CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-PDD)
Version 03 - in effect as of: 28 July 2006)

CONTENTS

Annexes

SECTION A. General description of project activity

A.1 Title of the project activity:

>>
Khon Kaen Sugar Power Plant
29th January, 2007
Version 1

A.2. Description of the project activity:

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The project activity involves the installation of a high pressure boiler and turbine generator for the generation of electrical power. The project activity is being undertaken by Khon Kaen Power in Khon Kaen province, Thailand and is located next to an existing power plant, both of which are adjacent to a sugar factory. The power plant will be fuelled by biomass, mainly bagasse that is produced from the milling of cane and some wood bark that has been historically purchased by the existing plant.

The existing power plant at the factory consists of four turbine generators, three 5 MW turbine generators and one 15MW turbine generator. These are fed from five boilers, four of 80 tph capacity and one of 200 tph capacity. The steam is generated at 21 bar and 360°C in the existing boilers. The existing power plant currently exports around 2MW to the grid.

The project activity will promote sustainable development mainly through a reduction in greenhouse gas (GHG) emissions and other gases that are generated in the operation of grid based plants. In the Thai grid a significant proportion of generation is fossil fuel based, the operation of these plants not only gives rise to (GHGs) but also NOx and SOx. Furthermore the disposal of ash from grid based coal and lignite power plants is a problem. The operation of the proposed power plant will result in a reduction in these gases and also ash and therefore provides a positive contribution to sustainable development.

An additional benefit that has also resulted from the installation of the project activity is an increase in direct employment at the plant. Sixty people will be directly employed through the implementation of the project activity with a number of these positions being of a technical nature – engineers and mechanics. The provision of employment and moreover technical skills is an important step in the development of the economy and provides much needed rural employment.

A.3. Project participants:

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Name of Party involved ((host) indicates a host Party)	Private and/or public entity(ies) project participants (as applicable)	If Party wishes to be considered as a project participant
Thailand (host)	Khon Kaen Sugar Power Plant Company Ltd	No
UK	Agrinergy Ltd	No

The official contact for the CDM project activity will be the Khon Kaen Sugar Power Plant Company Ltd, contact details as listed in Annex 1.

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

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A.4.1.1. Host Party(ies):

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Thailand

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

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Khon Kaen province

A.4.1.3. City/Town/Community etc:

>>
Nampong district

A.4.1.4. Detail of physical location, including information allowing the unique identification of this project activity (maximum one page):

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The project is located next to the Khon Kaen sugar factory of KSL and is identifiable from the following grid reference.

Latitude: 16-42-50.4N
Longitude: 102-50-43.5E

A.4.2. Category(ies) of project activity:

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Category 1: Energy industries (renewable - / non - renewable sources)

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

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The technology employed is a 70 bar, 135 tonnes per hour, 510^{o}C boiler, manufactured by the Yoshimine Company Ltd and a 30MW extraction cum condensing turbine generator manufactured by Shinko Industrial Ltd. The electricity will be generated at 11kV and stepped up on site to 115kV and connected to the grid via a new substation situated on the site.

A.4.4 Estimated amount of emission reductions over the chosen crediting period:

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Year	Annual estimation of emission reductions in tonnes of CO_2e
Year 1	56,677
Year 2	56,677
Year 3	56,677
Year 4	56,677
Year 5	56,677
Year 6	56,677
Year 7	56,677
Year 8	56,677

Year 9	56,677
Year 10	56,677
Total estimated reductions (tonnes CO_2e)	566,770
Total number of crediting years	10
Annual average over the crediting period of estimated reductions (tonnes of CO_2e)	56,677

A.4.5. Public funding of the project activity:

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The project has not received any public funding.

SECTION B. Application of a baseline and monitoring methodology

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

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The project activity follows the following methodology:
Version 04 of ACM0006

In line with the application of the methodology the project draws on element of the following tools and methodologies:
Version 02 of the tool for the demonstration and assessment of additionality
Version 06 of ACM0002

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

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The project activity involves the installation of a new biomass power generation unit which will be operated next to an existing power generation capacity both of which will use the same type of biomass residues, namely bagasse and wood chips and bark (**power capacity expansion project**). The project activity takes place at adjacent to an agro-industrial unit, a sugar factory, from which it will receive the majority of the biomass residues.

All the biomass used at the site qualifies under the definition of biomass residues as outlined in the methodology, i.e. the biomass is a by-product of agricultural activities.

The implementation of the project does not result in an increase in the processing capacity of the raw input or any other changes in the sugar manufacturing process. This is readily verifiable as the capacity of the adjacent sugar plant, the main supplier of biomass residues, will not increase after the implementation of the project.

The biomass residues used by the project will not be stored for more than one year. Small quantities of biomass residues may be held over from one season to the next to be used as start up fuel but this would only imply storage from the end of the season to the start of the new season. The actual length of this will depend on the running hours of the plant but it is expected to be less than 3 months.

The biomass residues are not prepared prior to its use in the boilers, the bagasse is transferred from the crushing process directly to the boiler or to the storage yard, from the storage yard the bagasse is returned to the boiler without and material change. The other biomass residues used, mainly wood bark and chips, will not be processed prior to its use in the boiler.

More generally the project activity qualifies under the baseline scenarios outlined in table 1 of the methodology as demonstrated in section B2 of the PDD.

B.3. Description of the sources and gases included in the project boundary

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	Source	Gas	Included?	Justification/Explanation

Baseline	Grid electricity generation	CO_2	Yes	Main emission source
	Heat generation	CO_2	No	No emission reductions are claimed for heat generated by the project activity as under the baseline the same quantity of heat would be generated during the sugar crushing season
	Uncontrolled burning or decay of Surplus biomass.	CH_4	No	Emissions from uncontrolled burning or decay of biomass are not included in the application of the methodology to the particular baseline scenario identified and therefore these sources are therefore not accounted for in project activity emissions.
Project activity	On-site fossil fuel consumption due to the project activity	CO_2	No	No fossil fuel will be consumed in the new boiler, the boiler is not permitted to burn fossil fuel.
	Off-site transportation of biomass	CO_2	Yes	Any biomass brought in from outside (i.e. biomass from sources outside the sugar mill situated adjacent to the project activity) will give rise to these sources of emissions and hence are included in the analysis of project emissions.
	Combustion of biomass for electricity and/or heat generation	CH_4	No	Emissions from uncontrolled burning or decay of biomass are not included in the baseline scenario and these sources are therefore not accounted for in project activity emissions.

The project boundary includes the equipment installed for the operation of the new power plant, the main elements of which are the boiler, turbine generator, condenser, water treatment plant, effluent treatment plant, electrostatic precipitator, step up plant/transformers, transmission lines and the Thai electricity grid.

We do not consider the disposal of fly ash in the boundary nor do we consider the transport of bagasse to the boiler. This arises as a greater quantity of fly ash would arise in the baseline (coal has a much higher ash percentage than bagasse) and this would have to be transported to disposal sites. The transport of bagasse to the boiler is via conveyor but this is normal practise in any sugar mill and the boilers in the project activity are located within the sugar factory.

The boundary for the determination of the grid carbon dioxide emissions factor has been taken as the national grid.

B.4. Description of how the baseline scenario is identified and description of the identified baseline scenario:

The determination of the baseline scenario requires us to consider the most conservative baselines for the generation of power, the generation of heat and the use of biomass.

There are six power baselines detailed in the methodology, namely:

P1 The proposed project activity not undertaken as a CDM
P2 The proposed project activity (installation of a power plant), fired with the same type of biomass but with a lower efficiency of electrical generation (e.g. an efficiency that is common practice in the relevant industry sector)
P3 The generation of power in an existing plant, on-site or nearby the project site, using only fossil fuels
P4 The generation of power in existing and/or new grid-connected power plants

P5 The continuation of power generation in an existing power plant, fired with the same type of biomass as (co-)fired in the project activity, and implementation of the project activity, not undertaken as a CDM project activity, at the end of the lifetime of the existing plant
P6 The continuation of power generation in an existing power plant, fired with the same type of biomass as (co-)fired in the project activity and, at the end of the lifetime of the existing plant, replacement of that plant by a similar new plant

Of the outlined baselines P5 and P6 may be ruled out as the new power plant is not a replacement for the existing cogeneration units as it would not satisfy the sugar factory's demand for steam. P3 may be ruled out as setting up a similar sized fossil fuel power plant to supply to the grid is not feasible given the scale of the plant nor is it part of the core business of the company. Furthermore this type of project would also not qualify as an SPP. P1 is not a credible baseline scenario as without the registration of the project as a CDM it would not occur, as demonstrated in section B3. P2 is not a credible baseline as whilst it would be possible to install a lower efficiency system this would likely entail a back pressure system. The installation of this type of system would require greater steam demand from the sugar factory or other units which are not available. We therefore limit the power baseline to P4 – the generation of power in existing and/or new grid connected plants. This is a credible baseline as the power from the project activity will be fed into the grid and is thus expected to displace power from existing and planned capacity additions of the grid.

Heat baselines
H1 The proposed project activity not undertaken as a CDM project activity
H2 The proposed project activity (installation of a cogeneration power plant), fired with the same type of biomass but with a different efficiency of heat generation (e.g. and efficiency that is common practice in the relevant industry sector)
H3 The generation of heat in an existing cogeneration plant, on-site or nearby the project site, using only fossil fuels
H4 The generation of heat in boilers using the same type of biomass residues
H5 The continuation of heat generation in an existing power plant, fired with the same type of biomass as in the project activity, and implementation of the project activity, not undertaken as a CDM project activity, at the end of the lifetime of the existing plant
H6 The generation of heat in boilers using fossil fuels
H7 The use of heat from external sources, such as district heat
H8 Other heat generation technologies (e.g. heat pumps or solar energy)

As the project is a cogeneration plant we are required to establish the baseline for heat generation even though no emission reductions will be claimed for the heat component. As the project is located next to a sugar factory we can rule out H3, H6, H7 and H8 as sugar factories are typically energy independent. H1 is not a credible baseline scenario as without the registration of the project as a CDM it would not occur, as demonstrated in section B3. H2 is not a credible baseline as the current generation of heat is sufficient to meet the demands of the sugar plant and therefore there is no requirement to install a lower heat efficiency plant. We therefore determine the heat baseline as H4 – the generation of heat in boilers using the same type of biomass residues, which conforms to the current set-up at the plant.

Biomass residue baselines
B1 The biomass residues are dumped or left to decay under mainly aerobic conditions. This applies, for example, to dumping and decay of biomass residues on fields.
B2 The biomass residues are dumped or left to decay under clearly anaerobic conditions. This applies, for example, to deep landfills with more than 5 meters. This does not apply to biomass residues that are stock-piled or left to decay on fields.

B3 The biomass residues are burnt in an uncontrolled manner without utilising it for energy purposes.
B4 The biomass residues are used for heat and/or electricity generation at the project site
B5 The biomass residues are used for power generation, including cogeneration, in other existing or new grid connected power plants
B6 The biomass residues are used for heat generation in other existing or new boilers at other sites
B7 The biomass residues are used for other energy purposes, such as the generation of biofuels
B8 The biomass residues are used for non-energy purposes, e.g. as fertilizer or as feedstock in processes

From the alternatives listed above we can rule out B1, B2, B3, B5 and B6 for the biomass residues under consideration as these have been used in the baseline scenario to generate power and heat for the factory. B7 and B8 are not credible baselines as the technology is not available for the generation of biofuel from bagasse and whilst bagasse may be used in fibre board the fibre board plant was closed 3 years ago due to low returns and is hence not the baseline. Therefore we are limited to B4, that the biomass residues would be used for heat and/or electricity generation at the project site.

From the analysis above the scenario that results from P4, H4 and B4 is scenario 12. The baseline scenario is therefore that the existing power plant would continue to operate and provide electricity and steam to the adjacent sugar plant. The biomass residues would continue to be combusted in the boilers at the site to generate this electricity and steam. This baseline scenario therefore relates to the current situation.

B.5. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered CDM project activity(assessment and demonstration of additionality)

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In line with the methodology the demonstration of additionality is shown through using the latest version of the Additionality Tool[1].

Step 0: Preliminary screening based on the starting date of the project activity

The project activity started (i.e. real action began) in March 2004. This falls between 1 January 2000 and the first registration of a CDM project activity (18th November 2004). A PIN was produced for the project at this time and this was submitted to the Danish CDM purchase programme. We can therefore provide evidence that the CDM was seriously considered at the time the decision was taken to proceed with the project activity and may move to additionality Step 1.

Step 1: Identification of alternatives to the project activity consistent with current laws and regulations

Sub-step 1a: Define alternatives to the project activity
As set out in section B2 the alternatives to the project activity are:
- The supply of grid based electricity, i.e the continuation of the current situation
- The proposed project activity not undertaken as a CDM project activity

Sub-step 1b: Enforcement of applicable laws and regulations

[1] Tool for demonstration and assessment of additionality, version 2, 28th November 2005.

All these alternatives are in compliance with applicable laws and regulations as evidenced through other renewable energy plants and the supply of electricity from grid based plants.

Step 2: Investment analysis
We have undertaken investment analysis of the project activity.

Sub-step 2a: Determine appropriate analysis method
As the project activity has a dual revenue stream, the revenue from the sale of emission reductions and the opportunity cost of power generated we have a choice of Option II or Option III. From these two options, we follow Option III as there is only one investment option in the baseline scenario.

Sub-step 2b - Option III: Apply benchmark analysis
The financial indicator calculated for the project activity will be the IRR of the project activity and the benchmark will be the weighted average cost of capital.

Sub-step 2c: Calculation and comparison of financial indicators
The calculation of the financial indicator for the project activity includes the initial investment cost and the costs and revenues associated with operating the power plant. The initial investment cost is US$ 30m. The revenues associated with the power plant relate to the sales of electricity to the grid and the supply of a small amount of steam. The costs relate to O&M and administration.

The calculation of the IRR on this basis yields an IRR of 6.88%. The benchmark for the project activity is the WACC which is estimated at 9.95%. This uses a cost of debt of 5.95%[2] and a cost of equity of 14.1%, coupled with a tax rate of 30%.

Sub-step 2d: Sensitivity analysis
Applying sensitivity analysis to the results above revolves around the revenue side in the form of the electricity price paid as this is variable and not fixed and the number of days the plant operates. We have assumed above that the price for electricity is US$ 0.0575/kWh and that the plant operates for a 300 days. The electricity price has therefore been varied as per the following table as has the days of operation. The power plant will normally remain closed for one month for maintenance, at a minimum, and therefore the variability in days is only downwards. This also reflects current operational performance of the attached sugar factory where due to poor weather the plant has only been crushing cane for an average of 120 days over the last 3 years.

Table of sensitivity analysis

		Electricity price, US$/kWh			
		0.0550	0.0563	0.0588	0.0600
Days	300	2.3%	4.6%	9.1%	11.2%
	280	-3.5%	-1.1%	3.4%	5.5%
	260	-9.9%	-7.4%	-2.8%	-0.6%

Even with the upward revisions in the opportunity cost of electricity the IRR only meets the benchmark in one instance and when the days of operation are considered the probability of this event is low.

Step 3: Barrier analysis

[2] http://www.thaibma.or.th/priceyield/GovQuoted.aspx. This source provides government bond rates, the data therefore presented in the PDD is conservative as there is no risk premium attached to the rate shown to reflect private investment and/or project type.

The project has used Investment analysis and therefore we move to step 4.

Step 4: Common practice analysis

Sub-step 4a:Analyse other activities similar to the proposed project activity
There are three other large scale grid based bagasse cogeneration plants that are at various stages of investment – Ratchasima SPP undertaken by the Wangkanai Group and Dan Chang and Phu Khieo undertaken by the Mitr Phol Group. Ratchasima has been considered as a CDM project and a methodology was submitted for this project that is the basis of the methodology used here. Dan Chang and Phu Khieo have been submitted for validation as a CDM and were hosted on the UN website between 23rd Dec 2005 and 21st Jan 2006[3].

Sub-step 4b: Discuss any similar options that are occurring
As the similar options are all proposed as CDM projects it is not necessary to undertake further analysis.

Step 5: Impact of CDM registration

The registration of the project as a CDM will improve the financial returns of the project activity and reduce the risks in undertaking the project.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

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The application of the baseline methodology results in scenario 12 in relation to bagasse and scenario 10 in relation to other biomass. This requires the calculation of baseline emission associated with the electricity generation, the generation of heat and the usage of biomass residues. Broadly the emission reductions from the project are calculated from the application of the following equation:

$$ER_y = ER_{heat,y} + ER_{electricity,y} + BE_{biomass,y} - PE_y - L_y$$

The methodology requires us to demonstrate for scenario 12 that the lifetime of the baseline is consistent with the period that emission reductions are being claimed for. In the case of the project activity the existing power plant has a technical lifetime in excess of 10 years.

In terms of emission reductions due to heat generation we do not claim for these in the case of the project activity but are required to show that emissions do not arise from the combustion of more biomass. In line with the methodology this may be shown by demonstrating that the efficiency of heat generation in the project is larger than the baseline scenario and assume $ER_{heat,y}$ = 0, i.e.:

$$\varepsilon_{th,projectplant} > \varepsilon_{th,referenceplant}$$

In order to show this we have calculated the heat generated per unit of biomass residues in the project activity and shown that this is greater than or equal to the heat generated per unit of biomass residues in the baseline. This may be demonstrated on the basis of the specification of the boilers (operating

[3] http://cdm.unfccc.int/Projects/Validation/?archive=yes

temperatures and pressures) and the enthalpies that arise (we have considered the same efficiencies of the two boilers).

Consideration of heat emissions

Baseline configuration, 21kg/cm², ***310°C***			***Project configuration, 67kg/cm²,*** ***515°C***		
Capacity	kg/hr	1	Capacity	kg/hr	1
Enthalpy out	kCal	727	Enthalpy out	kCal	824
Enthalpy in	kCal	110	Enthalpy in	kCal	180
Calorific value fuel	kCal/kg	1,813	Calorific value fuel	kCal/kg	1,813
Efficiency	%	60%	Efficiency	%	70%
Bagasse	kg/hr	0.5856	Bagasse	kg/hr	0.4089
Steam/bagasse	mt/mt	1.71	Steam/bagasse	mt/mt	1.97

The above table therefore highlights that the project has a higher thermal efficiency than the baseline and therefore that $ER_{heat,\ y} = 0$[4].

In terms of baseline emissions, the main source in the project activity is through the generation of electricity. The calculation of these emissions are provided by the following equations.

$$ER_{electricity} = EG_y.EF_y$$

For scenarios 12 EG_y corresponds to the net quantity of increased electricity generation resulting from the project plant:

$$EG_y = MIN\left[\left(EG_{projectplant,y}\right)and\left(EG_{total,y} - \frac{EG_{historic,3yr}}{3}\right)\right]$$

The emission reductions due to electricity generation are the product of EG_y determined above and the grid based emission factor, EF_y, as set out in ACM0002.

The calculation of EF_y is carried out through the application of relevant sections of methodology ACM0002 version 6. The combined margin, representing EF_y is explicitly presented in Annex 3 and consists of the calculation of the average of the Operating Margin (OM) and the Build Margin (BM). In calculating the OM, we select the Simple OM option as despatch data is not available and low cost/must run sources make up less than 50% of the generation. The application of the methodology does require the use of default values for the weightings applied to the Simple OM and BM and we have applied the standard weightings of 50:50.

In terms of baseline emission arising from the natural decay or uncontrolled burning of biomass we do not claim for these under scenario 12 as the biomass would be combusted in the baseline scenario, therefore as set out in the methodology for scenario 12 $BE_{biomass,\ y} = 0$.

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[4] The net calorific value of bagasse is taken from E Hugot, Handbook of cane sugar engineering, 3rd edition, page 922 equation 41.20. The net calorific value is given by: *NCV= 4,250-12s-48.5w*, where *s* is the % of sugar in bagasse and *w* is the % of moisture in bagasse. For the above calculation we have assume *s* = 1% and *w* = 50%.

The project emissions arising from the project activity are limited to four sources; combustion of fossil fuels for the transport of biomass to the site, on-site consumption of fossil fuels, electricity consumption at the site attributable to the project activity and methane emissions from the combustion of biomass. As some biomass may be taken from outside sources, under scenario 10, we have to consider the emissions arising from the transportation of biomass. The project activity does not plan to co-fire any fossil fuels in the boiler and under the terms of its environmental consent is not permitted to burn fossil fuels, therefore emissions from these sources are not included[5]. As highlighted above we do not seek to claim baseline emissions from the decay of biomass we are not required to account for the methane emissions from the combustion of biomass. In terms of electricity consumption arising as a result of the project activity this is not included as the only consumption will be from the auxiliaries which already accounted for in the baseline calculation.

In determining the project emissions that arise from transport there is a choice of two approaches, we have outlined both for the sake of completeness.

Option 1

$$PET_y = N_y . AVD_y . EF_{km,CO2}$$

Option 2

$$PET_y = \sum_i F_{Trans,i,y} . COEF_{CO2,i}$$

The last area of analysis required in the determination of the emission reductions is leakage, in line with the methodology leakage is not considered for scenario 12 and therefore $L_y = 0$.

In light of the analysis above the equation to calculate the emission reductions may be simplified to:

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

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

(Copy this table for each data and parameter)

Data / Parameter:	$\mathbf{F_{i,j,y}}$
Data unit:	Mt, mcbm, kl
Description:	Consumption of fossil fuel by existing grid connected power plants
Source of data used:	EGAT
Value applied:	Varies for each plant
Justification of the choice of data or description of measurement methods and procedures actually applied :	For thermal power plants EGAT provides fuel consumption data. The choice of data therefore satisfies the guidance in the methodology, ACM0002.

[5] However we include monitoring of fossil fuels by the new boiler just in case changes to the set-up occur at a later date.

Any comment:	Full data set provided in Annex 3

Data / Parameter:	**$GEN_{j,y}$**
Data unit:	GWh
Description:	Generation of electricity by existing grid connected power plants
Source of data used:	EGAT
Value applied:	Varies for each plant
Justification of the choice of data or description of measurement methods and procedures actually applied :	The EGAT provides data on the generation of electricity by grid based units.
Any comment:	Full data set provided in Annex 3

Data / Parameter:	**NCV_i**
Data unit:	TJ/kt
Description:	Net calorific value of the fuel combusted in grid based power plants used in the determination of the emission factor
Source of data used:	Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual Table 1-2
Value applied:	Varies for each fuel type
Justification of the choice of data or description of measurement methods and procedures actually applied :	National net calorific values are not available and therefore we have used country specific IPCC data.
Any comment:	Full data set provided in Annex 3

Data / Parameter:	**$EF_{CO2,i}$**
Data unit:	tCO2/TJ
Description:	Tonnes of carbon dioxide per energy unit of fuel in grid based plants used in the determination of the emission factor
Source of data used:	Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual Table 1-1
Value applied:	Varies for each fuel type
Justification of the choice of data or description of measurement methods and procedures actually applied :	The values in Table 1-1 have been converted to a carbon dioxide equivalent by multiplying by 44/12.
Any comment:	Full data set provided in Annex 3

Data / Parameter:	**$OXID_i$**
Data unit:	%
Description:	Oxidation factor applied to the combustion of fuels in grid based plants for the

	determination of the emission factor
Source of data used:	Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual Table 1-6
Value applied:	98% for coal and 99.5% for gas
Justification of the choice of data or description of measurement methods and procedures actually applied :	
Any comment:	Full data set provided in Annex 3

Data / Parameter:	**$F_{i,m,y}$**
Data unit:	Mt, mcbm, kl
Description:	Consumption of fossil fuel by existing grid connected power plants
Source of data used:	EGAT
Value applied:	Varies for each plant
Justification of the choice of data or description of measurement methods and procedures actually applied :	For thermal power plants EGAT provides fuel consumption data. The choice of data therefore satisfies the guidance in the methodology, ACM0002.
Any comment:	Full data set provided in Annex 3

Data / Parameter:	**$GEN_{m,y}$**
Data unit:	GWh
Description:	Generation of electricity by existing grid connected power plants
Source of data used:	EGAT
Value applied:	Varies for each plant
Justification of the choice of data or description of measurement methods and procedures actually applied :	The EGAT provides data on the generation of electricity by grid based units.
Any comment:	Full data set provided in Annex 3

Data / Parameter:	**$EF_{km,CO2}$**
Data unit:	tCO_2/km
Description:	Emissions factor for transport of biomass
Source of data used:	Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual Table 1-32
Value applied:	0.001108
Justification of the choice of data or description of measurement methods	The use of IPCC data is specified in the methodology if local values are not available. We have chosen these in a conservative manner, i.e. used the highest value.

and procedures actually applied :	
Any comment:	Left blank on purpose

Data / Parameter:	**$EG_{historic,3yr}$**
Data unit:	MWh
Description:	Historic 3 year average net generation of existing power plant
Source of data used:	Plant records
Value applied:	70,847
Justification of the choice of data or description of measurement methods and procedures actually applied :	The data for generation has been historically measured by energy meters situated on the site along with the power plant auxiliaries. The net generation has been determined by subtracting auxiliary consumption from total generation. Historically this data has been collected daily and has been held at the plant.
Any comment:	The time series data is provided in Annex 3

B.6.3 Ex-ante calculation of emission reductions:

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For the purposes of determining the emission reductions for the project activity we apply the following equation:

$$ER_y = ER_{heat,y} + ER_{electricity,y} + BE_{biomass,y} - PE_y - L_y$$

As outlined in section B6.1 this may be simplified to:

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

Where:

ER_y are the emission reductions of the project activity during the year y in tons of CO_2

$ER_{electricity, y}$ are the emission reductions due to the displacement of electricity during the year y in tons of CO_2

PE_y are the project emissions during the year y in tons of CO_2

In order to calculate the baseline emissions we apply the following equations.

$$EG_y = MIN\left[\left(EG_{projectplant,y}\right) and \left(EG_{total,y} - \frac{EG_{historic,3yr}}{3}\right)\right]$$

Where:

EG_y Net quantity of increased electricity generation as a result of the project activity (incremental to the baseline generation) during the year y (MWh/yr)

$EG_{projectplant, y}$ Net quantity of electricity generated in the project plant during the year y (MWh/yr)

$EG_{total, y}$ Net quantity of electricity generated in all power units at the project site, generated from firing the same types(s) of biomass as in the project plant,

	including the new power unit installed as part of the project activity and any previously existing units, during the year y (MWh/yr)
$EG_{historic, 3yr}$	Net quantity of electricity generated during the most recent three years in all power plants at the project site, generated from firing the same types(s) of biomass as used in the project plant MWh

The emission reductions due to electricity generation are the product of EG_y determined above and the grid based emission factor, EF_y, as set out in ACM0002.

In the case of the project activity EG_y is likely to be equal to $\left(EG_{total,y} - \frac{EG_{historic,3yr}}{3} \right)$ and therefore the calculation in this section is based on this. $EG_{historic, 3yr}$ is 70,847 MWh as set out in section 6.2. Assuming that the total generation of the plant is 183,047 MWh per year this results in EG_y = 112,200 MWh.

$$ER_{electricity} = EG_y.EF_y$$

Where:

$ER_{eletricity, y}$ = are the emission reductions relating to the electricity generation from the project activity tCO_2e
EG_y = is the net quantity of increased electricity generation as a result of the project activity (incremental to baseline generation) during the year y in MWh
EF_y = is the grid based emission factor, determined through the combined margin approach as set out in ACM0002 tCO_2e/MWh

EF_y has been set at 0.535 tCO_2e/MWh as shown in Annex 3 and combining this with EG_y (112,200) gives $ER_{electricity, y}$ = 60,001 tCO_2e

Project emissions relate to the transport of biomass to the plant. In the initial years of operation some biomass may be combusted from outside sources but as the cane area develops this source will be reduced and it is expected that once the sugar factory has stabilised this will be zero. We provide an estimate of initial consumption of biomass as 50,000 tonnes and assume that this will be procured from a radius of 50km from the plant, with each truck carrying a load of 8 tonnes, therefore the number of trips will be 6,250, the average return distance will be conservatively 100km and a CO_2 emission factor of 0.001108 tCO_2/km will be applied.

Therefore from:

$$PET_y = N_y.AVD_y.EF_{km,CO2}$$

PET_y = 3,324 tCO_2e

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

>>

	Estimation of project activity	Estimation of baseline emissions	Estimation of leakage (tonnes of	Estimation of overall emission

Year	emissions (tonnes of CO_2e)	(tonnes of CO_2e)	CO_2e)	reductions (tonnes of CO_2e)
Year 2007	3,324	60,001	0	56,677
Year 2008	3,324	60,001	0	56,677
Year 2009	3,324	60,001	0	56,677
Year 2010	3,324	60,001	0	56,677
Year 2011	3,324	60,001	0	56,677
Year 2012	3,324	60,001	0	56,677
Year 2013	3,324	60,001	0	56,677
Year 2014	3,324	60,001	0	56,677
Year 2015	3,324	60,001	0	56,677
Year 2016	3,324	60,001	0	56,677
Total tonnes of CO_2e	33,239	600,010	0	566,770

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

Data / Parameter:	**$EG_{Projectplant, y}$**
Data unit:	MWh
Description:	Electrical energy generated by the project activity
Source of data to be used:	Plant records
Value of data applied for the purpose of calculating expected emission reductions in section B.5	112,200
Description of measurement methods and procedures to be applied:	The project activity will install a DCS system which will permit continuous monitoring and measurement from the new turbine generator. Meters will be installed on the new turbines to permit continuous monitoring and measurement. Hourly recordings of data will be taken from energy meters located at the project activity site. This data will be recorded hourly by the Switch Board attendant and entered into logbooks on site. This hourly data will be signed off at the end of every shift by an engineer in charge of the shift and again at the end of each day and signed off by the power plant manager. The meters will be calibrated annually by an independent third party.
QA/QC procedures to be applied:	This parameter may be checked with the quantity of biomass fired, i.e. show that the electricity generation divided by the quantity of biomass fired results in a reasonable efficiency as compared with the previous year.
Any comment:	Data will be held for a period of 2 years after the end of the crediting period.

Data / Parameter:	**$EG_{total,y}$**
Data unit:	MWh
Description:	Electrical energy generated by the project activity
Source of data to be used:	Plant records
Value of data applied for the purpose of	The emission reductions in section B5 have been calculated on the basis of $EG_{total, y}$

calculating expected emission reductions in section B.5	183,047 MWh is the value used for $EG_{total,y}$ The value for EGy is equal to 112,200 MWh
Description of measurement methods and procedures to be applied:	The project activity will install a DCS system which will permit continuous monitoring and measurement. Meters will be installed on the existing turbines to permit continuous monitoring and measurement and these couples with the meters on the new turbines will allow monitoring to total net generation. Hourly recordings of data will be taken from energy meters located at the project activity site. This data will be recorded hourly by the Switch Board attendant and entered into logbooks on site. This hourly data will be signed off at the end of every shift by an engineer in charge of the shift and again at the end of each day and signed off by the power plant manager. The meters will be calibrated annually by an independent third party.
QA/QC procedures to be applied:	This parameter may be checked with the quantity of biomass fired, i.e. show that the electricity generation divided by the quantity of biomass fired results in a reasonable efficiency as compared with the previous year.
Any comment:	Data will be held for a period of 2 years after the end of the crediting period.

Data / Parameter:	**N_y**
Data unit:	Integer
Description:	Number of trips undertaken to transport biomass to the project site
Source of data to be used:	Transporter receipts
Value of data applied for the purpose of calculating expected emission reductions in section B.5	6,250
Description of measurement methods and procedures to be applied:	Each truck that enters the site will be recorded at the weighbridge from which the number of trucks and will be established.
QA/QC procedures to be applied:	Procedures to cross check this with financial statements and purchase orders may be provided and it may also be checked with the quantity of biomass combusted.
Any comment:	Data will be held for a period of 2 years after the end of the crediting period.

Data / Parameter:	**AVD_y**
Data unit:	Km
Description:	Average return distance
Source of data to be used:	Transporter
Value of data applied for the purpose of calculating expected emission reductions in section B.5	100
Description of measurement methods and procedures to be	The average return distance will be recorded for each truck that delivers material to the site. This will be taken from the transporter contracted to provide this service.

applied:	
QA/QC procedures to be applied:	This data may be cross checked with payments for transportation of the material and with maps.
Any comment:	Data will be held for a period of 2 years after the end of the crediting period.

Data / Parameter:	**TL_y**
Data unit:	t/truck
Description:	Average truck load
Source of data to be used:	Transporter
Value of data applied for the purpose of calculating expected emission reductions in section B.5	8
Description of measurement methods and procedures to be applied:	The capacity of the truck will be taken from the transporter contracted to provide this service. If more than one contractor is used, each contractor will provide their average truck load and the lowest average will be used.
QA/QC procedures to be applied:	As per the methodology no QA/QC procedures are specified for this parameter.
Any comment:	Data will be held for a period of 2 years after the end of the crediting period.

B.7.2 Description of the monitoring plan:

>>
Please refer to Annex 4.

B.8. Details of baseline information, including the date of completion of the baseline study and the name of person (s)/entity (ies) determining the baseline:

>>
The baseline information has been taken from the following sources, a complete set of the baseline data and its determination is set out in Annex 3 of the PDD.

Table 1: Baseline data

Baseline data	Source
Generation data of grid based generating units	Electricity Generating Authority of Thailand
Fossil fuel consumption of grid based generating units	Electricity Generating Authority of Thailand
Timing of expansions to determine build margin	Electricity Generating Authority of Thailand and Energy and Policy Planning Office
Net calorific value of fossil fuel used in grid plants	IPCC
Emissions factor of fossil fuel used in grid plants	IPCC
Oxidation factor of fossil fuel used in grid plants	IPCC

Date of completion of the baseline study: 29/01/2007
Robert Taylor, Agrinergy Ltd, contact details as listed in Annex I.

SECTION C. Duration of the project activity / Crediting period

C.1 Duration of the project activity:

C.1.1. Starting date of the project activity:

>>
15/03/2004
This represents the date that the project activity was first submitted to the Danish purchase programme in Thailand.

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

>>
20y 0m

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

A fixed ten year crediting period has been chosen

C.2.1. Renewable crediting period

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

>>
Not applicable

C.2.1.2. Length of the first crediting period:

>>
Not applicable

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

>>
15/12/2006

C.2.2.2. Length:

>>
10y 0m

SECTION D. Environmental impacts

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

>>
No negative environmental impacts will arise as a result of the project activity. As part of the approval process for the plant and EIA was undertaken by the company Consultant of Technology. On 10th June 2004 the EIA was approved by the Ministry of Natural Resources and Environment.

The EIA has set out the monitoring of parameters associated with the plant, namely:

- Stack emissions, undertaken twice a year, once during crushing and once during the offseason. This monitoring will involve the measurement of particulate matter, NOx and SOx.
- Air quality, at 3 points outside the factory the air quality will be monitored. This monitoring will involve total suspended particulates, particulate matter less than 10 microns and SOx.

The reporting of this monitoring will be produced at the time of each verification.

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

>>
Environmental impacts are not considered significant.

SECTION E. Stakeholders' comments

>>

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

>>

The stakeholder review has been conducted on three levels:

A local stakeholder review
A national stakeholder review
An international stakeholder review

The local stakeholder review was conducted as part of the EIA process. Within a 5km radius of the plant leaflets were distributed and also radio adverts were carried out in Thai and the local language explaining the project activity. In each *tambon* a local meeting was organised and the heads of the local villages were invited to the factory to view the project activity site.

The national stakeholder review will be undertaken through approval obtained from the Thai DNA – the Ministry of Natural Resources and Environment.

An international stakeholder review will be conducted at the time of validation.

E.2. Summary of the comments received:

>>

No adverse comments have been received on the project activity to date.

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

>>

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	Khon Kaen Sugar Power Plant Co Ltd
Street/P.O.Box:	Sriayudhya Road
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FAX:	
E-Mail:	
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Represented by:	
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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

The project has not received any public funding.

Annex 3

BASELINE INFORMATION

The emission factor for the relevant grid is calculated in line with ACM0002 version 6, "Consolidated baseline methodology for grid-connected electricity generation from renewable sources", 19th May 2006. The determination of the emission factor follows the guidance and uses the Simple OM (option (a)) and the Build margin applying a weighting of 50% to each to arrive at the final Combined margin emissions factor for the project activity. The relevant grid for the determination of the combined margin is selected as the national grid. In the case of imports to the grid, which occur from Malaysia and Laos, the emission factor for these supplies is set at zero as outlined in ACM0002.

The Simple OM method may only be used where low-cost/must run resources constitute less and 50% of total grid generation in the average of the 5 most recent years. In Thailand low cost/must run generating resources constitute less than 20% of grid generation and this is shown in the following table.

Percentage of low cost/must run generating units, MW

	2000	2001	2002	2003	2004
Hydro	2,880	2,886	2,886	2,922	3,422
Renewable	1	1	1	1	1
SPP renewable	335	348	369	542	598
Imports	340	340	640	640	640
Total	22,269	22,035	23,755	25,647	25,969
% low cost	16.0%	16.2%	16.4%	16.0%	17.9%

Aggregate data is used to determine the emission factor for each type of power plant on the grid. The following equations are applied to determine the emissions factors for each fuel type.

$$EF_{OM,y} = \frac{\sum_{i,j} F_{i,j,y} . COEF_{i,j}}{\sum_{j} GEN_{j,y}}$$

Where:

$F_{i,j,y}$ is the amount of fuel in year(s) y

$COEF_{i,j}$ is the CO_2 emission coefficient of fuel i, taking into account the carbon content of the fuels used by relevant power sources j and the percent oxidation of the fuel in year(s) y

$GEN_{j,y}$ is the electricity (MWh) delivered to the grid by source j

$$COEF_{i,j} = NCV_i . EF_{CO2,i} . OXID_i$$

Where:

NCV_i is the net calorific value of fuel i

$EF_{CO2,i}$ is the CO_2 emission factor per unit of energy of the fuel i

$OXID_i$ is the oxidation factor of the fuel

The calculation has drawn upon IPCC default country specific values for the NCV and the standard default values for the EF and OXID factors.

Fuel usage and generation by type of plant

	Generation, mkWh			Fuel demand			Units of fuel
	2004	2003	2002	2004	2003	2002	demand
Natural gas	30241.54	31969.63	35607.91	285645	304769	344184	m ft3
Fuel oil	5273.13	2112.69	2024.49	1255.4	529	514	m litres
Lignite	17505.82	17133.53	16890.3	16	16	15	m tonnes
Diesel oil	262.69	48.04	259.33	61.51	17	71	m litres

Emission factors for fuel types

	EF, tCO2/MWh
Natural gas	0.5062
Furnace oil	0.6779
Lignite	1.0980
Diesel	0.8123

In determining the Simple OM we apply the above emission factors to the most recent generation data available for plants on the grid excluding the low cost/must run options. The generation data is aggregated for the SPP (small power producers) which consist of fossil fuel and renewables, we have therefore apportioned generation from this category on the basis of the capacity of units that fall within the renewable/non-renewable generating types. The following table details the calculation of the Simple OM. In some cases the plants may operate on a number of fuels, i.e. natural gas and furnace oil, in these cases we apply the most conservative emission factor (the lowest) to the plant in order to determine the emissions.

Simple OM data

Name	**MWh**			**Emissions tCO_2**		
	2005	**2004**	**2003**	**2005**	**2004**	**2003**
PhranakornTai	3,786,903	3,930,049	4,097,743	1,916,744	1,989,198	2,074,076
Bangphakong 1-2	4,913,570	2,530,060	4,240,488	2,487,008	1,280,592	2,146,327
Bangphakong 3-4	5,751,940	6,293,541	5,179,994	2,911,350	3,185,481	2,621,859
Mae Mou 1-3	0	0	0	0	0	0
Mae Mou 4-7	4,496,275	4,501,249	4,581,205	4,936,944	4,942,405	5,030,198
Mae Mou 8-13	13,863,310	13,027,124	12,581,488	15,222,019	14,303,881	13,814,569
Krabi	1,144,734	1,256,014	145,688	776,057	851,498	98,768
Bangpakong 1-2	624,348	988,510	153,584	316,014	500,335	77,737
Bangpakong 3-4	2,071,559	1,837,158	2,032,197	1,048,521	929,879	1,028,598
Num Phong	1,505,745	1,669,712	2,213,994	762,134	845,126	1,120,615
Phranakorn Tai	6,304,956	5,681,855	5,098,283	3,191,259	2,875,876	2,580,501
Wang Noi	13,436,798	10,475,317	9,752,664	6,801,047	5,302,091	4,936,320
Rachaburi	0	0	95,969	0	0	48,575
Lankrabau	1,267,205	1,083,969	1,081,209	641,397	548,652	547,255
Nhong Chok	6,420	504	0	5,215	409	0
Suratthani	40,361	5,791	3,435	32,786	4,704	2,790
Mae Hong Sorn	2,080	2,322	4,145	1,690	1,886	3,367

Rayong Electric	6,392,882	6,992,211	5,697,194	3,235,763	3,539,114	2,883,640
Khanom Electric	1,030,543	993,234	1,013,345	521,610	502,726	512,905
Khanom Electric	5,242,923	5,167,743	4,935,858	2,653,710	2,615,658	2,498,289
Rachaburi	8,166,390	6,913,899	6,987,554	4,133,425	3,499,476	3,536,757
Rachaburi	14,519,226	13,826,489	11,789,402	7,348,919	6,998,290	5,967,217
Issara	4,286,901	2,831,332	2,081,887	2,169,819	1,433,081	1,053,749
Tri Energy	5,163,179	5,177,686	4,876,644	2,613,348	2,620,690	2,468,318
Glow IPP	4,560,690	5,416,331	3,209,309	2,308,397	2,741,481	1,624,394
Eastern power	2,626,863	2,246,802	1,472,005	1,329,589	1,137,221	745,057
SPP	9,583,386	9,849,634	9,833,361	6,025,927	6,193,341	6,183,108
Totals	120,789,184	112,698,533	103,158,645	73,390,693	68,843,091	63,604,987
CEF	0.6076	0.6109	0.6166			

In the case of the calculation of the Simple OM we have used 3 years worth of data and therefore hold the resultant Simple OM constant over the first crediting period.

In considering the BM we are required to calculate the carbon emissions factor based on an examination of recent capacity additions to the grid. These capacity additions should be chosen from the greater generation accounted for:

- The five power plants that have been built most recently, or
- The power plants capacity additions in the electricity system that comprise 20% of the system generation (in MWh) and that have been built most recently.

The total generation of the grid under consideration is 134,826 GWh, 20% of which is 26,965 GWh. The five most recent plants only account for 361 GWh and therefore the sample to determine the build margin is selected on the basis of the "power plants capacity additions in the electricity system that comprise 20% of the system generation (in MWh) and that have been built most recently". The calculation of the BM requires us to undertake a generation weighted average of the emission of the individual plants, this is shown in the following table. We have chosen to calculate the BM using Option 1 therefore the BM emission factor will be held constant over the crediting period chosen. The following table shows in chronological order the commissioning of plants and the total generation they supply. Four plants are excluded from the calculation i.e. where generation is set to zero as these projects are proposed CDM projects.

The following equation is applied to determine the build margin emissions factor.

$$EF_{BM,y} = \frac{\sum_{i,m} F_{i,m,y}.COEF_{i,m}}{\sum_{m} GEN_{m,y}}$$

Build margin data

Name	**Type**	**Capacity addition, MW**	**Date**	**Generation, MWh**	**Emissions, tCO_2**
Rachaburi	Gas or Furnace oil	3,200	2002	22685616	11,482,345

Malaysia	Hydro	300	2002	1855419	0
Lumtakong Dam	Hydro	500	2002	483798	0
Kanchanaburi Sugar Industrial Co	Renewable	4	Jan-02	23272	0
Saraburi Sugar Co	Renewable	8	Jan-02	46544	0
Pisanulok Sugar Co	Renewable	4	Mar-02	23272	0
PRG Granary Co	Renewable	5	Dec-02	29090	0
Glow IPP	Gas	713	2003	4560690	2,308,397
Eastern power	Gas	350	2003	2626863	1,329,589
Thai Rungruang Industry Co	Renewable	4	Jan-03	23272	0
TLP Cogeneration Co	Natural gas	60	Jan-03	349079	176,687
Mitr Kaset Industry Co	Renewable	3	Feb-03	17454	0
Country Electric Co	Renewable	15	Feb-03	87270	0
Buri Ram Sugar Co	Renewable	5	Mar-03	29090	0
Pranburi Sugar Co	Renewable	3	Apr-03	17454	0
Korat Industry Co	Renewable	8	Apr-03	46544	0
Roi Et Green Co	Renewable	9	May-03	51198	0
Phuket Municipality	Waste	1	Jun-03	5818	0
Gulf Electric	Renewable	20	Aug-03	117523	0
Ratchasima Sugar Factory Co	Renewable	30	Aug-03		
Advance Agro Public Co	Renewable	50	Nov-03	290899	0
A.A. Pulp Mill	Renewable	25	Dec-03	145450	0
Krabi	Furnace Oil	340	2004	1144734	776,057
Mae Hong Sorn	Renewable	1	2004	538	0
Thai Power Supply	Renewable	2	Mar-04	12800	0
New Krung Thai Sugar Factory	Renewable	2	Apr-04	11636	0
New Kwang Sun Hree Sugar	Renewable	2	Apr-04	11636	0
Tha Maka Sugar Co	Renewable	2	Apr-04	11636	0
Kumpawapee Sugar	Renewable	5	Apr-04	29090	0
Singburi Sugar	Renewable	4	Jul-04	23272	0
Dan Chang Bio Energy	Renewable	27	Aug-04		
Sahareang Co	Renewable	8	Dec-04		
Khon Kaen Sugar Co	Renewable	3	Dec-04	17454	0
Siam Power Generation Co	Natural gas	60	Dec-04	349079	176,687
Thai Permpoon Industry	Renewable	4	Mar-05	23272	0
Ream Udom Sugar	Renewable	7	Mar-05	40726	0
A.T. Bio Power	Renewable	20	Dec-05		
Isan Sugar Industrial	Renewable	3	Jan-06	14545	0
Satuk Bio-mas Co	Renewable	7	Jan-06	37817	0
Thai Petrochemical Industry	Waste gas	45	May-94	261809	0
Asian Supireer Food Co	Natural gas	1	Nov-05	6982	3,534
Total				35,512,639	16,253,295
CEF					0.4577

The weights applied to the operating and build margin are fixed at 0.5, therefore in order to calculate the combined margin we apply these to the Simple OM and BM as calculated above. The following table shows this calculation arriving at the combined margin of 0.5348 tCO_2/MWh.

Calculation of the combined margin

	tCO_2/MWh
Simple OM, $EF_{OM, y}$	0.6119
Build margin $EF_{BM, y}$	0.4577
Combined margin, EF_y	0.5348

The following table shows the net generation data for the last 3 years and thus permits us to arrive at a 3 year average for the determination of EG_y.

Year	MWh
2002/3	79,983
2003/4	64,837
2004/5	67,719
3 yr average	70,847

Annex 4

MONITORING PLAN

The monitoring of data revolves around the power generation from the turbine generators and the auxiliary consumption of the power plant. All auxiliary units at the power plant will be monitored and the meters will be checked and calibrated each year to ensure the quality of the data. There will also be main meters attached to each turbine generator to determine their total generation. The monitoring frequency will be done on a continuous basis through a DCS system but records will be maintained on an hourly basis. These records will then be collated at the end of every shift and then again at the end of every day and signed off by the power plant manager.

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