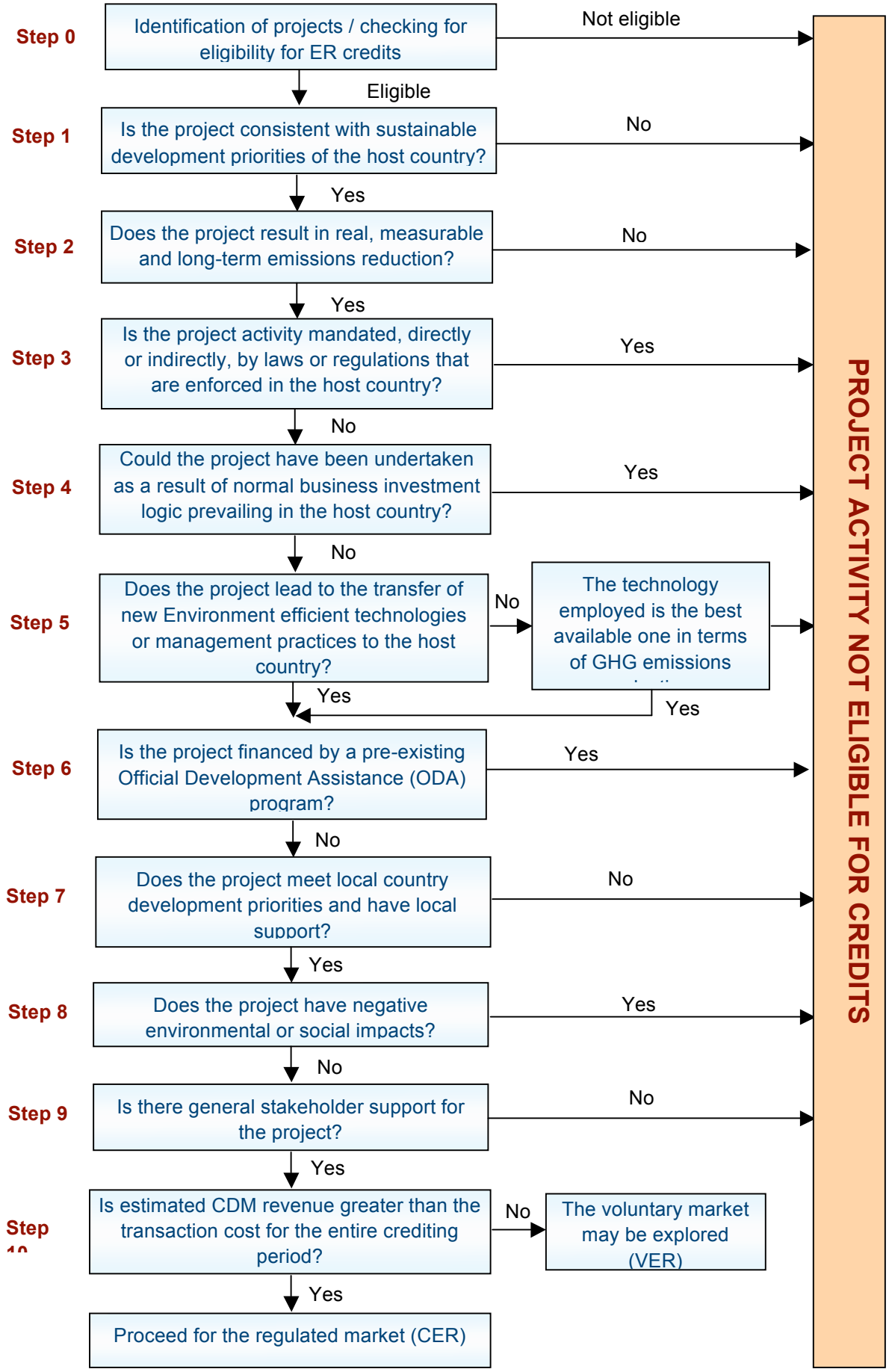
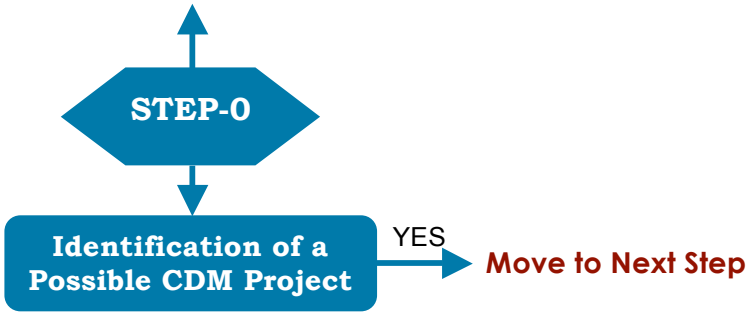


Figure 1: *Framework used to assess CDMability of activities under the Total Sanitation Campaign*

STEP 0: IDENTIFICATION OF A POSSIBLE CDM PROJECT

GUIDELINES TO IDENTIFY PROJECT

- No credit for projects which started before 1 January 2000
- To request for the retroactive credits for project activities that started during the period 1 January 2000 and 18 November 2004, the project developer must have submitted a new methodology or have requested validation by a DOE latest by 31 December 2005 and the project must have been registered by the Executive Board latest by 31 December 2006
- For project activities that have started before 18 November 2004 and for which, the process of applying for carbon credit is not yet initiated, no retroactive credit can be claimed before the actual date of registration. However carbon credits from actual date of registration can be claimed
- The projects need to provide evidence that the incentive from the CDM was seriously considered in the decision to proceed with the project activity. This evidence shall be based on documentation that was available at, or prior to, the start of the project activity



Screening of project implemented under TSC against Step O

Since the Total Sanitation Campaign is being implemented in a phased manner, TLBs and LPTs to be set up in the future are eligible for CDM benefits, provided the necessary documentation is in place to provide evidence that the incentive from CDM is considered in the decision to proceed with the project activity

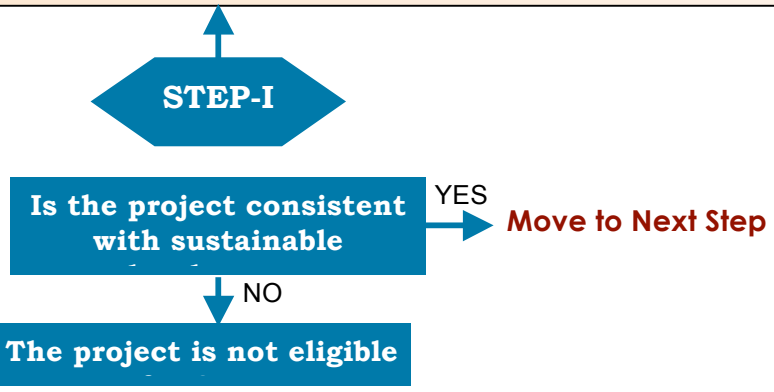
The project is eligible to move to Step I

STEP 1: IS THE PROJECT CONSISTENT WITH SUSTAINABLE DEVELOPMENT PRIORITIES OF THE HOST COUNTRY?

GUIDELINES TO ANSWER STEP I

A project meets the sustainable development priorities of the host country IF it addresses the following aspects:

- Social well being: The CDM project activity should lead to alleviation of poverty by generating additional employment, removal of social disparities and contribute to provision of basic amenities to people leading to improvement in quality of life
- Economic well being: The CDM project activity should bring in additional investment consistent with the needs of the people
- Environmental well being: This should include a discussion of impact of the project activity on resource sustainability and resource degradation, if any, due to proposed activity; biodiversity friendliness; impact on human health; reduction of levels of pollution in general
- Technological well being: The CDM project activity should lead to transfer of environmentally safe and sound technologies with a priority to the renewable sector or energy efficiency projects that are comparable to best practices in order to assist in upgradation of technological base



Screening of projects implemented under TSC against Step 1

The TLBs and LPTs implemented under the Total Sanitation Campaign contribute to the social wellbeing by providing basic sanitation facilities leading to an improvement in the quality of life of a large number of people. The project activity also has a positive impact on health/hygiene of the target population. The project contributes to environmental wellbeing by providing a relatively clean fuel in the form of biogas in the absence of which fossil fuels would have been used. The project contributes to the economic wellbeing also as it helps save money that would have been spent on buying kerosene etc.

The above analysis indicates that the TLBs and LPTs are consistent with the sustainable development priorities of India.

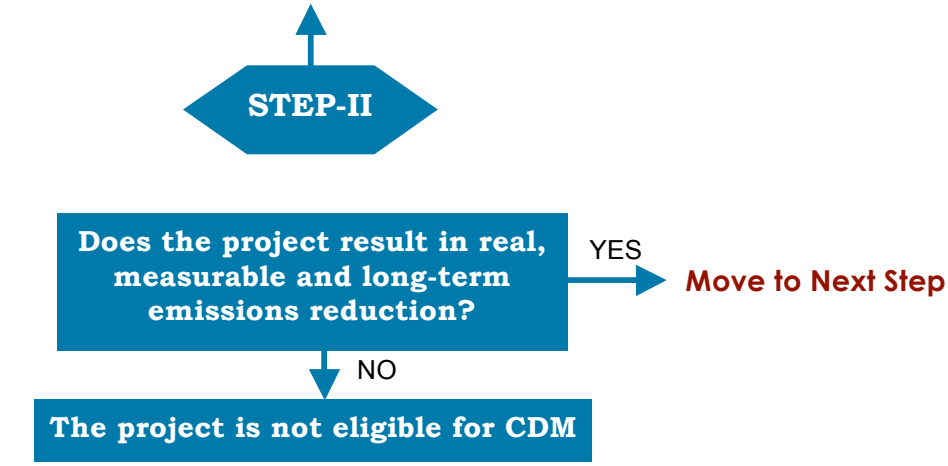
The project is eligible to move to Step II

STEP II: DOES THE PROJECT RESULT IN REAL, MEASURABLE AND LONG-TERM EMISSIONS REDUCTION?

GUIDELINES TO ANSWER STEP II

Real, measurable and long term emission reduction means:

- Real & measurable emission reductions: Only projects in which emissions are measurable should qualify for CDM. Measurability of emission reductions throughout the project life is important. Those who implement the project (project developer) must have thorough knowledge of the methods of data collection and measurement and their accuracy
- Long term emission reductions: It is also important to ensure that the overall effectiveness of the emission reductions from the project should not cancel out in future on account of any other development.



Screening of projects implemented under TSC against Step 2

During the course of this project, special experiments were carried out and it is proven that the shift from open defecation to TLBs and LPTs leads to GHG emission reduction. The emission reductions are quantifiable as clearly outlined in section 3 of this report. The TLBs and LPTs will be functional even after the crediting period of the project is over and hence the emission reductions are long term.

From the above, it is clear that the emission reductions achieved from the TLBs and LPTs are real, measurable and long term

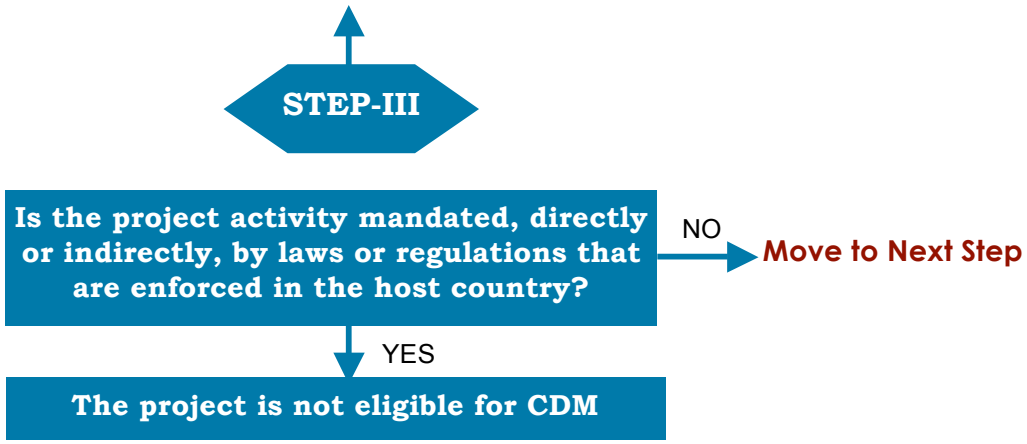
The project is eligible to move to Step III

STEP III: IS THE PROJECT ACTIVITY MANDATED, DIRECTLY OR INDIRECTLY, BY LAWS OR REGULATIONS THAT ARE ENFORCED IN THE HOST COUNTRY?

GUIDELINES TO ANSWER STEP III

Mandated project activity refers to:

- Proposed CDM project being implemented in compliance with the applicable legal and regulatory requirement(s).
- At the same time, if the applicable legal or regulatory requirements are systematically not enforced and non-compliance with those requirements is widespread in the country, then a project related to this legal or regulatory requirements too can be considered for CDM.



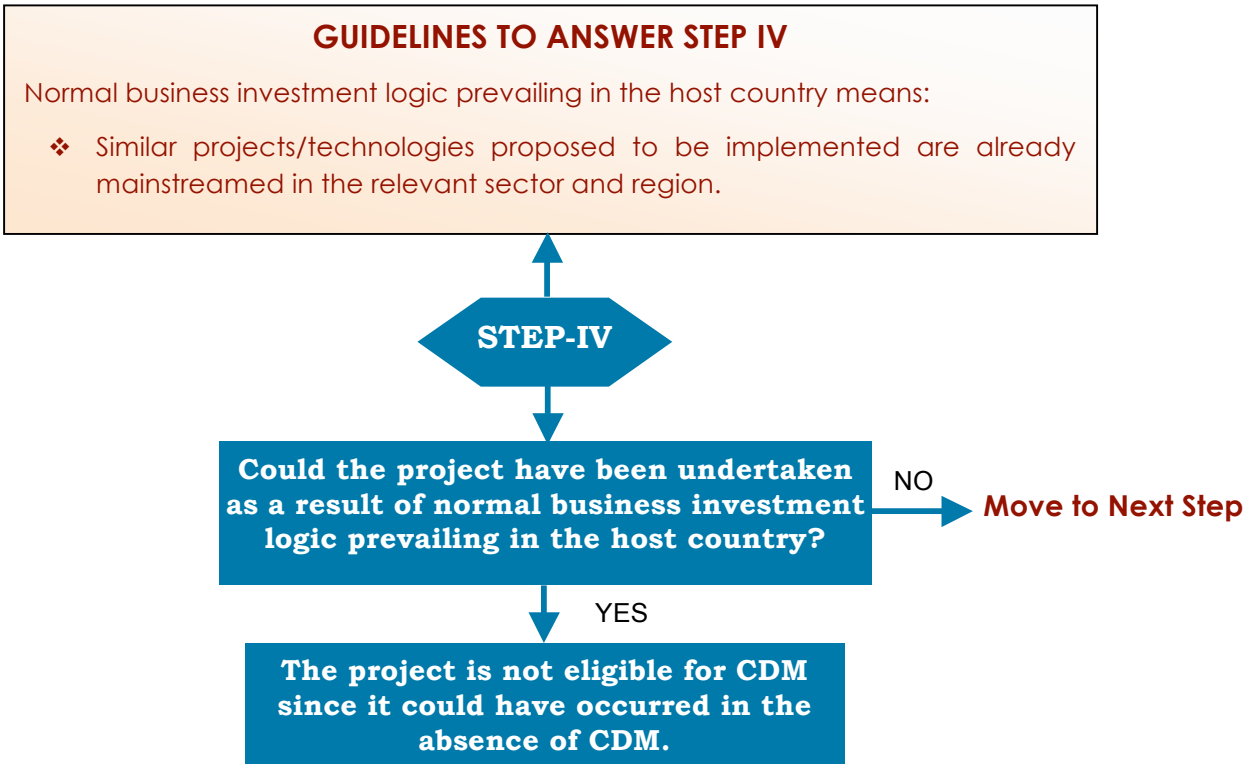
Screening of projects implemented under TSC against Step 3

The TLBs and LPTs are set up as part of the Total Sanitation Campaign. This is part of the Rajiv Gandhi Drinking Water Mission and is not implemented as part of a law or regulation. The initiative mainly focuses on providing a healthy living, clean environment and hygiene to the users and is an initiative that is not a result of any law.

As shown above, the LPTs and TLBs are not mandated by law or regulations that are enforced in the host country

The project is eligible to move to Step IV.

STEP IV: COULD THE PROJECT HAVE BEEN UNDERTAKEN AS A RESULT OF NORMAL BUSINESS INVESTMENT LOGIC PREVAILING IN THE HOST COUNTRY?



Screening of projects implemented under TSC against Step 4

In rural India, majority of the people still defecate in the open. Nothing much has been done in terms of tackling this problem. As an alternate to open defecation, the TLBs and LPTs being implemented under the TSC can be considered as technologies which are not mainstreamed into this sector yet. Also, several regions of the country are lagging behind in terms of the number of such toilets being installed there. Despite several efforts made by the government, people are not adopting the sanitary behaviour

As demonstrated above, the project could not have been undertaken as a result of normal business investment logic prevailing in the host country

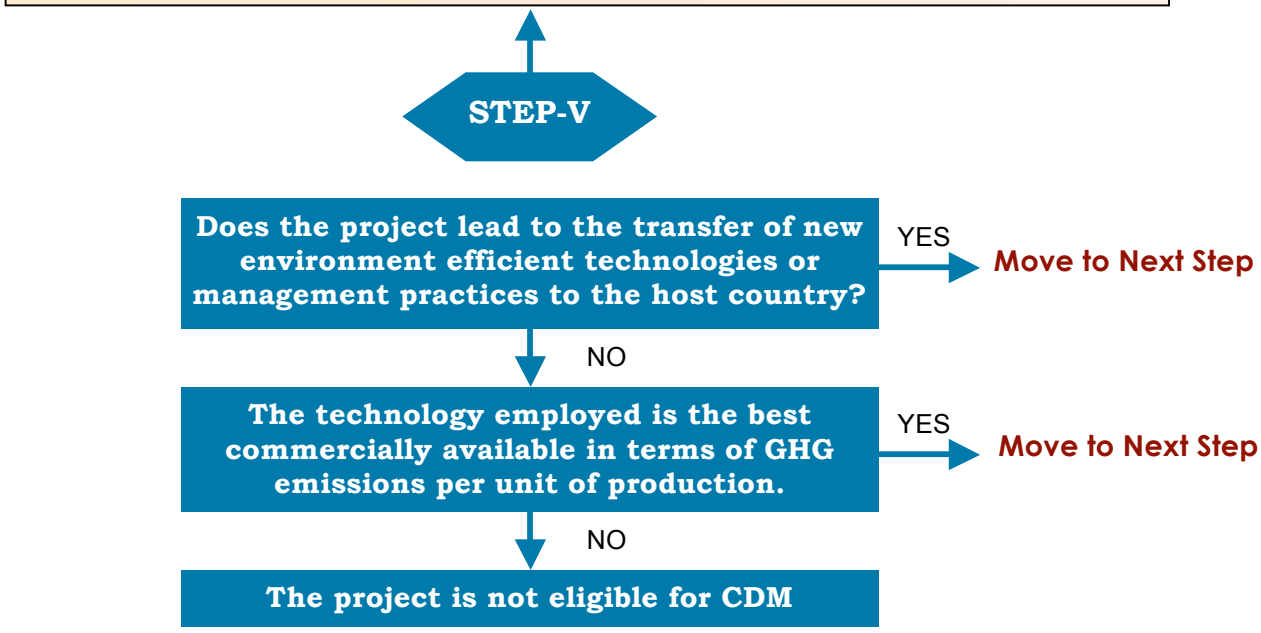
The project is eligible to move to Step V.

STEP V: IS THE TECHNOLOGY EMPLOYED/PROPOSED TO BE EMPLOYED THE BEST COMMERCIALLY AVAILABLE IN TERMS OF GHG EMISSION REDUCTIONS IN INDIA?

GUIDELINES TO ANSWER STEP V

The transfer of new environment efficient technologies or management practices means:

- The transfer of modern technology and know how, the spread of efficient management practices and better access to external markets, all are key building blocks to promoting climate friendly policies and technologies. The CDM, which allows governments or private entities in industrialized countries to implement emission reduction projects in developing countries and to receive credit for these projects in the form of 'certified emission reductions', presents an opportunity to foster technology cooperation and to attract investment from developed to developing countries
- Even if the proposed project does not lead to transfer of new cleaner technologies to the host country, it must definitely ensure that the technology implemented is the best commercially available one in terms of GHG emission reduction per unit of production



Screening of projects implemented under TSC against Step 5

GUIDELINES TO ANSWER STEP V

The project does not lead to transfer of technology. However, considering the vastness of India and the large number of villages (in excess of 500,000), this is the best commercially available in terms of GHG reductions. There are no other technologies that can be used at this scale/level.

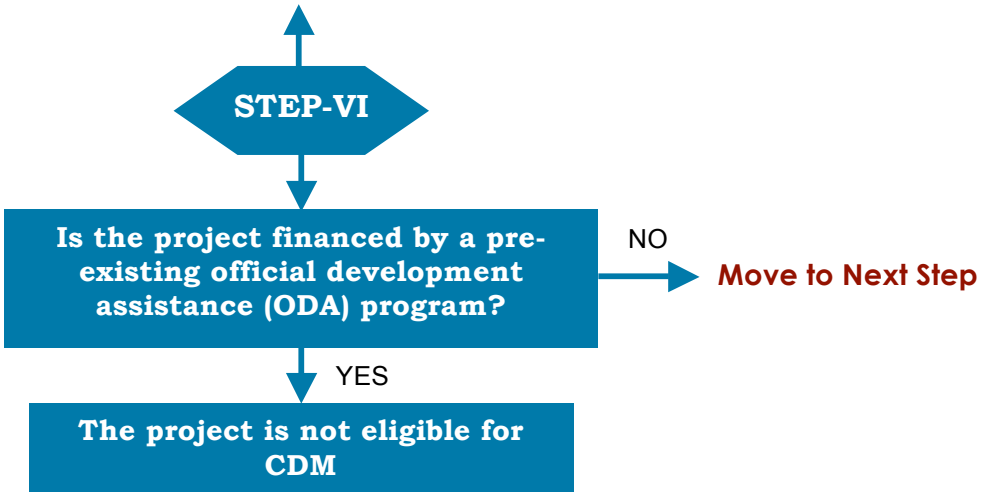
The project is eligible to move to Step VI

STEP VI: IS THE PROJECT FINANCED BY A PRE-EXISTING OFFICIAL DEVELOPMENT ASSISTANCE (ODA) PROGRAM?

GUIDELINES TO ANSWER STEP VI

Official Development Assistance (ODA) means:

- Grants or loans to countries and territories of developing countries which are: (a) undertaken by the official sector; (b) with promotion of economic development and welfare as the main objective; and (c) at concessional financial terms. In addition to financial flows, technical co-operation is included in the aid. Grants, loans and credits for military purposes are excluded.
- Although ODA should not be considered eligible for generating CERs, however ODA could be used to facilitate early components of projects such as feasibility studies, as well as generic transaction support activities such as setting up CDM project offices, and developing local/national capacity to implement and manage the CDM process.



Screening of projects implemented under TSC against Step 6

There is no official development assistance and the construction of the TLBs and LPTs are done with funds from Ministry of Rural Development.

The project is eligible to move to Step VII

STEP VII: DOES THE PROJECT MEET LOCAL COUNTRY DEVELOPMENT PRIORITIES AND HAVE LOCAL SUPPORT?

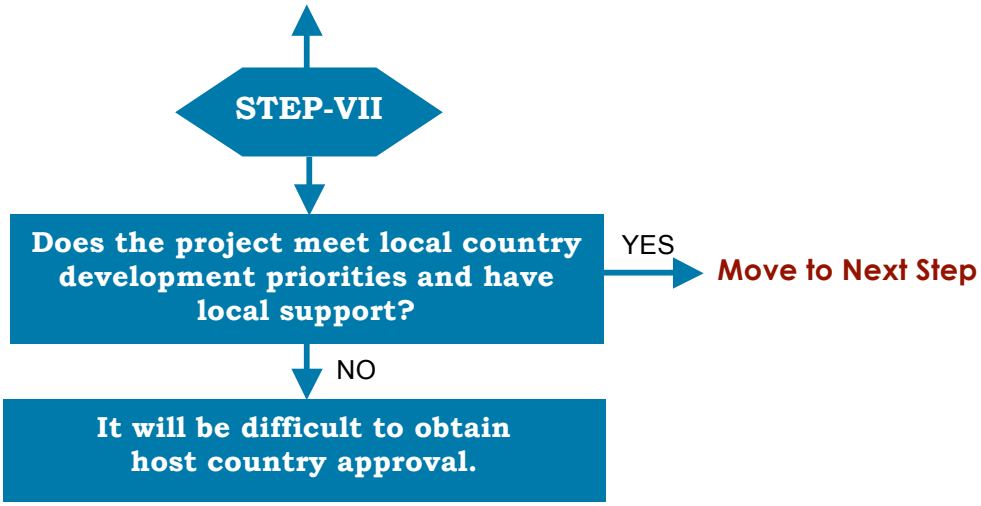
GUIDELINES TO ANSWER STEP VII

Local country development priorities means:

- A CDM project activity should meet national priorities set by India's five year planning process for achieving sustainable economic growth, poverty alleviation, employment generation, self-reliance, resource conservation, and public participation in planning, program implementation and infrastructure development.

Local support means:

- A CDM project should have been well received by various stakeholders without having any negative or adverse environmental and social concerns.



Screening of projects implemented under TSC against Step 7

The installation of these toilets definitely helps in meeting the country's developmental goals. It helps the users be self reliant, they conserve kerosene/fuel wood etc ane also save the costs associated and there is also a sense of public participation as sometimes more than 1 family use these toilets and all are jointly responsible for its functioning, The money saved can be used in other areas of their lives to improve the standard of living. These toilets are also well received by the target population. Thus it can be said that the project meets local country development priorities.

The project is eligible to move to Step VIII

STEP VIII: DOES THE PROJECT HAVE NEGATIVE ENVIRONMENTAL OR SOCIAL IMPACTS?

GUIDELINES TO ANSWER STEP VIII

The objective of a CDM project is to provide environmental and social benefits as well as to reduce GHG emissions. However, if the host country, upon review of a preliminary project proposal, feels that an Environmental Impact Assessment (EIA) is required or stakeholder input shows that there are significant local environmental or social concerns about the initiative, then an EIA must be completed before the project can proceed.

The impact assessment should include impacts from both within and outside the project boundary area and follow the Ministry of Environment and Forest (MoEF) procedures. In addition, the CDM project should be evaluated using the highest international environmental and social assessment procedures and standards. The results of the environmental assessment must be attached to the final Project Design Document.

Screening of projects implemented under TSC against Step 8

GUIDELINES TO ANSWER STEP VIII

The TLBs help reduce the indoor air pollution that is caused by the use of chulhas and also helps reduce the emissions from kerosene etc by using the biogas generated from the TLBs. The project also helps produce compost that can replace the use of chemical fertilizers to an extent. The use of TLBs/LPTs leads to an improvement in the quality of life and to the social evolution of the beneficiary groups.

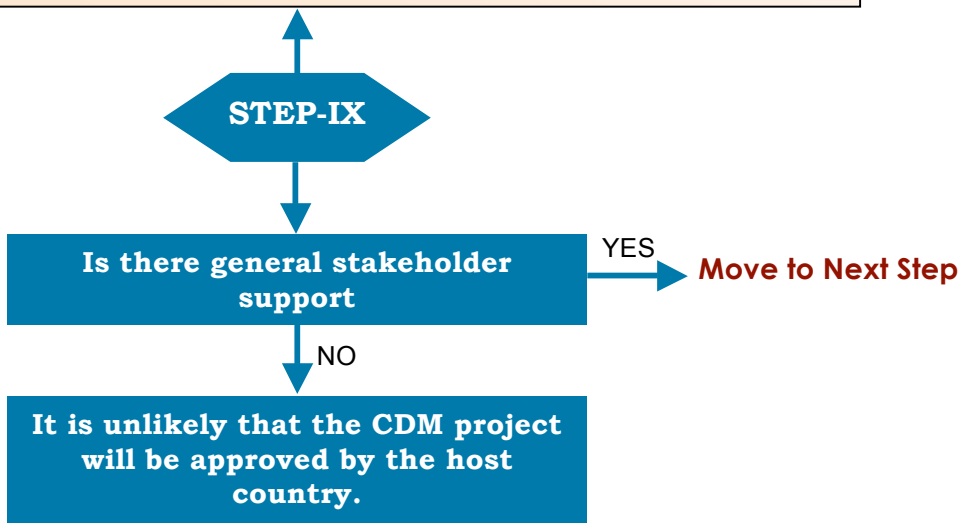
The project is eligible to move to Step IX

STEP IX: IS THERE GENERAL STAKEHOLDER SUPPORT FOR THE PROJECT?

GUIDELINES TO ANSWER STEP IX

The term stakeholder is defined as the "public, including individuals, groups or communities affected, or likely to be affected" by the proposed CDM project [see UNFCCC 2001, -/CMP (Article 12), Annex, para 1 (e)]. For CDM projects, the stakeholders broadly comprises of prospective investors, host country institutions, local NGOs, local bodies and technology providers.

CDM emphasizes on the consultation with local stakeholders prior to the implementation of a project. The stakeholder's comments as well as how these comments were taken into account, must be considered and documented.



Screening of projects implemented under TSC against Step 9

The usage of these toilets is quite high and this is due to the fact that the users are comfortable with this idea and support it fully. The Gram Panchayats and village associations encourage the villagers to use these facilities. The project also does not require any special clearances from Pollution Control Board etc and finds good support with the state government agencies.

The project is eligible to move to Step X

STEP X: IS ESTIMATED CDM REVENUE GREATER THAN THE TRANSACTION COST FOR THE ENTIRE CREDITING PERIOD?

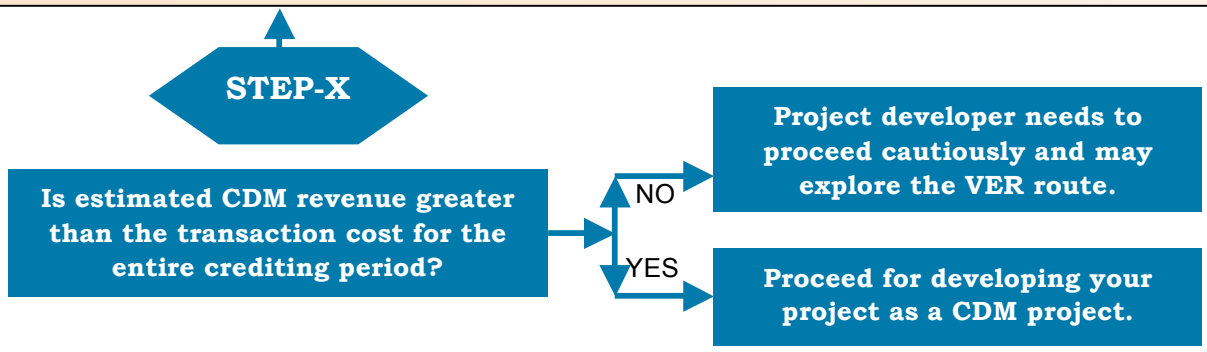
GUIDELINES TO ANSWER STEP X

Transaction costs: Transaction costs of CDM projects consist of the cost components like documentation costs (PDD, PIN & PCN), monitoring costs, host country approval costs, validation costs, on-site monitoring costs, registration costs, verification and certification costs and costs accruing from the adaptation and administration fees. The transaction cost is project specific and is difficult to generalize as it comprises of numerous variable cost components. In general, the range of transaction cost is illustrated as follows:

Transaction costs		USD	
Pre-implementation transaction costs (PIN, PCN & PDD)	Baseline Costs	20,000 - 25,000	
	Monitoring Plan Costs	8, 000 - 18,000	
	Host Country Approval Costs	0 - 40,000	
	Validation Costs	6,000 - 34,000	
	Registration Costs	5,000 - 30,000	
Implementation transaction costs	On-site Monitoring Costs	10,000 - 20,000	
	Verification & Certification Costs	4,000 - 18,000 per turn	
	Adaptation Costs	2% of CERs	
Min/Max Transaction Costs		53,000	185,000

Source: *Transaction Costs of CDM Projects in India – An Empirical Survey, by Matthias Krey, HWWA Report - 238, Hamburgisches Welt-Wirtschafts-Archiv (HWWA), Hamburg Institute of International Economics, 2004.*

For small scale CDM projects, where the emission reduction revenue is not sufficient enough to meet the transaction costs although the project is having the potential to reduce the greenhouse gases, it is recommended to follow the voluntary markets for emissions reductions that are not compliant with the Kyoto Protocol, and are available for sale to corporations and individuals who want to offset their emissions for non-regulatory purposes. Emission offsets in this category are verified by independent agents, but are not certified by a regulatory authority for use as a compliance instrument, and are commonly referred to as Verified Emission Reductions (VERs), (see Chapter 1).



Screening of projects implemented under TSC against Step 10

The CERs from individual projects is quite low. However, it is estimated that the total transaction costs for the project would be recovered from the CER revenue of just 1 year if the PoA approach is followed (as outlined in section 4 of the report) and the CDM benefits of individual projects are aggregated at a state level.

The toilet linked biogas plants constructed under the TSC has CDM potential an can be developed as a programmatic CDM project

3.0 GHG REDUCTION – ESTABLISHING THE BELIEF

The heart of this assignment was to quantify methane avoidance by eliminating open defecation and establish GHG reduction for the initiatives implemented under the TSC. This section outlines the designing of experimental set up and the analysis of the results obtained thereof. The project was quite unique and challenging as it is the first time that such an attempt is being made. The biggest problem that the project team faced was that though open defecation is being practiced for a long time, there has been no secondary information/data on GHG emission from open defecation.

Initially, a search was done to find literature on the types of gases emitted from open defecation, leach pit toilets etc. It was found that there is no such literature available on the web or even in text books. With assistance from the UNICEF Delhi office, several experts were then contacted for their opinion and it was found that there was no consistent opinion on the subject.

The Winrock team then met experts of the subject in a conference arranged by UNICEF on 8th January, 2008. There several interesting points emerged:

- It was said that the night soil from open defecation undergoes anaerobic as well as aerobic decomposition. While the surface is exposed to air, the inner portion degrades anaerobically.
- The decomposition is dependent on several external factors like climate, humidity, temperature etc.
- The decomposition also depends on the soil type.
- Some experts believed that open defecation leads to only carbon dioxide emissions while others argued that it is only methane
- It was also thought that the CH_4 generated in LPTs would enter the soil and get oxidized and converted to CO_2.
- Human excreta degrades differently in rural and urban areas
- In rural areas, the excreta is scattered and hence mainly aerobic degradation takes place
- In urban areas, the excreta is concentrated and hence mainly anaerobic degradation takes place
- In the open CH_4 and CO_2 are generated after 8 weeks

As can be clearly seen from the deliberation of the expert group meeting, there was no consensus on the subject. Additionally, there was no reported literature on the emission data. Keeping this in mind, it was decided by the WII team (in consultation with the UNICEF office) to design special experiments to quantify the GHG

emissions. Experiments were designed along with special experimental setup to capture GHG emission from the following:

- GHG emissions from open defecation (base case)
- GHG emissions from LPTs
- Composition of the biogas generated in the TLBs

In this section, the details of the experiments carried out for each of the above cases are presented.

3.1 GHG emission from open defecation (base case):

In open defecation or base case, monitoring of CH_4 & CO_2 gases was carried out by decomposing the night soil sample in open field. Sangareddy, headquarter of Medak district in Andhra Pradesh which is about 65km north of Hyderabad was selected finally as the test site after conducting surveys for a month to identify a site. Prior to this, the WII team had visited Muluku and Ranga reddy Mandal Development Offices (MDO) and discussed the issues with them. WII team visited 2 villages near Muluku for identification of site to conduct open defecation experiments but could not find the scavenger people to handle the night soil.

SCOPE, a voluntary organization agreed to assist in identifying the locations in Sangareddy for testing, identification of scavenger to bring and place the night soil sample during the experiments, identification of a supervisor to monitor the test sites for a month.

The basic aim of the experiment was to collect and measure the gases which are produced from human night soil in open defecation. Since it is impossible to collect the gas in open, so to simulate the same WII designed a chamber that was placed over the night soil sample. The chamber dimensions were designed so as to replicate ambient conditions. The ratio of volume of gas generated from decomposition of night soil to volume of chamber was 1:6. The dimension of the FRP enclosure was 1.2 m x 0.8 m. In order to simulate conditions as close to actual, the night soil samples were kept on the perforated polythene sheet to ensure oxygen flow.

A sample of night soil weighing 2200 gm was placed on 2 perforated polythene sheets. The polythene sheets had small perforations of 1-2 mm dia. to create the natural environment in terms of free oxygen flow to the samples. The sheets were covered with a FRP fabricated enclosure with a peep surface (30 x 30 cm) made out of acrylic material. The enclosures were placed on the channel filled with water to ensure that there was no leakage. Provision was made to monitor CH_4 and CO_2 in

the enclosure. To arrive at the CH_4 and CO_2 release from a particular mass of night soil, CH_4 and CO_2 concentration was monitored on a weekly basis. The duration of sampling was 30 days. The experimental setup alongwith gas sampling is shown in Fig. 3.1

Figure 3.1: **Full view of the test chamber**

Figure 3.2: ***Experimental setup/gas sampling***

The gas samples were collected at 7 day intervals by the science and technology division of Jawaharlal Nehru Technological University (JNTU). Gas samples were collected in tetlar plastic bags using vacuum pump from both samples (sites). Samples were tested in the laboratory using gas chromatographer for methane & carbon dioxide. The results are tabulated in table 3.1.

Table 3.1: *Methane and carbon dioxide content in the samples*

Sample no.	I		II		III		IV	
	CH_4(%)	CO_2(%)	CH_4	CO_2	CH_4	CO_2	CH_4	CO_2
1	2	Not detected	2.2	Not detected	2.1	Not detected	2	Not detected
2	1.5	Not detected	1.8	Not detected	1.8	Not detected	1.6	Not detected

3.2 Toilet linked biogas plants (TLB):

In order to identify a possible site, visits were undertaken to many places around Hyderabad as well as Bangalore. Finally WII interacted with TEDA (Tamil Nadu Energy Development Agency) as TEDA had been involved in construction of more than 25 TLBs in Tamil Nadu. Finally, 2 TLBs in Kongu Engineering College in Erode (Fig.3.3), Tamil Nadu were identified for monitoring. Two plants were identified in the same premises; one plant uses toilets wastes from Undergraduate (UG) hostel and the other from the Postgraduate (PG) hostel. 400 students use the toilets in UG hostel whereas PG hostel accommodate 300 students. The capacity of both the plants is 25 m^3 and can produce 15kg (designed capacity) of LPG gas equivalent per day. The utilities of gas are rice cooking, heating water, frying etc.

Figure 3.3: *Toilet linked biogas plant in Kongu College, Erode*

Sri Ram Institute for Industrial Research, Bangalore was selected after several rounds of interaction with local laboratories.

2 gas samples were collected from TLB plants near the stove in both the locations for testing gross calorific value (GCV) of biogas from TLB plant as well as CO_2 and CH_4. The results are tabulated in table 3.2

Table 3.2 ***CO_2, CH_4 content and GCV of gas from the TLBs***

Sample No.	Methane (CH4)%	Carbon dioxide (CO2)%	Gross calorific value(GCV) -Kcal/kg
1. UG Hostel	54.56	16.05	2970
2. PG Hostel	51.15	26.12	2805

3.3 Leach pit toilets

After extensive surveys in Andhra Pradesh, Karnataka and Tamil Nadu (through Mr. A. Devaraj, Project officer, UNICEF, Chennai, Mr. Krishnamurthy, Head, India NGO, Chennai and local bodies like block development office, village counsel and the master mason who has constructed the leach pits and toilets), the village Manivakkam was identified which is located around 35 km from Chennai. The village contains 500 house holds, out of which 100 families use the toilets constructed by master mason who has been trained in constructing sanitation systems. Two leach pit toilets were identified - one was constructed around 6 months back and second one was about a year old. The details of the identified locations are given in Table 3.3:

Table 3.3: ***LPT locations chosen for monitoring***

Sl. No.	Name and Address of the site	No. of people using toilets	Month and year of start
1	Mr. Basha Deripu street, Pudunagar Manivakkam, Chennai-48	5	September 2007
2	Mr. Kannan Kurunjipur street, Pudunagar Manivakkam, Chennai-48	5	June 2007

The basic aim of the experiment was to quantify the green house gases that escape through soil around the leach pits. WII designed a chamber to place over the leach pit in a channel constructed around the leach pit. The channel was constructed using cement, bricks and sand basically to hold water.

The chambers, shown in figures 3.4 to 3.6 are made up of galvanized iron (G.I) sheet and the dimension is 200 cm x 30 cm. The volume of the chamber is 1 m^3. The two chambers were checked for water leakage and it was ensured there was no leakage through the chamber

Figure 3.4: *Inside view of chamber*

Figure 3.5: *Provisions for sample collection*

Figure 3.6: *Channels during and after construction*

Provisions were made to monitor CH_4 and CO_2 in the enclosure. To arrive at the CH_4 and CO_2 release from a leach pit, CH_4 and CO_2 concentrations were monitored at 10 day intervals by the science and technology division of Jawaharlal Nehru Technological University (JNTU), Hyderabad. Gas samples were collected in tattler plastic bags using vacuum pump from both samples (sites). The samples were analyzed in the laboratory using gas chromatographer for CH_4 & CO_2. The results are tabulated in table 3.4.

Table 3.4: *CH_4 and CO_2 analysis*

Sampling date.	Basha		Kannan	
	CH_4 (%)	CO_2 (%)	CH_4 (%)	CO_2 (%)
11th July 2008	3.2	Not detected	3.4	Not detected
21st July 2008	3.5	Not detected	3.3	Not detected
31st July, 2008	3.2	Not detected	3.0	Not detected
11th August, 2008	2.9	Not detected	3.0	Not detected

4.0 GHG ESTIMATION

Based on the results of the GHG monitoring as outlined in Section 3.0, the quantification of GHG emissions was carried out. The estimation was done for the following cases:

- *GHG emission from open defecation*

As shown in Table 4.1, assuming that one person generates 250 gm of night soil per day, it is estimated that the methane generated from one person per day is 0.00108 kg.

Table 4.1: ***Methane generation from open defecation***

Volume of air in the glass chamber	m3	0.7
Volume of methane in the chamber	m3	0.014
Density of methane	kg/m3	0.68[1]
Amount of methane	kg	0.00952
Mass of night soil kept during experiments	kg	2.2
Methane generated from one person per day	kg	0.001081818

- *GHG emission from LPTs*

Assuming that one person generates 250 gm of night soil per day, it is estimated, as shown in Table 4.2, that the methane generated from one person per day is 0.0004624 kg from a LPT. The main assumption taken here is that the amount of night soil contributing to the methane generation over 10 days is 12.5 kg (for a family of 5 members contributing 250 gm of night soil per day for 10 days).

Table 4.2**: *Methane generation from LPT***

Volume of air in the glass chamber	m3	1
Volume of methane in the chamber	m3	0.034
Density of methane	kg/m3	0.68
Amount of methane	kg	0.02312
Mass of night soil	kg	12.5
Methane generated from one person per day	kg	0.0004624

- *GHG emission from TLBs*

Assuming that one person generated 250 gm of night soil per day, it is estimated that the methane generated from one person per day is 0.000162272 kg from a TLB as

[1] standard value

shown in Table 4.3. This methane emission is attributed to the leakage from the digester which is 15 % (IPCC values) of the total methane generated. This also includes the emissions from the incomplete combustion of the Methane.

Table 4.3: *Methane generation from TLB*

Methane generated from one person per day in open defecation	kg	0.001081818
Methane generated from one person per day from a TLB after considering 15 % leakage	kg	0.000162272

A schematic representation of the methane emissions from open defecation, TLBs and LPTs is shown in Fig. 4.1

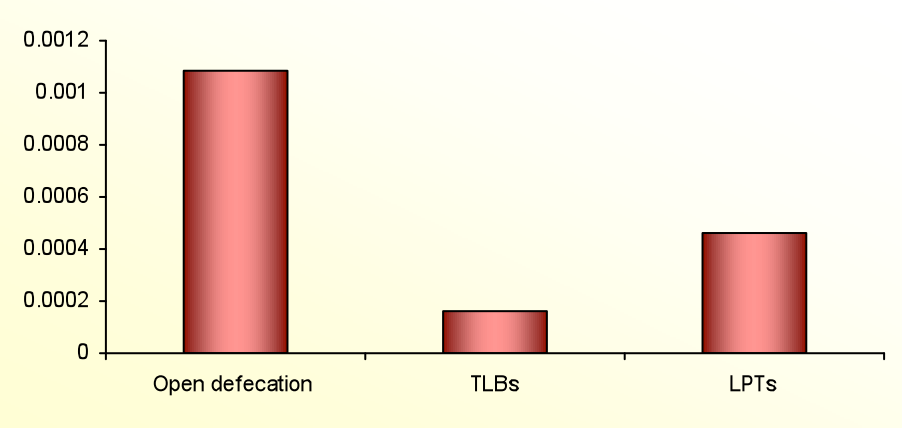


Figure4.1: *Methane emissions from open defecation, LPTs and TLBs*

5.0 POSSIBLE CDM PROJECTS UNDER THE TOTAL SANITATION CAMPAIGN

As outlined in Chapter 4 of this report, the GHG emission reductions from individual TLBs and LPTs are too small to be developed as a CDM project. Hence a PoA approach is recommended. Also, since it's mandatory for a PoA to use a single baseline and monitoring methodology a single PoA cannot be used. Hence, the following three PoA s are recommended to cover the various initiatives undertaken under the TSC:

- Shift from open defecation to TLBs (Methane avoidance component)
- Shift from open defecation to TLBs (energy component)
- Shift from open defecation to LPTs.

The CER calculations for each of the three options is provided below -

➲ *Shift from Open defecation to TLBs (Methane avoidance component)*

The use of TLBs compared to open defecation results in methane avoidance as the decomposition of the night soil takes place in a closed system and the resulting biogas is directly transferred for domestic use in households through pipes. The only methane emissions is the leakage which is around 15 % and happens from the digester, valves etc and incomplete combustion of CH_4.

The methane avoidance due to the shift from open defecation to TLB after considering the leakage is 0.000919545 per person per day. An estimate of the total CERs at a state level is done for West Bengal and assuming that 40 % of the population of the state defecates in the open, the total CERs from the state as a result of shift from open defecation to TLBs would be 226170 per year, as shown in Table 5.1. This results in a CER revenue of Rs. 22,05,15,750 per year at 15 Euro per CER.

Table 5.1: ***CER calculations for methane avoidance due to shift from open defecation to TLBs***

Methane avoidance from TLBs		0.000919545
Total population of West Bengal state		80221171
Total population in state defecating in the open		32088468
Total Methane generated for the population defecating in the open per day	kg	29507
Total Methane generated for the population defecating in the open in a year	t	10770
Total CERs	t CO2 eq	226170
Price of 1 CER	Euro	15
Total CER revenue per year	Rupees	220515750

➲ *Shift from open defecation to TLBs (energy component)*

It is assumed that in the absence of the biogas generated from the TLBs, kerosene would be used for cooking. For a 25m^3 plant, the emission reductions are shown in Table 5.2:

Table 5.2: ***CER calculations for shift from open defecation to TLBs (energy component)***

For a TLB of 25 m3 capacity -		
Gross calorific value of biogas generated from TLB	kcal/kg	2850
Quantity of gas obtained from TLB per day (approx)	kg	15
Total energy available in biogas per day	kcal	42759

Gross calorific value of Kerosene	kcal/kg	10000
Kerosene that would have been used in the absence of the project	kg	4.275
Emission factor of kerosene	kg CO2/kg	3.21
CO_2 emission from kerosene per year	t CO_2	5.0
Total CERs from 1 TLB	t CO_2	10.87641
Price of 1 CER	Euro	15
Total CER revenue per year	Rupees	10,604

The CERs generated from one TLB as a result of using the biogas produced from the TLB and avoiding kerosene use is 10.87641and the total CER revenue per annum is Rs. 10,604.

➲ *Shift from open defecation to LPTs.*

The CERs generated as a result of shift from open defecation to LPTs is shown in Table 5.3

Table 5.3: ***CERs generated due to shift from open defecation to LPT***

Methane generated from one person per day	kg	0.0006176
Total population of West Bengal state		80221171
Total population in state defecating in the open		32088468
Total Methane generated for the population defecating in the open per day	kg	19817
Total Methane generated for the population defecating in the open in a year	T	7233
CERs	t CO_2	151903
Price of 1 CER	Euro	15
Total CER revenue per year	Rupees	148106133

The total CER estimated for the state of West Bengal as a result of shift from open defecation to TLBs is 151903 and the CER revenue per year is Rs. 14,81,06,133 at 15 Euro per CER.

6.0 CDM PROJECT METHODOLOGY

Considering the geographical diversity of the project, involvement of various government (eg- Ministry of Rural Development) and non-government organizations (UNICEF and Ramakrishna mission etc) in the Total Sanitation Campaign, low CER from single TLBs and LPTs and considering that the Total Sanitation Campaign is

implemented in a phased manner, Programme of activities (PoA) – which is also referred to as 'Programmatic CDM' is recommended.

PoA is a set of an unlimited number of CDM Programme Activities (CPAs) that can be registered as a single CDM project. It entails measures coordinated by a private or public entity that reduce greenhouse gas emissions and which are not related to any mandatory and enforced policy.

The Total Sanitation Campaign, launched by the Rajiv Gandhi Drinking Water Mission, Ministry of Rural Development, Government of India is designed to reverse the trend of open defecation by using environment friendly technologies such as leach pits is a country wide programme. The use of leach pit toilets is CDM able as it results in methane avoidance (as is conclusively proved by experimentation carried out as part of the project) and can be approached through the PoA method.

PoA, as defined by the Executive Board, has a maximum duration of 28 years, which is higher than the normal CDM projects. The uniqueness of the PoA approach is that several individual project activities can be added to the PoA at any point in time during the lifetime of the PoA through a simple procedure and this option is very crucial for such type of activities. As the Total Sanitation Campaign is being implemented in a phased manner for different states by various agencies, leach pits can be added as individual CPAs in the PoA. This flexibility allows claiming emission reduction benefits for all the future initiatives.

As compared to normal CDM projects, only a sample of the project activities need to be periodically verified for emission reductions according to a defined sampling procedure and this innovation brings more flexibility to CDM project developers and reduces CDM related transaction costs.

6.1 Criteria to be met for PoA

However, in order to qualify for PoA, the project activities must meet certain criteria. In this section, a description of the eight main criteria to be met for a PoA is outlined alongwith an analysis as to whether the activities carried out under the TSC meet these criteria.

6.1.1 A programme of activities (*PoA*) is a voluntary coordinated action by a private or public entity which coordinates and implements any policy/measure or stated goal (i.e. incentive schemes and voluntary programmes), which leads to anthropogenic GHG emission reductions or net anthropogenic greenhouse gas removals by sinks

that are additional to any that would occur in the absence of the *PoA*, via an unlimited number of CDM project activities (*CPAs)*.

The Rajiv Gandhi National Drinking Water Mission (RGNDWM)[2] was launched to ensure maximum inflow of scientific and technical input into the rural water supply sector to improve the performance, cost effectiveness of the on-going programmes and ensure adequate supply of safe drinking water.

The Total Sanitation Campaign (TSC) is part of RGNDWM and leach pit toilet is one of the measures implemented as part of TSC.

The main objectives of the Total Sanitation Campaign are as under:

- Bring about an improvement in the general quality of life in the rural areas.
- Accelerate sanitation coverage in rural areas.
- Generate felt demand for sanitation facilities through awareness creation and health education.
- Cover Schools/Anganwadis in rural areas with sanitation facilities and promote hygiene education and sanitary habits among students.
- Encourage cost effective and appropriate technologies in sanitation.
- Eliminate open defecation to minimize risk of contamination of drinking water sources and food.
- Convert dry latrines to pour flush latrines, and eliminate manual scavenging practice, wherever in existence in rural areas.
- This action is voluntary and is coordinated by a public entity i.e. Ministry of Rural Development to ensure that the above mentioned goals are implemented.

From the above, it may be safely concluded that the project meets the first criteria.

6.1.2 The physical boundary of a *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 *CPAs,* assists it in achieving sustainable development.

The physical boundary in this case is the international boundary of India. All leach pit toilets inside the country are individual CPAs. Similar UNICEF programs are also being implemented in other neighboring countries (e.g. Bangladesh, Nepal, Pakistan etc.). So the aggregation can be carried out either at individual state level or for projects available.

[2] http://rural.nic.in/book98-99/chapter.7.pdf

The initiative meets the sustainable development criteria as already highlighted under Section 2.0 of the report.

6.1.3 A *PoA* shall comply with all current guidance by the Board concerning the treatment of local/regional/national policies and regulations. *PoAs* addressing mandatory local/regional/national policies and regulations are permissible provided it is demonstrated that these policies and regulations are systematically not enforced and that noncompliance with those requirements is widespread in the country/region. If they are enforced, the effect of the *PoA* is to increase the enforcement beyond the mandatory level required.

The toilet linked biogas plants are not mandated by and law or regulation and hence meets this criteria.

6.1.4 A *PoA* shall be proposed by the coordinating or managing entity which shall be a project participant authorized by all participating host country DNAs involved and identified in the modalities of communication as the entity which communicates with the Board, including on matters relating to the distribution of CERs.

MoRD/UNICEF would be the coordination/managing entity.

6.1.5 Project participants of the *PoA* shall make arrangements with the coordinator or managing entity, relating to communications, distribution of CERs and change of project participants.

Some of the implementing agencies like the state govt. who are actively involved in construction and maintenance of leach pits toilets will directly communicate with the coordination managing entity.

6.1.6 The coordinating entity of the *PoA* shall identify measures to ensure that all *CPAs* under its *PoA* are neither registered as an individual CDM project activity nor included in another registered *PoA* and that the CPA is subscribed to the *PoA*. These measures are to be validated and verified by DOE.

MoRD/UNICEF would take responsibility of the same and will maintain a comprehensive list of the number of leach pits comprising the PoA including the village/district where they exist and the organization involved in its construction, operation and maintenance. This list will be updated frequently and would be made available to the DOE.

6.1.7 All *CPAs* of a *PoA* shall apply the same approved baseline and monitoring methodology, involving one type of technology or set of interrelated measures in the same type of facility/installation/land.

The same methodology is applied for all the CPAs.

6.1.8 Each *CPA* 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*, the information required by the registered *PoA*.

As can be seen from the above discussion, the project activities can be registered as a PoA as it meets all the criteria laid above.

6.2 Crediting period and Methodology related issues

The duration of the PoA, will not exceed 28 years, and shall be defined by the MoRD/UNICEF at the time of request for registration of the PoA. Any CPA can be added to the PoA at any time during the duration of the PoA by MoRD/UNICEF. The MoRD/UNICEF shall inform the CDM Executive Board of the adding of leach pits through a DOE using a pre-defined format. The crediting period of a Leach pit will be either a maximum of seven years which may be renewed at most two times or a maximum of ten years with no option of renewal. However, the duration of crediting period of any leachpit shall be limited to the end date of the PoA regardless of when the leachpit was added.

The latest version of the "Procedures for Renewal of a Crediting Period of a Registered CDM project activity" shall be applied, mutatis mutandis, to the *PoA* every seven years. Any resulting changes to the *PoA* shall be applied by each leachpit at the time of the first renewal of its crediting period after such change to the *PoA*. In case of multiple host Parties, only those leach pits which can apply these changes may renew their crediting period.

If the approved methodology is put on hold or withdrawn, not for the purpose of inclusion in a consolidation, no new leach pits shall be added to the PoA in accordance with the timelines indicated in procedures. If the methodology is subsequently revised or replaced by inclusion in a consolidated methodology, the PoA shall be revised accordingly and changes validated by a DOE and approved by the Board. Once changes have been approved by the Board, each leachpit included in the PoA thereafter has to use the new version of the PoA. Leachpits included prior to the methodology being put on hold, shall apply the new version of the PoA at the time of the renewal of its crediting period.

The emission reductions or net anthropogenic removals by sinks of each leachpit 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 or removals by sinks (that may include random sampling) shall ensure the accuracy of these emission reductions.

7.0 ISSUES, RECOMMENDATIONS AND CONCLUSIONS

As shown from the experiments, there is considerable scope for developing these initiatives as a CDM project. These initiatives face several barriers in their operation and maintenance and the CER revenue flowing from these projects would not only help these projects to continue working for long periods of time by contributing to the operation and maintenance costs but will also help contribute to the global fight against Climate change. However, following issues need to be considered in order to take it through the CDM cycle.

- As a next step, a Project Design Document (PDD) will have to be developed
- While developing the project as a CDM project, more rigorous experiments would have to be carried out so as to make it acceptable by the UNFCCC
- Baseline would have to be developed carefully for both fuel substitution (TLB) and methane avoidance projects (TLBs and LPTs) for reasons mentioned below-

  In most areas in India, fuel wood is used for cooking and the current methodologies approved by the UNFCCC do not consider emission from fuel wood as they do from fossil fuels like Kerosene etc. The current methodologies provide benefits only for projects that use energy efficient stoves based on biogas
- For methane generated from open defecation and also methane generated from the LPTs, more experiments and live monitoring would be required to cover all agro climatic zones of the country
- Monitoring plans will have to be chalked out clearly considering the large number of individual units
- It is understood that several LPTs get destroyed during heavy rains and floods etc so some sort of a mechanism to replace these immediately or to make them withstand calamities has to be devised