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

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SECTION A. General description of project activity

A.1. Title of the project activity:

Natural gas based cogeneration plant at IRPC Public Co. Ltd. Thailand
Version: 03
Date of document completion: 02/11/2012

A.2. Description of the project activity:

IRPC Public Company Limited (IRPC)[1] has undertaken construction of a combined heat and power (cogeneration) project in IRPC Industrial Estate in Rayong, Thailand. IRPC's industrial complex consists of an upstream oil refinery unit and a downstream petrochemical production. The company's oil refinery unit has the total capacity of 215,000 barrels per day. The project activity once operational will replace the existing furnace oil based steam and electricity import from the grid. The IRPC is the country's largest integrated petrochemical complex and the project activity is being taken up in its existing industrial estate in Rayong.

Purpose of the project activity: The purpose of the project activity is construction and operation of a new natural gas based cogeneration plant to replace the fossil fuel based captive steam generation and import of electricity from the national grid. Under the project activity, a new natural gas based cogeneration plant is being installed in phase wise commissioning plan. The total installed capacity of the project activity plant will be (6 x 37.972) 227.83 MW and (6 x 68.083) 408.49 TPH. The project activity has six numbers of 37.972 MW gas engines and one will be always on standby. Thus, the available capacity for use is = 37.972 x 5 = 189.86 MW. Similarly, with one HRSG in standby, the available steam production capacity will be 340.42 TPH. The technical specifications and special features of the main components are presented below

No.	Equipment	Specifications	Special Features
1	GTG (6 No.s)	GT is single shaft/two bearings heavy duty type (GE Make -PG6581B, Steam injection) Capacity : 37.972 MW at site conditions 35°C, RH = 76%, 1.02barA, 50 Hz.	The heat available from exhaust gases of the gas turbine is used to generate steam in the HRSG Steam injection for de-NOx in GTG
2	HRSG (6 No.s)	Make : Vogt Power International Capacity: 68.083TPH, 420°C, 52barG. at site conditions 35°C, RH = 76%, 1.02 barA, 50 Hz.	without supplementary firing in HRSG

The project is being implemented on EPC basis by Marubeni Corporation. A gas supply agreement has been entered into with PTT Public Company Limited for 64,000 MMBTU/ day equivalent natural gas. All six units of the project activity are commissioned between January - May 2011.

Pre-project scenario- In the pre-project scenario, the steam demand was being met by in-house coal and oils (FO, propane, diesel and butane) fired boilers and 103.86 MW electricity import from the grid. Two coal based cogen units also exist in the plant and will continue their operations unaffected by the implementation of the CDM project activity. For the same reason, this is not included in the project boundary.

[1] www.irpc.co.th

How the project activity reduces greenhouse gas emissions

In the absence of the project activity, the PP's captive energy demand would have continued to be met by steam from oil fired boilers and electricity import from grid. The project activity would thus reduce anthropogenic GHG emissions (CO_2) into the atmosphere due to the use of relatively lower GHG intensive fuel (Natural Gas) and much higher efficient (owning to cogeneration) power generation in comparison to FO and the existing fuel mix in the grid.

Contribution of the project activity to sustainable development

Thailand Greenhouse Gas Management Organization (TGO) is the DNA for Thailand and indicates following four criteria as the Sustainable Development Indicators for the CDM project activities[2]. The PP presents the project activity's contribution to these indicators.

1) Natural Resources and Environment Indicators
- The project activity will reduce CO_2emissions.
- The use of relatively clean natural gas fuel compared to pre-project fuel oils and fuel mix in the national grid
- The project activity also does not have any adverse impacts like odour and noise pollution, groundwater contamination and hazardous waste generally associated with fossil fuel based power plants
- The project activity is being taken up in an existing industrial estate and does not affect any green areas, ecosystem and species diversity

2) Social indicators
- The implementation of the project activity will generate employment opportunities, 500 persons during construction and 58 on continuous basis during operations to the skilled and unskilled manpower
- The people's participation has taken place by a hearing process and the local stakeholders' meeting for CDM project
- The project activity will also generate opportunity for construction business, O&M and other traders/ suppliers
- This being a clean burning, natural gas based power generation, it does not impact workers' health

3) Development and/or technology transfer indicators
- The project activity uses latest available six Frame 6B gas turbines from globally renowned technology supplier[3] and includes best available De-NOx units for steam injection system
- The project activity will enhance the skill set of the employees as PP did not have NG based cogen plant in pre-project scenario

4) Economic indicators
- The project activity increases the new employment and hence the total income of employees
- The project activity is buying gas from PTT Public Company, national level supplier and increase their income

Thus, the project activity complies with the National Sustainable Development criteria. The project activity was awarded Host Country Approval on 27/10/2010.

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[2] www.tgo.or.th/english/

[3] GE Energy

A.3. Project participants:

Name of the Party involved (*) ((host) indicates 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 country)	IRPC Public Company Limited, Bangkok (Public Limited Company)	No

IRPC is implementing the project activity and will be the sole owner of the CERs.

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

A.4.1.1. Host Party(ies):

Thailand

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

Rayong Province

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

IRPC Industrial Estate, Rayong town

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

IRPC Industrial Estate is located on Sukhumvit Road east bound of Rayong town which provides the excellent inland transportation in nearby region and also to the major ports in Thailand. The distances to major transport modes are:

Bangkok Air Port	205 km
U-Tapao Air Port	35 km
IRPC Port (Deepest seaport in Thailand with16 meters draft)	Onsite

The geographic coordinates of the project activity plant are - 101°18’44.56” E and 12°39’26.49” N.

Figure 1: Location map of the project activity plant in Thailand

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

The project activity is construction and operation of a new natural gas based cogeneration plant. As per the scopes of the project activity listed in the "List of Sectoral scopes" (Document CDM-ACCR-06 Version 04)', the project activity will fall in Scope Number 1, Sectoral scope – Energy industries (renewable - / non-renewable sources).

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

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

The project is being implemented on EPC basis by Marubeni Corporation. The power plant comprises gas turbine generator (GTG) 6 units and heat recovery steam generator (HRSG) 6 units. A gas supply agreement has been entered into with PTT Public Company Limited for 64,000 MMBTU/ day natural gas.

The project activity has six numbers of 37.972 MW gas engines and one will be always on standby. Thus, the available capacity for use is = 37.972 x 5 = 189.86 MW. The annual electricity import from grid by IRPC in the pre-project scenario (using three years historic data – January to December of each year) was as below.

Year	2009	2008	2007
Imported electricity from grid by IRPC (MWh)	8,99,639	8,53,911	9,16,788

This is 101 MWh at 100% capacity utilization. The PDD hereafter uses 103.86 MW as captive demand based on future demand projection used for the investment decision.

The next 63 MW is planned to be sold to national grid. The PP has ~ 45 MW PPA with Electricity Generating Authority of Thailand (EGAT) to sell on non firm basis.
Table: electricity supply agreements with customers

Sr. No.	Customer name	Contracted demand as per electricity supply agreement (MW)	Whether customer is a group company/ unit owned by PP (yes/ no)
1	Thai Caprolactum Public Company Limited, Rayong (TCL)	10.1	No
2	Thai Synthetic Rubbers Company Limited, Rayong (TSR)	7.4	No

To summarise, the total electricity balance of the project activity from 189.86 MW plant is as below

User	Auxiliary consumption of plant	Captive demand of PP to replace grid import	Export to grid	Sale to TCL	Sale to TSR	Total
MW	5.5	103.86	63	10.1	7.4	189.86

The project activity will have six No.s of 68.083 TPH individual capacity HRSGs, thus, total steam generation capacity is 408.49 TPH. Further, similar to gas engines, with one HRSG in standby, the available steam production capacity will be 340.42 TPH.

The distribution of this steam capacity is as below.

Sr. No.	Steam demand for entity	Steam requirement (TPH)	Whether IRPC group company
1	IRPC – existing process plant	320.5	This is the PP
2	IRPC – additional steam demand for expanded capacity/ new process plants	9.92	This is the PP
3	Customer 1 - Thai Caprolactum Public Company Limited, Rayong (TCL)	5	This is neither PP nor a group company of PP
4	Customer 2 - Thai Synthetic Rubbers Company Limited, Rayong (TSR)	5	This is neither PP nor a group company of PP
Total		**340.42**	

The technology used in the project activity plant is natural gas based cogeneration power plant. The natural gas is used as fuel in the gas turbines. The turbogenerator train is composed by a PG 6581B heavy duty Gas Turbine, a reduction Gear Box supplied by Flender (model: TX 90/3C) and a11.0 kV (± 10%) - 50 Hz(± 20%) power Generator supplied by Brush (model: DG215ZP-04).

Gas turbine: PG 6581B is a simple-cycle, single shaft gas turbine with ten combustors, reverse flow combustion system. The PG 6581B gas turbine assembly contains five major sections Air inlet, Compressor, Combustion system, Turbine and Exhaust.

Working - When the starting system is actuated and the clutch is engaged, ambient air is drawn through the air inlet plenum assembly, filtered and compressed in the axial flow compressor and compressed in the combustion chambers. When the starting system has accelerated the rotor to ignition speed, the two sparkplugs are energized and fuel is turned on. The resulting fuel/air mixture is injected, by means of 10 burners, in the relevant combustion chambers and ignited by the spark plugs. When the chambers are lit, as indicated by the flame detectors the start-up sequence continues. Air from the compressor flows into the annular spaces between the outer combustion casings and the combustion liners, and enters the combustion zone through the combustion liner.

The hot gases from the combustion chambers flow through the transition pieces. The gases then enter series of nozzles. In the nozzle rows, the energy of the jet is increased, with an associated pressure drop and is absorbed as useful power on the turbine rotor. Further, the gases are directed into the exhaust hood and diffuser, which contains a series of turning vanes to turn the gases from an axial direction to a radial direction, to minimize exhaust hood loses. The gases then pass into the exhaust plenum and are introduced to atmosphere through the exhaust stack. Resultant shaft rotation is used to produce electric power turning the driven Generator.

The main characteristics of Gas Turbine PG 6581B are as follows

GT Air inlet temperature	35°C
Relative humidity	76%
Ambient pressure	102 kPa
Fuel Flow Rate	3.25 kg/S
Generator output power	37,972 kW
Exhaust temperature	562.2°C
Heat rate - LHV	12,290 kJ/ kWh
Thermal Efficiency	32%

Electric Generator: The Generator is used for producing Electric power. It is driven by a gas turbinePG-6581B and is completed with the relevant accessories necessary for its operation. It is planned to reach the following normal conditions provided by the project.

Generator main characteristics[4]:

Manufacturer	Brush HVA B.V.
Generator type	DG215ZP-04
Rated power at ambient air	37972 kVA
Power factor (overexcited)	0.8
Voltage	11,000 ± 5 % V
Full load current	2491 A
Rated speed	1500 RPM

The system is complete with its auxiliary units and safety measures in an acoustical enclosure.

Heat Recovery Steam Generator (HRSG): The function of HRSG system is to extract sensible heat from a gas turbine (GT) exhaust gas stream. The extracted sensible heat is converted into usable steam (HP) by the heat transfer surface within the HRSG. During normal operation, the steam produced in the HP section will be admitted to the Process Steam Header for use. The power plant produces electricity in GT and process steam in HRSG and is called cogeneration plant further.

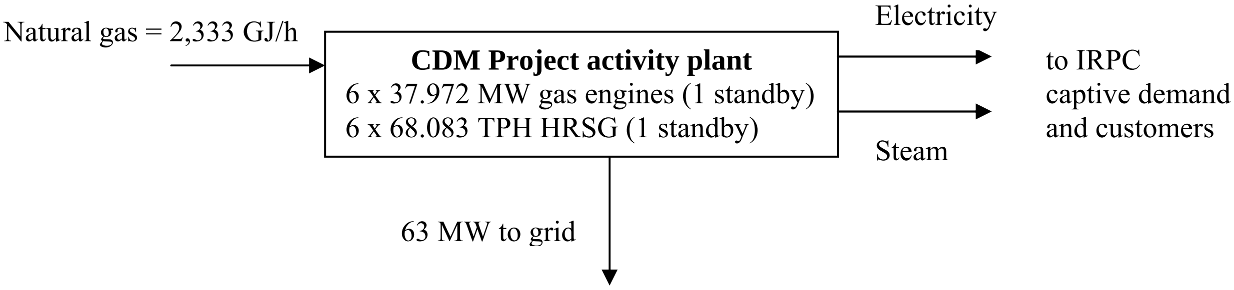

Figure 2: Schematic of the project activity and heat/ mass balance of the overall facility

[4] Generator characteristics as per manufacturer specifications submitted to the DOE

Pre-project scenario: The existing power plant for meeting the electricity and steam demand comprise combination of FO and coal fired boilers and import from grid. The following table gives main equipments in the pre-project scenario.

Plant	Boiler No.	Make	Capacity (TPH)
1. Power Plant	Boiler 05	Nebraska Boiler	80
2. LUT	35B001A	ABB Boiler	80
	35B001B	ABB Boiler	80
	35B002A	Nebraska Boiler	80
	35B002B	Nebraska Boiler	80
3. UT1	15B030A	Cleaver Brooks, U.S.A.	25
	15B030B	Cleaver Brooks, U.S.A.	25
		Total	450

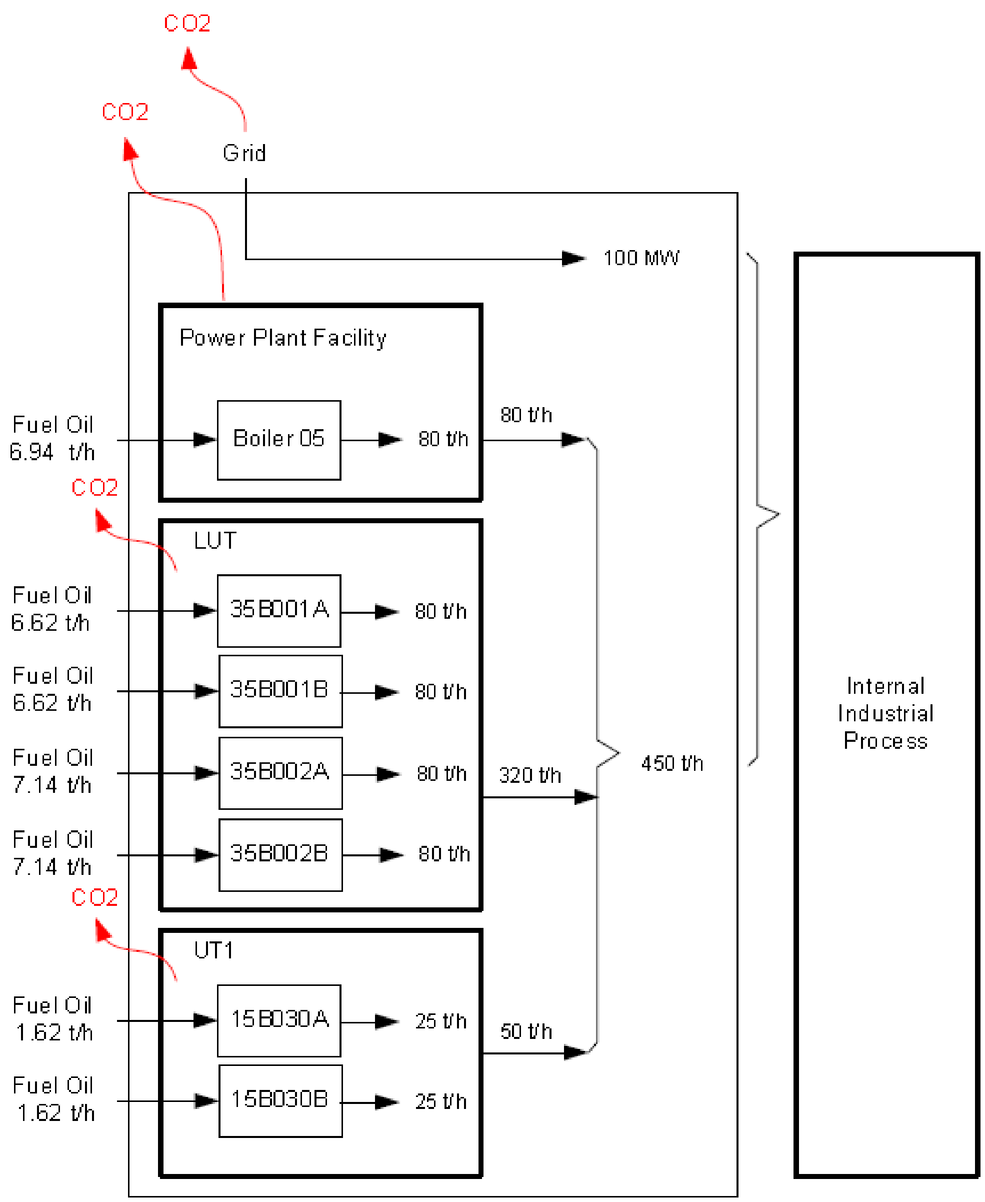

Figure 3: Schematic of the pre-project activity and heat/ mass balance

The energy units being replaced by the project activity have remaining useful lifetime more than the crediting period and are not expected to undergo replacement/ repair to result in fuel switch.

As the project activity employs new, lower carbon intensive fuel NG based cogeneration unit and it is environmentally safe and sound.

There is no technology transfer involved in the project activity.

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

Years	**Annual estimation of emission reductions in tonnes of CO_2e**
2012	261,393
2013	261,393
2014	261,393
2015	261,393
2016	261,393
2017	261,393
2018	261,393
2019	261,393
2020	261,393
2021	261,393
Total estimated reductions(tonnes of CO_{2e})	**2,613,930**
Total number of crediting years	**10**
Annual average over the crediting period of estimated reductions(tones of CO_{2e})	**261,393**

A.4.5. Public funding of the project activity:

Public funding from Annex 1 countries and diversion of official development assistance (ODA) is not involved in this project. The details of the project cost and means of finance are presented below.

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:

Title: "New cogeneration facilities supplying electricity and/or steam to multiple customers and displacing grid/off-grid steam and electricity generation with more carbon-intensive fuels"
Reference: Approved baseline methodology AM0048
Version 03,
Sectoral Scope: 01,
EB 52

Title: "Tool for the demonstration and assessment of additionality"
Version 06.0.0
EB 65

Title: "Tool to calculate emission factor for an electricity system"
Version 02.2.1
EB 63

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

The project activity is construction and operation of a new natural gas based cogeneration plant. The table below compares the applicability conditions of the AM0048 and the project activity scenario to justify the use of this methodology.

S. No.	Applicability condition of AM0048	Project activity condition	Remark
1	Fossil-fuel-fired cogeneration project activities that supply steam and electricity generation to multiple project customers, including both grid and off-grid applications	The project activity is a natural gas based cogeneration plant that supplies to the PP's captive demand and part of electricity to the grid and other customers in the Rayong industrial premises.	The applicability condition is met
2	If a project customer is expected to undertake, or during the crediting period undertakes, replacement and/or have major repair and maintenance of on-site electricity and/or steam equipment during the project lifetime which might result in fuel switch and/or changes inefficiency they shall be excluded from the project activity after the likely or actual date of the replacement or major repair and maintenance as per Table 2	The existing furnace oil based boilers being replaced by the project activity have an operational lifetime more than the crediting period and are not expected to result in fuel switch due to replacement or major repair[5]. The regional grid has a varied fuel mix with many old and significant new power plants including FO, diesel, NG, lignite, coal etc. Thus, there is no major fuel switch expected in the grid as well	The condition is not applicable here
3	To the existing capacity available at project customers previous to the implementation of the project activity.	The project activity replaces the existing capacity available at the PP and other project customers	The applicability condition is met
4	Project customers that do not co generate steam and electricity currently and/or in the baseline scenario	The major part of steam requirement was being met by FO based boilers and electricity from the grid. Thus, PP does not replace cogeneration in pre-project or baseline. The other project customer, the grid does not have reported cogeneration systems	The applicability condition is met
5	Only to project customers that ensure that the equipment displaced by the project activity will not be sold or used for other purposes	The equipment displaced by the project activity will not be sold or used for other purposes. These are either scrapped or retained as stand by units	The applicability condition is met

As all the applicability conditions of the baseline methodology AM0048, V. 03 are met, the project activity can uses this for further analysis.

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

As per the baseline methodology AM0048, V. 03, project boundary includes the site of the project facility(s) and the sites of all project customer(s). Thus, the boundary includes

[5] Analysis reports from an engineering company submitted to the DOE

- the project facility with the new NG based gas turbines – 6 numbers, HRSGs -6 numbers and all the allied units in the cogeneration plant
- the project customers include (1) IRPC's petroleum complex where the entire steam and significant part of electricity is utilized and (2) the grid to which part of electricity generated in the project facility is sold to

The gases included in the project boundary include

	Source	Gas	Included/ Excluded	Justification/Explanation
Baseline	Electricity and steam generation in baseline	CO_2	Yes	Main emission source.
		CH_4	No	Excluded for simplification. This is conservative.
		N_2O	No	Excluded for simplification. This is conservative.
Project Activity	On-site fuel (natural gas) combustion due to the project activity	CO_2	Yes	Main emission source.
		CH_4	No	Excluded for simplification.
		N_2O	No	Excluded for simplification.
	Fuel consumption for energy generation at customers' site for energy equivalent in project activity	CO_2	Yes	Main emission source.
		CH_4	No	Excluded for simplification.
		N_2O	No	Excluded for simplification.

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

For the identification of baseline scenario, the following steam wise approach as suggested by the applicable baseline methodology AM0048, V. 03 is used

Procedure for the selection of the most plausible baseline scenario
The project proponents shall select the most plausible baseline scenario through the following two steps:

STEP 1. Identification of alternative scenarios
Project proponents shall identify all reasonable potential alternative scenarios that could provide similar services as the proposed project activity.

Assessing potential for fuel switch: for all project customers, the project proponent should assess the potential of fuel switching under the baseline scenario. The project proponent first determines if fuel changes are technically feasible using existing baseline equipment/processes. Is the existing equipment capable of utilizing more than one fuel, without major capital investment? If not, then no additional considerations need to be undertaken in the given project period and it will be assumed the same fuel would have been used as in the past. If a fuel switch is a legitimate technical option given the existing equipment, then the project developer should annually monitor parameters that would indicate a fuel switch is also a logistically feasible option. Does the facility in question have access to other potential fuel sources? (Proximity of a natural gas supply line, fuel supply network developed, etc). If a fuel switch is not a legitimate option, then no additional considerations need to be undertaken in the given project year and it will be assumed the same fuel would have been used as in the past.

The methodology also stipulates that '*The identification of all reasonable potential alternative scenarios shall be made through interviews and/or surveys with each project customer to assess the project customer's future energy planning (plans for switching to a less carbon-intensive fuel, plans to increase the efficiency of on-site generation, plans that influence energy demand, self-generation capacity, etc.).*

The objective of the interviews/surveys is to assess for each project customer the potential for changes in the type of fuel used on-site, energy efficiency, on-site generation capacity and demand levels.'

The customers for steam are very small (10 TPH out of 340.42 TPH generated in the project activity, and rest is consumed in IRPC plant for captive consumption. This is also evident from the financial analysis sheet). These customers were buying steam from the IRPC even in the pre-project scenario. Thus, they do not have steam generation facility and no plans of setting up this facility in future considering very small demand and availability from IRPC (old steam generation plant in pre-project scenario and CDM project activity in future).

Similarly, for the electricity sale to customers, the national grid is major customer with 63 MW capacity out of total 189.86 MW of project activity. The grid will also develop capacity but there is no specific carbon emission intensity reduction plan from the Government. The customers will use estimated 17.5 MW electricity only and have been using electricity from the national grid in the pre-project scenario. Thus, continuation of existing fuel mix is assumed by the PP.

Thus, any customers of the project activity do not have plan plans for switching to a less carbon-intensive fuel, plans to increase the efficiency of on-site generation, plans that influence energy demand, self-generation capacity that can result in a lower emission factor and financially attractive alternative compared to the baseline established here.

STEP 2. Barrier analysis

Alternative		**Project developer**	**Project customer**	**How does the methodology apply if this is the most likely scenario element?**
		Project facilities in the absence of the project activity (CDM)	**Electricity and/or heat sources in the absence of the project activity (CDM)**	
Historical	1	No project facility.	Project customer maintains historical characteristics in terms of on-site fuel choice, on-site equipment efficiency, mix of on-site generation and grid purchase (on-site generation capped at self-generation capacity) and on-site generation equipment lifetime (must be greater than the crediting period).	The IRPC can continue the existing fuel choice, mix of onsite generation and grid purchase and lifetime of generation equipments is more than the crediting period **Applicable**
Fuel choice is likely to change at the project customers in the absence of the project activity	2a	No project facility.	Project customer is likely to switch to less GHG intensive fuel in the absence of the project activity (e.g. a switch from oil to natural gas by the project customer in absence of the project activity).	The IRPC was using FO for the onsite generation was not likely to switch to NG in the absence of the project activity **Not Applicable**
	2b	No project facility.	Project customer is likely to switch to more intensive GHG fuel in the absence of the project activity (e.g. a switch from oil to coal by the project customer in absence of the project activity).	The PP operates existing coal based energy generation units and the option of switching to coal could be considered. However, this alternative will be capital

				intensive[6] and will not be attractive compared to continuation of existing scenario (2a) above. **Not Applicable**
Efficiency is likely to change at the project customers in the absence of the project activity.	3a	No project facility.	Project customer is likely to increase efficiency of its off-grid electricity/steam production in the absence of the project activity (e.g. replacement of boilers, installation of cogeneration equipment, in absence of the project activity).	The off grid steam generation is from FO based boilers its efficiency cannot be increased any further significantly Cogen equipment would not have been installed in absence of project activity due to availability of grid as in pre-project scenario **Not Applicable**
	3b	No project facility.	Project customer is likely to decrease efficiency of its off-grid electricity/ steam production in the absence of the project activity.	The project customer, IRPC's industrial complex would not have decreased efficiency, apart from that resulting from the further aging of energy generation units **Not Applicable**
Energy consumption of project customer is likely to change in the absence of project activity	4	No project facility.	Project customer energy (electricity and/or heat) consumption in the baseline scenario is likely to be different from that of the project scenario.	The IRPC's industrial complex is not undergoing any change (including that in the production capacity). Thus, the energy consumption in baseline and project scenarios is the same. **Not Applicable**
Project customer is likely to be supplied by **external sources of electricity/heat** in the absence of the project activity	5	Proposed project activity without the CDM or other external sources of electricity/ heat supply the project customers energy demands.	Project customer is likely to be supplied by external sources of electricity/heat in the baseline scenario.	Project activity could be taken without CDM and this scenario is **Applicable** The huge steam requirement cannot be supplied by any external sources as no other energy supplier exists in/ near the PP's premises **Not Applicable**

[6] In 2007, the capital cost of a new coal based power plant is reported between $1,280 to $1,562/kW

http://www.naruc.org/grants/Documents/CoalGenerationTechnologies.pdf

http://www.netl.doe.gov/energy-analyses/pubs/BitBase_FinRep_2007.pdf

http://web.mit.edu/coal/The_Future_of_Coal.pdf

Thus, the available alternatives are

1. Project activity (new natural gas based cogen unit) taken without CDM
2. Continuation of existing scenario – onsite FO based steam generation and for electricity mix of onsite generation and grid purchase

As per last para on pg. 3 of the methodology, *"Assessing potential for fuel switch: for all project customers, the project proponent should assess the potential of fuel switching under the baseline scenario. The project proponent first determines if fuel changes are technically feasible using existing baseline equipment/processes. Is the existing equipment capable of utilizing more than one fuel, without major capital investment? This can then be verified during project validation. If not, then no additional considerations need to be undertaken in the given project period and it will be assumed the same fuel would have been used as in the past."*

As per, the existing equipments and steam generation using FO and grid import for electricity demand can continue for the crediting period. Further, the existing FO based boilers cannot be modified to use any other fuel. Thus, continuation of existing scenario is a realistic baseline and same fuel would have been used as in the past. The emission reduction calculation is also based on the actual three year fuel use for carbon intensity/ unit energy as per methodology.

Both the alternatives 1 and 3 require capital investment for these new power plants and thus will not be financially attractive compared to no project scenario option 2 – continuation of existing scenario. Thus, continuation of existing scenario is the baseline scenario and no project scenario being baseline is further substantiated in following Section B.5 by investment analysis using benchmark analysis.

Thus, the baseline scenario is 'Continuation of existing scenario – onsite FO based steam generation and for electricity mix of onsite generation and grid purchase'.

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):

CDM consideration

As per the Guidance of EB62, Annex 13, clause No. 7 and 8,

'7. Assessment of real and continuing actions shall be validated by the DOE and the validation should focus on real documented evidence as indicated in paragraph 6 (b), including an assessment by the DOE of the authenticity of the evidence....

8. In validating proposed CDM project activities where:

(a) there is less than 2 years of a gap between the documented evidence the DOE shall conclude that continuing and real actions were taken to secure CDM status for the project activity;'

The chronology of the project activity implementation and the efforts to secure CDM registration status are presented below.

S. N.	Date	Project Execution Step	CDM registration efforts	Evidence
1	09/02/2007	Internal committee proposes gas based cogen project	-	Internal directive appointing project team
2	20/02/2007	Internal memo for preparation of feasibility report)	-	Copy of LOI

3	12/03/2007	proposal to provide technical advisor services for the project activity by The Development Group, Electricity Generating Authority of Thailand' – a Government agency	-	Copy of proposal
4	23/04/2007	Feasibility report completed by Team and presented to the Management	Feasibility report emphasized financial un-viability and recommended securing CDM revenue – *prior awareness*	Copy of Feasibility report
5	25/05/2007	LOI with GE Oil and Gas for supply of GTG	LOI with GE required them to complete the CDM registration process	Copy of LOI Minutes of meeting with GE Oil and Gas dt. 25/05/2007
6	19/06/2007	IRPC Board of Directors approved investment for the implementation of project	Board considered CDM revenue for the viability of the project	Extracts of the Minutes of the Board meeting
7	12/10/2007	Supply agreement for the main units for Cogen plant	**CDM starting date**	Copy of supply agreement
8	20/10/2008	GTs arrived the IRPC site	-	Bill of lading
9	03/03/2009	EIA approval from Ministry of Natural Resources	-	Copy of Approval letter
10	09/06/2009	Agreement for supply of Natural Gas	-	Copy of agreement
11	18/07/2009	Construction of GTs civil foundation started	-	Copy of construction agreement
12	09/10/2009	-	Appointment of CDM Consultant	Copy of agreement and Press Briefings
13	12/01/2010	-	Local stakeholder meeting	Minutes of the meeting and attendance
14	05/07/2010	-	Appointment of DOE	Copy of agreement
15	09/10/2010 to 07/11/2010	-	PDD webhosted for global stakeholders comments	CDM web site validation link[7]
16	26/10/2010	-	Host country approval from NCDMA (TGO)	Copy of HCA letter
17	January to May 2011	Commissioning Schedule Unit 3: 21/01/2011 (earliest commissioned)	-	Synchronization certificates from EPC contractor

For the demonstration of Additionality, step wise approach as per the 'Tool for the demonstration and assessment of additionality' is used.

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

[7] http://cdm.unfccc.int/Projects/Validation

The existing applicable laws and regulations of the Thailand do not mandate the choice of fuel or the technology of energy generation[8]. Thus, all the short listed alternatives are in line with the applicable laws and regulations.

Step 2. Investment analysis
Project Developer: If using investment analysis, internal rate of return (IRR) of all the alternatives shall be estimated and compared to assess additionality. If the IRR of the implementing project activity without CDM is less than the other alternatives and less than accepted benchmark for rate of return within the country, then the implementation of project facility is additional. The benchmark, against which the IRR is compared, shall be established as described in the Additionality Tool.

Sub-step 2b. – Option III. Apply benchmark analysis
Identify the financial indicator, such as IRR, NPV, cost benefit ratio, or unit cost of service (e.g., levelized cost of electricity production in $/kWh or levelized cost of delivered heat in $/GJ) most suitable for the project type and decision context.

An investment of the project activity was conducted in line with the guidance from additionality tool and investment analysis. The internal rate of return (IRR) on investment as financial indicator is one of the known financial indicator used by banks, financial institutions and project developer for making investment decision. The IRPC Corporate Planning Guidance also recommends use of project IRR as the suitable financial indicator for the evaluation of new investments. Thus, the financial indicator chosen is the internal rate of return of the project (IRR). This is compared with the cost of financing which has been taken from the Weighted Average Cost of Capital (WACC). As per the Guidance on the Assessment of Investment Analysis, WACC is appropriate benchmark for project IRR. WACC is not calculated based on company's internal returns (to follow Para 13 of same Guidance), but taken from public available data on market returns (for three years) and performance of six energy companies. Following formula is used for WACC calculation.

$WACC = W_d * Kd\ (1-t) + W_e * K_e$
W_d = % debt
K_d = interest rate
t = tax rate
W_e = % equity
K_e = return on equity

Cost of equity in this is calculated using default ROE give for Thailand i.e. 11.2%[9] and adding five year average inflation (3.19%[10]). Thus, the default ROE is 14.39%.

The kd is taken from average loan rate of commercial banks in Thailand on 18/06/2007[11].

The tax rate is taken from The Income Tax Act[12] 2006 applicable rate in Thailand.

The We and Wd: the Thai power sector reforms 2005[13] recommended a maximum D/E of 1.5 for the state utilities equivalent to 40% debt. However, established companies get up to 90% debt[14].

[8] Energy Policy and Planning Office, Ministry of Energy, Thailand (www.eppo.go.th)
http://www.eppo.go.th/doc/index.html and http://www.energy.go.th/en/newsDetail.asp?id=83
[9] Pg. 11 of Guidelines on the assessment of investment analysis, version 05, EB 62, Annex 5
[10] Inflation projected in IMF report - five year average from 2008-2012 [5.468%,-0.846%,3.272%,4.006%,4.072%]
[11]http://www.bot.or.th/English/Statistics/FinancialMarkets/Interestrate/_layouts/application/interest_rate/IN_Rate.aspx
[12]refer pg. 20 of pdf file at http://pages.stern.nyu.edu/~adamodar/pdfiles/articles/KPMGtaxratesurvey.pdf
[13]National Energy Policy Council Resolution of 17 October 2005
http://www.eppo.go.th/power/FT-2548/Review_Tariff2005-2008-Eng.pdf
[14]World Bank paper, pg. 3.

The WACC works out to be 13.5% and is used as benchmark for the project IRR in this project activity[15]. The project activity is proposed by the project developer and investment analysis is used for the demonstration of additionality. The techno-economic parameters for the financial analysis are presented in the Table below.

Table: Techno-economic parameters of the implementation of new natural gas based cogen unit

Parameter	Value	Unit	Reference/ Evidence
Installed Capacity	210[16] 408.49	MW by GTs TPH steam by HRSG	Detailed technical and financial investigation by internal set up committee
Total Investment	223.67	million USD	Estimate based on quotes for GE turbines and consultancy with EGAT (proposal dt. 12/03/2007)[17]
Maintenance cost per annum	4% of the capital cost		Estimate based on existing cogen plant operation (supported by EPC contractor)
Life of Project Activity	20	Years	GE turbine specifications
Debt/ Equity ratio	0.8 : 1	ratio	In line with the Guidance 11 of EB 62, Annex 5 – the actual loan terms are used
Depreciation Rate (Straight Line Method basis)			Standard practice (SLM over 20 years) No special depreciation rates as per Thai Tax laws
Civil Works	5	%	
Plant and Machinery	5	%	
Depreciation up to (% of asset value)	90	%	
Income Tax			BOI Privilege[18] 30% income tax[19]

The project IRR is 7.64% which is less than the benchmark returns and the project is unviable without CDM. With CDM revenue, the project IRR improves to 14.05%.

Sensitivity analysis:
As per guideline provided by EB in meeting no. 41 annex 45 the criteria for choosing the sensitivity analysis parameter is:

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http://siteresources.worldbank.org/EXTFINANCIALSECTOR/Resources/282884-1303327122200/146gray.pdf
Book - Independent power projects in developing countries: legal investment By Henrik M. Inadomi pg. 229 (refer snapshot from Google Books in benchmark calculation sheet – D&E sheet)

[15] A detailed calculation sheet is provided to DOE

[16] These electricity and steam generation capacities are matched with the investment decision. The actual installed capacities are lower and hence conservatively, higher capacities considered at investment decision are used for demonstration of additionality

[17] pg. 10 of report gave an estimated project cost of 2 x 4,030 million Baht (which at exchange rate of 36 Baht/USD is 223.89 million USD)

[18]http://www.boi.go.th/english/about/boi_privileges_by_location.asp
(Highlights: 8 year 100% tax waver, next 5 years - 50% of prevailing tax rate; then full corporate tax)

[19]As per Income Tax Act (refer pg. 20 of pdf file at http://pages.stern.nyu.edu/~adamodar/pdfiles/articles/KPMGtaxratesurvey.pdf)

16. Guidance: Only variables, including the initial investment cost, that constitute more than 20% of either total project costs or total project revenues should be subjected to reasonable variation (all parameters varied need not necessarily be subjected to both negative and positive variations of the same magnitude), and the results of this variation should be presented in the PDD and be reproducible in the associated spreadsheets. Where a DOE considers that a variable which constitute less than 20% have a material impact on the analysis they shall raise a corrective action request to include this variable in the sensitivity analysis.

The parameters that can affect the financial returns of the project activity are discussed below.

1) Investment Cost: investment is estimated cost for project budgeting and financial analysis. There will be some deviation depends on the actual scope of work and EPC market situation. The sensitivity analysis will be conducted for ±10% of investment to cover the provision for contingency included in the budget.
2) O&M cost: this includes the cost of maintenance spares and manpower required for the operation of plant and support staff
3) Station heat rate: This is a standard parameter given by the gas turbine supplier and is not likely to change to a large extent. Also, a +10 sensitivity yields too low revenue and no IRR calculation is possible at that value (model gives error). Still a sensitivity of 5% is studied for this parameter
4) Sale price of electricity and steam: The electricity sale price to grid is decided power purchase agreement (non firm SPV in this case) and electricity and steam sale price to customers is decided by sale agreements and is dependent on fuel price. Thus, this cannot vary independently of fuel price. Considering possible escalation of these prices, the parameter is subjected to sensitivity of 5%
5) Price of natural gas: The natural gas price is linked to market as per the gas purchase agreement and thus is subjected to 10% sensitivity here.

The result of sensitivity analysis is shown below.

Sr. No.	Parameter	Project IRR with % variation in parameter		Benchmark
		+10%	-10%	
1	Investment cost	6.39	9.11	13.5%
2	O&M cost	6.71	8.51	
3	Station heat rate*	1.14	12.13	
4	Sale price of electricity and steam*	11.55	2.40	
5	Price of natural gas	7.4	7.88	

* sensitivity done for ±5% variation only due to above discussed reason

As can be seen from the summary table above, the project IRR in call cases is less than the benchmark return and the project is unviable without CDM.

As per the applied baseline methodology '*If the IRR of the implementing project activity without CDM is less than the other alternatives and less than accepted benchmark for rate of return within the country, then the implementation of project facility is additional.*'
However, the IRR of alternative to the project activity cannot be calculated as there is no capital investment. The net positive returns in each assessment year without any capital investment makes calculation of returns technically not possible. Thus, the returns of the alternative – continuation of existing scenario are not compared here.

Step 4: Common practice analysis

This test is a credibility check to complement the investment analysis and requires an analysis of the extent to which the proposed project type (e.g. technology or practice) has already diffused in the relevant sector and region.

The first step in the tool is to - Analyze other activities '*that are operational and that are similar to the project activity*' viz., projects that are in the same country/region and/or rely on a broadly similar technology, are of a similar scale, and take place in a comparable environment with respect to regulatory framework, investment climate, access to technology, access to financing etc. (but excluding the other CDM project activities). Accordingly, we are to analyze the following project activities(that are similar):

1) Technology: Natural gas based cogeneration projects catering mainly for captive consumption and part to third party sale
As the project activity fall in this technology, other purely grid connected NG based power only plants cannot be compared. Those power only plants have advantage of maximum efficiency of power generation due to combined cycle operations and assured revenue from electricity sale to grid/ customers. Also, if the plant supplies only to the grid on firm basis, it attracts a higher power sale tariff compared to a non-firm SPP like the project activity plant. Thus, such plants will be excluded from the analysis.

2) Scale: A comparison is made to similar NG based cogen projects with capacity range varying from ±50% of the project capacity[20](227.832 MWand 408.49 TPH) i.e. electricity generation between 114 to 341.75 MW and steam generation between 204.25 TPH to 612.75 TPH.

The project activity is selling < 90 MW to the grid and such power plant (sale between 10 to 90 MW) in Thailand are categorized as Small Power Producers (SPP)[21]. The EPPO maintains a list of all operating SPPs on the website and only SPP data will be analysed[22].

3) Comparable Environment (regulatory framework, investment climate, access to technology and finance): Non Government projects owned by Private sector Power Producers only are considered. Government implemented projects cannot be considered similar as they come under different investment climate such as special debt terms. Also, the central and state governments have additional drivers for the development of projects, such as ensuring the reliable supply of electricity to the community.

4) Time line: Projects commissioned prior to 2000 are excluded from analysis.

Hence to compliment the investment analysis and to pass the project activity through the credibility test, we have to:

- Find the similar project activities, that are operational (at the time of decision making and to be further conservative at the time of project validation), from a reliable information source that is available in the public database.
- Exclude if any are CDM project activities
- If still some project activities are left, analyze and demonstrate why the existence of these activities does not contradict the claim that the proposed project activity is financially/economically unattractive by pointing out serious changes in circumstances.

The project activity is a natural gas cogeneration plant for captive consumption and excess electricity sale to grid. The data available on grid connected power plants in Thailand shows maximum more (91.5% of the total installed capacity) electricity only power plants. These, cannot be compared with the project activity as they do not generate similar services as the project activity (which also generates steam as final

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[20] In line with the review comments on power project http://cdm.unfccc.int/Projects/DB/DNV-CUK1218186379.41/Review/3TJH2TJ7RN4X5NST0Q7FFB1EQVMEKT/display
[21] Dr. Sukamon Hinchiranan, Ministry of Energy, Thailand
http://www2.dede.go.th/cdm/520126_GridEmission2007.pdf (pg. 4)
[22]http://www.eppo.go.th/power/data/index.html

product)[23].Thus, power plants of this equivalent scale in similar investment scenario, installed by refineries in Thailand are analysed for the common practice analysis. Thailand has seven oil refineries and following table summarises the production capacities[24].

S.No.	Name of Refinery	Production capacity (thousand barrels/day)
1	Thai Oil	270
2	IRPC	215
3	ESSO	160
4	PTTAR	145
5	SPRC	145
6	Bangchak	120
7	RPC	17

For the captive power plants, there is no publicly available information/ database. However, as per the experience of PP, most of the refineries in Thailand use fuel oils for generation of steam and part is generated in coal/ oil based cogeneration power plants. There is also large reliance on the purchase of electricity from grid. This situation is also the pre-project scenario even in the case of IRPC which is hosting the CDM project activity power plant. Thus, it can be concluded that there is no similar power plant in the country that has come up at such a scale, using natural gas and under similar investment scenario.

Sub-step 4b: Discuss any similar Options that are occurring:
(2) If similar activities are widely observed and commonly carried out, it calls into question the claim that the proposed project activity is financially unattractive (as contended in Step 2) or faces barriers (as contended in Step 3).

As discussed in the step 4a, there are no similar projects occurring in the host country.

If Sub-steps 4a and 4b are satisfied, i.e.(i) similar activities cannot be observed or (ii) similar activities are observed, but essential distinctions between the project activity and similar activities can reasonably be explained, then the proposed project activity is additional).

As the sub-steps 4a and 4b are satisfied, it can be concluded that the project activity is additional.

The above discussions show that the project activity would not have came in the absence of CDM and is additional.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

As per the applicable baseline methodology AM0048, following step wise approach is used to calculate the emission reduction. The equations used in the calculations below are numbered directly as in the applicable baseline methodology, AM0048, V. 03 (and not in proper sequence in this section of PDD).

Baseline emissions
The baseline emissions are sum of emissions from generation of electricity and emissions from generation

[23] pg. VI (in pdf file13 of 61)
http://www.dede.go.th/dede/images/stories/stat_dede/ElectricPowerinThailand2009.pdf
[24]http://www.energy.go.th/moen/upload/File/Knowledge/ERE-Thailand_v.En_web.pdf
http://www.eppo.go.th/power/data/index.html

of steam:

$$BE_y = BE_{IC,y} + BE_{ST,y} + BE_{GR,y} \quad \textbf{(1)}$$

Where:

BE_y	Baseline emissions in year 'y' (tCO_2). Calculated below.
$BE_{IC,y}$	Emissions for the production of electricity that would be supplied to individual project customers in year 'y' in the baseline scenario (tCO_2). Calculated below under (a).
$BE_{ST,y}$	Emissions for the production of steam that would be supplied to individual project customers in year 'y' in the baseline scenario (tCO_2). Calculated below under (b).
$BE_{GR,y}$	Emissions for the production of electricity that would be supplied to the grid in year 'y' in the baseline scenario (tCO_2). Calculated below (c).

(a) Emissions for the production of electricity that would be supplied to individual project customers in year 'y' in the baseline scenario

$$BE_{IC,y} = \sum_j \sum_i \left(EL_{BL,j,i,y} \cdot EEF_{BL,i,y} \right) \quad \textbf{(2)}$$

Where:

$EL_{BL,j,i,y}$	Electricity consumed by the project customer 'i' from the proposed project facility 'j' in year 'y' eligible to certified emissions reductions (MWh). Calculated below as per equation (3).
$EEF_{BL,i,y}$	Baseline CO_2 emission factor for electricity of the project customer 'i' in year 'y' (tCO_2/MWh). Calculated below as per equation (5).

The electricity eligible to certified emissions reductions is limited to the maximum generating capacity of the project customer existing previous to the implementation of the project activity as per equations below:

$$EL_{BL,j,i,y} = \min\left(EL_{PJ,j,i,y}, EL_{MG,i} - EL_{PCSG,i,y} \right) \quad \textbf{(3)}$$

Where:

$EL_{PJ,j,i,y}$	Electricity purchased by the project customer 'i' from the proposed project facility 'j' in year 'y' (MWh). Measured at the project facility and/or at the project customer.
$EL_{MG,i}$	Total historical capacity of electricity generation of equipment existing at project customer 'i' previous to the implementation of the project activity (MWh). Calculated below as per equation (4).
$EL_{PCSG,i,y}$	Total electricity self-generated by project customer 'i' during year 'y' of the crediting period (MWh). Measured at the project customer 'i'.

The maximum generation capacity of the pre-project electricity generating equipment at project customer is calculated as

$$EL_{MG,i} = \frac{\sum_{n} GC_{EL,i,n} \cdot (8760 - MDH_{EL,i,n})}{J_{EL,i,y}} \quad \textbf{(4)}$$

Where:

$GC_{EL,i,n}$ Nameplate capacity of the electricity generating equipment 'n' existing at the project customer 'i' previous to the implementation of the project activity (MW). Obtained from the project customer 'i'.

$MDH_{EL,i,n}$ Average maintenance and down time hour of the electricity generating equipment 'n' existing at the project customer 'i' previous to the implementation of the project activity (hour). Obtained from the project customer 'i'.

$J_{EL,i,y}$ Number of project facilities 'j' supplying the project customer 'i' with electricity in year 'y' simultaneously (number). Obtained from the project customer 'i'.

The baseline CO_2 emission factor for electricity of the project customer is calculated as:

$$EEF_{BL,i,y} = w_{SG,i} \cdot EF_{PC,SG,i,y} + w_{GR,i} \cdot EF_{PC,GR,i,y} \quad \textbf{(5)}$$

Where:

$w_{SG,i}$ Fraction of electricity consumed on-site by project customer 'i' in the baseline that is self-generated (fraction). Calculated below as per equation (6).

$w_{GR,i}$ Fraction of electricity consumed on-site by project customer 'i' in the baseline that is purchased in the grid (fraction). Calculated below as per equation (7).

$EF_{PC,SG,i,y}$ CO_2 emission factor for self-generated electricity of the project customer 'i' in year 'y' (tCO_2/MWh). Calculated below as per equation (8).

$EF_{PC,GR,i,y}$ CO_2 emission factor of the grid connected to the project customer 'i' in year 'y' (tCO_2/MWh). The emission factor is estimated using the procedure described in the latest version of approved "Tool to calculate emission factor for an electricity system" making $EF_{PC,GR,i,y} = EF_y$.

The fractions of electricity that is self-generated and that produced on-site are calculated as:

$$w_{SG,i} = \frac{\sum_{k} EL_{SG,i,k}}{EL_{TC,i}} \quad \textbf{(6)}$$

$$w_{GR,i} = \frac{EL_{GR,i}}{EL_{TC,i}} \quad \textbf{(7)}$$

Where:

$EL_{SG,i,k}$ Electricity self-generated by project customer 'i' with fuel 'k' during the most recent three years previous to the implementation of the project activity (MWh). Obtained from the project customer 'i'.

$EL_{GR,i}$ Total amount of electricity obtained from the grid by project customer 'i' during the most recent three years previous to the implementation of the project activity (MWh). Obtained from the project customer 'i'.

$EL_{TC,i}$ Total electricity consumption for project customer 'i' during the most recent three years previous to the implementation of the project activity (MWh). Obtained from the project customer 'i'.

The CO_2 emission factor for self-generated electricity of each project customer is:

$$EF_{PC,SG,i,y} = \frac{44}{12} \cdot \frac{\sum_k \left(CEF_{i,k} \cdot FC_{SG,i,k}\right)}{\sum_k EL_{SG,i,k}} \qquad \textbf{(8)}$$

Where:

$CEF_{i,k}$ Carbon emission factor of fuel 'k' used by project customer 'i' to self-generate electricity in the baseline scenario (tC/TJ). Obtained from the project customer 'i' or technical literature.

$FC_{SG,i,k}$ Consumption of fuel 'k' by project customer 'i' to self-generate electricity in the baseline scenario, calculated as per equation below (TJ). Calculated below as per equation (9).

If data on fuel consumption in the baseline scenario is directly available at project customer 'i', then:

$$FC_{SG,i,k} = F_{SG,i,k} \cdot NCV_{i,k} \qquad \textbf{(9)}$$

Where:

$F_{SG,i,k}$ Consumption of fuel 'k' by project customer 'i' to self-generate electricity during the most recent three years previous to the implementation of the project activity (mass or volume units). Obtained from the project customer 'i'.

$NCV_{i,k}$ Net calorific value of fuel 'k' at project customer 'i' in the baseline scenario (TJ/mass or volume units). Obtained from the project customer 'i' or technical literature.

Otherwise, $FC_{SG,i,k}$ shall be calculated as:

$$FC_{SG,i,k} = \frac{EL_{SG,i,k}}{\eta_{SG,i,k}} \quad \textbf{(10)}$$

Where:

$\eta_{SG,i,k}$ Fuel consumption rate of self-generation of electricity at project customer 'i', with fuel 'k', in the baseline scenario (MWh/TJ). This parameter shall be one of the following:

i) Highest of the measured fuel consumption rate of electricity generating equipment with similar specifications; or,

ii) Highest of the efficiency values provided by two or more manufacturers for electricity generating equipment with similar specifications; or,

iii) Maximum efficiency of 100%, based on net calorific values of fuels.

(b) Emissions for the production of steam that would be supplied to individual project customers in year 'y' in the baseline scenario

It is assumed that steam is produced at constant temperature and pressure.

$$BE_{ST,y} = \sum_{j}\sum_{i}\left(SC_{BL,j,i,y} \cdot SEF_{BL,i,y}\right) \quad \textbf{(11)}$$

Where:

$SC_{BL,j,i,y}$ Steam consumed by the project customer 'i' from the proposed project facility 'j' in year 'y' eligible to certified emissions reductions, calculated as per equation (12) below (TJ).

$SEF_{BL,i,y}$ Baseline CO_2 emission factor for steam of the project customer 'i' in year 'y' (tCO_2/TJ). Calculated below as per equation (15).

The steam eligible to certified emissions reductions is limited to the maximum generating capacity of the project customer existing previous to the implementation of the project activity:

$$SC_{BL,j,i,y} = \min\left(SC_{PJ,j,i,y}, SC_{MG,i} - SC_{PCSG,i,y}\right) \quad \textbf{(12)}$$

Where:

$SC_{PJ,j,i,y}$ Steam purchased by the project customer 'i' from the proposed project facility 'j' in year 'y' (TJ). Calculated below as per equation (13).

$SC_{MG,i}$ Total historical capacity of steam generation of the equipment existing at project customer 'i' previous to the implementation of the project activity (TJ). Calculated below as per equation (14).

$SC_{PCSG,i,y}$ Total steam self-generated by project customer 'i' during year 'y' of the crediting period (MWh). Measured at the project customer 'i'.

The maximum generation capacity of steam of the pre-project generating equipment is calculated as:

$$SC_{MG,i} = \frac{\sum_m GC_{ST,i,m} \cdot (8760 - MDH_{ST,i,m}) \cdot EN_{BL,i,m}}{J_{ST,i,y}} \quad \textbf{(14)}$$

Where:

$GC_{ST,i,m}$ Nameplate capacity of the steam generating equipment 'm' existing at project customer 'i' previous to the implementation of the project activity (tonnes/hour). Obtained from the project customer 'i'.

$MDH_{ST,i,m}$ Normal maintenance and down time hour of the generation equipment 'm' existing at project customer 'i' previous to the implementation of the project activity (hour). Obtained from the project customer 'i'.

$EN_{BL,i,m}$ Specific enthalpy of steam of the pre-project generating equipment 'm' of project customer 'i' (TJ/tonnes). This data shall be obtained from steam tables, using temperature and pressure of the steam measured at the pre-project generating equipment of project customer 'i'.

$J_{ST,i,y}$ Number of project facilities 'j' supplying steam to the project customer 'i', in year 'y', simultaneously (number). Obtained from the project customer 'i'.

The baseline emission factor for self-generated steam $EF_{BL,ST,j,i,y}$ shall be calculated as:

$$SEF_{BL,i,y} = \frac{44}{12} \cdot \frac{\sum_k \left(CEF_{i,k} \cdot FC_{ST,i,k} \right)}{\sum_k HG_{ST,i,k}}$$

Where:

$CEF_{i,k}$ Carbon emission factor of fuel 'k' used by project customer 'i' to self-generate steam in the baseline scenario (tC/TJ). Obtained from the project customer 'i' or technical literature.

$FC_{ST,i,k}$ Consumption of fuel 'k' by project customer 'i' to self-generate steam in the baseline scenario (TJ), calculated as per equation below as per equation (17).

$HG_{ST,i,k}$ Steam self-generated by project customer 'i' with fuel 'k' in the baseline scenario (TJ). Calculated below as per equation (16).

(c) Emissions for the production of electricity that would be supplied to the grid in year 'y' in the baseline scenario

$$BE_{GR,y} = \sum_j EL_{PF,GR,j,y} \cdot EF_{PF,GR,j,y}$$

Where:

$EL_{PF,GR,j,y}$ Electricity supplied to the grid and/or to distribution entities by the proposed project facility 'j' in year 'y' (MWh). Measured at the project facility 'j'.

$EF_{PF,GR,j,y}$ CO_2 emission factor for the grid electricity connected to the project facility 'j' and/or to the distribution entities in year 'y' (tCO_2/MWh). The emission factor is estimated using the procedure described in the latest version of approved "Tool to calculate emission factor for an electricity system" making $EF_{GR,PF,j,y} = EF_y$.

The $EF_{PF,GR,j,y}$ is calculated as presented in Annex 5. The parameter is monitored ex-ante and fixed for the crediting period.

Project Emissions

To calculate the project emissions from the combustion of fossil fuels to produce steam and electricity at the project facility(s) (*PEy*), apply the latest approved version of the "Tool to calculate project or leakageCO_2 emissions from fossil fuel combustion". The parameter *PEy* corresponds to $PE_{FC,j,y}$ in the tool, where *j* are the processes that fire fossil-fuels attributable to the project activity.

$$PE_{FC,j,y} = \sum_i FC_{i,j,y} \times COEF_{i,y}$$

Where:

$PE_{FC,j,y}$	=	Are the CO_2 emissions from fossil fuel combustion in process j during the year *y* (tCO_2/yr);
$FC_{i,j,y}$	=	Is the quantity of fuel type *i* combusted in process *j* during the year *y* (mass or volume unit/yr);
$COEF_{i,y}$	=	Is the CO_2 emission coefficient of fuel type *i* in year *y* (tCO_2/mass or volume unit)
i	=	Are the fuel types combusted in process *j* during the year *y*

Leakage

Leakage may result from the extraction, processing, liquefaction, transportation, re-gasification and distribution of fossil fuels outside of the project boundary. This includes mainly fugitive CH_4 emissions and CO_2 emissions from associated fuel combustion and flaring. In this methodology, the following leakage emission sources shall be considered:

• Fugitive CH_4 emissions associated with the extraction, processing, liquefaction, transportation, re-gasification and distribution of fossil fuels used in the project plant and fossil fuels used in the grid in the absence of the project activity.

• In the case liquefied natural gas (LNG) is used in the project plant: CO_2 emissions from fuel combustion / electricity consumption associated with the liquefaction, transportation, re-gasification and compression into a natural gas transmission or distribution system.

Thus, leakage emissions are calculated as follows:

$$LE_y = LE_{CH4,y} + LE_{LNG,CO2,y}$$

Where:

LE_y	Leakage emissions (tCO_2).
$LE_{CH4,y}$	Leakage emissions due to fugitive upstream CH_4 emissions in the year 'y' (tCO_2). Calculated below under (a).
$LE_{LNG,CO2,y}$	Leakage emissions due to fossil fuel combustion/electricity consumption associated with the liquefaction, transportation, re-gasification and compression of LNG into natural gas transmission or distribution system during the year 'y' of the crediting period (tCO_2). Calculated below under (b).

$$LE_{CH4,y} = GWP_{CH4} \cdot \sum_j \sum_k \left(FC_{PJ,PF,j,k,y} \cdot NCV_{j,k} \cdot EF_{CH4,ups,k} \right) \quad \textbf{(21)}$$

Where:

$LE_{CH4,y}$	=	Leakage emissions due to fugitive upstream CH_4 emissions in the year y (tCO_2)
GWP_{CH4}	=	Global warming potential of CH_4 (tCO_2/tCH_4) valid for the commitment period. Obtained from IPCC
$FC_{PJ,PFj,k,y}$	=	Quantity of fuel consumed (mass or volume units) per fuel type k in the year y in the project facilities j. Measured at the project facility j
$NCV_{j,k}$	=	Net calorific value of fossil fuel k used at the project facility j during the crediting period (TJ/mass or volume units of fuel). Obtained from the project customer i or technical literature
$EF_{CH4,ups,k}$	=	Emission factor for upstream fugitive methane emissions from production, transportation and distribution of fuel k (tCH_4/TJ). Obtained from the project facility j or table below

Here, the default emission factor for the fugitive upstream CH4 emissions will be used form Table 3 of the baseline methodology, AM0048 i.e. 296 tCH_4/ PJ.

Emissions Reductions

The emissions reductions are calculated as:

$$ER_y = BE_y - PE_y - LE_y$$

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

Data / Parameter:	**$EL_{GR,i}$**
Data unit:	MWh
Description:	Total amount of electricity obtained from the grid by IRPC during the most recent three years previous to the implementation of the project activity.
Source of data used:	Bills from Provincial Electricity Authority (PEA)
Value applied:	2009: 899,639; 2008: 853,911; 2007: 916,788
Measurement procedures (if any):	As required by the applicable baseline methodology, last three years historic data (calendar year January to December) is used for the calculation of historic fuel consumption
Any comment:	Average = 890,113

Data / Parameter:	**$EN_{BL,i}$ and $EN_{BL,i,m}$**
Data unit:	TJ/tonnes
Description:	Specific enthalpy of steam of generating equipment existing at IRPC previous to the implementation of the project activity.
Source of data used:	Steam tables
Value applied:	Low Pressure Steam (LPS) – 20 bar (lower of range) = 2799.71 High Pressure Steam(HPS) – 43 bar (lower of range) = 2800.0
Measurement procedures (if any):	This data is obtained from steam tables, using temperature and pressure of the steam measured at the pre-project generating equipment
Any comment:	

Data / Parameter:	***Steam pressure***
Data unit:	bar
Description:	Pressure of steam generated by IRPC
Source of data used:	Log book record of the pressure gauges at IRPC
Value applied:	20-25 bar for LPS 43-46 bar for HPS
Measurement procedures (if any):	Direct reading from pressure gauges, reading daily, monthly average recording
Any comment:	-

Data / Parameter:	$\mathbf{F_{ST,i,fuel\ oil}}$
Data unit:	ton
Description:	Quantity of fuel oil consumption by IRPC to self-generate steam during the most recent three years previous to the implementation of the project activity
Source of data used:	SAP (Systems, Applications and Products in data processing software) data from July 2008 and steam generation database (SGDB) report earlier
Value applied:	see table below
Measurement procedures (if any):	As required by the applicable baseline methodology, last three years historic data (calendar years January to December) is used for the calculation of historic fuel consumption
Any comment:	

	2009	2008	2007
FO	79,820.26	159,537.19	163,701.1
Butane	32,741	0	0
Propane	199.52	0	0
FGL	0	3,752	0

Data / Parameter:	$\mathbf{GC_{EL,i,n}}$
Data unit:	MW
Description:	Nameplate capacity of the electricity generating equipment ‘n’ existing at IRPC previous to the implementation of the project activity.
Source of data used:	O&M manual at the site
Value applied:	0
Measurement procedures (if any):	Taken from the nameplate of the turbine generators
Any comment:	No cogen existed in the project boundary in pre-project scenario

Data / Parameter:	$\mathbf{GC_{ST,i,m}}$
Data unit:	Ton/ hour
Description:	Nameplate capacity of the steam generating equipment ‘m’ existing at IRPC previous to the implementation of the project activity
Source of data used:	O&M manual at the site
Value applied:	450
Measurement procedures (if any):	Taken from the nameplate of the turbine generators
Any comment:	Refer break up – individual boiler capacities in Section A.4.3 of PDD

Data / Parameter:	$H_{ST,i,k}$
Data unit:	Ton
Description:	Steam generation by IRPC with fuel k during the most recent three years previous to the implementation of the project activity
Source of data used:	SAP from July 2008 and SGDB report earlier
Value applied:	see table below
Measurement procedures (if any):	As required by the applicable baseline methodology, last three years historic data (calendar year January to December) is used for the calculation of historic fuel consumption
Any comment:	-

	2009	2008	2007
20 bar	387,680.38	575,318.00	488,576.31
43 bar	1,233,975.72	1,575,285.67	1,740,832.85

Data / Parameter:	$MDH_{ST,i,m}$
Data unit:	hour
Description:	Normal maintenance and down time hour of the steam generating equipment ‘m’ existing at the project customer ‘i’ previous to the implementation of the project activity
Source of data used:	Power plant performance indices report for boiler 05, shutdown record for LUT and UT1 boilers
Value applied:	Refer Annex 3
Measurement procedures (if any):	Taken from maintenance logs of the power plant
Any comment:	Multiple boiler had different durations, so presented separately in Annex 3

Data / Parameter:	$\eta_{ST,i,k}$
Data unit:	TJ/TJ
Description:	Fuel consumption rate of self-generation of steam at IRPC, with fuel ‘k’. This parameter shall be one of the following: i) Highest of the measured fuel consumption rate of electricity generating equipment with similar specifications; or, ii) Highest of the efficiency values provided by two or more manufacturers for electricity generating equipment with similar specifications; or, iii) Maximum efficiency of 100%, based on net calorific values of fuels
Source of data used:	Tool to determine the baseline efficiency of thermal or electric energy generation systems, V. 01, EB 48, Annex 12 Table 1: Default baseline efficiency for different technologies
Value applied:	85%
Measurement procedures (if any):	Default value provided by CDM Methodological Tool is used
Any comment:	Value default for old oil fired boilers

Data / Parameter:	NCV_{FO}
Data unit:	TJ/ ton
Description:	Net calorific value of furnace oil fuel
Source of data to be used:	2006 IPCC Guidelines for National Greenhouse Gas Inventories, Vol. 2, Ch. 1, Table 1.2, pg. 1.18
Value of data	0.0404
Measurement procedures (if any):	This is third party measured and given value for commercial purpose and will be used directly for the emission reduction calculation
Monitoring frequency:	monthly
QA/QC procedures to be applied:	This is a third party given value and does not require any QA/ QC by PP
Any comment:	-

Data / Parameter:	$EF_{CO2,\text{fuel oil}}$
Data unit:	tCO_2/ TJ
Description:	Emission factor of fuel oil
Source of data used:	2006 IPCC Guidelines for National Greenhouse Gas Inventories, Chapter 1, pg. 1.23
Value applied:	77.4
Measurement procedures (if any):	In absence of the project specific data, as suggested in the baseline methodology AM0048, default value recommended by IPCC is used.
Any comment:	Value is used for all hydrocarbon oils used in the project activity

Data / Parameter:	$EF_{PC,GR,i,y}$
Data unit:	tCO_2/ MWh
Description:	CO_2 emission factor of the grid connected to the IRPC in year 'y'. The emission factor is estimated using the procedure described in the latest version of approved "Tool to calculate emission factor for an electricity system" making $EF_{PC,GR,i,y}= EFy$
Source of data to be used:	As per "Tool to calculate emission factor for an electricity system"
Value of data	0.5742
Measurement procedures (if any):	As per the Tool to calculate emission factor for an electricity system The $EF_{PF,GR,j,y}$ is calculated, refer Annex 3 for detailed calculations.
Any comment:	The value is fixed ex-ante and will be used throughout the crediting period

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

Baseline emissions (BE_y):

$$BE_y = BE_{IC,y} + BE_{ST,y} + BE_{GR,y} \quad \text{(A)}$$

(a) Emissions for the production of electricity that would be supplied to individual project customers in year y in the baseline scenario

$$BE_{IC,y} = \sum_j \sum_i \left(EL_{BL,j,i,y} \cdot EEF_{BL,i,y} \right) \quad \text{(B)}$$

$$EL_{BL,j,i,y} = \min\left(EL_{PJ,j,i,y}, EL_{MG,i} - EL_{PCSG,i,y} \right) \quad \text{(C)}$$

The project activity will have an installed capacity of 227.83 MW. When using 1 gas engine as always on standby, the available capacity will be 189.86 MW. The project activity plant will need 5 MW auxiliary consumption and thus, net available electricity capacity is 184.86 MW. At planned 8,000 annual operating hours, this will generate gross electricity as

$EL_{BL,j,i,y}$= 1,478,880 MWh

However, as required by methodology, the electricity generation for emission reduction is capped at historic average (for captive use) and planned to grid. Thus, this (installed capacity of project activity and its auxiliary consumption) will not impact emission reduction during the monitoring.

As $EL_{MG,i}$ i.e. total historical capacity of electricity generation of equipment existing at project customer *I* previous to the implementation of the project activity is nil (0 MWh) as PP did not have electricity generation in the project boundary. PP was importing electricity from the grid and last three year average electricity import was 890,113 MWh.

Thus, $EL_{MG,i}$ = 890,113 MWh

Thus, $EL_{BL,j,i,y}$ = min (1,478,880; 890,113– 0)
= 890,113 MWh

$EEF_{BL,i,y}$ will be the emission factor of grid $EF_{PC,GR,i,y}$ (i.e. 0.5742 tCO_2/ MWh)[25].

Thus, $BE_{IC,y}$ = 890,113 x 0.5742

[25] Refer Annex 3 for the detailed calculations

= 511,103 tCO_2

In baseline, 103.86 MW was imported from the grid. In the post project scenario, out of 189.86 MW generated from the 5 GTs, 103.86 MW will be used for captive consumption in IRPC, 63 MW will be sold to grid and rest ~ 17.5 MW will be sold other customers (nearby industrial units).

Further, the steam generation was higher in baseline than in the project scenario. For this same reason, as recommended by the methodology, the CER calculation is capped at the three year historic energy use as presented in the CER calculation sheet.

(b) Emissions for the production of steam that would be supplied to individual project customers in year y in the baseline scenario

$$BE_{ST,y} = \sum_j \sum_i \left(SC_{BL,j,i,y} \cdot SEF_{BL,i,y} \right) \quad \text{(D)}$$

$$SC_{BL,j,i,y} = \min\left(SC_{PJ,j,i,y}, SC_{MG,i} - SC_{PCSG,i,y} \right) \quad \text{(E)}$$

$$SC_{PJ,j,i,y} = S_{PJ,j,i,y} \cdot EN_{PJ,i} \quad \text{(F)}$$

$S_{PJ,j,i,y}$ i.e. steam purchased by the project customer i from the proposed project facility j in year y (tonnes) is assumed equivalent to steam generation capacity of the project activity i.e. 340.42 TPH or 2,723,320 ton/ year.

$EN_{PJ,i}$ is enthalpy of steam provided by the project activity at required processes at 20-43 bar. Its enthalpy from the saturated steam table is 2,800 kJ/kg (or MJ/ton).

Thus, putting these values in equation (F)

$SC_{PJ,j,i,y}$ = (2,723,320 x 2,800) MJ
= 7,625 TJ

$$SC_{MG,i} = \frac{\sum_m GC_{ST,i,m} \cdot (8760 - MDH_{ST,i,m}) \cdot EN_{BL,i,m}}{J_{ST,i,y}} \quad \text{(G)}$$

= [450 x (8,760 – 1305.94) x 2,800]/ 1

= 9,392TJ

$SC_{PCSG,i,y}$ i.e. Total steam self-generated by project customer i during year y of the crediting period (TJ) is assumed zero for ex-ante calculations and will be monitored for ex-post calculations.

Thus, putting these in equation (E),

$SC_{BL,j,i,y}$ = min (7,625; (9,392– 0))
= 7,625 TJ

Further,

$$SEF_{BL,i,y} = \frac{44}{12} \cdot \frac{\sum_k \left(CEF_{i,k} \cdot FC_{ST,i,k} \right)}{\sum_k HG_{ST,i,k}} \quad \text{(H)}$$

$$HG_{ST,i,k} = H_{ST,i,k} \cdot EN_{BL,i} \quad \text{(I)}$$

= 5,601.6 TJ

$$FC_{ST,i,k} = F_{ST,i,k} \cdot NCV_{i,k} \qquad (J)$$

= 5,922 TJ

Keeping these values in equation (H),

As $CEF_{i,k}$ is directly CO_2 emission factor and not Carbon emission factor, ratio 44/12 is not used.

$SEF_{BL,i,j}$= 81.83 tCO_2/ TJ

Thus, equation (D) becomes

Please note that $SC_{PJ,j,i,y}$ is lower (7,625 TJ) than the $SC_{MG,i}$ (Total historical capacity of steam generation of the equipment existing at project customer – 9,392 TJ). This is due to the fact that pre-project steam generation capacity was 450 TPH higher than the project activity steam generation capacity 340.42 TPH. Now, further if the existing equipment is used, this will be monitored as $SC_{PCSG,i,y}$ and deducted from $SC_{MG,i}$ to arrive at $SC_{BL,j,i,y}$.

$BE_{ST,y}$ = 7,625 x81.83
= 623,959 tCO_2

(c) Emissions for the production of electricity that would be supplied to the grid in year y in the baseline scenario

$$BE_{GR,y} = \sum_{j} EL_{PF,GR,j,y} \cdot EF_{PF,GR,j,y}$$

Estimated 63 MW is planned to be sold to the grid and other industrial units = 504,000 MWh

Thus,
$BE_{GR,y}$ = 504,400 x 0.5742
= 289,397 tCO_2

Thus, total baseline emissions from equation A

BEy = 1,424,459tCO_2

Project emissions (PE_y):

From the 'Tool to calculate project or leakageCO_2 emissions from fossil fuel combustion'

PEy = $FC_{i,y}$ x $COEF_i$

Project activity will use only natural gas at estimated 2.333 TJ/ hr.
This natural gas at planned 8,000 operation hours a year becomes 18,664 TJ.

Thus, PE = 18,664 (TJ) x 56.1 (tCO_2/TJ)[26]
= 1,047,050 tCO_2

Leakage (LE_y):

[26] 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Chapter 1, pg. 1.24 (this will be monitored ex-post)

1) Fugitive methane emissions

Global average value as recommended in the baseline methodology, AM0048, page 16 i.e. 296 tCH_4/PJ is used.

$LE_{CH4,y}$ = 21 x (18,664/ 1000) PJ x 296 tCH_4/PJ

= 116,015tCO_2

Emission Reductions (ER_y)

ER_y = **261,393tCO_2**

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

Year	Estimation of project activity emissions (tonnes of CO_2e)	Estimation of baseline emissions (tonnes of CO_2e)	Estimation of leakage (tonnes of CO_2e)	Estimation of overall emission reductions (tonnes CO_2e)
2012	1,047,050	1,424,459	116,015	261,393
2013	1,047,050	1,424,459	116,015	261,393
2014	1,047,050	1,424,459	116,015	261,393
2015	1,047,050	1,424,459	116,015	261,393
2016	1,047,050	1,424,459	116,015	261,393
2017	1,047,050	1,424,459	116,015	261,393
2018	1,047,050	1,424,459	116,015	261,393
2019	1,047,050	1,424,459	116,015	261,393
2020	1,047,050	1,424,459	116,015	261,393
2021	1,047,050	1,424,459	116,015	261,393
Total (tonnes of CO_2e)	**10,470,500**	**1,424,459**	**1,160,150**	**261,393**

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

B.7.1 Data and parameters monitored:

Data / Parameter:	**$CEF_{j,k}$**
Data unit:	tCO_2/TJ
Description:	Carbon emission factor of fuel ‘k’ used by project facility ‘j’ to self-generate electricity in the baseline scenario.
Source of data to be used:	In absence of the project specific data, as suggested in the baseline methodology default value recommended by IPCC is used.2006 IPCC Guidelines for National Greenhouse Gas Inventories, Chapter 1, pg. 1.23
Value of data	77.4
Measurement procedures (if any):	Default value as recommended by baseline methodology is used
Monitoring frequency:	annual
QA/QC procedures to be applied:	Default value form IPCC is used, QA/QC not required by PP
Any comment:	-

Data / Parameter:	$COEF_i$
Data unit:	tCO_2/TJ
Description:	Carbon emission factor of natural gas used by project facility to generate electricity in the project activity scenario.
Source of data to be used:	In absence of the project specific data, as suggested in the baseline methodology default value recommended by IPCC is used.2006 IPCC Guidelines for National Greenhouse Gas Inventories, Chapter 1, pg. 1.24
Value of data	56.1
Measurement procedures (if any):	Default value as recommended by baseline methodology is used
Monitoring frequency:	annual
QA/QC procedures to be applied:	Default value form IPCC is used, QA/QC not required by PP
Any comment:	-

Data / Parameter:	$EF_{CH4,ups,k}$
Data unit:	tCH_4/TJ
Description:	Emission factor for upstream fugitive methane emissions from production, transportation and distribution of natural gas
Source of data to be used:	IPCC default Tier 1 emission factor as suggested in the baseline methodology AM0048, V. 03, pg. 15
Value of data	296
Measurement procedures (if any):	-
Monitoring frequency:	-
QA/QC procedures to be applied:	-
Any comment:	-

Data / Parameter:	$EF_{CO2,ups,LNG}$
Data unit:	tCO_2/TJ
Description:	Emission factor for upstream CO_2 emissions due to fossil fuel combustion / electricity consumption associated with the liquefaction, transportation, regasification and compression of LNG into a natural gas transmission or distribution system.
Source of data to be used:	IPCC default Tier 1 emission factor as suggested in the baseline methodology AM0048, V. 03, pg. 16
Value of data	6
Measurement procedures (if any):	-
Monitoring frequency:	-
QA/QC procedures to be applied:	-
Any comment:	-

Data / Parameter:	$EL_{PCSG,i,y}$
Data unit:	MWh
Description:	Total electricity self-generated by IRPC during year ‘y’ of the crediting period (MWh)
Source of data to be used:	Electricity meter at IRPC new power plant
Value of data	0

Measurement procedures (if any):	Value will be directly read form the electricity meter and recorded in the SAP Monitoring: Net electricity is computed after the deduction of auxiliary consumption from the gross electricity generation. Electricity meter in control room will measure the net quantity of electricity generated Data type: Measure Responsibility: Turbine operator would be responsible for monitoring and checks for regular calibration of electricity meter. Shift Supervisors will be responsible for calibration of the electricity meters. The daily readings will be further cross checked by the Manager (Production). Recording Frequency: continuous monitoring with monthly recording Archiving procedure: Paper and Electronic Calibration Frequency: Once in every two years Accuracy class: 0.5s
Monitoring frequency:	monthly
QA/QC procedures to be applied:	Crosscheck with salesreceipts and electricity supply data at project site.
Any comment:	The project boundary units are all substituted/ standby. In any case, there was not electricity generation in the project boundary and electricity was imported.

Data / Parameter:	**$SC_{PCSG,i,y}$**
Data unit:	TJ
Description:	Total steam self-generated by IRPC during year ‘y’ of the crediting period
Source of data to be used:	Steam flow meter at IRPC new power plant
Value of data	0
Measurement procedures (if any):	Value will be directly read form the steam flow meter and recorded in SAP Monitoring: total steam generated is measured in flow meter and multiplied by its enthalpy (calculated using steam pressure and temperature) to energy Data type: Calculate Responsibility: Turbine operator would be responsible for monitoring and checks for regular calibration of steam flow meter, pressure gauge and temperature meter. Shift Supervisors will be responsible for calibration of the meters. The daily readings will be further cross checked by the Manager (Engineering). Recording Frequency: continuous monitoring with monthly recording Archiving procedure: Paper and Electronic Calibration Frequency: Once in every two years Acceptable error: 2%
Monitoring frequency:	monthly
QA/QC procedures to be applied:	Crosscheck with sales receipts and steam supply data at project site
Any comment:	Equivalent to installed capacity in project activity = 408.498 TPH at 20 and 43 bar

Data / Parameter:	**$EL_{PF,GR,j,y}$**
Data unit:	MWh
Description:	Electricity supplied to the grid by the proposed project facility ‘j’ in year ‘y’
Source of data to be used:	Electricity meter at dispatch point of the IRPC

Value of data	504,000
Measurement procedures (if any):	Value will be directly read from the electricity meter and recorded in SAP Monitoring: Net electricity is computed after the deduction of import from the gross electricity generation. Electricity meter in control room will measure the net quantity of electricity generated Data type: Measure Responsibility: Turbine operator would be responsible for monitoring and checks for regular calibration of electricity meter. Shift Supervisors will be responsible for calibration of the electricity meters. The daily readings will be further cross checked by the Manager (Production). Recording Frequency: continuous monitoring with monthly recording Archiving procedure: Paper and Electronic Calibration Frequency: Once in every two years Meter accuracy: ±0.5s% class
Monitoring frequency:	monthly
QA/QC procedures to be applied:	Crosscheck with salesreceipts and electricity supply data at project site
Any comment:	Estimated 63 MW capacity can be utilized for the grid sale

Data / Parameter:	$EL_{PJ,j,i,y}$
Data unit:	MWh
Description:	Electricity utilised by the IRPC from the proposed project facility 'j' in year 'y'.
Source of data to be used:	Electricity meter at IRPC new power plant
Value of data	974,880
Measurement procedures (if any):	Value will be directly read form the electricity meter and recorded in the log book Data type: Measure Responsibility: process plant operators would be responsible for monitoring and checks for regular calibration of electricity meter. Shift Supervisors will be responsible for calibration of the electricity meters. The daily readings will be further cross checked by the Manager (Production). Recording Frequency: continuous monitoring with monthly recording Archiving procedure: Paper and Electronic Calibration Frequency: Once in every two years Accuracy class: 1%
Monitoring frequency:	monthly
QA/QC procedures to be applied:	Crosscheck with sales receipts and electricity supply data at project site.
Any comment:	-

Data / Parameter:	$EL_{PJ,j1,i,y}$
Data unit:	MWh
Description:	Electricity utilised by the Customer 1 (TCL) from the proposed project facility 'j' in year 'y'.
Source of data to be used:	Electricity meter at IRPC new power plant/ recipient facility
Value of data	0 (will be monitored ex-post)
Measurement	Value will be directly read form the electricity meter and recorded in the log

procedures (if any):	book Data type: Measure Responsibility: process plant operators would be responsible for monitoring and checks for regular calibration of electricity meter. Shift Supervisors will be responsible for calibration of the electricity meters. The daily readings will be further cross checked by the Manager (Production). Recording Frequency: continuous monitoring with monthly recording Archiving procedure: Paper and Electronic Calibration Frequency: Once in every two years Accuracy class: 1%
Monitoring frequency:	monthly
QA/QC procedures to be applied:	Crosscheck with sales receipts and electricity supply data at project site.
Any comment:	TCL has contracted 10.1 MW electricity, so exact exported units (MWh) are not given now in this table and will be monitored ex-post

Data / Parameter:	**$EL_{PJ,j2,i,y}$**
Data unit:	MWh
Description:	Electricity utilised by the customer 2 (TSR) from the proposed project facility 'j' in year 'y'.
Source of data to be used:	Electricity meter at IRPC new power plant / recipient facility
Value of data	0 (will be monitored ex-post)
Measurement procedures (if any):	Value will be directly read form the electricity meter and recorded in the log book Data type: Measure Responsibility: process plant operators would be responsible for monitoring and checks for regular calibration of electricity meter. Shift Supervisors will be responsible for calibration of the electricity meters. The daily readings will be further cross checked by the Manager (Production). Recording Frequency: continuous monitoring with monthly recording Archiving procedure: Paper and Electronic Calibration Frequency: Once in every two years Accuracy class: 1%
Monitoring frequency:	monthly
QA/QC procedures to be applied:	Crosscheck with sales receipts and electricity supply data at project site.
Any comment:	TSR has contracted 7.4 MW electricity, so exact exported units (MWh) are not given now in this table and will be monitored ex-post

Data / Parameter:	**$EN_{PJ,i}$**
Data unit:	TJ/ ton
Description:	Specific enthalpy of the steam utilised by IRPC. This data shall be obtained from steam tables, using temperature and pressure of the steam
Source of data to be used:	Steam tables
Value of data	2800
Measurement procedures (if any):	Use monitored pressure and temperature of the steam to obtain specific enthalpy from steam tables Data type: Measure

	Responsibility: process plant operators would be responsible for monitoring and checks for regular calibration of meters. Shift Supervisors will be responsible for calibration of the meters. The daily readings will be further cross checked by the Manager (Engineering). Recording Frequency: continuous monitoring with monthly recording Archiving procedure: Paper and Electronic Calibration Frequency: Once in every two years
Monitoring frequency:	monthly
QA/QC procedures to be applied:	Steam flow, pressure and temperature Meters shall be calibrated as per once in two years
Any comment:	Saturated steam at 20 and 43 bar

Data / Parameter:	**$EN_{PJ1,i}$**
Data unit:	TJ/ ton
Description:	Specific enthalpy of the steam utilised by Customer 1 (TCL). This data shall be obtained from steam tables, using temperature and pressure of the steam
Source of data to be used:	Steam tables
Value of data	2800
Measurement procedures (if any):	Use monitored pressure and temperature of the steam to obtain specific enthalpy from steam tables Data type: Measure Responsibility: process plant operators would be responsible for monitoring and checks for regular calibration of meters. Shift Supervisors will be responsible for calibration of the meters. The daily readings will be further cross checked by the Manager (Engineering). Recording Frequency: continuous monitoring with monthly recording Archiving procedure: Paper and Electronic Calibration Frequency: Once in every two years
Monitoring frequency:	monthly
QA/QC procedures to be applied:	Steam flow, pressure and temperature Meters shall be calibrated as per once in two years
Any comment:	Saturated steam at 20 and 43 bar

Data / Parameter:	**$EN_{PJ2,i}$**
Data unit:	TJ/ ton
Description:	Specific enthalpy of the steam utilised by Customer 2 (TSR). This data shall be obtained from steam tables, using temperature and pressure of the steam
Source of data to be used:	Steam tables
Value of data	2800
Measurement procedures (if any):	Use monitored pressure and temperature of the steam to obtain specific enthalpy from steam tables Data type: Measure Responsibility: process plant operators would be responsible for monitoring and checks for regular calibration of meters. Shift Supervisors will be responsible for calibration of the meters. The daily readings will be further cross checked by the Manager (Engineering). Recording Frequency: continuous monitoring with monthly recording

	Archiving procedure: Paper and Electronic Calibration Frequency: Once in every two years
Monitoring frequency:	monthly
QA/QC procedures to be applied:	Steam flow, pressure and temperature Meters shall be calibrated as per once in two years
Any comment:	Saturated steam at 20 and 43 bar

Data / Parameter:	**Steam pressure**
Data unit:	bar
Description:	Pressure of steam utilised by IRPC
Source of data to be used:	Pressure meters at IRPC
Value of data	20 and 43
Measurement procedures (if any):	Value will be directly read from steam pressure gauge Data type: Measure Responsibility: process plant operators would be responsible for monitoring and checks for regular calibration of meters. Shift Supervisors will be responsible for calibration of the meters. The daily readings will be further cross checked by the Manager (Engineering). Recording Frequency: continuous monitoring with monthly recording Archiving procedure: Paper and Electronic Calibration Frequency: Once in every two years Accuracy class: 0.2%
Monitoring frequency:	monthly
QA/QC procedures to be applied:	Crosscheck with records of common steam header
Any comment:	-

Data / Parameter:	**Steam pressure**
Data unit:	bar
Description:	Pressure of steam utilised by Customer 1 (TCL)
Source of data to be used:	Pressure meters at Customer 1 recipient facility
Value of data	20 and 43
Measurement procedures (if any):	Value will be directly read from steam pressure gauge Data type: Measure Responsibility: process plant operators would be responsible for monitoring and checks for regular calibration of meters. Shift Supervisors will be responsible for calibration of the meters. The daily readings will be further cross checked by the Manager (Engineering). Recording Frequency: continuous monitoring with monthly recording Archiving procedure: Paper and Electronic Calibration Frequency: Once in every two years Accuracy class: 0.2%
Monitoring frequency:	monthly
QA/QC procedures to be applied:	Crosscheck with records of common steam header
Any comment:	-

Data / Parameter:	**Steam pressure**

Data unit:	bar
Description:	Pressure of steam utilised by Customer 2 (TSR)
Source of data to be used:	Pressure meters at Customer 2 recipient facility
Value of data	20 and 43
Measurement procedures (if any):	Value will be directly read from steam pressure gauge Data type: Measure Responsibility: process plant operators would be responsible for monitoring and checks for regular calibration of meters. Shift Supervisors will be responsible for calibration of the meters. The daily readings will be further cross checked by the Manager (Engineering). Recording Frequency: continuous monitoring with monthly recording Archiving procedure: Paper and Electronic Calibration Frequency: Once in every two years Accuracy class: 0.2%
Monitoring frequency:	monthly
QA/QC procedures to be applied:	Crosscheck with records of common steam header
Any comment:	-

Data / Parameter:	**Steam temperature**
Data unit:	°C
Description:	Temperature of steam utilised by IRPC
Source of data to be used:	Temperature meters at IRPC
Value of data	-
Measurement procedures (if any):	Value will be directly read from steam pressure gauge Data type: Measure Responsibility: process plant operators would be responsible for monitoring and checks for regular calibration of meters. Shift Supervisors will be responsible for calibration of the meters. The daily readings will be further cross checked by the Manager (Engineering). Recording Frequency: continuous monitoring with monthly recording Archiving procedure: Paper and Electronic Calibration Frequency: Once in every two years Accuracy class: 2°C
Monitoring frequency:	monthly
QA/QC procedures to be applied:	Crosscheck with records of common steam header
Any comment:	-

Data / Parameter:	**Steam temperature**
Data unit:	°C
Description:	Temperature of steam utilised by Customer 1 (TCL)
Source of data to be used:	Temperature meters at Customer 1 recipient facility
Value of data	-
Measurement procedures (if any):	Value will be directly read from steam pressure gauge Data type: Measure Responsibility: process plant operators would be responsible for monitoring

	and checks for regular calibration of meters. Shift Supervisors will be responsible for calibration of the meters. The daily readings will be further cross checked by the Manager (Engineering). Recording Frequency: continuous monitoring with monthly recording Archiving procedure: Paper and Electronic Calibration Frequency: Once in every two years Accuracy class: 2°C
Monitoring frequency:	monthly
QA/QC procedures to be applied:	Crosscheck with records of common steam header
Any comment:	-

Data / Parameter:	**Steam temperature**
Data unit:	°C
Description:	Temperature of steam utilised by Customer 2 (TSR)
Source of data to be used:	Temperature meters at Customer 2 recipient facility
Value of data	-
Measurement procedures (if any):	Value will be directly read from steam pressure gauge Data type: Measure Responsibility: process plant operators would be responsible for monitoring and checks for regular calibration of meters. Shift Supervisors will be responsible for calibration of the meters. The daily readings will be further cross checked by the Manager (Engineering). Recording Frequency: continuous monitoring with monthly recording Archiving procedure: Paper and Electronic Calibration Frequency: Once in every two years Accuracy class: 2°C
Monitoring frequency:	monthly
QA/QC procedures to be applied:	Crosscheck with records of common steam header
Any comment:	-

Data / Parameter:	$FC_{LNG,j,y}$
Data unit:	m^3
Description:	Quantity of LNG consumed in the year ‘y’ in the project facilities
Source of data to be used:	Gas flow meter at the IRPC new power plant
Value of data	0
Measurement procedures (if any):	-
Monitoring frequency:	-
QA/QC procedures to be applied:	Crosscheck with LNG purchase receipts/ invoices
Any comment:	LNG use is not envisaged

Data / Parameter:	$FC_{PJ,PF,j,k,y}$
Data unit:	m^3
Description:	Quantity of natural gas consumed in the year ‘y’ in the project facilities
Source of data to be	Gas flow meter at the IRPC new power plant

used:	
Value of data	-
Measurement procedures (if any):	Value will be directly recorded from the gas flow meter and averaged monthly Data type: Measure Responsibility: process plant operators would be responsible for monitoring and checks for regular calibration of meters. Shift Supervisors will be responsible for calibration of the meters. The daily readings will be further cross checked by the Manager (Production). Recording Frequency: continuous monitoring with monthly recording Archiving procedure: Paper and Electronic Calibration Frequency: Once in every three years Accuracy class: 2%
Monitoring frequency:	monthly
QA/QC procedures to be applied:	Meters shall be calibrated as per their data book. Measuring conditions shall be as per meters data book. Crosscheck with NG purchase receipts/ invoices
Any comment:	Presently 2.333 TJ/ hr based on design specifications

Data / Parameter:	**NCV_{NG}**
Data unit:	TJ/ ton
Description:	Net calorific value of natural gas fuel
Source of data to be used:	It will be used as supplied by the gas suppliers' invoice
Value of data	0.048
Measurement procedures (if any):	This is third party measured and given value for commercial purpose and will be used directly for the emission reduction calculation
Monitoring frequency:	monthly
QA/QC procedures to be applied:	This is a third party given value and does not require any QA/ QC by PP
Any comment:	-

Data / Parameter:	**$STT_{PU,j,i,y}$**
Data unit:	Ton
Description:	Steam utilized by IRPC from the new power plant
Source of data to be used:	Steam flow meter at the project activity power plant
Value of data	2,723,320
Measurement procedures (if any):	Value will be directly read from the steam flow meter Data type: Measure Responsibility: process plant operators would be responsible for monitoring and checks for regular calibration of meters. Shift Supervisors will be responsible for calibration of the meters. The daily readings will be further cross checked by the Manager (Production). Recording Frequency: continuous monitoring with monthly recording Archiving procedure: Paper and Electronic Calibration Frequency: Once in every two years Accuracy class: 2%
Monitoring frequency:	monthly
QA/QC procedures to be applied:	cross check with in house consumption steam balance and sales receipts from customers

Any comment:	Equivalent to 408.498 TPH

Data / Parameter:	**$STT_{PU1,j,i,y}$**
Data unit:	Ton
Description:	Steam utilized by Customer 1 (TCL) from the new power plant
Source of data to be used:	Steam flow meter at TCL recipient facility
Value of data	0 (will be monitored ex-post)
Measurement procedures (if any):	Value will be directly read from the steam flow meter Data type: Measure Responsibility: process plant operators would be responsible for monitoring and checks for regular calibration of meters. Shift Supervisors will be responsible for calibration of the meters. The daily readings will be further cross checked by the Manager (Production). Recording Frequency: continuous monitoring with monthly recording Archiving procedure: Paper and Electronic Calibration Frequency: Once in every two years Accuracy class: 2%
Monitoring frequency:	monthly
QA/QC procedures to be applied:	cross check with in-house consumption steam balance and sales receipts from customers
Any comment:	Equivalent to 408.498 TPH

Data / Parameter:	**$STT_{PU2,j,i,y}$**
Data unit:	Ton
Description:	Steam utilized by Customer 2 (TSR) from the new power plant
Source of data to be used:	Steam flow meter at the TSR recipient facility
Value of data	0 (will be monitored ex-post)
Measurement procedures (if any):	Value will be directly read from the steam flow meter Data type: Measure Responsibility: process plant operators would be responsible for monitoring and checks for regular calibration of meters. Shift Supervisors will be responsible for calibration of the meters. The daily readings will be further cross checked by the Manager (Production). Recording Frequency: continuous monitoring with monthly recording Archiving procedure: Paper and Electronic Calibration Frequency: Once in every two years Accuracy class: 2%
Monitoring frequency:	monthly
QA/QC procedures to be applied:	cross check with in-house consumption steam balance and sales receipts from customers
Any comment:	-

Data / Parameter:	**$FC_{PJ,BF,j,k,y}$**
Data unit:	m^3
Description:	Quantity of fossil fuel consumed per fuel type 'k' in the year 'y' in the baseline facilities
Source of data to be used:	Fossil fuel mass/ flow meter at the IRPC existing utilities plant (pre-project)

Value of data	-
Measurement procedures (if any):	Value will be directly recorded from the mass/ flow meter and averaged monthly
Monitoring frequency:	Continuous monitoring with monthly recording
QA/QC procedures to be applied:	Meters shall be calibrated once in two years Check consistency with historical monitored data
Any comment:	This will be metered in case the stand by units are operated during the crediting period

Data / Parameter:	**$NCV_{BF,j,k,y}$**
Data unit:	TJ/ ton
Description:	Net calorific value of fossil fuel consumed per fuel type 'k' in the year 'y' in the baseline facilities
Source of data to be used:	It will be used as supplied by the fuel suppliers' invoice
Value of data	0.048
Measurement procedures (if any):	This is third party measured and given value for commercial purpose and will be used directly for the emission reduction calculation
Monitoring frequency:	monthly
QA/QC procedures to be applied:	This is a third party given value and does not require any QA/ QC by PP
Any comment:	This will be metered in case the stand by units are operated during the crediting period

Data / Parameter:	**$STT_{PU,j,i,y}$**
Data unit:	Ton
Description:	Steam utilized by IRPC from the existing utilities plant (pre-project)
Source of data to be used:	Steam flow meter at the existing power plant
Value of data	0
Measurement procedures (if any):	Value will be directly read from the steam flow meter
Monitoring frequency:	Continuous monitoring with monthly recording
QA/QC procedures to be applied:	Meters shall be calibrated once in two years cross check with in-house consumption steam balance and sales receipts from customers
Any comment:	This will be metered in case the stand by units are operated during the crediting period. Presently these boilers are proposed to be scrapped

Data / Parameter:	**$STT_{PU1,j,i,y}$**
Data unit:	Ton
Description:	Steam utilized by Customer 1 (TCL) from the existing utilities plant (pre-project)
Source of data to be used:	Steam flow meter at the existing power plant
Value of data	0
Measurement procedures (if any):	Value will be directly read from the steam flow meter
Monitoring frequency:	Continuous monitoring with monthly recording
QA/QC procedures to be applied:	Meters shall be calibrated once in two years cross check with in-house consumption steam balance and sales receipts from customers

Any comment:	This will be metered in case the stand by units are operated during the crediting period. Presently these boilers are proposed to be scrapped

Data / Parameter:	**$STT_{PU2,j,i,y}$**
Data unit:	Ton
Description:	Steam utilized by Customer 2 (TSR)from the existing utilities plant (pre-project)
Source of data to be used:	Steam flow meter at the existing power plant
Value of data	0
Measurement procedures (if any):	Value will be directly read from the steam flow meter
Monitoring frequency:	Continuous monitoring with monthly recording
QA/QC procedures to be applied:	Meters shall be calibrated once in two years cross check with in-house consumption steam balance and sales receipts from customers
Any comment:	This will be metered in case the stand by units are operated during the crediting period. Presently these boilers are proposed to be scrapped

Data monitored because of Baseline Scenario Selection/Additionality

Data / Parameter:	*Future energy plans and investment plans of IRPC, TCL and TSR*
Data unit:	-
Description:	Modernization or investment plans outlining planned upgrades or replacement to any generating unit within the project boundaries
Source of data to be used:	This will be updated as per the business plan, if any
Value of data	-
Measurement procedures (if any):	-
Monitoring frequency:	-
QA/QC procedures to be applied:	-
Any comment:	-

B.7.2. Description of the monitoring plan:

The project activity is operated and managed by the project proponent through internal operations team. The individual control rooms in the plant record data related to their respective equipments in the project activity. The project activity plant will abide by all regulatory and statutory requirements as prescribed under the state and central laws and regulations.

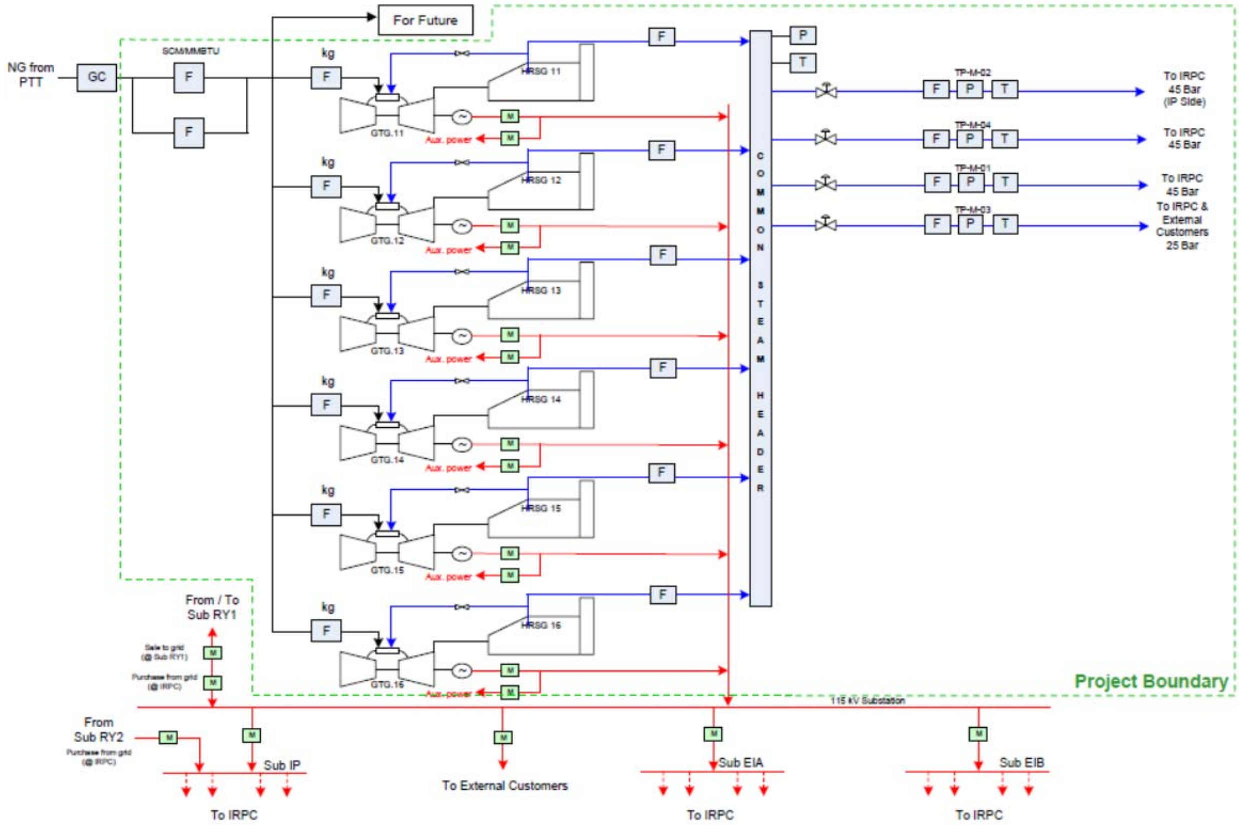


Figure: Process diagram of the project activity indicating monitoring equipments

A CDM project team has been established at the plant site in coordination with the Head Office. The project team is entrusted with the responsibility of storing, recording the data related to the project activity. The project team is also responsible for calculation of actual creditable emission reduction in the most transparent and relevant manner. Installed meters are calibrated according to the maintenance schedule programmed at the start of the operation and recalibrated according to the plant's performance requirement. All the monitoring data will be stored, recorded and kept under safe custody of the Project Coordinator at the plant site for the full crediting period + 2 years.

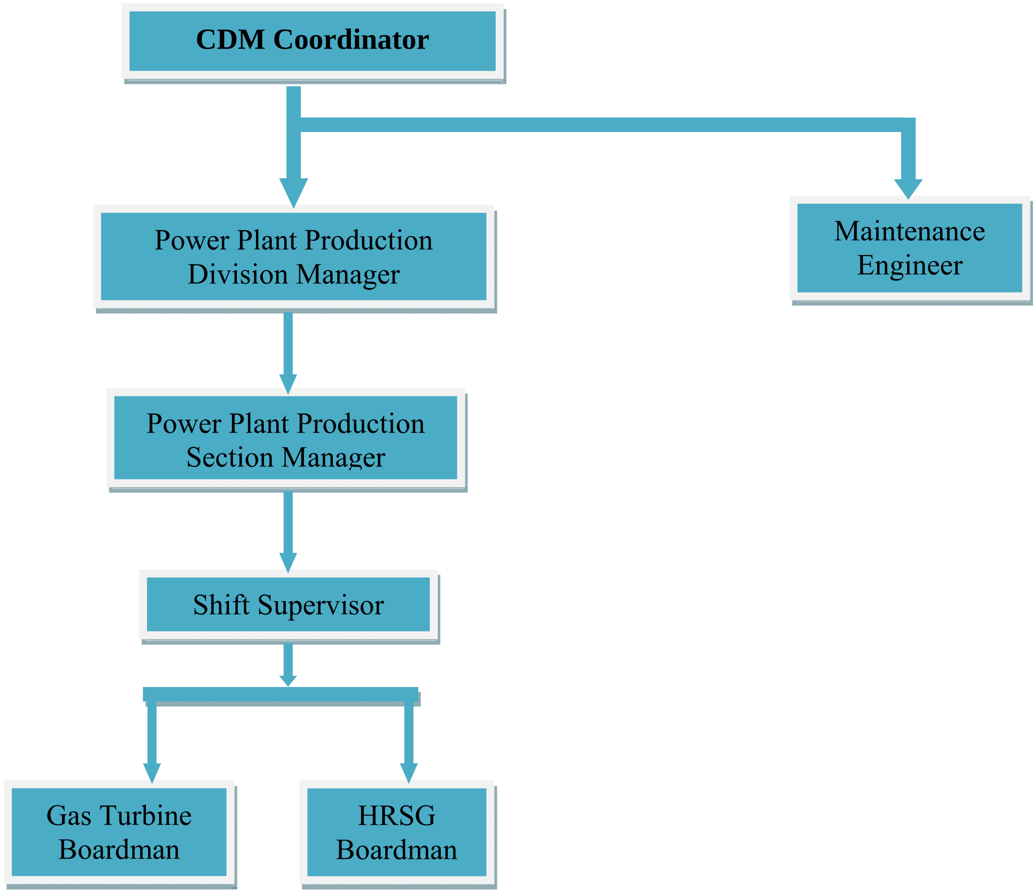
Performance reporting (QA/QC procedures):

The major parameters to be monitored are also part of the regular performance reporting. This system will also be utilized for the QA/QC procedures in the CDM project activity. The electricity generated is metered in the control room. The net electricity supplied to IRPC, grid and each of the project customers will also be cross checked with the meters installed at the receiving points with that of SCADA/ SAP records. The steam generated by the CDM project activity will also be cross checked with the monthly invoices of steam sale from customers and IRPC process plant records.

If any fossil fuels are used (in the stand by units), this will be directly metered as part of the regular operations procedure and cross checked with the monthly invoices of steam purchase from customers and receipt by IRPC process plant.

In case of both the net electricity and steam generation from the CDM project activity, are not matching with the cross check method, the lower value of two records will be used for conservative emission reduction calculations.

The CDM coordinator will also monthly review the data received, any abnormal readings and also the calibration requirements if any.



Designation	Responsibilities
CDM Coordinator	Registration Project Execution
Power Plant Production Divisional Manager and Maintenance Engineer	Operation Verification of data Inspection of data whenever necessary to independently check the authenticity of data and take corrective actions wherever required. Storage of data
Power Plant Section Production Manager	Operation, Monitoring and Verification of Data Data Recording Storage of data
Shift Supervisor With GT Boardman and HRSG Boardman	Operation and Maintenance Storage of data Data Recording Data Collection Archiving of data

Emergency Preparedness Plan:

There are not envisaged to be any incidents of unintended GHG emissions. However, a systematic plan is made in order to avoid any such incidents. The only GHG used in the project activity is natural gas (the fuel in gas turbines). This is directly taken from a piping station maintained by the gas supplier. Thus,

there is no possibility of its leakage from any storage etc. This is metered at the gas skid for the receipt and purification of the incoming gas. After that, this is circulated from all metered lines and a mass balance can be observed online for the gas received in an hour and utilized in each of the gas turbines. There are no other GHGs that could lead to accidental release creating unintended emissions.

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):

29/09/2012
IRPC Public Company Limited (IRPC), Bangkok
and their CDM Advisors General Carbon (www.general-carbon.com).

IRPC is the project participant and contact details are given in Annex 1.

SECTION C. Duration of the project activity / crediting period

C.1. Duration of the project activity:

C.1.1. Starting date of the project activity:

12/10/2007
This is the date of supply agreement for main energy units (gas turbines). It is taken as the starting date of the project activity which is the first major expense and financial commitment for the implementation of the project activity by PP.

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

20 years 0 months

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

Fixed crediting period is chosen

C.2.1. Renewable crediting period:

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

C.2.1.2. Length of the first crediting period:

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

15/05/2012 or the date of registration whichever is later

C.2.2.2. Length:

10 years 0 months

SECTION D. Environmental impacts

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

The project activity is taking place inside an existing industrial complex and within a notified industrial area. Thus, it will not have any direct impact on the environment and surrounding localities – human/ animal/ flora. As per the requirements, a detailed EIA study is completed by Air Save Co. Ltd. in July 2007. The report has identified various impacts and its mitigation measures are also suggested. The section discussed different aspects of the identified impacts.

1) Physical Impact to Surrounding Resources

1.1 Geology:

The project located inside the IRPC industrial complex which has been developed for the expansion of the industry and the land site has already been prepared for construction. Therefore there is no further requirement to change the geological landscape and the surrounding area of the project consist of existing factories or empty land waiting to be used for building more factories. Therefore the project will have very little impact on the changes of the area during construction.

1.2 Geological and Agronomy Appearance:

There are no mineral resources and the soil have good water drainage.

Since the project is located inside the industrial complex, the impact on geology or agronomy is very low.

1.3 Air Quality:

(1) During Construction

Air pollution during construction will be the dust from construction or from vehicle transporting the building material. The amount of dust will not be severe and may affect the workers at site only.

(2) Operation Period

2.1) Source of Pollution from the Project

The main source of pollution from the project is from the 6 units of smoke stacks. But since the fuel used is natural gas which is clean. Pollutants from burning NG consist of NO_x which we will give prior attention.

2.2) The Suitability of Pollution Control System

The project, beside using clean NG as fuel, it also control the occurrence of NO_x by using steam Injection System in the burning chamber to reduce peak temperature in the flame zone .

This project has been developed to replace the existing oil burn boiler with natural gas boiler, therefore, pollutant gas emission will be reduced and especially SO_2 will be reduced by 40%.

1.4 Noise Pollution Impact:

(1) During construction:

- Noise level will be at 65.2 decibel, increase from the existing 62.5 level the noise level is within the standard of national environment act no.15 (B.E.2540) which limit the noise level below 70 decibel

(2) During Operation

Noise occurred during operation coming from air compressor, HRSG, Gas Turbine and HRSG Feed Pump.

From the estimation the noise level during plant operation at Wat Pluag Gate School will remain the same at 62.5 decibel which will not impact the people in the community.

1.5 Water Quality Impact:

(1) Surface Water

1) During Construction

The project located inside the existing industrial complex which has been previously developed for further industrial expansion, it will not encroach on public water way or alter its flow. The water effluent during construction comes only from workers' residence. The effluent treatment will be done in accordant with municipal code.

Therefore, the impact on the water quality is low. Further measures include.

- Providing sufficient toilet.
- Good housekeeping in the construction site.
- Build necessary temporary water sewage.
- Build screen to trap garbage washed by rain into sewage.

2) Operating Period

The project activity does not require water in the process, coming in direct contact with any chemicals etc. Since the effluent water is mostly clean and have no toxic contaminants, the environmental impact is low.

(2) Underground Water

1) During Construction

During construction, there is no usage of underground water. Sufficient hygienic toilets will be built to prevent underground water contamination. Therefore, impact on underground water contamination is low.

2) During Operation

The operation of the project does not use underground water. Water effluent during operation will be treated and stored in storage pond. A quality check before discharging into the complex effluent storage will be undertaken. Therefore, the project operation has very low impact to underground water quality.

2) Impact to Organic Resources

The project surrounding has no forest resource or rare animals; no big wild life with economic value and it is located in the industrial complex area.

The project has good pollution control. Therefore, its impact on organic resource is low.

3) Impact on Human Utilities

3.1 Impact on land usage.

The project located inside an existing industrial complex area. Therefore, it will not increase the industrial land percentage. The land usage is in line with the National Policy on Industrial zone development and complement the urban planning. Therefore, the impact is low.

3.2 Impact on Traffic.

1) During Construction

The construction will have insignificant effect on the traffic. Therefore, the impact during construction is low.

2) During Operation

No impact on traffic during operation. Preventive measures planned are as below.

- Limit vehicle speed
- Keep strict traffic rules.
- Provide extra personnel for traffic supervision.
- Maintain vehicle at top condition.

3.3 Impact on Water Usage.

(1) During Construction

Use prefab concrete for construction, consume little water. Therefore, low impact.

(2) During Operation

The water supply will be managed by the local irrigation authority which has experience in regulating water allocation. Therefore impact on water usage of the community is low.

3.4 Electricity Usage.
(1) During Construction
The electricity supply will come from the industrial complex company. Therefore, the impact is low.
(2) During Operation
The project will generate 228 MW of electricity which is in excess of its own requirement and the excess to be sold to public utility. Therefore, the impact is low.
3.5 Water Drainage and Flood Prevention.
The project located inside an industrial complex which has been developed with a controlled drainage system capable of draining rain water from the factories into the sea efficiently. From the past record no flooding problem was found. Therefore, the impact is low.
3.6 Disposal of solid waste
(1) During Construction
The project will hire authorized garbage collector to handle the garbage created from the construction. The impact will be low.
(2) During Operation
The garbage created will be waste from production and from leftover food of the employees. The project will provide an indoor disposal centre. The impact will be low.
3.7 Impact to Agriculture.
The project area is inside the existing industrial complex. Therefore, the impact is low.

4) The Quality of Life
4.1 Social Economic Aspect.
(1) Impact to local Economy
The project will create jobs up to 500 positions for 24 months.
4.2 Public Health.
(1) During Construction
The project has good plan on preventing pollution and provide adequate number of toilet. Impact will be low.
(2) During Operation
The effect is focused on the respiratory ailment. But considered overall, the impact will be low.

4.3 Aesthetics and Tourism
There is no tourist spot within 5 km radius of the project site, beside the project is inside an industrial complex. Therefore, impact is low.

4.4 Hazard Appraisal
The project is well prepared to prevent work hazard by setting stringent standard for material and work procedure, transportation and emergency plan. Therefore, the impact is low.

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:

Only few impacts are identified as discussed above. Its mitigation measures that will be implemented are as below. The project has received approval for EIA on March 2009 from the Ministry of Natural Resources and Environment, Government of Thailand (EIA number 1009.7/2622 dated 03/04/2009).

1) Dust Pollution Control Preventions;
- All trucks to be covered
- Water spraying of the construction site
- Control vehicle speed less than 40 km/hr.

The main activity which created dust is the site preparation which lasting only a short period of 2-3 months. Therefore the environmental impact from construction will be acceptable.

2) Noise pollution control

Further measures to reduce the noise pollution impact.

- Avoid activities which create noise during night time.
- Maintain the construction equipment at top condition.
- Provide noise reduction protection kit to the workers.

During operations of the project activity plant after COD, there are no major impacts identified. The main energy generating units are in acoustic enclosure and have a lean burn, de-NOx system for control of possible pollutants. This will ensure the compliance to all the discharge norms and no impact on the environment.

SECTION E. Stakeholders' comments

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

The stakeholders were identified as the employees of the IRPC, neighbouring industries and some local residents residing in the neighbourhood villages. All the identified stakeholders, the elected representatives of the local residents, Government officials (Electricity Board, Pollution Control Board) were notified with written invitation with 15 days advance notice. Also, the stakeholders who cannot attend the meeting were given option to send their comments/ seek clarification from the contact person chosen by PP for the following 15 days.

A meeting of stakeholders was organised at the project activity site on 12/01/2010 and total 34 people attended the meeting. Those attended meeting were consist of 8 Local Administrative Officers, 3 representatives of neighbouring Factory, 5 villagers residing near the factory, 1 representative from Pollution Control Board, 1 representative from Local Electric Board; 1 representative from equipment supplier (GE Energy Co. Ltd.), 14 employees from IRPC Public Co. Ltd. and 1 CDM consultant. The meeting started with welcome address, election of chair and this was followed by a brief presentation on climate change, the Kyoto Protocol, CDM and role of project activity in sustainable development. The stakeholders were then invited to comment / seek clarification on the project activity.

E.2. Summary of the comments received:

The following queries were raised and the PP/ consultants responded to the satisfaction of the stakeholders as below.

S.N	Name	Comment/ Query	Response from PP
1	Ms.Phanumas Wuthiananchai	Where is the location of the project, commissioning schedule and where natural gas shall come from?	The project is located near the existing power plant (on the east of IRPC Seaboard Industrial Zone) on approx. 23 rai[27], with plant capacity 220 MW, the commissioning is expected in May 2011. The natural gas will be supplied by pipeline from PTT.
2	Mr. Rangsan Kulnil	How to solve the problem of bad odour and how it shall benefit the community	After completion of the project, the odor problem shall be reduced due to stoppage of operation of existing boiler which used bunker oil and the community environment shall become better. In addition, the company shall educate villagers/ representatives to jointly inspect and follow up the

[27] 1 rai =1600 m^2

			project once commissioned.
3	Mr. Prachuen Hengyi	How this project can benefit the local community?	In addition to better environment, the project shall promote employment to locals.
4	Mr. Phinyo Piriyo	This is the useful project, please rapidly take appropriate action for earliest start to project operations.	The project manager ensured timely commissioning and on behalf of the company, thanked all attendants.

The stakeholders viewed IRPC as a reputed company and appreciated local and global benefits from the project activity.

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

All the comments/ queries were satisfactorily responded by the PP and the stakeholder viewed the project as useful and one with significant contribution to local employment and sustainable development.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	IRPC Public Company Limited
Street/P.O.Box:	555/2 Vibhavadi Rangsit Road
Building:	Energy Complex, Building B, 6th Floor,
City:	Bangkok
State/Region:	-
Postcode/ZIP:	10900
Country:	Thailand
Telephone:	+66 2649 7000, +66 2649 7777
FAX:	+66 2649 7001
E-Mail:	
URL:	www.irpc.co.th
Represented by:	
Title:	
Salutation:	Mr.
Last name:	Assavadakorn
Middle name:	-
First name:	Pravet
Department:	Business Development
Mobile:	-
Direct FAX:	+66 2649 7672
Direct tel:	+66 2649 7944
Personal e-mail:	pravet.a@irpc.co.th

Annex 2

INFORMATION REGARDING PUBLIC FUNDING

Public funding from Annex I and diversion of official development assistance is not involved in this project. The project cost is met by the project participants by own sources and in part by the debt finance from banks and financial institutes.

Annex 3

BASELINE INFORMATION

Pre-project scenario in project boundary

1. Steam generation capacity

Plant	Boiler No.	Capacity (TPH)
1. Power Plant	Boiler 05	80
2. LUT	35B001A	80
	35B001B	80
	35B002A	80
	35B002B	80
3. UT1	15B030A	25
	15B030B	25
Total		**450**

2. Calculation of emission factor of grid

Here, methodological Tool 'Tool to calculate the emission factor for an electricity system', Version 02.2.1 is used. This calculation is also available in public database and is approved by the host country DNA[28]. As per following six steps are followed

STEP 1. Identify the relevant electricity systems;
The relevant project electricity system and connected electricity system is identified as the national grid. The Thailand DNA has not published any delineation of the project electricity system connected electricity system. Thus, default definition of the applicable electricity systems is used i.e. the national grid.

STEP 2. Choose whether to include off-grid power plants in the project electricity system (optional);
Option I: Only grid power plants are included in the calculation.
Option II: Both grid power plants and off-grid power plants are included in the calculation.

For this project activity, Option I is applied and only grid power plants are included in the following calculations.

STEP 3. Select a method to determine the operating margin (OM);
The calculation of the operating margin emission factor ($EF_{grid,OM,y}$) is based on one of the following methods, which are described under Step 4:
(a) Simple OM; or
(b) Simple adjusted OM; or
(c) Dispatch data analysis OM; or
(d) Average OM.

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[28]The Study of emission factor for an electricity system in Thailand 2010. Published on 30/12/2011. http://www.tgo.or.th/english/index.php?option=com_content&view=article&id=178:thailand-grid-emission-2010-report&catid=50:tgos-research-projects&Itemid=40

The simple OM method (Option a) can only be used if low-cost/must-run resources constitute less than50% of total grid generation in: 1) average of the five most recent years, or 2) based on long-termaverages for hydroelectricity production.

S. N.	Year	Hydro (GWh)	Others including geothermal, solar cell and wind turbine (GWh)	Total Low cost/must-run resources (GWh)	Generation from SPP and VSPP (GWh)	Total national grid generation (GWh)	% of low cost must run resources in total grid generation
1	2003	7,299	2	7,301	13,422	116,983	6.24%
2	2004	6,040	2	6,042	13,514	125,727	4.81%
3	2005	5,798	2	5,800	13,514	132,009	4.39%
4	2006	8,125	3	8,128	13,731	138,742	5.86%
5	2007	8,114	3	8,117	14,559	143,378	5.66%

This data is taken from publicly available data (Electricity Annual Report 2007 by DEDE Department Ministry of Energy, Thailand, Available on website:
http://www.dede.go.th/dede/fileadmin/upload/cc/EleThai110951.pdf)

Thus, the share of low cost must run power plants in the grid is below 50% and simple OM can be used.

STEP 4. Calculate the operating margin emission factor according to the selected method;

The simple OM may be calculated by one of the following two options:
Option A: Based on the net electricity generation and a CO_2 emission factor of each power unit, or
Option B: Based on the total net electricity generation of all power plants serving the system and the fuel types and total fuel consumption of the project electricity system.

The simple OM emission factor is calculated as the generation-weighted average CO_2 emissions per unit net electricity generation (tCO_2/MWh) of all generating power plants serving the system, not including low-cost / must-run power plants / units. It will be calculated according to Option A, i.e. based on the net electricity generation and a CO_2 emission factor of each power unit.

The simple OM emission factor is calculated as the generation-weighted average CO_2 emissions per unit net electricity generation (tCO_2/MWh) of all generating power plants serving the system, not including low-cost / must-run power plants / units. It will be calculated according to Option A, i.e. based on the net electricity generation and a CO_2 emission factor of each power unit.

The fuel consumption and Net Calorific Value data is taken from Electricity Annual Report 2007 by DEDE, Department Ministry of Energy, Thailand.

Year	Fuel	EGAT & IPP	SPP	$FC_{i,m,y}$	$NCV_{i,y}$	$EF_{co2,i,y}$	Total	$EG_{m,y}$	$EF_{grid,OM,y}$
		unit	unit	unit	TJ/unit	tCO_2/TJ	tCO_2	GWh	tCO_2/MWh
2005	Fuel oil million liters)	1,996	17	2,013	39.77	77.4	6,195,092		
	Diesel oil (million liters)	83	0	83	36.42	74.1	225,165		
	Coal and Lignite (Gg)	16,571	917	17,488	10.47	101	18,492,833		
	Natural gas (MMscf)	764,118	94841	858,959	1.03	56.1	49,633,228		
	Total						**74,546,368**	**130,628**	**0.5707**
2006	Fuel oil (million liters)	2,030	8	2,038	39.77	77.4	6,273,906		
	Diesel oil (million liters)	41	0	41	36.42	74.1	111,824		
	Coal and Lignite (Gg)	17,166	916	18,082	10.47	101	19,121,102		
	Natural gas (MMscf)	764,215 (Corrected value)	92888	857,103	1.03	56.1	49,525,983		
	Total						**75,032,815**	**136,609**	**0.5493**
2007	Fuel oil (million liters)	936	7	943	39.77	77.4	2,902,664		
	Diesel oil (million liters)	23	1	24	36.42	74.1	65,441		
	Coal and Lignite (Gg)	19,650	899	20,549	10.47	101	21,729,774		
	Natural gas (MMscf)	783,137	94725	877,862	1.03	56.1	50,725,500		
	Total						**75,423,379**	**139,752**	**0.5397**

The weighted average emission factor = 0.5532 tCO_2/ MWh

A 3-year generation-weighted average (2005-2007) is chosen, based on the most recent data available at the time of submission of the CDM-PDD to the DOE for validation, without requirement to monitor and recalculate the emission factor during the crediting period.

STEP 5. Calculate the build margin (BM) emission factor;

The group of power units is used for calculating the build margin (BM) emission factor which can be determined following with the option 1 (ex ante) and condition (b) B:
"*(b) Determine the annual electricity generation of the project electricity system, excluding power units registered as CDM project activities (AEGtotal, in MWh). Identify the set of power units, excluding power units registered as CDM project activities, that started to supply electricity to the gird most recently and that comprise 20% AEGtotal (if 20% falls on part of the generation of a unit, the generation of that unit is fully included in the calculation) (SET≥20%) and determine their annual electricity generation (AEGSET≥20%, in MWh)*".

The identified power plants that have been built the most recently and comprised more than 20% of the system generation in Thailand in 2007 are listed in the following table.

The ex-ante option is chosen. BM is calculated according to the most recent data available on units already built for sample group m at the time of submission of the CDM-PDD to the DOE for validation, without requirement to monitor and recalculate the emission factor during the crediting period.

Name of Power plant commercial	Operation date	Generation in 2007 (GWh)
Ratchaburi	Apr-02	13,818
Glow	Jan-03	5,271
EPEC	Mar-03	2,649
Krabi	Aug-03	1,015
BLCP	Oct-06	10,218
Total		32,971

Total grid generation in 2007	135,261 GWh
% of the set of power plants m	24.38%

Using the same DEDC Annual report, 2007, following inputs are used.

Name of Power plant commercial	Operation date	Generation in 2007 (GWh)	Type of fuel	Efficiency (BTU/ kWh)	Conversion Joules/ BTU	Energy (TJ)	$EF_{co2,i,y}$ (tCO_2/ TJ)	Emission tCO_2	$EF_{EL,m,y}$ (tCO_2 /MWh)
Ratchaburi	Apr-02	13,818	Natural gas	7,050	1,055	102,769	56.1	5,765,337	0.417
Glow	Jan-03	5,271	Natural gas	6,909	1,055	38,418	56.1	2,155,255	0.409
EPEC	Mar-03	2,649	Natural gas	6,831	1,055	19,089	56.1	1,070,919	0.404
Krabi	Aug-03	1,015	Fuel oil	8,895	1,055	9,524	77.4	737,192	0.726
BLCP	Oct-06	10,218	Coal	9,089	1,055	97,974	101	9,895,345	0.968
	Total m	32,971						$EF_{grid,BM,y}$ (tCO_2/MWh)	0.595

STEP 6. Calculate the combined margin (CM) emission factor

The combined margin emission factor CM is calculated as follows:

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

Where:

$EF_{grid,OM,y}$	=	Operating margin CO_2 emission factor in year y (tCO_2/MWh)
$EF_{grid,BM,y}$	=	Build margin CO_2 emission factor in year y (tCO_2/MWh)
w_{OM}	=	Weighting of operating margin emission factor (%)
w_{BM}	=	Weighting of build margin emission factor (%)

$\mathbf{EF_{grid,CM,y}}$ = 0.5 x 0.5532 + 0.5 x 0.595

= **0.5742 tCO_2/MWh**

Annex 4

MONITORING INFORMATION

Please refer Section B.7 above for monitoring details.

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