**CLEAN DEVELOPMENT MECHANISM**
**PROJECT DESIGN DOCUMENT FORM (CDM-SSC-PDD)**
**Version 03 - in effect as of: 22 December 2006**

## CONTENTS



## Annexes

**Revision history of this document**

| Version Number | Date | Description and reason of revision |
|---|---|---|
| 01 | 21 January 2003 | Initial adoption |
| 02 | 8 July 2005 | •The Board agreed to revise the CDM SSC PDD to reflect guidance and clarifications provided by the Board since version 01 of this document.<br>•As a consequence, the guidelines for completing CDM SSC PDD have been revised accordingly to version 2. The latest version can be found at <http://cdm.unfccc.int/Reference/Documents>. |
| 03 | 22 December 2006 | •The Board agreed to revise the CDM project design document for small-scale activities (CDM-SSC-PDD), taking into account CDM-PDD and CDM-NM. |

## SECTION A. General description of small-scale project activity

### A.1 Title of the small-scale project activity:

Mungcharoen Green Power - 9.9 MW Rice Husk Fired Power Plant Project
Version number: 04.5
Date: 03 August 2010

### A.2. Description of the small-scale project activity:

**Purpose of the project activity**

The Project aims to reduce $CO_2$ emission by using rice husks as the primary fuel for power generation to displace grid electricity.

Mungcharoenporn Family first conceptualized the Project in late 2002 when rice husks were burned mostly in the open air or left to decay creating environmental hazards. Due to some difficulties and barriers in realizing such concept, the benefits from the CDM were considered since the very early stage of the project development as a vital element for the Project to overcome the difficulties and barriers. Therefore, the CDM has clearly been an integral part of the project development and implementation since the project conceptualization.

The Family itself produces about 200 tons of rice husks per day from its three rice mills with a total daily capacity to process 1,250 tons of paddies. In addition, there are other rice mills owned by close associates producing approximately 100 tons of rice husks. This group of rice mills has a total daily capacity of 700 tons of paddy. With sufficient rice husks, the Family established Mungcharoen Green Power Co., Ltd. (MGP) in October 2003 to develop, invest, implement, operate and maintain this CDM Project.

Although the Project will predominantly run on rice husks, the boiler is capable of burning other biomass fuels, such as, woodwastes. This provision ensures a stable supply of biomass fuels for the Project although the supply of rice husks seems sufficient locally.

The Project is the first large-scale biomass project solely developed by rice mill owners to sell electricity to the Electricity Generating Authority of Thailand (EGAT) under the utility's stringent and firm supply contract of the Small Power Producer Program (SPP) for 21 years.

The gross power generation of the Project is 9.9 MW, out of which, 8.0 MW is sold to EGAT, 0.8 MW is distributed to two adjacent rice mills and the rest is indigenously consumed by the power plant. It should be noted that prior to the project activity, the two rice mills bought electricity from the grid.

Recognizing the project participants' determination and efforts in developing, implementing and operating the Project in the most environmentally friendly and socially responsible manner, the Thai government and the Association of Southeast Asia Nations (ASEAN) have recently awarded the Project with the Best Thailand Renewable Energy Project in July 2008 and the Best ASEAN Renewable Energy Project in August 2008, respectively.

**Contribution to sustainable development**

The use of rice husks as fuel for power generation leads to the promotion of sustainable growth as rice husks are available locally. When managed properly, they are also environmentally friendly and renewable.

The Project is in line with the Thai Government renewable energy policy while reducing the country's reliance on imported fossil fuels and helping improve the environment since rice husks are handled much more appropriately and burned in a boiler that is much more efficient and environmentally friendly than the traditional ones, or in many cases, burned in open fields.

In socio-economic aspect, this CDM Project leads to an increase in local economic activities and employment opportunities for local people. Such local employment generates more incomes and improves people's quality of life. The Project also establishes a local community fund mutually managed by community leaders and the management of the Project to directly serve local needs in education, health and others.

Economically, the project creates additional value added to rice husks leading to rice mill owners willing to pay more to farmers for their paddies. On local tax contribution, the Project is the largest financial contributor to Surin Province in the form of value-added tax.

Most rice husk ashes (RHAs) produced from the Project are distributed to local farmers who use them as a major ingredient for making organic fertilizers contributing to a local Surin Provincial Administration's campaign of "organic farming." The remaining RHAs can be sold to industries, such as, cement, steel and tire manufacturers making use of silica in the RHAs.

Due to the lack of power generation in the lower northeast of Thailand, including Surin Province, the electricity from the Project helps increase the power system stability in the area. It also reduces transmission loss since the Project is located closer to the load in Surin city than other power plants.
The Project plays an important role in being an energy learning centre for stakeholders at all levels be it local, regional, national and even international. Virtually on a daily basis, it disseminates information and knowledge in renewable energy to visitors, such as, local pupils, vocational and university students, government officials, businessmen and others. The project proponent has also shared their experiences in developing and operating the Project with government officials who have, subsequently, formulated and implemented more conducive renewable and biomass energy policies. The Project has as well implemented a strong and continuous community relation and participation program. Its relationship with local communities is excellent.

## A.3. Project participants:

The information of the project participants and parties involved is shown in the following Table.

| Name of Party involved | Private and/or public entity (ies) project participants | Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No) |
|---|---|---|
| Thailand (host) | Mungcharoen Green Power Co., Ltd. | No |

## A.4. Technical description of the small-scale project activity:

**A.4.1. Location of the small-scale project activity:**

**A.4.1.1. Host Party(ies):**

Thailand

**A.4.1.2. Region/State/Province etc.:**

Surin Province (See Thailand map below).


**A.4.1.3. City/Town/Community etc:**

Burusi Sub-district in Muang District

**A.4.1.4. Details of physical location, including information allowing the unique identification of this small-scale project activity:**

The Project is located at 333 Moo 7, Surin-Sikhoraphum Road, Burusi Sub-district, Muang District, Surin Province. Its coordinates are Latitude 14° 52' 20.38" N and Longitude 103° 36' 14.02" E, about 11 kilometers to the east of Surin city.


**A.4.2. Type and category (is) and technology/measure of the small-scale project activity:**

Type 1 – RENEWABLE ENERGY PROJECTS
Category I.D. – Grid connected renewable electricity generation

**Technology / measure**

The Project is a new project comprising a renewable energy generation using renewable biomass as fuels. It aims to reduce green house gas emissions by supplying electricity to and at the same time displacing part of electricity from the national power grid whose electricity is predominantly derived from fossil fuels.

Rice husks produced by the two neighbouring rice mills are transported and stored in the Project's 45-day and 2-day silos. These rice husks account for about eighty percents of biomass fuels required by the Project. The remaining rice husks are brought in from rice mills owned by closed associates and friends of the Project owners. The close relationships with these rice mills provide the Project with fuel supply security.

The stored rice husks are then transported to the superheat boiler where a state-of-the-art and expensive step-grate is employed and the combustion takes place. Flue gases from the combustion heat up water in the boiler's water pipes generating steam which rotates the steam turbine-generator set producing electricity for the grid and rice mills.

Fly ashes in the flue gases are properly removed by a multi-cyclone and an electrostatic precipitator to meet the stringent Thailand's emission standards before the clean flue gases are released to the atmosphere through a 40-meter high stack.

It should be noted that the step-grate provides the Project with additional biomass fuel security since it can handle a wide range of biomass fuels. Operationalwise it is more complicated to operate the step-grate than other grate systems.
As mentioned earlier, the water consumption of the Project is self-sufficient due to the large on-site raw water ponds providing the Project with water supply security and avoiding a competition with local farmers for water in the public water channels.

Out of the 8.8 MW net output from the Plant, 8-MW is sold to EGAT via a 22 kV step-up transformer under Thailand's stringent Firm SPP program. The remaining net output of 0.8 MW is distributed to two rice mills which are adjacent to the Project. These two rice mills used to buy electricity from the grid prior to the project activity.

Since the gross power output of the Project is only 9.9 MW and less than the 15-MW limit, the Project is qualified as a small-scale CDM project and fully complies with the conditions set forth in the Simplified Baseline and Monitoring Methodologies of AMS-I.D. - Grid connected renewable electricity generation.

The table below lists the main technical specifications of the main equipment.[1]

| **Technical Data of Main Equipments** | |
|---|---|
| **Steam Turbine:** | |
| Manufacturer | Hang Zhou Steam Turbine Works China |
| Model | NK 35 / 45 / 0 |
| Quantity | 1 unit |
| Design Output | 9.9 MW |
| Steam Consumption | 4,727kg/kWh |
| Isentropic Efficiency | 81% |
| No. of stages | 18 |
| Rated Speed / Trip Speed | 7,300 / 8,030 rpm |
| **Boiler:** | |
| Manufacturer | Industrial Power Technology |
| Model | IPT55-39 / 450 – RH |
| Quantity | 1 unit |
| Fuel Type | Rice Husks and Wood wastes |
| Type | Corner Water Tube (Membrane Wall) |
| Boiler efficiency | 80% |
| Working Pressure | 39 +/-0.5 barg |
| Working Temperature | 450 +/-$10^0$ C (Superheated) |
| Evaporation Capacity | 55 t/hr @ MCR |
| **Generator:** | |
| Manufacturer | AVK, Germany |
| Model No: | DIG 163m/4W |
| Quantity | 1 unit |
| Type | Brushless, self excitation with automatic voltage regulations |
| Apparent Power Output | 12,500 KVA |

[1] See *"Specifications of boiler, turbine and generator.pdf"*

| Technical Data of Main Equipments | |
|---|---|
| Power Factor | 0.8 lag |
| Active Power Output | 10,000 kW |
| Voltage | 11KV |
| Current | 656 A |
| Frequency | 50Hz |

**A.4.3 Estimated amount of emission reductions over the chosen crediting period:**

| Years | Annual estimation of emissions reductions in tonnes of $CO_2$ e |
|---|---|
| Year 2011 | 39,462 |
| Year 2012 | 39,462 |
| Year 2013 | 39,462 |
| Year 2014 | 39,462 |
| Year 2015 | 39,462 |
| Year 2016 | 39,462 |
| Year 2017 | 39,462 |
| Total estimated reductions (tonnes of $CO_2$e) | 276,234 |
| Total number of crediting years | 7 years (renewable) |
| Annual average of the estimated reductions over the crediting period ($tCO_2e$) | 39,462 |

**A.4.4. Public funding of the small-scale project activity:**

This Project does not involve any public funding from Annex I Parties. (see Attachment 1 for MGP Letter Confirming No Public Funding Involvement).

**A.4.5. Confirmation that the small-scale project activity is not a debundled component of a large scale project activity:**

According to Paragraph 2 of Appendix C to the Simplified Modalities and Procedures for Small-scale Project Activities, a small-scale activity is considered a debundled component of a large project activity if there is a registered small-scale activity or an application to register another small-scale activity:

1. With the same project participants;
2. In the same project category and technology;
3. Registered within the previous two years; and
4. Whose project boundary is within 1 km of the project boundary of the proposed small-scale activity at the closest point.

The project participants confirm that none of the above conditions is applicable to this project activity, and that there is not any small-scale project activity registered or applied to register within the same project boundary, in the same project category and technology. The project technology will not be substituted by other technologies within the project period (see Attachment 2 for MGP Letter Confirming No Change to Existing Technology).

## SECTION B. Application of a baseline and monitoring methodology

### B.1. Title and reference of the approved baseline and monitoring methodology applied to the small-scale project activity:

The approved baseline and monitoring methodology used for the project activity is:
"Grid connected renewable electricity generation AMS I.D. (version 15)"
"General guidance on leakage in biomass project activities. (version 03)"

The tools used for demonstrating and assessing the additionality of the project activity are:
"Attachment A of Appendix B of Simplified Modalities and Procedures for small-scale CDM Project Activity"
"Guidance of the Demonstration and Assessment of Prior Consideration of the CDM"

### B.2 Justification of the choice of the project category:

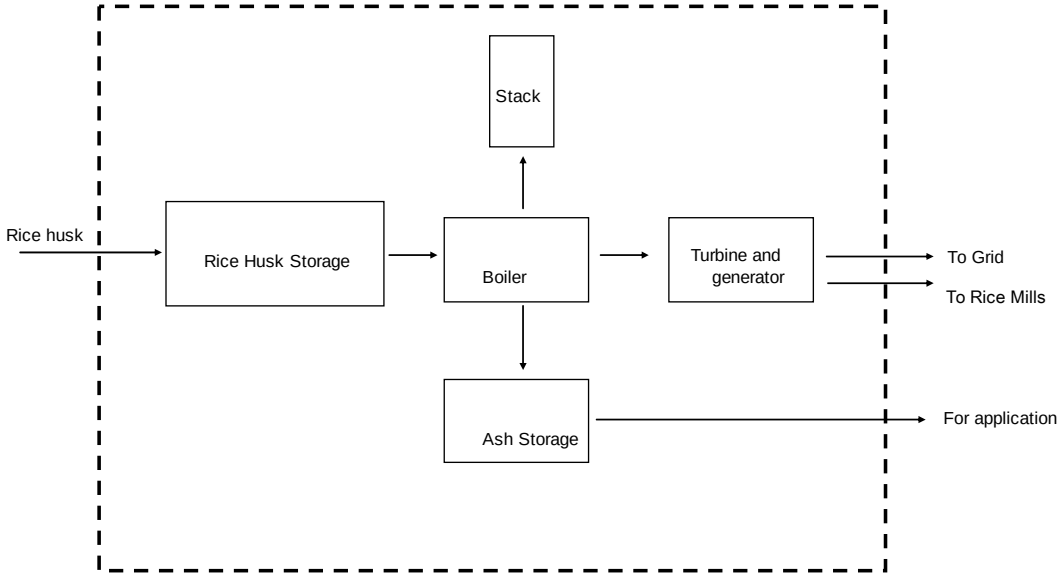
The Project meets all the conditions listed in the approved methodology. It is new and designed to use only biomass as fuel to produce electricity. It is connected and supply electricity to EGAT's grid under Thailand's Small Power Producer scheme. The installed capacity of the Project is 9.9 MW and does not exceed 15 MW limit. Details of the applicability of the project activity to AMS I.D (version 15) are listed in the following table:

| Applicability criteria | Project Activity |
|---|---|
| 1. This category comprises renewable energy generation units, such as photovoltaic, hydro, tidal/wave, wind, geothermal and renewable biomass, that supply electricity to and/or displace electricity from an electricity distribution system that is or would have been supplied by at least one fossil fuel fired generating unit. | The project activity uses only rice husks and wood wastes which are renewable biomass to generate and supply electricity to and displace electricity from an electricity distribution system that is or would have been supplied by at least one fossil fuel fired generating unit. Therefore, it fits into this category. |
| 2. Hydro power plants with reservoirs that satisfy at least one of the following conditions are eligible to apply this methodology:<br>• The project activity is implemented in an existing reservoir with no change in the volume of reservoir;<br>• The project activity is implemented in an existing reservoir, where the volume of reservoir is increased and the power density of the project activity, as per definitions given in the Project Emissions section, is greater than 4 | Not applicable since the project activity does not involve hydro power. |

| | |
|---|---|
| W/m2;<br>· The project activity results in new reservoirs and the power density of the power plant, as per definitions given in the Project Emissions section, is greater than 4 W/m2. | |
| 3. If the unit added has both renewable and non-renewable components (e.g. a wind/diesel unit), the eligibility limit of 15MW for a small-scale CDM project activity applies only to the renewable component. If the unit added co-fires fossil fuel1, the capacity of the entire unit shall not exceed the limit of 15MW. | The project activity comprises only renewable component with 9.9 MW gross capacity which is less than 15 MW. |
| 4. Combined heat and power (co-generation) systems are not eligible under this category. | Not applicable since the project activity only produces electricity output. |
| 5. In the case of project activities that involve the addition of renewable energy generation units at an existing renewable power generation facility, the added capacity of the units added by the project should be lower than 15 MW and should be physically distinct from the existing units. | Not applicable since the project activity is a brand new project. |
| 6. Project activities that seek to retrofit or modify an existing facility for renewable energy generation are included in this category. To qualify as a small-scale project, the total output of the modified or retrofitted unit shall not exceed the limit of 15 MW. | Not applicable since the project activity is a brand new project. |

## B.3. Description of the project boundary:

The project boundary encompasses the physical, geographical site of the renewable generation source as shown in the diagram below:




## B.4. Description of baseline and its development:

According to the Simplified Baseline and Monitoring Methodologies, the baseline is the kWh produced by the renewable generating unit multiplied by an emission coefficient measured in kg $CO_2$e/kWh and calculated in a transparent and conservative manner as (a) a combined margin (CM), consisting of the combination of operating margin (OM) and build margin (BM) according to the procedures prescribed in the "Tool to calculate the emission factor for an electricity system"; or (b) the weighted average emissions of the current generation mix. For this Project, the former is chosen. (See Annex 3 for the calculation of combined margin grid emission factor.)

## B.5. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered small-scale CDM project activity:

According to the Annex 22 EB49 "Guidance on the Demonstration and Assessment of prior Consideration of the CDM", the following elements clearly demonstrate that the CDM was seriously considered in the decision to implement the project activity:

**a) Awareness of the CDM prior to the Project start date**

Since the early stage of the project development, the project participants have been well aware of the potential benefit from the CDM which would make the project feasible financially. In early 2003, when

they first met the Biomass One-stop Clearing House (BOSCH) who they eventually hired as the Project's overall consultant in June 2003, they required the CDM services to be included in the scope of consulting services as well. Finally, the consultancy agreement included technical, commercial, financial, legal, public relations and CDM services.

**b) The benefits of the CDM being a decisive factor:**

It will be shown later that there was an investment barrier to overcome by the project activity, and the benefits of the CDM were a decisive factor for the Management to proceed with the Project.

**c) Indication of actions to secure CDM status:**

A letter from the Thailand Greenhouse Gas Management Organization, Thailand DNA, confirms continuing and real actions have been taken by the project proponent to secure CDM status for the project (See Attachment 3.1). Moreover, the documents and activities listed below clearly indicate that real and continuing actions have been taken to secure CDM status for the Project in parallel with its implementation (See Attachment 3.2 for the Project Timeline):

1. Contract with BOSCH as CDM consultant in June 2003;
2. Proposal submission to the Royal Danish Embassy (RDE) in responses to its Call for Proposal to receive RDE's financial support to implement the CDM activities in November 2003 (1st round) and July 2004 (2nd round);
3. Stakeholder consultations from December 2003 to February 2005. (See details in Section E.);
4. Bank Thai's letter indicating its acceptance of the additional revenue from the CDM for its evaluation of the Project's viability in July 2004;
5. Continued participation in CDM seminars and conferences, such as, Capacity Building for Thai Consultants on Developing CDM Projects in Thailand by Royal Danish Embassy in April 2004, Carbon Market Insights Amsterdam in March 2005, etc;
6. Signing of an EPC contract with a turnkey contractor, and signing of a bank loan agreement with a local bank in April 2005;
7. Continued meetings and discussions with financial institutions and carbon funds, such as, EcoSecurities Ventures (Thailand) Ltd., KfW Bankengruppe, Mitsubishi securities, etc.
8. Contract with Biomass Energy Development Centre Co., Ltd. (BEDC) as a CDM consultant in May 2006;
9. Continued meetings and discussions on CER transactions with EcoSecurities Ventures (Thailand) Ltd., KfW Bankengruppe, etc.
10. Contract with CEWA as a CDM consultant in May 2007;
11. Correspondences with DOEs, such as, DNV Industry, TUV SUD PSB (Thailand) Limited, Bureau Veritas Certification (Thailand) Ltd., and SGS United Kingdom Ltd., in January 2008;
12. Correspondences and discussions on CER transactions with CER buyers, such as, EcoSecurities Ventures (Thailand) Ltd., EDF Trading Limited, Royal Danish Embassy in Thailand, Suez Energy Asia PVT., Ltd., Tricorona Carbon Asset Management, Swedish Energy Agency, KfW Bankengruppe, Carbon Resource Management, Natsource Europe Limited, South Pole Carbon Asset Management Ltd., Tradition Financial Services Ltd., in 2007 and 2008.
13. Contract with a broker in carbon emission trading, Tradition Financial Services Ltd. (TFS), U.K. in May 2008;
14. Meeting with Thai DNA in July 2008 (see Attachment 1 for Thai DNA's Letter regarding LoA Issuance for MGP dated 19 November 2008);
15. Validation Contract with SGS United Kingdom Ltd. as DOE, in August 2008;

16. ERPA with Green Initiative Carbon Assets, S.A. (GICA) and due diligence by GICA's lawyers in August 2008;
17. Continued participation in CDM seminars and conferences, such as, Integrated Capacity Strengthening for Clean Development Mechanism in Thailand by the European Union in July 2008, Workshop on CDM Projects Preparation and Implementation of Monitoring Procedures by Carbon Partners Asiatica in August 2008, etc.

In addition, the matrix in Attachment 3.3 includes an array of activities and documents indicating that continuing and real actions were taken to secure CDM status for the project in parallel with its implementation. The matrix categorizes activities according to the EB's suggestion as follows: 1) contracts with consultants for CDM services; 2) carbon sale documents; 3) correspondence with CER buyers, etc.; 4) correspondence, proposals, contracts and/or documentation related to retaining DOEs for CDM validation and/or verification; and 5) correspondences, interviews and meetings with DNA or UNFCCC secretariat.

With regard to the Attachment A to Appendix B of the Simplified Modalities and Procedures for small-scale CDM project activities, the project activity would not have occurred anyway due to at least one of the following barriers:

a) Investment barrier;
b) Technology barrier;
c) Barrier due to prevailing practice;
d) Other barriers

The following barriers have been identified to demonstrate the additionality of the project.

**a) Investment barrier**

Compared with conventional fossil-based power plants which emit large amount of $CO_2$, biomass power plants require a significantly larger per-unit investment. This is due to biomass power plants being generally much smaller and much less common than conventional power plants; they are, therefore, suffering from a lack of economy of scales.

The Project, which particularly pays considerable attention to the environment and local communities, has invested even more than other similar-sized biomass power plants to take care of the environment and communities. It chose to install a high efficiency step-grate combustion system. The step-grate system burns less fuels but it is more expensive than other grates. It also burns fuels more cleanly. To take a better care of the ashes, the Project employs both a multi-cyclone and an electrostatic precipitator where one of them is typically sufficient to control the particulates although the step-grate already produces fewer ashes than other grate systems.

In order to avoid competing with local farmers for water, the project participants decided to build very large on-site storages with a total capacity that is ample to run the power plant for more than two years.

To effectively accommodate visitors to the Project as a showcase biomass power generation learning center, the Project owners decided to build administrative and operational buildings larger and more comfortable than what would have been normally required. The green areas of the Project are also very spacious and much larger than those of other plants.

Regarding the revenues from selling electricity to EGAT, the investment in biomass power plants incurs higher risks than the investment in conventional fossil-fired power plants since the tariffs of the latter vary according their fuel prices. Most of the risks associated with the fuel price hikes are passed through to electricity consumers where as biomass power plant investors have to shoulder the risks themselves.

The dispatchability and hence the revenues of biomass power plants was dependent upon EGAT's dispatching order. During the off-peak period (9:30 p.m. to 8:30 a.m. on weekdays and all day on weekends) EGAT required biomass power plants to lower their electricity output to 65% of the contracted capacity or from 8 MW to 5.2 MW in MGP case, resulting in significant revenue losses.

Operationalwise, power plants sacrifice a great deal of efficiency when they run significantly below their full-load capacity. (Due to an appeal by the project participants, the 65% dispatching limit was subsequently removed by the government after the Project had been implemented for about 7 months (from January 23 to August 15, 2007). The lesson learned from the Project leading to the removal of these investment and operational barriers truly benefit other biomass plants implemented after the Project).

From the operational and maintenance expense point of view, biomass power plants are subject to relatively higher expenses than their fossil-based counterparts due to their lack of economy of scales. The per MW requirements for manpower, spare parts and other resources are higher for biomass than utility-scale fossil-based power plants.

Being an exemplary rice husk-fired power plant, the Project has attracted many visitors virtually on a daily basis. Such frequent visits are always welcome but there are also costs associated with them. The maintenance of large green areas and the implementation of the comprehensive community programs are also costly.
The results from a financial analysis shown in Table 1 indicate an Equity IRR of only 14.61% which is much lower than the expected return on equity to be calculated subsequently in this PDD. This indicates a clear investment barrier to the project activity. This point will be further illustrated in this PDD.

It is noted that the assumptions and parameters used in the base case analysis are considered quite conservative. For example, the project total investment of only Baht 550 million is lower than other biomass projects. The operational and maintenance (O&M) expenses in the base case assumed to be 3% of the total investment cost is relatively small as well and even considered very small when coupled with the small total investment cost. The annual operating hours of 7,884 is also regarded as very conservative and challenging. It requires stringent planning, operation and maintenance by power plant management and personnel.

**Table 1: Key financial parameters and results from base case financial analysis[2]**

[2] References: *1) Shared capital , Company certificate by department of business development, ministry of commerce that indicated the registered equity of MGP, dated 28th August 2008; 2) Long term loan, Loan agreement between MGP and BankThai dated 7th April 2005; 3) Interest rate, Interest rate announcement of BankThai in year 2004 , reference 02/2547; 4) Gross and Net power output, Technical documents from Industrial Power Technology Pte Ltd, dated 15th February 2005; 5) Power Purchase Agreement with Rice mill, dated 2nd March 2007, agreement reference No.ACC/0703002; 6) Power Purchase Agreement with EGAT, dated 2nd August 2007, agreement reference No.44/8-5H-0908; 7) Annual number of operating hours, confirmation letter from third party Engineering company (Team Consulting Engineering and Management Co.,Ltd) , Ref No. UEP/ENV/PE4980/P1740/GE666; 8) Electricity tariff, calculation formulae issued by EGAT for MGP, as addendum to PPA; 9) Biomass price,*

| | |
|---|---|
| Total Project Cost | THB 550 million |
| Means of Finance:<br>- Shared Capital<br>- Long-term Loan | <br>THB 150 million<br>THB 400 million |
| Interest rate | 8% |
| Gross Capacity | 9.9 MW |
| Auxiliary Consumption | 1.1 MW |
| Net Power sold to Rice Mills | 0.8 MW |
| Net Power sold to EGAT | 8.0 MW |
| Annual Operating hours | 7,884 |
| Plant factor | 90% |
| Sales Price of Electricity | 2.3722 THB/kWh |
| Average Biomass Price | 600 THB/Ton |
| Annual O&M Expenses | 3% of Project Cost |
| Equity IRR | 14.61% |

(See Attachment 4.0 for the detailed analysis worksheet)

In supporting the investment barrier analysis and following the guidance in EB 41 Annex 45 Paragraph 11, an appropriate benchmark for the project activity is chosen to be a required or expected return on equity since the type of IRR calculated for the project activity is an equity IRR.

The determination of the expected return on equity of the project is based on the Capital Asset Pricing Model (CAPM)[3] for the power generation industry consisting of power generation companies listed in the stock exchange of Thailand (SET) as follows:

$$R_E = R_{F,TH} + \beta_{equity} * Market\ Premium \qquad \textit{(equation 1)}$$

where:

| | | |
|---|---|---|
| $R_E$ | = | required or expected return on equity for the project activity |
| $R_{F,TH}$ | = | risk-free rate or average yield on long-term Thai government's bonds |
| $\beta_{equity}$ | = | is the beta-equity for power generation industry in Thailand |
| *Market Premium* | = | $R_{M,TH} - R_{F,TH}$ |
| $R_{M,TH}$ | = | expected return from the Thai stock market |

The product of $\beta_{equity}$ and the *Market Premium* is considered as the risk premium for investing in the power generation industry in Thailand where the project belongs both in terms of sector and country. It is the risk premium based upon the risk profile of the power generation industry and not the risk profile of the market itself. Therefore, this model conforms to the guidance in EB 41, Annex 45, Paragraph 14: "It is not considered reasonable to apply the rate general stock market returns as a risk premium for project activities that face a different risk profile than an investment in such indices."

*Confirmation letter from Roi-et rice mill for the rice husk price in year 2004 – 2005; 10) Operation and maintenance budget, Letter dated 09/09/2004 with Ref.No. IPT51/IPT-MGP/L-3481/04 from Industrial Power Technology Pte Ltd. Regarding O & M cost for the project*

[3] Ross, Stephen A; Westerfield, Randolph W; and Jaffe, Jeffrey. *Corporate Finance.* 5th ed., New York: McGraw-Hill, 1999. ISBN 0-07-116757-9

Substituting $R_{F,TH}$ = 5.09%; $R_{M,TH}$ = 20.75%; and $\beta_{equity}$ = 1.134, determined in Attachment 5[4], into equation 1 results in **the expected return on equity, $R_E$ , equal to 22.84%.**

The expected return on equity calculated above is much higher than the 14.61% equity IRR shown in Table 1 rendering the project financially unattractive or there is an investment barrier that the additional revenues from the project activity could help overcome.

**Sensitivity Analysis**

According to EB 41 Annex 45 Paragraph 16 guidance, the PDD must include a sensitivity analysis for parameters which could have a substantial impact on the Project. In this specific case, the critical parameters are 1) biomass price; 2) total investment cost; 3) sales price of electricity; 4) annual operational hours or plant factor; and 5) annual operational and maintenance expenses.

Furthermore, according to EB 41 Annex 45 Paragraph 17, the sensitivity analysis should at least cover a range of +10% and -10%, unless it is not deemed appropriate in the context of the specific project circumstances.

Although in this project, it is unlikely that the rice husks price and the total investment cost will be lower than the base case values since they are already considered very conservative. Nonetheless, the sensitivity analysis in this PDD includes such two unlikely scenarios for references.

As for the annual operational hours, the base case 7,884 hours is in general at the upper operational limit of almost all thermal power plants. Beyond that, the life of the power plant would be shortened. Therefore, the sensitivity analysis on the operational hours should not include the scenario where the number of operational hours is larger than 7,884. However, to show that even with an all-year operation at the rated capacity, the investment barrier to the project activity is still very evident, the project proponent includes a scenario where the number of the operating hours is 8,760 hours.

For the annual O&M expenses, the base case budget of 3% of the total project cost is generally at the lowest end of thermal power plants budgets whose yearly O&M expenses typically range from 5 to 10% of the project cost. Therefore, the sensitivity analysis will not cover the case where the O&M expenses are lower than 3%.

The results of the sensitivity analyses are shown in Table 2 below.

**Table 2: Financial Sensitivity Analysis**

| Parameter | Variation | Value | Unit | Equity IRR |
|---|---|---|---|---|
| Biomass prices | -10% | 540 | THB/ton | 17.51% |
| Biomass prices | +10% | 660 | THB/ton | 11.85% |
| Investment cost | -10% | 495 | mil.THB | 20.24% |
| Investment cost | +10% | 605 | mil.THB | 11.27% |
| Electricity tariff | -10% | 2.1350 | THB/kWh | 8.58% |
| Electricity tariff | +10% | 2.6094 | THB/kWh | 21.34% |

[4] See *"Attachment 5 - MGP required or expected return on equity calculation.xls"* (Note: all other related references used in the calculation can be found in related worksheets included in the Excel file.)

| | | | | |
|---|---|---|---|---|
| Hours of operation | -10% | 7,008 | hours | 12.64% |
| Hours of operation | maximum | 8,760 | hours | 16.66% |
| O&M expenses | - | 5% of project cost | % | 10.80% |

(See Attachments 4.1 to 4.9 for the detailed sensitivity analysis worksheets)

The sensitivity analysis shows that all scenarios would yield an Equity IRR that is less than the expected return on equity of 22.84% calculated earlier. The only scenario where the equity IRR is considered close to the expected return on equity is the one with the electricity tariff increased by 10% from the base case value yielding an equity IRR of 21.34%. It would be achieved when the plant factor is 90% or the power plant must operate at full output of 8.8 MW (net) for 7,884 hours per year. That stringent operational requirement is considered quite a challenge taking into account the lack of experience of the project proponent and the power plant personnel in operating and maintaining this type of power plant.

Moreover, should there be any contingencies on the utility network and/or the rice mills preventing the power plant from exporting its full electricity output, or equipment malfunctions causing the power plant to shut down more than the planned maintenance shut down, the equity IRR will be suffered and could considerably drop below the benchmark or the expected return on equity. This clearly indicates the investment barrier to the project activity that the benefits from the CDM would overcome.

**b) Technological barrier**

The Project was the first large-scale rice husk-fired power plant wholly invested by rice mill owners under the stringent Firm SPP Contract of EGAT. Although the project owners did not have the experience in managing a power plant before, they had to choose the stringent Firm SPP Contract since it provided the Project with the most favorable tariff structure at the time.

Without the required experiences, it was quite risky and there was no guarantee that the Project would run according to the predetermined operational plan. Due to the possibility that there might be shortages of rice husks from time to time, the Project had to be incorporated with some fuel flexibility capability. With such requirement, the project owners decided to install a high efficiency and environmentally friendly step-grate combustion system that can burn a wide range of biomass fuels. The costly step-grate, however, is more complicated to operate than other grate systems. This is another type of technological risk which the project has to face.

## B.6. Emission reductions:

### B.6.1. Explanation of methodological choices:

As explained in Section B.4, the baseline for the Project is chosen to be the kWh produced by the Project multiplied by an emission coefficient (measured in kg $CO_2e$/kWh) calculated in a transparent and conservative manner as a combined margin (CM), consisting of the combination of operating margin (OM) and build margin (BM) according to the procedures prescribed in the Tool to calculate the emission factor for an electricity system. (See Annex 3)

The emission reductions of the project activity are calculated as (see Attachment 6 for MGP Emission Calculations):

$$ER_y = ER_{electricity,y} - PE_y - L_y$$

where:

$ER_y$ = Emission reductions of the project activity during the year y ($tCO_2$);
$ER_{electricity,y}$ = Emission reductions due to substitution of grid electricity during the year y ($tCO_2$);
$PE_y$ = Project emissions during the year y ($tCO_2$);
$L_y$ = Leakage emissions during the year y ($tCO_2$).

**A) Emission Reductions due to substitution of grid electricity**

The emission reductions due to the substitution of grid electricity generation by renewable electricity from the Project are calculated by multiplying the amount of exported electricity, which is, for this Project, equal to the sum of the electricity exported to EGAT and to rice mills, by an emission coefficient calculated as a combined margin as:

$$ER_{electricity,y} = EG_{export,y} \, x \, EF_{grid,CM,y}$$

$$EG_{export,y} = EG_{EGAT,y} + EG_{ricemills,y}$$

where:

$ER_{electricity,y}$ = Emission reductions due to substitution of grid electricity ($tCO_2$);
$EG_{EGAT,y}$ = Electricity exported to EGAT by the Project in year *y* (MWh);
$EG_{ricemills,y}$ = Electricity exported to rice mills by the Project in year *y* (MWh);
$EF_{grid,CM,y}$ = Emission factor for grid electricity for year *y* ($tCO_2$/MWh).

**B) Project emissions**

The project emissions include $CO_2$ emissions from the transportation of biomass fuels to the project site. The ashes are sold at the project site. Thus, there are no $CO_2$ emissions from transportation of ash to the plantation. The power plant has been designed to utilize 100 percent of biomass as primary fuel. It is not required to use fuel oil during the start-up. Therefore, there are no $CO_2$ emissions from on-site consumption of fossil fuels. There are no $CO_2$ emissions from electricity consumption because the electricity consumed in the project activity is supplied by the renewable electricity generated by the power plant.
The project emissions are:

$$PE_y = PET_y$$

where:

$PE_y$ = Project emissions during the year y ($tCO_2$);
$PET_y$ = Project emissions from the transportation of biomass to and from the project site ($tCO_2$) calculated as:

$$PET_y = DISTANCE_y \, x \, EF_{km,CO2,y}$$

$$DISTANCE_y = (N_{ricehusk,y} \, x \, AVD_{ricehusks,y}) + (N_{woodwastes,y} \, x \, AVD_{woodwastes,y})$$

where:

$PET_y$ = Project emissions from transportation of biomass ($tCO_2$);
$N_{ricehusks,y}$ = Number of truck trips carrying rice husks to the project site during the year y;
$AVD_{ricehusks,y}$ = Average round trip distance between rice mills and the project site during the year y (km);
$N_{woodwastes,y}$ = Number of truck trips carrying wood wastes to the project site during the year y;
$AVD_{woodwastes,y}$ = Average round trip distance between wood wastes sources and the project site during the year y (km);
$EF_{km,CO2,y}$ = Average $CO_2$ emission factor for the trucks during the year y ($tCO_2$/km).

**C) Leakage emissions**

As the project activity does not involve the transfer of energy generating equipment to or from another activity, there are no leakage effects according to AMS-I.D.

In addition, according to EB 28 Annex 35 “General Guidance on leakage in biomass project activities”, the leakage from the project activity can be neglected since the quantity of available biomass in the region, namely for this Project, both rice husks and wood wastes in Surin Province, is at least 25% larger than the quantity of biomass that is utilised including the usage in the project activity.

Attachments 7.1 and 7.2 of this PDD shows that, on a yearly basis in Surin Province, there were a minimum of 252,271 tons of available rice husks during the crop years 2004/2005 to 2007/2008, against 120,650 tons of total rice husk usages; and 120,000 tons of available wood wastes per year against 57,055 tons of total woodwastes usages. In both cases, the available or surplus biomass is much larger than 25% beyond the total use quantity (see Attachment 7.2 for MGP Leakage Assessment and Fuel Use Calculations Worksheet).

**B.6.2. Data and parameters that are available at validation:**

| **Data / Parameter:** | $EF_{grid,CM,y}$ |
|---|---|
| Data unit: | $tCO_2/MWh$ |
| Description: | Combined margin emission factor for grid electricity |
| Source of data used: | EGAT, DEDE, PTT, IPCC |
| Value applied: | 0.57045 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | As per the Tool to calculate the emission factor for an electricity system |
| Any comment: | |
| **Data / Parameter:** | $EF_{grid,OMSimple,y}$ |
| Data unit: | $tCO_2/MWh$ |
| Description: | Simple operating margin $CO_2$ emission factor |
| Source of data used: | EGAT |
| Value applied: | 0.56774 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | As per the Tool to calculate the emission factor for an electricity system |
| Any comment: | |

| **Data / Parameter:** | $EF_{grid,BM,y}$ |
|---|---|
| Data unit: | $tCO_2/MWh$ |
| Description: | Build margin $CO_2$ emission factor |
| Source of data used: | EGAT |
| Value applied: | 0.57317 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | As per the Tool to calculate the emission factor for an electricity system |
| Any comment: | |

| **Data / Parameter:** | $SF_{ricehusks}$ |
|---|---|
| Data unit: | tons/MWh |
| Description: | Specific rice husks consumption |

| | |
|---|---|
| Source of data used: | Guaranteed heat rate by Turnkey Contractor and net calorific value of rice husks from Mahasarakam University Test Report |
| Value applied: | 1.58 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | The parameter is the quotient of the guaranteed heat rate and the net calorific value of rice husks. It is the maximum rice husks consumptions per MWh output |
| Any comment: | |

| **Data / Parameter:** | $SF_{woodwastes}$ |
|---|---|
| Data unit: | tons/MWh |
| Description: | Specific woodwastes consumption |
| Source of data used: | Guaranteed heat rate by Turnkey Contractor and net calorific value of woodwastes from Mahasarakam University Test Report |
| Value applied: | 1.64 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | The parameter is the quotient of the guaranteed heat rate and the net calorific value of woodwastes. It is the maximum woodwastes consumptions per MWh output |
| Any comment: | |

### B.6.3 Ex-ante calculation of emission reductions:

From Section B.6.1. the emission reductions of the project activity are calculated ex-ante as:

$$ER_y = ER_{electricity,y} - PE_y - L_y$$

**A) Emission Reductions due to substitution of grid electricity**

$$ER_{electricity,y} = EG_{export,y} \times EF_{grid,CM,y}$$

The Project is estimated to operate for 7,884 hours annually at its full capacity of 8.8 MW (net) to substitute grid electricity by exporting to EGAT and rice mills; therefore, its annual substitution of grid electricity is 69,379 MWh. With the combined margin emission coefficient of 0.57045 $tCO_2$/MWh, the annual emission reductions due to the substitution of grid electricity are estimated to be **39,577 $tCO_2$.**

**B) Project emissions**

$$PE_y = PET_y$$

To calculate the project emissions, it is necessary to calculate biomass consumptions. In case the Project consumes 100% of rice husks, the annual ex-ante rice husks consumption is equal to:

(69,379 MWh) x (11.09 MJ/kg) x (17.50 MJ/kWh) or **109,480 tons**

Where, 69,379 MWh is the annual substitution of grid electricity; 11.09 MJ/kg is a net calorific value of rice husks (tested by a qualified university) and 17.50 MJ/kWh is the power plant's heat rate guaranteed by a turnkey contractor.

Out of the maximum 109,480 tons rice husks consumption, about 70,000 tons (= 350 days x 200 tons/day) of rice husks can be supplied from the adjacent rice mills. The remaining 39,480 tons will be brought in from other rice mills with an average return distance of 28 km. from the project site. Each truck trailer can carry approximately 10 tons; therefore, the number of trips for the transportation of rice husks from other rice mills is 3,948 yearly. Calculated using IPCC guidelines and DEDE data, the emission factor of a diesel truck is 0.001043 $tCO_2$/km. Therefore, the annual project emissions from rice husk transportation are estimated to be **115 $tCO_2$.**

(In this ex-ante calculation, it is assumed that no wood wastes are used in the Project during the year. If, however, during any year of operation, wood wastes are used and transported to the Project, the project emissions due to the transportation of wood wastes can be calculated in the same manner as an ex-ante emission calculation for rice husks transportation shown above). As to the ex-ante wood wastes consumption calculation, the Project is expected not to use wood wastes more than 50% of the total biomass energy requirements since rice is grown in large quantity in Surin Province. Therefore, the maximum ex-ante annual wood wastes consumption is (69,379/2 MWh) x (10.64 MJ/kg) x (17.50 MJ/kWh) or (57,055 tons)

**C) Leakage emissions**

According to the leakage assessment in Section B.6.1, the leakage emissions can be neglected.

Therefore, the total ex-ante calculations of emission reductions from the project activity are equal to 39,577 minus 115 or **39,462 $tCO_2$/year.**

## B.6.4 Summary of the ex-ante estimation of emission reductions:

| Year | Estimation of project activity emissions ($tCO_2e$) | Estimation of baseline emissions ($tCO_2e$) | Estimation of leakage ($tCO_2e$) | Estimation of overall emission reductions ($tCO_2e$) |
|---|---|---|---|---|
| Year 2011 | 115 | 39,577 | 0 | 39,462 |
| Year 2012 | 115 | 39,577 | 0 | 39,462 |
| Year 2013 | 115 | 39,577 | 0 | 39,462 |
| Year 2014 | 115 | 39,577 | 0 | 39,462 |
| Year 2015 | 115 | 39,577 | 0 | 39,462 |
| Year 2016 | 115 | 39,577 | 0 | 39,462 |
| Year 2017 | 115 | 39,577 | 0 | 39,462 |
| Total (tonnes of $CO_2e$) | 805 | 277,039 | 0 | 276,234 |

## B.7 Application of a monitoring methodology and description of the monitoring plan:

### B.7.1 Data and parameters monitored:

| Data / Parameter: | $EG_{EGAT,y}$ |
|---|---|
| Data unit: | MWh |
| Description: | Amount of electricity supplied to EGAT by the Project in year *y* |
| Source of data to be used: | MGP and EGAT |
| Value of data | 63,072 MWh |
| Description of measurement methods and procedures to be applied: | This parameter is continuously measured by two electricity meters, one for primary and the other as backup. It is read and recorded hourly by plant operators from one of the two meters. |
| QA/QC procedures to be applied: | Hourly records are summarized daily, checked and approved by Plant Manager. Monthly summary is also needed approval by Plant Manager and EGAT. The meters are calibrated yearly. The level of accuracy is +/- 0.5%. |
| Any comment: | N/A |

| **Data / Parameter:** | $EG_{ricemills,y}$ |
|---|---|
| Data unit: | MWh |
| Description: | Amount of electricity supplied to the adjacent rice mills by the Project in year *y* |
| Source of data to be used: | MGP |
| Value of data | 6,307 MWh |
| Description of measurement methods and procedures to be | This parameter is continuously measured by an electricity meter. It is read and recorded hourly by plant operators. There is a provision for calculating this parameter from other relevant meter readings in case this meter malfunctions. |
| QA/QC procedures to be applied: | Hourly records are summarized daily, checked and approved by Plant Manager. Monthly summary is also checked and approved by Plant Manager and rice mill management. The meter is calibrated yearly. The level of accuracy is +/- 0.5%. |
| Any comment: | N/A |

| **Data / Parameter:** | $EG_{aux,y}$ |
|---|---|
| Data unit: | MWh |
| Description: | Amount of electricity consumed internally by the Project in year *y* |
| Source of data to be used: | MGP |
| Value of data | 8,672 MWh (taken into account losses in main and station service transformers. |
| Description of measurement methods and procedures to be | This parameter is continuously measured by an electricity meter. It is read and recorded hourly by plant operators. There is a provision for calculating this parameter from other relevant meter readings in case this meter malfunctions. |
| QA/QC procedures to be applied: | Hourly records are summarized daily, checked and approved by Plant Manager. Monthly summary is also checked and approved by Plant Manager and rice mill management. The meter is calibrated yearly. The meter is calibrated yearly. The level of accuracy is +/- 0.5%. |
| Any comment: | N/A |

| **Data / Parameter:** | $EG_{gross,y}$ |
|---|---|
| Data unit: | MWh |
| Description: | Gross amount of electricity generated by the Project in year *y* |
| Source of data to be used: | MGP |
| Value of data | 78,051 MWh |
| Description of measurement methods and procedures to be | This parameter is continuously measured by an electricity meter. It is read and recorded hourly by plant operators from a meter measuring gross generated electricity. There is a provision for calculating this parameter from other relevant meter readings in case this meter malfunctions. |
| QA/QC procedures to be applied: | Hourly records are summarized daily, checked and approved by Plant Manager. Monthly summary is also checked and approved by Plant Manager and rice mill management. The meter is calibrated yearly. The level of accuracy is +/- 0.5%. |
| Any comment: | N/A |

| Data / Parameter: | $BF_{ricehusks,y}$ |
|---|---|
| Data unit: | tons |
| Description: | Amount of rice husks consumed by the Project during the year y |
| Source of data to be used: | MGP |
| Value of data | 109,480 |
| Description of measurement methods and procedures to be applied: | Each incoming rice-husk truck is weighed by a weigh bridge for its incoming and outgoing weights after it unloads the rice-husk at the storage.<br>The difference between the incoming and outgoing weights is the weight of the rice-husks which is recorded along with the name of the rice-husk supplier. |
| QA/QC procedures to be applied: | Daily record is reported to and approved by Plant Manager. According to government regulations, the weigh bridge is tested and calibrated by a government agency every two years to the accuracy level of i) +/- 20 kg. for test weights of up to 10,000 kg.; ii) +/- 40 kg. for test weights of 10,000 kg. to 40,000 kg., and iii) +/- 60 kg. for test weights of 40,000 kg. to 80,000 kg. |
| Any comment: | N/A |

| Data / Parameter: | $N_{ricehusks,y}$ |
|---|---|
| Data unit: | Trips per year |
| Description: | Number of truck trips transporting rice husks to the Project during the year y |
| Source of data to be used: | MGP |
| Value of data | 3,948 |
| Description of measurement methods and procedures to be applied: | All necessary data associated with each truck bringing rice husks to the Project are properly recorded by power plant personnel. For each monitoring period, the number of trips is counted. |
| QA/QC procedures to be applied: | Daily record is reported to and approved by Plant Manager |
| Any comment: | N/A |

| Data / Parameter: | $AVD_{ricehusks,y}$ |
|---|---|
| Data unit: | km. |
| Description: | Average round trip distance between rice mills and the project site during the year y |
| Source of data to be used: | MGP |
| Value of data | 28 |
| Description of measurement methods and procedures to be applied: | Rice husks source or supplier and its distance from the Project are recorded for each incoming truck. For each monitoring period, the average distance is computed. |
| QA/QC procedures to be applied: | On a daily basis, the information related to rice husks used and the abovementioned distance is reported to the Plant Manager. |
| Any comment: | N/A |

| Data / Parameter: | $BF_{woodwastes,y}$ |
|---|---|
| Data unit: | tons |
| Description: | Amount of wood wastes consumed by the Project during the year y |
| Source of data to be used: | MGP |
| Value of data | 0 |
| Description of measurement methods and procedures to be applied: | Each incoming wood-waste truck is weighed by a weigh bridge for its incoming and outgoing weights after it unloads the wood wastes at the storage.<br>The difference between the incoming and outgoing weights is the weight of the wood wastes which is recorded along with the name of the wood wastes supplier. |
| QA/QC procedures to be applied: | Daily record is reported to and approved by Plant Manager. According to government regulations, the weigh bridge is tested and calibrated by a government agency every two years to the accuracy level of i) +/- 20 kg. for test weights of up to 10,000 kg.; ii) +/- 40 kg. for test weights of 10,000 kg. to 40,000 kg., and iii) +/- 60 kg. for test weights of 40,000 kg. to 80,000 kg. |
| Any comment: | N/A |

| Data / Parameter: | $N_{woodwastes,y}$ |
|---|---|
| Data unit: | Trips per year |
| Description: | Number of truck trips transporting wood wastes to the Project during the year y |
| Source of data to be used: | MGP |
| Value of data | 0 |
| Description of measurement methods and procedures to be applied: | All necessary data associated with each truck bringing wood wastes to the Project are properly recorded by power plant personnel. For each monitoring period, the number of trips is counted. |
| QA/QC procedures to be applied: | Daily record is reported to and approved by the Plant Manager |
| Any comment: | N/A |

| Data / Parameter: | $AVD_{woodwastes,y}$ |
|---|---|
| Data unit: | km. |
| Description: | Average round trip distance between wood wastes source or suppliers and the project site during the year y |
| Source of data to be used: | MGP |
| Value of data | 0 |
| Description of measurement methods and procedures to be applied: | Wood wastes source or supplier and its distance from the Project are recorded for each incoming truck. For each monitoring period, the average distance is computed. |
| QA/QC procedures to be applied: | On a daily basis, the information related to wood wastes used and the abovementioned distance is reported to the Plant Manager. |
| Any comment: | N/A |

| Data / Parameter: | $EF_{km,CO2,y}$ |
|---|---|
| Data unit: | $tCO_2$/km |
| Description: | Average $CO_2$ emission factor for trucks during the year y |
| Source of data to be used: | IPCC and DEDE |
| Value of data | 0.001043 |
| Description of measurement methods and procedures to be applied: | This parameter will be reviewed yearly during the crediting period and two years after the end of the crediting period. |
| QA/QC procedures to be applied: | IPCC and DEDE values will be used and checked by Plant Manager. |
| Any comment: | N/A |

| Data / Parameter: | $AF_{ricehusks,y}$ |
|---|---|
| Data unit: | tons |
| Description: | Amount of rice husks available in Surin Province during the year y |
| Source of data to be used: | Government agencies |
| Value of data | 252,271 to 302,424 |
| Description of measurement methods and procedures to be applied: | From the yearly government records, the amount of harvested paddy in Surin Province is collected and multiplied by a typical yield (23%) to arrive at the amount of rice husks available yearly. It will be used to demonstrate surplus availability of rice husks |
| QA/QC procedures to be applied: | Yearly government records are collected and verified by Plant Management. |
| Any comment: | N/A |

| Data / Parameter: | $OF_{ricehusks,y}$ |
|---|---|
| Data unit: | tons |
| Description: | Amount of rice husks consumed by others in Surin Province during the year y |
| Source of data to be used: | Government agencies |
| Value of data | 11,170 |
| Description of measurement methods and procedures to be applied: | From the yearly government records, the amount of rice husks used by others are collected and compiled. It will be used to demonstrate surplus availability of rice husks |
| QA/QC procedures to be applied: | Yearly government records are collected and verified by Plant Management. |
| Any comment: | N/A |

| Data / Parameter: | $AF_{woodwastes,y}$ |
|---|---|
| Data unit: | tons |
| Description: | Amount of woodwastes available in Surin Province during the year y |
| Source of data to be used: | Government agencies |
| Value of data | 120,000 |
| Description of measurement methods and procedures to be applied: | From the yearly government records, the amounts of woodwastes available in Surin Province are collected. It will be used to demonstrate surplus availability of woodwastes. |
| QA/QC procedures to be applied: | Yearly government records are collected and verified by Plant Management. |
| Any comment: | N/A |

| Data / Parameter: | $OF_{woodwastes,y}$ |
|---|---|
| Data unit: | tons |
| Description: | Amount of woodwastes consumed by others in Surin Province during the year y |
| Source of data to be used: | Government agencies |
| Value of data | - |
| Description of measurement methods and procedures to be applied: | From the yearly government records, the amount of woodwastes used by others are collected and compiled. It will be used to demonstrate surplus availability of woodwastes. |
| QA/QC procedures to be applied: | Yearly government records are collected and verified by Plant Management. |
| Any comment: | N/A |

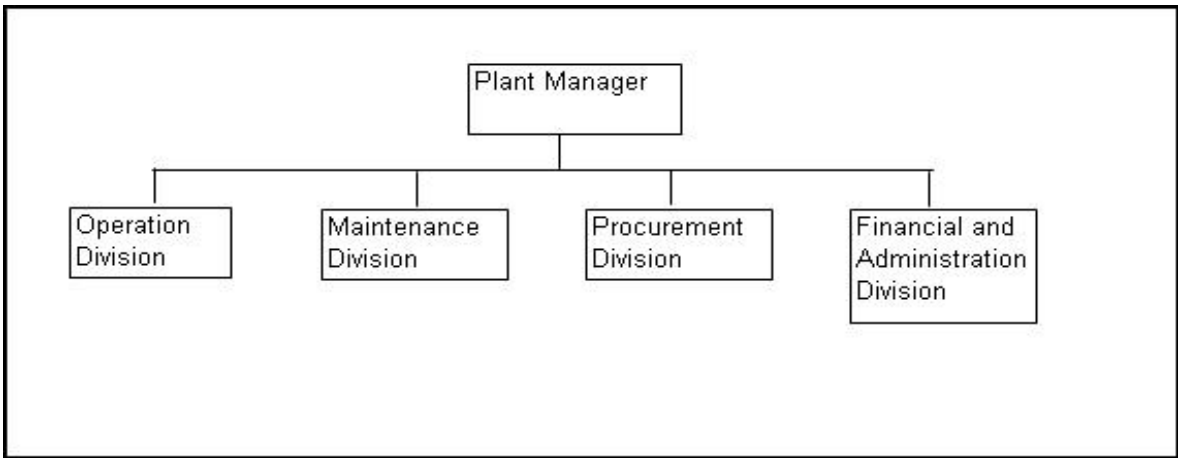
### B.7.2 Description of the monitoring plan:

The Project is staffed with highly qualified and experienced personnel. The plant manager is in charge of the overall operation of the Project including the supervision of CDM monitoring activities that involve four divisions, namely, Operation, Maintenance, Procurement, and Financial, Administration and Accounting as shown in the organization chart below.

The procedures for monitoring key and related parameters have been established including provisions for calculating missing data in case a measuring device malfunctions. As shown in the metering diagram in Annex 4, the most important parameters are the electricity exported to EGAT and rice mills. There are two meters measuring the export to EGAT, one as main and the other as backup meter. For the export to rice mills, should this meter does not work properly; data from other meters in the diagram in Annex 4 can be used to calculate the missing data according to an established procedure.

All the meters are read on an hourly basis by plant operators. The daily readings are then reported to the Plant Manager who also checks and approves the readings daily and at the end of each month. Finally they are checked and approved by local (Surin) and central EGAT personnel before EGAT makes the

payment for electricity bought during the month. The meter readings and transactions for the electricity sales and payment between the Project and the rice mills are handled similarly.




For information related to biomass used in the Project, MGP Accounting staff properly records, for each incoming biomass truck, its license plate number, driver's name, biomass type, weight and source or supplier (for calculating transportation distance.) On a daily basis, the biomass information is summarized, reported and approved by the Plant Manager. The Accounting staff or management staff also collects from government agencies the information related to biomass availability and biomass used by others in Surin Province and then calculates a surplus of the biomass in Surin. The information is checked and verified by the Project's top management.

All measuring devices required in the monitoring plan are calibrated yearly or periodically by a qualified organization according to the recommendations by manufacturers. The calibration reports along with all monitored parameters mentioned above are archived for at least 2 years both in hardcopy and in electronic form.

Relevant standard MGP work procedures for the above monitoring activities are attached to this PDD (see Attachment 8 for MGP Monitoring Procedures).

## B.8 Date of completion of the application of the baseline and monitoring methodology and the name of the responsible person(s)/entity(ies)

Date of completion of the application of the methodology to the project activity: 09/07/2009

Contact information of the person/entity responsible for the application of the baseline and monitoring methodology to the project activity:
Dr. Surachet Tamronglak
Charoen Energy and Water Asia Co., Ltd. (CEWA)
252/101, 20th Floor, Muang Thai Phatra Tower 2, Ratchadaphisek Road
Huay Kwang, Bangkok, 10320, Thailand
Phone/Fax: +66-2694-3333 ext. 122 / +66-2694-3444
E-mail: surachet_tam@cewa.co.th
CEWA is not a project participant listed in Annex 1.

## SECTION C. Duration of the project activity / crediting period

### C.1 Duration of the project activity:

#### C.1.1. Starting date of the project activity:

7 April 2005 (The date on which a turnkey engineering, procurement and construction (EPC) contract was signed with a turnkey contractor; and a bank loan agreement was signed with a local bank)

#### C.1.2. Expected operational lifetime of the project activity:

25 years

### C.2 Choice of the crediting period and related information:

The renewable crediting period is chosen as described below.

#### C.2.1. Renewable crediting period

##### C.2.1.1. Starting date of the first crediting period:

1 January 2011 or the registration date, whichever comes later

##### C.2.1.2. Length of the first crediting period:

7 years

#### C.2.2. Fixed crediting period:

##### C.2.2.1. Starting date:

Not applicable

##### C.2.2.2. Length:

Not applicable

## SECTION D. Environmental impacts

In Thailand, according to section 46 of the National Environmental Quality Act (NEQA) B.E. 2535 (A.C. 1992), the Ministry of Natural Resources and Environment (MONRE) with the approval of the National Environmental Board (NEB) has the power to specify the type and size of projects or activities required to conduct an Environmental Impact Assessment (EIA). The Environmental Impact Assessment (EIA) is used to evaluate possible environmental impacts and to establish measures necessary to prevent or mitigate any environmental damages that may occur during the development and implementation of large-scale projects. This process ensures that projects are sustainably developed in an environmentally responsible manner. Consequently, large-scale CDM projects are required to conduct the EIA report and submit the report to the Office of the Natural Resources and Environmental Policy and Planning (ONEP), under the Ministry of Natural Resources and Environment, for review and make any necessary recommendations.

### D.1. If required by the host Party, documentation on the analysis of the environmental impacts of the project activity:

In case of power generating plants, an EIA is required for any plant with an installed capacity of 10 MW or larger, and the EIA results have to be presented to the local community as well. During the process, the public will get to know the project and have the opportunity to ask any questions or raise any concerns they may have, so that the project owner could address them properly. For small-scale CDM projects similar to MGP the installed capacity of which is less than 10 MW, the EIA study is not required but rather encouraged.

According to the project size and category, the Project is not required under Thailand's environmentally related laws and regulations to conduct an Environmental Impact Assessment (EIA) study. However, the project owner decided to undertake a comprehensive Initial Environmental Evaluation[5] (IEE), mitigation measures and monitoring programs, as well as several local community consultations, though they are not considered regulatory requirements. The project's objective of public participation is to allow public, non-governmental organizations (NGOs) and relevant agencies to be informed. The participants can share their comments or experiences, which have been taken into account in project development and assessment. The IEE report submitted by the Project received an approval from the Ministry of Natural Resources and Environment on August 4, 2006.

[5] Initial Environmental Evaluation (IEE) report is the initial study, using primary data, for forecasting the environmental impacts that may occur during project development period. In Thailand, The IEE report has been used for the small project development or the project that is not required to submit the EIA report. It investigates generic conditions of the environments at the project site and surrounding neighborhood at a stage before the project construction. Also, it will evaluate any impacts that might occur during the construction and after the project implementation. The scope of the investigation will cover nuisance conditions, focusing on the populated areas surrounding the project site, and other effects including atmospheric, surface water, groundwater, health risks, safety, and socio-economic conditions.

**D.2. If environmental impacts are considered significant by the project participants or the host Party, please provide conclusions and all references to support documentation of an environmental impact assessment undertaken in accordance with the procedures as required by the host Party:**

Mungcharoen Green Power Co., Ltd. (MGP), 9.9 MW rice husk fired power plant project, is a small-scale biomass power plant, which creates low or even insignificant environmental impacts. Positive effects will be gained and negative effects are low. In addition, this type of project is considered to have no significant impact to the environment, so the Environmental Impact Assessment (EIA) is not required by the Thailand National Environmental Board.

As required by laws, prior to the project construction, MGP project owner had received all required licenses and permits as following.

- Factory Operation License issued by the Department of Industrial Works, the Ministry of Industry
- Building Construction Permits from the local authority, issued by Burusi-Subdistrict Administration Organization and Surin Provincial Public Works Office
- Power Concession issued by the Department of Energy Business, the Ministry of Energy
- Controlled Energy Generation License issued by the Department of Alternative Energy Development and Efficiency, the Ministry of Energy
- Boiler Safety Operation License issued by the Department of Industrial Works, the Ministry of Industry
- Machinery Registration issued by the Department of Industrial Works, the Ministry of Industry.

During project implementation, in accordance with the Public Health Act, the Pollution Control Department (PCD) under the Ministry of Natural Resources and Environment (MONRE), has been involved in a wide range of waste disposal issues, from overseeing the process of waste transportation and disposal to establishing criteria aimed at controlling public nuisance caused by odor, light, radiation, sound, heat, vibration, dust, toxic tar and ash, and other hazardous substances. Along with other parties (e.g., the Department of Industrial Works, the Office of Natural Resources and Environmental Policy and Planning (ONEP), local municipalities, etc.), depending on the case, the PCD oversees business activities that endanger public health and regulates wastewater discharge and air emissions.

As required for implementation of the project activity, project owner had studied the possibility of environmental impacts and concluded that no negative impacts are possible due to the project activity. Having satisfied with the project design, local pollution control department represented by the Department of Industrial Works has accorded its consent for implementation and operation of the project.

Brief summary of Environmental Management Plan is summarized as follows.

**Water Supply and Treatment System:**

Two sources of raw water have been planned to use in this project; the first one comes from raw water ponds that collected rainwater, and the second one will be used as reserve water coming from groundwater from nearby areas. The project owner decided not to use water from the Aumpuen Reservoir (located approximately 15 kilometers from the site location) to reduce local people's concerns

about water quantity during a water shortage season in Surin province (about 5 months from April to August).

Raw water is supplied to water treatment system that comprised of a water pretreatment plant and a demineralization plant. Water pretreatment plant is used to eliminate or reduce water impurities. Treated water from pretreatment plant is delivered to demineralization plant to remove the ionic impurities and dissolved solid in the treated water before feeding to boiler. The power plant uses raw water approximately 62 $m^3$/hour that supply for cooling water makeup 60 $m^3$/hour, plant service water 0.5 $m^3$/hour, and water make up corresponding to steam blow-down of 1.5 $m^3$/hour.

**Cooling Water System:**

Cooling water system is mainly used for transfer heat from condenser to ambient, and some is used for turbine-generator oil cooler, feed water pump cooler, etc. Cooling water will be pumped from water tank to surface condenser, and transfer rejected heat from power plant process that cause increasing water temperature. High temperature cooling water will be sent to the cooling water and sprayed down, cross current with air direction, and then water temperature is declined. Low temperature cooling water will return to cool condenser and loss some vaporized water during decrease its temperature in cooling tower, and need make up water around 60 $m^3$/hour.

**Discharged Water System:**

The MGP project has been active to concerns of farmers and communities about discharged water to surrounding agricultural areas. Then, the zero discharged water system has been applied. The discharged water qualities are agreed with Thailand Industrial Discharge Water regulation issued by the Department of Industrial Works, the Ministry of Industry. Total discharge cooling water of the power plant is around 200 $m^3$/day, and is treated in equalizing tank, neutralizing tank, sludge thickener and dewater system, and finally treated water will be stored in a 10 $m^3$ tank to monitor pH, conductivity and turbidity before collecting treated water to a 400 $m^3$ wastewater earth pond that can collect treated water for two days for sludge sedimentation. Then, clear treated water will be stored in a 15,000 $m^3$ discharged water storage pond that can collect treated water for 2.5 months. The MGP project has sprinkled all clear treated water on grasses and trees in the 127,700 square meter (sq.m.) project's green areas.

| Total Discharge Water of the Project | $m^3$/hour | $M^3$/day |
|---|---|---|
| 1. Cooling tower rejected water | 5.40 | 129.60 |
| 2. Boiler rejected water Blow-down steam | 1.07 | 25.68 |
| 3. Reverse Osmosis (about 20% rejection of feed water) | 0.53 | 12.72 |
| 4. Demin. plant rejected water from resin | - | 8.00 |
| 5. Office & Factory wastewater | 1.00 | 24.00 |
| Total | | 200.00 |

**Air Pollution Management:**

During construction period, project owner had set the speed limit of trucks at 30 km./hour, provided two times (in the morning and afternoon) of water spraying on construction area and concrete road, and using plastic cover on soil, sand, and construction parts during transportation to reduce dust dispersion.

Moreover, project owner had been concerned about good operation and maintenance on engines of construction equipment and trucks to reduce air pollution.

The quantity of rice husks available from the operation of the Mungcharoenporn Rice Mill Group is sufficient to supply about 80 percent of the required rice husk for the electricity generation facility, while the remaining 20 percent will be provided by other rice mills within an average distance of 14 km. from the project site). (It is estimated that the Project would consume about 85,000 tons of rice husks while the two adjacent rice mills can supply about 70,000 tons of rice husks yearly.)

During project implementation, due to its light weight, small-size, moisture absorbable, and easy to be contaminated characteristics of rice husk, the project owner has constructed the 45-day rice husk indoor storage, and used wheel loader for unloading rice husk from truck to the indoor storage to minimize rice husk dust dispersion, maintain good quality of rice husk, control rice husk moisture content (around 15% of moisture), and reduce air pollution from the dust during transportation. Rice husk has been transported to the boiler by the conveyor system. The maximum height of the rice husk piles in the outdoor storage is 15 meters. The storage silo with the capacity of 1,300 $m^3$ at the adjacent rice mill has been used for night operation. Also, the project owner has planned for the operation and maintenance of fuel feeding system, and the combustion room has been designed for easy and efficient ash dumping and clean-up.

**Ash Handling System:**

According to Hazardous Substance Act, B.E. 2535 (1992), the Ministry of Industry has the statutory power to classify hazardous substances. Hazardous substances are defined as substances, chemicals, or other materials capable of endangering human health and safety, livestock, plants, property, or the environment. The list of hazardous substances includes explosives, inflammables, oxidizing substances, substances containing peroxide composites, toxic substances, substances capable of causing diseases, radioactive substances, substances capable of causing genetic changes, corrosive substances, and substances causing irritation. As a result, rice husk ash is not hazardous waste defined by the Ministry of Industry. The rice husk ash compositions are shown below.

| Rice Husk Ash Compositions | % (by weight dry basis) |
|---|---|
| $SiO_2$, Silica Dioxide, % | 92.7 |
| $Al_2O_3$, Aluminium Trioxide, % | 0.14 |
| $Fe_2O_3$, Iron Trioxide, % | 2.0 |
| CaO, Calcium Oxide, % | 0.54 |
| $TiO_2$, Titanium Dioxide, % | 0.02 |
| MgO, Magnesium Oxide, % | 0.35 |
| $SO_3$, Sulfur Trioxide, % | 0.37 |
| $P_2O_5$, Phosphate Pentoxide, % | 0.43 |
| $Na_2O$, Sodium Oxide, % | 0.07 |
| $Mn_3O_4$, Manganese Oxide, % | 0.19 |
| $K_2O$, Potassium Oxide, % | 2.5 |

The ash handling system provides for the collection of the steam boiler bottom ash and fly ash. The bottom ash from boiler is removed by using drag chain conveyors and fed into silos where the ash is stored. Fly ash is removed from the flue gases using an ash separator, which is composed of pre-separator system (Multi-Cyclones) and electrostatic precipitator (ESP). Fly ash in hoppers is manually removed and loaded onto trucks for onsite/offsite disposal. There are four methods that the MGP project has planned for the ash handling system as follows.

1. Ash Packing House is built to feed ash into silos and to pack bottom ash in packing bags using semi-automatic pneumatic machines. The MGP project has planned to sell the good quality bottom ash to cement industries or export them to foreign countries. The ash packing is processed in closed system to avoid ash dispersion to the atmosphere.
2. If the bottom ash cannot be sold, the MGP project will give all the ash to farmers for soil conditioning or for making fertilizer (free of charge).
3. In case that there are the remaining ash from item 1. and 2., the MGP project will hire the disposal company that registered with the Ministry of Industry to manage or dispose ash.
4. Inside the project area (around 1,120 sq. m.) is used as 6,700 $m^3$ ash disposals by sanitary landfill, in case that the project has to wait for the disposal company to pick up ash. The prepared sanitary landfill can fill ash about 49 days.

**Air Emissions Control System:**

The flue gas from boiler is removed by using induced draft fans, blown through the exhaust stack, and released to the atmosphere. Fly ash in flue gas is collected by two kinds of equipments, which are placed serially. First, large particles in flue gas is captured in cyclone by centrifugal force, that forces particle hit cyclone wall and drop down to the bottom. Smaller size particle will then be collected at the electrostatic precipitator that uses electrostatic force for capturing particle. Fly ash is sent through negatively charged plates which give the particles a negative charge. The negatively-charged particles are then routed past positively charged plates, and then are captured at these plates. Electrostatic precipitator normally have 2-3 cells, that can switch each cell for operation, while other is discharged for taking off ash from collecting plates. The air quality control system is designed to comply with all applicable regulations of the Pollution Control Department, the Ministry of Natural Resources and Environment (MONRE).

The air emission from the power plant has been tested. The test results showed that the air emission are not exceeded the air emission standard of the Department of Industrial Works, the Ministry of Industry. The test results are as following:

1. TSP- average 24 hours: 126.66 –318.66 $\mu g/Nm^3$
2. $SO_2$ - average 1 hour: 59.37 - 66.02 $\mu g/Nm^3$
3. $NO_2$ - average 1 hour: 130.69 – 137.19 $\mu g/Nm^3$
4. CO - average 1 hour: 302.47 – 1,051.89 $\mu g/Nm^3$

Preventive maintenance has been used in the project by setting that TSP must not exceed 108 $mg/Nm^3$. In order to support 24-hour monitoring of the Multi-cyclones and ESP operations, the project has used the Continuous Opacity Monitoring by installed Opacity Meter to measure Smoke Density. The Smoke Density signal will be shown at the control room to allow power plants operators to detect and solve problems in time.

**Solid Waste Management:**

The project has followed declare of the Department of Industrial Works on solid waste management. Solid waste occurred from water treatment system, resin, and lubricant oil have been disposed and managed by the Disposal Company that registered with the Ministry of Industry.

**Fire Protection System:**

Rice husk, which is sensible for fire, has been stored and managed in the 45-day indoor storage. To ensure fire protection, the MGP project has fire protection plan and coordinate with outside agency. The statutory requirements under the National Fire Protection Association (NFPA) have been adopted. At least every three-month, the project has planned to check the readiness of all fire extinguishers.

## SECTION E. Stakeholders' comments

**Public consultation requirements in Thailand**

In order for a project owner to construct and operate an industrial facility in the country, it is a normal procedure that the owner needs several official licenses from concerned authorities. Among these documents, there is a permit to be granted by the concerned local government authority. In Thailand, the administration of each province is divided into districts, sub-districts, villages. Being a government body, that is closest to a local community, the Subdistrict Administrative Organization is the local government authority with elected members from individual villages. Therefore, in the consideration of a project development in its responsible area, the Subdistrict Administrative Organization will represent its community to comment on the plan, whether to approve or to file a complaint or an objection against its development. Accordingly, prior to the construction, the project owner needs to discuss with the relevant Subdistrict Administrative Organization to obtain the permit. This is considered the first step towards public consultation for the project owner.

Apart from that, there are no specific public consultation requirements in Thailand, as is common in Europe, unless an Environmental Impact Assessment (EIA) is required. According to the regulations issued by the National Environment Board (NEB), EIA is required for large-scaled projects, including electric power facilities. In case of power generating plants, EIA is required for any plant with an installed capacity of 10 MW or larger, and the EIA results have to be presented to the local community as well. During the process, the public will get to know the project and have the opportunity to ask any questions or raise any concerns they may have, so that the project owner could address them properly. For smaller power plants, like Mungcharoen Green Power Co., Ltd. (capacity below 10 MW), the EIA process is not required but rather encouraged.

### E.1. Brief description how comments by local stakeholders have been invited and compiled:

**Community consultations**

Since the early stage of project development, the project owner has conducted regular consultations with the local community to explain the project activity and address any concerns that local stakeholders might have. Key local partners involved include community members, community leaders, Surin Sustainable Energy Working Group, other local NGOs and government officials in Surin Province. From December 2003 to December 2006, three public consultation programs and two study tours to Roi-Et Green[6] 9.9 MW rice husk fired power plant at Roi-Et province had been arranged.

Additional to the above programs, there was also a local radio interview arranged for public awareness campaign by a radio program in Surin province. Regular consultations and follow-up activities with the local community are also ongoing. Following is a brief summary of some official community consultation programs.

[6] Roi-Et Green Power Plant operated by Roi-Et Green Co. Ltd. is located in Roi-et province in the northeastern region of Thailand. It is a pilot biomass power plant with effective environmental management and is well accepted by the local community. It was developed and operated by EGCO, a subsidiary of EGAT. In 2004, Roi-Et Green won the top prize for on-grid alternative energy power plant from the Alternative Power Development Department, Ministry of Energy and the Asean Energy Forum held in the Philippines.

**Modalities of Invitations**

For the consultation sessions listed below, the project proponent invited local stakeholders and other participants by means of invitation letters and public notices.

**Public consultation programs:**

December 12, 2003 — 1st public consultation program

(1) Meeting at Mungcharoen Rice Mill: consultation with community leaders and heads of villages, about 20 village leaders and Chairperson of Burusi-Subdistrict Administrative Organization attended the meeting.

(2) Meeting at Northeast Development Foundation: consultation with local NGOs. About 11 NGO members attended the meeting. The meeting was also carried out with Surin Sustainable Energy Working Group, a network of local NGOs.

September 28, 2004 — 2nd public consultation program at Rachamongkol Institution of Technology (RIT) Surin: An open discussion was organised with a discussion topic of "Alternative fuels: Rice husk power plant. Share your ideas". There were at least 200 people attending the program. Participants included villagers from within 5-kilometre radius of the project site, head of villages, Chairmen and members of relevant Subdistrict Administrative Organization, academic institutions, government officers, NGOs, media and others. The program was also carried out with cooperation from Surin Sustainable Energy Working Group and broadcasted live in the Surin Sustainable Energy Working Group's radio program.

July 1, 2005 — 3rd public consultation program at Mungcharoen Rice Mill: Another open discussion was arranged with the project site visit. The program was set up more specifically for the community members and leaders in the neighboring area of the project site. About 100 people attended the program. Participants included villagers, especially from within 2-kilometre radius from the project site, head of villages, Chairmen and members of relevant Subdistrict Administrative Organization, government officers, and local NGOs.

Study tour to Roi-Et Green power plant:

February 19, 2004 — Study tour to Roi-Et Green power plant was arranged for Surin Sustainable Energy Working Group (Local NGO).

February 3, 2005 — Study tour to Roi-Et Green power plant was arranged for members of Burusi-Subdistrict Administrative Organization.

In each program above, the rational and the intention make the power plant a "Green and Clean" project to contribute to the Surin economy was explained. Also, simplified technical and practical information about the power project was also provided. There were open discussions among the participants. With considerable encouragement from the community leaders and NGOs, the project development is well welcomed and accepted among the community members.

## E.2. Summary of the comments received:

**December 12, 2003: 1st public consultation program**

- Morning session: consultation with community leaders and heads of villages, about 20 village leaders and Chairperson of Burusi-Subdistrict Administrative Organization attended the meeting, totaling 25 persons. Since simplified technical and practical information about the MGP project was also provided, the community leaders felt more comfortable about the power plant technology and had no concern. However, community leaders requested a site visit to Biomass power plant that already operated in Thailand to observe the problems of dust, wastewater, and local community that may occur due to power plant operation. The project owner offered to arrange a site visit to Roi-Et Green 9.9 MW rice husk fired power plant at Roi-Et province, Northeastern region of Thailand.
- Afternoon session: meeting at Northeast Development Foundation: consultation with Surin Sustainable Energy Working Group, a network of local NGOs. About 11 NGO members attended the meeting. Local NGOs had comments on rice husk ash handling management, farmer benefits, local people benefits, and future open discussion for local people. Please see section E.3 for details of each comments and action taken by project owner. After project owner's clarification session, local NGO members were agreed with the biomass power plant concept and technology. They hoped that this project will be the first "Green and Clean" biomass power plant project in Surin province.

**September 28, 2004: 2nd public consultation program**

An open discussion for local people was organized at Rachamongkol Institution of Technology (RIT) Surin. The discussion topic is "Alternative fuels: Rice husk power plant. Share your ideas". There were at least 200 people attending the program. Participants included villagers from within 5-kilometre radius of the project site, head of villages, Chairmen and members of relevant Subdistrict Administrative Organization, academic institutions, government officers, NGOs, media and others. The program was also carried out with cooperation from Surin Sustainable Energy Working Group and broadcasted live in the Surin Sustainable Energy Working Group's radio program.

Major comments from the open discussion are as following:

- Local people's concerns about water quantity during a water shortage season in Surin (5 months from April to August) if the power plant used water from the Aumpuen Reservoir
- Local people concern about safety of discharged water to surrounding agricultural and community areas.
- Farmers felt that once the MGP power plant is operated, rice husk price will be increased and they will have a hard time to buy rice husk to make fertilizer.
- Local people concern about effects from dust dispersion from rice husk and ash from power plant.
- Local people concern about traffic occurred during rice husk transportation from rice mills to the MGP project.

Once, the project owner and technical consultant team had answered local people's concerns and comments. Local people felt more comfortable and had no resistance on the MGP project, after they received more information about rice husk fired power plant project, as well as the implementation and

mitigation plan to reduce any concerns of local people, farmers, and communities. Moreover, local people also said that the Mungcharoenporn Group is famous for good corporate governance, so they are proud that there will be the first biomass power plant located in Surin and owned by Surin people.

**July 1, 2005: 3rd public consultation program**

Another open discussion was arranged at Mungcharoen Rice Mill with the project site visit. The program was set up more specifically for the community members and leaders in the neighboring area of the project site. About 100 people attended the program. Participants included villagers from in 2-kilometre radius from the project site, head of villages, Chairmen and members of relevant Subdistrict Administrative Organization, government officers, and local NGOs. Major comments from the open discussion and the project site visit are as following:

- Currently, rice mills cause dust problem to communities, so local people concern about dust from power plant would increase their dust problem
- Loud noise from rice mill
- Safety issues and mitigation plan of the MGP project

## E.3. Report on how due account was taken of any comments received:

**December 12, 2003: 1st public consultation program:**

- Morning session: consultation with community leaders and heads of villages since simplified technical and practical information about the MGP project was also provided; the community leaders felt more comfortable and had no concern. However, community leaders requested a site visit to Biomass power plant that already operated in Thailand.

Action taken by project owner: February 3, 2005, the project owner arranged a study tour to Roi-Et Green power plant for members of Burusi-Subdistrict Administrative Organization.

**December 12, 2003: 1st public consultation program:**

- Afternoon session: consultation with Surin Sustainable Energy Working Group, a network of local NGOs. About 11 NGO members attended the meeting. The meeting had comments and the project owner clarified each comment as table below.

| Local NGOs' Comments / Suggestions | Project Owner's Clarification |
|---|---|
| 1. Rice husk ash has the alkalinity characteristics. If ash-handling system is not well managed, it may have the impact on the soil condition of farmers in the neighboring area. | 1. The project has planned to manage all rice husk ash in closed system to avoid ash dispersion and cleanliness problems. Moreover, the project has planned to sell good quality ash to other industries, so that well management of ash must be used. |
| 2. Will the MGP power plant create any benefits to farmers? | 2. The project owner showed the intention to increase rice grain price for farmers who sell rice grain to the Mungcharoenporn Rice Mills. Farmers will also receive additional |

| Local NGOs' Comments / Suggestions | Project Owner's Clarification |
|---|---|
| | amount of money to the normal price. The MGP project will lead to an increase in local economic activities and employment opportunities of people in the local area. The local employment will generate more incomes and lead to the improvement in people's quality of life. |
| 3. Local NGOs commented that there was no opponent from local communities at the first stage. However, if local people have received incorrect information from other sources, the project may face the obstacle from local people. So, local NGOs suggested that the project owner should arrange another public consultation program as an open discussion for local people to reduce future problems. | 3. The project owner has agreed with local NGOs' comment and confirmed that there will be another public consultation program for local people after the study tour to Roi-Et Green power plant for community leaders. |
| 4. Local NGOs has agreed with the MGP project owner that the biomass power plant project will help country as an alternative energy (as Green and Clean energy). | |
| 5. Local NGO members were glad that the MGP power plant will be the first biomass power plant project in Surin and owned by Surin people. The MGP project will create value added to natural resources within the province, create more job occupancy, and increase local people's quality of life. | |
| 6. Northeast Development Foundation has broadcasted about energy topic every Thursday during 11 a.m. – noon, so this program will help provide more information about the project to local people. | |

Action taken by project owner: February 19, 2004, the project owner arranged a study tour to Roi-Et Green power plant for members of Surin Sustainable Energy Working Group (Local NGO).

**September 28, 2004: 2nd public consultation program**

An open discussion for local people with the discussion topic of "Alternative fuels: Rice husk power plant. Share your ideas". About 200 people had joined the program. Major comments from the open discussion and project owner clarification are as table below.

| Local NGOs' Comments / Suggestions | Project Owner's Clarification |
|---|---|
| 1. Local people concern about water quantity during a water shortage season in Surin (five months from April to August) if the power plant used water | 1. The project owner decided not to use water from the Aumpuen Reservoir (located approximately 15 kilometers |

| Local NGOs' Comments / Suggestions | Project Owner's Clarification |
|---|---|
| from the Aumpuen Reservoir | from the site location) to reduce local people's concerns. So, two sources of raw water had been planned to use in this project; the first one comes from raw water ponds that collected rainwater, and the second one will be used as reserve water coming from groundwater from nearby areas. |
| 2. Local people concern about safety of discharged water to surrounding agricultural and community areas. | 2. The MGP project has been active to concerns of farmers and communities about discharged water to surrounding agricultural areas. Then, the zero discharged water system has been applied. The MGP project has sprinkled all clear treated water on grasses and trees in the 32,000 square meter (sq.m.) project's green areas. |
| 3. Farmers felt that once the MGP power plant is operated, rice husk price will be increased and they will have a hard time to buy rice husk to make fertilizer. | 3. From the statistics, rice husks quantity produced in Surin province is about 252,271 to 302,424 tons/year. The MGP project will use rice husk no more than 111,091 tons/year. There are still sufficient rice husks (approximately 141,000 to 191,000 tons) in the province. Moreover, MGP project will give rice husk ashes to farmers for soil conditioning or for making fertilizer free of charge. |
| 4. Local people concern about effects from dust dispersion from rice husk and ash from power plant. | 4. The project owner has constructed the 45-day rice husk indoor storage, and used wheel loader for unloading rice husk from truck to the indoor storage to minimize rice husk dust dispersion and reduce air pollution from the dust during transportation. Rice husk has been transported to the boiler by the conveyor system. Also, the project owner has planned for the operation and maintenance of fuel feeding system, and the combustion room has been designed for easy and efficient ash dumping and clean-up.<br><br>The ash handling system provides for the collection of the steam boiler bottom ash and fly ash. The bottom ash from boiler is removed by using drag chain conveyors and |

| Local NGOs' Comments / Suggestions | Project Owner's Clarification |
|---|---|
| | fed into silos where the ash is stored. Fly ash is removed from the flue gases using an ash separator, which is composed of pre-separator system (Multi-Cyclones) and electrostatic precipitator (ESP). Fly ash in hoppers is manually removed and loaded onto trucks for onsite/offsite disposal. |
| 5. Local people concern about traffic occurred during rice husk transportation from rice mills to the MGP project. | 5. The project will transport rice husks no more than 30 trucks/day (or around 1% of all truck transportation in Surin), comparing to normal transportation by truck in Surin (about 2,500 – 3,700 trucks/day). The project has planned to transport rice husk within 30-kilometer radius from the project site. |

**July 1, 2005: 3rd public consultation program**

Another open discussion was arranged at Mungcharoen Rice Mill with the project site visit. The program was set up more specifically for the community members and leaders in the neighboring area of the project site. About 100 people attended the program. Participants included villagers from in 2-kilometre radius from the project site, head of villages, Chairmen and members of relevant Subdistrict Administrative Organization, government officers, and local NGOs. Major comments from the open discussion and the project site visit, including project owner clarification are as table below.

| Local NGOs' Comments / Suggestions | Project Owner's Clarification |
|---|---|
| 1. Currently, rice mills cause dust problem to communities, so local people concern about dust from power plant would increase their dust problem. | 1. The project owner and technical advisor had planned to manage and remove fly ash from the flue gases using an ash separator, which is composed of pre-separator system (Multi-Cyclones) and electrostatic precipitator (ESP). This technology has efficiency to detect more than 99.6% of more than 0.1-micron dust. Moreover, dust from power plant will be less than 40-kilogram per day, which is less than dust from rice mill about 50 times. Once, the MGP power plant is operated, Mungcharoenporn rice mill will use power produced from power plant. The conventional rice mill technology will be removed, so the dust from rice mill will be reduced. |
| 2. Loud noise from rice mill | 2. After the power plant operated, Mungcharoenporn rice mill will use electrical motors instead of the old rice mill |

| Local NGOs' Comments / Suggestions | Project Owner's Clarification |
|---|---|
| | technology. As a result, the noise from the rice mill will be reduced. |
| 3. Safety issues and mitigation plan of the MGP project | 3. During the construction and operation, safety measure and equipment will be provided according to industrial safety standard. |

## Annex 1

## CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

| | |
|---|---|
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## Annex 2

## INFORMATION REGARDING PUBLIC FUNDING

No public funding from Annex I Parties is involved in the project activity (see Attachment 1 for MGP Letter Confirming No Public Funding Involvement).

## Annex 3

## BASELINE INFORMATION

As explained in Section B.4, the baseline for the Project is chosen to be the kWh produced by the Project multiplied by an emission coefficient (measured in kg $CO_2e$/kWh) calculated in a transparent and conservative manner as a combined margin (CM), consisting of the combination of operating margin (OM) and build margin (BM) according to the procedures prescribed in the Tool to calculate the emission factor for an electricity system.

**Step 1. Identify the relevant electric power system**

Since the Project is connected to the EGAT's national grid through transmission and distribution lines, the relevant project electricity system is the EGAT's national grid.

**Step 2. Select an operating margin (OM) method**

The calculation of the OM emission factors can be based on one of the following four methods: (a) Simple OM, (b) Simple Adjusted OM, (c) Dispatch Data Analysis OM, or (d) Average OM.

Since low-cost/must-run resources constitute less than 50 percent of the total grid generation in average of the five most recent years, the Simple OM method is chosen here.

**Step 3. Calculate the operating margin emission factor according to the selected method**

The emission factor of the Simple OM chosen in Step 2 above will be calculated using the Ex ante option where a 3-year generation weighted average based on the most recent data available. In this case the gross and/or net generation of each power plant connected to EGAT's system is available up to the year 2007. Therefore the calculation will be based on the data from 2005 to 2007. The emission factor calculated in this PDD will be used throughout the crediting period.

Due to the unavailability of fuel consumption of each power plant in EGAT power system, Option B will be chosen. Therefore the Simple OM emission factor will be calculated based on data on net electricity generation, the average efficiency of each power unit and the fuel type(s) used in each unit.

Therefore,

$$EF_{grid,OMSimple,y} = \frac{\sum_m EG_{m,y} \cdot EF_{EL,m,y}}{\sum_m EG_{m,y}}$$

Where:

$EF_{grid,OMSimple,y}$ = Simple operating margin $CO_2$ emission factor in year y ($tCO_2$/MWh);

$EG_{m,y}$ = Net quantity of electricity generated and delivered to the grid by power unit m in year y (MWh);

$EF_{EL,m,y}$ = $CO_2$ emission factor of power unit m in year y ($tCO_2$/MWh);

m = All power units serving the grid in year y except low-cost/must-run power units;

y = the three most recent years for which data is available at the time of submission of CDM-PDD to the DOE for validation (ex ante option) following the guidance on data vintage in Step 2.

Since only the data on electricity generation and the fuel types used is available, the emission factor should be determined based on the $CO_2$ emission factor of the fuel type used by the power plant and the efficiency of the power unit as follows:

$$EF_{EL,m,y} = \frac{EF_{CO2,m,i,y}.3.6}{n_{m,y}}$$

Where:

$EF_{EL,m,y}$ = $CO_2$ emission factor of power unit m in year y ($tCO_2/MWh$);

$EF_{CO2,m,i,y}$ = Average $CO_2$ emission factor of fuel type i used in power unit m in year y ($tCO_2/GJ$);

$EG_{m,y}$ = Net quantity of electricity generated and delivered to the grid by all power unit m in year y (MWh);

$n_{m,y}$ = Average net energy conversion efficiency of power unit m in year y (%);

y = the three most recent years for which data is available at the time of submission of CDM-PDD to the DOE for validation (ex ante option) following the guidance on data vintage in step 2.

From EGAT's most recent PDP (PDP 2007: Revision 1), the average net efficiency of each type of power plant can be calculated as follows:

**Table A.1: Average Net Efficiency Calculation for Each Type of Power Plant from below PDP Information**

| Type of Power Plant | 5-year Gross Generation (GWh) | Auxiliary Consumption (%) | 5-year Net Generation (GWh) | 5-year Fuel Consumption | | Net Calorific Value | | Net Efficiency (%) |
|---|---|---|---|---|---|---|---|---|
| | | | | Amount | Unit | Amount | Unit | |
| **Lignite** | **92,268** | **6.6** | **86,178** | **80,970** | **ktons** | **2,500** | **kcal/kg** | **36.61** |
| **Coal** | | | **57,828** | **21,120** | **ktons** | **6,300** | **kcal/kg** | **37.37** |
| **Fuel Oil** | **2,174** | **7.0** | **2,022** | **511** | **mil.lit.** | **9,500** | **kcal/lit** | **35.81** |
| **Diesel** | **190** | **7.0** | **177** | **50** | **mil.lit.** | **8,700** | **kcal/lit** | **34.93** |
| Natural Gas-EGAT | 253,371 | 2.5 | 247,037 | 1,980,490 | mil.cu.ft. | 1,000 | Btu/cu.ft. | 42.56 |
| Natural Gas-Private | | | 315,095 | 2,289,645 | mil.cu.ft. | 1,000 | Btu/cu.ft. | 46.96 |
| **Natrual Gas - Overall** | | | **562,132** | **4,270,135** | **mil.cu.ft.** | **1,000** | **Btu/cu.ft.** | **44.92** |

References: EGAT PDP-2007 - for power generation and fuel consumptions (shown in next page)
EGAT Annual Generation Data - for auxiliary consumption of each type of power plant
PTT - for NCV of natural gas
DEDE - for NCV of lignite, coal, fuel oil and diesel

| EGAT PDP - 2007 | | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|
| Lignite | Gross Generation (GW | 18,313 | 18,144 | 18,553 | 18,648 | 18,610 |
| | ktons | 16,390 | 15,850 | 16,200 | 16,290 | 16,240 |
| Coal | Net Generation (GWh) | 10,533 | 10,081 | 10,081 | 11,085 | 16,048 |
| | ktons | 3,840 | 3,690 | 3,690 | 4,060 | 5,840 |
| Fuel Oil | Gross Generation (GW | 296 | 51 | 1,033 | 102 | 692 |
| | mil.lit | 73 | 12 | 245 | 23 | 158 |
| Diesel | Gross Generation (GW | 38 | 38 | 38 | 38 | 38 |
| | mil.lit | 10 | 10 | 10 | 10 | 10 |
| Natural Gas - EGAT | Gross Generation (GW | 42,161 | 49,746 | 50,846 | 55,730 | 54,888 |
| | Mcu.ft./day | 946 | 1,095 | 1,070 | 1,189 | 1,126 |
| | Mcu.ft. | 345,290 | 399,675 | 390,550 | 433,985 | 410,990 |
| Natural Gas - Private | Net Generation (GWh) | 61,881 | 62,224 | 60,632 | 64,243 | 66,115 |
| | Mcu.ft./day | 1,236 | 1,244 | 1,204 | 1,289 | 1,300 |
| | Mcu.ft. | 451,140 | 454,060 | 439,460 | 470,485 | 474,500 |
| Note: for Natural Gas | Total Generation (GW | 113,420 | 121,174 | 120,891 | 129,178 | 130,219 |
| | SPP Generation (GWh | 9,378 | 9,204 | 9,413 | 9,205 | 9,216 |
| | Total Mcu.ft/day | 2,182 | 2,339 | 2,274 | 2,478 | 2,426 |

The $CO_2$ emission factor in $tCO_2/MWh$ for each type of power plant can then be calculated as shown below:

**Table A.2: $CO_2$ Emission Factor Calculation in $tCO_2/MWh$**

| Type of Fuel | Fraction of Carbon Oxidised | CO2 Emission Factor (tCO2/GJ) | Average Net Efficienc (%) | CO2 Emission Factor (tCO2/M |
|---|---|---|---|---|
| IPCC Data Source | Default | Table 2.2 | | |
| Lignite | 1.000 | 0.1010 | 36.61 | 0.99328 |
| Coal | 1.000 | 0.0983 | 37.37 | 0.94696 |
| Fuel Oil | 1.000 | 0.0774 | 35.81 | 0.77808 |
| Diesel Oil | 1.000 | 0.0741 | 34.93 | 0.76375 |
| Natural Gas | 1.000 | 0.0561 | 44.92 | 0.44962 |

Reference: IPCC2006

From EGAT's most recent record of power generation and the above $CO_2$ emission factors, the Simple OM emission factors from 2007 to 2005 are calculated as:

**Table A.3: Simple Operating Margin Emission Factors from the three most recent years (2005-2007)**

| Type of Power Plant | $CO_2$ Emission Factor ($tCO_2$/MWh) | Net Generation | | | Grid Emissions | | |
|---|---|---|---|---|---|---|---|
| | | 2007 (GWh) | 2006 (GWh) | 2005 (GWh) | 2007 ($tCO_2$) | 2006 ($tCO_2$) | 2005 ($tCO_2$) |
| Lignite | 0.99328 | 17,295 | 16,855 | 17,142 | 17,178,429 | 16,741,637 | 17,026,399 |
| Coal | 0.94696 | 12,300 | 6,361 | 2,238 | 11,648,023 | 6,023,172 | 2,118,957 |
| Heavy oil | 0.77808 | 2,860 | 7,943 | 7,288 | 2,225,103 | 6,180,504 | 5,670,619 |
| Diesel | 0.76375 | 19 | 70 | 169 | 14,557 | 53,188 | 129,128 |
| Natural Gas | 0.44962 | 97,024 | 93,082 | 93,649 | 43,623,751 | 41,850,992 | 42,106,225 |
| Total | | 129,498 | 124,310 | 120,486 | 74,689,864 | 70,849,492 | 67,051,328 |
| Grid Emission Factor | | | | | 0.57676 | 0.56994 | 0.55651 |
| **Average Simple Operating Margin Grid Emission Factor** | | | | | | | **0.56774** |

Reference: EGAT Annual Generation Data

The 3-year generation-weighted average of the Simple OM emission factor is **0.56774 $tCO_2$/MWh.**

**Step 4. Identify the cohort of power units to be included in the build margin**

The sample group of power units m used to calculate the Build Margin for this Project consists of the set of power capacity additions in the EGAT's national grid system that comprise 20% of the system generation (in MWh) and that have been built most recently. The power plants included in this sample are listed below. They altogether generated a net electricity of 35,386.14 GWh. That was more than 20% of power generation in 2007 (28,872.61 GWh) where the overall net power generation was 144,363.08 GWh. It was also larger than the annual generation of the set of five power plants built most recently. None of the sample power units below have been built more than 10 years ago. Neither of them has been registered as CDM project activities:

**Table A.4: Power Plants included in the Build Margin Emission Factor Calculation**

| No. | Power Plant | Type of Fuel | COD | Net Generation in 2007 (GWh) | Accumulated Net Generation (GWh) |
|---|---|---|---|---|---|
| | Various | Hydro and Renewable | 2007-2003 | 2,180.83 | 2,180.83 |
| 1 | Ratchaburi Power | Natural Gas | 2007 | 66.72 | 2,247.55 |
| 2 | B.L.C.P. | Coal | 2006 | 10,155.69 | 12,403.24 |
| 3 | District Cooling | Natural Gas | 2006 | 40.15 | 12,443.39 |
| 4 | Gulf Power Generation | Natural Gas | 2006 | 4,300.96 | 16,744.36 |
| 5 | Asean Superia Food | Natural Gas | 2005 | 12.21 | 16,756.57 |
| 6 | Krabi | Fuel Oil | 2004 | 918.67 | 17,675.24 |
| 7 | Eastern Power&Elec. | Natural Gas | 2003 | 2,582.82 | 20,258.06 |
| 8 | Glow IPP Co.,Ltd. | Natural Gas | 2003 | 5,175.34 | 25,433.41 |
| 9 | Ratchaburi | Natural Gas | 2002 | 9,952.74 | 35,386.15 |

**Step 5. Calculate the build margin emission factor**

The Build Margin emission factor is the generation-weighted average emission factor ($tCO_2/MWh$) of all power units *m* during the most recent years for which power generation data is available, calculated as follows:

$$EF_{grid,BM,y} = \frac{\sum_m EG_{m,y} x EF_{EL,m,y}}{\sum_m EG_{m,y}}$$

where:

$EF_{grid,BM,y}$ = Build margin $CO_2$ emission factor in year y ($tCO_2/MWh$);

$EG_{m,y}$ = Net quantity of electricity generated and delivered to the grid by power units m in year y (MWh);

$EF_{EL,m,y}$ = $CO_2$ emission factor of power unit m in year y ($tCO_2/MWh$);

$m$ = Power units included in the build margin;

$y$ = Either the three most recent years for which data is available at the time of submission of CDM-PDD to the DOE for validation (ex ante option).

The total emissions of the Build Margin power plants listed in Step 4 above is computed from the net power generation and the $CO_2$ emission factor calculated earlier as follows:

**Table A.5: Total $CO_2$ Emissions of Build Margin Power Plants**

| Type of Power Plant in Build Margin List | Total (GWh) | $CO_2$ Emission Factor ($tCO_2/MWh$) | $CO_2$ Emission ($tCO_2$) |
|---|---|---|---|
| Hydro and Renewable | 2,180.83 | 0.0 | 0 |
| Coal | 10,155.69 | 0.94696 | 9,617,035 |
| Fuel Oil | 918.67 | 0.77808 | 714,803 |
| Natural Gas | 22,130.96 | 0.44962 | 9,950,433 |
| Total | 35,386.15 | | 20,282,271 |

Therefore, the Build Margin emission factor is 20,282.271/35,386.15 = **0.57317 $tCO_2/MWh$.**

**Step 6. Calculate the combined margin emissions factor**

The combined margin emission factor is calculated as follows:

$$EF_{grid,CM,y} = EF_{grid,OM,y} x\, w_{OM} + EF_{grid,BM,y} x\, w_{BM}$$

where:

$EF_{grid,CM,y}$ = Combined margin emission factor in year y ($tCO_2$/MWh);

$EF_{grid,OM,y}$ = Operating margin emission factor in year y ($tCO_2$/MWh);

$EF_{grid,BM,y}$ = Build margin emission factor in year *y* ($tCO_2$/MWh);

$w_{OM}$ = Weighting of operating margin emission factor (%), 0.5 for the first crediting period;

$w_{BM}$ = Weighting of build margin emission factor (%), 0.5 for the first crediting period.

| Type of Margin | Emission Factor (tCO2/MWh) | Weight |
|---|---|---|
| Avg. Simple OM | 0.56774 | 0.5 |
| Build Margin | 0.57317 | 0.5 |
| Combined Margin | 0.57045 | 1.0 |

Using the default values of the weighting factors for both operating and build margin emission factors, the combined margin emission factor is then equal to **0.57045 $tCO_2$/MWh.**

**Project Emission Calculation**

| | | | |
|---|---|---|---|
| Maximum annual rice husks use | 109,480 | tons | Reference: Fuel use calculation in "Leakage Assessment Worksheet" |
| Rice husks supplied by adjacent rice mills | 70,000 | tons | |
| Rice husks supplied by others | 39,480 | tons | |
| Rice husks loading per each truck trailer | 10 | tons | Reference: typical values |
| No. of trips for transporting rice husks from other mills | 3,948 | trips | |
| Average round trip distance between other mills and MGP | 28 | km. | Reference: Initial estimate, but will be recorded as part of the monitoring plant |
| Average $CO_2$ emission factor for trucks | 0.001043 | $tCO_2$/km | Reference: See notes below |

**Calculated Project Emissions** **115 tons**

Notes:

| | | | |
|---|---|---|---|
| Fuel economy of heavy duty diesel vehicle (20-ton truck) | 2.2 | km/l | Reference: Revised 1996 IPCC table 1-32 |
| Default $CO_2$ emission factor for diesel | 74.1 | $tCO_2/TJ$ | Reference: 2006 IPCC table 3.2.1 page 3.16 |
| Default Net calorific Values (NCV) for diesel | 36.42 | MJ/kg | Reference: DEDE |
| Density of diesel fuel | 0.85 | kg/l | |
| | 0.001043 | $tCO_2/km$ | |

**Emission Reductions**

| | | |
|---|---|---|
| Electricity exported to EGAT in MW | 8.0 | MW |
| Annual operation hours | 7,884 | hours |
| Electricity exported to EGAT in MWh | 63,072 | MWh |

| | | |
|---|---|---|
| Electricity exported to Rice Mills in MW | 0.8 | MW |
| Annual operation hours | 7,884 | hours |
| Electricity exported to Rice Mills in MWh | 6,307 | MWh |

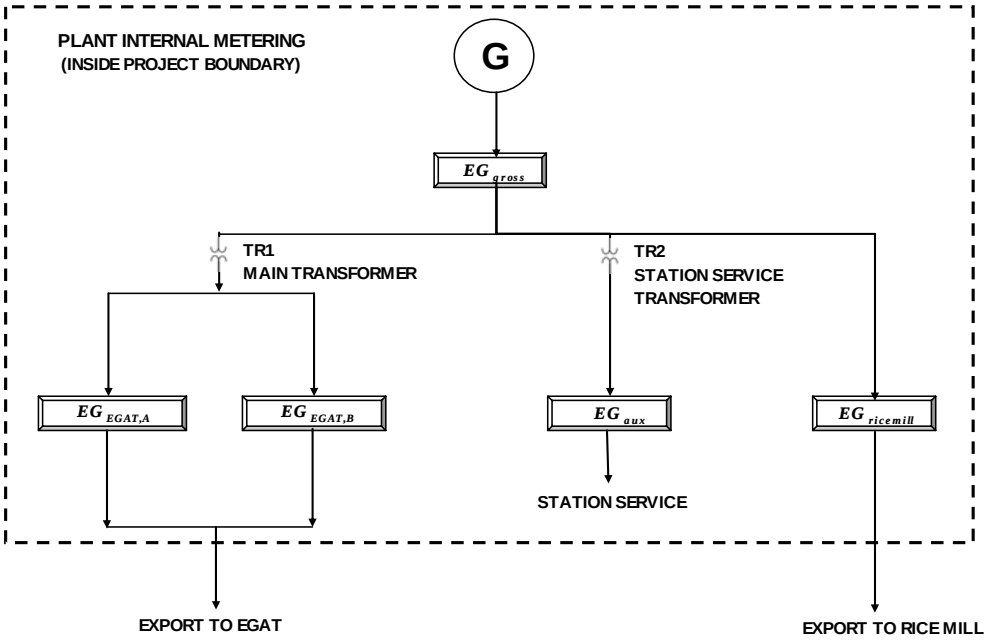
| | | |
|---|---|---|
| Total annual exported electricity | 69,379 | MWh |
| Combined margin emission factor (from another worksheet) | 0.57045 | tCO2/MWh |
| Emission reduction due to substitution of grid electricity | 39,577 | tCO2 |
| Project emissions (from another worksheet) | 115 | tCO2 |
| Leakage emissions (from attached Leakage Assessment) | - | tCO2 |
| Therefore, ex-ante calculation of emission reductions from the project activity | 39,462 | tCO2 |

## Annex 4

## MONITORING INFORMATION

**Mungcharoen Green Power Co., Ltd., Surin Province, Thailand**

**Energy Metering Diagram**




| Meter Tag | Meter name | Function |
|---|---|---|
| $EG_{gross}$ | Gross Generation Meter | Measure gross generation |
| $EG_{EGAT,A}$ | Export to EGAT (Main meter) | Measure energy export to EGAT (Main Meter) |
| $EG_{EGAT,B}$ | Export to EGAT (Back up meter) | Measure energy export to EGAT (Back up Meter) |
| $EG_{aux}$ | Auxiliary Load Meter | Measure energy usage by MGP |
| $EG_{ricemill}$ | Export to Rice mill meter | Measure energy export to rice mill |

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