三菱証券

Project Design Document

for

A.T. Biopower
Rice Husk Power Project

April 2003

Mitsubishi Securities

Clean Energy Finance Committee

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A. General description of project activity

A.1. Title of the project activity:

A.T. Biopower Rice Husk Power Project in Thailand. (The ATB Project or the Project.)

A.2. Description of the project activity:

A.2.1. Purpose of the Project activity

The Project is designed to use for combined heat and power (CHP) generation rice husk that would otherwise be burned in the open air or left to decay.

It involves the construction and operation of five new rice husk power plants in central Thailand, each having approximately 22 MW gross generating capacity, 20MW net. Electricity will be sold through 25-year power purchase agreements (PPAs) with the Electricity Generating Authority of Thailand (EGAT). The designed-as CHP facilities, the plants will also supply steam to industrial and agricultural users in their vicinity. The Project will assist Thailand's sustainable growth by providing electricity and steam through biomass power production without relying on fossil fuel combustion.

Two additional greenhouse gas (GHG) reduction benefits will materialise as an integral part of this project activity. The first benefit is the reduced disposal of rice husk, which will result in a reduction of methane emissions. The other benefit stems from the use of the ash product as a replacement for cement ingredient, thus reducing emissions associated with the emission-intensive cement manufacturing process.

A.2.2. Contribution to the sustainable development of the host country

According to the Power Development Plan (PDP) by the Electricity Generating Authority of Thailand (EGAT)[1], Thailand's demand for electricity will double from 100,322 GWh in 2001 to 203,778 GWh in 2012. Against this backdrop, securing steady supply sources of electricity is a matter of vital importance for the Thai economy.

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[1] EGAT Power Development Plan (PDD) 2001, Appendix 8

Biomass fuels, especially rice husk and bagasse, represent particularly rich energy resources for Thailand. These renewable energy sources currently fuel less than 1% of Thailand's electricity generation, which is dominated by natural gas, lignite and imported fuel oil.

Recognizing the potential contribution of renewable energy to the Thai energy mix, the government has placed great importance on supporting environmentally friendly, indigenous, and renewable sources of energy. It is noteworthy that Thailand's National CDM Strategy[2] released by the Office of Environmental Policy and Planning, places biomass renewable energy at the top of the list of promising CDM project areas for Thailand. In addition to providing renewable energy, the Project will have an added contribution to Thailand's sustainable development in that it will improve the disposal of a major source of agricultural waste.

A.2.3. Project plans

A.2.3.1. Electricity sales

The main channel for EGAT's purchases of renewable energy is the *Small Power Producer Program*[3]. Standardized power purchase agreements (PPAs) with EGAT under the SPP Program run from 6 to 25 years. ATB will apply for 25-year firm agreements with a contracted capacity of 20 MW per plant, whereby EGAT guarantees minimum purchase of 80% of the contracted capacity.

Given ATB's plan to operate its plants for 24 hours a day, 346 days a year, the minimum amount of electricity sales to EGAT will be 660,000MWh/year:

$$5 \times 20\text{MW} \times 24^{h} \times 346^{d} \times 80\% \cong 660{,}000\text{MWh/year}$$

It is expected that ATB's plants will internally consume about 10% of the electricity they produce. Taking this into consideration, exporting the above amount to EGAT requires ATB to

2 National Clean Development Mechanism Strategy Study for the Kingdom of Thailand 2002, p.7

3 A Small Power Producer (SPP) can be any private, government or state enterprise that generates electricity either (a) from non-conventional sources such as wind, solar and mini-hydro energy or fuels such as waste, residues or biomass, or (b) from conventional sources as well as producing steam through cogeneration.

generate 730,000MWh/year of electricity:

(660,000MWh/year)/(1 - 0.1) = 730,000MWh/year

A.2.3.2. Steam sales

ATB plans to sell steam to agricultural and industrial users.

Using rice husk as fuel, ATB can generate low-pressure steam at a much lower cost than using fuel oil. Thus, selling steam to nearby industrial and agricultural users could result in substantial advantages both environmentally and economically. In addition, the provision of low cost steam for agricultural uses such as paddy drying, for which there is substantial demand, would offer large social and political benefits.

The sale of steam will require additional capital investment in the equipment, most significantly a boiler about 20% larger than is necessary for electricity generation alone. The cost of this larger boiler has been included in the Project's cost estimates.

For industrial sales, the discussions ATB has had with one of the largest paper mill in East Asia, located next to one of ATB's plant sites, indicate that there is a strong possibility that the paper mill will purchase a significant part of its steam requirements from ATB[4].

The purchase is expected to be of the order of 24 tonnes an hour, 10 hours a day on 346 days a year (days on which the ATB plant operates). This brings ATB's total annual steam supply to 83,000tonnes. ATB will provide the steam at 6 bar.

A.2.3.3. Sale of rice husk ash to cement manufacturer(s)

As stated in A4.3.3, rice husk to be used as fuel by the Project will yield about 127,000 tonnes/year of ash. Rice husk ash (RHA) produced in properly controlled facilities such as ATB's power plants is a non-crystalline silica ash suitable for mixing with Portland cement to make concrete. When RHA is used in lieu of the same amount of Portland cement, it would effectively displace GHG emission-intensive cement manufacturing process.-Much research has been conducted on RHA's role as a strengthening admixture for cement, with the following

[4] The name of the paper mill has been disclosed to the validator under a confidentiality agreement.

patent showing the practical potential.

United States Patent: "Highly Durable Cement Products Containing Siliceous Ashes"
Date: September 13, 1994
Inventor: Mehta, Provinhdar K. (El Cerrito, CA)
Assignee: The Regents of California (Oakland, CA)
Application Number: 000047

ATB has entered into discussions with well-established Thai cement manufacturers for the sale of approximately 30,000 tonnes/year of RHA[5]. In the best case, these and other cement manufacturers will buy all of ATB's RHA expected to amount to 127,000 tonnes annually.

The purchase agreements to be concluded with cement manufacturers will stipulate that the RHA purchase from ATB is for the purpose of using it as a cement replacement by mixing it with cement. They will also state that the cement manufacturer who buys the RHA will not develop a separate CDM project based on GHG emissions reduction in its cement production accomplished with the RHA purchased from ATB.

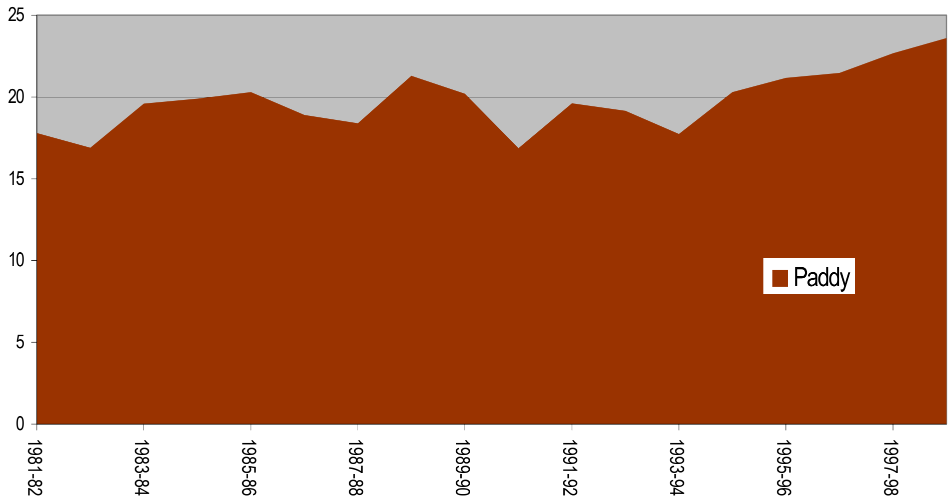
A.2.3.4. Rice husk availability and procurement

Rice has always been Thailand's flagship agricultural product, with Thailand the world's largest exporter of rice. Production is stable. From 1981 to 1999, the average yearly production was about 20 million metric tons a year. The following graph[6] shows a general increase of about 1 to 2% per year. In the 1998-99 crop year, 23.5 million tonnes were produced, and in the record crop of 2000-01, some 26 million tonnes were produced.

5 The names of these cement manufacturers have been disclosed to the validator under a confidentiality agreement.

6 Statistics from the Office of Agricultural Economics, Ministry of Agriculture and Cooperatives.

Paddy Production in Thailand 1981-99 (millions of metric ton)



Central Thailand, the location of ATB's power plants and fuel supply, is a rich alluvial plain with an extensive network of irrigation canals. Most farmers in the region enjoy three rice harvests a year.

ATB considers its fuel supply area to be the 18 provinces[7] comprising the five provinces where the plants are located, plus 13 adjacent provinces within an economical transport distance, about 100 km. These provinces have annually produced 8.6 million ~ 10.1 million tonnes of paddy in 1996 to1999, amounting to about 40% of the nation's total. (Please refer Appendix A for details.)

According to a study by Black and Veatch[8], rice husk makes up about 23% of the total paddy weight. The rice millers in the 18 provinces therefore should be generating 2.0 ~ 2.3 million tonnes of rice husk annually[9]. This amount represents about three times the quantity of rice husk required by the five ATB plants, estimated in A.4.3.3 to be about 715,000 tonnes per year.

There is reason to believe that the fuel supply for the ATB plants will be even more abundant. In

[7] Thailand has 78 provinces.

[8] Black and Vetch (Thailand) Ltd., November 2000. "Thailand Biomass-Based Power Generation and Cogeneration Within Small Rural Industries." Study commissioned by the National Energy Policy Office.

[9] 8.6~10.1 million tonnes×23%=2.0~2.3 million tonnes

addition to local supply, rice husk from paddy grown in other provinces is available in ATB's fuel supply area. This is due to a disproportionately higher concentration of rice mills in central Thailand, for closeness to the population centre of Bangkok and its vicinity (for domestic consumption), as well as to the ports (for export). These mills process large amounts of paddy transported from the northern and north-eastern provinces. According to the rice millers' association of Supanburi, one of ATB's plant sites, the province produces some 1 million tonnes of rice husk annually, even though rice husk from its own paddy averages only at 280,000 tonnes per year in 1996 - 1999.

ATB estimates that the amount of rice husk produced in its targeted fuel supply area is more than four times its requirements.

Demand for rice husk is low. As a result, the disposal of rice husk is a serious problem for many millers, many of whom must burn or dump it. The most common industrial use for rice husk in rice-growing countries is to produce heat or steam for parboiling or paddy drying. A few of the largest rice mills are able to burn their rice husk to generate mechanical or electrical power, mainly for their own use. However, but for a few exceptions, mills in Thailand are too small to economically generate electricity from rice husk.

ATB has entered into 8-year fuel supply agreements with about 100 rice millers, principally within 80 km of the proposed plants. The total quantity of rice husk already contracted to ATB represents most of the fuel needed to generate the planned amount of electricity. Rice husk will be delivered to each power plant primarily by small local truckers.

A.2.3.5. Financial plans

The Project cost is estimated at US$32 million per plant – about US$160 million for the five plants. This includes the cost of an EPC contract as well as the cost of land, interest during construction, project development fees, financing fees, and contingencies.

The Project has been granted 5-year subsidies for SPPs from the National Energy Policy Office (NEPO). This subsidy is incorporated into the financial projections.

ATB's financial plan assumes a relatively conservative percentage of 60-15-25 among senior debt, mezzanine financing in the form of subordinated debt, and common equity. The major equity investors noted in A.3 will provide most of the common equity. The interest of these investors in the Project is predicated on the strong expectation that the Project will be designated as a CDM project and generate CERs.

A.3. Project participants:

Project company

A.T. Biopower Co. Ltd. (ATB)

ATB is a project development and finance company that undertakes a comprehensive development and finance responsibility. The Project will be managed by a full-time project development and management team of over ten staff at ATB, led by Dr. Thawat Watanatada, CEO. Dr. Watanatada has over 25 years of experience in infrastructure project development and finance, including 18 years at the World Bank in Washington.

CDM advisor and the contact for the CDM project activity

Mitsubishi Securities Co., Ltd.

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Major equity investors

Rolls-Royce Power Ventures Ltd. (RRPV) is the industrial investor in the Project and will hold a 50% equity share in ATB. Part of the Rolls-Royce plc network, RRPV focuses on developing independent power projects between 5 MW to 150 MW in selected markets internationally. RRPV is headquartered in London.

Al Tayyar Energy Ltd. (ATE) is an energy investment and development company that will be a major investor in ATB. Based in the United Arab Emirates and Washington, DC, ATE focuses on renewable energy and energy efficiency projects in developing and newly industrialized countries.

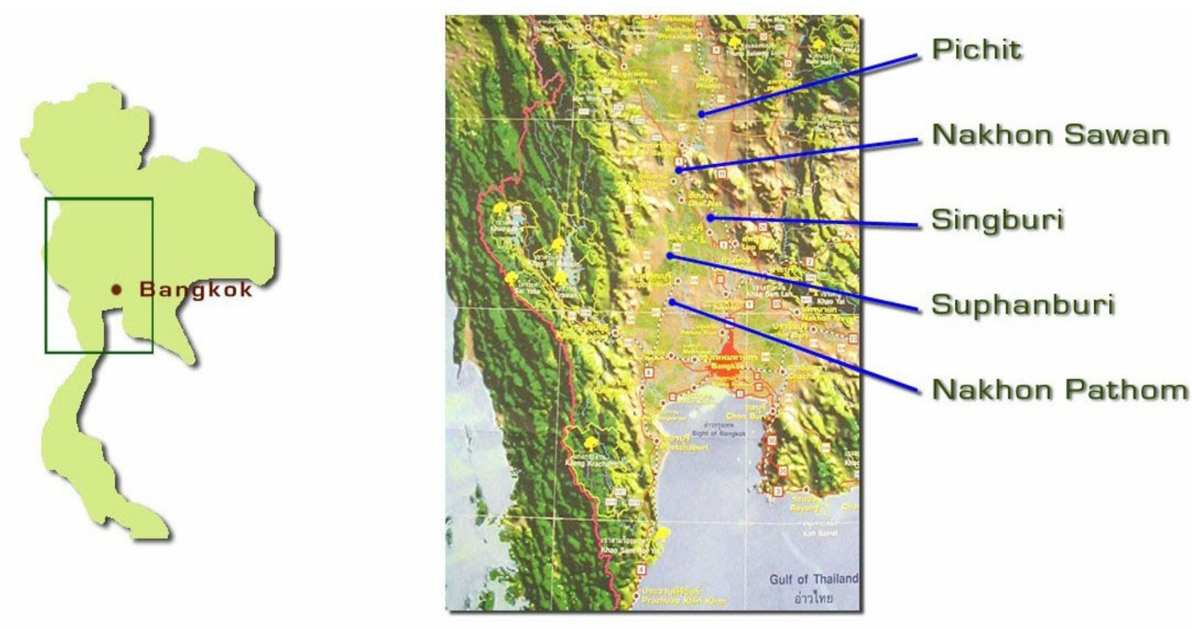
Engineering partner

The Engineering Business Division of the Electricity Generating Authority of Thailand (EGAT EB) combines expertise in the area of power planning, transmission and environmental engineering. It is considered to be the largest power engineering service provider in Thailand.

A.4. Technical description of the project activity:

A.4.1. Location of the project activity

The project involves five locations in Thailand



A.4.1.1. Host country Party(ies):

The Kingdom of Thailand

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

Pichit
Nakhon Sawan
Singburi
Suphanburi
Nakhon Pathom

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

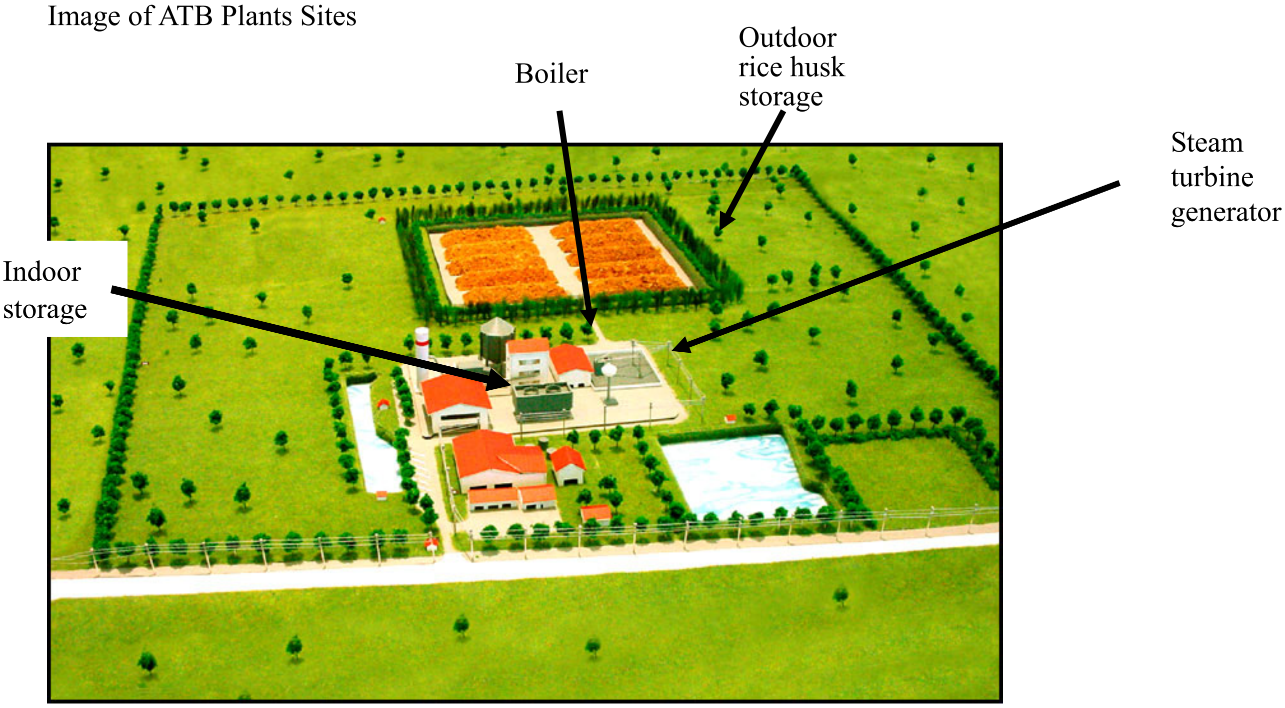
Ampur Bang-moon-nak, Tambon Hor-krai
Ampur Payuha-kiri, Tambon Nam-song

Ampur Muang, Tambon Po-kruam
Ampur Sri Prajan, Tambon Bang-Ngam
Ampur Kam-pang-saen, Tambon Tung Bua

A.4.1.4. Detail on physical location, including information allowing the unique identification of this project activity:

Each of ATB's plants will be located on a 30 to 35 hectare site. About half the site will be used for plant buildings, equipment, and storage facilities. The rest will be used as buffer zones and green space.

Image of ATB Plants Sites



A.4.2. Category(ies) of project activity

There are currently no defined categories of project activities available from the UNFCCC. Tentatively, the Project will be categorised as follows:

Renewable energy project: Grid-connected CHP

It should be noted that the Project is not a collection of sub-activities, but rather one project activity with multiple GHG reduction benefits. The project activity is grid-connected, biomass-fuelled CHP generation, from which all GHG emission reductions stem. The GHG emission reductions associated with the displacement of disposed rice husk and cement production are entirely dependent on, and will not occur in the absence of, this project activity.

This logic also applies to the additionality of the Project, which is assessed based on the additionality of the project activity as described in A.2.1. It is not possible to determine the respective additionalities of each emission reduction that result from a single project activity, and hence will not be discussed in Sections A.4.2 and B.4.

A.4.3. Technology to be employed by the project activity:

A.4.3.1. Technology to be employed

All five ATB plants will use identical equipment and operating systems based on suspension-fired boilers.

Designed to burn ground rice husk in suspension, suspension-fired boilers are arguably the most fuel efficient of the different boiler types that can be used with rice husk. This particular boiler technology was adopted due to their ability to produce high quality ash product, which will be suitable as a substitute ingredient for cement. As the first example to use this state-of-the-art technology in Thailand, the Project represents an important case of technology transfer.

The ATB plants will be constructed by Electrowatt-Ekono (Thailand) Ltd. (EWE) as EPC contractor with McBurney Corp. (McB) as combustion technology provider. A highly qualified company will operate the plants under *O&M (Operation and Maintenance)* contracts.

EWE will be required to guarantee equipment performance, net power output, fuel consumption rates, reliability, availability, and emissions. Under the EPC contract, the construction cost and completion date will be guaranteed on a lump sum, fixed-price, date-certain basis.

A.4.3.2. Training as a way for technology transfer

Under ATB's general guidance, the O&M contractor will staff each power plant with Thai staff (including the Site Manager), contributing to technology transfer of this state-of-the-art combustion and power generation technology. Whenever possible, preference will be given to recruiting suitably qualified staff from local communities. This will greatly enhance the well being of the communities surrounding the power plant.

ATB places particular emphasis on staff training, providing all staff members with basic training consisting of:

- Basic safety
- Basic plant knowledge
- Basic rice husk fuel fired technology
- Environmental awareness
- Supervisory training (where applicable)

In addition, classroom sessions will be held on job-specific subjects. This training will cover the following areas:

- Plant and steam cycle overview
- Boiler design and operation
- Turbine design and operation
- Fuel handling equipment and operation
- Ash handling equipment and operation
- Water treatment and water chemistry
- Power plant HV reticulation
- Power plant control philosophy

The most important training will be on-the-job training. This will include:

- Start up
- Shut down
- Emergency Response

All the training will be supplemented by comprehensive Operations and Maintenance Manuals that will be supplied by EWE. Staff members will also be trained through work instructions for all key activities. These work instructions will be developed during the mobilization phase, the period of time running up to power plant commissioning and the start of operation. Please refer to Appendix E for further details.

A.4.3.3. Energy balance and related analysis

Thorough laboratory tests conducted by ATB show the following characteristics for the rice husk to be used as fuel:

Ultimate Analysis:

Carbon	37.13%
Hydrogen	4.12%
Oxygen	31.60%
Nitrogen	0.36%
Sulphur	0.05%
Ash	17.75%
Moisture	9.00%
Total:	100.00%

Calorific Value: 13,607J/kg → 0.013607Tj/tonne

As described in A.2.3.1, ATB expects to produce approximately 730,000MWh of electricity annually, of which 660,000MWh will be exported to EGAT, with the remaining 70,000MWh consumed internally at the plants. In terms of energy[10], the amount of electricity produced at ATB's plants will equal 2,628TJ/year:

730,000MWh/year x 3,600MJ/MWh x (1TJ/1millionMJ) = 2,628TJ/year

ATB's feasibility study indicates that the plants will convert approximately 30% of the heat generated in the boilers to electrical power. Therefore, the boilers need to provide 8,760TJ/year of heat (energy) in order to generate the planned amount of electricity:

(2,630TJ/year) / 0.3 = 8,760TJ/year

Since the expected efficiency for ATB's boilers is 90%, the rice husk to be combusted at the ATB plants must contain the following amount of energy:

[10] Energy is measured in joules (J), the SI unit equivalent to watt second. Since 1 hour contains 60 seconds x 60 minutes = 3,600 seconds, 1 watt hour = 3,600J. It follows then that 1 MWh = 3,600MJ.

(8,760TJ/year) / (0.9) = 9,733TJ/year

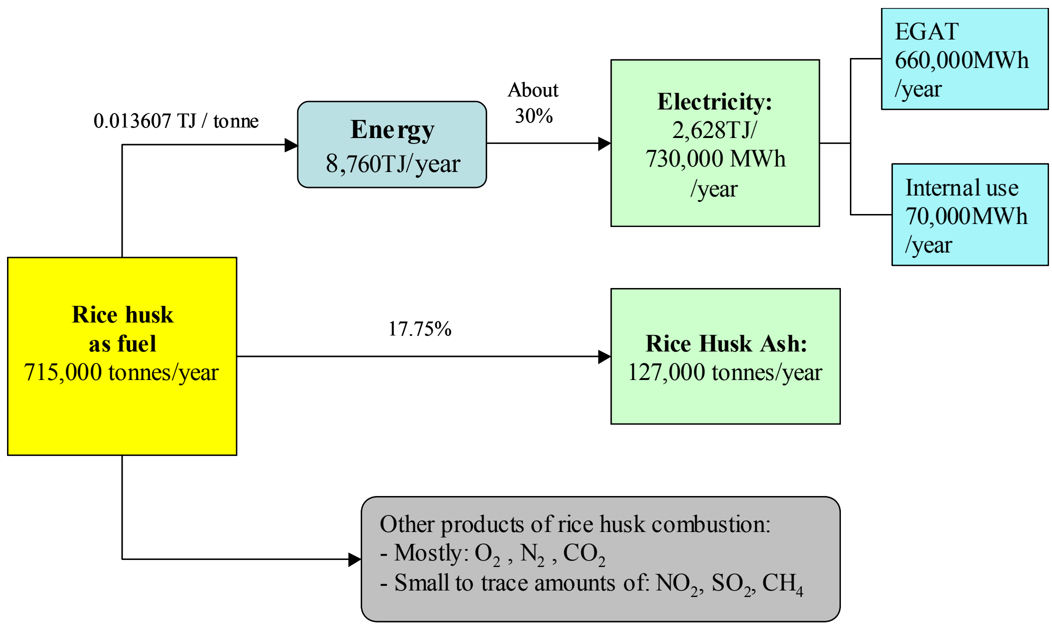
Based on the calorific value of 0.013607TJ/tonne for the rice husk to be used as fuel, the quantity of rice husk needed to produce the required amount of energy is approximately 715,000tonnes/year:

(9,733TJ/year) / (0.013607TJ/tonne) ≅ 715,000tonnes/year

Since the ultimate analysis shows that rice husk contains 17.75% of ash content, the Project will produce approximately 127,000tonnes/year of ash.

715,000tonnes/year x 17.75% ≅ 127,000tonnes/year

The relationships are summarized in the following diagram:



A.4.4. Brief explanation of how the anthropogenic emissions of anthropogenic greenhouse gas (GHGs) by sources are to be reduced by the proposed CDM project activity, including why the emission reductions would not occur in the absence of the proposed project activity, taking into account national and/or sectoral policies and circumstances:

The Project will reduce anthropogenic GHG emissions by replacing fossil fuel-based electricity and steam production with GHG-free biomass CHP power generation. In addition, the Project will assist Thailand with greenhouse gas (GHG) reduction by curbing methane emissions from open-air burning of rice husk and by providing high-quality rice husk ash which can lower requirements for energy-intensive cement manufacturing.

The Project will generate approximately 400,000 tonnes of CERs annually, about 2.8 million tonnes for the entire 7-year initial crediting period.

The Project differs from any of a small number of undertakings hitherto seen in Thailand for rice husk power generation. While other projects rely on one large rice mill for the supply of all or nearly all of the rice husk to be used at their power plants, the Project sources its rice husk from a great number of smaller mills for whom rice husk-fuelled power generation is not feasible. Without the Project, the rice husk at these mills would continue to be either dumped or burned in the open air or in simple incinerators.

As further delineated in B.4, the Project has not been able to attract sufficient investment due to it being a less attractive investment compared to conventional power plants. If registered under the CDM, the Project will generate an estimated average of 400,000tCO_2/year of CERs, which will significantly assist implementation of the Project. At the current price of about US$5, the CERs will enhance the Project's ROE by 5.0%, based on the Project's financial plans described in Section A.2.3.5, bringing the ROE closer to a level acceptable to investors.

An added incentive for investors is the higher status associated with CDM designation. The Project will publicly highlight its participants' environmental commitment. When registered with the CDM Executive Board, the Project will be one of the first CDM projects in all Southeast Asia, let alone in Thailand. Project participants will also benefit from pioneering the learning experience for the CDM process.

A.4.5. Public funding of the project activity:

The financial plans for the Project do not involve public funding from Annex I countries.

B. Baseline methodology

B.1. Title and reference of the methodology applied to the project activity.

There are currently no approved methodologies provided by the UNFCCC. Therefore, new baseline methodologies, which are in accordance with the Marrakesh Accords, will be proposed.

The Project, through CHP generation using biomass, will achieve GHG emission reductions from four emission sources: grid electricity generation, steam generation, methane emissions from disposed rice husk and emissions from cement production. As these reductions occur as a result of biomass-fuelled CHP, a single methodology may be proposed that will account for all these emission reductions. However, such a methodology will at best be only applicable to projects of exactly the same nature as this Project. In order to introduce a more widely applicable methodology, separate methodologies to account for emission reductions from each emission source will be proposed, as follows:

a. Displacement of grid electricity: *Retrospective annual application of weighted average carbon emission factors calculated from actual official data.*
b. Displacement of steam generated from the combustion of fossil fuels: *Energy balance calculation for displaced steam where the displaced fuel(s) and technology(ies) are known.*
c. Methane avoidance: *Estimation of emission reduction from uncontrolled biomass disposal where BAU is open air burning*
d. Cement production displacement: *Estimation of emission reduction associated with the use of ash product as a substitute for clinker in cement production*

Methodologies a to c above are detailed in Annex 3. The new baseline methodology for the cement displacement component of the project will be submitted at a later stage, prior to application for registration of the PDD with the CDM Executive Board.

B.2. Justification of the choice of the methodology and why it is applicable to the project activity

Paragraph 48 of the Marrakesh Accords stipulates that:

"In choosing a baseline methodology for a project activity, project participants shall select from among the following approaches the one deemed most appropriate for the project activity, taking into account any guidance by the executive board, and justify the appropriateness of their choice:

(a) Existing actual or historical emissions, as applicable; or
(b) Emissions from a technology that represents an economically attractive course of action, taking into account barriers to investment; or
(c) The average emissions of similar project activities undertaken in the previous five years, in similar social, economic, environmental and technological circumstances, and whose performance is among the top 20 percent of their category."

A preliminary baseline analysis was conducted prior to selecting the most appropriate approach for selecting the baseline scenario. As discussed further in B.3 below, no circumstances were identified that saw any foreseeable change in existing practices in the absence of the project activity. Since the project activity will serve to reduce emissions from existing emission sources, approach (a) was deemed to be the most applicable approach in selecting the baseline scenario for the Project. The four methodologies selected are all in accordance with approach (a).

B.3. Description of how the methodology is applied in the context of the project activity:

B.3.1. Electricity generation baseline

The baseline emissions for the Project represent the volume of GHG that would be emitted to provide the same amount of electricity to the grid without the Project. The baseline methodology to be used deems the average emissions of the grid to which the Project is connected as the baseline emissions.

The underlying assumption in applying this baseline methodology is that there exists no convincing reason to suggest that a specific fuel(s) will be displaced by the project activity. A careful analysis was therefore conducted to determine whether the electricity from the Project will displace any particular component of the grid, based on EGAT's Power Development Plan (PDP) 2001 and talks with EGAT officials.

EGAT's PDP 2001 (Appendix 8) provides the actual and projected total energy generation for the Thai national grid until year 2016, including current and future electricity import from Lao PDR. The relevant parts of this PDP are reproduced below.

Table 1: Forecast of Total Energy Generation in Thailand

Type		Unit	2000	2006	2007	2008	2009	2010	2011	2012
Hydroelectric		GWh	3853	4503	4479	4241	4413	4461	4457	4476
		%	3.9	3.2	3.0	2.7	2.6	2.5	2.3	2.2
Natural Gas		GWh	52500	87007	85836	81518	90443	96000	91408	82703
		%	53.7	61.9	57.3	51.3	53.0	53.0	47.6	40.6
Heavy Oil		GWh	12935	1112	1080	1051	1050	1052	1050	1054
		%	13.2	0.8	0.7	0.7	0.6	0.6	0.5	0.5
Diesel Oil		GWh	63	80	41	0	2	5	2	2
		%	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Lignite		GWh	16115	17257	17255	17309	16254	16252	16255	15797
		%	16.5	12.3	11.5	10.9	9.5	9.0	8.5	7.8
Imported Coal		GWh	0	13979	23291	25170	25094	25094	25094	25170
		%	0	9.9	15.6	15.8	14.7	13.8	13.1	12.4
Other Purchases	SPP	GWh	9571	13786	14417	14417	14417	14417	14417	14417
		%	9.8	9.8	9.6	9.1	8.5	8.0	7.5	7.1
	Lao PDR	GWh	2701	2875	3330	15332	18835	18787	18722	18699
		%	2.8	2.0	2.2	9.6	11.0	10.4	9.7	9.2
	New IPP	GWh	0	0	0	0	0	5190	20742	41460
		%	0	0	0	0	0	2.9	10.8	20.2
	Sub-total	GWh	12293	16661	17747	29749	33252	38394	53881	74576
		%	12.6	11.9	11.9	18.7	19.5	21.2	28	36.6
Grand Total		GWh	97759	140599	149729	159038	170508	181258	192147	203778

Source: EGAT Power Development Plan 2001 (Appendix 8)

The table above shows the current prevalent mode of electricity generation for the Thai grid to be combined-cycle natural gas. It also shows the electricity provided from this fuel is projected to increase in absolute terms. Of equal significance is the projected rise in imported coal, which is projected to compose 12.4% of the grid by 2012 from the current 0%. Given that electricity generation is expected to more than double during by 2012, combined-cycle natural gas and imported coal at first seem the likely fuels to be displaced by the project activity.

However, EGAT's PDP shows the oil-fuelled component of the grid to decrease rapidly in coming years, which is a reflection of the Thai government's aim at curbing oil imports to improve the trade balance. It is most likely then that the electricity produced by the Project will contribute towards a reduced reliance on imported oil. This scenario would lead to a significantly higher baseline emission for the Project and accord it almost twice as many CERs in comparison to using the grid's average for the baseline.

Despite its high probability, however, displacement of oil-fuelled electricity would not be ascertained as a definite fact. EGAT officials point out that it is often a mistake to see a casual link of displacement between an increase in one component of the grid and a concurrent reduction in another. The emphasis is on the importance of treating the grid as an integral whole. To keep the Project's baseline conservative, displacement of the oil-fuelled component of the grid was rejected in favour of the grid's average.

B.3.2. Steam generation baseline

ATB intends to supply 83,000 tonnes of steam to a paper mill located next to one of its plant sites. The mill currently uses bunker oil to produce the steam it requires, using a boiler with 90% efficiency. The methodology proposed in Annex 3 considers this to be the baseline for steam generation.

As all of ATB's plants are to be equipped to supply steam to nearby industrial users, there is a possibility that ATB's steam supply will substantially exceed the 83,000 tonnes currently projected, either to the same buyer or others. The steam baseline for the Project will include these additional steam sales when they displace steam production by bunker oil or other conventional fuels.

B.3.3. Unused rice husk baseline

In Thailand, low demand for rice husk makes its disposal a serious problem for millers. Most of the rice husk is either burned in open air or left in piles to decay. As there are no circumstances to suggest that the large surplus in rice husk will decrease in the foreseeable future, the methodology (delineated in Annex 3) deems the baseline to be emissions from uncontrolled open air burning of the equivalent amount of rice husk that the Project will consume.

It should be noted that this is a conservative assumption. When rice husk is left to decay, it will release more of the carbon it contains as methane than when it is burned in the open air. This results in a significantly greater baseline emission given the potency of methane as a GHG. By assuming open air burning of all currently unused rice husk and excluding from the baseline methane emission from decaying rice husk, the Project's PDD understates baseline emissions and keeps the baseline conservative.

B.3.4. Cement production baseline

In the absence of the Project, which plans to sell 30,000 tonnes a year of rice husk ash (RHA) to well-established Thai cement manufacturers as a cement mixture, pulverised clinker will continue to be used as the major ingredient for Portland cement. RHA used in lieu of the same amount of cement will contribute to GHG emission reductions by displacing the highly GHG emission-intensive cement manufacturing process.

The first source of CO_2 emissions in cement production is the calcinations process during which calcium carbonate ($CaCO_3$) from limestone, chalk, or other calcium-rich materials is heated to form lime (CaO). The second source of CO_2 emissions is from the combustion of fossil fuels to operate the rotary kiln. Emissions from both these sources will form the baseline for the displacement of cement production by the project activity.

B.4. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered CDM project activity *(i.e. explanation of how and why this project is additional and therefore not the baseline scenario)*

The Project, which introduces state-of-the-art technology to Thailand, provides clean energy by using otherwise unused agricultural waste as fuel. The project is environmentally additional in that it achieves GHG reductions from four emission sources – grid electricity generation, steam generation, methane emissions from disposed rice husk and emissions from cement production.

The Project differs from any of a small number of undertakings hitherto seen in Thailand for rice husk power generation. While other projects rely on one large rice mill for the supply of all or nearly all of the rice husk to be used at their power plants, the Project sources its rice husk from a great number of smaller mills.

With few exceptions, rice mills in Thailand are too small to use the rice husk they produce for electricity generation. The Project will collect unused rice husk from these mills to be used as fuel for its power plants. Without the Project, the rice husk at these mills would continue to be either dumped or burned in the open air or in simple incinerators.

The absence of a core rice husk supplier increases investors' perceived risk of the Project, specifically in relation to future availability and prices of rice husk needed to fuel ATB's plans. This is added to the difficulty which is common to nearly all biomass renewable projects in Thailand: a lower ROE (Return on Equity) than that for investment in conventional power plants such as combined cycle gas[11]. On a business-as-usual basis, it has not been possible to attract investors to the Project.

If registered under the CDM, the Project will generate an estimated average of 400,000tCO_2/year of CERs, which will significantly assist implementation of the Project. At the current price of about US$5, the CERs will enhance the Project's ROE by 5.0%, based on the Project's financial plans described in Section A.2.3.5.

(1) Common Equity amount: 25% x US$160million = US$40million
(2) Annual revenue from CERs: (400,000tCO_2/year) x (US$5/t$CO_2$)
= US$2,000,000/year
(2)/(1): US$2,000,000 / US$40million = 5.0%

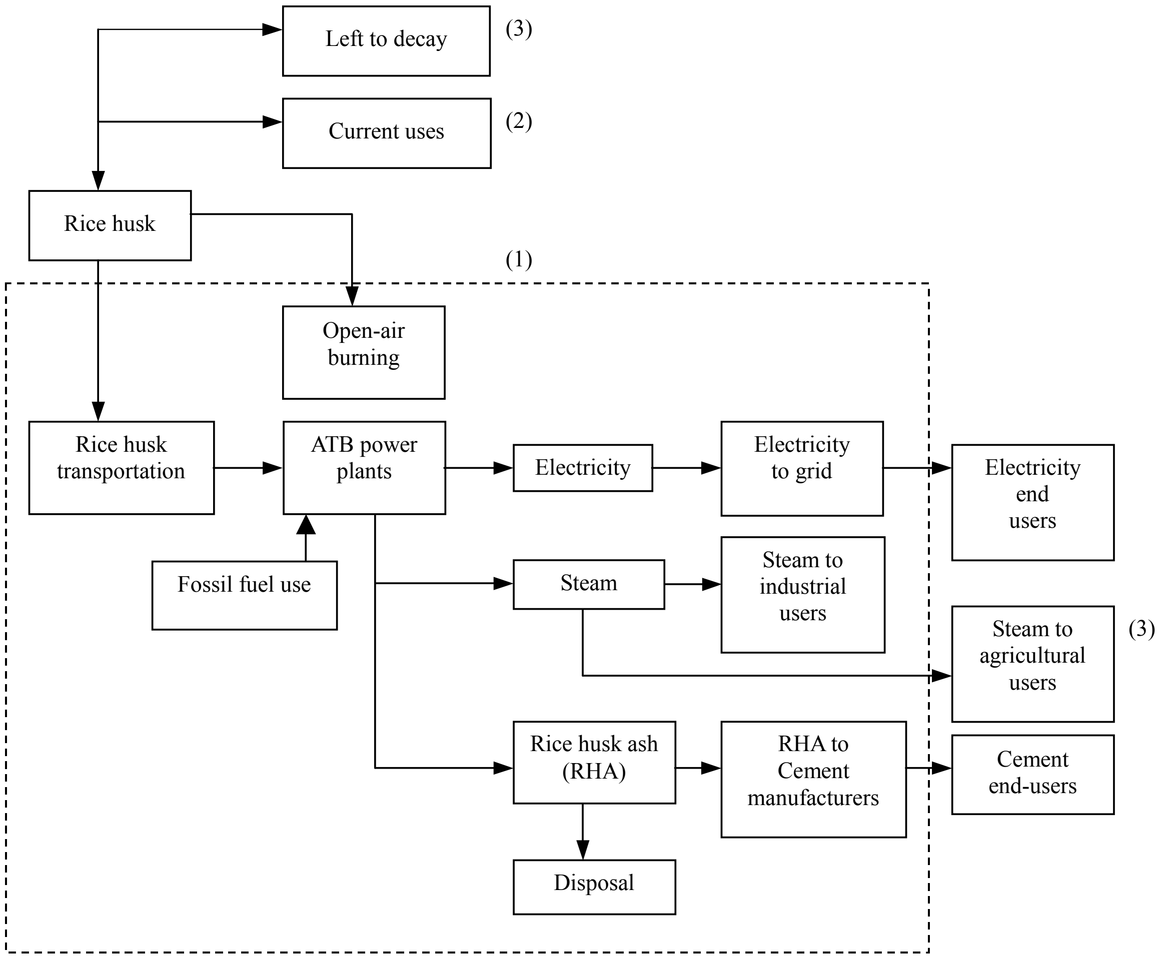
This brings the Project's ROE closer to a level acceptable to investors.

An added incentive for investors is the higher status associated with CDM designation. The Project will publicly highlight its participants' environmental commitment. When registered with the CDM Executive Board, the Project will be one of the first CDM projects in all Southeast Asia, let alone in Thailand. Project participants will also benefit from pioneering the learning experience for the CDM process.

B.5. Description of how the definition of the project boundary related to the baseline methodology is applied to the project activity

The following figure represents the project boundary of the project activity.

[11] The Project's financial projections have been provided to the validator under a confidentiality agreement.



Notes:

(1) The dotted lines indicate the Project's boundaries.

(2) For the reasons mentioned in Section E.2, this item is viewed as outside the Project boundaries.

(3) For conservatism, these reduction possibilities are not included in the calculation of the Project's CERs.

Direct on-site emissions for the project activity are:

- methane emissions from controlled combustion of rice husk
- GHG emissions from the combustion of supplementary (fossil) fuel
- GHG emissions from on-site transportation

Direct off-site emissions for the project activity are:

- GHG emissions from off-site transportation

No significant source of indirect on- or off-site emissions associated with the Project was identified.

The project boundary encompasses the following emission sources to account for the displacement of baseline emissions by the project activity:

- grid electricity generation
- steam production using conventional fuels
- open air burning of rice husk
- cement production

B.6. Details of baseline development

B.6.1. Date of completing the final draft of this baseline section *(DD/MM/YYYY)*

15/04/2003

B.6.2. Name of person/entity determining the baseline

Clean Energy Finance Committee
Mitsubishi Securities
Tokyo, Japan
Tel: +81-3-6213-6860
E-mail: hatano-junji@mitsubishi-sec.co.jp

Mitsubishi Securities is the CDM adviser to the Project. The firm is not a project participant.

C. Duration of the project activity / Crediting period

C.1. Duration of the project activity:

C.1.1. Starting date of the project activity:

01/01/2006

The starting date of the project activity is here defined as the date on which the ATB plants will commence operation, subsequent to financial closure and plant construction.

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

Minimum of 25 years.

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

C.2.1. Renewable crediting period *(at most seven (7) years per period)*:

C.2.1.1. Starting date of the first crediting period *(DD/MM/YYYY):*

01/01/2006

The starting date of the crediting period is defined as the first day of operation of the ATB plants. Should the commissioning of the plants be delayed, the starting date will also be delayed accordingly.

C.2.1.2. Length of the first crediting period:

Seven (7) years.

D. Monitoring methodology and plan

D.1. Name and reference of approved methodology applied to the project activity:

There are currently no approved methodologies provided by the UNFCCC. Therefore, new monitoring methodologies will be proposed. These, detailed in Annex 4, are:

a. *Monitoring emissions from biomass power generation using direct measurements and commercial records*
b. *Monitoring emissions from biomass steam generation using direct measurements and commercial records*
c. *Monitoring emissions from biomass energy generation and methane avoidance*
d. *Monitoring emissions from biomass energy generation and cement displacement*

The monitoring methodologies for a to c are detailed in Annex 4. The new monitoring methodology for the cement displacement component of the project will be submitted at a later stage, prior to application for registration of the PDD with the CDM Executive Board.

D.2. Justification of the choice of the methodology and why it is applicable to the project activity:

All four monitoring approaches involve, where possible, the direct measurements of the variables required to monitor baseline and project emissions. Commercial data will be collected and archived for the purpose of verifying the measured data. Where direct measurements are not possible, commercial data will be used as the primary data, with an appropriate quality control measure.

The methodologies are straightforward and orthodox in their approach. By obtaining actual data pertinent to the project activity, and by ensuring an appropriate quality control measure for every piece of data collected, it allows for the most accurate calculation of GHG emission reductions associated with the project activity. Where the collection of the relevant data is possible, as is the case for this Project, this approach is the most appropriate.

D.3. Data to be collected in order to monitor emissions from the project activity, and how this data will be archived:

ID number	Data type	Data variable	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	For how long is archived data kept?
D.3-1	Quantitative	Methane emissions	%	m	annually	-	electronic	minimum of two years after last issuance of CERs
D.3-2	Quantitative	Rice husk combustion amount	t fuel	m	monthly (aggregate)	100%	electronic	minimum of two years after last issuance of CERs
D.3-3	Quantitative	Fuel oil use	L	m	continuous	100%	electronic	minimum of two years after last issuance of CERs
D.3-4	Quantitative	On-site use of transport fuel	L	m	continuous	100%	electronic	minimum of two years after last issuance of CERs
D.3-5	Quantitative	Off-site transport distance	km	m	monthly (aggregate)	100%	electronic	minimum of two years after last issuance of CERs

Spectroscopic measurements (D.3-1) will be carried out annually to obtain the proportion of methane in the stack gas emitted to the atmosphere. This data, together with the aggregated monthly report on rice husk usage (D.3-2), will be used to calculate the total methane emission from rice husk combustion at the ATB plants.

Emissions from fuel oil used as supplementary and start-up fuel are expected to be insignificant, but will be monitored and included in project emissions regardless. Flow meters will continuously record the amount of fuel being fed into the boilers (D.3-3).

Transportation of rice husk and rice husk ash will occur both on- and off-site. On-site emissions can be calculated by obtaining the amount of fuel used (D.3-4). Off-site emissions can be calculated by recording the distance travelled by the trucks (D.3-5).

D.4. Potential sources of emissions which are significant and reasonably attributable to the project activity, but which are not included in the project boundary, and identification if and how data will be collected and archived on these emission sources.

As discussed in E.2, no leakage issues were identified for this Project.

D.5. Relevant data necessary for determining the baseline of anthropogenic emissions by sources of GHG within the project boundary and identification if and how such data will be collected and archived.

D.5.1. Data required for baseline emissions from grid-electricity generation

ID number	Data type	Data variable	Data unit	Will data be collected on this item? (If no, explain).	How is data archived? (electronic/ paper)	For how long is data archived to be kept?
D.5-1	Quantitative	Electricity exported to grid	MWh	yes	electronic	minimum of two years after last issuance of CERs
D.5-2	Quantitative	Fuel mix for grid electricity	MWh	yes	electronic	minimum of two years after last issuance of CERs

Electricity exported to the grid (D.5-1) will be monitored through meter readings and indicates the amount of grid electricity that is displaced by the Project. ATB will issue monthly invoices to EGAT based on the readings, and will keep copies of the invoices and corresponding meter reading records for verification.

Fuel mix data (D.5-2) will be obtained as it is released by EGAT. This will be used to calculate the weighted average CEF, which will be multiplied with the exported electricity to determine the baseline emissions.

D.5.2. Data required for baseline emissions from steam production

ID number	Data type	Data variable	Data unit	Will data be collected on this item? (If no, explain).	How is data archived? (electronic/ paper)	For how long is data archived to be kept?
D.5-3	Quantitative	Steam exported	t	yes	electronic	minimum of two years after last issuance of CERs
D.5-4	Quantitative	Steam exported	bar	yes	electronic	minimum of two years after last issuance of CERs

By monitoring the amount (D.5-3) and pressure (D.5-4) of the exported steam, the heat value of the steam supplied to the end-user can be determined from steam tables. Once this is known, the efficiency of the displaced boiler and the IPCC CEF value for the displaced fuel will be used to derive the baseline emissions. As with electricity sales, ATB will issue monthly invoices based on steam meter readings. Payment records from the purchasers serve as confirmation of the amount of steam purchased from ATB. ATB will keep records of steam readings, invoices, and payments from users for verification.

D.5.3. Data required for baseline emissions from disposal of unused rice husk

ID number	Data type	Data variable	Data unit	Will data be collected on this item? (If no, explain).	How is data archived? (electronic/ paper)	For how long is data archived to be kept?
D.5-5	Quantitative	Rice husk combustion amount	t	yes	electronic	minimum of two years after last issuance of CERs

The amount of rice husk consumed by the plant (D.5-5) will be used together with the carbon content of rice husk and the IPCC factor for the proportion of carbon released as methane in open-air burning to deduce the baseline emissions.

D.5.4. Data required for baseline emissions from cement production

ID number	Data type	Data variable	Data unit	Will data be collected on this item? (If no, explain).	How is data archived? (electronic/ paper)	For how long is data archived to be kept?
D.5-6	Quantitative	Ash sold to cement producers	t	yes	electronic	minimum of two years after last issuance of CERs

The amount of clinker and associated emissions displaced by the project activity will be monitored through the amount of RHA sold and delivered to the purchasing cement manufacturer (D.5-6). The end-use of RHA will not occur within the bounds of the project activity. However, the use of RHA as a substitute ingredient for cement production will be ensured by entering into the following agreements with the purchaser:

- the RHA purchase from ATB is for the purpose of using it as an ingredient in cement production, and
- the cement manufacturer will not develop a separate CDM project based on GHG emissions reduction in its cement production accomplished with the RHA purchased from ATB.

D.6. Quality control (QC) and quality assurance (QA) procedures are being undertaken for data monitored

Data	Uncertainty level of data (High/Medium/Low)	Are QA/QC procedures planned for these data?	Outline explanation why QA/QC procedures are or are not being planned.
Project activity emissions:			
D.3-1	Low	Yes	The sampling instruments will undergo maintenance subject to appropriate industry standards. The spectroscopy results will be compared to the IPCC default emission factor. The larger of the two values will be used to ensure conservatism.
D.3-2	Low	Yes	Trucks carrying rice husk will be weighed twice, upon entry and exit. Meters at the weighing station will undergo maintenance subject to appropriate industry standards. This

			will be checked against purchase receipts and inventory data.
D.3-3	Low	Yes	Meters will undergo maintenance subject to appropriate industry standards. The meter readings will be checked against purchase receipts and inventory data.
D.3-4	Low	Yes	Fuel pump readings will be compared against fuel purchase invoices.
D.3-5	Low	Yes	The distance records will be compared against invoices from rice husk and rice ash transport contractors.
Baseline emissions – grid-electricity generation:			
D.5-1	Low	Yes	Meters will undergo maintenance/calibration subject to appropriate industry standards. The accuracy of the meter readings will be verified by EGAT, who will issue receipts.
D.5-2	Low	N/A	This involves the use of official data released by EGAT. Quality control of this data is beyond the control of the project operators.
Baseline emissions – fossil fuel-based steam generation:			
D.5-3	Low	Yes	As the meter readings of the recipient rather than the project operator is used, overstatement of the displaced steam is not an issue. This will be compared against meter readings at the project site.
D.5-4	Low	Yes	As above.
Baseline emissions – disposal of unused rice husk:			
D.5-5	Low	Yes	As per D.3-2
Baseline emissions – cement production:			
D.5-6	Low	Yes	As trucks carrying RHA will be weighed at the cement plant, upon entry and exit, overstatement of displaced cement ingredient is not an issue. The trucks will be weighed upon exit from the ATB plant to verify the readings.

Note: The numbers in the form of D.X-X correspond to the ID numbers used in tables D.3 and D.5

The plant operation and training procedures that will be put in place will also ensure the integrity of the data collected. These procedures are outlined below.

D.6.1. Operation and Maintenance logs

Daily O&M logs will be maintained by each shift leader on a real time basis. They will provide detailed on-the-spot information about the operations at each of ATB's plants. The O&M contractor will be instructed to immediately report to the ATB management, should an event of significance occur.

D.6.1.1. Operation and Maintenance Report

This report will be developed by the O&M contractor each month and presented to ATB's CEO and board of directors. The report will include the following topics:

- Summary
- Accidents and malfunctions
- Safety and environment
- Plant performance and availability
- Meter records
- Fuel report
- Personnel changes

Data relevant to the monitoring plan will be selected and stored in the monitoring files.

D.6.1.2. Procedures for calibration of equipment

EWE will be responsible for developing an "Equipment Calibration Procedures" booklet, which will delineate the frequency and detail of each equipment calibration. The O&M contractor will be responsible for ensuring that equipment calibration be carried out as specified.

It is important to note that ATB will be required to install and maintain all electricity metering equipment and associated transformers conforming to specifications set by EGAT. This consists of primary watt-hour metering equipment and back-up watt-hour metering equipment. The metering equipment is to be sealed in the presence of both EGAT and ATB representatives. The seals can only be broken in the presence of both EGAT and ATB representatives for inspection, testing or calibration.

D.6.2. Monitoring and verification organization

ATB will be responsible for the execution of the MVP. Based on the modern system it intends to use for control and reporting, ATB will collect and store relevant data in a systematic and reliable way, evaluate them regularly, generate reports, and ensure the availability of pertinent information fore verification. To facilitate this task, ATB will require the O&M contractor to continuously transmit to it the operations data generated by the power plant's operational monitoring system.

Appendix B gives ATB's organization chart for monitoring and verification activities. To ensure the quality of these activities, ATB will appoint Jackrit Watanatada, Assistant to CEO, as the executive to oversee the entire monitoring process. While Mr. Jackrit Watanatada will perform only a few monitoring functions directly and rely mostly on the work to be performed by the ATB and O&M contractor staff, he will be responsible for ensuring the accuracy and consistency in implementing the monitoring plan.

D.7. Name of person/entity determining the monitoring methodology:

Clean Energy Finance Committee
Mitsubishi Securities
Tokyo, Japan
Tel: +81-3-6213-6860
E-mail: hatano-junji@mitsubishi-sec.co.jp

Mitsubishi Securities is the CDM adviser to the Project. The firm is not a project participant.

E. Calculation of GHG emissions by sources

E.1. Description of the formulae used to estimate anthropogenic emissions by sources of greenhouse gases of the project activity within the project boundary: *(for each gas, source, formulae/algorithm, emissions in units of CO_2 equivalent)*

The GHG emissions resulting from the Project is caused by a single project activity as described in Section A.2.1. Unlike baseline emissions, any effort to separately describe project emissions stemming from one project activity, albeit with multiple GHG reduction benefits, will only result in the duplication of the same formulae, and will hence not be attempted here.

E.1.1. Direct on-site emissions

E.1.1.1. GHG emissions from rice husk combustion

Consistent with IPCC Guidelines[12], CO_2 emission from rice husk combustion at ATB's plants, being the release of the CO_2 absorbed on a sustainable basis by rice as it grows annually, are not counted as project emissions.

The same treatment is not extended to methane emissions. When rice husk is combusted in a well-controlled environment at ATB plants, methane emissions are small in quantity but still not zero.

According to the IPCC Guidelines[13], a methane emission from wood/wood waste combustion in energy industries is 30kg/TJ. As described in A.4.3.3, ATB's boilers will burn approximately 715,000 tonnes of rice husk a year with a calorific value of 9,733TJ. On the basis of the IPCC default factor of 30kg/TJ, the combustion at ATB's plants will result in methane emissions of:

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[12] Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual, p.6.1. Please also see Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, Workbook and IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, p.5.5

[13] IPCC Guidelines, p. 1.35

9,733 TJ/year x 30kg/TJ x 1tonne/1,000kg = 292tonnes/year

In terms of CO_2 equivalent[14], this represents **6,200tCO_2e/year**:

292tCH_4/year x 21 = 6,200tCO_2e/year

This amount is included as a component of project emissions in this baseline study.

To increase the accuracy of project methane emissions calculation, actual methane emissions from ATB's boilers will be measured by spectroscopy when ATB's plants commence operation. For conservatism, the larger of the default factor and the spectroscopic measurement will be used in computing project methane emissions. In case the spectroscopic measurement is larger, it will replace the default factor of 30kg/TJ in the above formula.

E.1.1.2. GHG emissions from fuel oil combustion

In start-up operations, 500-600 litres of fuel oil will be used several times a year. Assuming conservatively as many as five start-up operations a year, the total fuel oil consumption for this purpose will amount to about 3,000 litres per year per plant. For the five plants, the total will be 15,000 litres a year.

Based on the IPCC Guidelines, it is calculated that in a warm climate, where bunker oil has the density of approximately 0.97kg/liter, the following calculation shows that bunker oil combustion results in emission of 3.0kgCO_2/liter

0.97 kg/L	x	40.19 TJ/10^6kg	x	21.1 x 10^3kgC/TJ	x	3.67	=	3.0kgCO_2/L
Density of bunker oil[15]		Calorific value of bunker oil[16]		Carbon emission factor of bunker oil[17]		Conversion factor ($C \rightarrow CO_2$)		

---

[14] For the GHG potency of methane, please refer to footnote 29 in E.4.3.

[15] Properties of Crude Oils and Oil Products, Bunker C Fuel Oil
http: landlytika.free.fr/html/bunker_c_spec.html

[16] Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual, p.1.23

[17] Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual, p. 1.13

For 15,000 litres, CO_2 emissions will amount to 45tCO_2/year for all the five plants.

15,000 L/y x 3.0 kgCO_2/L x (1 tonne/1,000 kg) = 45tonnes/year

While GHG emission from this source is expected to be minimal in size, it is included in the calculations of project emissions.

Fuel oil is also required to increase the efficiency of combustion when rice husk is extremely wet in the rainy season. However, with the precaution to cover rice husk with tarpaulin, such occasions are expected to be infrequent and short. Fossil fuel used for this purpose, heavily dependent of the weather, cannot be projected in advance.

At current prices, fossil fuel is several times more expensive than rice husk as fuel. There are strong economic disincentives to use fossil fuel except when absolutely necessary. For this reason, the Project expects its use of fuel oil to be small in quantity.

However, the Project's fuel oil usage, be it for start-up, in the rainy season, or for any other purpose, will be accurately monitored and incorporated in the CER calculation as project emissions. The following formula will gauge GHG emissions resulting from the actual amount of fuel oil consumption.

Fuel oil GHG emissions (tCO_2)

= Fuel oil combusted at the Project's boilers (litre)

x

3.0 kgCO_2/liter

x

(1 tonne/1,000kg)

E.1.1.3. GHG emissions from transporting rice husk within plant sites

Within each plant site, diesel-fuelled dump trucks and bulldozers will transport rice husk to the boilers.

ATB will directly measure the fuel consumption of these trucks, which will be exclusively used for ATB on-site operations.

This emission, despite its small size, is included in the calculations of project emissions.

E.1.2. Direct off-site emissions

E.1.2.1. Transportation of rice husk to ATB plants

Transporting rice husk from rice mills to ATB's plants by trucks results in direct off-site emissions. Calculated in the following steps, the amount of GHG emissions from this source is estimated at 6,300tCO_2/year.

Data/estimates

(1) Rice husk supply needed[18]	715,000tonnes/year for the 5 plants
(2) Approximate load for 1 trip[19]	15 tonnes/truck
(3) Average distance between supplying mills and ATB plants[19]	60 km
(4) Emission factor for heavy truck transportation[20]	1.097 kgCO_2/km

Calculations

(5) Number of trips needed for the 5 plants	(1)÷(2)	48,000 trips/year
(6) Total distance travelled[21]	(3)×(5)×2	5,760,000 km/year
(7) Total transport emissions	(4)×(6) ×(1tonne/1000kg)	≅ 6,300 tCO_2/year

E.1.2.2. Transportation of rice husk ash from ATB plants to cement manufacturers

Transporting rice husk ash from ATB's plants to cement manufacturers by trucks also results in direct off-site emissions. Calculated in the following steps, the amount of GHG emission from

[18] A.2.3.4

[19] ATB data

[20] IPCC Guidelines P.1.75. The IPCC Guidelines provide several carbon emission factors for large trucks. For conservatism, this PDD uses the highest of them all, the one for US heavy duty uncontrolled diesel vehicles.

[21] For conservatism, it is assumed that trucks need to make return journeys without picking up other loads.

this source is estimated at approximately 900tCO_2/year.

Data/estimates

(1) Rice husk ash to be sold and delivered[22]	30,000tonnes/year
(2) Approximate load for 1 trip[23]	15 tonnes/truck
(8) Average distance between ATB plant and cement manufacturers[23]	200 km
(9) Emission factor for heavy truck transportation[20]	1.097 kgCO_2/km

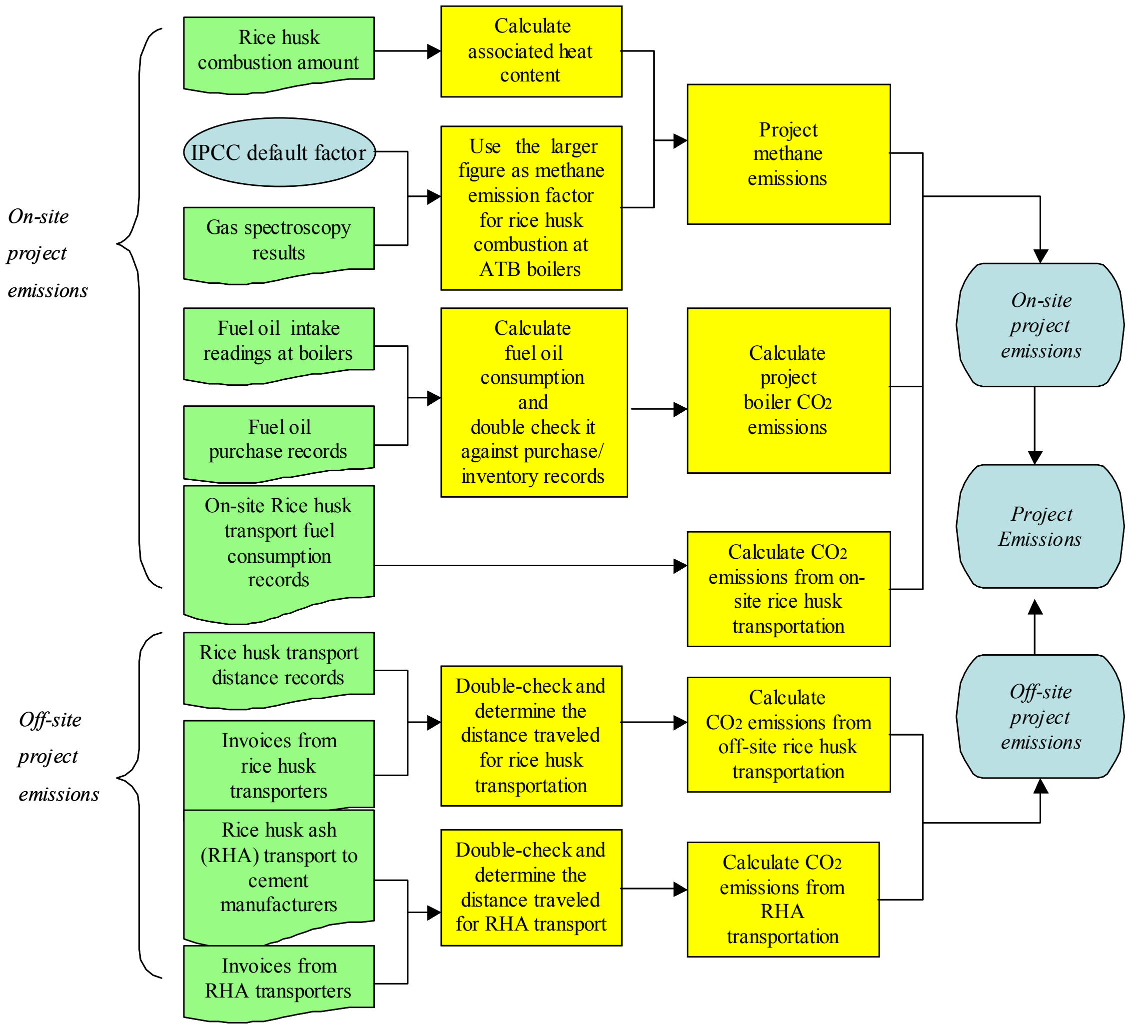
Calculations

(10) Number of trips needed to deliver RHA	(1)÷(2)	2,000 trips/year
(11) Total distance traveled[21]	(3)×(5)×2	800,000 km/year
(12) Total transport emissions	(4)×(6)÷1000	≅ 900 tCO_2/year

[22] A.2.3.3

[23] ATB data

E.1.3. Summary of estimation process of project emissions



E.2. Description of the formulae used to estimate leakage, defined as: the net change of anthropogenic emissions by sources of greenhouse gases which occurs outside the project boundary, and that is measurable and attributable to the project activity: *(for each gas, source, formulae/algorithm, emissions in units of CO_2 equivalent)*

No leakage of significance is anticipated.

One factor which needs close examination with regard to leakage is whether the Project displaces current use of rice husk as fuel. If this occurs and drives current users of rice husk to resort to more carbon-intensive fuels, the amount of such fuel switch must be deducted from the Project's emissions reduction benefits.

There are four primary areas in the current use of rice husk as fuel:

- Power generation at rice mills for internal use
- Sold to nearby factories for fuel
- Burning rice husk to produce steam for paddy drying, and
- Use of rice husk as a domestic fuel source

The following observations indicate that the potential displacement is not likely to occur.

- Only a small portion of rice husk is currently used for any purpose. Rough estimates based on anecdotal information are:

1-2%	sold for bedding in chicken coops
1-2%	sold for brick making
25%	burned for fuel
70%	unused - dumped or burned (approximately 25% dumped, remaining 75% burned in the open or in simple incinerators).

- ATB's requirements represent less than 1/4 of the estimated amount of rice husk produced in the provinces where ATB plans to procure its fuel. (For details, please refer to A.2.3.6.)

- ATB's procurement will be based on long-term contracts, with steady purchase amounts that will be known well in advance. This arrangement will allow rice millers to plan ahead to meet both the current users' demand and ATB's requirements.

Leakage is considered on a project level, and as such the discussion on an emission source basis is not necessary.

E.3. The sum of E.1 and E.2 representing the project activity emissions:

Given that no leakage of significance is anticipated, E.3 equals E.1. The expected emissions from the project activity are summarized in the following table.

($000tCO_2e$)

Item	Relevant section of the PDD	Year							Total
		2006	2007	2008	2009	2010	2011	2012	
On-site project emissions	E1.1	7	7	7	7	7	7	7	49
Off-site project emissions	E.1.2	7	7	7	7	7	7	7	49
Leakage	E.2	0	0	0	0	0	0	0	0
Total project emissions		14	14	14	14	14	14	14	98

E.4. Description of formulae used to estimate the anthropogenic emissions by sources of greenhouse gases of the baseline: *(for each gas, source, formulae/algorithm, emissions in units of CO_2 equivalent)*

E.4.1 Electricity generation Baseline

Based on the baseline methodology presented in B, the annual electricity generation baseline emissions for the Project are calculated as

Annual amount of electricity exported to EGAT (MWh)

x

Average carbon intensity of grid power generation (tonne CO2/MWh)

In the absence of official figures, present and future annual average carbon emission factors (CEFs) for the Thai national grid are estimated in the manner outlined below. In the future, when annual CEFs for the national grid are officially established, the Project will use the official figures to calculate its CERs.

E.4.1.1. Grid composition by generation type

EGAT's Power Development Plan (PDP) 2001 Appendix 8 provides the actual and projected amounts of electricity supplied to the grid by each type of power generation. Projections extend to year 2016 and include current and future hydro-electricity import from Lao PDR[24]. The relevant parts of this Appendix were reproduced in B.3.1. of this PDD.

For the analysis of the Thai grid's baseline emissions, it is necessary to make two assumptions, both of which are conservative in baseline estimation.

The first assumption relates to the extent to which Thailand's natural gas electricity generation is combined-cycle. In 2000, 53.7% of the Thai grid was fuelled by natural gas. How much of this is combined-cycle is a key factor in baseline determination, in view of a significant difference in emission levels between single-cycle and combined-cycle facilities (0.610kgCO_2/kWh vs. 0.398kgCO_2/kWh as noted in E.1.2).

A close study of Appendices 3 and 7 of EGAT's PDP reveals that Thailand's natural gas power generation capacity is predominantly combined-cycle. Given the difficulty in ascertaining the exact ratio of combined-cycle in the actual amount of electricity generated, this document treats all natural gas-fuelled power generation in Thailand as combined-cycle.

The second assumption concerns a line item labelled as "Other IPP" in the "Other Purchases" category in Appendix 8 of the PDP. (Please refer to the table in B.3.1.) The percentage of this item is zero in 2000 and continues to be zero until 2009. Beginning its rapid growth in 2010, this line item is projected to amount to 20.3% of the entire grid in 2012. It represents unspecified IPP generation facilities to be installed in the future.

The PDP classifies all existing and firmly contracted IPP projects in their respective fuel categories. However, future IPP projects are lumped together in a separate line item called "New IPP" since no decision has been made on their fuel composition.

Discussion with EGAT officials indicated that while the targeted fuel mix for New IPPs is 70% combined-cycle natural gas and 30% imported coal, the attainment of such ratio was not certain in view of local opposition to coal-fuelled plants. In the absence of firm projections, the baseline emissions calculation in this document assumes that "New IPP" under "Other Purchases" will

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[24] In addition to electricity import from Lao PDR, the Thai government is negotiating with China on the supply of hydro electricity. This purchase, still inconclusive, has not been incorporated into EGAT's PDP and as such not reflected in the baseline calculations for the Project. Baseline calculations for the Project will be adjusted if the Chinese hydro deal materializes and is added to EGAT's PDP.

be 100% combined-cycle natural gas. This assumption will be replaced with the actual fuel mix of "New IPPs" given in each new edition of the PDD. The Project's CERs will be calculated on the basis of the actual fuel mix for New IPPs.

E.4.1.2. CEFs by generation type

The World Bank EM Model[25] provides default CEFs for various types of electricity generation. The relevant figures are reproduced in Table 2 below.

Table 2: Carbon Emission Factors for Electricity Generation

Type	CEF in kgCO2/kWh
Hydro	0.000
Natural Gas- Single Cycle	0.610
Natural Gas- Combined Cycle	0.398
Heavy Oil	0.721
Diesel Oil	0.717
Lignite	0.885
Imported Coal	0.930
Coal (small scale)	0.988
Oil (small scale)	0.613
Combined cycle gas (small scale)	0.415
Renewables	0.000

E.4.1.3. Grid CEFs

The estimation of Thai Grid CEFs over the Project's crediting period starts with the calculation of the CEF for a given year. This is the weighted-average of CEFs for each fuel type of power generation in that year and can be obtained in Steps 1-3.

[25] Version 1. Developed by Oeko Institute and University of Kassel, sponsored by the World Bank et al http://www.worldbank.org/html/fpd/em/model/model.stm

STEP 1: (1) Weight of generation type in national grid (%) (Table 1 in B.3.1)
x
(2) CEF for the generation type (kgCO_2/kWh) (Table 2)

STEP 2: Repeat STEP 1 for every generation type in the national grid

STEP 3: Add all the products of above calculations for the given year

Table 3 shows the calculation for the grid CEF for 2006, the first year in the baseline. The result is 0.504kgCO_2/kWh. Since 1 tonne = 1000kg and 1MWh = 1000kWh, the figure can also be expressed as 0.504tonneCO_2/MWh.

Table 3: Estimated Grid CEF for 2006

Type of Generation	(1) Weight in the Grid (%)	(2) CEF (tCO2/MWh)	(1) X (2)
Hydroelectric	3.2		
Natural gas	61.9	0.398	0.246
Heavy oil	0.8	0.721	0.006
Diesel oil	0.1	0.717	0.001
Lignite	12.3	0.885	0.109
Imported coal	9.9	0.930	0.092
Other purchases			
SPP	9.8	0.514	0.050
Lao PDR	2.0	0	0
New IPP	0	0.398	0
Total Grid CEF for the year	**100**	—	

To estimate annual CEFs for the entire baseline period, Steps 1-3 will then be repeated for each year until 2012. The grid CEFs so derived are given in Table 4 below.

Table 4: Annual Carbon Emission Factor for Thai Electricity Grid

YEAR	Carbon Emissions Factor tCO_2/MWh
2000	0.494
2006	0.504
2007	0.531
2008	0.501
2009	0.482
2010	0.478
2011	0.473
2012	0.466

E.4.1.4. Electricity Baseline Emissions

As calculated in A.2.3.1, the Project will supply 660,000MWh/year to the grid, replacing the same amount of grid electricity. Annual baseline emissions are obtained by multiplying this amount of electricity by the annual grid CEFs obtained in STEP 4. In other words,

BASELINE EMISSIONS (tonneCO_2/year) =

(1) Annual Grid Electricity Replaced by Project (MWh/year)

x

(2) Annual Grid CEFs (tCO_2/MWh)

Table 5 summarizes the annual baseline emissions for the Project.

Table 5: Baseline Emissions

Year	(1) Electricity Amount	(2) CEF	(1) X (2) Baseline Emissions
Unit	MWh/year	tCO_2/MWh	tCO_2/year
2006	660,000	0.504	332,600
2007	660,000	0.531	350,500
2008	660,000	0.501	330,700
2009	660,000	0.482	318,100
2010	660,000	0.478	315,500
2011	660,000	0.473	312,200
2012	660,000	0.466	307,600
Total	4,620,000	--	2,267,200

E.4.2. Steam generation baseline

E.4.2.1. Energy content of the steam

As mentioned in A.2.3.3, ATB intends to supply 83,000 tonnes of steam at 6 bar to a paper mill located next to one of its plant sites.

Steam tables show that steam at 6 bar has the energy of 659 kcal/kg. For 83,000 tonnes/year, the total energy of the steam ATB supplies is calculated as:

$$83{,}000 \text{ tonnes/year x } (10^3\text{kg/tonne}) \text{ x } 659 \text{ kcal/kg} = 54.7 \text{ x } 10^9 \text{ kcal/year}$$

In terms of terajoules, the steam ATB supplies to the paper mill will contain

$$54.7 \text{ x } 10^9 \text{ kcal/year x } 4.18 \text{ kJ/kcal x } (1 \text{ TJ}/10^9 \text{ kJ}) = 228 \text{ TJ/year}$$

of energy.

E.4.2.2. Calculation of steam baseline emissions

The paper mill burns bunker oil to produce the steam it requires. Based on the energy efficiency of 90% given in the specifications of for the paper mill's boilers, bunker oil combustion in the mill's boiler needs to supply 253TJ/year of energy to produce the same amount of steam as ATB provides, 83,000tonnes (228TJ) a year.

228TJ/year	x	(1/0.9)	=	253TJ/year
Heat value of the steam ATB supplies		Energy efficiency of the paper mill's boiler		

The IPCC Guidelines[26] put the carbon emission factor of bunker oil at 21.1tonne carbon/TJ. For 253TJ/year, the emissions will amount to

253TJ/year x 21.1tC/TJ = 5,345tC/year

In terms of CO_2 equivalent, this translates to **22,000tCO_2e/year**:

5,345 t C/year x (3.67 CO_2/C) = 19,600tCO_2e/year

E.4.2.3. Possible modification of steam baseline

There is a possibility that ATB's steam supply will substantially exceed the 83,000 tonnes currently projected, either to the same buyer or to others. All of ATB's plants will be equipped to supply steam to nearby industrial users. The steam baseline for the Project will include these additional steam sales when they displace steam production by bunker oil. It will be derived by using the formulae in the preceding sections in conjunction with the actual amount of steam ATB has supplied.

When the steam provided by ATB is of a different pressure from 6 bar, the figure 659 kcal/kg in E.4.2.1 will be replaced with an energy content corresponding to the pressure of the steam supplied. Energy content figures are readily be available from steam tables.

E.4.2.4. Consistency Check

Executives of the paper mill indicated that the mill burns approximately 90 litres of bunker oil to produce 1 tonne of its steam.

[26] Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual, p.1.13

The quantity of bunker oil to be burned for 83,000 tonnes of steam if ATB does not supply the amount will then be

(90 L/tonne) x (83,000 tonnes/year) = 7,470,000 L/year

For 7,470,000L/year mentioned above, the GHG emissions will be about 22,400tCO_2/year.

(7,470,000 L/year) x (3.0kgCO_2/L) x (1 tonne/1,000 kg) = 22,400 tCO_2/year

This is the amount of CO_2 emissions that will be eliminated when the 83,000 tonnes/year of steam supplied by ATB replaces the combustion of 7,470,000 litres of bunker oil at the paper mill. The figure is slightly larger than the reduction estimate of 19,600 tCO_2e/year, derived in the preceding section, attesting to the validity and conservatism of the approach and formulae outlined therein.

E.4.3. Unused rice husk baseline

In Thailand, low demand for rice husk makes its disposal a serious problem for millers. Most of the time, rice husk is either burned in the open air or left in piles to decay. Since open-air burning is the most prevalent disposal method for rice husk in Thailand, this PDD assumes that rice husk would be burned in the open air if not used by the Project.

It is noted that this is a conservative assumption. When rice husk is left to decay, it will release more of the carbon it contains as methane than when it is burned in the open air. This results in greater GHG emission given the large global warming potential of methane. By assuming open-air burning of all currently unused rice husk and excluding from the baseline methane emission from decaying rice husk, the Project's PDD understates baseline emissions and keeps the baseline conservative.

In open-air burning, most of the carbon contained in rice husk is released in the form of CO_2. However, a small amount is released as methane. Given methane's potency for global warming, the baseline analysis addresses the amount of carbon released as CH_4 in open-air burning.

As noted in Section A.4.3.3, ATB expects to combust approximately 715,000tonnes of rice husk a year in its boilers. The amount of methane released by open-air burning in the absence of the Project is estimated as follows:

Step 1:

Rice husk used as fuel tonnes/year	x	Carbon content of rice husk[27] (%)	=	Annual carbon released tonnes/year
715,000 t /y	x	37.13 %	=	265,500 t /y

Step 2:

Carbon released in total	x	Carbon released as CH_4 in open-air burning[28]	x	Conversion Factor (molecular weight CH_4 vs. C)	x	Global warming potency of methane[29]	=	**Annual CH_4 released (tonnesCO_2 equivalent/year)**
265,500 t / y	x	0.5%	x	16/12	x	21	=	**37,170tCO_2e/year**

For carbon released as CH_4 in open burning, the IPCC Guidelines give a range of 0.3-0.7%, with 0.5% as the representative figure.

E.4.4. Cement production baseline

As described in Section 2.3.3, ATB plans to sell 30,000 tonnes a year of rice husk ash (RHA) produced by the Project to well-established Thai cement manufacturers as a cement mixture. RHA used in lieu of the same amount of cement will contribute to GHG emissions reduction by displacing the highly GHG emission-intensive cement manufacturing process.

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27 Carbon content of rice husk to be used by ATB. See A.4.3.3

28 Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual, Table 4-16.

29 For the global warming potential of methane, this PDD uses the figure contained in the current IPCC Guidelines. If and when the IPCC Working Group's recommendation of 23 is formally adopted, the new figure will be consistently applied throughout the PDD, both to baseline and project emissions. For the IPCC Working Group I recommendation, please see "Climate Change 2001: The Scientific Basis" (c.6 Global Warming Potentials), at http://www.gridas.no/climate/ipcc_tar/wg1/020.htm

The first source of CO_2 emissions in cement production is the calcinations process during which calcium carbonate ($CaCO_3$) from limestone, chalk, or other calcium-rich materials is heated to form lime (CaO). The IPCC Guidelines provide a carbon emission factor $CEF_{Clinker}$ of 0.5 tCO_2 / 1 tonne clinker produced.[30] Both the Working Group II Report and IEA Green Report recommend using the same factor.

The second source of CO_2 emissions in cement production is from the combustion of fossil fuels to operate the rotary kiln. Different sources offer a range of carbon emission factors for energy use (CEF_{Energy}) in the production of cement. According to the IPCC Working Group II, approximately 0.75 tCO_2 / 1 tonne cement produced is emitted from the combustion of fossil fuels[31]. This PDD uses a much lower CEF_{Energy} figure of 0.5tCO2/1 tonne of cement produced. This is partly for conservatism and partly for accounting for possible energy consumption entailed in preparing and mixing RHA for use with cement. Such energy consumption is deemed small, but not zero.

Combining $CEF_{Clinker}$ and CEF_{Energy}, 1 tonne of cement production produces 1 tonne of CO_2.

$CEF_{Clinker}$	+	CEF_{Energy}	=	CO_2 emission from cement manufacturing
0.5 tCO_2/tonne cement	+	0.5 tCO_2/tonne cement	=	1 tCO_2/tonne cement

One tonne of RHA, when used as a cement mixture, will displace 1 tonne of cement manufacturing. For the Project, the baseline CO_2 emission for of cement by RHA is calculated as follows:

RHA sold	x	CO_2 emission from cement manufacturing	=	**CO_2 emissions for cement to be replaced by RHA**
30,000 tonnes/year	x	1 tCO_2/ tonne cement	=	**30,000tonnesCO_2/year**

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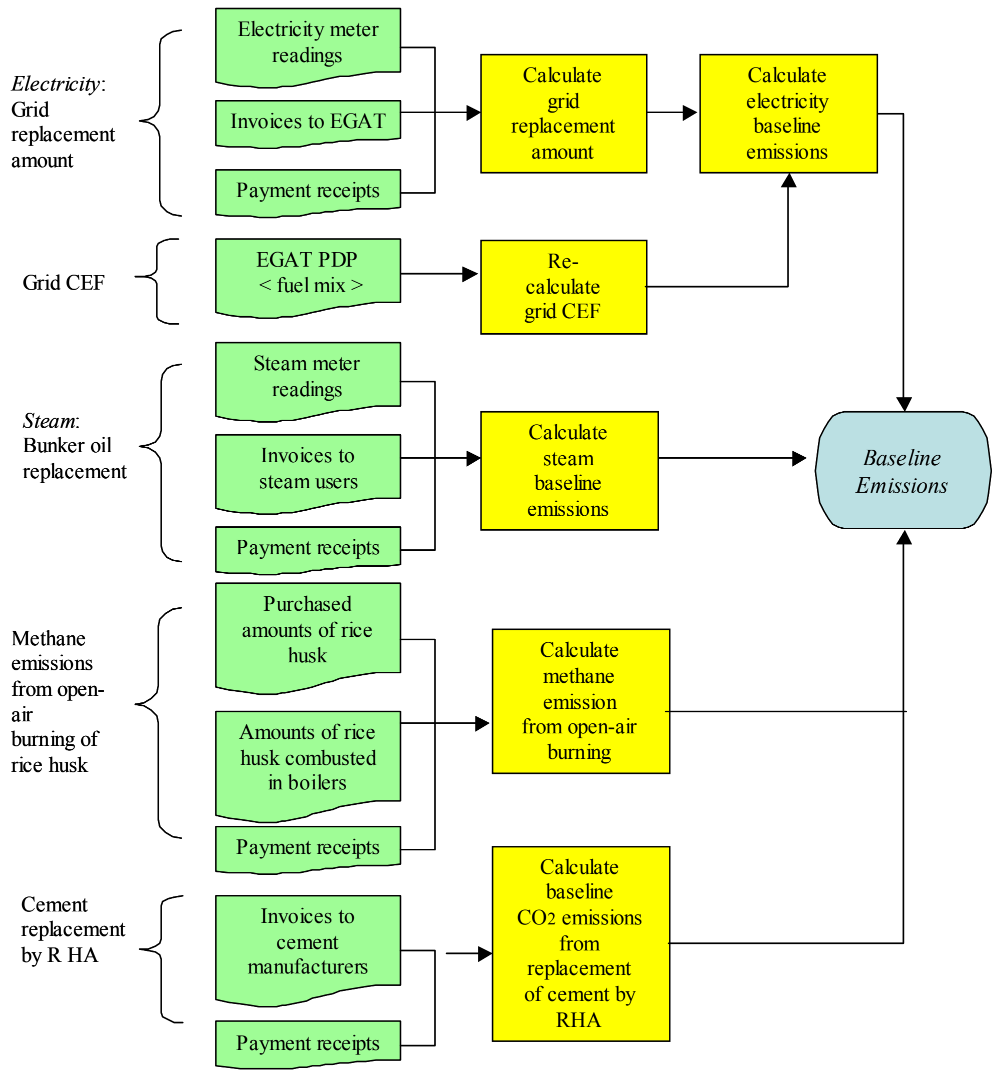
30 Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual, Section 2.3.2, p. 2.6.

31 1995 IPCC Working Group II, Section 20.3.4.1 Cement and Concrete, p. 661

It is important to note that the actual RHA sale to cement manufacturers may be greater or smaller in quantity than the estimated 30,000tonnes a year. The actual amount of RHA sales, monitored by ATB and verified by an independent third party, will be used in the Project's CER calculation.

E.4.5. Baseline emissions summary

The following flowchart summarizes the process of baseline emissions estimation, while the table below showing the results of calculations.



($000tCO_2e$)

Item	Relevant section of the PDD	Year							Total
		2006	2007	2008	2009	2010	2011	2012	
Electricity baseline	E4.1	332	350	331	318	316	312	308	2,267
Steam baseline	E4.2	19	19	19	19	19	19	19	133
Methane from open-air burning	E4.3	37	37	37	37	37	37	37	259
Cement replacement by RHA	E4.4	30	30	30	30	30	30	30	210
Total baseline emissions		418	436	417	404	402	398	394	2,869

E.5. Difference between E.4 and E.3 representing the emission reductions of the project activity:

Based on E.3 and E.4, the Project's contribution to GHG reduction is expected to be about 400,000tCO_2/year and 2,800,000tCO_2 for the initial crediting period of 7 years.

E.6. Table providing values obtained when applying formulae above:

($000tCO_2e$)

No	Item	Relevant section of the PDD	Year 2006	2007	2008	2009	2010	2011	2012	Total
(1)	Electricity baseline	E.4.1	332	350	331	318	316	312	308	2,267
(2)	Steam baseline	E.4.2	19	19	19	19	19	19	19	133
(3)	Methane from open-air burning	E.4.3	37	37	37	37	37	37	37	259
(4)	Cement replacement by RHA	E.4.4	30	30	30	30	30	30	30	210
(5)	Total baseline emissions	(1)+(2)+(3)+(4)	418	436	417	404	402	398	394	2,869
(6)	On-site project emissions	E.1.1	7	7	7	7	7	7	7	49
(7)	Off-site project emissions	E.1.2	7	7	7	7	7	7	7	49
(8)	Leakage	E.2	0	0	0	0	0	0	0	0
(9)	Total project emissions	(6)+(7)-(8)	14	14	14	14	14	14	14	98
(10)	Total reduction from the Project	(5)-(9)	404	422	403	390	388	384	380	2,771

F. Environmental Impacts

F.1. Documentation on the analysis of the environmental impacts, including transboundary impacts

The controlled combustion of rice husk burning in a modern facility such as ATB's eliminates serious environmental consequences that arise from the usual methods of rice husk disposal, i.e. dumping or open-air burning. The following picture illustrates the environmental hazard caused by open-air burning of rice husk.

Other points noted for ATB's plants are as follows:

- SO_2 emissions will be minimal. NO_x emissions will be kept within the standards prescribed by the Ministry of Science, Technology and Environment and the Ministry of Industry. To ensure observance of the standards, a continuous air emission monitoring system (CEMS) will be installed.

- Particulates and fly ash will be captured in an electrostatic precipitator for controlled removal. Preliminary air dispersion simulations suggest that the maximum concentrations of solid particulate emitted by the ATB plants will be less than 20% of the national standard.

- Wastewater will not be permitted to leave the plant sites. Instead, it will be first treated and then evaporated from an evaporating pond.
- Ash will be disposed of safely. If 127,000 tonnes / year RHA expected when all 5 plants are operational cannot be sold, provision has been made to bury the ash on-site, thereby preventing it from escaping into the atmosphere or entering the local waterways via runoff.
- The large size of the sites combined with tree plantings at each plant will buffer ambient noise.
- EPC and O&M contractors will be required to guarantee that each plant will follow World Bank environmental guidelines for thermal power plants, in addition to Thailand's NEB regulations.

F.2. If 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 that has been undertaken in accordance with the procedures as required by the host Party.*

Environmental Impact Assessments are required for the proposed plants. These assessments and mitigation plans for any impacts must be approved by the Office of Environmental Policy and Planning (OEPP) and National Environmental Board (NEB).

In September 2001, ATB submitted its first completed EIA, for the Pichit site, whose English summary is attached as Reference File I. The EIA was approved by the National Environmental Board (NEB) on 20 November 2002. Approval of the Project's EIA signifies conformity to all the Thai environmental standards specified in the Enhancement and Conservation of the National Environmental Quality Act B.E. 2535.

EIAs for three of the other four sites have been submitted in November. Their review process is expected to take only a few months as they are identical to the Pichit plant whose EIA has already been approved. The EIA for the fifth plant, also identical to others, will be submitted subsequently.

As part of EIA compliance, ATB will submit to the OEPP regular semi-annual EIA reports, which will include the following:

- Results of continuous monitoring of air emission from the stack
- Ambient air quality
- Noise level at monitoring points in the neighbourhood
- Water quality at the holding pond
- Occupational health and safety
- Record of accidents

G. Stakeholders comments

G.1. Brief description of the process on how comments by local stakeholders have been invited and compiled:

ATB has held numerous meetings with local stakeholders at all its plant sites. As an example, Appendix C lists 24 principal meetings held for the Pichit site.

Local stakeholder comments are also sought in formal surveys. For the Pichit site, opinion surveys were conducted amongst 20 community leaders and 150 villagers, in accordance with the methodology described in Reference File II. Similar opinion surveys are under way or planned for other sites.

G.2. Summary of the comments received:

The opinion survey results were very positive for the Project, with as many as 87% of the respondents expressing agreement, while only 2.7% disagreed. Details are provided in Reference File II.

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

G.3.1. Environmental Protection Guarantee Fund

ATB is establishing an Environmental Protection Guarantee Fund to ensure that financial resources are available to pay for damages in the unlikely event that environmental degradation occurs as a result of the operations of its plants.

During plant operation, the Fund earmarks annually a sum of 1 million baht (about US$23,000) for each site, totalling 5 million baht (about US$115,000) for ATB's five plants. Please refer Appendix D for detail.

A careful process has been developed to monitor the funds, meetings, actions, and public participation proceedings. These records will be available for inspection.

The monitoring procedure is summarized in the following table.

Performance Evaluation for:	Documentation	Comments:
Environmental well-being & compliance	- Meeting minutes of Fund Committee meetings	Committee meetings will be held on a regularly scheduled basis, with details to be finalized at the start of construction.
Environmental well-being & compliance	- Independent 3rd party assessments	Technical expert assessments by an independent third party will support the Committee's work in monitoring environmental impact.
Environmental well-being & compliance	- Fund's bank statements	If local communities are compensated for environmental non-compliance, the Fund's bank will record drawdowns from the Fund.
Community resident satisfaction	- Resident comment logs	Residents within the community will be encouraged to voice concerns with the local government, who will be responsible for bringing them to the Committee. The Committee will maintain a record of residents' comments.

G.3.2. Socio-economic contribution to local communities

ATB intends to make certain that its power plants will substantially contribute to the well being of the local communities.

Many locals have become stakeholders in the ATB Project. Rice millers and truckers, many of whom are residents in communities in the vicinity of the power plant sites, have entered into fuel supply and fuel transport agreements. Other local residents will be involved during plant construction as construction workers and civil work subcontractors, and during plant operation as skilled and unskilled operations and maintenance personnel. In addition, local communities have expressed strong support for ATB's plans to make low cost steam available for paddy drying, as this helps farmers achieve better margins for their crop.

The list of specific local economic development impacts include;

- Creation of construction and power plant operation jobs (All contractors and suppliers to the project are mandated to give preference to local labour.);

- Training and professional development (Training in equipment operation and computers; internet access will also be available for workers.);

- Increased employment opportunities in rural areas (People may choose to work locally, instead of moving to urban centres for employment.);

- Increased economic activity is expected in the local communities at all plant sites to meet transportation, housing, and catering needs, etc.;

- Increased prices for rice paddy (Since the Project requires very large quantities of rice husk, the newly created market will likely drive up prices paid to rice traders, as well as to farmers.)

G.3.3. Community Development Fund

To contribute to the local communities' social development, ATB is establishing the Community Development Fund in additional to the Environmental Protection Guarantee Fund mentioned above. The fund earmarks for each plant site 1 million baht (about US$ 23,000) annually, totalling 5 million baht (about US$115,000) for ATB's five plants. The annual endowments are not contingent on the Project's financial performance.

Run by a committee composed of local leaders, ATB representatives and 3rd party advisors, the fund's mandate will be to design, organize, and run projects focusing on education for the youth, cultural life, and the environment.

ATB's discussions with local communities have revealed some common goals:

- Increase the number of young people continuing onto higher education (high school completion, technical college, etc.) through merit and need-based scholarships;

- Improve education experience at primary and secondary levels through donations and endowments to local schools;

- Increase computer literacy through factory-based and/or school-based computer facilities and workshops;

- Promote greater awareness and understanding of environmentally sustainable farming and irrigation techniques.

The fund will positively impact social development at community level, through streamlined, focused activities. Please refer Appendix D for more detail.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

The financial plans for the Project do not involve public funding from Annex I countries.

Annex 3

NEW BASELINE METHODOLOGY

Three new baseline methodologies will be proposed, for grid electricity displacement, fossil fuel-based steam displacement and avoidance of biomass disposal.

NEW BASELINE METHODOLOGY 1

1. Title of the proposed methodology:

Displacement of grid electricity: *Retrospective annual application of weighted average carbon emission factors calculated from actual official data.*

2. Description of the methodology:

2.1. General approach

✗◻ Existing actual or historical emissions, as applicable;

◻ Emissions from a technology that represents an economically attractive course of action, taking into account barriers to investment;

◻ The average emissions of similar project activities undertaken in the previous five years, in similar social, economic, environmental and technological circumstances, and whose performance is among the top 20 per cent of their category.

2.2. Overall description (other characteristics of the approach):

The proposed methodology is an application of 48(a) of the Marrakesh Accords. This methodology uses official data for the national/regional/local electricity grid to calculate the weighted average carbon emission factor for grid electricity. The weighted average is then multiplied by the amount of electricity replaced by the project activity to arrive at the baseline emissions. This is the most appropriate approach for all grid-connected power generation CDM projects unless there are specific reasons to believe that some component(s) of the grid, instead of the grid average, will be displaced by the project activity.

The salient feature of the proposed methodology is the retrospective use of actual annual grid data – as opposed to the projection data – for the calculation of the weighted averaged CEFs. While annual baseline emissions are estimated initially on the basis of the projected fuel mix of the grid, they will be replaced each year by a figure calculated by applying actual official data to the formulae described in 6. It is these baseline emissions derived retrospectively from actual data that will be used for CER calculations.

3. Key parameters/assumptions (including emission factors and activity levels), and data sources considered and used:

Key parameters/assumptions:

Grid-connected power generation projects – Absence of convincing reasons to believe that a specific fuel(s) will be displaced by the project activity.

Data sources:

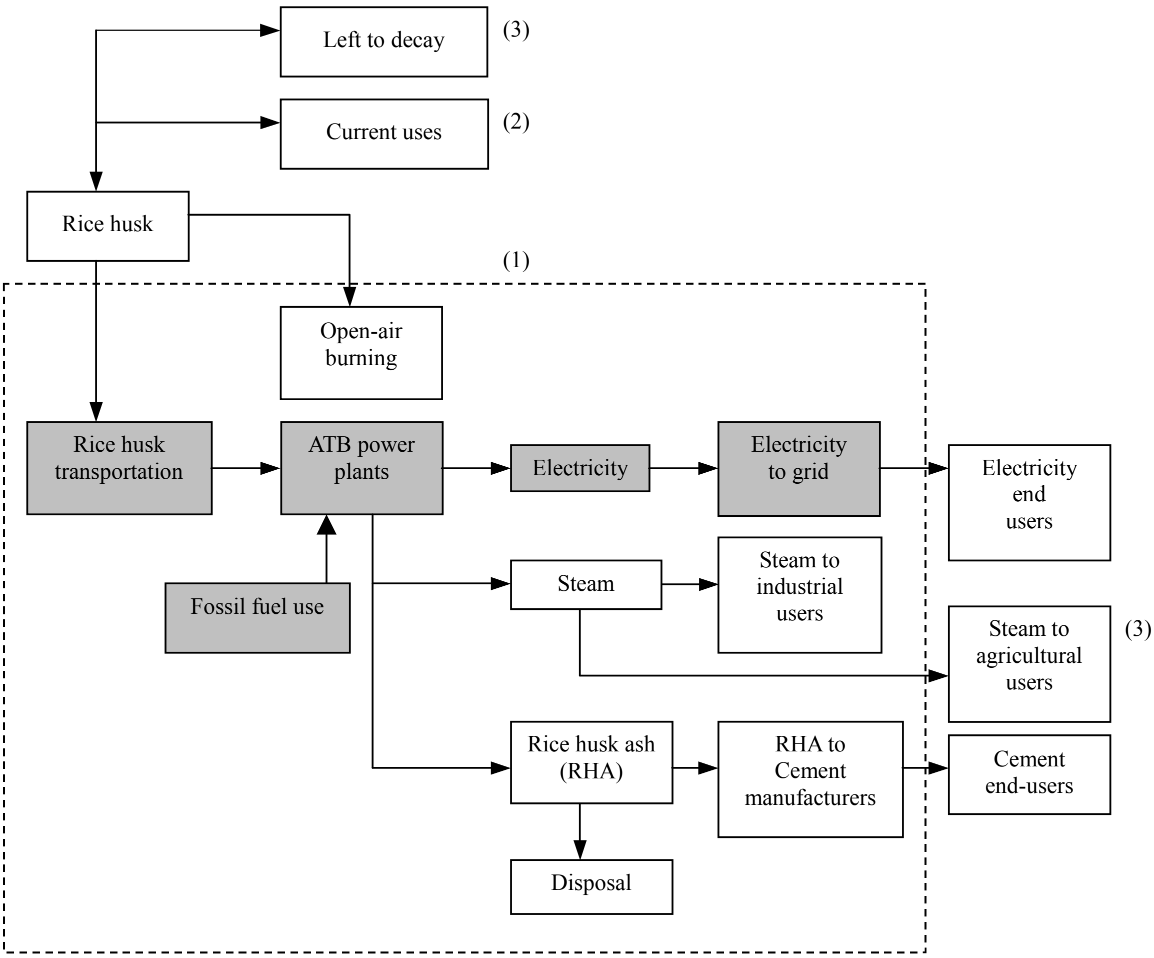
Grid fuel mix – Historical data issued officially for the relevant local/regional national grid, showing the amount of electricity supplied by each type of power generation. This will be used as a primary indication of the national and sectoral circumstances, as the energy plan is typically a reflection of the energy sector priorities as well as the pertinent national policies.

CEF – Emission factor for each fuel type of power generation derived from the Environmental Manual for Power Development Model (EM Model)[32].

4. Definition of the project boundary related to the baseline methodology:

The project boundary will differ depending on the characteristics of the project to which the methodology is applied, and therefore cannot be defined here. Typically, fuel combustion to produce electricity and transportation of fuel are included in the project boundary.

The project boundary for the Project is shown in the following diagram. The shaded boxes are relevant to this baseline methodology.



5. Assessment of uncertainties:

The proposed methodology is low in uncertainty. It eliminates the major uncertainty often encountered in setting the baseline for grid power generation: the deviation of the actual from the projected fuel mix. By obtaining and using actual annual data from the relevant power generating authority, the methodology allows an accurate grid average CEF to be calculated retrospectively.

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32 http://www.worldbank.org/html/fpd/em/model/model.stm

The only uncertainty lies in the applicability of the EM model. There is a possibility that the actual efficiencies of the power generating facilities of a grid differ from those assumed in the EM Model, resulting in inaccurate estimation for the baseline. This risk, however, can be mitigated by appropriate selection of the parameters from the wide choices the Model provides.

6. Description of how the baseline methodology addresses the calculation of baseline emissions and the determination of project additionality:

The baseline emission for a particular year is obtained by multiplying the electricity displaced by the project with the weighted average grid CEF calculated in the following manner.

STEP 1: (1) Weight of generation type in national grid (%)
x
(2) CEF for the generation type (kgCO_2/kWh)

STEP 2: Repeat STEP 1 for every generation type in the grid

STEP 3: Add all the products of above calculations for the given year

The determination of project additionality, environmental or otherwise, is not within the scope of this baseline methodology. Project additionality will be determined after thorough analysis of the fuel or technology to be used for the project, financial projections with and without CERs, and relevant national and sectoral circumstances.

7. Description of how the baseline methodology addresses any potential leakage of the project activity:

Leakage will depend on the characteristics of the specific project. For biomass energy projects, one of which the accompanying PDD deals with, an example of a project-specific characteristic is the current end uses of the biomass. Such current uses may be diverted to a more carbon-intensive fuel if the biomass becomes scarce as it begins to be used for power generation. Hence, leakage will be defined when the baseline methodology is actually applied in Section B of the PDD.

8. Criteria used in developing the proposed baseline methodology, including an explanation of how the baseline methodology was developed in a transparent and conservative manner:

The first criterion is accuracy. The methodology represents the most accurate baseline for grid-connected power projects, unless there is a definite indication that a specific fuel(s) will be displaced by the project activity.

Equally important is transparency. The methodology is clearly transparent in that it requires the use of actual fuel mix data sourced from a relevant power generating authority. The data is readily available to the public and can easily be double-checked by the verifier.

In addition, the use of the grid average is conservative in most cases, as it includes in the calculation hydro- and renewable power with zero or very low emission. The approach avoids overestimation of the baseline which may arise from prematurely selecting, as the target of displacement, more carbon-intensive power generation such as coal-fuelled or oil-fuelled electricity.

9. Assessment of strengths and weaknesses of the baseline methodology:

The strength of the proposed methodology is in the accuracy and transparency of the grid average CEFs used for calculating CERs for each year. By recalculating the weighted average CEF for the grid based on official actual data, the methodology has in effect a built-in automatic update function.

The weakness of the methodology lies not in the methodology itself but in the possibility of misguided application of the methodology. If it is reasonable to predict a specific fuel(s) that will be replaced by the project activity, this methodology is not pertinent. However, when the displacement of a carbon-intensive fuel is likely but inconclusive, the use of this methodology may be preferable for the sake of conservatism.

10. Other considerations, such as a description of how national and/or sectoral policies and circumstances have been taken into account:

This methodology itself, once applied, implicitly takes into account all national and sectoral policies and circumstances in that the actual fuel mix is a reflection of these circumstances.

NEW BASELINE METHODOLOGY 2

1. Title of the proposed methodology:

Displacement of steam generated from the combustion of fossil fuels: Energy balance calculation for displaced steam where the displaced fuel(s) and technology(ies) are known.

2. Description of the methodology:

2.1. General approach

☒ Existing actual or historical emissions, as applicable;

☐ Emissions from a technology that represents an economically attractive course of action, taking into account barriers to investment;

☐ The average emissions of similar project activities undertaken in the previous five years, in similar social, economic, environmental and technological circumstances, and whose performance is among the top 20 per cent of their category.

2.2. Overall description (other characteristics of the approach):

The proposed methodology is an application of 48(a) of the Marrakesh Accords. It considers the baseline to be emissions from combustion of fuel required to produce steam, where the specific fuel(s) and technology(ies) being displaced by the project activity is known. The emissions are calculated through energy balance calculations and using IPCC carbon emission factors.

This methodology is applicable where the project activity involves the supply of steam to current users of steam, which are produced through technologies or fuels resulting in higher greenhouse gas emissions than that for the project.

3. Key parameters/assumptions (including emission factors and activity levels), and data sources considered and used:

Key parameters/assumptions:

Steam generation – There are no circumstances to suggest that the transfer to the cleaner technology will occur as part of the business-as-usual scenario.

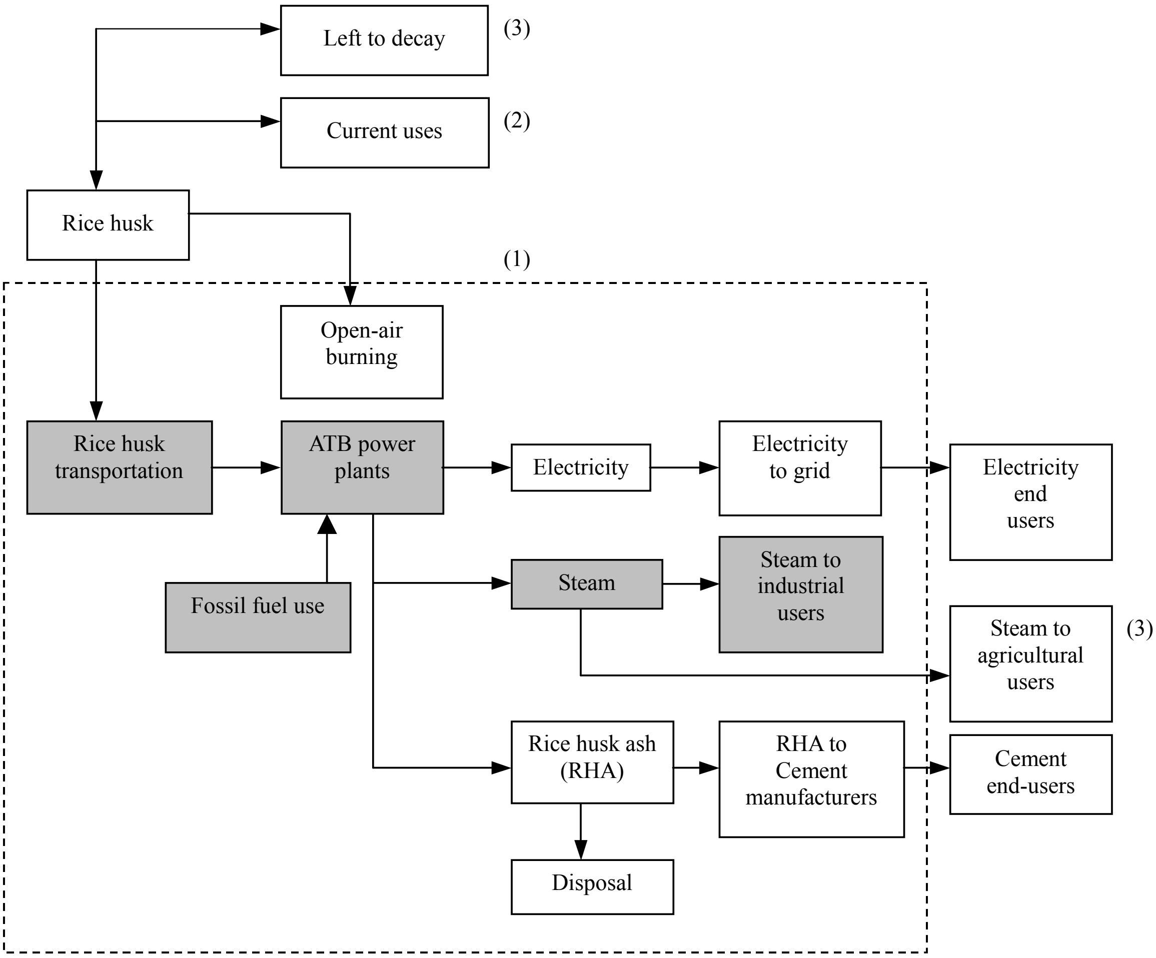
Data sources:

Displaced fuel – current user of steam
Displaced boiler – current user of steam
CEF – IPCC default carbon emission factors
BAU practice – current user of steam, fuel costs, Host country environmental regulations

4. Definition of the project boundary related to the baseline methodology:

The project boundary will include emissions from fuels used to produced steam, as well as from fuel transportation.

The project boundary for the Project is shown in the following diagram. The shaded boxes are relevant to this baseline methodology. However, for this Project, the emissions related to fuel transportation have already been accounted for in the proposed methodology for displacement of grid electricity, and need not be elaborated further.



5. Assessment of uncertainties:

The proposed methodology is low in uncertainty. Due to the large heat losses associated with the transport of steam, the end-user of the steam produced by the plant is necessarily located in the vicinity of the project site, and hence the fuel and technology being displaced is readily identified with accuracy.

6. Description of how the baseline methodology addresses the calculation of baseline emissions and the determination of project additionality:

The baseline emissions are calculated based on the amount of steam exported by the project. The emissions are back calculated by using the appropriate IPCC CEF and efficiency for the displaced fuel and technology, respectively. The efficiency specified by the manufacturer of the boiler will be used in the calculation. As the stated efficiency is normally higher than the actual operating efficiency, this will result in a conservative estimation of the baseline emissions. Where steam is recycled at the current plant, the increased efficiency will be taken into account, adding to the conservatism.

Transfer loss can be significant when exporting steam. However, this issue is negated as the calculation involves using the steam properties actually received by the buyer.

The determination of project additionality, environmental or otherwise, is not within the scope of this baseline methodology. Project additionality will be determined after thorough analysis of the fuel or technology to be used for the project, financial projections with and without CERs, and relevant national and sectoral circumstances.

7. Description of how the baseline methodology addresses any potential leakage of the project activity:

Leakage will depend on the characteristics of the specific project. For biomass energy projects, one of which the accompanying PDD deals with, an example of a project-specific characteristic is the current end use of the biomass which may be diverted to a more carbon-intensive fuel if the biomass becomes scarce as it begins to be widely used for energy generation. Hence, leakage will be defined when the methodology is actually applied in Section B of the PDD.

8. Criteria used in developing the proposed baseline methodology, including an explanation of how the baseline methodology was developed in a transparent and conservative manner:

Transparency and accuracy are of importance in developing a baseline methodology. Where the fuel and technology to be displaced by the project activity is clear, as is the case for most projects involving steam generation and sales, this methodology provides the most accurate determination of the baseline. It is transparent in that the DOE will be able to readily assess the validity of the baseline.

This baseline methodology will result in a conservative estimate of baseline emissions as it will use the boiler efficiency specified by the manufacturer, rather than the operating efficiency. That it will also include increased efficiency from the recycling of steam, which is often overlooked in such calculations, adds considerably to the conservatism.

9. Assessment of strengths and weaknesses of the baseline methodology:

The strength of this methodology is in its transparency and accuracy delineated in 8 above.

The weakness is in its limited applicability, in that it is designed for projects which export steam to existing users of steam generated from a fuel(s) and technology(ies) that can be readily identified. It does not extend its applicability to projects that will export steam to a new facility.

10. Other considerations, such as a description of how national and/or sectoral policies and circumstances have been taken into account:

The foremost national/sectoral policy that will be taken into account in the baseline determination is the environmental regulations of the Host country. This will be used as an indicator on whether an upgrade to a cleaner technology is mandated regardless of the project activity.

Other considerations that would be taken into account is the age of the existing boilers that produce the steam, to determine if the boiler is coming to the end of its operating lifetime, and will be replaced in a business-as-usual scenario.

NEW BASELINE METHODOLOGY 3

1. Title of the proposed methodology:

Estimation of emission reduction from uncontrolled biomass disposal where BAU is open air burning

2. Description of the methodology:

2.1. General approach

☒ Existing actual or historical emissions, as applicable;

☐ Emissions from a technology that represents an economically attractive course of action, taking into account barriers to investment;

☐ The average emissions of similar project activities undertaken in the previous five years, in similar social, economic, environmental and technological circumstances, and whose performance is among the top 20 per cent of their category.

2.2. Overall description (other characteristics of the approach):

The proposed methodology is an application of 48(a) of the Marrakesh Accords. This methodology applies to project activities utilizing agricultural waste products, which, through the controlled combustion of such biomass, reduce emissions from dumping or uncontrolled burning that would have otherwise occurred. The baseline is considered to be greenhouse gas emissions from the uncontrolled burning of biomass.

Although energy generation is an integral part of methane avoidance projects such as the one the accompanying PDD deals with, the baseline and monitoring methodologies have already been defined for the power and heat generation components. These baselines cover the monitoring of emissions from displaced energy generation and fuel transportation, and will therefore not be included as part of this methodology. This methodology is to be used to determine project and baseline emissions solely for methane avoidance from the reduction of disposed biomass, and should be used in conjunction with a relevant methodology for displaced energy generation.

3. Key parameters/assumptions (including emission factors and activity levels), and data sources considered and used:

Key parameters/assumptions:

Use of biomass – the biomass fuel is available in large surplus quantities and is currently being treated mainly as a waste product. There are no circumstances to reasonably suggest the proportion of surplus agricultural waste will change significantly.

Data sources:

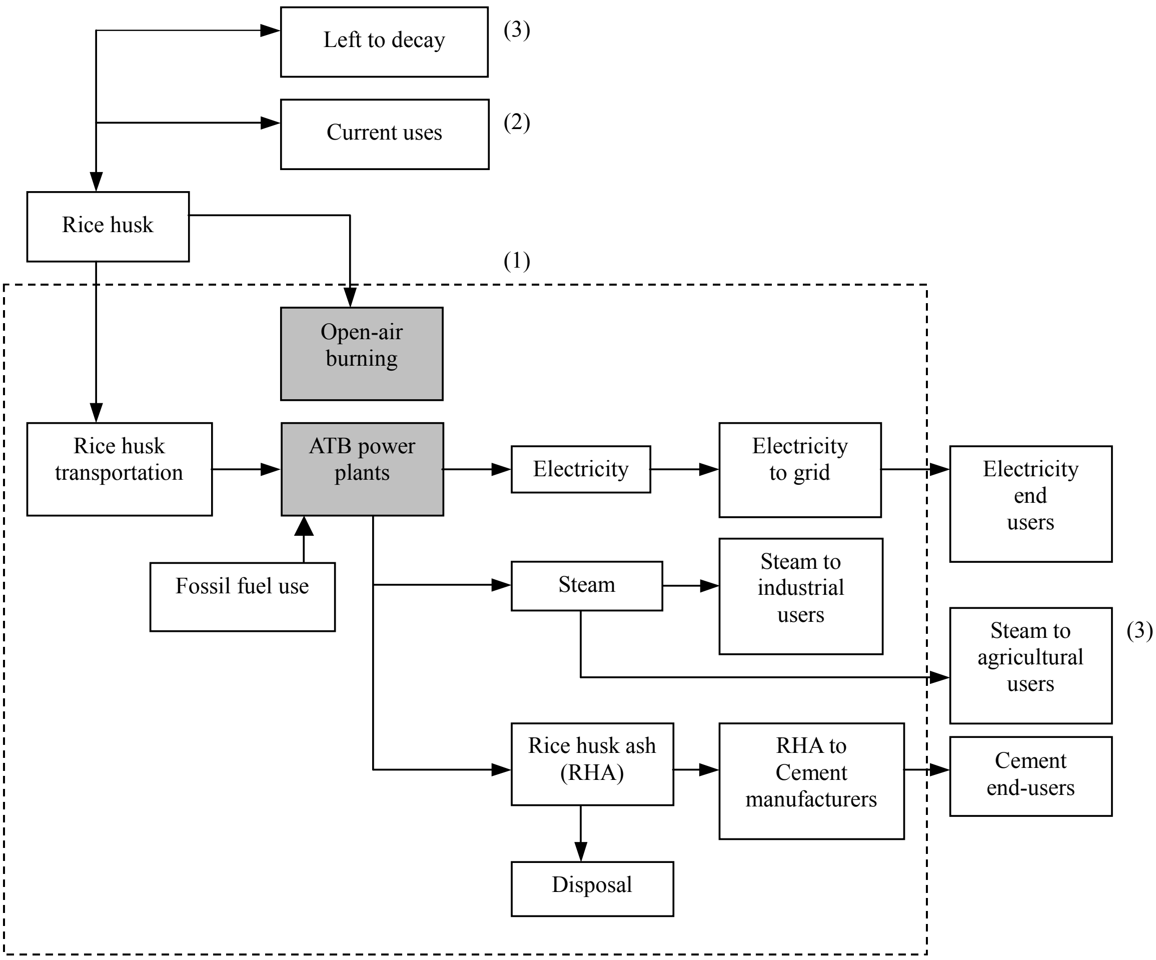
Current use/disposal of biomass – relevant industry sources, Host country GHG inventories
BAU practice – current producer of agricultural waste, fuel costs, Host country environmental regulations, incentives provided for biomass utilisation

CEF – IPCC default carbon emission factors

4. Definition of the project boundary related to the baseline methodology:

The project boundary relating to the proposed baseline methodology will include methane emissions from the combustion of biomass by the project and the reduction of emissions associated with the uncontrolled disposal of unused biomass.

The project boundary for the Project is shown in the following diagram. The shaded boxes are relevant to this baseline methodology.



5. Assessment of uncertainties:

The proposed methodology considers the baseline to be methane emissions from uncontrolled burning of surplus biomass. The uncertainty lies in the assumption that all agricultural waste for which uses cannot be found will be burned, whilst in reality, a significant quantity of the agricultural waste is dumped. The methodology duly addresses this uncertainty by erring on the side of conservatism, as dumping of biomass will result in higher baseline emissions due to the larger quantities of methane – a potent greenhouse gas – produced.

6. Description of how the baseline methodology addresses the calculation of baseline emissions and the determination of project additionality:

The baseline emissions are calculated based on the amount of biomass consumed by the project. The emissions for uncontrolled burning are back calculated by using the appropriate carbon content and IPCC factor for the proportion of carbon released as methane in open-air burning.

For projects involving mitigation of methane emitted from biomass by using it as a source of renewable energy, the environmental additionality is clear. However, the determination of the exact degree of environmental additionality, as well as other forms of additionality, is not within the scope of this baseline methodology. Project additionality will be determined after thorough analysis of the technology to be used for the project, financial projections with and without CERs, and relevant national and sectoral circumstances.

7. Description of how the baseline methodology addresses any potential leakage of the project activity:

Leakage will depend on the characteristics of the specific project. For biomass energy projects, one of which the accompanying PDD deals with, an example of a project-specific characteristic is the current end use of the biomass which may be diverted to a more carbon-intensive fuel if the biomass becomes scarce as it begins to be widely used for energy generation. Hence, leakage will be defined when the methodology is actually applied in Section B of the PDD.

8. Criteria used in developing the proposed baseline methodology, including an explanation of how the baseline methodology was developed in a transparent and conservative manner:

Due to the uncertainty relating to the disposal method of agricultural waste identified in 5 above, transparency and conservatism was given precedence over accuracy in developing the baseline methodology.

There are two methods of disposing biomass for which no use is found – dumping and uncontrolled burning. Unless there exists reliable data on the ratio of the respective modes of disposal, the method that results in the more conservative estimation of baseline emissions shall be chosen. The degradation of biomass is accompanied by the emission of large amounts of methane, whilst it is significantly less for open-air burning. As methane is 21 times more potent a greenhouse gas than carbon dioxide, the assumption that all unused biomass will be disposed through uncontrolled burning results in a considerable underestimation of baseline emissions. Therefore, the baseline methodology is clearly conservative.

9. Assessment of strengths and weaknesses of the baseline methodology:

The strength of this methodology is in the conservatism of the assumptions made to address the uncertainty in the current disposal method for unused agricultural waste. It will also reduce the complexity of the baseline emission calculation and subsequent monitoring plan, which will reduce the cost to be borne and commitment required on the part of project operators. Moreover, the simplicity of the methodology will find wide application in many biomass energy projects.

The other side of this is that the conservative estimation will inevitably result in less CER credits than warranted. As even a minor fluctuation in methane emission reduction will significantly impact the CER claims due to its potency as a GHG, this may not be a suitable methodology for many, especially smaller, project operators who will need to claim all legitimate CERs to sustain the financial feasibility of the project.

10. Other considerations, such as a description of how national and/or sectoral policies and circumstances have been taken into account:

An important consideration is the degree to which the agricultural waste is currently utilised. Trends in biomass supply and demand should be thoroughly analysed to determine whether this methodology is applicable to the project. If considered necessary, the collection of supply and demand data should be incorporated into the monitoring plan.

Annex 4

NEW MONITORING METHODOLOGY

Three new monitoring methodologies will be proposed, for grid electricity displacement, fossil fuel-based steam displacement and avoidance of biomass disposal. The methodologies themselves are essentially identical, in that they all rely on direct measurements and use of commercial records. However, they have been prepared separately so that they may be readily used in conjunction with the respective baseline methodologies.

NEW MONITORING METHODOLOGY 1

Proposed new monitoring methodology

Monitoring emissions from biomass power generation using direct measurements and commercial records.

1. Brief description of new methodology

The monitoring of baseline emissions will be based on official fuel mix records of the relevant power generating authority. The fuel mix data will be used together with relevant emission factors to calculate the weighted average CEF. The CEF will in turn be multiplied by the amount of electricity exported to the grid to calculate the GHG emission reduction.

For project emissions, GHG emissions from fuel transportation on- and off-site and start-up fuel use will be monitored. The methodology is applicable to power generation through combustion of biomass, which is considered to be carbon-neutral.

This methodology relies heavily on the use of commercial records. This approach has the benefit of streamlining the monitoring and verification process by making use of data that have already been checked by independent outside parties in the course of regular business.

2. Data to be collected or used in order to monitor emissions from the project activity, and how this data will be archived

The data to be collected to monitor emissions from the project activity will differ from project to project. Typically, emissions from electricity generation (fuel combustion) will be monitored by recording on-site fuel use.

The following table represents data that will be collected to monitor emissions from the Project, as per the PDD.

ID number	Data type	Data variable	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	For how long is archived data kept?
1	Quantitative	Methane emissions	%	m	annually	-	electronic	minimum of two years after last issuance of CERs
2	Quantitative	Rice husk combustion amount	t fuel	m	monthly (aggregate)	100%	electronic	minimum of two years after last issuance of CERs
3	Quantitative	Fuel oil use	L	m	continuous	100%	electronic	minimum of two years after last issuance of CERs
4	Quantitative	On-site use of transport fuel	L	m	continuous	100%	electronic	minimum of two years after last issuance of CERs
5	Quantitative	Off-site transport distance	km	m	monthly (aggregate)	100%	electronic	minimum of two years after last issuance of CERs

Spectroscopic measurements (Data 1) will be carried out annually to obtain the proportion of methane in the stack gas emitted to the atmosphere. This data, together with the aggregated monthly report on rice husk usage (Data 2), will be used to calculate the total methane emission from rice husk combustion.

Emissions from fuel oil used as supplementary fuel are expected to be insignificant, but will be monitored and included in project emissions regardless. Flow meters will continuously record the amount of fuel being fed into the boilers (Data 3).

Transportation of rice husk and rice husk ash will occur both on- and off-site. On-site emissions can be calculated by obtaining the amount of fuel used (Data 4). Off-site emissions can be calculated by recording the distance travelled by the trucks (Data 5).

The determination of the baseline emissions will involve the calculation of the weighted average CEF from the official fuel mix data released periodically. Therefore, the following table, which represents the data to be collected for the Project, is provided as an example.

ID number	Data type	Data variable	Data unit	Will data be collected on this item? (If no, explain).	How is data archived? (electronic/ paper)	For how long is data archived to be kept?
6	Quantitative	Electricity exported to grid	MWh	yes	electronic	minimum of two years after last issuance of CERs
7	Quantitative	Fuel mix for grid electricity	MWh	yes	electronic	minimum of two years after last issuance of CERs

Electricity exported to the grid (Data 6) will be monitored through meter readings and indicates the amount of grid electricity that is displaced by the Project.

Fuel mix data (Data 7) will be obtained as it is released by EGAT. This will be used to calculate the weighted average CEF, which will be multiplied with the exported electricity to determine the baseline emissions.

3. Potential sources of emissions which are significant and reasonably attributable to the project activity, but which are not included in the project boundary, and identification if and how data will be collected and archived on these emission sources

As identified in Annex 3, leakage will depend on the characteristics of the specific project. This section can therefore only be filled out once these specifics are known.

For the Project, no leakage issues were identified.

ID number	Data type	Data variable	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	For how long is archived data kept?

4. Assumptions used in elaborating the new methodology:

The methodology involves the use of emission factors for various fuels to compute the GHG emissions from power generation and fuel transportation. Emission factor data should be from recognised sources such as the IPCC.

Where a variable can be monitored through either direct measurements or commercial records, the measured value will be monitored, and the commercial record will be used for quality control purposes. Where a variable will not be measured, the appropriate commercial record will be used as the primary data. The underlying assumption for this approach is that the use of commercial data will result in a high degree of accuracy, as it involves two or more parties with opposing interests reaching a consensus on its validity.

5. Please indicate whether quality control (QC) and quality assurance (QA) procedures are being undertaken for the items monitored. *(see tables in sections 2 and 3 above)*

On the whole, the use of official data from the power generating authority and commercial records from the project company will ensure the integrity of most of the data to be monitored. However, detailed quality control measures can only be outlined when the methodology is applied to an individual project.

The quality control measures planned for the Project are outlined in the following table.

Data	Uncertainty level of data (High/Medium/Low)	Are QA/QC procedures planned for these data?	Outline explanation why QA/QC procedures are or are not being planned.
2-1	Low	Yes	The sampling instruments will undergo maintenance subject to appropriate industry standards. The spectroscopy results will be compared to the IPCC default emission factor. The larger of the two values will be used to ensure conservatism.
2-2	Low	Yes	Trucks carrying rice husk will be weighed twice, upon entry and exit. Meters at the weighing station will undergo maintenance subject to appropriate industry standards. This will be checked against purchase receipts and inventory data.
2-3	Low	Yes	Meters will undergo maintenance subject to appropriate industry standards. The meter readings will be checked against purchase receipts and inventory data.
2-4	Low	Yes	Fuel pump readings will be compared against fuel purchase invoices.
2-5	Low	Yes	The distance records will be compared against invoices from rice husk and rice ash transport contractors.
2-6	Low	Yes	Meters will undergo maintenance/calibration subject to appropriate industry standards. The accuracy of the meter readings will be verified by EGAT, who will issue receipts.
2-7	Low	N/A	This involves the use of official data released by EGAT. Quality control of this data is beyond the control of the project operators.

6. What are the potential strengths and weaknesses of this methodology?

The use of commercial records will ensure high accuracy for the monitored data. At the same time, the effective use of existing systems in place will streamline the monitoring and verification process and reduce the costs to be borne by the project operator. Another merit of using commercial data is that the proportion of data monitored will be high, in many cases being 100%.

Also, by monitoring project emissions from sources that have only minor impacts on the total project emissions such as start-up fuel use, this methodology eliminates the potential sources of leakage and ensures a conservative calculation of project emissions.

The downside of this, however, is that the monitoring and archiving of emissions from such minor sources will be a laborious process. Although the monitoring of these emission sources is desirable in the interest of conservatism, it is an added burden for project operators, who, particularly for biomass projects, may not have the sufficient capacity to carry this out.

7. Has the methodology been applied successfully elsewhere and, if so, in which circumstances?

This methodology has not been applied in the context of a CDM project. However, this monitoring methodology is in principle the same as that provided for small-scale CDM projects under the "Renewable electricity generation for a grid" category, whereby the following variables are recorded:

1. electricity generated by the project
2. biomass input (for co-fired plants)
3. energy content of the biomass (for co-fired plants)

MONITORING METHODOLOGY 2

Proposed new monitoring methodology

Monitoring emissions from biomass steam generation using direct measurements and commercial records.

1. Brief description of new methodology

The proposed monitoring methodology is a simple one, where the amount of steam generated and exported will be used to calculate the baseline emissions. For project emissions, GHG emissions from energy generation and transportation will be monitored.

This methodology relies heavily on the use of commercial records. This approach has the benefit of streamlining the monitoring and verification process by making use of data that have already been checked by independent outside parties in the course of regular business.

2. Data to be collected or used in order to monitor emissions from the project activity, and how this data will be archived

The data to be collected to monitor emissions from the project activity will differ from project to project. Typically, emissions from steam generation (fuel combustion) will be monitored by recording on-site fuel use.

The Project involves the installation of a cogeneration unit in order to produce steam from a clean technology, in addition to clean power. The monitoring of emissions from the cogeneration unit and associated fuel transport for the steam generation component of the Project is hence already encompassed in the monitoring plan for the power generation component, and need not be elaborated here. However, the data collected to monitor project emissions will be reproduced here for convenience to the reader.

ID number	Data type	Data variable	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	For how long is archived data kept?
1	Quantitative	Methane emissions	%	m	annually	-	electronic	minimum of two years after last issuance of CERs
2	Quantitative	Rice husk combustion amount	t fuel	m	monthly (aggregate)	100%	electronic	minimum of two years after last issuance of CERs
3	Quantitative	Fuel oil use	L	m	continuous	100%	electronic	minimum of two years after last issuance of CERs
4	Quantitative	On-site use of transport fuel	L	m	continuous	100%	electronic	minimum of two years after last issuance of CERs
5	Quantitative	Off-site transport distance	km	m	monthly (aggregate)	100%	electronic	minimum of two years after last issuance of CERs

Spectroscopic measurements (Data 1) will be carried out annually to obtain the proportion of methane in the stack gas emitted to the atmosphere. This data, together with the aggregated monthly report on rice husk usage (Data 2), will be used to calculate the total methane emission from rice husk combustion.

Emissions from fuel oil used for start-up are expected to be insignificant, but will be monitored and included in project emissions regardless. Flow meters will continuously record the amount of fuel being fed into the boilers (Data 3).

Transportation of rice husk and rice husk ash will occur both on- and off-site. On-site emissions can be calculated by obtaining the amount of fuel used (Data 4). Off-site emissions can be calculated by recording the distance travelled by the trucks (Data 5).

The table below represents data collected in order to calculate baseline emissions for the Project.

ID number	Data type	Data variable	Data unit	Will data be collected on this item? (If no, explain).	How is data archived? (electronic/ paper)	For how long is data archived to be kept?
6	Quantitative	Steam exported	t	yes	electronic	minimum of two years after last issuance of CERs
7	Quantitative	Steam exported	bar	yes	electronic	minimum of two years after last issuance of CERs

By monitoring the amount (Data 1) and pressure (Data 2) of the exported steam, the heat value of the steam supplied to the end-user can be determined from steam tables. Once this is known, the efficiency of the displaced boiler and the IPCC CEF value for the displaced fuel will be used to derive the baseline emissions.

3. Potential sources of emissions which are significant and reasonably attributable to the project activity, but which are not included in the project boundary, and identification if and how data will be collected and archived on these emission sources

As identified in Annex 3, leakage will depend on the characteristics of the specific project. This section can therefore only be filled out once these specifics are known.

For the Project, no leakage issues were identified.

ID number	Data type	Data variable	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	For how long is archived data kept?

4. Assumptions used in elaborating the new methodology:

The assumptions used in the new methodology are identical to that for displaced grid electricity, and are reproduced below.

The methodology involves the use of emission factors for various fuels to compute baseline and project emissions. Emission factor data should be from recognised sources such as the IPCC.

Where a variable can be monitored through either direct measurements or commercial records, the measured value will be monitored, and the commercial record will be used for quality control purposes. Where a variable will not be measured, the appropriate commercial record will be used as the primary data. The underlying assumption for this approach is that the use of commercial data will result in a high degree of accuracy, as it involves two or more parties with opposing interests reaching a consensus on its validity.

5. Please indicate whether quality control (QC) and quality assurance (QA) procedures are being undertaken for the items monitored. *(see tables in sections 2 and 3 above)*

On the whole, the use of official data from the power generating authority and commercial records from the project company will ensure the integrity of most of the data to be monitored. However, detailed quality control measures can only be outlined when the methodology is applied to an individual project.

The quality control measures planned for the Project are outlined in the following table.

Data	Uncertainty level of data (High/Medium/Low)	Are QA/QC procedures planned for these data?	Outline explanation why QA/QC procedures are or are not being planned.
2-1	Low	Yes	The sampling instruments will undergo maintenance subject to appropriate industry standards. The spectroscopy results will be compared to the IPCC default emission factor. The larger of the two values will be used to ensure conservatism.
2-2	Low	Yes	Trucks carrying rice husk will be weighed twice, upon entry and exit. Meters at the weighing station will undergo maintenance subject to appropriate industry standards. This will be checked against purchase receipts and inventory data.
2-3	Low	Yes	Meters will undergo maintenance subject to appropriate industry standards. The meter readings will be checked against purchase receipts and inventory data.
2-4	Low	Yes	Fuel pump readings will be compared against fuel purchase invoices.
2-5	Low	Yes	The distance records will be compared against invoices from rice husk and rice ash transport contractors.
2-6	Low	Yes	As the meter readings of the recipient rather than the project operator is used, overstatement of the displaced steam is not an issue. This will be compared against meter readings at the project site.
2-7	Low	Yes	As above.

6. What are the potential strengths and weaknesses of this methodology?

The potential strengths and weaknesses of the proposed methodology are identical to that for displaced grid electricity, and are reproduced below.

The use of commercial records will ensure high accuracy for the monitored data. At the same time, the effective use of existing systems in place will streamline the monitoring and verification process and reduce the costs to be borne by the project operator. Another merit of using commercial data is that the proportion of data monitored will be high, in many cases being 100%.

Also, by monitoring project emissions from sources that have only minor impacts on the total project emissions such as start-up fuel use, this methodology eliminates the potential sources of leakage and ensures a conservative calculation of project emissions.

The downside of this, however, is that the monitoring and archiving of emissions from such minor sources will be a laborious process. Although the monitoring of these emission sources is desirable in the interest of conservatism, it is an added burden for project operators, who, particularly for biomass projects, may not have the sufficient capacity to carry this out.

7. Has the methodology been applied successfully elsewhere and, if so, in which circumstances?

This methodology has not been applied in the context of a CDM project. However, this monitoring methodology is in principle the same as that provided for small-scale CDM projects under the "Thermal energy for the user" category. One of the monitoring methods provided under this category consists of metering the energy produced and multiplying this by an emission coefficient.

MONITORING METHODOLOGY 3

Proposed new monitoring methodology

Monitoring emissions from biomass energy generation and methane avoidance

1. Brief description of new methodology

In the proposed methodology, the methane emission avoided through the utilisation of currently unused biomass is deduced from the amount of biomass consumed for energy generation purposes by the project activity.

As stated in 2.2 of the baseline methodology, energy generation is typically an integral part of methane avoidance projects such as the one the accompanying PDD deals with, but is not encompassed in the proposed methodology as it has already been defined for the power and heat generation components. It then follows that the monitoring methodology will also preclude monitoring of this component. This monitoring methodology should be used in conjunction with the appropriate methodology for energy generation displacement, which will cover monitoring of emissions related to energy generation and associated fuel transport.

For project emissions, this methodology will involve collection of data on methane emissions from combustion of biomass. Baseline emissions will be derived from the amount of biomass utilized by the project activity.

This methodology relies on the use of commercial records to monitor the amount of biomass consumed by the project activity. This approach takes advantage of the data that have already been checked by independent outside parties in the course of regular business, and serves to reduce the burden on the project operators both in terms of cost and labour.

2. Data to be collected or used in order to monitor emissions from the project activity, and how this data will be archived

This methodology applies to projects involving the controlled combustion of biomass or biogas. For such projects, methane emissions shall be monitored.

The data which will be monitored for the Project are given below.

ID number	Data type	Data variable	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	For how long is archived data kept?
1	Quantitative	Methane emissions	%	m	annually	-	electronic	minimum of two years after last issuance of CERs
2	Quantitative	Rice husk combustion amount	t fuel	m	monthly (aggregate)	100%	electronic	minimum of two years after last issuance of CERs

Spectroscopic measurements (Data 1) will be carried out annually to obtain the proportion of methane in the stack gas emitted to the atmosphere. This data, together with the aggregated monthly report on rice husk usage (Data 2), will be used to calculate the total methane emission from rice husk combustion.

The table below represents data collected in order to calculate baseline emissions for the Project.

ID number	Data type	Data variable	Data unit	Will data be collected on this item? (If no, explain).	How is data archived? (electronic/ paper)	For how long is data archived to be kept?
3	Quantitative	Rice husk combustion amount	t	yes	electronic	minimum of two years after last issuance of CERs

The amount of rice husk consumed by the plant (Data 3) will be used together with the carbon content of rice husk and the IPCC factor for the proportion of carbon released as methane in open-air burning to deduce the baseline emissions.

3. Potential sources of emissions which are significant and reasonably attributable to the project activity, but which are not included in the project boundary, and identification if and how data will be collected and archived on these emission sources

As identified in Annex 3, leakage will depend on the characteristics of the specific project. This section can therefore only be filled out once these specifics are known.

For the Project, no leakage issues were identified.

ID number	Data type	Data variable	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	For how long is archived data kept?

4. Assumptions used in elaborating the new methodology:

The methodology involves the use of a default factor for the fraction of carbon released as methane from open-air burning of biomass (agricultural waste), which is used to compute the baseline emissions. It also uses a default factor to calculate the methane emissions associated with energy generation. Emission factor data should be from recognised sources such as the IPCC.

To monitor both the baseline and project emissions, this methodology requires the collection of data on the amount of biomass consumed by the project plant. The primary sourcing of data is carried out by direct measurement, and commercial records will be used for quality control purposes. The underlying assumption for this approach is that the use of commercial data will result in a high degree of accuracy, as it involves two or more parties with opposing interests reaching a consensus on its validity.

5. Please indicate whether quality control (QC) and quality assurance (QA) procedures are being undertaken for the items monitored. *(see tables in sections 2 and 3 above)*

The quality control measures planned for the Project are outlined in the following table.

Data	Uncertainty level of data (High/Medium/Low)	Are QA/QC procedures planned for these data?	Outline explanation why QA/QC procedures are or are not being planned.
2-1	Low	Yes	The sampling instruments will undergo maintenance subject to appropriate industry standards. The spectroscopy results will be compared to the IPCC default emission factor. The larger of the two values will be used to ensure conservatism.
2-2	Low	Yes	Trucks carrying rice husk will be weighed twice, upon entry and exit. Meters at the weighing station will undergo maintenance subject to appropriate industry standards. This will be checked against purchase receipts and inventory data.
2-3	Low	Yes	As per 2-2

6. What are the potential strengths and weaknesses of this methodology?

The use of commercial records as a quality control measure will ensure high accuracy for the monitored data. At the same time, the effective use of existing systems in place will streamline the monitoring and verification process and reduce the costs to be borne by the project operator. Another merit is that the proportion of data monitored will be high – for the Project, the proportion monitored is 100%.

There are no apparent weaknesses identified for this methodology.

7. Has the methodology been applied successfully elsewhere and, if so, in which circumstances?

This methodology has not been applied in the context of a CDM project.

Annex 5

TABLE: BASELINE DATA

The tables below summarises the key elements used to determine the baseline scenario for the Project. Further details are contained in the main text of the PDD.

Grid-electricity

Parameter	**Variable**	**Data Source**
Fuel and component of grid (new or existing) to be displaced by project activity	Fuel mix given in power development plan	EGAT (refer to table below)
	Stated fuel mix target of the Host country	EPPO (formerly NEPO)/EGAT
BAU technology	New plants planned in power development plan	EGAT
	Incentives given to increase renewable power	EPPO (formerly NEPO)
Factors affecting achievability of targets (e.g. in the power development plan)	Fuel costs	Domestic fuel prices

Table: Forecast of Total Energy Generation in Thailand

Type		Unit	2000	2006	2007	2008	2009	2010	2011	2012
Hydroelectric		GWh	3853	4503	4479	4241	4413	4461	4457	4476
		%	3.9	3.2	3.0	2.7	2.6	2.5	2.3	2.2
Natural Gas		GWh	52500	87007	85836	81518	90443	96000	91408	82703
		%	53.7	61.9	57.3	51.3	53.0	53.0	47.6	40.6
Heavy Oil		GWh	12935	1112	1080	1051	1050	1052	1050	1054
		%	13.2	0.8	0.7	0.7	0.6	0.6	0.5	0.5
Diesel Oil		GWh	63	80	41	0	2	5	2	2
		%	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Lignite		GWh	16115	17257	17255	17309	16254	16252	16255	15797
		%	16.5	12.3	11.5	10.9	9.5	9.0	8.5	7.8
Imported Coal		GWh	0	13979	23291	25170	25094	25094	25094	25170
		%	0	9.9	15.6	15.8	14.7	13.8	13.1	12.4
Other Purchases	SPP	GWh	9571	13786	14417	14417	14417	14417	14417	14417
		%	9.8	9.8	9.6	9.1	8.5	8.0	7.5	7.1
	Lao PDR	GWh	2701	2875	3330	15332	18835	18787	18722	18699
		%	2.8	2.0	2.2	9.6	11.0	10.4	9.7	9.2
	New IPP	GWh	0	0	0	0	0	5190	20742	41460
		%	0	0	0	0	0	2.9	10.8	20.2
	Sub-total	GWh	12293	16661	17747	29749	33252	38394	53881	74576
		%	12.6	11.9	11.9	18.7	19.5	21.2	28	36.6
Grand Total		GWh	97759	140599	149729	159038	170508	181258	192147	203778

Source: EGAT

Fossil fuel-based steam production

Parameter	Variable	Data Source
Fuel and technology to be displaced by project activity	Fuel and technology currently used by buyer	Buyer
BAU technology	Host country environmental regulation	Office of Environmental Policy and Planning, Pollution Control Department
	Remaining operational lifetime of existing boiler	Buyer

Disposal of unused rice husk

Parameter	Variable	Data Source
Supply and demand trends	Current use of biomass and the level of use	Survey of rice millers
BAU	Current disposal methods	Survey of rice millers
	Host country environmental regulations	Office of Environmental Policy and Planning, Pollution Control Department
	Incentives provided for biomass utilisation	Office of Environmental Policy and Planning, Pollution Control Department

Cement production

Parameter	Variable	Data Source
BAU	Current ingredients used	Survey of cement manufacturers
	Attitude of cement manufacturers towards the use of substitute ingredients	Survey of cement manufacturers