# CDM Feasibility Study of Biogas Utility Programme in Bangladesh

-PEAR Carbon Offset Initiative, Ltd.-

## 1. Implementation Framework of the Study

PEAR as an outsourcee, is to conduct financial analysis and assessment of the project, to take charge of validation response including developing of PoA-DD and CPA-DD.
Grameen Shakti (GS), as a host country counter-partner, is the implementer of the programme and responsible for data and information collection and technology screening.

## 2. Project Description

### (1) About the Project

The project is to introduce plant type biogas digesters through PoA to provide biogas for the households in local cities that are not covered by natural gas distribution pipeline networks. Feedstock for biogas digesters is municipal waste, which is disposed to the landfills in the case of absence of the project activity.

The generated biogas from the digesters is supplied to households to replace renewable biomasses used at the households so that reduce $CO_2$ emission from the non-renewable biomasses.

GS (http://www.gshakti.org/), as a programme coordinator, coordinate the whole programme, develop, implement and operate CPAs of he PoA.

The PoA is the voluntary action of GS and not relevance to the domestic biogas digester promotion programme commissioned by IDCOL.

The first CPA of the PoA is to be implemented in Faridpur city and planned to start in July 2010.

### (2) Methodology Application

AMS-I. E and AMS-III.AO are to be applied.

## 3. Content of the Study

### (1) Subjects

1. Baseline Scenario Setting

In order to grasp the fuel consumption amount and structure of households and waste treatment condition in the local cities, GS conducted a survey study towards households in Faridpur city. At the same information about waste management situation and biomass market was collected.

2. Biogas Generation System

In order to understand the domestic biogas digester technology, hearing and visits to local biogas digester manufactures were conducted and exchanges with relevant technicians are done.
Quantitative and qualitative evaluations of the configuration of the biogas digester introduction are completed.

3. Biogas Supply System

A pilot biogas digester using municipal wastes operated by a NGO was visited. Consultation with experts from gas supplying company was conducted to discuss and understand configuration of feasible gas supply networks.

4. Adjustment of Wastes

In order to understand municipal waste management standing in Bangladesh, visits to Dhaka City Corporation and landfill under its operation were done.

5. PoA Development

Through meeting and discussions with managers and experts from GS, a financial model which evaluates the feasibility of the whole PoA, was developed.

**(2) Findings**

1. Baseline Scenario Setting

For the CPAs under the PoA the methodologies of AMS-I.E and AMS-III.AO were applied.
The result of the survey in Faridpur showed that among the household biomass consumption the non-renewable biomass shared 77%. And the current waste treatment situation in Faridpur was disposing the municipal wastes to unmanaged solid waste disposal sites thereby the methane conversion factor of the disposal sites was conservatively taken to be 0.4.
Also it was found that most households were using conventional cooking stoves with low energy efficiency. Although there were households of using improved cooking stoves; however, the PoA will not target that households in its CPAs.

2. Biogas Generation System

2 biogas digesters with total 500 $m^3$/day biogas generation capacity are to be installed and there is no technology transfer except management system and some related devices (such as desulfurized device) are to be introduced from China.

3. Biogas Supply System

Regarding the CPA1, underground gas distribution pipelines designed by natural gas distribution company, are used to supply biogas for households.

4. Waste Adjustment

For municipal waste collection for biogas digesters, the new elected mayor of Faridpur city promised his support for the project implementation including waste collection.
It is recommend that GS collects segregated wastes from disposal sites to where municipal government organized to transport wastes from each household.

5. PoA Development

In local cities of Bangladesh, it can be said that the portion of NRB in households fuel consumption is higher than that of rural households.
That is proved by the result of the survey and from the fact of low fossil fuel consumption dominating in Bangladesh, it is believed that there is enough NRB to ensure the amount of CER with that the project seems to be succeeded.

**4. CDM Project Implementation**

**(1) Baseline and Project Boundary Setting**

The PoA covers whole Bangladesh; a boundary of CPA delineates the area which covers targeted households, biogas digesters and project relevant activities.
As for baseline scenario, the AMS-I.E describes the baseline scenario as in the absence of the project activity, the baseline scenario would be the use of fossil fuels for meeting similar thermal energy needs. And emission factor of LPG is used as fossil fuel emission factor while

the survey result show households use LPG in some portion for cooking.
On the other hand, the baseline scenario for AMS-III.AO, is the situation where, in the absence of the project activity, biomass and other organic matter (including manure where applicable) are left to decay within the project boundary and methane is emitted to the atmosphere. The baseline emissions are the amount of methane emitted from the decay of the degradable organic carbon in the biomass and other organic matter.

For emission calculation the following equations are applied. In the case of AMS-I.E

$$ER_y = B_y * f_{NRB,y} * NCV_{biomass} * EF_{projected\_fossilfuel}$$

Here, in order to estimate $B_y$ use option (b) in the methodology the:

$$B_y = HG_{p,y} / (NCV_{biomass} * \eta_{old})$$

Here, *HG* is thermal energy generated by renewable energy technology that implies the thermal energy is logically gained from gas stoves. Regarding the ways to measure the thermal energy generated, requesting the DOE of having clarification from EB.

In the case of AMS-III.AO, the following equation can be used

$$BE_y = BE_{SWDS,y}$$

$$BE_{CH4,SWDS,y} = \varphi \cdot (1-f) \cdot GWP_{CH4} \cdot (1-OX) \cdot \frac{16}{12} \cdot F \cdot DOC_f \cdot MCF \cdot \sum_{x=1}^{y} \sum_{j} W_{j,x} \cdot DOC_j \cdot e^{-k_j (y-x)} \cdot \left(1 - e^{-k_j}\right)$$

**（2）Project Emission**

Project emission is the emission part of the AMS-III.AO that includes emission of fossil fuel consumption at the plant, emission of additional truck activities for waste and sludge transportation.
As for leakage, it can be neglected as zero according to the guideline of leakage for biomass application CDM project and the project does not apply any appliance from other project activities.

**（3）Monitoring Plan**

Programme coordinator and the CPA operators conduct the monitoring.
The typical parameters need to be monitored and their frequencies are:

- Amount of organic waste need feeding the biogas digesters and its composition（each feeding time）
- Biogas generation and its heat content （daily）
- Additional distance and vehicle type （yearly）
- Operation condition of biogas digesters（yearly）
- Sludge treatment ways （yearly）

Table 1 Functions of Programme Coordinator and CPA Operators

| | The program coordinator (supported by PEAR) | The CPA operators |
|---|---|---|
| Monitoring management | - Develop the operation and monitoring manual for CPAs.<br>- Develop and establish data collection and reporting system for parameters monitored in every CPAs.<br>- Implement and manage monitoring of CPAs. | - Implement and manage monitoring of CPAs. |
| Data collection | - Establish and maintain data collection systems for parameters monitored.<br>- Check data quality and collection procedures of each CPAs regularly. | - Implement data collection including the entire household survey before the CPA starts and sample household survey after the CPA starts.<br>- Check data quality and collection procedures regularly. |
| Data storage and management | - Develop database format of CPA.<br>- Check the reported data from each CPAs.<br>- Calculate emission reductions based on the data reported by the CPA implementers.<br>- Implement data management of PoA.<br>- Store and maintain records. | - Enter collected data to a computer.<br>- Implement data management of CPA.<br>- Store and maintain records. |
| Reporting | - Analyze data and compare project performances.<br>- Prepare and forward monthly or annual reports. | - Report electronic data to the program coordinator. |
| CDM training and capacity building | - Develop and establish training program for the CPA implementers and households. | - Implement simple training for households, ensuring enabled to meet the needs of the monitoring plan. |
| Quality assurance and verification | - Establish and maintain quality assurance system with a view to ensuring transparency and allowing for verification.<br>- Prepare for, facilitate and co-ordinate verification process. | - Undertake regular maintenance of biogas digesters.<br>- On-site verifications of household questionnaire survey. |

## （4） Emission Reduction

The emission reduction through the project is concluded in the table e below.

Table 2 Summary of Estimated Emission Reduction

| Year | Estimation of project activity emissions (tonnes of $CO_2$ e) | Estimation of baseline emissions (tonnes of $CO_2$ e) | Estimation of leakage (tonnes of $CO_2$ e) | Estimation of overall emission reductions (tonnes of $CO_2$ e) |
|---|---|---|---|---|
| 2012 | 76 | 2,184 | 0 | 2,108 |
| 2013 | 76 | 2,459 | 0 | 2,382 |
| 2014 | 76 | 2,643 | 0 | 2,566 |
| 2015 | 76 | 2,766 | 0 | 2,689 |
| 2016 | 76 | 2,849 | 0 | 2,772 |
| 2017 | 76 | 2,904 | 0 | 2,827 |
| 2018 | 76 | 2,941 | 0 | 2,865 |
| 2019 | 76 | 2,966 | 0 | 2,889 |
| 2020 | 76 | 2,983 | 0 | 2,906 |
| 2021 | 76 | 2,994 | 0 | 2,917 |
| Total (tonnes of CO2 e) | 762 | 27,690 | 0 | 26,921 |

## （5） Project Operation Period and Crediting Period

Operation time of each CPA is around 2—25years that is based on the lasting time of biogas digesters. On the other hand, the crediting period of the PoA is 28 years and crediting period of each CPA is 10 years. Starting date of operation of the CPA, expected to be 01/07/2012.

## （6）Environmental Impacts and other Indirect Impacts

Biogas digester promotion projects are seen to have no negative impacts on the environment; however, due to the nature of the individual CPA activities and the potential site-specific concerns, the environmental impact analysis will be carried according to the Environment Conservation Rules (1997) at the SSC-CPA level.

## （7）Stakeholder Consultation

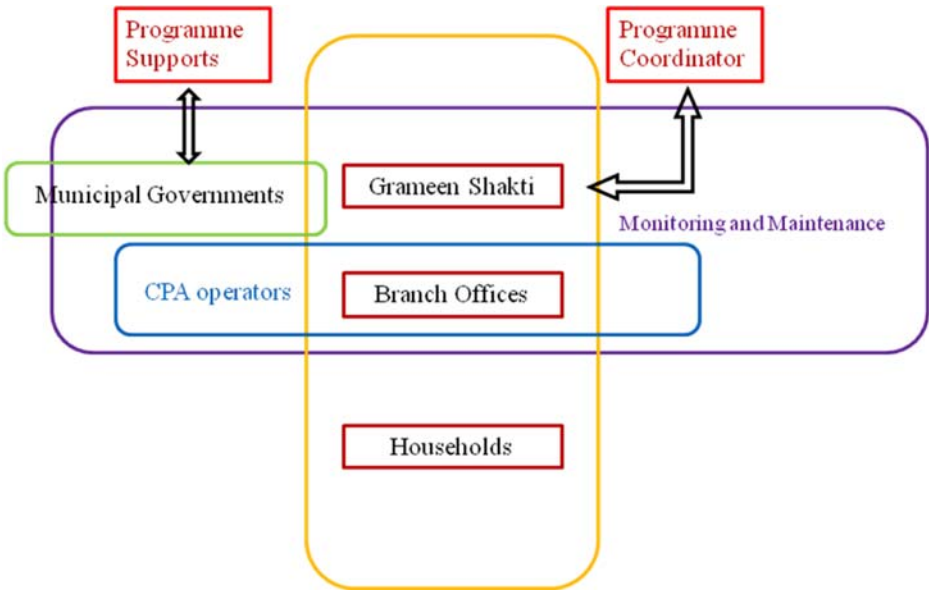
To get public opinion towards the proposed project, the project owner distributed questionnaires soliciting public input. The investigation lasted for one month.

GS completed the survey of stakeholders (Faridpur city dwellers and GO/NGO officials) on 13/01/2011. All 70 stakeholders (dwellers= 30 male+20 female and GO/NGO officials=20) were each supplied with one questionnaire. The completed questionnaires have been preserved at the Grameen Shakti Office. The findings of the survey work are summarized as shown in D.3.

70 questionnaires were distributed and all of the distributed questionnaires had been returned with 100% response rate.

As a result, the residents/households, local government officials, experts and delegates of NGO are all very supportive of the proposed project. No negative comments have been received on the project.

## (8) Project Management Framework




Fiugre 1 Implementation Framework the PoA

GS is in charge of coordinating all project participants and CPA operators of the PoA, collecting necessary data and information from each CPA for the purpose of monitoring, and also communicating with DOE and CDM Executive Board. GS is supported by PEAR for doing so.

The tasks of household recruiting, information survey, biogas digesters construction and inspection are conducted by GS's corresponding branch offices. GS ensures completion of the tasks through activating branch offices at the municipal/district level.

Each CPA operator will report monitored data to GS and GS will then check the data, record the probed data electronically and calculate emission reduction with the monitored data.

## (9) Financial Plan

The project cash flow is given as follows.

| Cash Flow | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Cash flow from operating acitivities | (50,000) | 38,074 | 39,962 | 41,230 | 42,077 | 42,649 | 43,028 | 43,290 | 43,455 | 43,572 | 43,648 |
| Cash flow from investing activities | (125,295) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cash flow from financing activities | 220,000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Increase (decrease) in cash and cash equivalents | 44,706 | 38,074 | 39,962 | 41,230 | 42,077 | 42,649 | 43,028 | 43,290 | 43,455 | 43,572 | 43,648 |
| Cash and cash equivalents at beginning of period | 0 | 44,706 | 82,780 | 122,742 | 163,972 | 206,049 | 248,699 | 291,727 | 335,017 | 378,472 | 422,045 |
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GS plans to adjust the investment needs for the CPA1 and other CPAs.

## (10) Economic Analysis

The economic analysis regarding the CPA1 is given as below. The average bank rate is taken as benchmark while there has been no well organized stock market in Bangladesh.

| Scenario | IRR (after tax) |
|---|---|
| Without CER | 5.8% |
| With CER | 19.6% |
| Financial benchmark | 12.3% |

## （11）Additionality Demonstration

In the case of PoA, it needs to demonstrate the additionality at the both PoA and CPA level.
At first, the additonality of PoA is demonstrated according to the “PROCEDURES FOR REGISTRATION OF A PROGRAMME OF ACTIVITIES AS A SINGLE CDM PROJECT ACTIVITY AND ISSUANCE OF CERTIFIED EMISSION REDUCTIONS FOR A PROGRAMME OF ACTIVITIES”[1](EB55 Annex 38).
That is to say, there have been no nay mandatory regulations and rules for promotion of biogas projects and GS has no any obligation to develop such a kind of project. GS voluntarily coordinates the programme keeping the CDM in mind.
Also without the PoA, the programme could be realized. It needs big amount of investment to develop the PoA and economic viability of the project is low. For example, without CER income, the project IRR is 5.8% and with CER income, the IRR is up to 19.6%. In other words, being CDM is the precondition for GS coordinating the PoA. Therefore, the PoA is additional.
On the other hand, in the case of CPA , if a CPA that employs renewable energy under the PoA is up to 5 MW, then the CPA is demonstrated to be additional by following the guidelines specified in “Guidelines for demonstrating additionality of renewable energy projects =< 5 MW and energy efficiency projects with energy savings <= 20 GWh per year (version 01)” approved in the 54th meeting of EB.

The Guidelines states:

*Paragraph 2. Project activities up to 5 megawatts that employ renewable energy as their primary technology2 are additional if any one of the below conditions are satisfied:*

*(a) The geographic location of the project activity is in LDCs/SIDs or in a special underdeveloped zone of the host country identified by the Government before 28 May 2010;*

Each CPA under the PoA is designed as to keep the aggregated cooking stoves’ rated capacity lower than 15 MWth as specified in an eligibility criterion.
Bangladesh is a LDC (least developing country) that each CPA satisfy the condition stipulated in the “Guidelines for demonstrating additionality of renewable energy projects =< 5 MW and energy efficiency projects with energy savings <= 20 GWh per year”.
Therefore, according to the guidelines mentioned above, any CPA under the PoA is additional.
However, applicability of the Guidelines to PoAs will be confirmed; moreover the extension of the guidelines to the type III projects is on the public comment consultation.
Even if the guidelines finally will not be approved by EB, the additioality of a CPA can be demonstrated use of “first-of-its-kind” concept in prevail practice analysis

## （12）Feasibility

Regarding implementation of the PoA, there have been no technical barriers and it is believed that GS could adjust some fund to implemente the PoA.
On the other hand, the PoA is the first trial for GS, thereby there is some risks on operation.
However, as the nature of the PoA , the sources of revenue of the project is divided into

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1 http://CDM.unfccc.int/filestorage/XT12DHPN79U4FISGMYA0OJW5KZLQVR.1/eb55_repan38.pdf?t=WWx8MTI5NTAwODIxOS4yNA==|zhwWCZZbAK5KeoOShaxoqixTF-8=

2 All technologies/measures included in approved Type I Small-Scale CDM methodologies are eligible to be considered.

biogas selling income, fertilizer selling income and CER income. With a condition of continuous availability of organic wastes, these incomes would cover project costs.

## 5. Validation

### (1) Description of Validation

Validation has started on 29 January 2011 and from 29 of January global stakeholder consultation has commenced and PoA-DD、CPA-DD(generic)、CPA-DD(specific) are uploaded to the homepage of the UNFCCC.
http://cdm.unfccc.int/ProgrammeOfActivities/Validation/DB/L5R0TMVTFQCYAKGX0XJYDUG2QG3SJI/view.html
Site visit of the validation is conducted from 27 February 2011~3 March 2011.

(2) Exchange with DOE

On the Middle of January 2011, the PoA-DD、CPA-DD(generic)、CPA-DD(specific) were submitted to DOE.
Regarding some questions from DOE, clarifications were given. For example:
Related to the ODA application, there is possibility of use of ODA for the project and Bangladesh government will judge the rationality of ODA application (there has been no specification in Marrakesh Accord on who will judge the ODA application). Also as for the requesting application of AMS-I.I instead of AMS-I.E the clarification is given as below[3]

## 6. Co-benefit

In order to clarify co-benefits from the project, apply Tier 1in the manual. The manual validation standard emphasizes the certainty of emission reduction. It is assumed that the point for certain emission reduction is 5.
On the other hand, emission reduction potentiality varies by different evaluation method such as index and standard.
For this project, 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, 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 10000 ~ several thousand $\mu g/m^3$ in the peak and 24 hour average is several hundred~ several thousand $\mu g/m^3$.

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[3] Regarding the AMS-I.E, there is a political background.
Small scale CDM methodology related to non-renewable biomass had existed from the beginning, however, from the consideration of its inconsistency with the Marrakesh accord (LULUCF activities are only limited to A/R activities), even that CMP3 finally has approved its applicability through the long process.
However, as a counteraction it defines the baseline scenario like "It is *assumed* that in the absence of the project activity, the baseline scenario would be the use of fossil fuels for meeting similar thermal energy needs (Paragraph 5 of AMS- I.E, ver.03)".
Naturally, the exact baseline scenario is to use non-renewable biomasses that is recorded in CDM Methodology Booklet. The remark of *assumed* in the methodology indicated coming to terms with political judgment. That is, the baseline scenario is to continuously use non-renewable biomass.
Meantime, the $CO_2$ emission factor for non-renewable biomasses is more than twice of that of fossil fuels.

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.

## 7. Sustainable Development

From a general meaning of co-benefits, the project will contribute to provide affordable and convenient clean energy.
In addition, the project generates several benefits like municipal waste treatment, energy security guarantee and forest protection.
Fundamentally economic benefits from energy supply are considered to be co-benefits. In this case, it is important to specify the contribution level of the benefits.

# Appendix

## Economic analysis sheets

| **Cash Flow** | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Cash flow from operating acitivities | (50,000) | 38,074 | 39,962 | 41,230 | 42,077 | 42,649 | 43,028 | 43,290 | 43,455 | 43,572 | 43,648 |
| Cash flow from investing activities | (125,295) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cash flow from financing activities | 220,000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
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| **Income Statement** | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Total revenues | 0 | 86,085 | 89,106 | 91,134 | 92,490 | 93,405 | 94,011 | 94,430 | 94,695 | 94,882 | 95,004 |
| Biogas revenue | | 19,048 | 19,048 | 19,048 | 19,048 | 19,048 | 19,048 | 19,048 | 19,048 | 19,048 | 19,048 |
| Fertilizer revenue | | 43,800 | 43,800 | 43,800 | 43,800 | 43,800 | 43,800 | 43,800 | 43,800 | 43,800 | 43,800 |
| CER revenue | | 23,238 | 26,258 | 28,287 | 29,643 | 30,558 | 31,164 | 31,583 | 31,847 | 32,035 | 32,156 |
| Total expenses | 50,000 | 34,529 | 34,529 | 34,529 | 34,529 | 34,529 | 34,529 | 34,529 | 34,529 | 34,529 | 34,529 |
| COGS | | 12,000 | 12,000 | 12,000 | 12,000 | 12,000 | 12,000 | 12,000 | 12,000 | 12,000 | 12,000 |
| O&M | | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 |
| SG&A | 50,000 | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 |
| Depreciation | 0 | 12,529 | 12,529 | 12,529 | 12,529 | 12,529 | 12,529 | 12,529 | 12,529 | 12,529 | 12,529 |
| Operating profit | (50,000) | 51,556 | 54,577 | 56,605 | 57,961 | 58,876 | 59,482 | 59,901 | 60,165 | 60,353 | 60,474 |
| Interest expense | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Income before taxes | (50,000) | 51,556 | 54,577 | 56,605 | 57,961 | 58,876 | 59,482 | 59,901 | 60,165 | 60,353 | 60,474 |
| Taxes | 0 | 26,011 | 27,144 | 27,904 | 28,413 | 28,756 | 28,983 | 29,140 | 29,240 | 29,310 | 29,355 |
| VAT and other taxes | 0 | 10,684 | 10,684 | 10,684 | 10,684 | 10,684 | 10,684 | 10,684 | 10,684 | 10,684 | 10,684 |
| Income tax | 0 | 15,327 | 16,460 | 17,220 | 17,729 | 18,072 | 18,299 | 18,456 | 18,556 | 18,626 | 18,671 |
| Net income | (50,000) | 25,545 | 27,433 | 28,700 | 29,548 | 30,120 | 30,499 | 30,761 | 30,926 | 31,043 | 31,119 |

| **With CER** | 2,011 | 2,012 | 2,013 | 2,014 | 2,015 | 2,016 | 2,017 | 2,018 | 2,019 | 2,020 | 2,021 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Cash flow from operating acitivities | (50,000) | 38,074 | 39,962 | 41,230 | 42,077 | 42,649 | 43,028 | 43,290 | 43,455 | 43,572 | 43,648 |
| Cash flow from investing activities | (125,295) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| FCF | (175,295) | 38,074 | 39,962 | 41,230 | 42,077 | 42,649 | 43,028 | 43,290 | 43,455 | 43,572 | 43,648 |
| Project IRR | 19.6% | | | | | | | | | | |

| **Without CER** | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Cash flow from operating acitivities | (50,000) | 23,551 | 23,551 | 23,551 | 23,551 | 23,551 | 23,551 | 23,551 | 23,551 | 23,551 | 23,551 |
| Cash flow from investing activities | (125,295) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| FCF | (175,295) | 23,551 | 23,551 | 23,551 | 23,551 | 23,551 | 23,551 | 23,551 | 23,551 | 23,551 | 23,551 |
| Project IRR | 5.8% | | | | | | | | | | |