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:

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Title: Siam Cement (Thung Song) Waste Heat Power Generation Project (TS46 Project)
Document Version 05
Date of completion: 26 February 2010

A.2. Description of the project activity:

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The Siam Cement Group (SCG) was founded under the Royal Decree of His Majesty King Rama VI in 1913 as the nation's first cement producer, a construction material critical to national development. The Group has expanded continuously since that time, and become the largest and most advanced industrial conglomerate in Thailand with five strategic business units: chemicals, paper, cement, building materials, and distribution. All Siam Cement businesses promote innovation in their products and services to delight consumers. The Group continually rejuvenates itself to sustain business leadership in Thailand and in the region, while being internationally competitive.

The cement business produces and supplies cement, ready-mixed concrete, concrete products, white cement and refractory as well as providing technical services and consultation on plant installation to customers both within and beyond the Group.

The project activities involve waste heat recovery and utilisation for power generation at Siam Cement Thung Song (STS) in Nakhon Si Thammarat province of Thailand. The SCG established the TS plant on a 839-rai (134-ha) site close to limestone and shale deposits in the Thung Song district of Nakorn Si Thammarat province in 1966 and it became the first and only cement plant in the southern region of Thailand. The plant has 3 clinker production lines (Kilns No.4, 5, and 6), and has a production capacity of 16,000 tonnes of clinker per day. The TS plant has an advantage in shipping cement to the South Asian countries as it is located close to the seaport in Krabi province. This project activity will be undertaken by Cementhai Energy Conservation Co., Ltd. (CEC), a subsidiary company of SCG Cement.

In the plant’s current clinker production process, the raw meal is heated up to 1,000°C in the pre-heater tower before entering the rotary kiln to form clinker at 1,450°C. The hot gas leaving the rotary kiln which still has the temperature around 1,000°C is re-circulated to the pre-heater before leaving to the raw mill with the temperature of 360°C. Clinker from rotary kiln will enter a clinker cooler where it will be cooled down to 100°C, while the fresh air is heated to 300°C. The current practice for cement production in Thailand is to vent most of the waste heat to the atmosphere, while some plants may re-circulate a portion of the waste heat to pre-heat the raw material before entering the clinker production process.

In the TS46 Project, two of the production lines (Kilns No.4 and 6) are to be modified by installing waste heat recovery and power generator. These hot gases from the pre-heater and clinker cooler will be collected and passed through suspension pre-heater boilers (SP boiler) and air quenching cooler boilers (AQC boiler) with total capacity to produce steam at 98.65 tonnes per hour. The steam will be sent to a

steam turbine to generate 20.50 MW of electricity (gross), of which 1.23 MW will be used in the power general unit and 19.27 MWwill be supplied to the cement plant, displacing parts of electricity currently supplied from national grid. After the project activity is implemented, the exhaust of the heat recovery boilers fitted as part of the project activity will still be used to dry the raw materials as before. The proposed project activity will alter neither the plant's production process nor its production capacity.

The baseline scenario as discussed in Section B.4 is the continuation of the current activities, ie the waste heat from the clinker production process would continue to be vented and the electricity would continue to be supplied from the national grid. In short, the project activity will reduce anthropogenic greenhouse gas by displacing electricity generated from fossil fuel supplied by other grid-connected power plants.

The purpose of the project activity can be summarised as:

⇒ Recovery of waste heat from clinkering process and utilisation for power generation;
⇒ Mitigating the environmental impacts of existing practice of venting hot gases and dust;
⇒ Reduction of atmospheric emissions of the greenhouse gas (GHG) through displacement of fossil fuel based grid electricity; and
⇒ Use of the CDM process to offset some of the financial and technical risks associated with the investments.

It is expected that the project would deliver multiple benefits in respect of sustainable development in Thailand, including:

Environmental benefits

⇒ Reduction of greenhouse gas emission through the avoided electricity generation by other grid-connected power plant;
⇒ Reduction of dust and particulate matters from the installation of de-dusting chamber;
⇒ Reduction of the water used to cool down the waste heat before venting;
⇒ Reduction in usage of non-renewable energy, ie fossil fuel for grid electricity generation;

Social benefits

⇒ Involvement of local communities through public participation meeting, in which people accepted the project;
⇒ Increased employment by employing 9 full time staff to operate the system;

Economic benefits

⇒ Reduction in the dependency fossil fuel for electricity generation while at the same time enhancing energy security by increasing diversity of supply;
⇒ Promoting the best practices of waste management in the cement industry in Thailand;
⇒ Generating incomes to the local community through additional local employment;
⇒ Enhancing competitiveness of cement industry in Thailand which is currently facing a lot of competitive pressure in the global market;
⇒ Demonstrating the use of CDM as an incentive for bringing about an energy efficiency project;

Technology transfer

⇒ Promoting technological excellence in the waste heat recovery project in Thailand; and
⇒ The power plant staff will receive necessary training on the management of the power plant.

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)	Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)
Thailand (host)	• Cementhai Energy Conservation Co., Ltd.	No
(*) In accordance with the CDM modalities and procedures, at the time of making the CDM-PDD public at the stage of validation, a Party involved may or may not have provided its approval. At the time of requesting registration, the approval by the Party(ies) involved is required.		

Contact information of the project participant is provided in Annex 1.

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

A.4.1.1. Host Party(ies):

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The Kingdom of Thailand

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

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Nakhon Si Thammarat Province

A.4.1.3. City/Town/Community etc:

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Tambon Teewang, Thung Song 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 activity is located at TS plant in Nakhon Si Thammarat province, approximately 835 km to the south of Bangkok. The location of this project activity is depicted in *Figure 1*.

Street address: 52 Moo 6, Thung Song-Huai Yat Road, Tambon Teewang, Thung Song District, Nakhon Si Thammarat 80110, THAILAND

Geographical coordinates: 8° 6’ 1.20” N 99° 41’ 2.50” E

Figure 1 Project Location, Nakhon Si Thammarat Province, Thailand

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

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The project activity falls into **sectoral scope 1 – Energy industries (renewable / non-renewable sources)** – and **sectoral scope 4 – Manufacturing industries** – as defined by the UNFCCC.

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

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Portland cement is the most common type of cement in general usage in many parts of the world and is also the major product of TS plant. Portland cement is made up of more than 90% ground cement clinker, a maximum of about 5% gypsum and up to 5% minor constituents. Cement production at The Siam Cement (Thung Song) consists of the following stages:

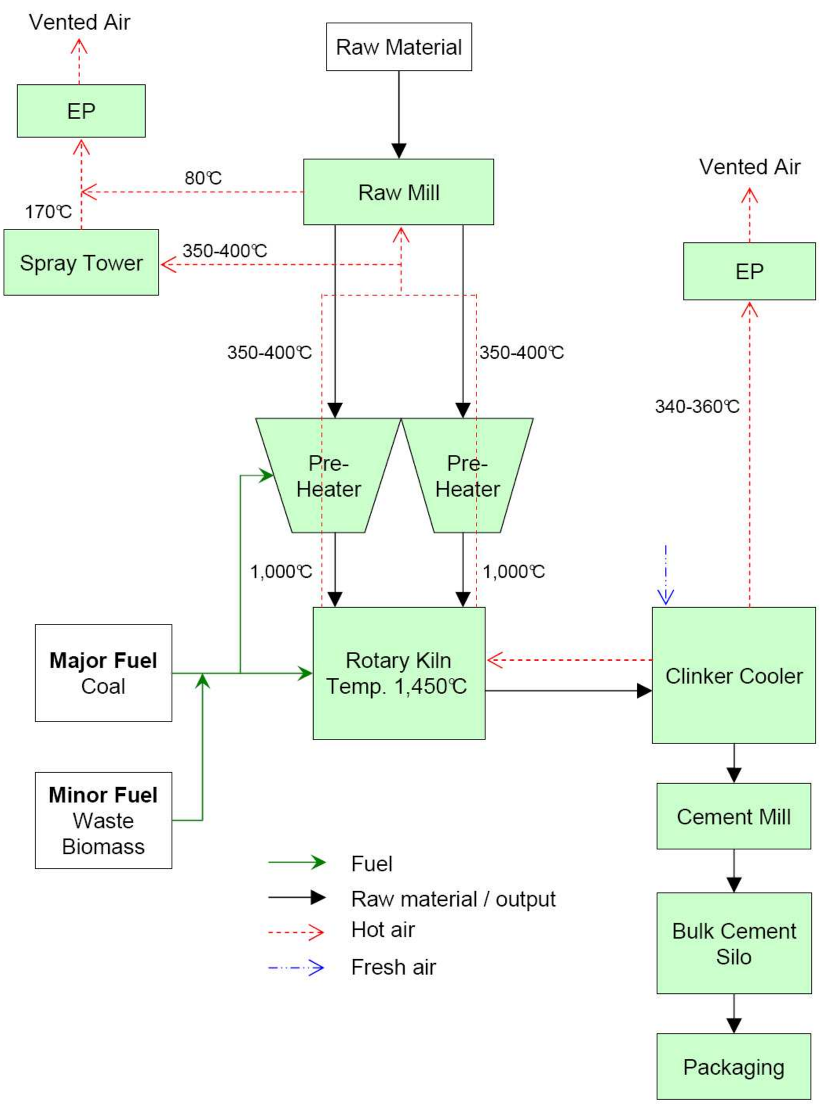
1. **Raw material preparation**. Raw materials, such as lime stone, shale and laterite are pounded into a size of 25 mm before being stockpiled in a storage house.
2. **Raw material grinding**. Prepared raw materials are passed to a raw mill to be ground and then mixed in a blending silo before storing in a raw meal silo. In this process, the hot gas at the temperature around 350-400°C leaving the pre-heater tower is used to remove moisture from the raw meal.
3. **Clinker burning**. The raw meal is heated up to approximately 1,000°C in 5-stage cyclone type pre-heater tower before entering the rotary kiln to form clinker at 1,450°C. The hot gas leaving

the pre-heater still has the temperature around 360°C. Clinker from rotary kiln will enter a clinker cooler where it will be cooled down to 100°C, while the fresh air is heated to 300°C.

4. **Clinker grinding**. Clinker is ground into bulk cement in a cement mill.
5. **Cement packing**. Cement is packed in 50-kg bags and stored before being distributed or bulk cement is transported by trucks.

Figure 2 illustrates the plant initial production process flow.

Figure 2 ***Thung Song initial production process flow***



Source: TS plant EIA report, August 2008.

TS plant currently has 3 clinker production lines with total production capacity of 16,000 tonnes clinker/day. Two of the clinker production lines (Kilns No.4 and 6) will be modified to recover and utilise waste heat to generate electricity supplied to the plant itself.

In the cement production process, there are 2 main sources that generate significant amount of waste heat, which are hot gas leaving the cement kiln and hot air leaving the clinker cooler. Prior to the implementation of the project, most of the waste heat is vented to the atmosphere and some is used to pre-heat the raw material before entering the clinker burning process. The source, flow and temperature of waste heat that is expected to be vented for a typical production year are shown in *Table 1*.

Table 1 Sources, flows and temperatures of hot gases utilised for power generation

Kiln #	Boiler	Flow (Nm^3/h)	Temp (°C)	
			Inlet	Outlet
4	SP-1[1]	203,300	400	210
	AQC[2]	109,914	340	85
6	SP-1[1]	250,000	400	210
	SP-2[1]	250,000	400	210
	AQC[2]	191,627	340	83

Source: TS plant EIA report, August 2008.
Notes: 1 Natural circulation (horizontal) boiler
2 Natural circulation (vertical) boiler

Technology Employed

The technology to be employed by the project activity is a waste heat recovery and electricity generation which is transferred from Sinoma Energy Conservation Limited, China. Models, specifications and origins of main equipment – including turbine, generator and boilers – are presented in *Table 2*.

Table 2 Models, specifications and origins of main equipment

	Model	Capacity	Supplier	Origin
SP boiler K4	QC203/400-22.88-1.35/380	22.88 t/h 1.35 Mpa 380C	Nantong boiler	China
SP boiler K6.1	QC250/400-26.7-1.35/380	26.7 t/h 1.35 Mpa 380C	Nantong boiler	China
SP boiler K6.2	QC250/400-26.7-1.35/381	26.7 t/h 1.35 Mpa 380C	Nantong boiler	China
AQC boiler K4	QC110/340-8.13-1.35/340	8.13 t/h 1.35 Mpa 320 C	Nantong boiler	China
AQC boiler K6	QC192/340-14.24-1.35/320	14.24 t/h 1.35 Mpa 320 C	Nantong boiler	China
Turbine	BN22-1.25/0.12	22 MW (rated)*	Hangzhou turbine	China
Generator	QF-25-2	25 MW (rated)	Hangzhou generator	China

Note: * Since turbines are available in standard size, while the available waste heat from kilns 4 and 6 can generate power at 20.5 MW, thus the 22MW turbine is most appropriate for TS46 project.

The project activity will collect these gases and pass them through waste heat recovery boilers to generate steam for power generation. The exhausted heat from each rotary kiln, passed through the pre-heaters to preheat the raw meal, will be collected and utilised in SP boilers. The hot air from the clinker cooler will be collected and fed into the AQC boiler. The expected amounts of steam generation from each kiln are shown in *Table 3*.

Table 3 Rate of steam generation from boilers

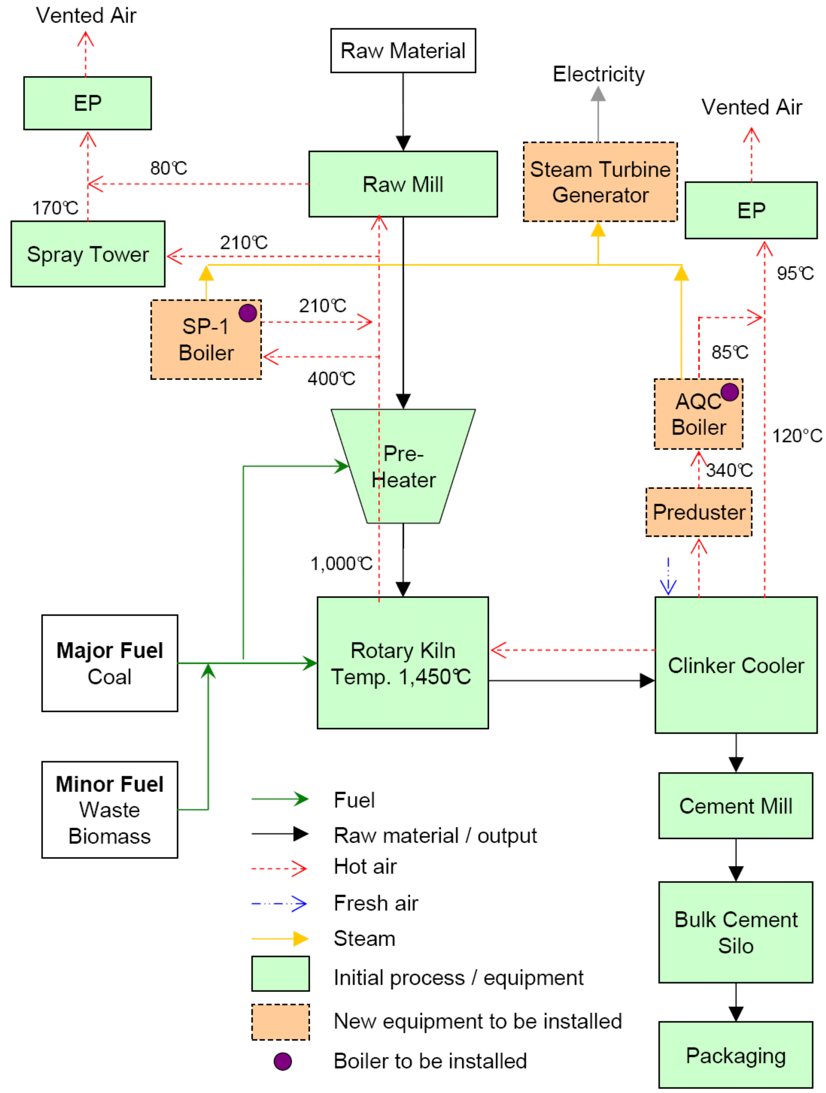
Kiln #	Boiler	Pressure (bar)	Temp (°C)	Flow (t/h)
4	SP-1	13.5	380	22.88
	AQC	13.5	320	8.13
6	SP-1	13.5	380	26.70
	SP-2	13.5	380	26.70
	AQC	13.5	320	14.24

Source: TS plant EIA report, August 2008.

The total amount of steam generated from SP boilers and AQC boilers, of 2 rotary kilns, accounts for approximately 98.65 tonnes per hour. The steam turbine generator, driven by high pressure steam from the 5 boilers will convert heat energy into mechanical energy which will drive the waste heat generator to produce electricity which will be used in the electricity generation unit and supplied to the plant's cement production lines. It is estimated that the power generation with a gross capacity of 20.50 MW will generate 107,184 MWh of net electricity per year to be supplied to the cement works.

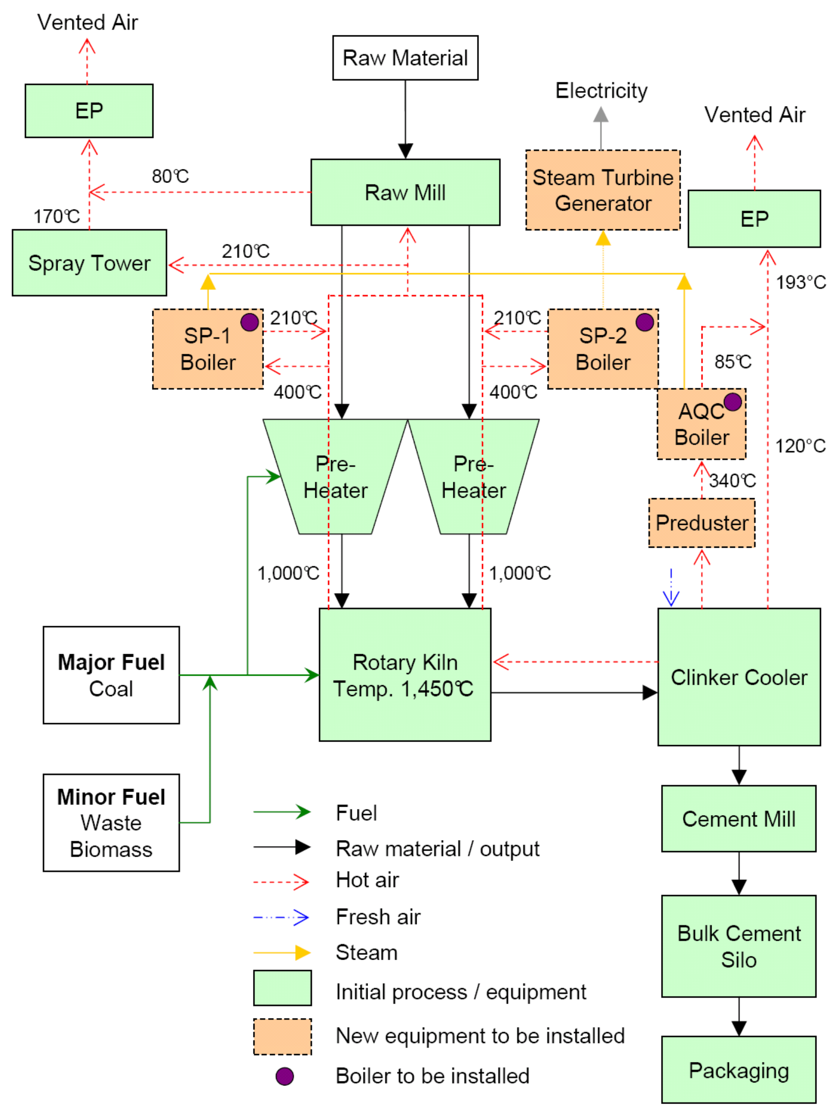
The flow diagrams of waste heat recovery and power generation process of Kilns no.4 and 6 are depicted in *Figure 3* and *Figure 4*, respectively.

Figure 3 Kiln no.4 production, waste heat recovery and power generation flow of TS plant



Source: TS plant EIA report, August 2008.

Figure 4 *Kiln no.6 production, waste heat recovery and power generation flow of TS plant*



Source: TS plant EIA report, August 2008.

The environmentally safe and sound technology to be employed in this TS46 Project will deliver multiple benefits to the Host Party, Thailand. Those environmental benefits include:

⇒ Reduction of dust and particulate matters from the installation of de-dusting chamber;
⇒ Reduction of the water used to cool down the waste heat before venting; and
⇒ Reduction in usage of non-renewable energy, ie fossil fuel for grid electricity generation, due to the plant's decrease in reliability on grid electricity supply.

The project is also promoting technological excellence in the waste heat recovery project in Thailand and the power plant staff will receive necessary training on the management of this power plant. Since this project is very new to the cement sector in Thailand, an extensive training programme for TS plant staff is required. TS plant will set up a WHG (Waste Heat Generator) Project Training Team to be trained at the similar cement plant of the contractor for 3-4 weeks. The training mainly covered the operation and maintenance of the waste heat recovery project, as well as safety knowledge. Moreover, SCG Cement has also provided additional trainings concerning power plant to its all cement plants.

In the absence of an implementation of the proposed TS46 Project, the continuation of partial utilisation of waste heat and electricity supply from grid, existing scenario, is considered a baseline scenario.

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

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Years	Annual estimation of emission reductions in tonnes of CO_2 e
2010 (7 months)	31,779
2011	54,203
2012	54,203
2013	54,203
2014	54,203
2015	54,203
2016	54,203
2017	54,203
2018	54,203
2019	54,203
2020 (5 months)	22,423
Total estimated reductions (tonnes of CO_2 e)	**542,029**
Total number of crediting years	**10**
Annual average over the crediting period of estimated reductions (tonnes of CO_2 e)	**54,202**

A.4.5. Public funding of the project activity:

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No Annex-I country financial support for this project has been received.

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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- Version 02.1 of AM0024 "Baseline methodology for greenhouse gas reductions through waste heat recovery and utilisation for power generation at cement plants" (EB 35);
- Version 02 of Tool to calculate the emission factor for an electricity system (EB 50); and
- Version 05.2 of Tool for the demonstration and assessment of additionality (EB 39).

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

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The proposed project activity meets each of the applicability conditions of the methodology AM0024, as justified in the following table.

Applicability conditions	Justification
1) The electricity produced is used within the cement works where the proposed project activity is located and excess electricity is supplied to the grid; it is assumed that there is no electricity export to the grid in the baseline scenario (in case of existing captive power plant);	- The electricity produced by the project activity will be used for the electricity generation unit and within the cement works where the project activity is located, which will partially displace electricity currently bought from the grid. There is no electricity export to the grid in the baseline scenario.
2) Electricity generated under the project activity displaces either grid electricity or from an identified specific generation source. Identified specific generation source could be either an existing captive power generation source or new generation source;	- TS plant currently buys most of the electricity used for its cement works from the grid. Electricity generated under the project activity will displace grid electricity (please also refer to Step 1 of Section B.1).
3) The grid or identified specific generation source option is clearly identifiable;	- Thailand has a single national grid electricity system so that the grid generation source option is clearly identifiable. For TS46 Project, the cement plant currently purchases grid electricity from EGAT*.
4) Waste heat is only to be used in the project activity;	- Waste heat from Kilns No. 4 and 6 at the TS plant will be recovered and only be used in boilers to generate steam. The 25-MW steam turbine generator, driven by high pressure steam, will convert heat energy into mechanical energy which will drive the waste heat generator to produce electricity to supply to the TS plant. There is no other use of waste heat outside the project activity.
5) In the baseline scenario, the recycling of waste heat is possible only within the boundary of the clinker making process (eg clinker production lines in baseline scenario could include some heat recovery systems to capture a portion of the waste heat from the cooler end of the clinker kiln and use this to heat up the incoming raw materials and fuel - so called	- Most of the waste heat is currently vented to the atmosphere and some is used within the boundary of the clinker making process to pre-heat the raw material before entering the clinker burning process, which is classified as Type 1 Waste Heat Utilisation.

Applicability conditions	Justification
Type 1 Waste Heat Utilisation as described in explanatory note);	
6) This methodology is NOT applicable to project activities where the current use of waste heat or the identified alternative business as usual use of waste heat is located outside of the clinker making process (so called Type 2 Waste heat utilisation as described in explanatory note below);	- There is no current use of waste heat or the identified alternative business as usual use of waste heat outside of the clinker making process or Type 2 Waste Heat Utilisation.
7) This methodology is NOT applicable to project activities that affect process emissions from cement plants.	- The project activity does not involve any changes in the cement production process, and therefore will not affect process emissions from cement plant.

Note: *EGAT = Electricity Generating Authority of Thailand

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

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For the purpose of determining GHG emissions of the project activity, the following emissions sources are included:

- CO_2 emissions from on-site fuel consumption of fossil fuels.

For the purpose of determining the baseline, the following emission sources are included:

- On-site fossil fuel consumption within project boundary; and
- From electricity generation, either in captive power generation source or the generation sources connected to grid that serves the proposed project site, as in the identified baseline scenario.

The physical boundary of TS46 Project includes the facilities constructed/erected on account of the project activity at the cement plant and the local power grid system, which supplied from EGAT (Electricity Generating Authority of Thailand), connected to the project activity. There is no captive power plant; hence, neither export nor import of electricity from the project boundary.

The spatial extent of the project electricity system, including issues related to the calculation of the build margin (BM) and operating margin (OM), as further defined in the **Tool to calculate the emission factor for an electricity system**.

Table 4 illustrates which emissions sources are included and which are excluded from the project boundary for determination of both baseline and project emissions.

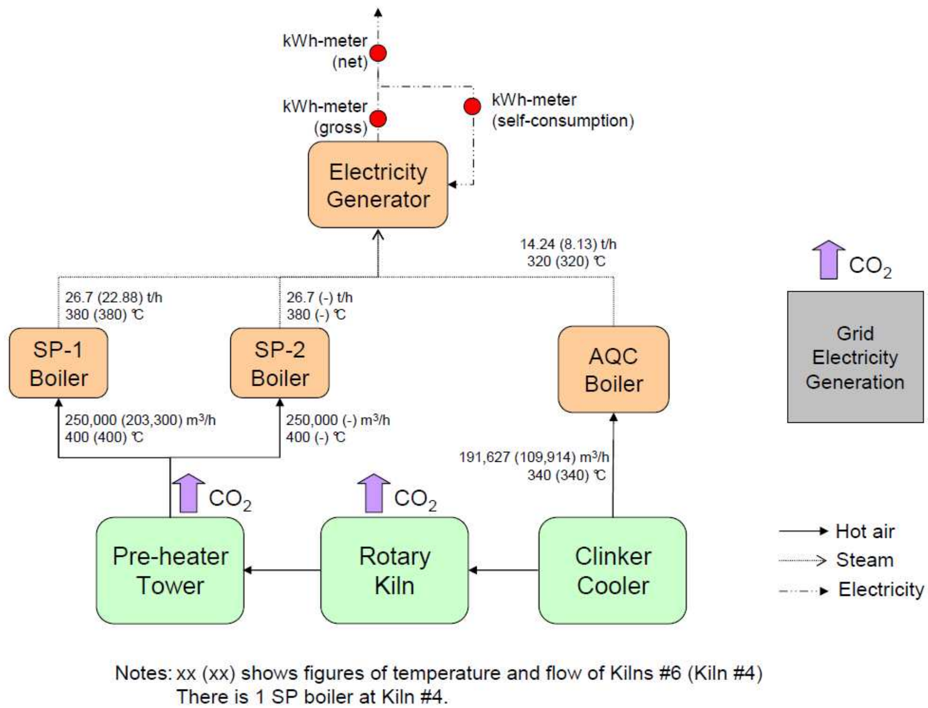
Table 4 Overview on emissions sources included in or excluded from the project boundary

	Source	Gas	Included?	Justification
Baseline	Grid electricity generation/identified specific generation source	CO_2	Included	Main emission source.
		CH_4	Excluded	Excluded for simplification. This is conservative.
		N_2O	Excluded	Excluded for simplification. This is conservative.
ct Activi	On-site fossil fuel consumption due to the project activity	CO_2	Included	Main emission source.
		CH_4	Excluded	Excluded for simplification. This emission source is assumed to be very small.

	Source	Gas	Included?	Justification
		N_2O	Excluded	Excluded for simplification. This emission source is assumed to be very small.

Figure 5 demonstrates a flow diagram of the project boundary showing equipment, processes and flows of heat and steam, described in Section A.4.3, as well as the emissions sources and gases included in the project boundary.

Figure 5 TS46 Project boundary and flow diagram



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

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Following the procedure in AM0024 (version 02.1), the baseline scenario for the project activity will be identified through the following steps:

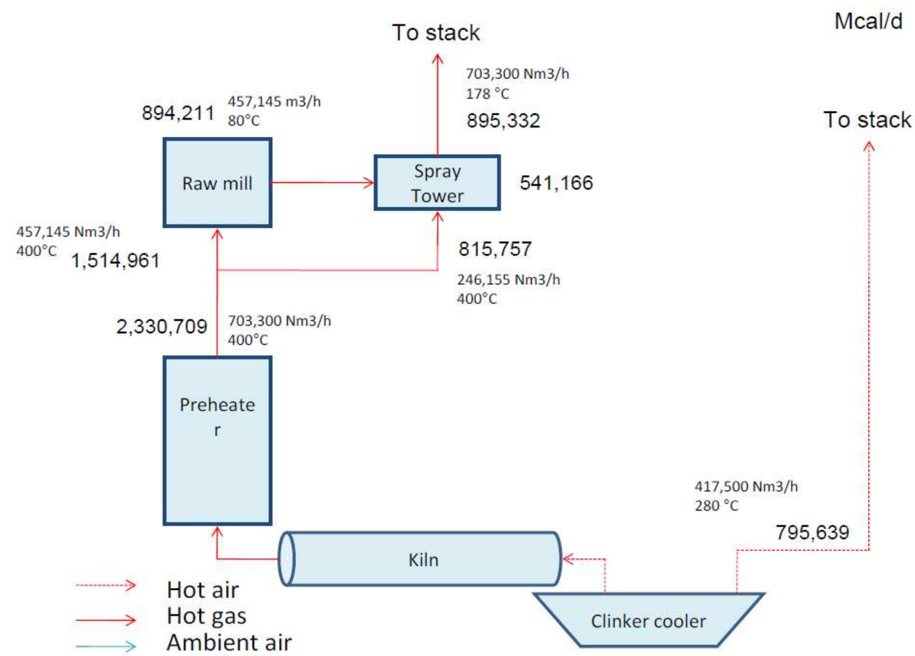
- Step 1: Determination of technically feasible alternatives to the project activity;
- Step 2: Compliance with regulatory requirements; and
- Step 3: Undertake economic analysis of all options that meets the regulatory requirements.

This methodology is not applicable if the baseline scenario is different from the current waste heat recovery in the clinker production of the cement plant where the proposed project activity will be implemented.

Step 1: Determination of technically feasible alternatives to the project activity:

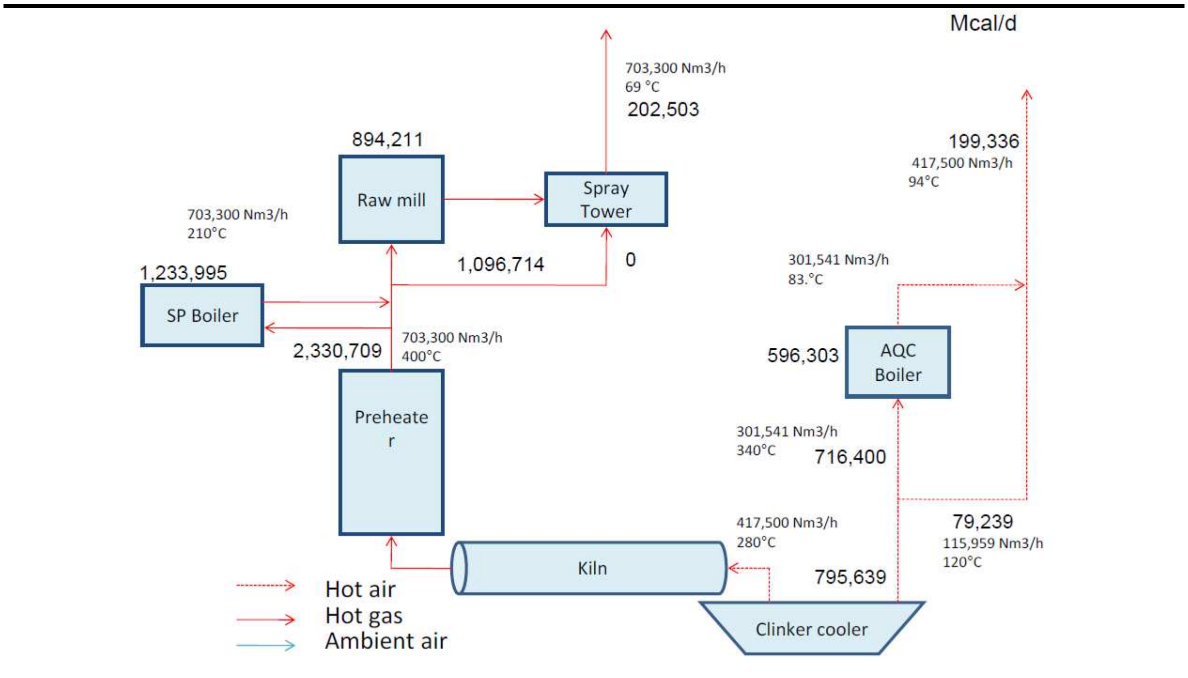
Step 1.A ***Identify options for waste heat utilisation.*** The general practice for the management of waste heat from clinker production process is to vent it to the atmosphere, while some more modern plant might re-circulate it to dry the raw material. Although TS plant has already recovered and utilised some of the waste heat within the energy balance boundary of the clinkering process (Type 1 waste heat utilisation), a large proportion of the waste heat is still vented to the atmosphere, illustrated in *Figure 6*. There are no other industrial facilities in the vicinity of the plant that could make economic use of the waste heat. Thus, **the alternative to venting of waste heat (with possible re-circulating some portion for drying raw material) is to utilise it for power generation as the proposed project activity** (*Figure 7*).

Figure 6 ***Energy balance <u>before</u> project implementation***



Notes: - Hot gas is the waste heat resulted from combustion of fuel.
- Hot air is the waste heat from heating up of fresh air in clinker cooling process.

Figure 7 *Energy balance after project implementation*



Notes: - Hot gas is the waste heat resulted from combustion of fuel.
- Hot air is the waste heat from heating up of fresh air in clinker cooling process.

Step 1.B ***Identify source of electricity supply.*** In 2007, TS plant purchases grid electricity from EGAT at around 437 GWh. According to the methodology, E_{CEMENT} and E_{LOAD}, which are the electricity demand of the cement works and other local loads, should be included in the Project Design Document for at least two years prior to the start date of the project activity. The following table shows the average electricity demand of the cement work at TS plant for 3 years prior to the start date of the project activities. There are no other local loads at TS plant.

		2005	**2006**	**2007**
Clinker production	tonnes/year	4,299,596	4,453,439	4,681,176
Clinker production capacity	tonnes/year	5,840,000	5,840,000	5,840,000
Kiln utilisation factor	-	73.6%	76.3%	80.2%
Electricity consumption (E_{CEMENT})	MWh	392,814	434,428	436,581
Electrical demand for cement work	MW	60.9	65.0	62.2

According to SCG Cement Medium Term Plan, the electricity demand of the cement work for the next years covering the crediting period is not expected to increase since there is no plan to increase clinker production capacity at TS plant, as shown in the following table.

		2008F	2009F	2010F	2011F	2012F	2013F	2014F	2015F	2016F	2017F	2018F	2019F	2020F
Total Clinker Produced	mt Clinker	4.70	4.70	4.75	4.75	4.81	4.81	4.86	4.91	4.96	5.02	5.02	5.02	5.02
Clinker production capacity	mt Clinker	5.84	5.84	5.84	5.84	5.84	5.84	5.84	5.84	5.84	5.84	5.84	5.84	5.84
Kiln utilisation factor	-	80%	80%	81%	81%	82%	82%	83%	84%	85%	86%	86%	86%	86%
Total Power Consumed (E_{CEMENT})	GWh	376	385	393	403	413	423	417	412	421	419	419	419	419
Electrical demand for cement work	MW	53.3	54.6	55.1	56.5	57.3	58.7	57.2	56.0	56.6	55.7	55.7	55.7	55.7

As shown above, the *ex-ante* projection of electricity demand (GWh) is only subject to the amount of clinker production without any alteration to the production process itself. Thus, the level of electrical demand for cement work (MW) is expected to be flat over the crediting period. All the electricity demand was in the past entirely met by supply from the grid; however, TS plant has recently installed a new WHG system as a CDM project at one of its production line (Kiln #5 or TS5), with net electricity generation of 7.30 MW. The 3.77 MW standby generator connected to the cement plant is not counted as a captive power plant as it operates only in case of grid electricity outage. Since the abovementioned WHG system has completed equipment its installation and performance test in July 2008, after the starting date of TS46 Project, there is no historical production data to be included in this PDD. Nevertheless, *ex-ante* projection of production capacity for the crediting period can be demonstrated in the most conservativeness manner in the following table.

		2008F	2009F	2010F	2011F	2012F	2013F	2014F	2015F	2016F	2017F	2018F	2019F	2020F
Kiln utilisation factor	-	80%	80%	81%	81%	82%	82%	83%	84%	85%	86%	86%	86%	86%
Net power of TS5 WHG	MW	7.30	7.30	7.30	7.30	7.30	7.30	7.30	7.30	7.30	7.30	7.30	7.30	7.30
***Ex-ante* generation of TS5 WHG**	MWh	22.2*	46.3	46.8	46.8	47.4	47.4	47.9	48.3	48.9	49.4	49.4	49.4	49.4

Note: WHG utilisation factor = 90%, according a guaranteed figure from the supplier.
* An *ex-ante* of generation is estimated starting from the completion of equipment installation and performance test.

Given that TS5 WHG can only supply 7.30 MW out of total electricity demand of around 55 MW, the remaining power demand of 47.7 MW is now being met by the supply from the grid. In the absence of the project activity, electricity supply of 19.27 MW[1] will be supplied by one of the following scenarios.

Scenario	Practice
ES-1	Electricity supply from the project activity will displace grid electricity (19.27 MW), and not the captive power plant TS5.
ES-2	Electricity supply from the project activity will displace electricity supplied from TS5 (7.30 MW) and the remaining grid electricity (11.97 MW).

Note: As per the methodology, since there is no increase in electrical demand for cement work, the analysis of baseline option for (i) an expansion of existing captive power plant or (ii) construction of captive power plant using other types of fuel is not required.

In the presence of the project activity, the displacement of power supplied by the existing captive power plant TS5 WHG is not envisaged because TS5 WHG is also a waste heat power generation. This is because the marginal cost (operating and maintenance cost) of generating electricity from this existing captive power plant (not including fixed capital cost) is much lower than the cost of buying electricity from the grid. Therefore, considering the cost of supply, the grid electricity (the most expensive option) will first be displaced, then it will be the captive power plant, hence scenario ES-1. In terms of carbon credit, given that TS5 WHG is also implemented as a CDM project, the project owner would have its best interest to maximise electricity generation from this power plant. Therefore, scenario ES-2 will not be possible.

Furthermore, an expansion of the captive power plant TS5 WHG is not possible since there is no excess waste heat from Kiln #5 to supply to TS5 WHG.

Even with the combined capacity of TS5 WHG and TS46 WHG (7.30 MW + 19.27 MW = 26.57 MW), this is still not enough to meet electricity demand of the cement and almost 30 MW will still need to be imported from the grid.

Regarding the grid electricity, it is a common practice for the cement industry in Thailand to buy electricity from the grid because Thai grid electricity provides reliable electricity supply at a competitive price. Therefore, it can be concluded that the only most likely option for electricity supply for the project activity is that it will displace grid electricity.

In conclusion, **the most likely baseline scenario is the continuation of partial utilisation of waste heat for drying raw material and the rest being vented and the supply of electricity from the national grid**.

Step 2: Compliance with regulatory requirements:

The options identified in Step 1 (venting of the waste heat with possible re-circulating some portion for drying raw materials, versus recovery and utilisation of waste heat for power

[1] This figure is referred from the net power generation of the proposed project activity, TS46 Project.

generation and the purchase of grid electricity) are all in full compliance of existing regulatory requirements.

Step 3: **Undertake economic analysis of all options that meets the regulatory requirements:** Since there is only one alternative to the project activity, which is the continuation of the current situation, no further analysis is required. It can be concluded that the continuation of the current situation is the baseline. (Please also refer to Step 2 of Section B.5)

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):

>>

The additionality of the project activity is demonstrated below using version 05.2 of the **"Tool for the demonstration and assessment of additionality"**.

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

Please refer to Step 1 and Step 2 of Section B.4. The following alternatives are identified.

1. Continuation of the current situation, ie continue venting waste heat and purchase electricity from the grid.
2. The proposed project activity undertaken without being registered as a CDM project activity

Both alternatives are in full compliance with current laws and regulations.

Step 2: Investment analysis

Sub-step 2a. Determine appropriate analysis method

As the project activity generates financial benefits other than CDM related incomes, the simple cost analysis (Option I) is not applicable. The project proponent chooses to apply the benchmark analysis (Option III).

Sub-step 2b – Option III. Apply benchmark analysis

The relevant financial indicator that the project proponent uses as benchmark is IRR or Internal Rate of Return which is calculated as equity IRR. The project proponent chooses to apply the benchmark rate derived from the government bond rates, increased by a suitable risk premium to reflect private investment, as substantiated by an independent (financial) expert. The benchmark is to represent standard returns in the market, considering the specific risk of the project type, but not linked to the subjective profitability expectation or risk profile of a particular project developer.

As of 10th October 2007, the 18-year government bond yield of was 5.23%[2]. The longest 18-year maturity is chosen to reflect the project life time of 20 years. To reflect the risk of private investment, a

[2] Source: Thai Bond Market Association, http://www.thaibma.or.th/price_yield.html; as of 10th October 2007.

long term risk premium for Thailand of 6.41% as updated in early 2007 is applied[3]. This risk premium is based on the estimate of the default spread for US corporate over the Treasury bond rate, added with the country risk premium based on the country rating from Moody's. *Table 4* and *Table 5* show the Thai government bond rate of 10th October 2007and the country's risk premium, respectively.

Table 5 ***Thai government bond rate as of of 10th October 2007***

TTM (years)	*Yield (%)*	*TTM (years)*	*Yield (%)*
0.08	*3.08*	*9*	*4.79*
0.25	*3.05*	*10*	*4.87*
0.50	*3.23*	*11*	*5.01*
1	*3.48*	*12*	*5.12*
2	*3.62*	*13*	*5.15*
3	*3.83*	*14*	*5.17*
4	*3.98*	*15*	*5.19*
5	*4.20*	*16*	*5.20*
6	*4.46*	*17*	*5.21*
7	*4.57*	*18*	**5.23**
8	*4.71*		

Source: Thai Bond Market Association, http://www.thaibma.or.th/price_yield.html; as of 10th October2007

Table 6 ***Country's risk premium (2006)***

Country	**Long-Term Rating**	**Adj. Default Spread**	**Total Risk Premium**	**Country Risk Premium**
Thailand	Baa1	100	***6.41%***	1.50%
United States	Aaa	0	4.91%	0.00%

Source: http://pages.stern.nyu.edu/~adamodar/pc/archives/ctryprem06.xls Professor Aswath Damodaran, Stern Business School

According to the **Guidance on the Assessment of Investment Analysis** (version 02, attached to the Additionality Tool version 05.2), *Risk premiums applied in the determination of required returns on equity shall reflect the risk profile of the project activity being assessed, established according to national/international accounting principles.* As the risk premium above only reflect the expected return of the general stock market, it is necessary to factor the risk premium with sensitivity of a particular assets to market returns, also known as **beta coefficient** in the CAPM model below.

$$E(R_i) = R_f + \beta_i[E(R_m)-R_f]$$

Where:

$E(R_i)$ is the expected return of the capital assets;

[3] http://pages.stern.nyu.edu/~adamodar/pc/archives/ctryprem06.xls This country risk premium is calculated by Professor Aswath Damodaran, who is Professor of Finance at Stern School of Business, New York University. Before coming to Stern, he also lectured in Finance at the University of California, Berkeley. See also http://w4.stern.nyu.edu/faculty/facultyindex.cgi?id=70 for biography of Professor Damodaran.

R_f is the risk free rate of interest;
β_i is the beta coefficient or sensitivity of the asset returns to market returns;
$E(R_m)$ is the expected return of the market;
$E(R_m) - R_f$ is the expected market risk premium.

Although the project is implemented as a power plant, but, with specific fuel used – waste heat exhausted from the clinker production process, the suitable beta coefficient is for assets in Construction Material (CONMAT) sector within the Stock Exchange of Thailand. This beta coefficient, which would better reflect the risk of the project as compared to conventional power plants, is calculated as 0.944[4]. Thus, the suitable benchmark rate to be applied for this project is:

$$E(R_i) = R_f + \beta_i[E(R_m)-R_f]$$
$$= 5.23\% + (0.944 * 6.41\%)$$
$$= 11.28\%$$

Sub-step 2c: Calculation and comparison of financial indicators (only applicable to options II and III):

The IRR calculation is based on 20-year project life time. The key assumptions made in the calculation of the IRR are detailed in *Table 7*.

Table 7 Key Assumptions for IRR Calculation

Assumption	Value	Source
Project investment (million Baht)	840.0	Supplier contract
MLR	6.875%	Minimum Loan Rate – Krung Thai Bank (23rd July 2007)
Company Income Tax	30%	Corporate Tax – The Revenue Department
Debt to Equity Ratio	1:2	SCG Accounting Policies
Actual Salvage Value	5.0%	Estimated from other similar projects
Kiln Utilisation Factor	71%	Historical performance of Kiln no.4 and 6 in 2005-2007
WHG Utilisation Factor[1]	90%	Benchmark from Supplier's record
Initial Working Capital	3 mth of O&M	SCG Accounting Policies
WHG Supply Stop from Major Maintenance @Yr10	3 mth	Benchmark from Supplier's record
Additional Capital Expenses @Yr10 (of Total	30%	Benchmark from Supplier's record

[4] The beta coefficient describes how the expected return of a stock or portfolio is correlated to the return of the financial market as a whole. The formula for the beta of an asset within a portfolio is:

$$\beta_a = \frac{Cov(r_a, r_p)}{Var(r_p)}$$

where r_a measures the rate of return of the asset, r_p measures the rate of return of the portfolio, and $Cov(r_a,r_p)$ is the covariance between the rates of return. [source: http://en.wikipedia.org/wiki/Beta_coefficient]

Data used to calculate beta coefficient were the daily closing SET index and CONMAT taken from the Stock Exchange of Thailand during 16 Oct 2006 – 15 Oct 2007, ie before the decision about the project was made. [source: www.setsmart.com/ism/ism_sectorquotation_historical.jsp]

Assumption	Value	Source
Investment)		
Gross Power (MW)	20.50	Supplier specification
Self-power Consumption (MW)	1.23	Supplier specification
Net Power (MW)	19.27	Supplier specification
Annual Net Power Generation (GWh)[2]	107.18	Supplier specification
Electricity price (Baht/kWh)	2.36	Average electricity cost that TS plant paid to EGAT during Jan-Sep 2007
Emission factor (t CO_2/MWh)	0.563	The study of Implications of renewable energy on total CO_2 emissions in the power sector: The full-energy chains analysis in Thailand[3]
Annual O&M Cost (million Baht)	148.33	Calculation
O&M Cost per unit (Baht/kWh-Net)	1.38	Calculation
- Annual Electricity Cost (million Baht)	12.66	5% from EGAT price
- Water Cost	62.71	Estimated from 0.550 Baht/kWh-Gross
- Chemicals Cost	29.65	Estimated from 0.260 Baht/kWh-Gross
- Contractor Cost	4.17	Estimated from 60man x 300 Baht/day
- Maintenance Cost	19.95	Estimated from 0.175 Baht/kWh-Gross
- Employee Salary	10.68	Estimation
- Administration Cost of CEC	8.51	Estimation

Note: 1 Waste Heat Generator (WHG) running factor denotes the proportion of time during which WHG produces electricity to the time that waste heat is available (the kiln is running).
2 An assumption of annual net power generation is subject to kiln utilisation factor.
3 Accessed at http://www.sjst.psu.ac.th/journal/27-3-pdf/10energy.pdf

The project financial feasibility study shows that the IRR is 7.0% (not including CER revenue) based on 20-year lifetime of the project. The detail calculation of the IRR is provided in Annex 5.

Sub-step 2d: Sensitivity analysis (only applicable to options II and III):

The main revenue of the project comes from the sale of electricity, which varies in proportion of the electricity price and the amount of electricity generated (which in turn depends on the kiln running hours), while the operating and maintenance cost presents the largest operating cost of the power generation in the absence of fuel cost. However, the O&M cost would be a significant factor for other power plant burning fossil fuel or biomass. Without fuel cost, O&M cost is not a significant part that affect IRR. By varying the electricity price and kiln utilisation factor, the IRR will change as in the following tables. WHG utilisation factor would have the same effect as kiln utilisation factor, also shown below, and its value of 90% is already very high. Moreover, the sensitivity on the largest portion of initial investment cost, machinery (accounted for 56% of total), is also shown below.

	Electricity Unit Price (Baht/kWh)				
	Optimistic		**Base Case**	**Pessimistic**	
	+10%	+5%	0%	-5%	-10%
	2.60	2.48	2.36	2.24	2.13
IRR	10.8%	8.9%	7.0%	4.9%	2.4%

	Kiln Utilisation Factor (%)

	Optimistic		Base Case	Pessimistic	
	+10%	+5%	0%	-5%	-10%
	77.6%	74.1%	70.6%	67.0%	63.5%
IRR	8.6%	7.8%	7.0%	6.2%	5.3%

	WHG Utilisation Factor (%)				
	Optimistic		Base Case	Pessimistic	
	+10%	+5%	0%	-5%	-10%
	99.0%	94.5%	90.0%	85.5%	81.0%
IRR	8.6%	7.8%	7.0%	6.2%	5.3%

	Machinery Cost (million baht)				
	Optimistic		Base Case	Pessimistic	
	-10%	-5%	0%	+5%	+10%
	424	448	471	495	518
IRR	8.0%	7.5%	7.0%	6.5%	6.1%

As shown above, with the reasonable variations of the critical assumptions, the equity IRR of this project is still lower than the benchmark of 11.28%. These sensitivity analyse demonstrate that the result of the financial analysis is robust. Likelihood of the variations used for the above sensitivity analysis is discussed below.

Sensitivity on electricity price
Electricity price in Thailand consist of 3 major parts ie base tariff, Ft and VAT. Since VAT will have to be passed on to the government thus, VAT is omitted in this analysis. Base tariff consists of demand charge and energy charge, each having a fixed rate. Ft is an automatic fuel adjustment cost that also incorporates the fuel cost. Thus, in reality, only Ft will change, not the base tariff, which remains constant regardless of fuel price fluctuation. Although, the Ft varies due to changes in fuel cost, from historical record, Ft charges did not change proportionally in line with the oil price because the majority of electricity in Thailand is generated from natural gas, the price of which is regulated. The Ft charge is also subject to load management of electricity generation system. Therefore, it rises periodically due to the load generated from fuel oil- or diesel-fuelled plans.

The savings from project electricity generation would be subject to the electricity unit price. The project could be financially feasible if the electricity price is at THB2.63/kWh, 11% higher than the base case. Since the Ft is approximately accounted for 30% of the electricity unit price. The variation of +11% of unit price implies approximately +37% of Ft. Moreover, the base case of Ft used in the sensitivity analysis is THB0.7175/kWh which was the value at the time the decision was made. This value was nearly the highest Ft at the time due to high oil prices before coming down to THB0.6285/kWh only a year after when the oil price tumbled. This makes it very unlikely that the Ft charge will be sustained at 30% above THB0.7175/kWh

Sensitivity on kiln utilisation factor
The kiln utilisation factor used in the base case represented an average of the latest 3 years, 2005-2007. While it reached the highest point at 74.3% in 2007, this level is still below the 10% optimistic case (77.6%) in the analysis. To meet the benchmark of 11.28%, the kiln must be continually utilised at 90%

over the project lifetime. The projection of clinker production was made before the economic downturn in 2008, making that projection already too optimistic. According to the historical record over the last three years prior the project implementation (2005-2007), the average utilisation factor of kilns 4 and 6 is only around 71%. Therefore, it is unlikely that the clinker production will be sustained at 10% higher than what were projected.

Sensitivity on WHG utilisation factor
As generally recommended in version 2 of **Guidance on the Assessment of Investment Analysis**, the sensitivity analysis should at least cover a range of +10% and -10%. In this sensitivity analysis of TS46 project, it already covers 99% of WHG utilisation factor which results in the IRR below the benchmark. In order to reach the benchmark at 11.28%, the WHG utilisation factor would have to be 115%, which is impossible.

Sensitivity on machinery investment cost
To meet the benchmark, the machinery cost in Thai Baht must be at approximately 290 million THB, which is 39% lower than the cost estimated at the time the decision was made. The machinery cost constitutes 56% of total project cost and directly came from an actual amount quoted by the supplier. Thus, the key variable of this component is an exchange rate. At the time the decision was made in October 2007, the exchange rate was around THB34.17/USD. The lowest rate ever since was only in early 2008 at THB31.46/USD, an appreciation of less than 8%. Taking this strongest Thai Baht, the investment cost would still not reach the optimistic case. In 2009, the exchange rate is around THB33.50/USD, making it even more unlikely that the IRR would reach the optimistic case.

After the sensitivity analysis it can be concluded that the proposed CDM project activity is unlikely to be financially/economically attractive.

However, having included the revenue from CER, the IRR will be increased to 12.8%, which is over and above the benchmark of 11.28%, thus making this project financially feasible. Details of IRR calculation is exhibited in Annex 5.

Step 3: Barrier analysis

The project participant has chosen to demonstrate the project additionality through Step 2: Investment analysis. Thus, Step 3: Barrier analysis will not be considered.

Step 4: Common practice analysis

Sub-step 4a. Analyse other activities similar to the proposed project activity:

There are 4 major cement manufacturers in Thailand, which are Siam Cement (SCG), Siam City Cement (SCCC), TPI Polene (TPIPL) and Asia / Jalaprathan (JCC), accounting for more than 95% cement production capacity in Thailand[5]. According to an investigation by Thai Cement Manufacturers Association (TCMC), it is revealed that venting of waste heat has always been the common practice of the industry with only one waste heat recovery for power generation installed at one clinker production

[5] http://www.siamcitycement.com/downloads/corporate_briefing/Corporate%20briefing%20Presentation%20-%20Challengage%20Ahead.ppt#365,4,Slide 4

line in 1989. This installation is considered as a pilot plant. No other cement plants have installed waste heat recovery power generation since then, which clearly proves that this type of project is not a common practice in the cement industry in Thailand.

Other similar projects are being developed in Thailand, all as a CDM project.

Sub-step 4b: Discuss any similar options that are occurring:

Not applicable as there is no similar project activity occurring elsewhere in Thailand except the CDM project activities.

Since the Step 4a and 4b are satisfied, it can be concluded that the project activity is additional.

SCG Cement has seriously considered the benefits from the CDM as part of the project decision. *Table 8* demonstrates the implementation timeline of the project activity.

Table 8 Implementation timeline of the project activity

Incident	Date	Source
Consideration of CDM benefits	05/10/2007	Internal memo: Approval of the benefits of GHG emission reductions resulting from installation of WHG projects
Approval of project investment by the Board of directors, showing consideration of carbon credit benefits from the project implementation	24/10/2007	Minutes of board of directors meeting
Example of discussion with potential buyer – Thai ORIX Leasing Co., Ltd.	14/03/2008	Email communication between CEC and ORIX
Example of discussion with potential buyer – Royal Danish Embassy (RDE)	13/05/2008	Email communication between CEC and the RDE[1]
Commitment to an implementation of the project activity (starting date of project activity as stated in C.1.1)	21/05/2008	Supply and engineering contract
Starting CDM PDD preparation / hiring CDM consultant	03/06/2008	Authorisation ERM-Siam as a CDM consultant
Public participation event	30/07/2008	Summary of event
MDG Carbon Facility Indicative Price Quote	01/09/2008	Email from UNDP
Commencement of the construction of the project	01/09/2008	Project proponent
Approval of EIA[2] report by ONEP[3]	16/09/2008	EIA[2] report and its approval letter
Invitation to Sellers Pavilion in Carbon Forum Asia, 12-13 November 2008, Singapore	07/10/2008	Email communication between CEC and Asian Development Bank
Engagement of DOE for validation	21/11/2008	Signed acceptance of quotation
Open for global stakeholder comments for a period of 30 days on UNFCCC website	19/12/2008	UNFCCC website (http://cdm.unfccc.int/Projects/Validation/index.html)

Incident	Date	Source
Starting the 2-day site visit with assigned validator team	23/02/2009	Project proponent
Receipt of LoA from Thai DNA	23/04/2009	Approval date of the LoA issued by Thai DNA (TGO)

Notes: 1 RDE = Royal Danish Embassy
2 EIA = Environmental Impact Assessment
3 ONEP = Office of Natural Resources and Environmental Policy and Planning, Ministry of Natural Resources and Environment

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

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The equation applied in the estimate of emission reductions are based on the latest version of approved methodology, AM0024 and **Tool to calculate the emission factor for an electricity system**, and are summarised in *Table 9* below.

Table 9 Summaries of equations applied

Emissions	Equations applied		Note
	AM0024 (ver.02.1, EB 35)	**Emission factor for electricity system tool (ver.02, EB 50)**	
Emission reductions	1	-	-
Project emissions	2, 3, 4, 5, 6	-	-
Baseline emissions	7	-	-
Grid baseline emission factor	-	7, 13, 14	Please refer to *The estimation of emission factor for an electricity system in Thailand 2007* (DEDE, 2009). The study of the estimation of grid emission baseline was carried out in accordance with Annex 12 Methodological tool (Version 01.1) **"Tool to calculate the emission factor for an electricity system"**, approved by the CDM Executive Board (CDM EB) at its 35th meeting in July 2008. Although the referred version of the Tool in the study is version 01.1, it should be noted that the method applied in this study is analogous to version 02, approved at EB 50 meeting in December 2009. Note that, only grid power plants are included in the calculation (Option I of Step 2).
Emission factor from identified generation source	-	-	Captive power plant is not in the baseline.

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

(Copy this table for each data and parameter)

Data / Parameter:	$\mathbf{F_B}$
Data unit:	TJ
Description:	Average annual energy consumption of clinker making process prior to the start of operation of the project activity.
Source of data used:	Siam Cement (Thung Song) Co., Ltd.
Value applied:	see table below
Justification of the choice of data or description of measurement methods and procedures actually applied :	The data is based on one full year of TS plant cement production of 2007, which is the most recent year before the project implementation.
Any comment:	-

Clinker Production Line	Symbol	Energy Consumption
1 (Kiln #4)	$F_{B,1}$	2,476
2 (Kiln #6)	$F_{B,2}$	7,206
Total	$\mathbf{F_B}$	**9,682**

Data / Parameter:	$\mathbf{O_{clinker,B}}$
Data unit:	Tonnes
Description:	Average annual output of clinker production prior to the start of operation of the project activity.
Source of data used:	Siam Cement (Thung Song) Co., Ltd.
Value applied:	see table below
Justification of the choice of data or description of measurement methods and procedures actually applied :	The data is based on one full year of TS plant cement production in 2007, which is the most recent year before the project implementation.
Any comment:	-

Clinker Production Line	Symbol	Clinker Output
1 (Kiln #4)	$O_{clinker,B,1}$	730,843
2 (Kiln #6)	$O_{clinker,B,2}$	2,242,686
Total	$\mathbf{O_{clinker,B}}$	**2,973,530**

Data / Parameter:	$\mathbf{E_{CEMENT}}$
Data unit:	MWh
Description:	Electricity consumption of cement works prior to project

Source of data used:	Siam Cement (Thung Song) Co., Ltd.
Value of data applied:	<table><tr><td></td><td>2005</td><td>2006</td><td>2007</td></tr><tr><td>E_{CEMENT}</td><td>392,814</td><td>434,428</td><td>436,581</td></tr></table>
Justification of the choice of data or description of measurement methods and procedures actually applied :	E_{CEMENT} is electricity consumption of each particular year.
Any comment:	-

B.6.3 Ex-ante calculation of emission reductions:

>>

Emission Reduction

The emission reduction, ER_y, during a given year *y* is given by:

$$ER_y = EB_y - PE_y \qquad (1)$$

Where:

EB_y are the baseline emissions in year *y*, expressed in tCO_2;

PE_y are the project emissions due to possible fuel consumption changes in the cement kilns, of the cement works where the proposed project activity is located, as a result of the project activity in year *y*, expressed in tCO_2.

ER_y	EB_y	PE_y
tCO_2/year	tCO_2/year	tCO_2/year
54,203	54,203	0

Project Activity

Project emission (PE_y) is the difference in CO_2 emissions from use of fossil fuel in the clinkering process in cement manufacturing unit, where the project is being implemented, before and after the project implementation.

$$PE_y = \left(EI_{P,y} - EI_B\right) * O_{clinker,y} * COEF_{fuel,y} \qquad (2)$$

Where:

EI_B is the pre-project energy consumption per unit output of clinker in TJ/tonne of clinker produced (ie measured before the Project activity goes in operation);

$EI_{P,y}$ is the *ex-post* energy consumption per unit output of clinker for given year, *y*, in TJ/tonne of clinker produced;
$COEF_{fuel,y}$ is the carbon coefficient (tCO_2/TJ of input fuel) of the fuel used in the cement works in year *y* to raise the necessary heat for clinker production;
$O_{clinker,y}$ is the clinker output of the cement works in a given year *y*.

As suggested in the methodology, PE_y can be calculated using disaggregated information as in equation (6) below:

$$PE_y = \sum_i \Delta EI_i * \left[O_{clinker,i}\right] * COEF_{fuel,i} \quad (6)$$

Where:
i is the index for each clinker production line in the cement plant where the project activity is being implemented;
ΔEI_i is the *ex-ante* design estimate of the change in the energy consumption of each clinker kiln in TJ/tonne clinker, due to project implementation.

i	PE_y	$EI_{P,y}$	EI_B	$O_{clinker,y}$	$COEF_{fuel,y}$
	tCO_2/year	TJ/t clinker	TJ/t clinker	t clinker/year	tCO_2/TJ
1	0	3.39E-03	3.39E-03	730,843	89.94
2	0	3.21E-03	3.21E-03	2,242,686	82.90
Total	0	3.26E-03	3.26E-03	2,973,530	84.70

Note: Clinker production line 1 and 2 denote Kiln No.4 and 6, respectively.

Since the project activity only recovers the waste heat which would otherwise be vented, and does not alter the clinker production process, there expects to be no change in energy consumption per unit output of clinker.

EI_B shall be calculated using equation (3) as follow:

$$EI_B = \frac{F_B}{O_{clinker,B}} \quad (3)$$

Where:
F_B is the average annual energy consumption, expressed in TJ, of clinkering process prior to the start of operation of the project activity. At least one full year of data should be used. If a year’s worth of pre-Project Activity data is not available, then the Project Developer should outline the plan for ensuring conservativeness based on a combination of the *ex-ante* design estimate of energy consumption plus available measured data;
$O_{clinker,B}$ is the average annual output, expressed in tonnes, of clinker prior to the start of operation of the project activity. At least one full year of data should be used.

i	EI_B	F_B	$O_{clinker,B}$

	TJ/t clinker	TJ/year	t clinker/year
1	3.39E-03	2,476	730,843
2	3.21E-03	7,206	2,242,686
Total	3.26E-03	9,682	2,973,530

Note: Clinker production line 1 and 2 denote Kiln No.4 and 6, respectively.

By the same token, $EI_{P,y}$ shall be calculated using equation (4).

$$EI_{P,y} = \frac{F_{P,y}}{O_{clinker,y}} \tag{4}$$

Where:

$F_{P,y}$ is monitored annual energy consumption in a year *y*, expressed in TJ, of clinker making process;

$O_{clinker,y}$ is monitored annual output, expressed in a year *y*, in tonnes of clinker.

i	$EI_{P,y}$	$F_{P,y}$	$O_{clinker,y}$
	TJ/t clinker	TJ/year	t clinker/year
1	3.39E-03	2,476	730,843
2	3.21E-03	7,206	2,242,686
Total	3.26E-03	9,682	2,973,530

Note: Clinker production line 1 and 2 denote Kiln No.4 and 6, respectively.

Although it is not clear in the methodology how $COEF_{fuel,y}$ should be calculated when there are more than one type of fuel combusted in the same kiln, in this PDD, $COEF_{fuel,y}$ is calculated as a weighted average of emission factor of each type of fuel weighted by energy generated from that type of fuel in year *y*.

Fuel	$COEF_{fuel,y}$	Energy Consumption ($F_{P,y}$)		
		Line 1	Line 2	Total
	tCO_2/TJ	TJ	TJ	TJ
Fuel oil	77.40	51	55	106
Coal	98.30	960	4,876	5,836
Pet coke	97.50	792	498	1,291
Lignite (krabi)	101.00	215	162	377
Lignite (burma)	101.00	80	265	345
Anthracite	98.30	0	51	51
Charcoal	112.00	155	152	308
Palm fiber	0.00	1	52	53
Saw dust	0.00	4	514	518
Wood chip	0.00	213	372	585
Rice husk	0.00	4	160	164
Coconut dust	0.00	1	48	49

Weighted Average $COEF_{fuel,y}$	89.94	82.90	**84.70**

Note: Clinker production line 1 and 2 denote Kiln No.4 and 6, respectively.

AM0024 requires that $COEF_{fuel,y}$ be calculated based on equation (5) as follows:

$$COEF_{fuel,y} = \frac{EF_{CO2,fuel,y}}{NCV_{fuel,y}} \quad (5)$$

Fuel	**$COEF_{fuel,y}$**	**$EF_{CO2,fuel,y}$**	**$NCV_{fuel,y}$**
	tCO_2/TJ	tCO_2/tonne	TJ/tonne
Fuel oil	77.40	3.13	0.0404
Coal	98.30	2.40	0.0244
Pet coke	97.50	3.18	0.0327
Lignite (krabi)	101.00	1.70	0.0168
Lignite (burma)	101.00	1.98	0.0196
Anthracite	98.30	2.53	0.0257
Charcoal	112.00	1.72	0.0153
Palm fiber	0.00	0.00	0.0147
Saw dust	0.00	0.00	0.0142
Wood chip	0.00	0.00	0.0142
Rice husk	0.00	0.00	0.0115
Coconut dust	0.00	0.00	0.0124

Baseline Emissions

The baseline emissions during given year *y* are calculated as:

$$EB_y = EG_{CP,y} * EF_{Elec,y} + EG_{Grid,y} * EF_{Grid,y} \quad (7)$$

Where:

$EG_{CP,y}$ is the electricity supplied from the project activity to the cement plant, expressed in MWh;

$EF_{Elec,y}$ is the emissions factor of the baseline electricity supply source, expressed as tCO_2/MWh. If in the baseline scenario electricity is supplied from the grid, then $EF_{Elec,y}$ is the emission factor of the grid – $EF_{Grid,y}$; if electricity is supplied from the identified specific captive power generation source, then $EF_{Elec,y}$ is the emission factor of it – $EF_{Captive,y}$;

$EG_{Grid,y}$ is the electricity supplied from the project activity to the grid, expressed in MWh;

$EF_{Grid,y}$ is the emissions factor of the electricity grid, expressed as tCO_2/MWh.

In the baseline scenario of TS46 Project, the plant demand for electricity is met by grid electricity supply. Thus, $EF_{Elec,y}$ is the emission factor of the grid, $EF_{Grid,y}$. Since all the electricity produced from the project activity will be supplied to the cement works, there will be no electricity supplied from the project activity to the grid, ie $EG_{Grid,y} = 0$.

EB_y	**$EG_{CP,y}$**	**$EF_{Elec,y}$**	**$EG_{Grid,y}$**	**$EF_{Grid,y}$**

tCO_2/year	MWh	tCO_2/MWh	MWh	tCO_2/MWh
54,203	107,184	0.5057	0	0.5057

The grid baseline emission factor ($EF_{Grid,y}$) is referred to *The estimation of emission factor for an electricity system in Thailand 2007* which has been carried out by Bureau of Energy Research, Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy of Thailand, in accordance with version 01.1 of **Tool to calculate the emission factor for an electricity system** approved by the CDM Executive Board on EB 35 meeting. Although the referred version to calculate the emission factor for an electricity system in the study is version 01.1, it should be noted that the method applied in this study is analogous to version 02 of the Tool, approved at EB 50 meeting in December 2009.

Leakage

According to version 02.1 of AM0024, even though the project activity could lead to some plausible leakages – ie construction and fuel handling in the context of electric sector projects, they are negligible and can therefore be ignored.

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

>>

The *ex-ante* estimation of emission reductions for all years of the crediting period is summarised in the table below.

Year	Estimation of project activity emissions (tonnes of CO_2 e)	Estimation of baseline emissions (tonnes of CO_2 e)	Estimation of leakage (tonnes of CO_2 e)	Estimation of overall emission reductions (tonnes of CO_2 e)
2010 (7 m)	0	31,779	0	31,779
2011	0	54,203	0	54,203
2012	0	54,203	0	54,203
2013	0	54,203	0	54,203
2014	0	54,203	0	54,203
2015	0	54,203	0	54,203
2016	0	54,203	0	54,203
2017	0	54,203	0	54,203
2018	0	54,203	0	54,203
2019	0	54,203	0	54,203
2020 (5 m)	0	22,423	0	22,423
Total (tonnes of CO_2 e)	**0**	**542,029**	**0**	**542,029**

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

B.7.1. Data and parameters monitored:

(Copy this table for each data and parameter)

Data / Parameter:	$\mathbf{F_{P,y}}$
Data unit:	TJ
Description:	Energy of the fuel used in clinker making process in year *y*
Source of data to be used:	On-site measurement
Value of data applied for the purpose of calculating expected emission reductions in section B.5	See table below
Description of measurement methods and procedures to be applied:	The energy of each fuel type consumed in the clinker making process must be calculated from the amount of fuel (mass or volume) multiplied by its net calorific value (NCV). The amount of fuel consumed should be measured and recorded on daily basis using weigh feeder with less than 3% error while the sample of each type of fuel used should be taken at least once a day to measure the NCV. The record is to be archived continuously for 10+2 years in paper/electronic format starting from the commencement of the crediting period. This task will be performed by the Production Department. For roles and responsibility, and internal procedure for data collection, please refer to Annex 4.
QA/QC procedures to be applied:	Any direct measurements with mass or volume meters at the plant site should be cross-checked with an annual energy balance that is based on purchased quantities and stock changes. The monitoring equipment should be calibrated according to manufacturer's recommendation on yearly basis. The uncertainty of this data is considered low.
Any comment:	-

Fuel Type	Line 1	Line 2	Total
Fuel oil	51	55	106
Coal	960	4,876	5,836
Pet coke	792	498	1,291
Lignite (krabi)	215	162	377
Lignite (burma)	80	265	345
Anthracite	0	51	51
Charcoal	155	152	308
Palm fiber	1	52	53
Saw dust	4	514	518
Wood chip	213	372	585
Rice husk	4	160	164
Coconut dust	1	48	49
Total	**2,476**	**7,206**	**9,682**

Note: Clinker production line 1 and 2 denote Kiln No.4 and 6, respectively.

Data / Parameter:	$\mathbf{O_{clinker,y}}$
Data unit:	tonnes

Description:	Annual production of clinker after implementation of project
Source of data to be used:	On-site measurement
Value of data applied for the purpose of calculating expected emission reductions in section B.5	<table><tr><th>Clinker Production Line</th><th>Symbol</th><th>Clinker Output</th></tr><tr><td>1 (Kiln #4)</td><td>$O_{clinker,y,1}$</td><td>730,843</td></tr><tr><td>2 (Kiln #6)</td><td>$O_{clinker,y,2}$</td><td>2,242,686</td></tr><tr><td>**Total**</td><td>$\mathbf{O_{clinker,y}}$</td><td>**2,973,530**</td></tr></table>
Description of measurement methods and procedures to be applied:	The clinker produced from the clinker production process is generally not weighed directly due to its high temperature. The common practice of cement industry is to calculate the amount of clinker production from the raw material input because the chemical reaction of the clinker production has been fully understood and the chemical composition and amount of each raw material feed are measured with high level of accuracy, 0.5 % of full scale (Max 2 % stop machine). Clinker output must be continuously monitored and summarised in a daily report. All the recorded data will be manually/electronically during, and 2 years beyond, the crediting period. This task will be performed by the Production Department. For roles and responsibility, and internal procedure for data collection, please refer to Annex 4.
QA/QC procedures to be applied:	Although the amount of clinker production is not directly weighed, the amount of clinker used for cement production or sold is weighed directly. Thus, the amount of clinker production calculated by the method described above can be cross-checked with the amount of clinker used and the change in clinker stock. All the weighing equipment will be calibrated every 6 months. The uncertainty of this data is considered low.
Any comment:	-

Data / Parameter:	$\mathbf{NCV_{fuel,y}}$
Data unit:	TJ/ tonne
Description:	Net calorific value (energy content) per mass or volume unit of a fuel used in clinker making process in year *y*
Source of data to be used:	On-site measurement
Value of data applied for the purpose of calculating expected emission reductions in section B.5	<table><tr><th>Fuel Type</th><th>Symbol</th><th>NCV</th></tr><tr><td>Fuel oil</td><td>$NCV_{FO,y}$</td><td>0.040</td></tr><tr><td>Coal</td><td>$NCV_{coal,y}$</td><td>0.024</td></tr><tr><td>Pet coke</td><td>$NCV_{coke,y}$</td><td>0.033</td></tr><tr><td>Lignite (krabi)</td><td>$NCV_{lignite\_k,y}$</td><td>0.017</td></tr><tr><td>Lignite (burma)</td><td>$NCV_{lignite\_b,y}$</td><td>0.020</td></tr><tr><td>Anthracite</td><td>$NCV_{anthracite,y}$</td><td>0.026</td></tr><tr><td>Charcoal</td><td>$NCV_{charcoal,y}$</td><td>0.015</td></tr></table>

	Palm fiber — $NCV_{palm,y}$ — 0.015 Saw dust — $NCV_{sdust,y}$ — 0.014 Wood chip — $NCV_{wood,y}$ — 0.014 Rice husk — $NCV_{rhusk,y}$ — 0.012 Coconut dust — $NCV_{cdust,y}$ — 0.012
Description of measurement methods and procedures to be applied:	Sample of each fuel used should be taken at least once a day to measure the NCV for the calculation of $F_{P,y}$ and taken once a month for the calculation of $COEF_{fuel,y}$. The measurement shall be undertaken according to the international standard. Equipment accuracy is ±70 Cal/gm. The record is to be archived in paper/electronic format for 10+2 years from start of crediting period. This task will be performed by the Production Department. For roles and responsibility, and internal procedure for data collection, please refer to Annex 4.
QA/QC procedures to be applied:	The measurement equipment – the bomb calorie meter – will be calibrated every 2 months. The domestic values provided annually by the Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy, can be used for cross-checking purpose. Otherwise, the abovementioned data source should be used for estimate the emission reduction. The uncertainty of this data is considered low.
Any comment:	-

Data / Parameter:	**$EF_{CO2,fuel,y}$**
Data unit:	tCO_2/tonne of fuel
Description:	Emission factor of fuel used in clinker production
Source of data to be used:	On-site measurement
Value of data applied for the purpose of calculating expected emission reductions in section B.5	(see table below)

Fuel Type	**$EF_{CO2,fuel,y}$**
Fuel oil	3.13
Coal	2.40
Pet coke	3.18
Lignite (krabi)	1.70
Lignite (burma)	1.98
Anthracite	2.53
Charcoal	1.72
Palm fiber	0.00
Saw dust	0.00
Wood chip	0.00
Rice husk	0.00
Coconut dust	0.00

Description of measurement methods and procedures to be applied:	This emission factor shall be calculated based on the laboratory measurement of % carbon in each type of fuel, which might be provided with fuel upon purchase or measured on-site on a monthly basis. Emission factor of biomass is zero since it is carbon neutral. The record is to be archived in paper/electronic format for 10+2 years from start of crediting period. This task will be performed by the Production Department. For roles and responsibility, and internal procedure for data collection, please refer to Annex 4.
QA/QC procedures to be applied:	The measurement equipment should be calibrated according to manufacturer's recommendation on yearly basis. The IPCC default values can be used for cross-checking purpose. Otherwise, the abovementioned data source should be used for estimate the emission reduction. The uncertainty of this data is considered low.
Any comment:	-

Data / Parameter:	**$EG_{CP,y}$**
Data unit:	MWh
Description:	Electricity supplied from the project activity to the cement plant
Source of data to be used:	On-site measurement
Value of data applied for the purpose of calculating expected emission reductions in section B.5	107,184
Description of measurement methods and procedures to be applied:	The electricity supplied to the cement plant must be continuously measured, using electricity meter, with record taken daily. This shall be net electricity after the power plant own use. The data is to be recorded and archived electronically during, and 2 years after, the crediting period. An operational staff of WHG Cell will be in charge of electricity measurement and monthly reports will be reviewed by WHG Engineer. For roles and responsibility, and internal procedure for data collection, please refer to Annex 4.
QA/QC procedures to be applied:	The meter should be calibrated annually by accredited agency. Backup electricity meters are recommended in case the main meter is out of order, as well as for cross-checking. The uncertainty of this data is considered low.
Any comment:	The value applied in the calculation is the net electricity generation estimated based on the generating capacity of the power generator.

Data /Parameter:	**$EG_{Grid,y}$**
Data unit:	MWh
Description:	Electricity supplied from the project activity to the grid

Source of data to be used:	On-site measurement
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0
Description of measurement methods and procedures to be applied:	Continuously
QA/QC procedures to be applied:	Any direct measurements with mass or volume meters at the plant site should be cross-checked with an annual energy balance that is based on purchased quantities and stock changes.
Any comment:	There is no plan to supply any electricity produced from the project activity to the grid. All will be used within the cement works.

Data / Parameter:	$\mathbf{EF_{Grid,y}}$
Data unit:	tCO_2/MWh
Description:	Emissions factor of the electricity grid
Source of data to be used:	*The estimation of emission factor for an electricity system in Thailand 2007* (DEDE, 2009)
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.5057
Description of measurement methods and procedures to be applied:	The emission factor of the electricity grid shall be obtained from a reliable local source, otherwise calculated on a yearly basis using the latest publicly available information.
QA/QC procedures to be applied:	The emission factor of the electricity grid should be cross-checked with previous calculation to ensure data consistency.
Any comment:	This parameter can be referred as $EF_{grid,OMsimple,y}$ in **Tool to calculate the emission factor for an electricity system** (version 02).

Data / Parameter:	$\mathbf{FC_{i,y}}$
Data unit:	Mass or unit volume
Description:	Amount of fossil fuel type *i* consumed in the project electricity system in year *y* (referred in version 02 of **Tool to calculate the emission factor for an electricity system**)
Source of data to be used:	Please refer to *The estimation of emission factor for an electricity system in Thailand 2007* (DEDE, 2009).
Value of data applied for the purpose of calculating expected	-

emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	For Simple OM, data shall be monitored annually during the crediting period for the relevant year. For BM, data shall be monitored annually *ex-post*.
QA/QC procedures to be applied:	-
Any comment:	The study of the estimation of grid emission baseline was carried out in accordance with Annex 12 Methodological tool (Version 01.1) **"Tool to calculate the emission factor for an electricity system"**, approved by the CDM Executive Board (CDM EB) at its 35th meeting in July 2008. Although the referred version of **Tool to calculate the emission factor for an electricity system** in the study is version 01.1, it should be noted that the method applied in this study is analogous to version 02 of the Tool, approved at EB 50 meeting in December 2009. Note that, only grid power plants are included in the calculation (Option I of Step 2). The data employed in *The estimation of emission factor for an electricity system in Thailand 2007* (DEDE, 2009) was based on the DEDE annual report "Electricity Power in Thailand 2007"

Data / Parameter:	$\mathbf{NCV_{i,y}}$
Data unit:	GJ / mass or volume unit
Description:	Net calorific value (energy content) of fossil fuel type *i* in year *y* (referred in version 02 of **Tool to calculate the emission factor for an electricity system**)
Source of data to be used:	Please refer to *The estimation of emission factor for an electricity system in Thailand 2007* (DEDE, 2009).
Value of data applied for the purpose of calculating expected emission reductions in section B.5	-
Description of measurement methods and procedures to be applied:	For Simple OM, data shall be monitored annually during the crediting period for the relevant year. For BM, data shall be monitored annually *ex-post*.
QA/QC procedures to be applied:	-
Any comment:	The study of the estimation of grid emission baseline was carried out in accordance with Annex 12 Methodological tool (Version 01.1) **"Tool to calculate the emission factor for an electricity system"**, approved by the CDM Executive Board (CDM EB) at its 35th meeting in July 2008. Although the referred version of **Tool to calculate the emission factor for an electricity system** in the study is version 01.1, it should be noted that the method applied in this study is analogous to version 02 of the Tool, approved

	at EB 50 meeting in December 2009. Note that, only grid power plants are included in the calculation (Option I of Step 2). The data employed in *The estimation of emission factor for an electricity system in Thailand 2007* (DEDE, 2009) was based on the DEDE annual report "Electricity Power in Thailand 2007"

Data / Parameter:	**$EF_{CO2,i,y}$**
Data unit:	tCO_2/GJ
Description:	CO_2 emission factor of fossil fuel type i in year *y* (referred in version 02 of **Tool to calculate the emission factor for an electricity system**)
Source of data to be used:	Please refer to *The estimation of emission factor for an electricity system in Thailand 2007* (DEDE, 2009).
Value of data applied for the purpose of calculating expected emission reductions in section B.5	-
Description of measurement methods and procedures to be applied:	For Simple OM, data shall be monitored annually during the crediting period for the relevant year. For BM, data shall be monitored annually *ex-post*.
QA/QC procedures to be applied:	-
Any comment:	The study of the estimation of grid emission baseline was carried out in accordance with Annex 12 Methodological tool (Version 01.1) **"Tool to calculate the emission factor for an electricity system"**, approved by the CDM Executive Board (CDM EB) at its 35th meeting in July 2008. Although the referred version of **Tool to calculate the emission factor for an electricity system** in the study is version 01.1, it should be noted that the method applied in this study is analogous to version 02 of the Tool, approved at EB 50 meeting in December 2009. Note that, only grid power plants are included in the calculation (Option I of Step 2). The data employed in *The estimation of emission factor for an electricity system in Thailand 2007* (DEDE, 2009) was based on the DEDE annual report "Electricity Power in Thailand 2007"

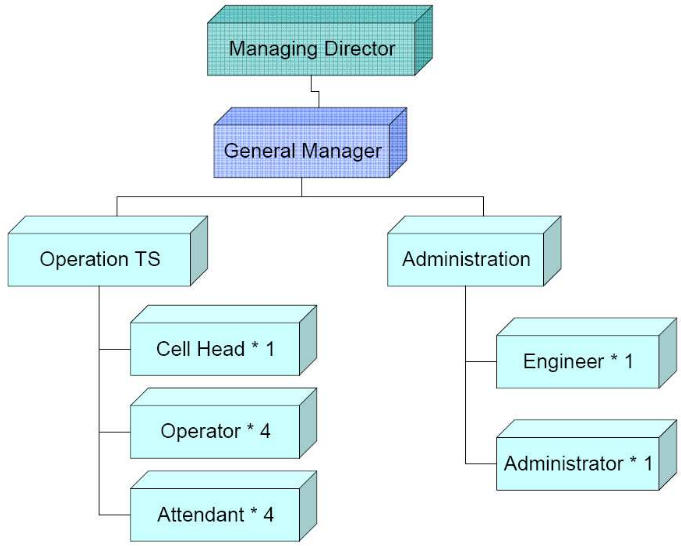
Data / Parameter:	**EG_y**
Data unit:	MWh
Description:	Net electricity generated and delivered to the grid by all power sources serving the system, not including low-cost / must-run power plants / units, in year *y* (referred in version 02 of **Tool to calculate the emission factor for an electricity system**)
Source of data to be used:	Please refer to *The estimation of emission factor for an electricity system in Thailand 2007* (DEDE, 2009).

Value of data applied for the purpose of calculating expected emission reductions in section B.5	-
Description of measurement methods and procedures to be applied:	For Simple OM, data shall be monitored annually during the crediting period for the relevant year. For BM, data shall be monitored annually *ex-post*.
QA/QC procedures to be applied:	-
Any comment:	The study of the estimation of grid emission baseline was carried out in accordance with Annex 12 Methodological tool (Version 01.1) **"Tool to calculate the emission factor for an electricity system"**, approved by the CDM Executive Board (CDM EB) at its 35th meeting in July 2008. Although the referred version of **Tool to calculate the emission factor for an electricity system** in the study is version 01.1, it should be noted that the method applied in this study is analogous to version 02 of the Tool, approved at EB 50 meeting in December 2009. Note that, only grid power plants are included in the calculation (Option I of Step 2). The data employed in *The estimation of emission factor for an electricity system in Thailand 2007* (DEDE, 2009) was based on the DEDE annual report "Electricity Power in Thailand 2007"

B.7.2 Description of the monitoring plan:

>>

The organisation chart of CEC for TS waste heat power generation unit is shown below.



At TS, there will be at least 1 operator and 1 attendant working at the power plant at all time. The attendant, under the supervision of the operator, will be responsible for recording the required data and coordinating with the cement plant operation unit for clinker production data. Daily report will be produced and approved by the cell head. The cell head will also have the responsibility of consolidating and report monthly data to the general manager each month. Before the production of monthly report, the cell head should undertaken an internal check of the data provided. All the data should be stored in electronic format with data backup performed at least once a week.

CEC is currently developing an operation manual which will provide greater details of roles and responsibility of each staff, reporting format, QA/QC procedure, etc.

In addition, since this project is very new to the cement sector in Thailand and the major equipments are sourced from overseas, an extensive training programme for CEC staff is required. CEC will set up a WHG Project Training Team to be trained at the similar cement plant of the contractor for 3-4 weeks. The training mainly covered the operation and maintenance of the waste heat recovery project, as well as safety knowledge. When the Training Team comes back, they will also have an on-site training for another 2 months, covering the project commissioning period.

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

>>

Date of completing of this baseline section: 15/02/2010

Name of person/entity determining the baseline: ERM-Siam Co., Ltd.

Nontaya Krairiksh
ERM-Siam, Co Ltd
17th floor, Wave Place Building

55 Wireless Road
Lumpini, Pathumwan
Bangkok 10330
Thailand

ERM-Siam Co., Ltd. is not a "project participant".

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:

>>
The supply and engineering contract between the project proponent and technology provider was signed on 21/05/2008, which is defined as the starting date of the project activity, and the real construction started on 01/09/2008.

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

>>
20 years 00 month

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

>>
Fixed crediting period.

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:

>>
01/06/2010 or the date of registration by the CDM EB, whichever is later

C.2.2.2. Length:

>>
10 years 0 month

SECTION D. Environmental impacts

>>

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

>>

The waste heat recovery project requires an EIA because it is an alteration of the existing cement plant. The EIA report was completed in August 2008 and has been approved by the Office of Natural Resources and Environmental Policy and Planning (ONEP), Ministry of Natural Resources and Environment, on 16th September 2008.

In this report, there are 4 environmental aspects that could be affected from the project activities.

1. **Air pollution –** Since the project activity will not have any alterations on fuel consumption of the cement works, after the implementation of the project activity, there will be no change in this aspect.
2. **Wastewater**
   - *Domestic wastewater* from the staff consumption is expected to increase from 26.9 m^3/day to 27.5 m^3/day.
   - *Process wastewater* includes wastewater from boilers, cooling tower and reverse osmosis (RO) system.
3. **Waste**
   - *Domestic and office waste* is expected to increase from 384.8 kg/day to 392.8 kg/day.
   - *Industrial waste,* generated from the project activity, includes membrane filters and used oil.
4. **Noise –** Additional equipment such as air compressor, blower, turbine, boilers and cooling tower may cause nuisance.

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:

>>

Even though the environmental impacts are considered not significant, it is also stated in the EIA about procedures in lessening the impacts as follows:

1. **Air pollution** – There will be no change in this aspect.
2. **Water treatment –** The wastewater from the domestic consumption will be treated in the plant's existing septic tank. The wastewater from the canteen activities will be treated in an anaerobic filter tank, with 92.6% efficiency. An effluent with a BOD (Biological Oxygen Demand) of 20 mg/litre will be discharged to the nearby canal. The wastewater from project activities (1,220.64 m^3/day) will be directed to the plant's existing drainage system, passing through a grease trap before being channelled to the 200,000-m^3 retention pond. The treated water from the pond is to be recycled and thus none will be discharged into watercourses.
3. **Waste management** – The TS plant has settled a number of 200-litre rubbish bins around the plant area are divided into two types: one for general domestic waste and the other for recyclable waste. For the industrial waste, it is to be sorted, piled and labelled separately and properly. Both the domestic and industrial then will be burnt in the plant's existing incinerator.

4. **Noise**
    - *Sources:* Additional equipment such as air compressor, blower, turbine, boilers and cooling tower are designed to have the noise level at 85 dB(A) at 1-m distance. Preventive maintenance programme for the equipment is applied. Moreover, once the project is in full implementation, noise contour will be conducted in order to identify specific areas where noise-preventive equipment is required, thus leading to other procedures in preventing noise pollution.
    - *Receptors:* Signs will be put properly where noise level is over 85 dB(A) while protective equipment will be all set. The staff working in the ear-piercing areas is strictly required to use personal protective equipment (PPE), ie ear plugs and ear muffs. Besides, regulations on PPE application are strongly recommended.

SECTION E. Stakeholders' comments

>>

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

>>

The process by which comments by local stakeholders was received is through public participation event. It was conducted at Thung Song Cement Plant, Wednesday 30 July 2008, 9:00-12:00. A list of participating organisations is shown below:

- Nakhon Si Thammarat Provincial Industry Office
- Thung Song District Office
- Teewang Sub-district Administration Organisation
- Teewang District Municipal Office
- Baan Kang Pla Health Centre
- Teewang community leaders

A few selected pictures at the public participation event are shown in *Figure 8*.

Figure 8 ***Public Participation Event at Thung Song Plant, 30th July 2008***

The main objectives of the public participation event are:

- To disseminate information about implementation of WHG project, its benefits and safety procedures;
- To demonstrate information on Clean Development Mechanism (CDM); and
- To receive further recommendations and to respond on the issues of public concerns.

E.2. Summary of the comments received:

>>

The issues of concerns from the participants during the public participation event, and responses from TS plant had been summarised and shown below:

Issue #1 (Deputy to Thung Song District Sheriff): Beside the WHG project, does the TS plant use any other alternative sources of energy eg solar cells and wind turbine?

Response: The SCG Cement has been seriously concerned about, and recently had pilot projects of, alternative fuels. The TS plant itself has utilised solar energy as a pilot project and installed wind turbines at the mine.

Issue #2 (Deputy to Thung Song District Sheriff): How would the plant utilise the 20 MW of electricity from the project? And how much would it require additional electricity from the grid?

Response: The electricity generated from the project is considered clean energy and will be used to replace approximately 20% of electricity supplied from the national grid.

Issue #3 (Engineer [level 7], Nakhon Si Thammarat Provincial Office of Industry): Why did the plant choose the technology from China?

Response: The WHG system has actually been introduced for 20 years but its investment was relatively high. In the past 5 years, Chinese government has regulated any newly-built cement production line must employ the WHG technology. Consequently, this technology has been improved to a great extent in China. Thus, we have put efforts in gathering information and learning the technology till we quite believe in the Chinese technology.

Issue #4 (Engineer [level 7], Nakhon Si Thammarat Provincial Office of Industry): Would the surrounding communities benefit from the implementation of the project?

Response: There is potential in providing light to the communities, as well as other kinds of public benefits. Thus, it is subject to continuation of the electricity generated from the project.

Issue #5 (Deputy Mayor, Teewang Sub-district Municipality): Is there any risk from the implementation of the WHG project?

Response: Our plant will have a periodically audit by a third party. The project itself has also installed safety valves. Moreover, the system is considered a low pressure system, 10 bar, as compared to power plants with pressure of 40 bar.

At the end, the meeting participants have agreed on the recovery and utilisation of the waste heat for the cement production lines of TS plant.

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

>>

Please refer to the responses in Section E.2.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	Cementhai Energy Conservation Co., Ltd.
Street/P.O.Box:	Siam Cement Road
Building:	No.1, 10th Floor
City:	Bangsue, Bangkok
State/Region:	
Postfix/ZIP:	10800
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Telephone:	+662 586 5684
FAX:	+662 586 3098
E-Mail:	kriengks@scg.co.th
URL:	http://www.scg.co.th
Represented by:	Kriengkrai Suksankraisorn
Title:	General Manager
Salutation:	Dr.
Last Name:	Suksankraisorn
Middle Name:	
First Name:	Kriengkrai
Department:	Energy
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Direct tel:	+662 586 5684
Personal E-Mail:	kriengks@scg.co.th

Annex 2

INFORMATION REGARDING PUBLIC FUNDING

There is no public funding from annex I countries involved in this project.

Annex 3

BASELINE INFORMATION

Parameter	Symbol	Value	Unit	Source	Note
Data available at validation					
Pre-project energy consumption of clinker production line 1 (Kiln #4)	$F_{B,1}$	2,476	TJ/year	CEC	Calculated from 2007 data
Pre-project energy consumption of clinker production line 2 (Kiln #6)	$F_{B,2}$	7,206	TJ/year	CEC	Calculated from 2007 data
Total pre-project energy consumption of clinker production	F_B	9,682	TJ/year		Calculated
Average output of clinker production line 1 (Kiln #4) in the baseline	$O_{clinker,B,1}$	730,843	tonnes/year	CEC	2007 data
Average output of clinker production line 2 (Kiln #6) in the baseline	$O_{clinker,B,2}$	2,242,686	tonnes/year	CEC	2007 data
Average total output of clinker in the baseline	$O_{clinker,B}$	2,973,530	tonnes/year		Calculated
Data to be monitored					
TS4 Annual fuel oil energy consumption in year y	$F_{P,FO,y,1}$	51	TJ	CEC, 2007 data	Calculated from amount of fuel consumed and its NCV
TS4 Annual coal energy consumption in year y	$F_{P,coal,y,1}$	960	TJ	CEC, 2007 data	Calculated from amount of fuel consumed and its NCV
TS4 Annual petrol coke energy consumption in year y	$F_{P,coke,y,1}$	792	TJ	CEC, 2007 data	Calculated from amount of fuel consumed and its NCV
TS4 Annual lignite (Krabi) energy consumption in year y	$F_{P,lignite\_k,y,1}$	215	TJ	CEC, 2007 data	Calculated from amount of fuel consumed and its NCV
TS4 Annual lignite (Burma) energy consumption in year y	$F_{P,lignite\_b,y,1}$	80	TJ	CEC, 2007 data	Calculated from amount of fuel consumed and its NCV
TS4 Annual anthracite energy consumption in year y	$F_{P,anthracite,y,1}$	0	TJ	CEC, 2007 data	Calculated from amount of fuel consumed and its NCV

Parameter	Symbol	Value	Unit	Source	Note
TS4 Annual charcoal energy consumption in year y	$F_{P,charcoal,y,1}$	155	TJ	CEC, 2007 data	Calculated from amount of fuel consumed and its NCV
TS4 Annual palm fiber energy consumption in year y	$F_{P,palm,y,1}$	1	TJ	CEC, 2007 data	Calculated from amount of fuel consumed and its NCV
TS4 Annual saw dust energy consumption in year y	$F_{P,sdust,y,1}$	4	TJ	CEC, 2007 data	Calculated from amount of fuel consumed and its NCV
TS4 Annual wood chip energy consumption in year y	$F_{P,wood,y,1}$	213	TJ	CEC, 2007 data	Calculated from amount of fuel consumed and its NCV
TS4 Annual rice husk energy consumption in year y	$F_{P,rhusk,y,1}$	4	TJ	CEC, 2007 data	Calculated from amount of fuel consumed and its NCV
TS4 Annual coconut dust energy consumption in year y	$F_{P,cdust,y,1}$	1	TJ	CEC, 2007 data	Calculated from amount of fuel consumed and its NCV
TS4 Annual energy consumption in year y	$F_{P,y,1}$	2,476	TJ/year	CEC, 2007 data	Assumed $F_{P,y,1} = F_{B,1}$. There would be no change in fuel consumption in the plant production process.
TS6 Annual fuel oil energy consumption in year y	$F_{P,FO,y,2}$	55	TJ	CEC, 2007 data	Calculated from amount of fuel consumed and its NCV
TS6 Annual coal energy consumption in year y	$F_{P,coal,y,2}$	4,876	TJ	CEC, 2007 data	Calculated from amount of fuel consumed and its NCV
TS6 Annual petrol coke energy consumption in year y	$F_{P,coke,y,2}$	498	TJ	CEC, 2007 data	Calculated from amount of fuel consumed and its NCV
TS6 Annual lignite (Krabi) energy consumption in year y	$F_{P,lignite\_k,y,2}$	162	TJ	CEC, 2007 data	Calculated from amount of fuel consumed and its NCV
TS6 Annual lignite (Burma) energy consumption in year y	$F_{P,lignite\_b,y,2}$	265	TJ	CEC, 2007 data	Calculated from amount of fuel consumed and its NCV

Parameter	Symbol	Value	Unit	Source	Note
TS6 Annual anthracite energy consumption in year y	$F_{P,anthracite,y,2}$	51	TJ	CEC, 2007 data	Calculated from amount of fuel consumed and its NCV
TS6 Annual charcoal energy consumption in year y	$F_{P,charcoal,y,2}$	152	TJ	CEC, 2007 data	Calculated from amount of fuel consumed and its NCV
TS6 Annual palm fiber energy consumption in year y	$F_{P,palm,y,2}$	52	TJ	CEC, 2007 data	Calculated from amount of fuel consumed and its NCV
TS6 Annual saw dust energy consumption in year y	$F_{P,sdust,y,2}$	514	TJ	CEC, 2007 data	Calculated from amount of fuel consumed and its NCV
TS6 Annual wood chip energy consumption in year y	$F_{P,wood,y,2}$	372	TJ	CEC, 2007 data	Calculated from amount of fuel consumed and its NCV
TS6 Annual rice husk energy consumption in year y	$F_{P,rhusk,y,2}$	160	TJ	CEC, 2007 data	Calculated from amount of fuel consumed and its NCV
TS6 Annual coconut dust energy consumption in year y	$F_{P,cdust,y,2}$	48	TJ	CEC, 2007 data	Calculated from amount of fuel consumed and its NCV
TS6 Annual energy consumption in year y	$F_{P,y,2}$	7,206	TJ/year	CEC, 2007 data	Assumed $F_{P,y,2} = F_{B,2}$. There would be no change in fuel consumption in the plant production process.
Annual output of clinker production line 1 (Kiln #3) in year y	$O_{clinker,y,1}$	730,843	tonnes/year	CEC	Assumed $O_{clinker,y,1} = O_{clinker,B,1}$. There would be no change in the plant's cement production
Annual output of clinker production line 2 (Kiln #4) in year y	$O_{clinker,y,2}$	2,242,686	tonnes/year	CEC	Assumed $O_{clinker,y,2} = O_{clinker,B,2}$. There would be no change in the plant's cement production
Annual output of clinker in year y	$O_{clinker,y}$	2,973,530	tonnes/year	CEC	Assumed $O_{clinker,y} = O_{clinker,B}$. There would be no change in the plant's cement production
Net calorific value of fuel oil	$NCV_{FO,y}$	0.040	TJ/tonne	CEC, 2007	

Parameter	Symbol	Value	Unit	Source	Note
used in year y				data	
Net calorific value of coal used in year y	$NCV_{coal,y}$	0.024	TJ/tonne	CEC, 2007 data	
Net calorific value of petrol coke used in year y	$NCV_{coke,y}$	0.033	TJ/tonne	CEC, 2007 data	
Net calorific value of lignite (Krabi) used in year y	$NCV_{lignite\_k,y}$	0.017	TJ/tonne	CEC, 2007 data	
Net calorific value of lignite (Burma) used in year y	$NCV_{lignite\_b,y}$	0.020	TJ/tonne	CEC, 2007 data	
Net calorific value of anthracite used in year y	$NCV_{anthracite,y}$	0.026	TJ/tonne	CEC, 2007 data	
Net calorific value of charcoal used in year y	$NCV_{charcoal,y}$	0.015	TJ/tonne	CEC, 2007 data	
Net calorific value of palm fiber used in year y	$NCV_{palm,y}$	0.015	TJ/tonne	CEC, 2007 data	
Net calorific value of saw dust used in year y	$NCV_{sdust,y}$	0.014	TJ/tonne	CEC, 2007 data	
Net calorific value of wood chip used in year y	$NCV_{wood,y}$	0.014	TJ/tonne	CEC, 2007 data	
Net calorific value of rice husk used in year y	$NCV_{rhusk,y}$	0.012	TJ/tonne	CEC, 2007 data	
Net calorific value of coconut dust used in year y	$NCV_{cdust,y}$	0.012	TJ/tonne	CEC, 2007 data	
CO_2 emission factor per unit of energy fuel oil used in year y	$EF_{CO2,FO,y}$	3.13	t CO_2/tonne		Calculated from COEF = 98.30 t CO_2/TJ, IPCC 2006 Table 2.2
CO_2 emission factor per unit of energy coal used in year y	$EF_{CO2,coal,y}$	2.40	t CO_2/tonne		Calculated from COEF = 97.50 t CO_2/TJ, IPCC 2006 Table 2.2
CO_2 emission factor per unit of energy petrol coke used in year y	$EF_{CO2,coke,y}$	3.18	t CO_2/tonne		Calculated from COEF = 77.40 t CO_2/TJ, IPCC 2006 Table 2.2
CO_2 emission factor per unit of energy lignite (Krabi) used in year y	$EF_{CO2,lignite\_k,y}$	1.70	t CO_2/tonne		Calculated from COEF = 101 t CO_2/TJ, IPCC 2006 Table 2.2
CO_2 emission factor per unit of energy lignite (Burma) used in year y	$EF_{CO2,lignite\_b,y}$	1.98	t CO_2/tonne		Calculated from COEF = 107 t CO_2/TJ, IPCC 2006 Table 2.2
CO_2 emission factor per unit of energy anthracite used in year y	$EF_{CO2,anthracite,y}$	2.53	t CO_2/tonne		Calculated from COEF = 101 t CO_2/TJ, IPCC 2006 Table 2.2
CO_2 emission factor per unit of energy charcoal used in year y	$EF_{CO2,charcoal,y}$	1.72	t CO_2/tonne		Carbon neutral
CO_2 emission factor per unit of energy palm fuber used in year	$EF_{CO2,oalm,y}$	0.00	t CO_2/tonne		Carbon neutral

Parameter	Symbol	Value	Unit	Source	Note
y					
CO_2 emission factor per unit of energy saw dust used in year y	$EF_{CO2,sdust,y}$	0.00	t CO_2/tonne		Carbon neutral
CO_2 emission factor per unit of wood used in year y	$EF_{CO2,wood,y}$	0.00	t CO_2/tonne		Carbon neutral
CO_2 emission factor per unit of rice husk used in year y	$EF_{CO2,rhusk,y}$	0.00	t CO_2/tonne		Carbon neutral
CO_2 emission factor per unit of coconut dust used in year y	$EF_{CO2,cdust,y}$	0.00	t CO_2/tonne		Carbon neutral
Electricity supplied from the project activity to the cement plant	$EG_{CP,y}$	107,184	MWh	CEC	Calculation
Emissions factor of the baseline electricity supply source	$EF_{Elec,y}$	0.5057	t CO_2/MWh		$EF_{Elec,y} = EF_{Grid,y}$
Electricity supplied from the project activity to the grid	$EG_{Grid,y}$	0	MWh	CEC	There would be no electricity supply to the grid.
Emissions factor of the electricity grid	$EF_{Grid,y}$	0.5057	t CO_2/MWh		The estimation of emission factor for an electricity system in Thailand 2007 (DEDE, 2009)

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Annex 4

MONITORING INFORMATION

ROLES AND RESPONSIBILITY IN MONITORING

Monitoring implementation requires support from many members of the organisation. Thus, as the project proceeds to the operation stage, monitoring requirements need to be communicated across the organisation. Following list presents different tasks performed by each cell/division of the organisation.

1. Technical/engineering/maintenance department

1.1 WHG Cells

- Measuring/monitoring electricity generation from the WHG and electricity supplied to cement plant;
- Monitoring equipment calibration and maintenance as part of the Standard Operation/Maintenance Procedure; and
- Data archiving and recording during the crediting period plus 2 years after the end of crediting period.

1.2 Cement Production Department

- Measuring data related to fuel consumption and clinker production such as calorific value of fuel used in clinker production, annual energy (fuel) consumption of clinker making process and annual production of clinker after project implementation etc. Further details would be elaborated in the subsequent section.; and
- Data archiving and recording during the crediting period plus 2 years after the end of crediting period

1.3 Plant CDM Coordinator

Selected Plant CDM coordinator will lead and coordinate CDM activities with two abovementioned departments in the cement plant. The responsibility covers supervision for:

- Monitoring equipment compliance check, ensuring that instrumentations and devices are available and properly suited to perform its function for emission reduction monitoring;
- Development, execution, analysis and improvement of the Standard (CDM) Monitoring/Reporting Procedures;
- Deployment of the procedures through trainings, ensuring that these procedures are fully complied with the Standard Monitoring/Reporting Procedures;
- Communication and coordination between and among multiple departments in the plant to disseminate CDM related information;
- Consolidating monitored parameters from other departments and conducting emission reduction calculation and reporting; and
- Liaison with a DOE during the verification.

2. Accounting/Sales/Purchasing Department

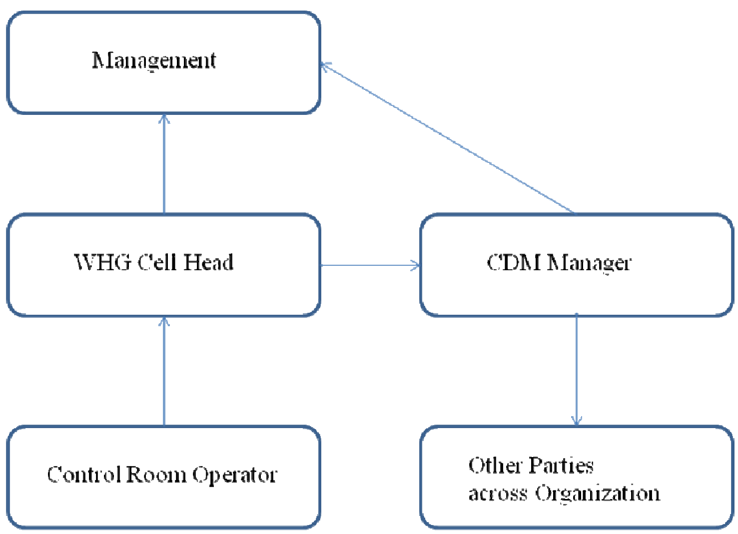
Reconciling and consolidating data obtained from monitoring with those from other sources. For example, crosscheck electricity meters against the sale receipts issued by an electric utility.

Recording of this kind of reconciliation is required as DOE may request for such information during verification

PROCEDURE FOR DATA COLLECTION

Data from the plant monitoring equipment is displayed in the control room. The control room operator logs data, including data errors and/or equipment failure, and submit daily log sheet to a WHG Cell Head for approval. Approved by the WHG Cell Head, the daily log sheets will be summed up on monthly basis and signed by the Cell Head before being conveyed to Dr. Kriengkrai Suksankraisorn, a CDM manager, who is responsible for consolidating monthly report and calculation of emission reduction. Subsequently, emission reductions and monthly summary data spreadsheet will be disseminated to all relevant parties. The procedure for collection and record of data is illustrated in the figure below.

Figure A4-1 Flow chart shows procedure of data collection



Hard copies of the daily records are checked and signed by the Cell Head prior to being stored in the file. Electronic copies of the spreadsheets are stored on the computer system and the monthly report is emailed to the CDM management team.

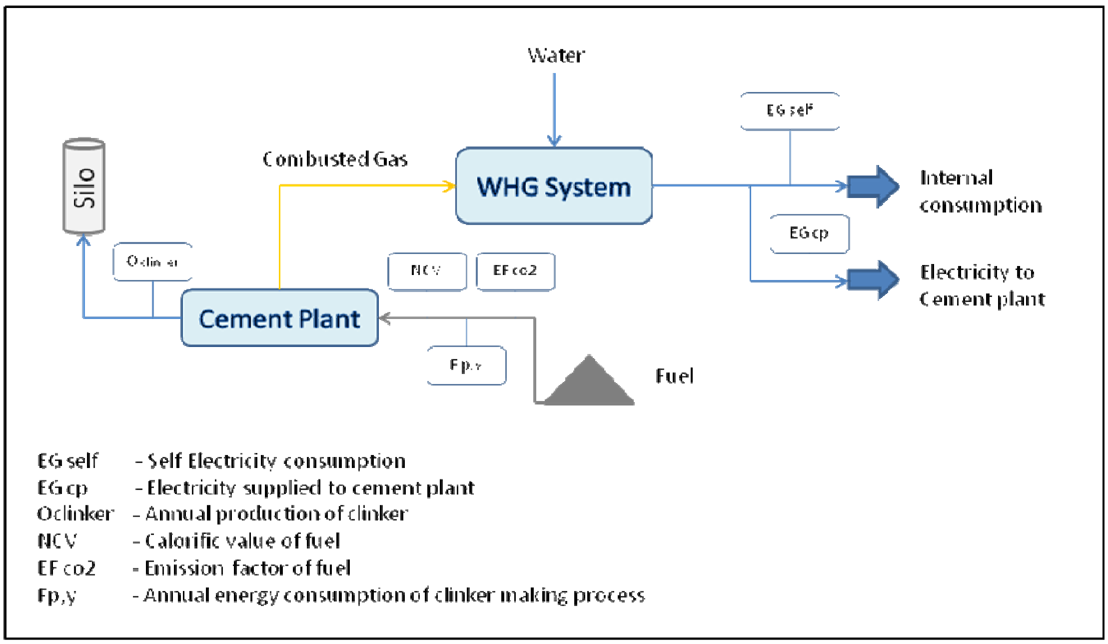
PROCESS FLOW DIAGRAM

As the project approaches monitoring stage, it is necessary for project developer to check the availability of equipments and instrumentation. This can be achieved by naming and labelling those equipments required to be installed. Process flow diagram, accompanied with equipments names and labels, allows project developer to easily refer and identify equipments onsite as well as to take benefit for documentation purpose. The process flow diagram with naming and labelling system should, at minimum, indicate:

- Major machines with a name; and
- Location of equipment/instrumentation connected to material flow of interest

Figure A4-2 illustrates process flow diagram of a waste heat power generation system that supplies electricity to cement plant and simultaneously displaces a portion of electrical demand previously served by the national grid. Also indicated in the figure are measuring equipment connections relative to monitored parameters as required in the monitoring methodology.

Figure A4-2 Process flow diagram of a waste heat power generation system



Other monitoring information can be referred to Section B.7.

Annex 5

PROJECT FINANCIAL ANALYSIS

ASSUMPTION

Description		Source
MLR	6.875%	Minimum Loan Rate - Krung Thai Bank (July 23, 2007)
Company Income Tax	30%	Corporate Tax - The Revenue Department
Debt to Equity Ratio	1:2	SCG Accouting Policies
Actual Savage Value	5.0%	Estimated from other similar projects
Kiln Utilization Factor	71%	Historical performance of kilns 4 and 6 in 2005-2007
WHG Utilization Factor	90%	Benchmark from Supplier's record
Initial Working Capital	3 mth of O&M	SCG Accouting Policies
WHG Supply Stop from Major Maintenance @Yr10	3 mth	Benchmark from Supplier's record
Additional Capital Expenses @Yr10 (of Total Investment)	30%	Benchmark from Supplier's record
Emission Factor (ton-CO2/MWh)	0.563	Article: *Implications of renewable energy on total CO2 emissions in the power sector: The full-energy-chains analysis in Thailand*

INVESTMENT COST

Description	(MB)
Total Investment	840.0
Initial Working Capital	37.1

OPERATION AND MAINTENANCE COST

Description	
Generated Power (MW)	**20.50**
Self-power Consumption (MW)	1.23
Realized Power (MW)	19.27
Annually Supplied Power (GWh)	**107.2**
O&M Cost (Baht/kWh)	**1.38**
TOTAL O&M COST	**148.33**

Project financial analysis without CER revenue

COST SAVING

Items	Unit	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Power Supplied to Plant	GWh	107.2	107.2	107.2	107.2	107.2	107.2	107.2	107.2	107.2	80.4	107.2	107.2	107.2	107.2	107.2	107.2	107.2	107.2	107.2	107.2
Electricity Unit Price	B/kWh	2.36	2.36	2.36	2.36	2.36	2.36	2.36	2.36	2.36	2.36	2.36	2.36	2.36	2.36	2.36	2.36	2.36	2.36	2.36	2.36
Total Electricity Cost Saving	MB	253.2	253.2	253.2	253.2	253.2	253.2	253.2	253.2	253.2	189.9	253.2	253.2	253.2	253.2	253.2	253.2	253.2	253.2	253.2	253.2
CO2 Emission Reduction	ton-CO2	60,345	60,345	60,345	60,345	60,345	60,345	60,345	60,345	60,345	45,258	60,345	60,345	60,345	60,345	60,345	60,345	60,345	60,345	60,345	60,345
Estimated Price of Carbon Credit	B/ton-CO2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Benefit from Carbon Credit	MB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Revenue	MB	253.2	253.2	253.2	253.2	253.2	253.2	253.2	253.2	253.2	189.9	253.2	253.2	253.2	253.2	253.2	253.2	253.2	253.2	253.2	253.2
O&M Variable Cost	B/kWh	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38
O&M Expense	MB	(148.3)	(148.3)	(148.3)	(148.3)	(148.3)	(148.3)	(148.3)	(148.3)	(148.3)	(111.3)	(148.3)	(148.3)	(148.3)	(148.3)	(148.3)	(148.3)	(148.3)	(148.3)	(148.3)	(148.3)
Net Contribution	**MB**	**104.9**	**104.9**	**104.9**	**104.9**	**104.9**	**104.9**	**104.9**	**104.9**	**104.9**	**78.6**	**104.9**	**104.9**	**104.9**	**104.9**	**104.9**	**104.9**	**104.9**	**104.9**	**104.9**	**104.9**

PROJECTED INCOME STATEMENTS AND CASH GENERATION

(Million Baht)

OperatingYear		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Net Contribution		104.86	104.86	104.86	104.86	104.86	104.86	104.86	104.86	104.86	78.64	104.86	104.86	104.86	104.86	104.86	104.86	104.86	104.86	104.86	104.86
- Depreciation		(79.52)	(79.52)	(79.52)	(79.52)	(79.52)	(79.52)	(79.52)	(79.52)	(79.52)	(79.52)	(25.48)	(25.48)	(25.48)	(25.48)	(25.48)	(25.48)	(25.48)	(25.48)	(25.48)	(25.48)
- Financial & Interest expenses		(17.55)	(15.79)	(14.04)	(12.28)	(10.53)	(8.77)	(7.02)	(5.26)	(3.51)	(1.75)	(5.77)	(5.20)	(4.62)	(4.04)	(3.46)	(2.89)	(2.31)	(1.73)	(1.15)	(0.58)
Net income before tax		7.79	9.54	11.30	13.05	14.81	16.56	18.32	20.07	21.83	(2.63)	73.60	74.18	74.76	75.33	75.91	76.49	77.07	77.64	78.22	78.80
Income tax of CEC	30%	(2.34)	(2.86)	(3.39)	(3.92)	(4.44)	(4.97)	(5.50)	(6.02)	(6.55)	0.00	(22.08)	(22.25)	(22.43)	(22.60)	(22.77)	(22.95)	(23.12)	(23.29)	(23.47)	(23.64)
NET INCOME AFTER TAX		5.45	6.68	7.91	9.14	10.37	11.59	12.82	14.05	15.28	(2.63)	51.52	51.93	52.33	52.73	53.14	53.54	53.95	54.35	54.75	55.16
CASH GEN. AFTER TAX		102.52	101.99	101.47	100.94	100.41	99.89	99.36	98.83	98.31	78.64	82.78	82.60	82.43	82.26	82.08	81.91	81.74	81.56	81.39	81.22
EBITDA		104.86	104.86	104.86	104.86	104.86	104.86	104.86	104.86	104.86	78.64	104.86	104.86	104.86	104.86	104.86	104.86	104.86	104.86	104.86	104.86

FINANCIAL AND INTEREST EXPENSE CALCULATION

(Million Baht)

Operating Year			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
LONG-TERM INTEREST																						
Total investment		877.06																				
Debt to equity	(1 : 2)	0.33																				
Total debt		292.35																				
Initial working capital		37.08																				
Long-term loan		255.27																				
Beginning balance			255.27	229.74	204.22	178.69	153.16	127.63	102.11	76.58	51.05	25.53	84.00	75.60	67.20	58.80	50.40	42.00	33.60	25.20	16.80	8.40
Repayment			(25.53)	(25.53)	(25.53)	(25.53)	(25.53)	(25.53)	(25.53)	(25.53)	(25.53)	(25.53)	(8.40)	(8.40)	(8.40)	(8.40)	(8.40)	(8.40)	(8.40)	(8.40)	(8.40)	(8.40)
Outstanding balance			229.74	204.22	178.69	153.16	127.63	102.11	76.58	51.05	25.53	0.00	75.60	67.20	58.80	50.40	42.00	33.60	25.20	16.80	8.40	0.00
LONG - TERM INTEREST EXPENSES		**6.875%**	**17.55**	**15.79**	**14.04**	**12.28**	**10.53**	**8.77**	**7.02**	**5.26**	**3.51**	**1.75**	**5.77**	**5.20**	**4.62**	**4.04**	**3.46**	**2.89**	**2.31**	**1.73**	**1.15**	**0.58**

PROJECTED CASH FLOW STATEMENTS

(Million Baht)

Operating year		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
CASH GENERATION																					
Net income after tax		5.45	6.68	7.91	9.14	10.37	11.59	12.82	14.05	15.28	(2.63)	51.52	51.93	52.33	52.73	53.14	53.54	53.95	54.35	54.75	55.16
+ Depreciation		79.52	79.52	79.52	79.52	79.52	79.52	79.52	79.52	79.52	79.52	25.48	25.48	25.48	25.48	25.48	25.48	25.48	25.48	25.48	25.48
+ Interest		17.55	15.79	14.04	12.28	10.53	8.77	7.02	5.26	3.51	1.75	5.77	5.20	4.62	4.04	3.46	2.89	2.31	1.73	1.15	0.58
TOTAL CASH GENERATION		**102.52**	**101.99**	**101.47**	**100.94**	**100.41**	**99.89**	**99.36**	**98.83**	**98.31**	**78.64**	**82.78**	**82.60**	**82.43**	**82.26**	**82.08**	**81.91**	**81.74**	**81.56**	**81.39**	**81.22**
CASH OUTFLOW																					
Investment	(839.97)										(251.99)										
Contribution loss from shut down	0.00																				
Incremental W/C	(37.08)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
TOTAL CASH OUTFLOW	**(877.06)**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**(252.0)**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
CASH INFLOW																					
Cash generation		102.52	101.99	101.47	100.94	100.41	99.89	99.36	98.83	98.31	78.64	82.78	82.60	82.43	82.26	82.08	81.91	81.74	81.56	81.39	81.22
Salvage value																					42.00
W/C return																					37.08
TOTAL CASH INFLOW		**102.52**	**101.99**	**101.47**	**100.94**	**100.41**	**99.89**	**99.36**	**98.83**	**98.31**	**78.64**	**82.78**	**82.60**	**82.43**	**82.26**	**82.08**	**81.91**	**81.74**	**81.56**	**81.39**	**160.30**
PROJECT CASH FLOW	**(877.06)**	**102.52**	**101.99**	**101.47**	**100.94**	**100.41**	**99.89**	**99.36**	**98.83**	**98.31**	**(173.35)**	**82.78**	**82.60**	**82.43**	**82.26**	**82.08**	**81.91**	**81.74**	**81.56**	**81.39**	**160.30**
EQUITY CASH FLOW	**(584.70)**	**59.44**	**60.67**	**61.90**	**63.13**	**64.36**	**65.58**	**66.81**	**68.04**	**69.27**	**(200.63)**	**68.60**	**69.00**	**69.41**	**69.81**	**70.22**	**70.62**	**71.03**	**71.43**	**71.83**	**151.32**
Equity IRR		**7.0%**																			

Project financial analysis with CER revenue

COST SAVING

Items	Unit	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Power Supplied to Plant	GWh	107.2	107.2	107.2	107.2	107.2	107.2	107.2	107.2	107.2	80.4	107.2	107.2	107.2	107.2	107.2	107.2	107.2	107.2	107.2	107.2
Electricity Unit Price	B/kWh	2.36	2.36	2.36	2.36	2.36	2.36	2.36	2.36	2.36	2.36	2.36	2.36	2.36	2.36	2.36	2.36	2.36	2.36	2.36	2.36
Total Electricity Cost Saving	MB	253.2	253.2	253.2	253.2	253.2	253.2	253.2	253.2	253.2	189.9	253.2	253.2	253.2	253.2	253.2	253.2	253.2	253.2	253.2	253.2
CO2 Emission Reduction	ton-CO2	60,345	60,345	60,345	60,345	60,345	60,345	60,345	60,345	60,345	45,258	60,345	60,345	60,345	60,345	60,345	60,345	60,345	60,345	60,345	60,345
Estimated Price of Carbon Credit	B/ton-CO2	857.7	857.7	857.7	857.7	857.7	857.7	857.7	857.7	857.7	857.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Benefit from Carbon Credit	MB	51.8	51.8	51.8	51.8	51.8	51.8	51.8	51.8	51.8	38.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Revenue	MB	304.9	304.9	304.9	304.9	304.9	304.9	304.9	304.9	304.9	228.7	253.2	253.2	253.2	253.2	253.2	253.2	253.2	253.2	253.2	253.2
O&M Variable Cost	B/kWh	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38
O&M Expense	MB	(148.3)	(148.3)	(148.3)	(148.3)	(148.3)	(148.3)	(148.3)	(148.3)	(148.3)	(111.3)	(148.3)	(148.3)	(148.3)	(148.3)	(148.3)	(148.3)	(148.3)	(148.3)	(148.3)	(148.3)
Net Contribution	**MB**	**156.6**	**156.6**	**156.6**	**156.6**	**156.6**	**156.6**	**156.6**	**156.6**	**156.6**	**117.5**	**104.9**	**104.9**	**104.9**	**104.9**	**104.9**	**104.9**	**104.9**	**104.9**	**104.9**	**104.9**

PROJECTED INCOME STATEMENTS AND CASH GENERATION

(Million Baht)

OperatingYear		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Net Contribution		156.62	156.62	156.62	156.62	156.62	156.62	156.62	156.62	156.62	117.46	104.86	104.86	104.86	104.86	104.86	104.86	104.86	104.86	104.86	104.86
- Depreciation		(79.52)	(79.52)	(79.52)	(79.52)	(79.52)	(79.52)	(79.52)	(79.52)	(79.52)	(79.52)	(25.48)	(25.48)	(25.48)	(25.48)	(25.48)	(25.48)	(25.48)	(25.48)	(25.48)	(25.48)
- Financial & Interest expenses		(17.55)	(15.79)	(14.04)	(12.28)	(10.53)	(8.77)	(7.02)	(5.26)	(3.51)	(1.75)	(5.77)	(5.20)	(4.62)	(4.04)	(3.46)	(2.89)	(2.31)	(1.73)	(1.15)	(0.58)
Net income before tax		59.55	61.30	63.06	64.81	66.57	68.32	70.08	71.83	73.59	36.19	73.60	74.18	74.76	75.33	75.91	76.49	77.07	77.64	78.22	78.80
Income tax of CEC	30%	(17.86)	(18.39)	(18.92)	(19.44)	(19.97)	(20.50)	(21.02)	(21.55)	(22.08)	(10.86)	(22.08)	(22.25)	(22.43)	(22.60)	(22.77)	(22.95)	(23.12)	(23.29)	(23.47)	(23.64)
NET INCOME AFTER TAX		41.68	42.91	44.14	45.37	46.60	47.83	49.05	50.28	51.51	25.33	51.52	51.93	52.33	52.73	53.14	53.54	53.95	54.35	54.75	55.16
CASH GEN. AFTER TAX		138.75	138.22	137.70	137.17	136.64	136.12	135.59	135.07	134.54	106.60	82.78	82.60	82.43	82.26	82.08	81.91	81.74	81.56	81.39	81.22
EBITDA		156.62	156.62	156.62	156.62	156.62	156.62	156.62	156.62	156.62	117.46	104.86	104.86	104.86	104.86	104.86	104.86	104.86	104.86	104.86	104.86

FINANCIAL AND INTEREST EXPENSE CALCULATION

(Million Baht)

Operating Year			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
LONG-TERM INTEREST																						
Total investment		877.06																				
Debt to equity	(1 : 2)	0.33																				
Total debt		292.35																				
Initial working capital		37.08																				
Long-term loan		255.27																				
Beginning balance			255.27	229.74	204.22	178.69	153.16	127.63	102.11	76.58	51.05	25.53	84.00	75.60	67.20	58.80	50.40	42.00	33.60	25.20	16.80	8.40
Repayment			(25.53)	(25.53)	(25.53)	(25.53)	(25.53)	(25.53)	(25.53)	(25.53)	(25.53)	(25.53)	(8.40)	(8.40)	(8.40)	(8.40)	(8.40)	(8.40)	(8.40)	(8.40)	(8.40)	(8.40)
Outstanding balance			229.74	204.22	178.69	153.16	127.63	102.11	76.58	51.05	25.53	0.00	75.60	67.20	58.80	50.40	42.00	33.60	25.20	16.80	8.40	0.00
LONG - TERM INTEREST EXPENSES		**6.875%**	**17.55**	**15.79**	**14.04**	**12.28**	**10.53**	**8.77**	**7.02**	**5.26**	**3.51**	**1.75**	**5.77**	**5.20**	**4.62**	**4.04**	**3.46**	**2.89**	**2.31**	**1.73**	**1.15**	**0.58**

PROJECTED CASH FLOW STATEMENTS

(Million Baht)

Operating year		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
CASH GENERATION																					
Net income after tax		41.68	42.91	44.14	45.37	46.60	47.83	49.05	50.28	51.51	25.33	51.52	51.93	52.33	52.73	53.14	53.54	53.95	54.35	54.75	55.16
+ Depreciation		79.52	79.52	79.52	79.52	79.52	79.52	79.52	79.52	79.52	79.52	25.48	25.48	25.48	25.48	25.48	25.48	25.48	25.48	25.48	25.48
+ Interest		17.55	15.79	14.04	12.28	10.53	8.77	7.02	5.26	3.51	1.75	5.77	5.20	4.62	4.04	3.46	2.89	2.31	1.73	1.15	0.58
TOTAL CASH GENERATION		**138.75**	**138.22**	**137.70**	**137.17**	**136.64**	**136.12**	**135.59**	**135.07**	**134.54**	**106.60**	**82.78**	**82.60**	**82.43**	**82.26**	**82.08**	**81.91**	**81.74**	**81.56**	**81.39**	**81.22**
CASH OUTFLOW																					
Investment	(839.97)										(251.99)										
Contribution loss from shut down	0.00																				
Incremental W/C	(37.08)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
TOTAL CASH OUTFLOW	**(877.06)**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**(252.0)**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
CASH INFLOW																					
Cash generation		138.75	138.22	137.70	137.17	136.64	136.12	135.59	135.07	134.54	106.60	82.78	82.60	82.43	82.26	82.08	81.91	81.74	81.56	81.39	81.22
Salvage value																					42.00
W/C return																					37.08
TOTAL CASH INFLOW		**138.75**	**138.22**	**137.70**	**137.17**	**136.64**	**136.12**	**135.59**	**135.07**	**134.54**	**106.60**	**82.78**	**82.60**	**82.43**	**82.26**	**82.08**	**81.91**	**81.74**	**81.56**	**81.39**	**160.30**
PROJECT CASH FLOW	**(877.06)**	**138.75**	**138.22**	**137.70**	**137.17**	**136.64**	**136.12**	**135.59**	**135.07**	**134.54**	**(145.39)**	**82.78**	**82.60**	**82.43**	**82.26**	**82.08**	**81.91**	**81.74**	**81.56**	**81.39**	**160.30**
EQUITY CASH FLOW	**(584.70)**	**95.67**	**96.90**	**98.13**	**99.36**	**100.59**	**101.82**	**103.05**	**104.27**	**105.50**	**(172.67)**	**68.60**	**69.00**	**69.41**	**69.81**	**70.22**	**70.62**	**71.03**	**71.43**	**71.83**	**151.32**
Equity IRR		**12.8%**																			

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