CDM Feasibility Study 2011: Final Report

CDM PoA Feasibility Study for Household Biogas Digester Promotion Programme in Bangladesh

By PEAR Carbon Offset Initiative, Ltd.

FS Partner(s)	Grameen Shakti
Location of the Project Activity	Bangladesh
Category of Project Activity	Renewable energy (Biomass)
Targeted GHG	CO_2
CDM/JI	CDM
Description of Project Activity	The proposed PoA is to accelerate National Domestic Biogas and Manure Progamme (NDBMP) in Bangladesh through the programmatic CDM. Households being included in CPAs under the PoA should meet the following conditions: In baseline scenario: Households use biomass (fuel-wood portion is 100% non-renewable) for thermal energy need through conventional coking stoves Project scenario: Households use biogas instead of biomass for thermal energy need through introduced biogas stoves It can be said that the PoA will facilitate rural households accessibility for affordable renewable energy at the same time improve the life condition of rural households by cutting indoor air pollutions. The PoA also includes micro utility business model in which households who install biogas digesters bigger than 4.8 m^3/day (NDBMP covers biogas digesters less than 4.8 m^3) provide their spare biogas to neighbor households who do not have own conditions to install biogas digesters.
Methodology to be applied	AMS-I.E. ver. 04: “Switch from non-renewable biomass for thermal applications by the user”
Baseline Scenario	The baseline scenario for the project activities under the PoA is the continuation of current practice that households use non-renewable biomass for their thermal need. For the main parameter B^B of baseline fuel wood consumption, the default value (household annual biomass consumption) for Asian region is applied.
Monitoring	The main and only parameter need monitoring is the number of households ($N^{OP}_{HH,y}$) who are using biogas from biogas digesters having operated appropriately. The parameter can be grasped as a function of time given as below through the recording system that covers entire households with

	considering the following elements. $B^{PJ}_{y} = B_{HH}{}^{PJ} \cdot (1/365) \cdot \sum_{i} n_i{}^{OP}{}_{HH,y}$ • Identify failure period (non operated period) of biogas digesters through integrating monitoring system with maintenance system. Households are required and agreed to report any failure of their biogas digesters in due time in the agreements with IDCOL. Under the NDBMP, the staffs regularly visit households during the loan period (two years at most); for the programme the practice should be kept during the crediting period to grasp operation condition of biogas digesters.） • Biogas operation period of the first year is identified per diem. The point being that developing a database by a household rather than a biogas digester is very important.
Estimation of GHG Emission Reduction	Estimated emission reduction is 3.83 t CO2/household/year. At present, in the case of Grammen Shakti, the installation rate of biogas digesters is 500/month. The rate will be up to 800/month if counting numbers of other NOGs also. Of that rate, the emission reduction after 10 years becomes 380 thousand ton; with a 1.5 times accelerated rate the emission reduction will exceed 4 million ton.
Duration of Project Activity/ Crediting Period	The crediting period is 28 years (PoA) / 21 years (CPA). As validation of the PoA was started on 13 December 2011, activities from the date onward are eligible for the first CPA under the PoA. Registration would be completed in May 2011.
Environmental Impact Analysis	Regarding domestic biogas digester projects, there has ben no requirement for environment impact assessment in Bangladesh.
Demonstration of Additionality	For additionality demonstration of CPAs, the “GUIDELINES FOR DEMONSTRATING ADDITIONALITY OF MICROSCALE PROJECT ACTIVITIES” is applied. Regarding additionality of the PoA, it can be said that the PoA is additional if each CPA is to be included in the PoA is additional. Thus additionality check of CPAs is included in the eligibility criteria for inclusion of a CPA to the PoA.
Project Feasibility	As the PoA mostly covers the existing program, there has been no problem for the project feasibility. However, there is still a task to accelerate micro utility business and diffuse industrial product biogas digesters under the PoA.
"Co-benefits" (*i.e.* Improvement of Local Environmental Problems)	Reduce indoor air pollution such as eliminate indoor black carbon pollution.
Contribution to Sustainable Development in Host Country	Local benefits related to energy: Increase rural households energy accessibility (micro utility ensure biogas accessibility to poor rural households) Other benefits: Income generation through energy cost

	saving, gas selling and women's labor load alleviation, *etc*. National level benefits: Increase energy security and reduce deforestation, *etc*.

1. Implementation Framework of the Study

Grameen Shakti (GS), as a host country counter-partner, is a key implementer of the IDCOL Infrastructure Development Company Limited's (IDCOL) National Domestic Biogas and Manure Program (NDBMP) and is responsible for data, information collection and supporting for business model designing.

In addition, IDCOL became the coordinating/or managing (CME) entity of the PoA by the end of the 2011.

2. Project Description

(1) About the Project

The project is to expand biogas utilization in rural Bangladesh through a programmatic CDM project under the NDBMP.

The CME of the PoA is the IDCOL who is an implementer and financial supporter of the NDBMP in Bangladesh. Grameen Shakti (GS), a non-governmental organization, is one of the project participants as it is one of the big players under the NDBMP.

The PoA also covers project activities of installing biogas digesters larger than 4.8 m^3/day[1]that are not included under the NDBMP. Then, the IDCOL not only coordinate and manage activities under the program but also coordinate and manage other all biogas digester installation activities.

GS is also one of the project participants of the PoA while its activity covers more than half of the activities under the NDBMP.

Households being included in CPAs under the PoA should meet the following conditions:

In baseline scenario: Households use biomass (fuel-wood portion is 100% non-renewable) for thermal energy need through conventional coking stoves

In project scenario: Households use biogas instead of biomass for thermal energy need through introduced biogas stoves

So far rural households in Bangladesh mainly use biomass (fuel wood, leaves and cow dung) for their cooing purpose thermal, the PoA will provide renewable biogas for households instead of biomass so that the PoA contributes to reduce deforestation and also improve living condition rural community through consuming animal wastes and improving indoor air quality.

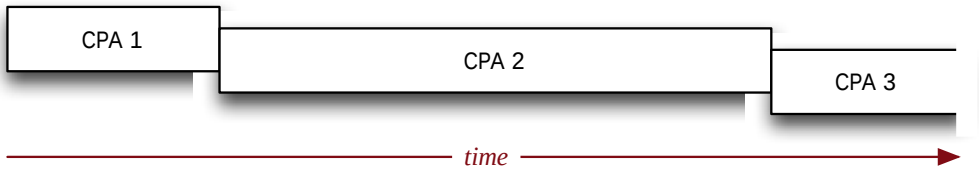
As mentioned previously, the PoA also covers biogas digesters larger than 4.8 m3/day. Owners of the kind of larger biogas digesters (small poultry farm or cattle owners) can sell their spare biogas to neighbors who have difficulties to install their own biogas digesters. This kind of innovative rural development model called "micro-utility" which enables the larger biogas digester owner to undertake a gas utility business to supply biogas to his neighbors by tube. This model enables the poorest farmers incapable to invest in biogas digester to enjoy the benefits of biogas with around 1/2 cost for purchasing fuel wood.
The number of biogas digesters belonging to a CPA is decided

Any typical CPA under the PoA, regardless of households' geographical locations, is defined

[1] For biogas digester size, biogas generation rate rather than physical volume has been used in Bangladesh.

by the number of biogas burners their total capacity should not exceed the threshold of microscale CDM projects (15 MWth). Eligibility criteria for inclusion of a CPA set the maximum number of the burners as 8,000[2]. Therefore, each CPA covers biogas digesters completed by several implementers[3].

CPA-DD for each CPA will be developed based on the database after actual completion of biogas digesters installation. However, CER will be counted from the date of operation started.



The first CPA includes biogas digesters installed from 13 December 2011 (the date of validation started) to 31 January 2012 in Bangladesh.

The estimated emission reduction per household from the CPA is 3.83 ton CO_2/year.

The crediting period of the PoA is 28 years while 21 years for each CPA with two times renewal.

(2) Methodology Application

AMS-I.E. ver. 04 “Switch from non-renewable biomass for thermal applications by the user”

3. Content of the Study

(1) Subjects

Methodology Applicability

There is an applicable methodology of AMS-I.E. (ver. 04: “Switch from non-renewable biomass for thermal applications by the user”) for the kind of activities under the PoA.

In order to demonstrate the eligibility of the methodology for the CPAs, local data and related information collection was done such as survey study[4] on micro utility users and potential users; review of existing CDM projects like “Improved Cooking Stoves in Bangladesh” (registered September 2011) and look closely CDM EB’s decisions on AMS-I.E.

Monitoring System

IDCOL has its own monitoring and management system for its NDBMP while partner organizations including GS also have their corresponding monitoring and management system under the NDBMP.

Therefore, for the PoA, the key point is how to expand the existing system to satisfy CDM requirements.

The operations start dates and operation conditions of the biogas digesters are seen to be the very critical and feasible parameters need monitoring.

However, for keeping micro utility business in place, there is a need for additional database that includes both of biogas digester and users (households) information.

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[2] As biogas stoves under the PoA have 0.3-m3/hour gas flow rate, then each biogas stove has 1.83 kW capacity (net caloric value of biogas with 60%methane content is, 22 MJ/m^3).

[3] Under the NDBMP, there are 30 partner organizations that are implementers to the program.

[4] Grameen Shakti has conducted the survey study to understand current situation of micro utility users and potentiality of micro utility business under the JICA BOP business feasibility study project.

PoA-DD, CPA-DD Development and Validation

As per the methodology and related data and information, PoA-DD and CPA-DDs were developed. The validation of the PoA was conducted from 15~18 February 2012.

(2) Findings

Methodology Applicability

During the study, we submitted some comments to SSC WG and CDM EB. As a result, some of the our comments have been reflected in the issues of PoA additionaly and eligibility criteria of CPA inclusion.

And we also submitted comments for the calling of public inputs for non-renewable biomass issue[5]; however, at the moment, our concern has not been reflected yet.

Moreover, materiality concept is launched in CMP 7 for CDM projects. Based on the concept, we have asked a clarification from CDM EB on avoidance of ex-post monitoring of non-renewable biomass consumption through ex-anti demonstration of its materiality.

Monitoring System

Additional items for the existing monitoring system to need CDM requirements are identified

IDCOL and GS agreed to enrich their database system according to CDM requirement and detailed discussion on this issue will be done in March.

PoA-DD, CPA-DD Development and Validation

Validation was started based on the initial version of PoA-DD that formally showed IDCOL as the CME of the PoA.

Based on feedbacks from DOE after site visit, revision of the PoA-DD and CPA-DD is ongoing and new templates of PoA-DD and CPA-DD that probably come up in 66th meeting of EB will be applied in due time.

4. CDM Project Implementation

(1) Baseline and Project Boundary Setting

CPAs under the PoA satisfied all applicable conditions of the AMS-I.E.

In the case of PoA, the eligibility criteria for inclusion of CPAs are as important as the applicable conditions of methodology.

- Number of biogas burners is included in the database of monitoring to keep each CPA under the micro scale (conservatively 8, 000 burners is the limit and current biogas installation rate is 500/day).
- Each CPA is defined by time period rather than geographical area/location.
- As the PoA includes micro utility model also, expansion of existing database of IDCOL and GS should cover both of owners and end users of biogas.
- Households with improved cooking stove/s are excluded from the PoA to avoid double counting for CER. Thus, the item is included in the parameter lists of monitoring.

Explanation of the criteria and ways of DOE's checking while inclusion review are included in the PoA-DD for avoiding different interpretation for the criteria.

[5] Call for inputs on standardized baselines in SSC methodologies for displacing non renewable biomass http://cdm.unfccc.int/public_inputs/2011/eb63_03/index.html

Geographical boundary of the both PoA and each CPA is delineated as whole Bangladesh.

The baseline scenario for each CPA is continuation of the current practice of using biomass (including non-renewable biomass[6]) for cooking purpose. That can be demonstrated through results of survey studies conducted in rural Bangladesh. The demonstration is identical for all CPAs.

The following equation (1) is applied for emission calculation

$$ER_y = B_y \cdot f_{NRB,y} \cdot NCV_{biomass} \cdot EF_{projected\_fossilfuel} \quad (1)$$

where

B_y : Quantity of woody biomass that is substituted or displaced (ton). See the calculation method below.

$f_{NRB,y}$: Fraction of woody biomass used in the absence of the project activity that can be established as non-renewable biomass using survey methods (no dimension).Fixed (time-independent) parameter. See the definition below.

$NCV_{biomass}$: Net calorific value of the non-renewable woody biomass that is substituted. IPCC default factor for wood fuel (0.015 TJ/ton) is applied.

$EF_{projected\_fossilfuel}$: Emission factor for the substitution of non-renewable woody biomass by similar consumers. Default value of 81.6 tCO_2/TJ is applied per the methodology.

$$f_{NRB,y} = NRB / (NRB + DRB) \quad (2)$$

where

NRB : Share of non-renewable woody biomass used in the absence of the project activity,

DRB : Share of (demonstrably) renewable woody biomass used in the absence of the project activity.

Non-renewable portion fNRB,y among the woody biomass is seen to be 1 in Bangladesh.

B_y is calculated through the way given below.

(a) Calculated as the product of the number of appliances multiplied by the estimate of average annual consumption of woody biomass per appliance (tonnes/year); This can be derived from historical data or estimated using survey methods.

The term of “appliances” above can be interpreted as “household” that is clarified by SSC_538.

For leakage, as per the methodology a conservative factor of 0.95 is applied.

$$B_y = (B^{BL}_y - B^{PJ}_y) \cdot 0.95 \quad (3)$$

In order to demonstrate the consumption of negligible amount of woody biomass (BPJ) after the project implementation and then avoid ex-post monitoring of that item, it is proposed to

[6] Treatment of non-renewable biomass in the CDM is special. That is regardless of using biomass in a baseline scenario, a fossil fuel emission factor is applied for emission calculation from the baseline scenario.

conducted ex-anti sample survey to 100 households. Feasibility of the proposal is under clarification.

For identifying baseline woody biomass consumption $B^{BL}{}_{y}$ the default value of households' woody biomass consumption for Asian region will be applied.

As a result, the main parameter need monitoring is the number of biogas digesters operated appropriately ($N^{OP}{}_{HH,y}$) that can ben depicted as a function of time.

$$B^{PJ}{}_{y} = B_{HH}{}^{PJ} \cdot N^{OP}{}_{HH,y} \quad (4)$$

The parameter can be breakdown by 365 days to express operation days of biogas digesters.

$$N^{OP}{}_{HH,y} = (1/365) \cdot \sum_{i} n_{i}{}^{OP}{}_{HH,y} \quad (5)$$

$n_{i}{}^{OP}{}_{HH,y}$ is the operation days of a biogas digester at a household. The parameter can grasped through:

- Identify failure period (non operated period) of biogas digesters through integrating monitoring system with maintenance system. Households are required and agreed to report any failure of their biogas digesters in due time in the agreements with IDCOL. Under the NDBMP, the staffs regularly visit households during the loan period (two years at most); for the programme the practice should be kept during the crediting period to grasp operation condition of biogas digesters.）
- Biogas operation period of the first year is identified per diem.

(2) Project Emission

The project emission is zero if the woody biomass consumption at households after project implementation is negligible that can be demonstrated through ex-anti sample survey.

(3) Monitoring Plan

As mentioned previously, each CPA targets the number of biogas end users start to use biogas within the certain period of time.

Therefore, CPA-DD can be developed based on the database of completion of biogas digester installation and under operation. The list of biogas digesters being installed and operated appropriately should be attached to the CPA-DD.

All partner organizations should integrate their existing management systems with CDM requirements and provide monthly reports of their activities in the common format to IDCOL.

Monitoring parameters should be feasible and credible; moreover, the number of monitoring parameters is the less, the better. Thus $n_{i}{}^{OP}{}_{HH,y}$ is taken as the credible and feasible parameter for monitoring under the existing management and monitoring system.

In principle, sample survey will not been applied as information of entire number is very important to efficiently implement the project.

In the case of the number of CPAs are more than 10; DOE can apply sample survey method to conduct verification.

(4) Emission Reduction

As mentioned, annual emission reduction per household is 3.83 t CO_2/year/household.

Current biogas digester installation rate is 500/month.

The following table shows the emission reduction from the cases such as continuation of current installation rate and 1.5 times accelerated rate per year. It assumed that installation start from January 2012.

	Biogas Users (accumuated)		Annual CO2 Emission Reductions	
	Constaant pase introduction case	Accerelated introduction case	Constaant pase introduction case	Accerelated introduction case
2012	10,000	10,000	38,300	38,300
2013	20,000	25,000	76,600	95,750
2014	30,000	47,500	114,900	181,925
2015	40,000	81,250	153,200	311,188
2016	50,000	131,875	191,500	505,081
2017	60,000	207,813	229,800	795,922
2018	70,000	321,719	268,100	1,232,183
2019	80,000	492,578	306,400	1,886,574
2020	90,000	748,867	344,700	2,868,161
2021	100,000	1,133,301	383,000	4,340,542

[Note] Accerelated introduction case: 1.5%/yr. This case is more conservative than IDCOL's new target (150,000 in 2016)

However, in order to significantly accelerate biogas digester promotion, conventional brick structure biogas digesters is not enough. It becomes important to introduce industrial product biogas digesters like fiberglass biogas digesters.

Biogas digester potentiality in Bangladesh is quite big as there are 10 million rural households in Bangladesh. With the yearly installation rate of 1.5 times, 1 million biogas digesters will be completed within 10 years. IDCOL is planning to complete additional 150-thousand biogas digester by 2016.

(5) Project Operation Period and Crediting Period

Validation date: 13 December 2011 then project activities from the date onward are eligible for the first CPA1.

Registration application: Early date of 2012.

Crediting period for the PoA is 28 years while 21 years for each CPA (with 2 times renewal in the 7 years interval)

(6) Environmental Impacts and other Indirect Impacts

So far, for domestic biogas promotion projects, there has been no requirement for environmental impact assessment in Bangladesh.

(7) Stakeholder Consultation

Since CPAs under the PoA will be implemented dispersedly in all rural Bangladesh, which is also the geographical boundary for the PoA and the program design, distribution and implementation aspects including the CDM issues are essentially uniform across the country with no CPA specific characteristics, hence it is appropriate to conduct a stakeholder

consultation at a PoA level

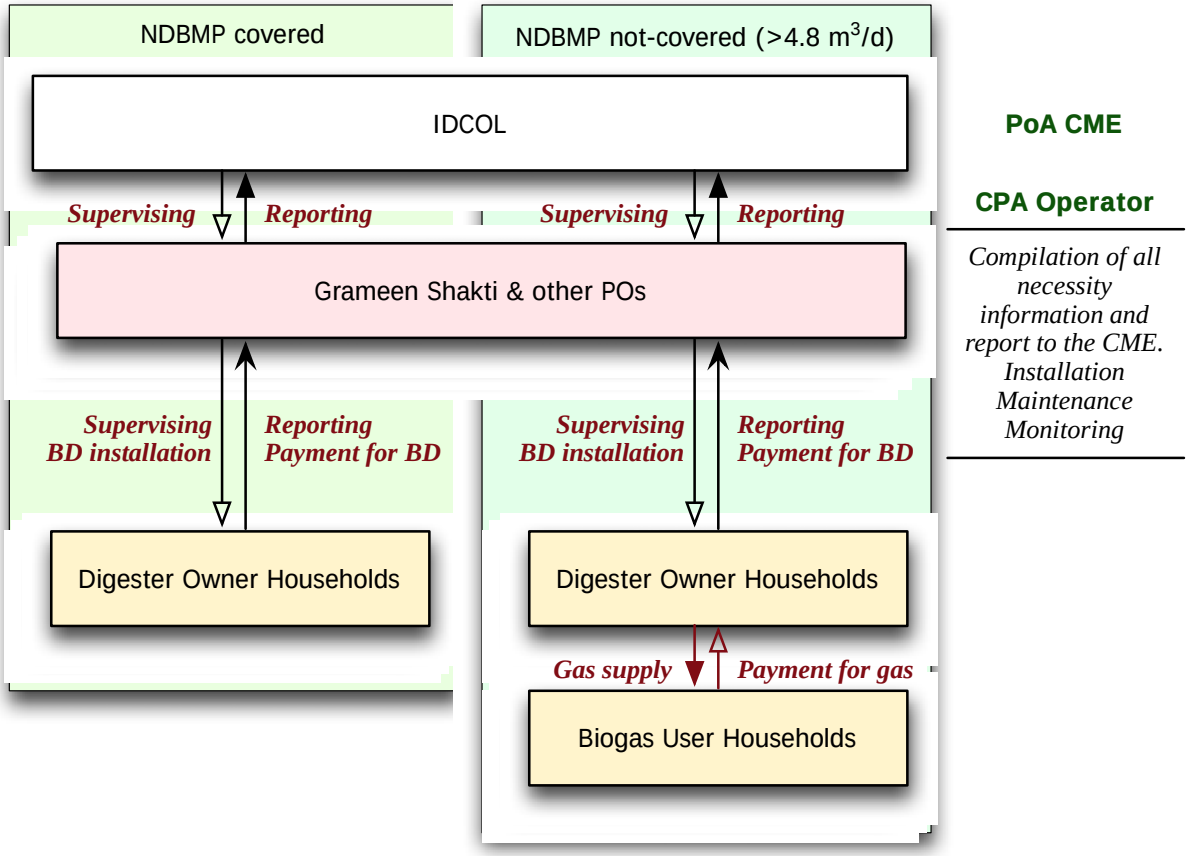
The local stakeholder consultation meeting was held on 3 October 2011, at the Conference room of Proshiku Training Center in Mowna, Gazipur, Bangladesh. As the programme is also applied for gold standard, therefore the local stakeholder consultation was conducted as per requirements of gold standard process.

All participants showed their positive attitudes to the programme and there were no comments regarding objections to the proposed PoA.

(8) Project Management Framework

IDCOL as the CME of the PoA, coordinate and manage all activities both of covered and not covered by NDBMP.

The implementers are the partner organizations including GS. One CPA may has several implementers.



(9) Financial Plan

GS's and other partner organizations businesses under the PoA is a fee business through acquiring financial support (loan) from IDCOL to provide micro credit loan for rural households.

The PoA covers the existing biogas promotion program. Investment for implementation of the PoA comes from SNV (Netherlands Development Organization) in the form of grant and from KfW (German Financial Cooperation) in the form of soft loan.[7]

[7] Existing IDCOL program targets domestic biogas digesters ranges from 1.6 m^3 to 4.8m^3. Regardless of

On the other hand, biogas digesters bigger than 4.8m^3 are expected to install by medium and small poultry farm owners for micro utility business purposes. It order to smoothly promote the kind of business, financial incentives like subsidy or soft loan are considered to be important. It is envisioned that this kind of business model gradually covered by IDCOL program.

(10) Economic Analysis

As mentioned above, partner organization are doing fee businesses, therefore it is rational to look economical viability of an individual household. The following is the economic analysis for an individual household.

For a household, benefits are fuel cost saving; costs are investment on purchasing of a digester.

There are two typical financing models exist in GS business model as well as under the NDBMP.

- The buyer pays 25% of the total cost as down payment. The remaining 75% of the cost is to be repaid through 24 monthly installments with 8% service charge (flat rate) within 2 years. (model A)
- The buyer can construct his plant with his own funds under the supervision of GS engineers. In this case, half of the technical and supervision fees will be paid as advance and the rest will be paid after the commissioning of the plant. (model B)

Here, direct benefits for partner organizations including GS are the service fee 5,000 Taka/digester (among the 9000 Taka subsidy from SNV).

Conditions and Information for Economic Analysis

Items	Descriptions	Conditions
Basic Conditions	Biogas generation rate Project life Crediting period Biomass consumption CER	3 m^3/day 10 years 10 year 3.29 ton/year/household[8] 3.83 ton/year/household[9]
Equipment[10]	Grant Own investment	119 US$/digester 411 US$/digester
Benefits	CER price Cost for woody biomass	10 US$/ton CO_2 13 US$/month/house[11]（Average）
Tax	VAT	15.0%
Exchange Rate	USD/BD || BD/USD	75.45 || 0.0132

The Result of Analysis

Grameen Bank's lending interest rate[12] (16%) is applied as a benchmark for economic analysis.

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the biogas digester size, 9,000 Taka subsidy is provided to per household besides the micro credit loan. However, the PoA also covers biogas digesters larger than 4.8 m^{3}that are not covered the IDCOL program.

[8] Default value from revision for AMS-I.E.

[9] It is assumed that 50% of the CER returned to households

[10] Biogas digester with 3m^3/day costs 40,000 Taka.

[11] Survey study of JICA BOP business study project (Average 1,000 Taka)

[12] Grameen Bank Home page

A	IRR (after tax)	Investment recovery period
Without CER	56%	3.0 year
With CER	67%	2.7 year
Benchmark	16%	

B	IRR (after tax)	Investment recovery period
Without CER	36%	2.6 year
With CER	41%	2.4 year
Benchmark	16%	

In the case of finance scheme B, it is shown trade off between attractive investment recovery period (2–3 years) and lower IRR. That may be caused by the lower micro credit rate than the benchmark.

The result implies that micro utility business seem to be very attractive since 50% of the fuel cost can be saved through biogas utilization.

For biogas digester owners, their investment will be recovered within 3 years by paying back loans with the income from selling of biogas.

(11) Additionality Demonstration

"GUIDELINES FOR DEMONSTRATING ADDITIONALITY OF MICROSCALE PROJECT ACTIVITIES" is applied for additionality demonstration of CPAs.

The PoA is additional if all CPAs are to be included in the PoA are additional that is clarified EB among the 63th meeting decisions.

(12) Feasibility

As the PoA mostly covers the existing program, there has been no problem for the project feasibility. However, there are still some tasks to accelerate micro utility business and diffuse industrial product biogas digesters under the PoA.

Application for host country approval will be conducted in April 2012.

(13) PoA Diffusion Scenario

The detailed study has not conducted yet.

5. Co-benefit

In order to clarify co-benefits from the project, we apply Tier 1in the manual. The evaluation standard of the manual emphasizes the certainty of emission reduction. And the validation point for credible emission reduction is assumed to be 5 (in the MoE's Guidelines).

On the other hand, emission reduction potentiality varies by different evaluation methods such as how to select index and standards for evaluation. For this project, we compare the standard of evaluation, with the US EPA standard and WHO guideline to observe what extension is seen to be improvement.

The manual takes SOx, NOx and emission of soot dust as indexes to evaluate emission reduction impacts. However, in the case of the project, the main problem is the indoor air pollution. For this regard concentration level of matters more make sense rather than absolute amount of emission itself. According to the studies there are typical cases like

$PM_{2.5}$ reaches from 10000 to several thousand μg/m^3 in the peak and 24 hour average is from several hundred to several thousand μg/m^3.

US EPA and WHO guideline standards

	Year average		24 hour average	
	EPA standard	WHO guideline	EPA standard	WHO guideline
$PM_{2.5}$	15 μg/m^3	10 μg/m^3	35 μg/m^3	25 μg/m^3

From the above figures it is possible to judge the improvement level of indoor air quality through the project.

6. Sustainable Development

From a general meaning of co-benefits, the PoA will contribute to generate the following benefits.

■ Local benefits related to local energy service

(1) Increasing of energy provision to rural poverty group (alleviation of energy accessibility).

(2) Micro utility business model enables poverty groups to gain benefit from renewable energy

(3) Realization of energy saving consciousness. Owners of biogas digesters may take actions of energy saving to gain more income from selling gas; on the other hand, biogas user households may also be expected to have energy saving consciousness through participating commercial activity.

■ Local benefits except energy service

(1) Energy cost reduction. Costs on purchasing of biomass for cooking is reduced

(2) Empowerment of business and cash income. Micro utility business will generate cash income that is the incentive for most rural households.

(3) Workload alleviation. Biogas provides a direct benefit, especially to rural women, a result of the reduction of the workload when shifting from cooking on conventional biomass to biogas. On average, biogas enables to save approximately 1 hour and 5 minutes per day per family due to the reduction of time used for collecting biomass, cooking and cleaning of utensils; this saved time can be used for childcare, income generating activities, education, recreation and other social works.

(4) Indoor air pollution reduction. Poor indoor air quality (especially black carbon) is one of the major risks factors for acute respiratory infections especially with housewives and children. Biogas reduces the smoke exposures and significantly improves the air condition inside the kitchen which will ultimately improve the health conditions by reducing the incidences of eye infection, respiratory diseases, coughing, dizziness and headache.

(5) Water contamination prevention. Construction of biogas plants results in better living condition due to appropriately treated solid wastes then avoiding surface and ground water contamination from these wastes.

(6) Organic fertilizer and fish food provision. Biogas sludge and slurry are the good organic fertilizer. Biogas sludge also can be used as fish food.

■ National level benefits

(1) Contribute to climate change mitigation and formulate low carbon energy self-supply rural development model.

(2) Promise national energy security through increasing domestic energy generation

(3) Contribute to realize government development program by saving government fund through private sector participation

(4) Contribute to protect forests by significantly reducing biomass consumption.

(5) Generate new financial sources through initiating interests of people and companies in developed countries through emphasizing social development aspects of LDC.