



**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:**

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Project Ulubelu Unit 3 – 4 PT. Pertamina Geothermal Energy  
Version 02.4  
6 February 2012

Document history:

Version 01, 3 June 2011  
Version 02, 10 August 2011  
Version 02.1, 18 November 2011  
Version 02.2, 6 December 2011  
Version 02.3, 19 January 2012  
Version 02.4, 6 February 2012

**A.2. Description of the project activity:**

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The Project Ulubelu Unit 3 – 4 PT. Pertamina Geothermal Energy (hereafter, the Project) developed by PT. Pertamina Geothermal Energy (PGE), hereafter referred to as the Project Developer, is a geothermal power plant in Lampung, Indonesia (hereafter referred to as the “Host Country”). The Project’s net installed capacity is 2 x 55 MW<sup>1</sup>, while its total gross power output installed capacity will be 2 x 58 MW. An estimated power generation of 867 GWh per annum (based on the predicted load factor of 90% multiplied with the net installed capacity) will be supplied to the grid operator.

The key purpose of the project is to utilise the geothermal resources of the mountain areas surrounding Ulubelu to generate electricity to be transmitted to the Sumatera Interconnected grid (hereafter referred to as the Grid) through the Perusahaan Listrik Negara (PLN, state-owned electricity company) interconnection point in the Ulubelu geothermal project area.

The Ulubelu geothermal field<sup>2</sup> is developed and operated by PGE as per government concession regulation and consists of production and injection wells. The Ulubelu geothermal field will supply steam to the 110 MW Ulubelu I power plant<sup>3</sup> (units 1 and 2, owned by PLN) and the Project, which is Ulubelu II power plant, (officially known as Ulubelu unit 3 and 4, owned by the Project Developer). Ulubelu I and Ulubelu II geothermal power plants are considered two different power plants that are owned and operated by different entities. In addition to that, both power plants will not share same steam wells and steam header during their operational time.

<sup>1</sup> As per technical specification documentation that was sent to PLN in October 2010, 2 x 58 MW is Ulubelu’s power output or total gross installed capacity as per turbine’s nameplate. While 2 x 55 MW is the net installed capacity, which the project developer used in the Power Purchase Agreement with PLN dated on 11 March 2011. The difference between power output or total installed capacity and net installed capacity, which is 2 x 3 MW, will be covering power plant auxiliaries (referred also as the project developer’s internal consumption).

<sup>2</sup> Ulubelu geothermal working area (concession area) is given to Pertamina (parent company of PT. Pertamina Geothermal Energy) based on Ministry of Mining and Energy Decree No. 1521 K/034/M.PE/1990 issued in 30 October 1990.

<sup>3</sup> “Ulubelu Unit I and Unit II 2 x 55 MW Geothermal Power Plant Project (PT. PLN)”. This Ulubelu power plant owned by PLN is being developed as a CDM project, submitted to UNFCCC Prior Consideration on 24 March 2010 <http://cdm.unfccc.int/Projects/PriorCDM/notifications/index.html>



As a geothermal company, PGE business has been focusing on geothermal resource development and steam production. Most of produced geothermal steam is sold<sup>4</sup> to power plant owner, and the only PGE owned power plant PLTP Kamojang unit IV<sup>5</sup> was realised in 2008 as a registered CDM project. Ulubelu II power plant will be the second total project by PGE, to have a specific Power Purchase Agreement with PLN.

The project is contributing to sustainable development of the Host Country<sup>6</sup>. Specifically, the project:

- Increasing community development and corporate social responsibility at Ulubelu geothermal area, as this project shows great improvement to existing geothermal field operation (social sustainability)
- Enhances the local investment environment and therefore improves the local economy, increases employment opportunities as 30 – 40 persons will be permanently employed for the project activity operation, another 40 persons will be employed for the Ulubelu geothermal field operation, and the construction of the project provides employment in the construction sector (economic sustainability)
- Diversifies the sources of electricity generation, which is important for meeting growing energy demands and facilitates the transition away from diesel and coal-supplied electricity generation (environmental sustainability)
- Makes greater use of geothermal renewable energy generation resources for sustainable energy production with leading local contractor (technology sustainability)

### **A.3. Project participants:**

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<b>Name of Party involved (*) (host) indicates a host Party)</b>	<b>Private and/or public entity(ies) project participants (*) (as applicable)</b>	<b>Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)</b>
Republic of Indonesia (host)	PT. Pertamina Geothermal Energy (private entity)	No
Switzerland	South Pole Carbon Asset Management Ltd. (private entity)	No

(\*) In accordance with the CDM modalities and procedures, at the time of making the CDM-PDD public at the stage of validation, a Party involved may or may not have provided its approval. At the time of requesting registration, the approval by the Party(ies) involved is required.

Further contact information of project participants is provided in Annex 1.

### **A.4. Technical description of the project activity:**

#### **A.4.1. Location of the project activity:**

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

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<sup>4</sup> PGE as a steam seller and power plant owner typically has a Steam Sales Contract (SSC). Specifically for power plant owned by PGE such as Kamojang IV and Ulubelu II, PGE has Power Purchase Agreement (PPA) with PLN. .

<sup>5</sup> Kamojang Geothermal (Project Ref. No. 3028), <http://cdm.unfccc.int/Projects/DB/RWTUV1255101629.04/view>

<sup>6</sup> Sustainable Development criteria defined by the National Commission on Climate Change (representative of Indonesian DNA) <http://pasarkarbon.dnpi.go.id/web/index.php/dnacdm/cat/5/sustainable-development-criteria-.html>



Republic of Indonesia.

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

&gt;&gt;

Lampung.

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

&gt;&gt;

Tanggamus Regency, Ulubelu Sub-district.

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

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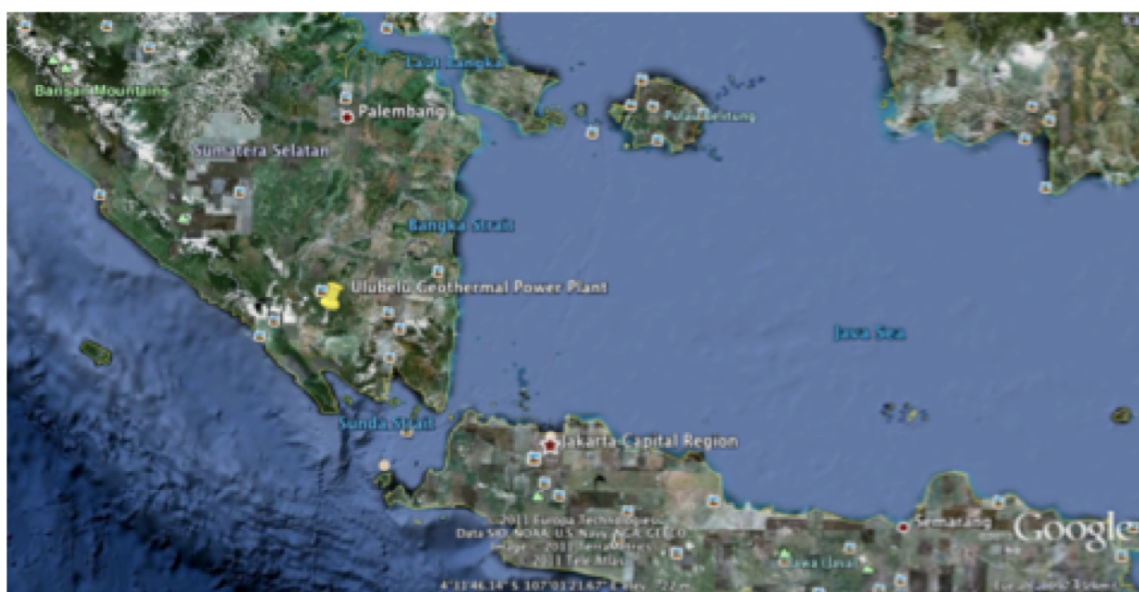


Figure 1 – Location of Ulubelu Geothermal Area. Source: Google Earth

Ulubelu II geothermal power plant is located approximately 100 km east of Bandar Lampung, the capital of Lampung province.

The exact location of the geothermal power plant is defined using GPS coordinates  $-5.30500^{\circ}$ ,  $104.57841^{\circ}$ .

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

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According to Annex A of the Kyoto Protocol, this project fits in Sectoral Category 1, Energy Industries (renewable/non renewable).

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

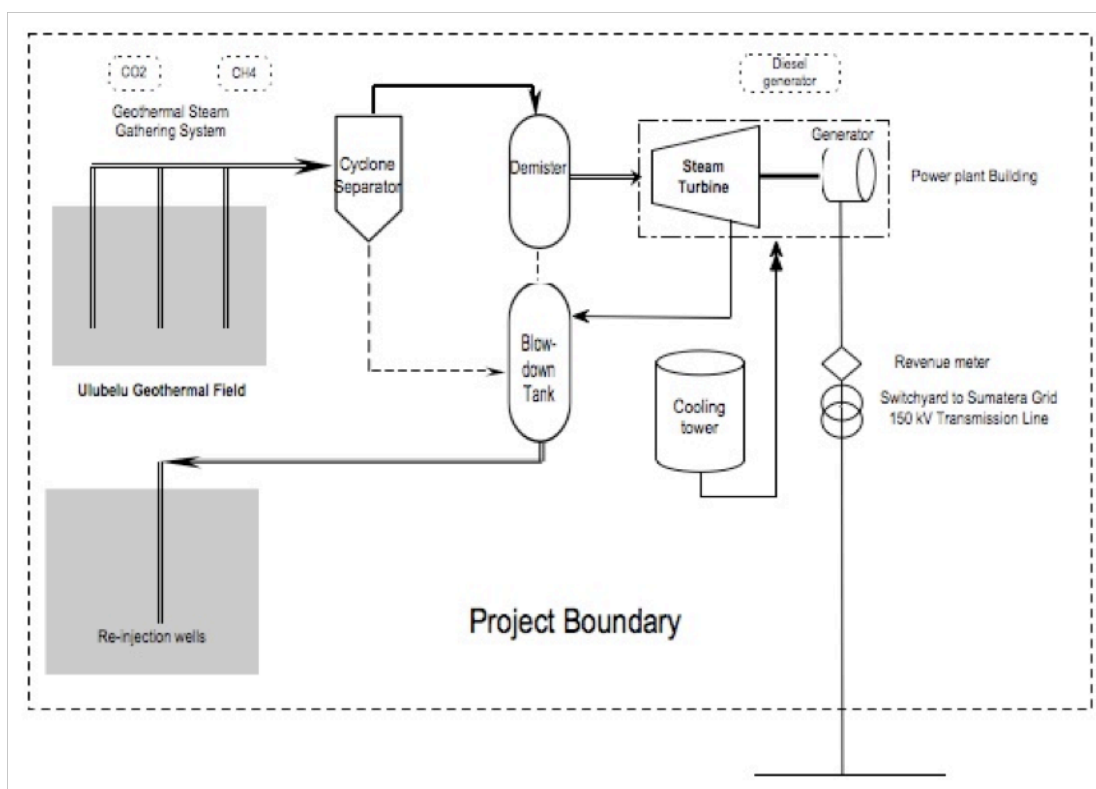
&gt;&gt;

The Project uses well-established geothermal power plant technology for electricity generation and transmission, with total gross power output of 2 x 58 MW and net installed capacity of 2 x 55 MW. The Project consists of a geothermal power plant with a steam turbine generator, gas extraction system,

switchyard and utility system. The steam for the project will be provided by active geothermal wells from the Ulubelu geothermal field, with condensate re-injection wells to maintain groundwater supply. The main technical parameters of the proposed project are shown in Table 1.

**Table 1 – Main technical parameters of the proposed project**

<i>Variable</i>	<i>Value</i>	<i>Source</i>
Turbine generator capacity (MW)	2 x 58	Power plant technical specification as sent to PLN, page D-25
Net installed capacity (MW)	2 x 55	Feasibility Study Report, page 9
Operating time yearly (hours)	7884 (8760 x 90%)	Calculated based on 90% load factor as per Feasibility Study Report, page 9
Expected annual power generation / effective supply to the grid (MWh)	867,240	Feasibility Study Report, page 9



**Figure 2 – Ulubelu Geothermal Area (wells and power plant)**

The Project will utilise state of the art but known technology in electricity generation and transmission. The geothermal steam turbine generator systems and other equipments e.g. cooling system must be imported. All supporting equipments used in the Project are produced domestically, whereby the project developer is experienced in handling and operating equipment of this nature.

Steam collected from the Ulubelu geothermal field is sent to the Ulubelu II power plant, where it is separated from condensate and fed into steam turbine generator systems (direct steam expansion). Returning condensate from the turbine and steam separator is then collected and re-injected back into the geothermal field area. Electricity produced is sold to PLN.

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

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Year	Annual estimation of emission reductions (tonnes of CO <sub>2</sub> e)
Y1	581,784
Y2	581,784
Y3	581,784
Y4	581,784
Y5	581,784
Y6	581,784
Y7	581,784
<b>Total estimated reductions</b> (tonnes of CO <sub>2</sub> e)	4,072,488
<b>Total number of crediting years</b>	7
<b>Annual average over the crediting period of estimated reductions (tonnes of CO<sub>2</sub>e)</b>	581,784

**A.4.5. Public funding of the project activity:**

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The project does not involve any public funding<sup>7</sup> from Parties included in Annex I of the UNFCCC.

<sup>7</sup> The project will be financed through World Bank:

<http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/ENVIRONMENT/0,,contentMDK:22970142~menuPK:176751~pagePK:64020865~piPK:149114~theSitePK:244381,00.html>

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

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1. The baseline and monitoring methodology ACM0002 is used : “Consolidated baseline methodology for grid connected electricity generation from renewable sources” version 12.1, in effect as of 26 November 2010;
2. The “Tool to calculate the emission factor for an electricity system”, version 2.2.1, in effect as 29 September 2011;
3. The “Tool to calculate project or leakage CO<sub>2</sub> emissions from fossil fuel combustion”, version 02, in effect as of 2 August 2008;
4. The tool for demonstration and assessment of additionality used is: “Tool for demonstration and assessment of additionality”, version 05.2, in effect as of 26 August 2008.

Further information with regards to the methodology can be obtained at:

<http://cdm.unfccc.int/methodologies/PAmethodologies/approved.html>

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

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The methodology chosen is applicable to the proposed project due to the following reasons:

**Table 2 – Applicability Conditions of ACM0002**

<b>Methodology</b>	<b>CDM Project Activity</b>
This methodology is applicable to grid-connected renewable power generation project activities that (a) install a new power plant at a site where no renewable power plant was operated prior to the implementation of the project activity (greenfield plant); (b) involve a capacity addition; (c) involve a retrofit of (an) existing plant(s); or (d) involve a replacement of (an) existing plant(s).	The project is a grid-connected renewable power generation that install a new power plant at a site where no renewable power plant was operated prior to the implementation of the project activity
The project activity is the installation, capacity addition, retrofit or replacement of a power plant / unit of one of the following types : hydro power plant / unit (either with a run-of-river reservoir or an accumulation reservoir), wind power plant / unit, geothermal power plant / unit, solar power plant / unit, wave power plant/unit or tidal power plant / unit;	The project is an installation of geothermal power plant / unit.
In the case of capacity additions, retrofits or replacements (except for wind, solar, wave or tidal power capacity addition projects which use Option 2: on page 11 to calculate the parameter $EG_{PJ,y}$ ) : the existing plant started commercial operation prior to the start of a minimum historical reference period of five years, used for the calculation of baseline emissions and defined in the baseline emission section, and no capacity expansion or retrofit of the plant has been undertaken between the start of this minimum historical reference period and the implementation of the project activity;	The project is not a capacity addition, retrofits or replacements. It is a development of new power generation facility.



On the basis of the reasons stated above, the applicability criteria of the methodology are met.

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

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	Source	Gas	Included?	Justification / Explanation
Baseline	CO <sub>2</sub> emissions from electricity generation in fossil fuel fired power plants that is displaced due to the project activity	CO <sub>2</sub>	Included	According to ACM0002 only CO <sub>2</sub> emissions from electricity generation should be accounted for (main emission source)
		CH <sub>4</sub>	Excluded	According to ACM0002 (minor emission source)
		N <sub>2</sub> O	Excluded	According to ACM0002 (minor emission source)
Project Activity	Fugitive emissions of CH <sub>4</sub> and CO <sub>2</sub> from non-condensable gases contained in geothermal steam	CO <sub>2</sub>	Included	According to ACM0002 : CO <sub>2</sub> fugitive emissions from non-condensable gases should be accounted for (main emission source)
		CH <sub>4</sub>	Included	According to ACM0002 : CH <sub>4</sub> fugitive emissions from non-condensable gases should be accounted for (main emission source)
		N <sub>2</sub> O	Excluded	According to ACM0002 (minor emission source)
Project Activity	CO <sub>2</sub> emissions from combustion of fossil fuels required to operate the geothermal power plant	CO <sub>2</sub>	Included	According to ACM0002 : CO <sub>2</sub> emission from fossil fuels combustion should be accounted for (main emission source)
		CH <sub>4</sub>	Excluded	According to ACM0002 (minor emission source)
		N <sub>2</sub> O	Excluded	According to ACM0002 (minor emission source)

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

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Ulubelu II power plant or the project is a separate, distinct power plant from Ulubelu I power plant. Even though both power plants share the same Ulubelu geothermal field, different steam supply system under different Power Purchase Agreement / PPA (or Steam Sales Contract / SSC) between PGE and PLN, to supply contracted amounts of electricity to the Sumatera grid (or geothermal steam to power plant) is applied. Since this project does not modify or retrofit existing electricity generation facilities the baseline scenario is the following:

Electricity delivered to the grid by the project would have otherwise been generated by the operation of grid-connected power plants and by the addition of new generation sources, as reflected in the combined margin (CM) calculations in B.6.1.

Table 3 – Key Information and Data Used to Determine the Baseline Scenario

<u>Variable</u>	<u>Value / Unit</u>	<u>Source</u>
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Operating Margin Emissions factor	0.906 tCO <sub>2</sub> e / MWh	PLN database (own generation and IPPs*) in cooperation with the Indonesian DNA and the Ministry of Energy
Build Margin Emissions Factor	0.581 tCO <sub>2</sub> e / MWh	
Combined Margin Emissions Factor	0.743 tCO <sub>2</sub> e / MWh	
Generation of the project in year 'y'	867,240 MWh	110 MW x 90% x 24 hours x 365 days

(\*) Independent Power Producers

In the absence of the project, electricity will continue to be generated by the existing generation mix operating in the Sumatera grid.

The realistic and credible alternatives to the project activity are considered to investigate the baseline:

*Alternative 1:*

The proposed project activity implemented without CDM financing, i.e. the construction of a new geothermal power plant with net installed capacity of 110 MW connected to the local grid, implemented without considering CDM revenues. This alternative is in compliance with current laws and regulations of Indonesia. However, according to the investment analysis in section B.5, the proposed project activity without CDM revenues is economically unattractive, and therefore is not a realistic baseline scenario. For a full assessment, please see section B.5.

*Alternative 2:*

Continuation of the current situation, i.e. electricity will continue to be generated by the existing generation mix operating in the grid, with capacity additions as planned. This alternative will be considered as the baseline scenario.

*Alternative 3:*

Construction of a thermal power plant with the same installed capacity or the same annual power output. This alternative is in compliance with the existing laws and regulations in Indonesia; there are no laws or regulations prohibiting the construction of such a thermal power plant (gas, diesel or coal-fired power plant). Out of these power plants, gas power plants will have technical barriers, since there is no gas pipeline constructed in the Ulubelu mountain area. Construction of a diesel power plant will face less barriers to implement, however, with the increase in fuel price, it is expected that the operational cost of such a power plant will be very high; thus the generation cost per kWh is expected to be very high. The construction of a coal-fired power plant could also be considered as a potential baseline. Thus both the continuation of the current situation (Alternative 2) and the construction of a coal-fired power plant (Alternative 3) are possible baseline alternatives. In order to be conservative, the baseline scenario with the lowest emissions is selected for comparison; therefore alternative 3 will not be considered further.

*Alternative 4:*

Construction of renewable power generation with the same installed capacity or the same annual power output. This alternative is in compliance with the existing laws and regulations in Indonesia. However it is not plausible. PGE has no competencies in construction and operation of other renewable power generation (hydro, wind, solar etc.). Hence, this is not a plausible alternative to the project owner.

Thus two alternatives remain from this analysis which will be examined in more detail in section B.5:

Alternative 1

The proposed project activity implemented without CDM financing, i.e. the construction of a new geothermal power plant with net installed capacity of 110 MW connected to the local grid, implemented without considering CDM revenues.

Alternative 2

Continuation of the current situation, i.e. electricity will continue to be generated by the existing generation mix operating in the grid, with capacity additions as planned.

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

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The following steps are used to demonstrate the additionality of the project according to the latest version of the “Tool for the demonstration and assessment of additionality” agreed by the Executive Board for the assessment of alternatives, please refer to B.4:

The start of the crediting period of this project activity is not prior to the date of registration, however for the assessment of additionality it is important to note that the CDM was taken into account when investment decisions were considered, and in the planning stages of the project.

PT. Pertamina Geothermal Energy (PGE) is a subsidiary to Pertamina holding, incorporated in December 2006 as a spin-off from Pertamina Upstream Division. Its core business is geothermal steam exploration and production (E&P), and therefore selling geothermal steam to power plant owners<sup>8</sup> currently in 2 major areas and 1 minor area. Apart from those existing geothermal fields, Ulubelu was developed since 2007 as a new geothermal field project to supply geothermal steam for its future power plants. Currently, PLN builds Ulubelu I power plant (2 x 55 MW) and will purchase steam from Ulubelu geothermal field operated by PGE.

However, during subsequent years PGE management tried some possibilities of developing its own power plant, another 2 x 55 MW Ulubelu II power plant (the CDM Project Activity) to generate and sell electricity to the Sumatera interconnected grid. The Head of Agreements between PGE and PLN was then signed in 2010 for Ulubelu I power plant (steam sales, SSC) and Ulubelu II power plant (electricity sales, PPA). Geothermal wells drilling activity for Ulubelu II power plant has started in May 2010, and is expected to be completed in 2012 to start construction of the power plant itself. The electricity generation might start in 2014, under the Ulubelu PPA (Power Purchase Agreement), which was signed in March 2011.

The following shows the timeline of historical work on the site, pre-project activity, and project development:

**Table 4 – Ulubelu II geothermal power plant historical progress**

Activity	Date	Remarks
FS report for <i>steam</i> production and sales	March 2007	Internal Pre-FS document
PGE and PLN agreement facilitated by the National Development of Planning Agency (BAPPENAS)	13 July 2009	Signed Minutes of Meeting (MoM) describes PGE and PLN common interest to develop several geothermal fields in Indonesia
FS report for power plant development ( <i>electricity generation and</i>	September 2009	Total investment = USD 270.95 million ( <i>expected electricity price = USD 90/MWh</i> )

<sup>8</sup> Only in 2008 PGE started operating its own first geothermal power plant, a registered CDM project PLTP Kamojang unit IV



<i>sales to the Grid)</i>		
PGE Board of Directors and Board of Commissioners agreed to develop Ulubelu II as total project	21 January 2010	Minutes of Meeting describes Board of Directors and Board of Commissioners decision to develop Ulubelu II geothermal power plant
Head of Agreement (HoA) between PGE & PLN  (for eight geothermal areas)	17 February 2010	Steam sales = Ulubelu I, Lahendong IV, Hululais, Kotamobagu I-II, Sungaipenuh Electricity sales = Ulubelu II, Karaha, Kamojang, Lahendong V, Lumutbalai I-II
Contract for wells drilling works	8 April 2010	Umbrella contract to drill steam well is signed between PGE and Pertamina Drilling Services Indonesia (PDSI) to cover 7 wells dedicated for Ulubelu II.
Work order submitted to the drilling company (PDSI) for UBL #18	6 May 2010	Work order signed by Ulubelu project manager to commence drilling for UBL #18
Construction work, start geothermal wells drilling dedicated for Ulubelu II (UBL #18)	8 May 2010	PGE internal reports: list of drilled wells at Ulubelu geothermal field
CDM Prior consideration sent to the Indonesian DNA	30 August 2010	Prior consideration published in the Indonesian DNA website as following: <a href="http://pasarkarbon.dnpi.go.id/web/index.php/komnasmpb/cat/4/database/2.html">http://pasarkarbon.dnpi.go.id/web/index.php/komnasmpb/cat/4/database/2.html</a>
Confirmation of CDM prior consideration from the Indonesian DNA	4 September 2010	Letter to President Director of PGE from the Indonesian DNA regarding CDM prior consideration
CDM Prior consideration sent to UNFCCC	16 September 2010	Prior consideration published in the UNFCCC website on 12 October 2010: <a href="http://cdm.unfccc.int/Projects/PriorCDM/notifications/index.html">http://cdm.unfccc.int/Projects/PriorCDM/notifications/index.html</a>
Environmental Impact Assessment / EIA report	20 October 2010	Approval by Lampung province environmental agency
PPA signed with PLN	11 March 2011	Price = USD 7.53 cent / kWh (30 years from COD)
ERPA signing with South Pole Carbon Asset Management Ltd.	March 2011	Signed ERPA between PGE and South Pole CAM Ltd.
Power plant construction start	May 2012	PGE project planning as per Feasibility Study Report, page 8
Power plant operation start	1 January 2014	This is commercial operation for Ulubelu II, when both unit #3 and #4 are in operation, PGE project planning as per Feasibility Study Report, page 8

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

#### Sub-step 1a. Define alternatives to the project activity:



Two remaining alternatives are considered:

*Alternative 1:* The proposed project activity without CDM: construction of a new geothermal power plant with net installed capacity of 110 MW connected to the Grid, implemented without considering CDM revenues.

*Alternative 2:* Continuation of the current situation. Electricity will continue to be generated by the existing generation mix operating in the Grid.

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

All alternatives are in compliance with all applicable legal and regulatory requirements of Indonesia.

**Step 2. Investment Analysis**

According to the “Tool for the demonstration and assessment of additionality”, three options can be applied to conduct the investment analysis. These are the simple cost analysis (Option I), the investment comparison analysis (Option II) and the benchmark analysis (Option III).

***Sub-step 2a : Determine appropriate analysis method***

Since this project will generate financial / economic benefits other than CDM-related income, through the sale of generated electricity, Option I (Simple Cost Analysis) is not applicable.

According to the Additionality Tool, if the alternative to the CDM project activity does not include investments of comparable scale to the project, then Option III must be used.

Given that the Project Developer does not have alternative and comparable investment choices, the benchmark analysis (Option III) is more appropriate than investment comparison analysis (Option II) for assessing the financial attractiveness of the project activity.

***Sub-step 2b : Option III – Application of benchmark analysis***

The likelihood of the development of this project, as opposed to the continued generation of electricity by the existing generation mix operating in the grid (i.e. Alternative 2 – the baseline) will be determined by comparing the project IRR without CDM financing (Alternative 1) with a suitable benchmark that considers the specific context in which the proposed project activity takes place.

According to the paragraph 13 of the EB 51 Annex 58 in the case of projects which could be developed by an entity other than the project participant, the benchmark should be based on publicly available data sources. The project activity could have been developed by any other entity, as long as this entity had the authorization to do it. This authorization can be transferred from one company to another, as happened to the project in the past<sup>9</sup>. For this reason the benchmark has been duly derived from publicly available data sources.

An appropriate benchmark value represents the minimum required return which the project should earn to justify its financial viability. It has been determined according to the “Tool for demonstration and assessment of additionality” (hereinafter ‘Tool’) and the “Guidance on the assessment of investment analysis” (hereinafter ‘Investment Guidance’). The benchmark has been derived from government bond rates, increased by a suitable risk premium to reflect private investment in a particular industry; those parameters are based on information that is publicly available and standard in the market (‘Tool’, sub-step

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<sup>9</sup> Renewable Energy in Asean: Indonesia-geothermal, refer to Table “Suppliers and Manufacturers” (PT. Darmasatrya Arthasentosa Calpine tried to negotiate Ulubelu geothermal development, in 1999/2000) <http://www.aseanenergy.org/icra/indonesia/geothermal/geothermal.htm>



2b, para.6a; ‘investment guidance’ para.12). The risk premium applied reflects the risk of the project activity being assessed as required by the ‘Investment Guidance’ (para.15) but does not relate to an ‘internal benchmark’ that would apply an individual’s perception of risk involved in the project activity or individual profit expectations (‘Investment Guidance’, para.13). The weighted average cost of capital (WACC) of the project activity is used as most appropriate benchmark to compare with the project’s return (‘Investment Guidance’, para.12 in combination with para.14 WACC is an appropriate benchmark for a project IRR). The selected approach is widely accepted as a suitable approach among financial managers to take investment decisions.

Financial data used in the benchmark determination is obtained from Indonesian government bond rates which are increased by an appropriate risk premium that expresses the additional (market and financing) risk of equity investments over returns on riskless assets. The ‘Investment Guidance’ requires project participant to risk-adjust the benchmark according to the specific risk profile of the project activity, i.e. its market and financing risk (para.14). All information used in this financial analysis, including specific market risk is based on actual publicly available financial market information and provided by financial experts.

Considering information available to the project developer, the project WACC was calculated based on the following inputs:

**Table 5 – Values taken for benchmark determination**

Parameters	Value	Reference
Geothermal tax rate	34 %	Presidential Decree no. 49 issued in 1991
Cost of Debt	3.98 %	2009 investment rate value for commercial and joint bank from Central Bank of Indonesia statistic webpage
Risk free rate in Indonesia	10.50 %	Government bond rate FR0052 with validity until 15 August 2030
Equity return (Market return)	29.76 %	Jakarta Composite Index (JCI) between January 2003 until December 2009, on tab ‘Market Return’ in ER-IRR-WACC calculation worksheet
Cost of equity	47.57%	CAPM, Calculated
Electricity generation asset Beta	1.92	Bloomberg Finance LP
D / E ratio	1.63	Debt to Equity ratio, Bloomberg Finance LP for Asian market average
WACC	19.67 %	(calculated from above values)

The formula applied to calculate the WACC is the following:

$$\text{WACC}^{10} = [\text{Cost of Equity}(\%) \times \text{Equity Proportion}(\%)] + [\text{Cost of Debt}(\%) \times \text{Debt Proportion}(\%) \times (1 - \text{Tax rate})]$$

#### *Determination of “Cost of Equity”*

The cost of equity is determined by utilizing the Capital Asset Pricing Model (CAPM). The CAPM defines the compensation of investors for investments taken. One part of the formula is related to the time value of money (risk free rate) compensating for investment over a time period, the other part represents the risks for investment. This is calculated by taking a risk measure, so called beta ( $\beta$ ). The beta compares the returns of the asset to the market over a period of time and to the market premium. The formula correctly applied is as following:

<sup>10</sup> <http://www.investopedia.com/terms/w/wacc.asp>



$$\begin{aligned}\text{Cost of Equity} &= \text{Risk Free Rate} + [\text{Beta} \times (\text{Market return} - \text{Risk free rate})] \\ \text{Re} &= \text{Rf} + [\beta \times (\text{Rm} - \text{Rf})]\end{aligned}$$

Where:

Re: Cost of equity

Rf: Risk free rate

$\beta$ : Beta

Rm: Expected market return

The applied model is internationally known<sup>11</sup> and applied in making investment decision.

*Explanation of input values to the Cost of Equity*

Rf: 10.50 %

The risk free rate is determined for Indonesian government bond (long term, 30 years corresponding to the start date and the expected lifetime of the proposed project activity), first issue date published in August 2009. These bond rates were available at the time of making the investment decision. The data for the Risk free rate is sourced from Indonesian Central Bank webpage<sup>12</sup>, and the value of the Risk free rate can be found in the 'market return' tab in Ulubelu ER-IRR-WACC calculation spreadsheet.

$\beta$ : 1.92

The Beta value is calculated based on sector information, as provided by Bloomberg Finance L.P. taken from Asia region, power sector, where data is complete. One-year data (2009) was taken to give representative value, since typical business dynamics on different years might pose significant changes to company situation that often made diverse business activities. Hence longer data period would have less certainty to the specific business sector, i.e. energy generation.

Rm: 29.76 %

The market return is calculated based on the Jakarta Composite Index (JCI) and was used in the Capital Asset Pricing Model (CAPM) to calculate the cost of equity as shown in the Equation below. The compounded return for the market is calculated over a time period of seven years (January 2003 – December 2009, the longest dataset to give representative figure to the current and future market) to determine the market return. The Asian economic crisis gave significant impact to the national economy during 1997 – 1998, while recovery took several years following the crisis (prolonged when the global economy was once more under pressure after the 9/11 incident in 2001).

The Indonesian political situation was much more stable since year 2003. Prior to that, three different Presidents took office every two years, and six new Provinces emerged but then the Government realized it to be not very effective for economic development, and only one Province was formed in 2004 until today. The new elected President in 2004 was considered to be much more democratic and provided ample support to economic growth, as the Vice President was a prominent businessman with forward thinking to new economic and fiscal policies. This is considerably different than previous era of Indonesian democracy; therefore market situation has remarkably changed from the year 2003 onwards.

Cost of Equity as per CAPM approach:

$$\begin{aligned}\text{Re} &= \text{Rf} + [\beta \times (\text{Rm} - \text{Rf})] \\ &= 10.50\% + [1.92 \times (29.76\% - 10.50\%)]\end{aligned}$$

<sup>11</sup> <http://www.investopedia.com/terms/c/capm.asp>

<sup>12</sup> <http://www.bi.go.id/web/id/Moneter/Obligasi+Negara/?display=print>



= 46.57 %

Cost of Debt: 3.98 %

The interest rates / the lending rates statistics data by the Indonesian Central Bank (Bank Indonesia) are used as the cost of debt to calculate the WACC. The cost of debt has therefore been taken from the official data source. The Bank Indonesia<sup>13</sup> can be considered as credible and suitable data source for the purpose of the determination of the debt cost. The value corresponds to the average cost of debt for December 2009 (3.98 %, foreign and joint bank's investment loan, from Table I.27 Interest Rate of US Dollar Loans by Group of Banks).

Geothermal tax rate: 34 %

The reference used for Geothermal tax rate is the Presidential Decree which is a government regulation according to which the Geothermal projects are obliged to pay the 34% Tax, as per the Presidential Decree no. 49 / 1991. This tax rate has to be applied for geothermal projects in Indonesia. This tax rate was valid at the time of decision making.

Applying the above mentioned formulas and input values, the WACC is calculated as 19.67 %. This value is used as the project IRR benchmark.

#### ***Sub-step 2c: Calculation and comparison of financial indicators***

Upon obtaining the WACC, a financial analysis of the project activity was carried out. Table 5 shows the input data as well as the key parameters used in the financial analysis. Every input value had a reasonable and reliable source, and was backed up by third party information, showing the reasonableness of the numbers applied, as follows:

#### ***Electricity Tariff***

PGE expected to be able to sell generated electricity to PLN at the price of US\$ 90 / MWh, in the Feasibility Study for Ulubelu II power plant development. However, in March 2011 the Power Purchase Agreement (PPA) was finally signed with significantly lower price than expected, US\$ 75.3 / MWh. The highest price is used for PDD calculation, giving more conservative results to the IRR calculation.

#### ***Annual operating costs***

The applied value is taken from the Feasibility Study : Upstream (steam field) O&M: US\$ 30,000 / MW and Power Plant O&M: US\$ 50,000 / MW, this is equivalent to US\$ 8,800,000 / year or US\$ 10.10 / MWh. Specifically for Power Plant O & M costs (US\$ 5,500,000 / year or US\$ 6.3 / MWh) are significantly lower than the geothermal power plant O&M costs found in the study published by PT. Indonesia Power, an Indonesian geothermal power plant operator<sup>14</sup>, and considerably lower than in international literature<sup>15</sup>.

**Table 6 – Financial Parameters for Ulubelu II power plant**

<sup>13</sup>

<http://www.bi.go.id/web/en/Statistik/Statistik+Ekonomi+dan+Keuangan+Indonesia/Versi+HTML/Sektor+Moneter/Sektor+Moneter.htm>

<sup>14</sup> Kemampuan Sumber Daya Domestik Bidang Pembangkitan Dalam Mendukung Peningkatan Penyediaan Tenaga Listrik, published by PT Indonesia Power 2002 (Paper Indonesia Power – O&M Costs comparison.pdf) - Operational Cost for a geothermal power plant equivalent to 8.93 US\$/MWh)

<sup>15</sup> Cost of geothermal power and factors that affect it Subir K. Sanyal (2004) - This document states operational costs of 2.0 to 1.4 cents US\$ per kWh (14US\$/MWh)



Financial Parameter	Unit	Value	References
Total Investment	US \$	270,950,000	Feasibility Study page 15
Annual Operation and Maintenance (O & M) Costs	US \$ / year	8,800,000	Feasibility Study page 16
Annual power generation	MWh / year	867,240	Calculated based on net installed capacity 2 x 55 MW with capacity factor of 90%; Feasibility Study page 16
Project lifetime	years	30	Feasibility Study page 12, where mentioned that PLN will be bound to have a PPA of 30 years period.
Electricity tariff	US \$ / MWh	90.00	Feasibility Study page 16
Geothermal Income Taxes	%	34.00	Presidential Decree no. 49 / 1991
Depreciation for upstream	%	10.00	Feasibility Study page 16
Depreciation for downstream	%	5.00	Feasibility Study page 16
Make-up wells maintenance cost in year 2, 15, 27	US \$	12,250,000	Feasibility Study page 19
Residual make-up well (year 27)	US \$	8,575,000	Calculated, depreciation sheet
Make-up wells maintenance cost in year 9, 21	US \$	15,940,000	Feasibility Study page 19
Residual make-up well (year 21)	US \$	1,594,000	Calculated, depreciation sheet
Annual interest payment	%	3.98	Cost of debt in the Ulubelu ER-IRR-WACC calculation

Table 7 – Summary of Project Financial Analysis

	Without CDM
IRR	15.98 %
Benchmark	19.67 %

**Sub-step 2d: Sensitivity analysis**

A sensitivity analysis was undertaken using assumptions that are conservative from the point of view of analysing additionality, i.e. the 'best-case' conditions for the project IRR were assumed. It was supposed that the Project experienced a) no change of original assumptions; b) increasing revenue (increase of electricity tariff or operating hours); c) capital costs decreased; and d) operation and maintenance costs decreased. The results are shown in the table below. The project developer has chosen to alter key parameters by a value which increases the IRR to equal the benchmark value. In a second step it is demonstrated that such a variation is unlikely to occur as opposed to the occurrence of the base case scenario assumptions and considering the specific socio-economic and policy context of the project activity (para.17 Investment Guidance).

Table 8 – Summary of project sensitivity analysis

Scenario	% change	IRR (%)
a) no change in original assumptions	–	15.98 %
b) increase in project revenues	10 %	17.46 %
c) decrease in investment costs	10 %	17.43 %



d) decrease in O & M costs	10 %	16.15 %
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The variation in key parameters above were considered to be conservative because the parameters were not expected to vary by more than this amount (and are in fact not expected to vary in favour of the project at all) for the following reasons :

- A) Project revenue is unlikely to increase that much. Instead, final signed PPA price was 16 % lower than expected when PGE decided to develop the project. The PPA contract signed between PGE and PLN is unlikely to be revised upward during contract period, increasing the electricity price. It is not a common practice in the country neither in the sector. Revenues could be increased only by increasing the hours of operation. Revenues by rising operation hours could be increased at the most in 17 % (considering 100% of load factor of total gross power output 2 x 58 MW turbine generators). Assuming an increase in electricity generation through an increase of the overall load factor above, the IRR would increase but still below the benchmark. Even this increase is difficult to accomplish given the engineering constraints of a geothermal power plant, which requires regular and sufficient maintenance to ensure safe operation and performance over the lifetime of the equipment. Increasing the load factor above 90 % would jeopardise power plant maintenance. Therefore increasing revenues by 25.60 % to breach the benchmark is not possible to happen.
- B) Investment costs are unlikely to decrease the amount necessary to make the project profitable by the time of decision making. The short-term trend of investment costs is to continue this escalation. In addition to that, an increase of raw material and fuel price globally results in upward price pressure for equipment. To further justify that total investment cost will unlikely to decrease is a higher average cost of well drillings that have been developed by PGE at Ulubelu geothermal field compare to PGE assumption in the Feasibility Study. The average cost of already drilled wells in Ulubelu geothermal field is 4.3 Mill USD per well, while cost assumption used in the Feasibility Study is only 4 Mill USD per well. In addition to that, as a comparison with other similar geothermal projects that also consider upstream and downstream costs, which are now under validation such as Rantau Dedap<sup>16</sup> (USD 3,434/kW), Gunung Rajabasa<sup>17</sup> (USD 2,986/kW), Liki Pinangawan Muaralaboh<sup>18</sup> (USD 3,592/kW), Ulubelu II (USD 2,471/kW) investment cost is much more lower. Besides that, based on International Energy Agency study in 2010<sup>19</sup>, Ulubelu II cost per kW is lower than their average indicative cost, which is USD 4,000/kW. Therefore decreasing investment costs by 22.50 % to breach the benchmark is quite unlikely to happen for Ulubelu II as the investment cost is already very low.
- C) Operation and maintenance costs are also unlikely to significantly decrease during the operation period. The costs presented on the feasibility study include only fixed costs based on the installed capacity of the equipment. The fixed costs include the Power Plant O&M and the upstream costs on the geothermal field (US\$ 30 / kW for upstream costs and US\$ 50 / kW for power plant O&M, totalizing US\$ 8,800,000 / year). Even with decreasing operation and maintenance costs by 100% (assuming no operation costs at all) the project remains still unattractive.

<sup>16</sup> Rantau Dedap geothermal power plant,  
<http://cdm.unfccc.int/Projects/Validation/DB/KLFI1FEFBAl39NTVty2GAB0F7AODZ4/view.html>

<sup>17</sup> Gunung Rajabasa geothermal power plant,  
<http://cdm.unfccc.int/Projects/Validation/DB/VFB91YBBHSJHDSQP7P8EKD9CC6FK75/view.html>

<sup>18</sup> Liki Pinangawan Muaralaboh geothermal power plant,  
<http://cdm.unfccc.int/Projects/Validation/DB/BSBA7OIEMD12DICFOHA5HHQUDB6WNL/view.html>

<sup>19</sup> Geothermal Heat and Power, International Energy Agency ETSAP, May 2010



These results show that even under very favourable, but unreasonable, circumstances the Project IRR is still not higher than the benchmark for similar investments under similar conditions in the host country. Therefore we can conclude that the Best Case IRR is not financially attractive, and the proposed project without CDM (alternative 1 – Baseline Scenario) overall is also not financially attractive.

### Step 3. Barrier Analysis

Barrier analysis was not performed for this project activity.

### Step 4. Common Practice Analysis

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

Indonesia is defined as the geographical scope for the common practice analysis, and all geothermal power plants operational at the time of decision-making are considered in the analysis. Indonesia has significant geothermal energy potential due to the volcanic zone which stretches along the southern coast of Sumatera and Java. Geological Agency conducted surveys to have an insight of geothermal potential in all location in Indonesia. Until November 2007, a total of 27,441 MW geothermal potential calculated from 256 prospects area with 62.1% of them are still on preliminary survey stage, while 32.04% on detailed survey stage, 3.13% are ready to be developed and only 2.73% are producing<sup>20</sup>. Total geothermal potential until November 2007 is 27,441 MWe, of this potential, 13,273 MWe are located in Sumatera Island, 9,556 MWe are scattered across Java Island and remaining 4,612 MWe geothermal potential are divided between other Islands<sup>21</sup>.

Despite this potential, however, only a small proportion of the geothermal resource has been exploited. The proportion of grid electricity coming from geothermal in Indonesia is very low, accounting for less than 5% of electricity generation in Indonesia in 2010<sup>23</sup>. The geothermal capacity addition of 1% to total generation in the last 9 years, all were developed as CDM projects. The reasons for this are generally low rate of return and increased risks associated with geothermal plants when compared to other technologies, but economic uncertainties also play a role. Prior to the 1997-1998 financial crisis, the Indonesian government awarded contracts for 11 geothermal projects that would have had a generating capacity of 3,417 MW<sup>24</sup>. Due to the tight fiscal constraints imposed by the crisis and the political change that followed, 7 of the above projects were suspended.

All geothermal power plants operational at the time of decision making are considered in the analysis. By 2010<sup>25</sup>, geothermal electric power generation capacity in Indonesia was 1,187.3 MW. This also represents just 4.3 % of the estimated geothermal potential of 27,441 MW<sup>27</sup>.

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<sup>20</sup> Kasbani, et. al., Kesiapan Data Potensi Panas Bumi Indonesia Dalam Mendukung Penyiapan Wilayah Kerja, Proceeding Pusat Sumber Data Geologi,

<http://psdg.bgl.esdm.go.id/kolokium%202007/PANASBUMI/Kesiapan%20Data%20Potensi%20Panas%20Bumi%20Indonesia%20dalam%20Mendukung%20Penyiapan%20Wilayah%20Kerja.pdf>, page 1

<sup>21</sup> Kasbani, et. al., page 5

<sup>23</sup> Darma, Surya, et. al., Geothermal in Indonesia: Government Regulations and Power Utilities, Opportunities and Challenges of its Development, Proceedings World Geothermal Congress 2010, Bali, Indonesia 2010.

<sup>24</sup> US Embassy Report, Indonesia's Geothermal Development, Jakarta, Indonesia, 2002

<sup>25</sup> Darma, Surya, et. al., Geothermal in Indonesia: Government Regulations and Power Utilities, Opportunities and Challenges of its Development, Proceedings World Geothermal Congress 2010, Bali, Indonesia 2010.



In the year 2001, after the 1997-1998 financial crisis, PLN re-established the effort of developing new power plants in Indonesia. PLN started a renegotiation process on all the contracts signed prior to 1997/98. In the course of the renovation of the electricity sector two important milestones took place. These are the Electricity sector regulation (Electricity Law No 20/2002) and Geothermal Energy – no. 27/2003. Law on Geothermal Energy – no. 27/2003 allows private companies to develop geothermal projects based on a tendering process<sup>28</sup>.

Based on Electricity Law No 20/2002, the Government of Indonesia accommodates a long-term future trend towards an open market, based on ideal conditions for maintaining a multi buyer-multi seller system. The electricity supply business was unbundled into subsystems such as generation, transmission, distribution, exchange and market operation, and last mile (or retail) sales. The Government also established in 2003 a regulator, the Electricity Market Supervisory Body, EMSB, to regulate and monitor the electricity market to ensure fair competition and promote consumer interests. The new oil and gas law passed in October 2001 removed geothermal energy from the umbrella of oil and gas regulation, and precipitated the Indonesia Geothermal Law No. 27/2003. Thus projects developed before 2003 are not considered to have been developed under a similar regulatory environment. The only projects developed after the Law on Geothermal Energy in 2003 were the expansion the geothermal power plant in Darajat, West Java (Project Darajat III), in Wayang Windu (Project Wayang Windu II) in Kamojang (Project Kamojang IV) and in Lahendong (Project Lahendong II and III<sup>29</sup>), and to much smaller extent the Sibayak 11.3 MW geothermal<sup>30,31</sup>. Those projects were developed as CDM projects. Following the guidelines of common practice analysis, these projects were not considered as a similar activity to the project, and excluding the registered CDM projects this proposed project activity is the only geothermal project to have been built in the host country since 2001.

**Table 9 – Indonesia geothermal proven reserves and power plants constructed status**

Power Plant <sup>32</sup> <Location> (Capacity)	Commence- ment date	Policy Regime (prior to / post the financial crisis)	Steam Field Operator	Power Plant Operator	With or Without CDM Activity	Similar to the Project Activity (yes / no)	Remarks
Kamojang <sup>33</sup> unit I, II, III	Unit 1 – 1982	Prior to the financial	Pertamina (state owned)	PLN (state owned)	Without CDM activity	No	This project has separate business

<sup>27</sup> Kasbani, et. al., Kesiapan Data Potensi Panas Bumi Indonesia Dalam Mendukung Penyiapan Wilayah Kerja, Proceeding Pusat Sumber Data Geologi,  
<http://psdg.bgl.esdm.go.id/kolokium%202007/PANASBUMI/Kesiapan%20Data%20Potensi%20Panas%20Bumi%20Indonesia%20dalam%20Mendukung%20Penyiapan%20Wilayah%20Kerja.pdf>, page 1

<sup>28</sup> Market Study: Geothermal Sector in Indonesia Potential, Development, and Perspectives dated 2008  
[http://www.renewablesb2b.com/data/ahk\\_indonesia/publications/files/Geothermal\\_Market\\_Study\\_B2B.pdf](http://www.renewablesb2b.com/data/ahk_indonesia/publications/files/Geothermal_Market_Study_B2B.pdf),  
retrieved on 14 November 2011

<sup>29</sup> Indonesian DNA Letter of Approval for 20 MW Lahendong III was granted in February 2009  
<http://pasarkarbon.dnpi.go.id/web/index.php/komnasmpb/cat/4/database/4/7.html>

<sup>30</sup> Under validation Sibayak geothermal power plant,  
<http://cdm.unfccc.int/Projects/Validation/DB/O2CE1RL2JNZWXYHS7BRF66PQXYNKJ0/view.html>

<sup>31</sup> Indonesian DNA Letter of Approval for 11.3 MW Sibayak geothermal was granted in February 2009  
<http://pasarkarbon.dnpi.go.id/web/index.php/komnasmpb/cat/4/database/4/6.html>

<sup>32</sup> US Embassy Report, Indonesia's Geothermal Development, Jakarta, Indonesia,



Power Plant <sup>32</sup> <Location> (Capacity)	Commence- ment date	Policy Regime (prior to / post the financial crisis)	Steam Field Operator	Power Plant Operator	With or Without CDM Activity	Similar to the Project Activity (yes / no)	Remarks
<Jawa> (140 MW)	Unit 2,3 – 1987	crisis	company)	electricity company)			activities (steam and electricity selling) and is prior to electricity (2002) and geothermal (2003) laws
Kamojang <sup>34</sup> unit IV <Jawa> (60 MW)	December 2007	Post the financial crisis	Pertamina (state owned company)	Pertamina (state owned company)	CDM activity	N / A	N / A  This project is a CDM Activity
Salak <sup>35</sup> phase 1 <Jawa> (180 MW)	Unit 1,2 – 1994  Unit 3 – 1997	Prior to the financial crisis	Unocal / Chevron (IPP)	PLN (state owned electricity company)	Without CDM activity	No	This project has separate business activities (steam and electricity selling) and is prior to electricity (2002) and geothermal (2003) laws
Salak <sup>36</sup> phase 2 <Jawa> (195 MW)	1997	Prior to the financial crisis	Unocal / Chevron (IPP)	Unocal built and operated for 15 years, then transfer operations to PLN (state- owned) under BOT scheme	Without CDM activity	No	This project is prior to electricity (2002) and geothermal (2003) laws and its size is much bigger
Darajat <sup>37</sup> phase 1 <Jawa> (55 MW)	1994	Prior to the financial crisis	Indonesia Power (subsidiary of PLN, state- owned)	Chevron (IPP)	Without CDM activity	No	This project is prior to electricity (2002) and geothermal (2003) laws
Darajat <sup>38</sup> phase 2 <Jawa> (90 MW)	2000	Prior to the financial crisis	Chevron (IPP)	Chevron (IPP)	Without CDM activity	No	This project is prior to electricity (2002) and geothermal (2003) laws

<sup>33</sup> Registered CDM Project: Kamojang Geothermal Project PDD,  
<http://cdm.unfccc.int/Projects/DB/RWTUV1255101629.04/view>

<sup>34</sup> Registered CDM Project: Kamojang Geothermal Project PDD,  
<http://cdm.unfccc.int/Projects/DB/RWTUV1255101629.04/view>

<sup>35</sup> Registered CDM Project: Darajat Unit III Geothermal Project PDD,  
<http://cdm.unfccc.int/Projects/DB/KPMG1159285050.32/view>

<sup>36</sup> Registered CDM Project: Darajat Unit III Geothermal Project PDD,  
<http://cdm.unfccc.int/Projects/DB/KPMG1159285050.32/view>

<sup>37</sup> Registered CDM Project: Darajat Unit III Geothermal Project PDD,  
<http://cdm.unfccc.int/Projects/DB/KPMG1159285050.32/view>

<sup>38</sup> Registered CDM Project: Darajat Unit III Geothermal Project PDD,  
<http://cdm.unfccc.int/Projects/DB/KPMG1159285050.32/view>



Power Plant <sup>32</sup> <Location> (Capacity)	Commence- ment date	Policy Regime (prior to / post the financial crisis)	Steam Field Operator	Power Plant Operator	With or Without CDM Activity	Similar to the Project Activity (yes / no)	Remarks
Darajat <sup>39</sup> phase 3 <Jawa> (117 MW)	2006	Post the financial crisis	Chevron (IPP)	Chevron (IPP)	CDM activity	N / A	N / A  This project is a CDM Activity
Dieng <sup>40</sup> unit 1 <Jawa> (60 MW)	1998	Prior to the financial crisis	California Energy (IPP) developed, then transferred to Geo Dipa Energi (JV between Pertamina and PLN, both state- owned)	California Energy (IPP) developed, then transferred to Geo Dipa Energi (JV between Pertamina and PLN, both state-owned)	Without CDM activity	No	This project is prior to electricity (2002) and geothermal (2003) laws
Wayang Windu <sup>41</sup> phase 1 <Jawa> (110 MW)	1997	Prior to the financial crisis	Mandala Magma Nusantara (IPP)	Mandala Magma Nusantara (IPP)	Without CDM activity	No	This project is prior to electricity (2002) and geothermal (2003) laws
Wayang Windu <sup>42</sup> phase 2 <Jawa> (110 MW)	2009	Post the financial crisis	Mandala Magma Nusantara (IPP)	Mandala Magma Nusantara (IPP)	CDM activity	N / A	N / A  This project is a CDM Activity
Lahendong <sup>43</sup> I <Sulawesi> (20 MW)	2001	Prior to the financial crisis	Pertamina (state owned company)	PLN (state owned electricity company)	Without CDM activity	No	This project has separate business activities (steam and electricity), is prior to electricity (2002) and geothermal (2003) laws, and its size is much smaller
Lahendong II <sup>44</sup> <Sulawesi>	2007	Post the financial crisis	Pertamina (state owned company)	PLN (state owned electricity)	CDM activity	N / A	N / A  This project is a

<sup>39</sup> Registered CDM Project: Darajat Unit III Geothermal Project PDD,  
<http://cdm.unfccc.int/Projects/DB/KPMG1159285050.32/view>

<sup>40</sup> Geodipa, [http://www.geodipa.co.id/index.php?option=com\\_content&view=article&id=72&Itemid=110&lang=en](http://www.geodipa.co.id/index.php?option=com_content&view=article&id=72&Itemid=110&lang=en)

<sup>41</sup> Registered CDM Project: Wayang Windu phase 2 Geothermal PowerProject PDD,  
<http://cdm.unfccc.int/Projects/DB/TUEV-SUED1260194062.48/view>

<sup>42</sup> Registered CDM Project: Wayang Windu phase 2 Geothermal PowerProject PDD,  
<http://cdm.unfccc.int/Projects/DB/TUEV-SUED1260194062.48/view>

<sup>43</sup> Registered CDM project Lahendong II-20 MW Geothermal Project PDD,  
<http://cdm.unfccc.int/Projects/DB/TUEV-SUED1249404911.81/view>

<sup>44</sup> Registered CDM project Lahendong II-20 MW Geothermal Project PDD,  
<http://cdm.unfccc.int/Projects/DB/TUEV-SUED1249404911.81/view>



Power Plant <sup>32</sup> <Location> (Capacity)	Commence- ment date	Policy Regime (prior to / post the financial crisis)	Steam Field Operator	Power Plant Operator	With or Without CDM Activity	Similar to the Project Activity (yes / no)	Remarks
(20 MW)				company)			CDM Activity and its size is much smaller
Lahendong <sup>45</sup> III <Sulawesi> (20 MW)	2009	Post the financial crisis	Pertamina (state owned company)	PLN (state owned electricity company)	CDM activity as LoA has been approved and prior consideration has been sent.	N / A	N / A  This project is a CDM Activity and its size is much smaller
Sibayak I <sup>46</sup> <Sumatera> (2 MW)	2000	Prior the financial crisis	Pertamina (state owned company)	Pertamina (state owned company)	Without CDM activity	No	This project has separate business activities (steam and electricity), is prior to electricity (2002) and geothermal (2003) laws, is a stand-alone power plant and its size is much smaller
Sibayak II and III <sup>47</sup> <Sumatera> (11.3 MW)	2008	After the financial crisis	Pertamina (state owned company)	PT. Dizamatra Powerindo (IPP)	CDM Activity	N / A	N / A  This project is a CDM Activity and its size is much smaller
Ulumbu <sup>48</sup> <East Nusa Tenggara> (5 MW)	2011	After the financial crisis	Pertamina (state owned company)	PLN (state owned electricity company)	CDM activity as prior consideration has been sent <sup>49</sup> .	N / A	N / A  This project is a CDM Activity and its size is much smaller

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

Based on the above step, there is no activity similar to the proposed project activity in the defined region.

It is thus concluded that the realistic baseline scenario is the continuation of the current situation, where electricity will continue to be generated by the existing generation mix operating in the grid, with capacity additions as planned (Alternative 2).

<sup>45</sup> Indonesian DNA Letter of Approval for 20 MW Lahendong III was granted in February 2009  
<http://pasarkarbon.dnpi.go.id/web/index.php/komnasmpb/cat/4/database/4/7.html>

<sup>46</sup> Sibayak 1 is a 2 MW mono-block geothermal power plant,  
[http://www.pgeindonesia.com/index.php?option=com\\_content&view=article&id=70&Itemid=47](http://www.pgeindonesia.com/index.php?option=com_content&view=article&id=70&Itemid=47)

<sup>47</sup> Under validation Sibayak geothermal power plant,  
<http://cdm.unfccc.int/Projects/Validation/DB/O2CE1RL2JNZWXYHS7BRF66PQXYNKJ0/view.html>

<sup>48</sup> Ulumbu geothermal has been generating electricity, <http://www.pln.co.id/eng/?p=2756> (retrieved on 7 December 2011)

<sup>49</sup> Prior consideration under 6 MW Geothermal Project in Ulumbu, Flores, Indonesia,  
[http://cdm.unfccc.int/Projects/PriorCDM/notifications/index\\_html](http://cdm.unfccc.int/Projects/PriorCDM/notifications/index_html)

**B.6. Emission reductions:****B.6.1. Explanation of methodological choices:**

&gt;&gt;

Tool to calculate the emission factor for an electricity system version 02.2.1 describes that:

“for determining the electricity emission factors, if the DNA of the host country has published a delineation of the project electricity system and connected electricity systems, these delineations should be used”.

The Agency for the Assessment and Application of Technology (BPPT) and Directorate General of Electricity and Energy Utilization (DJLPE), under the Ministry of Environment of Indonesia as Indonesian DNA<sup>63</sup> has published emissions factor for Sumatera grid on 19 January 2009. Below is the summarized parameter.

Parameter	Value (in tCO <sub>2</sub> /MWh)
Operating margin	0.906
Build margin	0.581
Combined margin	0.743

However, for the proposed project activity, Sumatera EF Grid is re-calculated as per Tool to calculate the emission factor for an electricity system version 2.2.1 by using available data from the calculation published by the Indonesian DNA. The detailed calculations are presented in the Annex 3.

**Project Emissions**

Project emissions for geothermal power plants are calculated as follows:

$$PE_y = PE_{FF,y} + PE_{GP,y}$$

where:

$PE_y$	Project emissions in year $y$ (tCO <sub>2</sub> e/yr)
$PE_{FF,y}$	Project emissions from fossil fuel consumption in year $y$ (tCO <sub>2</sub> /yr)
$PE_{GP,y}$	Project emissions from the operation of geothermal power plants due to the release of non-condensable gases in year $y$ (tCO <sub>2</sub> e/yr)

**a) Fossil Fuel Combustion ( $PE_{FF,y}$ )**

$PE_{FF,y}$  is calculated as per the latest version of the “Tool to calculate project or leakage CO<sub>2</sub> emissions from fossil fuel combustion” as follows:

$$PE_{FF,y} = PE_{FC,j,y}$$

where:

$PE_{FC,j,y}$	CO <sub>2</sub> emissions from fossil fuel combustion for electricity generation using diesel genset ‘j’ during the year ‘y’ (tCO <sub>2</sub> e / year).
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<sup>63</sup> Sumatera EF grid published by the Indonesian DNA,  
<http://pasarkarbon.dnpi.go.id/web/index.php/dnacdm/cat/6/other-information.html>



For electricity generation, a diesel gen-set is to be used for emergency power supply to critical instruments only during shutdown and trip operation, where its project emission is calculated using the latest “Tool to calculate project or leakage CO<sub>2</sub> emissions from fossil fuel combustion” using Option B: the CO<sub>2</sub> emission coefficient COEF<sub>i,y</sub> is calculated based on net calorific value and CO<sub>2</sub> emission factor of the fuel type ‘i’,

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

$$COEF_{i,y} = NCV_{i,y} \cdot EF_{CO_2,i,y}$$

where:

PE <sub>FC,j,y</sub>	CO <sub>2</sub> emissions from fossil fuel combustion for electricity generation in diesel gen-set ‘j’ during the year ‘y’ (tCO <sub>2</sub> e / year)
FC <sub>i,j,y</sub>	Quantity of fuel type ‘i’ combusted for electricity generation in diesel gen-set ‘j’ during the year ‘y’ (mass or volume unit)
COEF <sub>i,y</sub>	CO <sub>2</sub> emissions coefficient of fuel type ‘i’ in year ‘y’ (tCO <sub>2</sub> e / mass or volume unit)
NCV <sub>i,y</sub>	Weighted average net calorific value of the fuel type ‘i’ in year ‘y’ (GJ / mass or volume unit)
EF <sub>CO<sub>2</sub>,i,y</sub>	Weighted average CO <sub>2</sub> emission factor of fuel type ‘i’ in year ‘y’ (tCO <sub>2</sub> / GJ)
i	the fuel type combusted for electricity generation in diesel gen-set ‘j’ during the year ‘y’

b) Emissions of non-condensable gases from the operation of geothermal power plants (PE<sub>GP,y</sub>)

PE<sub>GP,y</sub> is calculated as follows:

$$PE_{GP,y} = (w_{\text{steam},CO_2,y} + w_{\text{steam},CH_4,y} \cdot GWP_{CH_4}) \cdot M_{\text{steam},y}$$

Where:

PE <sub>GP,y</sub>	Project emissions from the operation of geothermal power plants due to the release of non-condensable gases in year y (tCO <sub>2</sub> e/yr)
w <sub>steam,CO<sub>2</sub>,y</sub>	Average mass fraction of carbon dioxide in the produced steam in year y (tCO <sub>2</sub> /t steam)
w <sub>steam,CH<sub>4</sub>,y</sub>	Average mass fraction of methane in the produced steam in year y (tCH <sub>4</sub> /t steam)
GWP <sub>CH<sub>4</sub></sub>	Global warming potential of methane valid for the relevant commitment period (tCO <sub>2</sub> e/tCH <sub>4</sub> )
M <sub>steam,y</sub>	Quantity of steam produced in year y (t steam/yr)

Ulubelu II utilises a direct steam expansion turbine from the geothermal field steam supply. It has no supplementary firing for additional steam supply. Estimated amount of NCG is 0.89467023 % of steam weight for CO<sub>2</sub> and 0.00097278 % of steam weight for CH<sub>4</sub>.

### Leakage Emissions

According to ACM0002, the leakage of the proposed project is not considered. No leakage is expected.

$$L_y = 0$$

**Baseline Emissions**

The baseline emissions are to be calculated as follows:

$$BE_y = EG_{PJ,y} \cdot EF_{grid,CM,y}$$

Where:

$BE_y$	Baseline emissions in year $y$ (tCO <sub>2</sub> /yr)
$EG_{PJ,y}$	Quantity of net electricity generation that is produced and fed into the grid as a result of the implementation of the CDM project activity in year $y$ (MWh/yr)
$EF_{grid,CM,y}$	Combined margin CO <sub>2</sub> emission factor for grid connected power generation in year $y$ calculated using the latest version of the “Tool to calculate the emission factor for an electricity system” (tCO <sub>2</sub> /MWh)

**Calculation of  $EG_{PJ,y}$** 

The calculation of  $EG_{PJ,y}$  is different for (a) greenfield plants, (b) retrofits and replacements, and (c) capacity additions.

Ulubelu II is a *greenfield* geothermal power plant, therefore option (a) is to be used here:

(a) Greenfield renewable energy power plants

If the project activity is the installation of a new grid-connected renewable power plant/unit at a site where no renewable power plant was operated prior to the implementation of the project activity, then:

$$EG_{PJ,y} = EG_{facility,y}$$

Where:

$EG_{PJ,y}$	Quantity of net electricity generation that is produced and fed into the grid as a result of the implementation of the CDM project activity in year $y$ (MWh/yr)
$EG_{facility,y}$	Quantity of net electricity generation supplied by the project plant/unit to the grid in year $y$ (MWh/yr)

Ulubelu II geothermal power plant is not a modified, or retrofit facility nor an additional power unit at an existing grid-connected renewable power plant. Ulubelu II is a new grid connected renewable power plant, with a separate Power Purchase Agreement for its electricity sales to the Sumatera grid system.

**Emission reductions**

Emissions reduction calculations are as follows:

$$ER_y = BE_y - PE_y$$

Where:

$ER_y$	Emission reductions in year $y$ (t CO <sub>2</sub> e/yr)
$BE_y$	Baseline emissions in year $y$ (t CO <sub>2</sub> /yr)
$PE_y$	Project emissions in year $y$ (t CO <sub>2</sub> e/yr)

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



Following are data and parameters not monitored:

<b>Data / Parameter:</b>	$GWP_{CH_4}$
Data unit:	$tCO_2 / tCH_4$
Description:	Global warming potential of methane valid for the relevant commitment period
Source of data used:	IPCC
Value applied:	Default value for the first commitment period = 21 $tCO_2 / tCH_4$
Justification of the choice of data or description of measurement methods and procedures actually applied :	–
Any comment:	–

<b>Data / Parameter:</b>	$NCV_{i,y}$
Data unit:	GJ / kg
Description:	Weighted average net calorific value of the diesel fuel in year ‘y’
Source of data used:	2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value applied:	0.043
Justification of the choice of data or description of measurement methods and procedures actually applied :	–
Any comment:	–

<b>Data / Parameter:</b>	$\rho_i$
Data unit:	kg / litre
Description:	Density of diesel fuel
Source of data used:	Pertamina diesel fuel specification <sup>64</sup>
Value applied:	0.84
Justification of the choice of data or description of measurement methods and procedures actually applied :	–
Any comment:	–

<b>Data / Parameter:</b>	$EF_{CO_2,i,y}$
Data unit:	$tCO_2 / GJ$
Description:	Weighted average $CO_2$ emission factor of diesel fuel in year ‘y’
Source of data used:	2006 IPCC Guidelines for National Greenhouse Gas Inventories

<sup>64</sup> Diesel fuel specification from Pertamina, <http://www.pertamina.com/index.php/detail/read/minyak-diesel> (retrieved on 9 November 2011)



Value applied:	0.074
Justification of the choice of data or description of measurement methods and procedures actually applied :	–
Any comment:	–

<b>Data / Parameter:</b>	$EF_{grid,CM,y}$
Data unit:	tCO <sub>2</sub> / MWh
Description:	Combined margin CO <sub>2</sub> emission factor for grid connected power generation (Sumatera Interconnected Grid) in year $y$ calculated using the latest version of the “Tool to calculate the emission factor for an electricity system”
Source of data used:	Grid calculation published by Department of Energy and Mineral Resources of Indonesia - Directorate General of Electricity and Energy Utilization and endorsed by Indonesia DNA on 19 January 2009.
Value applied:	0.743
Justification of the choice of data or description of measurement methods and procedures actually applied :	Calculated with “Tool to calculate the emission factor for an electricity system – version 2.2.1”.
Any comment:	Calculated once ex-ante at the start of the crediting period, using the most recent three historical years for which data is available from the Indonesian DNA at the time of submission of the CDM-PDD to the DOE for validation.

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

#### Project Emissions

$$\begin{aligned}
 PE_y &= PE_{GP,y} + PE_{FF,y} \\
 &= (w_{steam,CO_2,y} + w_{steam,CH_4,y} \times GWP_{CH_4}) \times M_{steam,y} + \sum FC_{i,j,y} \times NCV_{i,y} \times EF_{CO_2,i,y} \\
 &= (0.0089467023 + 0.0000097278 \times 21) \times 6,838,000 + (120 \times 0.84) \times 0.043 \times 0.074 \\
 &= 62,575 \text{ t.CO}_2\text{e / year}
 \end{aligned}$$

#### Leakage Emissions

$$LE_y = 0$$

#### Baseline Emissions

$$\begin{aligned}
 BE_y &= EG_{PJ,y} \times EF_{grid,CM,y} \\
 &= 867,240 \times 0.743 \\
 &= 644,359 \text{ t.CO}_2\text{e / year}
 \end{aligned}$$

#### Emissions Reduction

The ex-ante emission reductions calculations are as follows

$$ER_y = BE_y - PE_y$$



Please see the table below for a summary of the values used and the results of the calculation.

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

Year	Estimation of project activity emissions (tonnes of CO <sub>2</sub> e)	Estimation of baseline emissions (tonnes of CO <sub>2</sub> e)	Estimation of leakage (tonnes of CO <sub>2</sub> e)	Estimation of overall emission reductions (tonnes of CO <sub>2</sub> e)
Y1	62,575	644,359	0	581,784
Y2	62,575	644,359	0	581,784
Y3	62,575	644,359	0	581,784
Y4	62,575	644,359	0	581,784
Y5	62,575	644,359	0	581,784
Y6	62,575	644,359	0	581,784
Y7	62,575	644,359	0	581,784
<b>Total (tonnes of CO<sub>2</sub>e)</b>	<b>438,025</b>	<b>4,510,513</b>	<b>0</b>	<b>4,072,488</b>

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

##### B.7.1 Data and parameters monitored:

Following are data and parameters to be monitored:

<b>Data / Parameter:</b>	M <sub>steam,y</sub>
Data unit:	t steam/yr
Description:	Quantity of steam produced in year y
Source of data to be used:	Project Developer – main inlet steam flow-meter
Value of data applied for the purpose of calculating expected emission reductions in section B.5	6,838,000 ton of steam / year as referred to the Feasibility Study page 9
Description of measurement methods and procedures to be applied:	The steam quantity discharged from the geothermal wells should be measured with a venturi flow meter (or other equipment with at least the same accuracy). At the same time, temperature and pressure upstream of the venturi flow meter will also be measured to define the steam properties. The measurement of steam quantities will be conducted on a continuous basis, where daily total flow measurement will be available. The measurement results will be summarised transparently in regular production reports.
QA/QC procedures to be applied:	Meters will be calibrated according to the manufacturer standard
Any comment:	Continuous measurement, subsequently, the data will be aggregated monthly.

Data / Parameter:	W <sub>steam,CO<sub>2</sub>,y</sub>
Data unit:	tCO <sub>2</sub> /t steam
Description:	Average mass fraction of carbon dioxide in the produced steam in year y
Source of data to be	The NCG data is taken from sampling as prescribed in the methodology



used:	
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.0089467023 or 0.89467023 % as referred to Monitoring Report (page 9) of the registered Kamojang Geothermal Project that is operated by PGE. Link: <a href="http://cdm.unfccc.int/Projects/DB/RWTUV1255101629.04/view">http://cdm.unfccc.int/Projects/DB/RWTUV1255101629.04/view</a>
Description of measurement methods and procedures to be applied:	Non-condensable gases sampling should be carried out every three months in production wells and at the steam field-power plant interface using ASTM Standard Practice E1675 for Sampling 2-Phase Geothermal Fluid for Purposes of Chemical Analysis (as applicable to sampling single phase steam only).
QA/QC procedures to be applied:	PGE Laboratory QA / QC Procedure
Any comment:	-

<b>Data / Parameter:</b>	$W_{\text{steam,CH}_4,y}$
Data unit:	tCH <sub>4</sub> /t steam
Description:	Average mass fraction of methane in the produced steam in year $y$
Source of data to be used:	The NCG data is taken from sampling as prescribed in the methodology
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.0000097278 (or 0.00097278 %) as referred to Monitoring Report (page 10) of the registered Kamojang Geothermal Project that is operated by PGE. Link: <a href="http://cdm.unfccc.int/Projects/DB/RWTUV1255101629.04/view">http://cdm.unfccc.int/Projects/DB/RWTUV1255101629.04/view</a>
Description of measurement methods and procedures to be applied:	Non-condensable gases sampling should be carried out in production wells and at the steam field-power plant interface using ASTM Standard Practice E1675 for Sampling 2-Phase Geothermal Fluid for Purposes of Chemical Analysis (as applicable to sampling single phase steam only).
QA/QC procedures to be applied:	PGE Laboratory QA / QC Procedure
Any comment:	-

<b>Data / Parameter:</b>	$EG_{\text{facility},y}$
Data unit:	MWh/yr
Description:	Quantity of net electricity generation supplied by the project plant/unit to the grid in year $y$
Source of data to be used:	Project Developer – revenue meter (electricity sales)
Value of data applied for the purpose of calculating expected emission reductions in section B.5	867,240 MWh
Description of measurement methods and procedures to be applied:	Electricity produced will be measured by a watthour meter (connected to a digital control system and recorded continuously), which can measure both power delivered to the grid and received from the grid. Net electricity generation will be calculated from an electricity export to the grid (electricity supplied by Ulubelu II to the Sumatera grid) deducted with electricity import from the grid. The measurement of electricity export and import will be conducted on a



	continuous basis and will be summarised and recorded transparently in monthly production reports. In the case of main revenue meter failure, a cross-check meter will be used as a back-up meter to measure both power delivered to the grid and received from the grid.
QA/QC procedures to be applied:	The QA/QC will be conducted through cross checking with electricity sales receipts. Meters will be calibrated according to the Standard Operation Procedures (SOPs) signed between PGE and PLN. The QA/QC will also be applied to both revenue and back-up meters.
Any comment:	Standard Operation Procedures (SOPs) signed between PGE and PLN.

<b>Data / Parameter:</b>	$FC_{i,j,y}$
Data unit:	litres / year
Description:	The quantity of fuel type i (diesel fuel) combusted in process diesel gen-set j during the year y
Source of data to be used:	Project Developer – diesel fuel flow-meter
Value of data applied for the purpose of calculating expected emission reductions in section B.5	120 litres as referred to Monitoring Report (page 12) of the registered Kamojang Geothermal Project that is operated by PGE. Link: <a href="http://cdm.unfccc.int/Projects/DB/RWTUV1255101629.04/view">http://cdm.unfccc.int/Projects/DB/RWTUV1255101629.04/view</a>
Description of measurement methods and procedures to be applied:	Fuel consumption will be recorded monthly, specifically for each fuel (currently only diesel consumption is expected). Measurement will be made in litres and converted to tonnes using a constant for fuel specific density or scientifically proven fuel densities.
QA/QC procedures to be applied:	-
Any comment:	Fuel consumption will only occur in emergencies when power plant is not operational and the grid is also not available, a confluence of events which is expected to be very rare; at other times the plant will run on grid electricity. Emergency diesel gen-set is only for critical instruments / control system during turbine trip and shutdown.

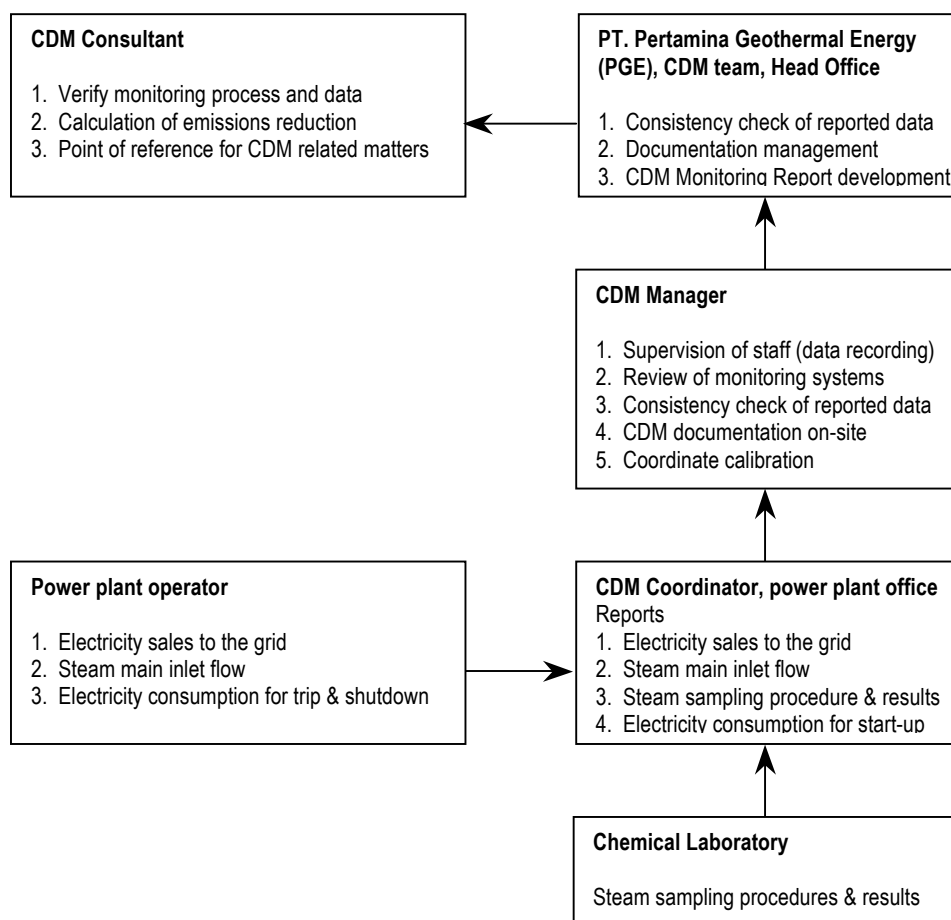
### B.7.2 Description of the monitoring plan:

This section details the steps taken to monitor on a regular basis the GHG emissions reductions from the Ulubelu II Geothermal power plant in Indonesia.

The Monitoring Plan for this project has been developed to ensure that from the start, the project is well organised in terms of the collection and archiving of complete and reliable data.

#### 1. Monitoring organisation

Prior to the start of the crediting period, the organisation of the monitoring team will be established. Clear roles and responsibilities will be assigned to all staff and the power plant manager involved in the CDM project, who will have the overall responsibility for the monitoring system on this project, ensuring the trained staff perform the monitoring duties and that where trained monitoring staff are absent, the integrity of the monitoring system is maintained by other trained staff. Initial training will be conducted and regular check performed to ensure adequacy of monitoring data.



**Figure 3 – Monitoring Organisation Chart**

### QA

The Project Developer has developed procedures that will ensure consistent quality of all data collection, recording, storage and reporting. The Project Developer has assigned a CDM manager, with the overall responsibility regarding the CDM monitoring process. The CDM manager cooperates with on-site CDM coordinator and collects all the monitored data required for the CDM. Monthly reports are prepared for the power plant manager that has the overall quality control.

## **2. Monitoring equipment and installation**

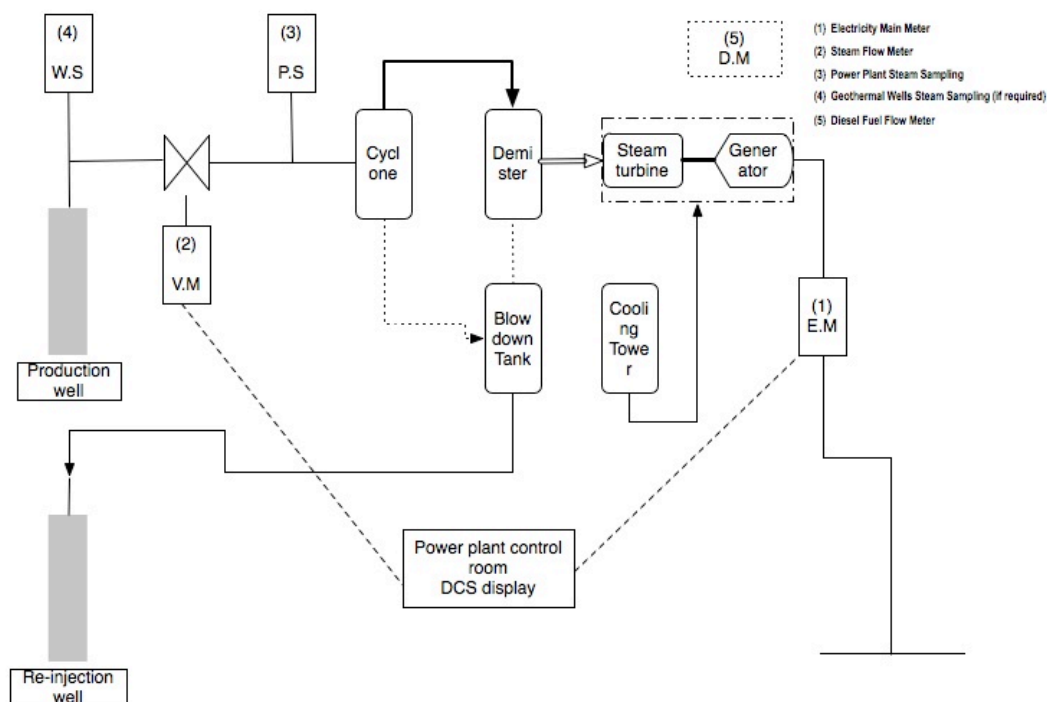
### Metering of Electricity Supplied to the Grid

This electricity meter will be the revenue meter that measures the quantity of electricity that the project will be paid for. As this meter provides the main CDM measurement, it will be the key part of the verification process. This meter is located at the interconnection point of Ulubelu II geothermal power plant.

To ensure maximum availability of CDM data and to introduce quality controls of the CDM data, a cross-check meter will be installed in addition to the revenue meter. This meter will also be located at the interconnection point of Ulubelu II geothermal power plant. Both revenue and cross-check meters will be measuring the electricity exported and imported from and to the project.

Electricity meters will meet the relevant local standards at the time of installation. Before the installation of the meters, it will be factory calibrated by the manufacturer. Records of the meter (type, make, model and calibration documentation) will be retained in the quality control system on-site.

Electricity measurements will be taken in accordance with PPA or SOP signed between PGE and PLN, or other documents which updates and replaces this SOP.



**Figure 4 – Monitoring Equipments**

#### Metering of geothermal steam flow

Available at local meter and remote (Central Control Room, CCR) where all data will be recorded. Printed report will be submitted to the Operation Steam Field of Area Ulubelu for daily steam production report.

#### Lab test of geothermal steam sampling procedure

Lab officer responsible for steam sampling procedure and chemical analysis at PGE laboratory. Report will be submitted to Manager of Ulubelu II power plant and Operations Steam Field of Area Ulubelu. All equipment will be calibrated by the manufacturer according to relevant local standards at the time of installation and maintained in accordance to the manufacturer's recommendations to ensure accuracy of measurements. Records of the meter (type, make, model, calibration and maintenance documentation) will be retained as part of the CDM monitoring system.

### **3. Data recording procedure**

All relevant data will be archived electronically, and backed up regularly. Uncertainty will be considered to achieve conservative results. Moreover, it will be kept for the full crediting period, plus two years after the end of the crediting period or the last issuance of CERs for this project activity (whichever occurs



later). The Monitoring Plan has been developed to ensure that the project has robust data collection, processing and archiving procedures.

Other data for CDM procedure will be managed by power plant operation assistant manager.

#### **4. Document management**

PGE will keep electricity sale and purchase invoices. All written documentation such as specifications, maps, drawings, will be stored for the crediting period and two years afterwards, and be made available to the verifier so that the reliability of the information may be checked.

The document management system will be developed to ensure adequate document control for CDM purposes. Monitoring report and supporting workbook will be provided for verification.

<b>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)</b>
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The baseline study and the monitoring methodology were concluded on 03 June 2011. The entity determining the baseline study and the monitoring methodology and participating in the project as the Carbon Advisor is South Pole Carbon Assets Management Ltd. listed in Annex 1 of this document as a project participant.

Name: Arrie Setiawan

Contact: [a.setiawan@southpolecarbon.com](mailto:a.setiawan@southpolecarbon.com)

Name: Alin Pratidina

E-mail: [a.pratidina@southpolecarbon.com](mailto:a.pratidina@southpolecarbon.com)

**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:**

&gt;&gt;

May 6, 2010 (Date of work order signed by Ulubelu project manager to commence drilling for UBL #18, the first well dedicated for Ulubelu II)<sup>65</sup>

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

&gt;&gt;

30 years<sup>66</sup>

**C.2 Choice of the crediting period and related information:****C.2.1. Renewable crediting period****C.2.1.1. Starting date of the first crediting period:**

&gt;&gt;

21 June 2014<sup>67</sup>

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

&gt;&gt;

7 years

**C.2.2. Fixed crediting period:****C.2.2.1. Starting date:**

&gt;&gt;

Not applicable

**C.2.2.2. Length:**

&gt;&gt;

Not applicable

<sup>65</sup> PGE Work Order signing date for UBL #18

<sup>66</sup> Ulubelu unit 3 and 4 Power Purchase Agreement (PPA)– between PLN and PGE (11 March 2011)

<sup>67</sup> Ulubelu II project plan and status report in December 2010

**SECTION D. Environmental impacts**

&gt;&gt;

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

&gt;&gt;

Based on the Environmental Ministry Decree no. 8 and 11 year 2006, an Environmental Impact Assessment (EIA) has to be conducted for electric power development activities in the Exploitation and Development of Geothermal power plants greater than 55 MW in capacity, in order to assess the environmental impacts that will occur from these geothermal field activities, and to prepare mitigation strategies to address impacts, if any. An EIA was completed in October 20, 2010 for the Ulubelu II geothermal power plant (developed by PGE), approved by the Lampung Provincial Environmental Agency (decree no. 89/KOMDAL-KPTS/II.04/X/2010).

The proposal for development of Ulubelu II geothermal power plant was presented to the Lampung province Environmental Agency in order to obtain inputs from the EIA commission. The project developer, together with the Lampung University conducted a study to develop this Environmental Impact Assessment (EIA), and presented the results to the provincial EIA commission. This commission invited stakeholders, among others the general public from the surrounding area, academics / university, related government agencies of the Lampung Province, the Environmental Health Laboratory, etc, to provide comments and input to the plan. During the consultation process, the stakeholders provided their comments to the provincial EIA commission, as summarised in the letter No. 84/KOMDAL/II.04/IX/2010 from the Lampung province Environmental Impact Assessment Commission (Komisi AMDAL) to the project developer.

The EIA report generally describes pre-construction, construction and operational stages to the project. Several environmental impacts were assessed with regard to physical/chemical (ambient air, noise, air quality), biological, and socio-economic aspects.

**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:**

&gt;&gt;

The environmental impact assessment<sup>68</sup> of geothermal field and power plant would give significant impact to the environment, specifically on the construction and operational stage, to several components identified positively such as physical/chemical, biological, and economy, whereas negative impact possible on health and psychology. Expected negative impact could be mitigated with various applied technology. Few sources of potential impacts are on the air quality and noise (heavy equipments and transport activities), water quality (earth works), economy (job opportunities) and psychology (activities socialization). Technological application and social approach to those impacts would be possible to mitigate and minimize. Therefore, development of geothermal field and power plant would be feasible to implement.

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<sup>68</sup> EIA Report (ANDAL) for Ulubelu Geothermal Field and Power Plant, 2010 (page VI-29 Environmental Assessment Recommendation)

**SECTION E. Stakeholders' comments**

&gt;&gt;

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

&gt;&gt;

The forum was hosted by PT. Pertamina Geothermal Energy, at the Ulubelu PGE project office on 3 May 2011. 24 local stakeholders attended the meeting, from 22 invitations that were distributed to 5 village offices and Ulubelu sub-district office. From each village, invitations were received by the head of village, community representative body (BHP), woman community (PKK) and youth organisation (Karang Taruna).

The meeting was opened with a welcoming speech by Anshoruddin, PGE, and then Arrie Tjahyo Setiawan delivered his presentation on the climate change and Clean Development Mechanism. A question and answer session follows, hosted by Anshoruddin and other PGE staff members.

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

&gt;&gt;

In general, all participated stakeholders in the forum support the development of PGE Ulubelu II power plant project. However, there are still many questions raised regarding the CDM process itself. The comments received from stakeholders could be categorized into two categories as follows: (1) inquiries on the CDM process; and (2) inquiries on the Ulubelu II geothermal power plant CDM project, especially regarding community development.

Below are the comments received by stakeholders:

Comment (C1) : Suroyo – Head of Ulubelu Sub-District

- Thanks for the explanation of the clean development mechanism and we are happy that PT. PGE will register Ulubelu project under this scheme. We are very aware of the climate change issue due to recent temperature increase in the country.

Question (Q1) : Suroyo – Head of Ulubelu Sub-District

- How about any preventive action due to air pollution and noise during steam production test? Because noise and air pollution could reach up to 3 km (Ngarip village).
- Is it possible to have the tree planting program? Because some forest was damaged

A1 : Hendrik, PGE

- In relation to the pollution, we always make great efforts to reduce them by installing noise silencer with different design depend on to each potential wells. In the end, evaluation was conducted until noise is reduced during the activity. The company has high concern to environmental issues; we always do our best to reduce pollution coming from the project activity. For example, we have designed and installed noise silencer at our wells location. As a conclusion, we always monitor noise pollution and evaluate until there were some reduction.
- PGE has begun to plant crops for example at roadside. To support the program, we strongly hope for participation from local communities group. PGE also has cooperation with local forest department to implement the program.

Q2 : Faisal – Head of Gunung Tiga Village

- Socialization seems only limited to head of villages. Could local villagers also be gathered so that they can understand better?



- We also thank PGE for physical improvements in the area. In addition to that, would it be possible to improve the quality of education for children?

A2 : Anshoruddin, PGE

- During this socialization, we invited all stakeholders including local villagers therefore it is not limited only to head of villages. Besides formal letters sent to head of villages, we also put open invitation to inform about this event so all stakeholders are aware and could share their thoughts and opinions. We thus hope that some stakeholders could attend this event as of now, however if they could not attend we also believe that participants here especially head of villages could communicate the socialization result to those who do not come.
- In 2009, PGE has brought 50 elementary school teachers for a benchmarking visit to develop Ulubelu's teachers capacity, which in the end could increase human resources in Ulubelu.

Q3 : Kasidah – Teacher of Karang Rejo Elementary School

- With this power plant operation, will consumer enjoy a reduction of electricity price, which in the end a reduction of household cost/expenditures?

A3 : Hendrik, PGE

- Authority of electricity management including its price is with PLN. PGE only sells power to PLN. Mechanisms of electricity price reduction will be the PLN policy and could not be affected by PGE even though we sell electricity generated to PLN.

Q4 : Paino - Karang Rejo residents

- We have formed small groups in Karang Rejo that involved local Boy Scout to plant trees. Can the group be part of PGE's program?

A4 : Anshoruddin, PGE

- We need more info regarding this group and its program. Nevertheless, we are ready to help but please advise us to whom should we discuss and also it would great if a proposal is prepared and submitted for our evaluation. Thank you very much for the initiative, we will wait for your proposal regarding this tree-planting program.

Q5 : Adiana – Local forum for family and welfare empowerment Gunung Tiga

- Schools in these villages (e.g. Datarajan and Ngarip Villages) are eager to have more qualified teachers by improving for example teaching techniques by visiting other schools. This benchmarking program to Wayang Windu was conducted for elementary school teachers, could we also have another program for middle school / high school teachers?
- Related to scholarship program, could you please check when can we expect it to happen?
- In addition to that, please also take into account that women really would like to have a more understanding with regard to the geothermal project or CDM.

A5 : Anshoruddin, PGE

- PGE wants all schools to enjoy the CSR benefit. Currently, CSR is calculated 0.2 - 2.5% from PGE net profits, which is not the case yet as PGE is not yet profitable. Because of this situation, we have not yet signed the MOU BPLHD Lampung regarding CSR program. Nevertheless, we still help school to build its building or do the benchmarking program for elementary school teachers even though we have not get profit yet. However, in the future, we could also expand our program to other schools that need this similar program so all-schools could benefit from the PGE CSR program.



- Related scholarship, PGE had proposed a number of scholarships but not yet approved the management. However, we are now under discussion to find and develop another school-oriented program that could give the same or even higher impact compare to the scholarship program.
- Thank you for your input. This event is one way to inform all stakeholders including women. We will definitely invite more women in the future so all people could get equal information from us.

Suggestion (S6) : Husni Malik – Head of Pagar Alam Village

- In addition to current tree planting program, we hope that you could distribute productive trees such fruit trees or flowers such as chrysolite.

A6 : Anshoruddin, PGE

- We fully agree to your suggestion. We ask kindly head of villages to coordinate with us. Thank you for the suggestion.

Q7 : Suroyo – Head of Ulubelu Sub-District

- Between Ngarip – Muara Dua Villages, some roads are damaged for nearly two months now, could you please facilitate this issue.
- In the group of Hutan Kemasyarakatan/HKM (Forest for Community), license to avoid deforestation is 30 years without logging 400 trees per Ha. We propose to have this HKM program conducted in non-productive forest first so it will not affect other productive forest area.

A7 : Hendrik, PGE

- Within PGE, we have planned realistic CSR program because a lot of funds are on the stake. Currently, road repair activity is not our priority as there are programs that are more urgent and important. Beside that, other entities are also using the road so we will need to discuss with other entity to see what kind of arrangement for this road repair activity. However, we will put this situation for our consideration.
- As for the HKM group (forest for community), we agree to have more productive trees for the tree-planting/reforestation program. However to fulfill the reforestation requirement from the HKM group (forest for community), we need to plant 400 non-productive trees per hectare first for 30 years.

Q8 : Istati - Datarajan Village

- This socialization event is very positive and we expect to have it more sustainable. Besides that, PGE assistance is needed especially for Elementary School 1 Datarajan for character development. One of the indicators is a sense of belonging. Therefore, could you please improve education quality through ICT as it is a very important element to enhance students' achievement.
- There are some students who join competition on district level. We kindly ask for PGE assistance to win this competition.
- As we are very grateful for PGE CSR program, we are ready to become a medium of socialization for other stakeholders.

A8 : Anshoruddin, PGE

- Through our programs, we hope we could improve students' character, and that is one of our goals. However, things should be planned and done gradually to achieve a maximum impact.
- We will discuss with our management and hope your comment could be inserted into our CSR program.
- Thank you very much for your help. PGE is really grateful if you are satisfied with our program.

Q9 : Murni M - Air Abang Village

- Could PGE explain how do you minimize impact of drilling activities?



- We would be very happy if our elementary schools could be part of PGE CSR program.

A9 : Hendrik, PGE

- Few weeks ago, we have reviewed this situation. Before the drilling activities began, we plan any related countermeasures to minimize these drilling impacts, but in relation to subsurface conditions, which are difficult to predict, we would need further evaluation. Our planning has been carefully reviewed and will be evaluated by the supervisors in case emergency situation happened.
- Air Abang area is inside the ring I, therefore it should be included in the program. We will review this situation. In addition to that, teachers are given some incentives to encourage them as part of our CSR program.

<b>E.3. Report on how due account was taken of any comments received:</b>
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The comments received were either questions concerning the project, or broad statements in support of the activity. General concern on community development plan for local people nearby project area was also raised. Several community development programmes have been performed by Pertamina (described in the project IEA documents).

No negative comments have been received on the project.

**Annex 1****CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY**

Organization:	PT. Pertamina Geothermal Energy
Street/P.O.Box:	Jalan M.H. Thamrin 9
Building:	15 <sup>th</sup> fl. Menara Cakrawala
City:	Jakarta
State/Region:	
Postfix/ZIP:	10340
Country:	Indonesia
Telephone:	+62 21 398 33 222
FAX:	+62 21 398 33 230
E-Mail:	
URL:	<a href="http://www.pgeindonesia.com">www.pgeindonesia.com</a>
Represented by:	
Title:	CEO
Salutation:	Mr.
Last Name:	Riadhhy
Middle Name:	
First Name:	Slamet
Department:	
Mobile:	
Direct FAX:	+62 21 398 33 230
Direct tel:	+62 21 398 33 222
Personal E-Mail:	<a href="mailto:cdm.pge@pertamina.com">cdm.pge@pertamina.com</a>

Organization:	South Pole Carbon Asset Management Ltd.
Street/P.O.Box:	Technoparkstrasse 1
Building:	
City:	Zurich
State/Region:	
Postfix/ZIP:	8005
Country:	Switzerland
Telephone:	+41 43 501 35 50
FAX:	+41 43 501 35 99
E-Mail:	
URL:	<a href="http://www.southpolecarbon.com">www.southpolecarbon.com</a>
Represented by:	
Title:	CEO
Salutation:	Mr.
Last Name:	Heuberger
Middle Name:	
First Name:	Renat
Mobile:	
Direct FAX:	
Direct tel:	
Personal E-Mail:	<a href="mailto:registration@southpolecarbon.com">registration@southpolecarbon.com</a>



**Annex 2**

**INFORMATION REGARDING PUBLIC FUNDING**

This project does not involve public funding.



### Annex 3

## BASELINE INFORMATION

Please also refer to PDD Section B.4, B.5 and B.6

### **Sumatera Interconnected Grid Emission Factor**

The data of emission factor of Sumatera grid is published by Indonesia DNA, which was calculated by BPPT. The calculation of emission factor of Sumatera Grid was conducted based on “Tool to calculate the emission factor for an electricity system Version 02.2.1”. The determination of the emission factor is performed by following the steps below:

#### Step 1. Identify the relevant electricity systems.

According to PLN’s actual grid structure, Sumatera grid covers NAD Province, North Sumatera Province, Riau Province, Jambi Province, West Sumatera Province, South Sumatera Province and Lampung Province. The project activity is located in Lampung province, which is covered by Sumatera Power Grid. Thus, the relevant electric power system is Sumatera Power Grid.

#### Step 2. Choose whether to include off-grid power plants in the project electricity system (optional).

Option I is chosen in this calculation which is only grid power plants are included in it.

#### Step 3. Select a method to determine the operating margin (OM).

The “Tool to calculate the emission factor for an electricity system Version 02.2.1” offers four methods to calculate the operating margin (OM):

- a. Simple OM; or
- b. Simple adjusted OM; or
- c. Dispatch data analysis OM; or
- d. Average OM

From 2003 to 2007, the low-cost / must-run resources in Sumatera grid were 20.95%, 17.90%, 17.28% and 21.99% respectively. All were accounted less than 50% of the total amount in the Sumatera grid. According to the data, the simple OM method is selected for calculating the emission factor. For the simple OM, the emission factor can be calculated using either of the two following data vintages:

1. *Ex ante* option: this option does not require monitoring and recalculation of the emission factor during the crediting period because the emission factor is determined once at the validation stage. A 3-year generation-weighted average, based on the most recent data available at the time of the submission of the CDM-PDD to the DOE for validation.
2. *Ex post* option: the emission factor is determined for the year in which the project activity displaces grid electricity, requiring the emission factor to be updated annually during monitoring. If the data required calculating the emission factor for year y is usually only available later than six months after the end of the year y, alternatively the emission factor of the previous year y-1 may be used. If the data is usually only available 18 months after the end of year y, the emission factor of the year preceding the previous y-2 may be used. The same data vintage (y, y-1 or y-2) should be used throughout all crediting periods.



“Ex ante option: A 3-year generation-weighted average” has been selected for the calculation of this project activity.

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

The simple OM emission factor is calculated as the generation-weighted average CO<sub>2</sub> emissions per unit net electricity generation (tCO<sub>2</sub> / MWh) of all generating power plants serving the system, not including low-cost / must-run power plants/units. The simple OM may be calculated by choosing one of these below two options:

- Option A: Based on the net electricity generation and a CO<sub>2</sub> 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.

Option B can only be used if:

- The necessary data for option A is not available; and
- Only nuclear and renewable power generation are considered as low-cost / must-run power sources and the quantity of electricity supplied to the grid by these sources is known; and
- Off-grid power plants are not included in the calculation (i.e., if Option I has been chosen in Step 2).

The calculation of the simple OM emission factor uses 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 reason of choosing option B is because the necessary data needed in Option A is not available for all power plants in the Sumatera grid. Data on fuel consumption of each power plant owned by Independent Power Producer (IPP) is not publicly available. Thus, option B is selected.

The simple OM emission factor is calculated based on the net electricity supplied to the grid by all power plants serving the system, not including low-cost / must-run power plants / units, and based on the fuel type(s) and total fuel consumption of the project electricity system, as follows :

$$EF_{grid,OMsimple,y} = \frac{\sum_i (FC_{i,y} \times NCV_{i,y} \times EF_{CO2,i,y})}{EG_y}$$

Where :

- $EF_{grid,OMsimple,y}$  = Simple operating margin CO<sub>2</sub> emission factor in year ‘y’ (tCO<sub>2</sub>/MWh)  
 $FC_{i,y}$  = Amounts of fossil fuel type ‘i’ consumed in the project electricity system in year ‘y’ (Mass or volume unit)  
 $NCV_{i,y}$  = Net calorific value (energy content) of fossil fuel type ‘i’ in year ‘y’ (GJ / mass or volume unit)  
 $EF_{CO2,i,y}$  = CO<sub>2</sub> emission factor of fossil fuel type ‘i’ in year ‘y’ (tCO<sub>2</sub>/GJ)  
 $EG_y$  = Net electricity generated and delivered to the grid by all power sources serving the system, not including low-cost / must-run power plants / units, in year ‘y’ (MWh)  
 i = All fossil fuel types combusted in power sources in the project electricity system in year ‘y’  
 y = The relevant year as per the data vintage chosen in step 3



## Calculation of Operating Margin (OM)

Table 3: Simple OM Emission Factors Calculation of Sumatera Grid for Year 2005

Fuel	Unit	Sumbagsel (Include IPP) A	Sumbagut B	Total C = A + B	EF (tC/TJ) D	Oxidation (%) E	NCV F	CO <sub>2</sub> Emission (tCO <sub>2e</sub> ) G
MFO	kiloliter	510	323,472	323,982	21.1	100%	40,767 MJ/kl	1,021,834
IDO	kiloliter	15,662	0	15,662	20.2	100%	37,219 MJ/kl	43,177
HSD	kiloliter	176,692	1,009,112	1,185,804	20.2	100%	36,542 MJ/kl	3,209,402
Coal	ton	1,651,943	0	1,651,943	25.8	100%	27,444 MJ/ton	4,288,852
Natural Gas	MMBTU	20,792,324	14,299,034	35,091,358	15.3	100%		2,076,978
								10,640,244

Table 4: Simple OM Emission Factors Calculation of Sumatera Grid for Year 2006

Fuel	Unit	Sumbagsel (Include IPP) A	Sumbagut B	Total C = A + B	EF (tC/TJ) D	Oxidation (%) E	NCV F	CO <sub>2</sub> Emission (tCO <sub>2e</sub> ) G
MFO	kiloliter	0	256,020	256,020	21.1	100%	40,767 MJ/kl	807,483
IDO	kiloliter	17,137	0	17,137	20.2	100%	37,219 MJ/kl	47,243
HSD	kiloliter	188,208	1,150,461	1,338,668	20.2	100%	36,542 MJ/kl	3,623,133
Coal	ton	1,530,391	0	1,530,391	25.8	100%	27,444 MJ/ton	3,973,273
Natural Gas	MMBTU	27,980,333	7,994,188	35,974,521	15.3	100%		2,129,251
								10,580,383

Table 5: Simple OM Emission Factors Calculation of Sumatera Grid for Year 2007

Fuel	Unit	Sumbagsel (Include IPP) A	Sumbagut B	Total C = A + B	EF (tC/TJ) D	Oxidation (%) E	NCV F	CO <sub>2</sub> Emission (tCO <sub>2e</sub> ) G
MFO	kiloliter	0	281,427	281,427	21.1	100%	40,767 MJ/kl	887,616
IDO	kiloliter	7,989	0	7,989	20.2	100%	37,219 MJ/kl	22,025
HSD	kiloliter	108,594	1,250,672	1,359,267	20.2	100%	36,542 MJ/kl	3,678,883
Coal	ton	1,706,554	0	1,706,554	25.8	100%	27,444 MJ/ton	4,430,637
Natural Gas	MMBTU	32,399,087	10,131,294	42,530,382	15.3	100%		2,517,277
								11,536,438

## Total Generation Capacity (2005-2007) excl. Low-Cost/Must-Run

Type of Power Plant	Fuel type	2005 MWh	2006 MWh	2007 MWh
Hydro		2,505,314	2,948,239	3,593,005
Geothermal		0	0	0
Steam - Oil	MFO	1,060,814	837,664	949,438
Steam - Gas	Natural Gas	125,254	113,808	119,821
Steam - Coal	Coal	2,932,330	2,868,414	3,257,691
Diesel	HSD	529,384	567,470	498,576
Diesel	IDO	66,887	73,971	34,026
Diesel	PPO	0	5,108	0
Combustion Turbine - Oil	HSD	451,084	517,802	417,080
Combustion Turbine - Gas	Natural Gas	1,154,204	974,046	1,206,994
Combined Cycle - Oil	HSD	0	0	0
Combined Cycle - Gas	Natural Gas	5,672,687	6,221,137	6,259,426
Total Generation incl. Low-Cost/Must-Run		14,497,958	15,127,659	16,336,057
Total Low Cost Must Run		2,505,314	2,953,347	2,953,347
Total Generation excl. Low-Cost/Must-Run		11,992,644	12,174,312	13,382,710
Internal use rate		3.98%	3.47%	3.52%
Net Electricity excl. Low-Cost/Must-Run		11,514,899	11,751,548	12,911,406

## Total Emissions / Total Generation

		2005	2006	2007
Total Emissions	tCO <sub>2e</sub>	10,640,244	10,580,383	11,536,438
Total Generation	MWh	11,514,899	11,751,548	12,911,406
EF <sub>OM,y</sub>	tCO <sub>2e</sub> /MWh	0.924	0.900	0.894

EF <sub>OM2005-2007</sub>	0.906	tCO <sub>2e</sub> /MWh	Operating Margin	
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## Step 5. Calculate the build margin emission factor.

In terms of vintage of data, project participants can choose between one of the following two options:

## Option 1:

For the first crediting period, calculate the build margin emission factor ex ante based on the most recent information available on units already built for sample group m at the time of CDM-PDD submission to



the DOE for validation. For the second crediting period, the build margin emission factor should be updated based on the most recent information available on units already built at the time of submission of the request for renewal of the crediting period to the DOE. For the third crediting period, the build margin emission factor calculated for the second crediting period should be used. This option does not require monitoring the emission factor during the crediting period.

**Option 2:**

For the first crediting period, the build margin emission factor shall be updated annually, ex post, including those units built up to the year of registration of the project activity or, if information up to the year of registration is not yet available, including those units built up to the latest year for which information is available. For the second crediting period, the build margin emissions factor shall be calculated ex ante, as described in Option 1 above. For the third crediting period, the build margin emission factor calculated for the second crediting period should be used.

Ex-ante calculation applying Option 1 data has been selected for the purpose of emission reductions calculation for the proposed project activity.

The sample group of power units  $m$  used to calculate the build margin should be determined as per the following procedure, consistent with the data vintage selected above:

(a) Identify the set of five power units, excluding power units registered as CDM project activities, that started to supply electricity to the grid most recently ( $SET_{5-units}$ ) and determine their annual electricity generation ( $AEG_{SET-5-units}$ , in MWh);

(b) Determine the annual electricity generation of the project electricity system, excluding power units registered as CDM project activities ( $AEG_{total}$ , in MWh). Identify the set of power units, excluding power units registered as CDM project activities, that started to supply electricity to the grid most recently and that comprise 20% of  $AEG_{total}$  (if 20% falls on part of the generation of a unit, the generation of that unit is fully included in the calculation) ( $SET_{\geq 20\%}$ ) and determine their annual electricity generation ( $AEG_{SET-\geq 20\%}$ , in MWh);

(c) From  $SET_{5-units}$  and  $SET_{\geq 20\%}$  select the set of power units that comprises the larger annual electricity generation ( $SET_{sample}$ );

Identify the date when the power units in  $SET_{sample}$  started to supply electricity to the grid.

If none of the power units in  $SET_{sample}$  started to supply electricity to the grid more than 10 years ago, then use  $SET_{sample}$  to calculate the build margin. Ignore steps (d), (e) and (f).

Otherwise:

(d) Exclude from  $SET_{sample}$  the power units which started to supply electricity to the grid more than 10 years ago. Include in that set the power units registered as CDM project activity, starting with power units that started to supply electricity to the grid most recently, until the electricity generation of the new set comprises 20% of the annual electricity generation of the project electricity system (if 20% falls on part of the generation of a unit, the generation of that unit is fully included in the calculation) to the extent is possible. Determine for the resulting set ( $SET_{sample-CDM}$ ) the annual electricity generation ( $AEG_{SET-sample-CDM}$ , in MWh);

If the annual electricity generation of that set is comprises at least 20% of the annual electricity generation of the project electricity system (i.e.  $AEG_{SET-sample-CDM} \geq 0.2 \times AEG_{total}$ ), then use the sample group  $SET_{sample-CDM}$  to calculate the build margin. Ignore steps (e) and (f).

Otherwise:

(e) Include in the sample group  $SET_{sample-CDM}$  the power units that started to supply electricity to the grid more than 10 years ago until the electricity generation of the new set comprises 20% of the annual



electricity generation of the project electricity system (if 20% falls on part of the generation of a unit, the generation of that unit is fully included in the calculation);

(f) The sample group of power units  $m$  used to calculate the build margin is the resulting set ( $SET_{\text{sample-CDM} \rightarrow 10\text{yrs}}$ ).

The Group of Power Units to be included in the Build Margin (BM)

No	Power station	Installed capacity (kW)	Commissioning year	Fuel type
1	PLTU Tarahan 1	100,000	2007	Coal & HSD
2	PLTU Tarahan 2	100,000	2007	Coal & HSD
3	PLTG Riau Power (r)	20,000	2007	Gas
4	PLTD Sewa Arti Duta (r)	15,000	2007	HSD
5	PLTG Meppogen (IPP)	80,000	2007	Gas
6	PLTG Apung	30,000	2007	HSD
7	PLTA Renun 1	41,000	2006	Hydro
8	PLTA Musi 1	71,825	2006	Hydro
9	PLTA Musi 2	71,825	2006	Hydro
10	PLTA Musi 3	71,825	2006	Hydro
11	PLTD 12 Gunung Sitoli	1,010	2005	HSD
12	PLTD 13 Gunung Sitoli	1,010	2005	HSD
13	PLTD Teluk Dalam	1,010	2005	HSD
14	PLTA Renun 2	41,000	2005	Hydro
15	PLTG Indralaya II	40,000	2004	Gas & HSD
16	PLTG Truck Mounted 1	20,000	2004	Gas
17	PLTG Truck Mounted 2	20,000	2004	Gas
18	PLTG Talang Duku (r)	20,000	2004	HSD
19	PLTD 12 Lueng Bata	3,450	2004	HSD
20	PLTD 13 Lueng Bata	3,450	2004	HSD
21	PLTD 14 Lueng Bata	3,450	2004	HSD
22	PLTGU Borang (IPP)	150,000	2004	Gas

The build margin emission factor is the ex-ante generation-weighted average emission factor ( $tCO_2/MWh$ ) of all power units  $m$  during the most recent year ‘y’ for which power generation data is available, calculated as follows:

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

Where:

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

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

$EF_{EL,m,y}$  = Emission factor of power station included in the build margin

$m$  = Power stations included in the build margin

$y$  = Most recent historical year for which power generation data is available



## Calculation of Build Margin (BM)

#	Station	Installed capacity (kW)	Year of Commission	Fuel Type	Fuel			Electricity Generation		
					Coal (ton)	Gas (MMBTU)	HSD (kl)	2007 (Gross) MWh	Parasitic load (ave) %	2007 (Net) MWh
1	PLTU Tarahan 1	100,000	2007	coal & HSD	47,926		1,284	105,450	3.52%	101,736
2	PLTU Tarahan 2	100,000	2007	coal & HSD	98,072		2,903	204,410	3.52%	197,212
3	PLIG Riau Power (rental)	20,000	2007	Gas		1,119,896		74,994	0.00%	74,994
4	PLID Sewa Arti Duta AU (rental)	15,000	2007	HSD			20,270	77,297	0.00%	77,297
5	PLIG Meppo Gen (IPP)	80,000	2007	Gas		5,292,873		297,674	0.00%	297,674
6	PLIG Apung	30,000	2007	HSD			2,816	9,817	3.52%	9,471
7	PLTA 1 Renun	41,000	2006	Hydro				163,003	3.52%	157,262
8	PLTA Musi 1	71,825	2006	Hydro				183,105	3.52%	176,657
9	PLTA Musi 2	71,825	2006	Hydro				183,499	3.52%	177,036
10	PLTA Musi 3	71,825	2006	Hydro				197,278	3.52%	190,330
11	PLID-12 Gunung Sitoli	1,010	2005	HSD			868	3,176	3.52%	3,064
12	PLID-13 Gunung Sitoli	1,010	2005	HSD			868	3,176	3.52%	3,064
13	PLID-1 Teluk Dalam	1,010	2005	HSD			871	3,176	3.52%	3,064
14	PLTA-2 Renun	41,000	2005	Hydro				163,003	3.52%	157,262
15	PLIG Inderalaya II	40,000	2004	Gas & HSD		2,492,620	1	227,141	3.52%	219,141
16	PLIG Truck Mounted 1	20,000	2004	Gas		1,463,191		125,434	3.52%	125,434
17	PLIG Truck Mounted 2	20,000	2004	Gas		0		0	3.52%	0
18	PLIG Rental 11 Duku #1	20,000	2004	Gas		365,123		16,040	0.00%	16,040
19	PLID 12 LUENG BATA*	3,450	2004	HSD			1,451	5,017	3.52%	4,841
20	PLID 13 LUENG BATA*	3,450	2004	HSD			1,451	5,017	3.52%	4,841
21	PLID 14 LUENG BATA*	3,450	2004	HSD			1,451	5,017	3.52%	4,841
22	PLIGU Borang (IPP)	150,000	2004	Gas		13,156,205		1,247,034	0.00%	1,247,034
					145,998	23,889,909	34,230		3,299,757	3,248,295

'power plant capacity additions in the elc. System that comprise 20% of the system generation...'

2007		
Total Generation	MWh	16,336,057
22-last	MWh	3,299,757
22-last / Total	%	20.2

## 22-last Total Emissions / 22-last Total Generation

Parameter	Unit	2007
Total Power Generated (net)	MWh	3,248,295
Fuel Consumption (HSD)	kl	34,230
	TJ	1,251
EF	tC/TJ	20.20
Oxidation		100%
Emissions from HSD	tCO <sub>2</sub> e	92,644
Fuel Consumption (Gas)	MMBTU	23,889,909
	TJ	25,205
EF	tC/TJ	15.30
Oxidation		100%
Emissions from Natural Gas	tCO <sub>2</sub> e	1,413,990
Fuel Consumption (Coal)	ton	145,998
	TJ	4,007
EF	tC/TJ	25.8
Oxidation		100%
Emissions from Coal	tCO <sub>2</sub> e	379,047
Total Emissions	tCO <sub>2</sub> e	1,885,681
EF <sub>BM2007</sub>	tCO <sub>2</sub> e/GWh	580.5
EF <sub>BM2007</sub>	tCO <sub>2</sub> e/MWh	0.581

EF <sub>BM2007</sub>	0.581	tCO <sub>2</sub> e/MWh	Build Margin	
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## Step 6. Calculate the combined margin (CM) emissions factor.

The calculation of the combined margin (CM) emission factor (EF<sub>grid,CM,y</sub>) is based on one of the following methods:

- (a) Weighted average CM; or
- (b) Simplified CM.

The weighted average CM method (option a) should be used as the preferred option.

The simplified CM method (option b) can only be used if:

- The project activity is located in a Least Developed Country (LDC) or in a country with less than 10 registered projects at the starting date of validation; and



- The data requirements for the application of step 5 above cannot be met.

a. Weighted average CM

The combined margin emissions factor is calculated as follows :

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

Where:

$EF_{grid,BM,y}$  = Build margin CO<sub>2</sub> emission factor in year y (tCO<sub>2</sub>/MWh)

$EF_{grid,OM,y}$  = Operating margin CO<sub>2</sub> emission factor in year y (tCO<sub>2</sub>/MWh)

$w_{OM}$  = Weighting of operating margin emissions factor (%)

$w_{BM}$  = Weighting of build margin emissions factor (%)

b, Simplified CM

The combined margin is calculated using equation above with the following conditions:

- $w_{BM} = 0$ ;
- $w_{OM} = 1$ ;

Under the simplified CM, the operating margin emission factor ( $EF_{grid,OM,y}$ ) must be calculated using the average OM (option (d) in step 3).

This Sumatera grid OM is calculated using weighted average CM.

Calculate the baseline emission factor  $EF_y$

$EF_y$	=	$w_{OM}$	*	$EF_{OM2006}$	+	$w_{BM}$	*	$EF_{BM2006}$
0.743		0.5		0.906		0.5		0.581

$w_{OM}$	0.5	(Default value)
$w_{BM}$	0.5	(Default value)

The EF of the Sumatera Electricity Grid for 2008 is

$EF_{2008}$  0.743 tCO<sub>2</sub>e/MWh



**Annex 4**

**MONITORING PLAN**

Please refer to PDD Section B.6 and B.7