CDM Feasibility Study for Biomass-based Power Generation by Utilization of Rice Husks

Industrial Decisions, Inc. (IDI)

1. Implementation structure of feasibility study

Bio Mass Power (BMP): Project owner of 3.5MW Biomass Power Project. They have a responsibility for the project activity, and operate and maintain the project.

STFE: An affiliate company of BMP. They are responsible for a technical engineering part of the project activity. They provide some advice for a feasibility study, selection of appropriate equipment and procurement of biomass fuel, etc.

GFCT: They provide consulting services to IDI with respect to acquisition of LOA from the host country and gathering data for PDD development.

AEP: They provide consulting services to IDI with respect to development of a PDD.

2. Project overview

(1)General information of project

The project participant, Bio-Mass Power Company Limited (BMP), installs 3.5 MW power plant which uses biomass such as rice husk as primary fuel for power generation. The project generates electricity under the Very Small Power Producer (VSPP) scheme in Thailand. The install capacity of the plant is 3.5 MW and 3.0 MW is expected to supply to Provincial Electricity Authority (PEA).
The project location is Chainat province, in northern direction from Bangkok city, the capital of Thailand.

BMP has selected the appropriate plant design concept with robust combustion technology in using rice husk fuel for the process and produce reliable generation. The company is undergoing the planning for expansion using multi-biomass fuel in conjunction with rice husk. According to the feasibility study conducted by BMP, amount of annual electricity generation as gross output will be 27636 MWh and amount of annual electricity supplied to the grid will be 23688 MWh.

For using biomass waste as fuel, the electricity generated by the plant displaces an equivalent amount of electricity generated by grid connected power plants. As a result, the project activity will reduce 13767 tCO2e annually by displacing electricity from fossil fired power plants in the electricity grid of Thailand.

For preparation as CDM, the project owner already had sent “Prior Consideration Form” to the secretariat of UNFCCC and LOI to the TGO (DNA in the host country) in June 2010.
The project owner expects that a commercial operation will start from January 2012.

(2)Approved baseline and monitoring methodology applied to the project activity

The approved baseline and monitoring methodology applied to the project is:
AMS-I.D. Grid connected renewable electricity generation, Version 16
Type I: Renewable energy projects
Category D: Grid connected electricity generation
Reference: Version 16, scope 1

3. Main Research Issues of Feasibility Study

(1)Main research issues

Main research issues are:

- Procurement of biomass fuel and stabilization of price of biomass fuel
- Funding
- Criteria of CDM approval from host country
- CO2 emission factor of electricity grid for baseline emissions calculation
- Demonstration of additionality
- Implementation of stakeholders consultation program

(2)Research content

- Procurement of biomass fuel and stabilization of price of biomass fuel
  - Chainart province, where the project is located, is good location for biomass power plant due to the vase numbers of rice mill from large size down to small size. Modern rice mill has installed and modernized their milling process for faster turn around time and can operate with longer hour per day, therefore lead to increase of rice husk in the area and can be used for biomass power plant. The company has conducted a full fuel study and survey of rice husk availability around the power plant location.
  - Also the project owner employs a multi-fuel biomass boiler which accepts not only rice husks but other biomass fuel such as wood barks and saw dust. This will help the stable operation of the proposed project against shortage of biomass fuel.

- Funding
  - A funding is a key factor for the project implementation. In Thailand there is a big potential of biomass power generation, however, even local bans are little interested in renewable energy development including biomass. Therefore the project owner has to emphasize CDM income in order to obtain a loan.

- Sustainable Development for CDM project in Thailand
  - There are 4 major groups in the Sustainable Development (SD) Criteria for CDM project evaluation: Natural Resources and Environment; Social; Technology; and Economics. The Scoring method is used for evaluation in each indicator /criterion. Minus (-1, -2, -3) indicates negative impact to the area. Zero (0) indicates no impact to the area, or equivalent to the baseline scenario (without a CDM project). Plus (+1, +2, +3) indicates positive impact, or shows contribution to the surrounding area of the project. There are 24 indicators in 4 groups of SD Criteria. For the project to be considered as a CDM project and receive a Letter of Approval from Thailand, the project must have a positive score in each group of criteria and the total score must be positive (more than zero).

- Carbon emissions factor for the Thailand Grid
  - The baseline scenario for the project activity is the continuation of operation of grid

connected electricity generation plants. The equal amount of energy generated by the project activity would have been produced by other grid connected sources.

- According to methodology of AMS-I.D, the baseline emissions are the product of electrical energy baseline expressed in kWh produced by the renewable generating unit multiplied by an emission factor.
- Summary Report "The Study of emission factor for an electricity system in Thailand 2009" was provided by TGO in 2010. Therefore, we apply this emission factor to the project activity.

- Demonstration of additionality
  - A local bank will prepare a letter which shows a loan is not able to be provided when the project activity is implemented without CDM.
  - Also the project owner can demonstrate that comparison between the project IRR and benchmark IRR in Thailand. It means the IRR of the project activity is lower than benchmark.
  - While, there is a possibility to simplify a demonstration of additionality according to the document of EB54, Annex15 "GUIDELINES FOR DEMONSTRATING ADDITIONALITY OF RENEWABLE ENERGY PROJECTS =<5 MW AND ENERGY EFFICIENCY PROJECTS WITH ENERGY SAVINGS <=20 GWH PER YEAR". If the project activity will satisfy a requirement of "Specific Renewable energy technologies recommended by the host country DNA and approved by the Board (Conditions apply: The installed capacity of technology/measure contributes =<5% to national electricity generation)", description of additionality in a PDD will be much simplified.

- Stakeholders Consultation Program
  - A local stakeholder consultation meeting was held at the community hall on December 17, 2010. To encourage active participation, invitation letters were sent to and handed out to the potential stakeholders identified and the local community members.
  - The stakeholder consultation meeting included a session of project activity description, a brief explanation on how this project activity will mitigate climate change and contribute to social, economic and environmental development of host country, an overview of benefits to local community, followed by a question and answer session.
  - To date no formal comments have been received from stakeholders. While, during the meeting, local stakeholders raised various questions pertaining to the project activity, including impact on the local environment and potential benefits to the local community, and requested for further explanation on their concerns.

4. Results of Feasibility Study

(1) Baseline scenario and project boundary

The baseline scenario for the project activity is the continuation of operation of grid connected electricity generation plants. The equal amount of energy generated by the project activity would have been produced by other grid connected sources.

According to methodology of AMS-I.D, the baseline emissions are the product of electrical energy baseline expressed in kWh produced by the renewable generating unit multiplied by an emission factor.

According to the methodology of AMS-I.D., the project boundary should include the physical,

geographical site of the renewable generation source delineates the project boundary.
Therefore, the boundary of the project activity covers biomass stock yard, boiler, steam turbine and generator and other relative facilities.

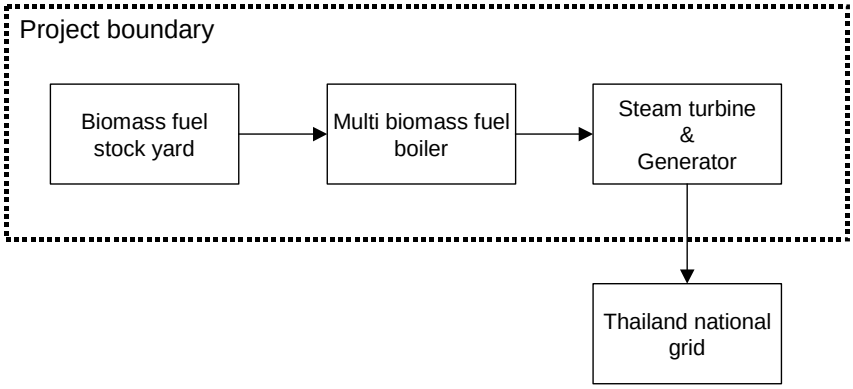

Figure 4-1 The project boundary

Table Combined margin emission factor of Thai electricity grid

OM/BM	Weight	Emission factor
Operating margin	0.5	0.6147
Build margin	0.5	0.5477
$EF_{grid,CM,y}$ (tCO_2/MWh) (Combined Margin)		**0.5812**

The calculation for baseline emissions is based on the following equation.

$BE_y = EG_{BL,y} * EF_{CO2,\ grid,\ y}$

Where,

BE_y	Baseline emissions in year y(t CO2)
$EG_{BL,y}$	Amount of electricity supplied by the project activity to the grid in year y (MWh)
$EF_{CO2,\ grid,\ y}$	CO2 emission factor of electricity grid (t CO2/MWh)

(2)Project emissions

As per paragraph 19 in version 16 of AMS I.D., the project activity utilizes biomass residues as a source of energy. There is no project emissions except the following type of projects:

geothermal power plants
water reservoirs of hydro power plants

Therefore the project emissions is zero.

$PE_y = 0$

Where,

PE_y	Project emissions in year y (t CO2)

As per attachment C to Appendix B of INDICATIVE SIMPLIFIED BASELINE AND

MONITORING METHODOLOGIES FOR SELECTED SMALL-SCALE CDM PROJECT ACTIVITY CATEGORIES "General guidance on leakage in biomass project activities (Version 03)", (EB47 annex 28), the emission source for type of biomass is shown in the table:

Table Emission source per type of biomass

Biomass type	Activity / source	Shift of pre-project activities	Emissions from biomass generation / cultivation	Competing use of biomass
Biomass from forests	Existing forests	-	-	x
	New forests	x	x	-
Biomass from croplands or grasslands (woody or non-woody)	In the absence of the project the land would be used as cropland / wetland	x	x	-
	In the absence of the project the land would be abandoned	-	x	-
Biomass residues or wastes	Biomass residues or wastes are collected and used	-	-	x

As the project activity uses biomass residues including rice husk, saw dust and wood bark. The project participants evaluate a surplus of the biomass in the region of the project activity, which is not utilized.

Table Survey on rice husk availability

Province	Rice Paddy (ton/day)	Rice Husk (ton/day)
Chainart (within 30km)	3,420	564
Uthaithani (within 30km)	320	69
Supanburi (within 60km)	3,580	662
Singburi (within 60km)	1,005	153
Total	8,325	1,448

According to the survey on rice husk availability, while the quantity of available rice husk is 1,448 ton /day comparing to that the quantity of consumption rice husk by the project activity is 140 ton/day. The quantity of available biomass in the region (60km radius) is at least 25% larger than the quantity of biomass that is utilised including the project activity. Therefore, this source of leakage can be neglected.

$$LE_y = 0$$

Where:

LE_y Leakage emissions in year y (t CO2/year)

(3)Monitoring plan

The methodology, AMS-I.D, indicates relevant parameters to be monitored. It includes the quantities and net calorific value of each biomass fuel consumed by the project activity.

Table Monitoring data/parameters

Monitoring data/parameters (essential)		
Item	Unit	Frequency
Electricity supply to grid	kWh	Monthly
Consumption of rice husk	ton	Monthly
Consumption of wood bark	ton	Monthly
Consumption of saw dust	ton	Monthly
Heating value of rice husk	kcal/kg	Monthly
Heating value of wood bark	kcal/kg	Monthly
Heating value of saw dust	kcal/kg	Monthly
Moisture content of rice husk	%	Annually
Moisture content of wood bark	%	Annually
Moisture content of saw dust	%	Annually
CO2 emission factor of fossil fuel(Diesel Oil)	tCO2/MJ	Annually
Heating value of fossil fuel(Diesel Oil)	MJ/l	Annually
Consumption of fossil fuel(Diesel Oil)	l	Monthly
Monitoring data/parameters (complementary)		
Item	Unit	Frequency
Electricity generation (net)	kWh	Monthly
Electricity for self consumption	kWh	Monthly
Procurement volume of rice husk	ton	Monthly
Procurement volume of wood bark	ton	Monthly
Procurement volume of saw dust	ton	Monthly

(4) Emission reductions of greenhouse gas

Emission reductions are calculated as follows:

$ER_y = BE_y - PE_y - LE_y = BE_y$

Where:

ER_y Emission reductions in year y (t CO2/year)
BE_y Baseline emissions in year y (t CO2/year)
PE_y Project emissions in year y (t CO2/year)
$LE_{,y}$ Leakage emissions in year y (t CO2/year)

The baseline emissions is calculated as follows:

$BE_y = EG_{BL,y} * EF_{CO2,\ grid,\ y}$

Applying the values, $EG_{BL,y}$ = 23,688 MWh and $EF_{CO2,\ grid,\ y}$ = 0.5812 tCO2/MWh, the baseline emissions are:

BE_y = 23,688 * 0.5812 = 13,767 tCO2

As the emission reductions are equal to the baseline emissions:

$ER_y = BE_y$ = 13,767 tCO2/year

Table GHG emission reductions

Year	Baseline emissions (t-CO2)	Project emissions (t-CO2)	Leakage (t-CO2)	GHG emission reductions (t-CO2)
2012	13,767	0	0	13,767
2013	13,767	0	0	13,767
2014	13,767	0	0	13,767
2015	13,767	0	0	13,767
2016	13,767	0	0	13,767
2017	13,767	0	0	13,767
2018	13,767	0	0	13,767
Total in 7years	96,369	0	0	96,369

(5) Duration of project activity and crediting period

The project lifetime is assumed as 21 years because a normal biomass fired power plant can be operated during such years by appropriate maintenance. A cash flow calculation is also based on the same period as 21 years.

Regarding crediting period, the Renewable crediting period is applied to the project activity because:

- a preferential term for a biomass power project is set as 7 years under the VSPP program
- periodic review of portfolio of biomass fuel mixture is necessary due to uncertainty of fuel procurement volume and price

The Starting date of the project activity is 30 June 2010 when the project owner concluded a loan contract with a local bank. The project owner provided both “Prior Consideration Form” to the secretariat of UNFCCC and “LOI” to the host country’s DNA.

Table Chronology of events for the project activity

No.	Date	Event/Activity	Evidence
1	September 2009	The feasibility study was completed by STFE (engineering support	Feasibility study

		company to BMP)	
2	13 August 2009	PPA approval was obtained.	PPA
3	25 March 2010	Annual General Meeting of Shareholder on project construction and CDM development.	Minute of meeting
4	7 April 2010	MOU regarding CERs purchase between BMP and IDI.	MOU
6	25 May 2010	CDM development contract was concluded between BMP and IDI.	Contract
7	3 June 2010	The Prior Consideration Form was submitted to the UNFCCC secretariat.	Email & F-Form
8	2 June 2010	Letter of Intent was submitted to DNA of Thailand (TGO).	LOI
9	6 June 2010	The Prior Consideration Form was confirmed receipt by UNFCCC secretariat.	Email
10	June 2010	Letter of Intent was confirmed receipt by DNA of Thailand (TGO).	TGO letter
11	30 June 2010	A loan agreement concluded between BMP and a local bank.	Loan agreement
12	20 July 2010	Construction contract agreement was concluded between BMP and an EPC company.	Contract
13	29 November 2010	Construction started.	
14	17 December 2010	Public Consultation Program was conducted.	Meeting minutes

(6)Environmental impacts/other impacts

In accordance with the Thai environmental regulations, projects with a capacity of electricity under 10MW are not required to conduct the Environmental Impact Assessment. Instead, the Initial Environmental Evaluation (IEE) is required by the Thai DNA (TGO). The IEE report must be approved in accordance with Thai sustainable development criteria for CDM.

The evaluation is conducted based on the basic information of natural resources and environmental value including the detail of activities of the project during the construction and operation periods by considering both positive and negative impacts as well as direct and indirect impacts. The primary result of the Initial environmental evaluation will be clarified for the sustainable development evaluation whether the project is in accordance with the Sustainable Development Criteria of Clean Development Mechanism or not.

According to the IEE report, there is no significant environmental impact likely to be caused due to the project activity.

Also the scores according to Sustainable Development Criteria can meet the conditions set by Thai DNA for Host country's CDM approval.

(7)Stakeholders' comments

A local stakeholder consultation meeting was held at the community hall on December 17, 2010. To encourage active participation, invitation letters were sent to and handed out to the potential stakeholders identified and the local community members.

Date: 17 December 2010
Time: 1: 40 pm – 3.40 pm
Venue: Meeting room of Makham Tao Subdistrict Administrative Organization, Makham Tao Subdistrict, Watsingh District, Chainart Province
Participants: The management team, the consultants and 45 persons of Government and local people

The stakeholder consultation meeting included a session of project activity description, a brief explanation on how this project activity will mitigate climate change and contribute to social, economic and environmental development of host country, an overview of benefits to local community, followed by a question and answer session.

The comments are carefully reviewed and there are no negative comments on the project activity. However, some villagers request more information about the project activity in terms of public relations. Therefore, the project company agrees to provide more public information of the project activity to the local people.

(8)Demonstration of additionality

The additionality of the project activity is demonstrated based on guidance for the Access-to-finance barrier and Investment barrier:

Access to finance barrier Analysis

Access-to-finance barrier: Best practice examples include but are not limited to, the demonstration of limited access to capital in the absence of the CDM, such as a statement from the financing bank that the revenues from the CDM are critical in the approval of the loan.

The access to finance barrier would have prevented implementation of the project because the project developer would not have been able to finance the project in the absence of CDM revenues which were crucial in the decision to approve the loan. This barrier does not prevent the continued operation of the existing power plants which supply electricity to the Thailand grid. The electricity from biomass power plant under the VSPP scheme will be supported by FIT (Feed in tariff) price (0.3 Baht/kWh).This subsidy is the lowest in renewable energy.
When CDM is not considered, a return of project is still low and a local financial institution will not provide a loan. Especially, increase of risk regarding the price of rice husks raises the hurdle of the funding, and sales of CER are important.
Therefore, it is clear that CDM project faces a barrier which does not prevent implementation of one alternative to the project activity.

Investment Barrier Analysis

The additionality has been demonstrated using the benchmark analysis as the project activity generates revenues from selling of power in addition to the CDM related income. The financial indicator chosen is the project IRR.
The project activity entails an investment of 174.98 million THB. The investment analysis has been done over a period of 20 years consistent with the project's operational lifetime. The input values have been sourced from the project's feasibility study and all the supportive documents will be provided to

the DOE for validation.
The following table outlines the key input parameters and the tariff used in the investment analysis:

Table key input parameters

Assumption	Projected Figures
Total Investment Cost	THB 174,980,000
Length of Construction and Testing	21 months
Plant Operation Hour	Annually 7896 hours
Gird Sale	3000kW
Peak Power Price	THB 2.9278/kWh
Off-Peak Power Price	THB 1.1154/kWh
Fuel Adjustment Price	THB 0.9177/kWh
Adder	THB 0.3/kWh
Average Fuel Price	THB 680/Ton
Labour Cost	THB 4,000,000 Annually
Maintenance Cost	THB 4,300,000 Annually
Escalation	1%

The project activity has an installed capacity of 3500 kW. 3000 kW of electricity will be exported to the national grid and 500kW will be used internally.
In line with the guidance available in "Guideline on the assessment of investment analysis" (Annex 58, EB51), depreciation has been added back to the net profits. The result of this analysis is a pre tax project IRR 13.26% which is not attractive enough to be viable under the business-as-usual scenario. The benchmark is referred from the two indicative rates associated with power generation in Thailand.We refer to a recent rate sourced from "IPP Bidding" by Ayudhya Securities Public Company Limited, which cites the benchmark of 15% for an Independent Power Producer (IPP). The 15% benchmark is chosen as bother realistic and conservative. In the light of the above, the project activity (project IRR – 10.94%) is clearly not financially attractive compared to the benchmark (15%). Also we also estimated 5-year weighted average of cost of capital (WACC) calculated by Thailand's actual minimum loan rate and the result of return of equity of Energy and Utilities sector of the stock market in the Stock Exchange of Thailand during 2004 to 2009. The pre tax WACC is 14.13%. If we include the revenue of CERs, a pre tax project IRR is 14.69% which exceeds WACC benchmark described above.

5. The research results of co-benefit

Articles for Evaluation
The evaluation median for the effectiveness of the environmental pollution control measures is "the amount of refuse reduced"

Baseline/Project Scenario
Although the project intends to use rice husks, an agricultural refuse, as the main source of fuel for power generation, as there is the inherent risk of fuel shortage, the project is also intending to utilize saw dust and wood barks from the neighboring area, in order for the project to ensure a steady supply of fuel. By utilizing the waste that would have been otherwise disposed of in landfill sites, the project aims to reduce the amount of refuse.
In order to evaluate the co-benefit effect of the project, the baseline scenario will be defined

as the situation, where the biomass refuse is disposed of in landfill sites, and the project scenario shall be defined as the situation, where the project utilizes the biomass refuse, thus reducing waste.
The planned annual power output of the project is approximately 24,000MWh, consuming up to 140t/day (46,060t/year, calculated at availability factor of 90.1%). Thus, it is possible to quantify the effect of the reduction in waste output as a means to evaluate the project's effectiveness as an environmental pollution control measure.

The Baseline Scenario evaluation and monitoring method
As the amount of refuse that is reduced by the project is equal to the amount of biomass (rice husk, saw dust and wood bark), consumed by the project, the baseline scenario evaluation shall be calculated on the data of actual consumption.
The monitoring method of refuse disposal amount shall be done by the amount of biomass, such as rice husks, stated on documents such as purchase slips.

The calculation method and results
The amount of refuse reduced by the project shall be calculated in the following manner:

$$D_{volume} = D_{volume,PJ} - D_{volume,BL}$$

Where,

D_{volume}	The amount of refuse reduced (t)
$D_{volume,PJ}$	The amount of refuse disposed of after the project's implementation (t)
$D_{volume,BL}$	The amount of refuse disposed of prior to the project's implementation (t)

As the amount the project consumes is 46,060t/year, all of which is used for electricity generation,
$D_{volume,PJ} = 0$ (t)
$D_{volume,BL} = 46{,}060$ (t)

Thus, the reduction amount is calculated as:

$$D_{volume} = D_{volume,PJ} - D_{volume,BL} = 46{,}060 \text{ (t)}$$

6. Research results regarding the contributions to a sustainable development

In addition to the co-benefit effects stated in the previous chapter, the implementation of the project will make the following contributions possible:

- Prevention of water pollution by decay of rice husks
- Prevention of offensive odour
- Reduction of air pollution caused by the burning of rice husks in open-air
- Reduction of air pollution through the usage of biomass power generation as a substitution of fossil fuels

Taking in to account the Baseline Scenario of the present project displacing the equivalent amount of electricity generated by grid connected power plants, it is possible to evaluate the project contribution to sustainable development through the decrease in the amount of sulfur oxides (SO_x) through reduction precipitated by the displacement of fossil fuel generated

electricity.
By using the fossil fuel usage amount figures published by the TGO, the host country's DNA, to calculate the So_x emission amount, it is possible to carry out a quantitative assessment of difference instigated by the Project Scenario. In addition to the above, it is possible to measure the economic effects of the project by using the reduction amount and referring it to the LIME2 Integration Factor, stated in the Japanese Life cycle Impact assessment Method based on Endpoint modeling (LIME).

Table Chart Evaluation outline of the project's contribution to a sustainable development

Item	Effect	Evaluation method	Baseline scenario	Project scenario
Sulfur Oxides (SOX)	Reduction of fossil fuel consumption on grid by increasing renewable energy	Reduction of SOX Economic effect	Emission of SOx from electricity grid due to using fossil fuel under the baseline scenario	Emission of SOx from electricity grid due to using fossil fuel under the project scenario