PROJECT DESIGN DOCUMENT FORM
FOR CDM PROJECT ACTIVITIES (F-CDM-PDD)
Version 04.1

PROJECT DESIGN DOCUMENT (PDD)

Title of the project activity	Project Kamojang Unit 5 PT. Pertamina Geothermal Energy
Version number of the PDD	01.6
Completion date of the PDD	24/10/2012
Project participant(s)	South Pole Carbon Asset Management Ltd. PT. Pertamina Geothermal Energy
Host Party(ies)	Republic of Indonesia
Sectoral scope and selected methodology(ies)	Sectoral scope: (1) Energy industries (renewable - / non-renewable sources) Selected methodology: ACM0002 "Consolidated baseline methodology for grid connected electricity generation from renewable sources" version 13.0
Estimated amount of annual average GHG emission reductions	156,669 t.CO_2e

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

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The Project Kamojang Unit 1 PT. Pertamina Geothermal Energy (hereafter referred to as Kamojang or the Project) developed by PT. Pertamina Geothermal Energy (PGE), hereafter referred to as the Project Developer, is a geothermal power plant in West Jawa, Indonesia (hereafter referred to as the "Host Country"). The Project's net installed capacity is 30 MW[1], while its total gross power output will be 31.8 MW. An estimated power generation of 236.52 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 Kamojang to generate electricity to be transmitted to the Jamali Interconnected grid (hereafter referred to as the Grid) through the Perusahaan Listrik Negara (PT. PLN (Persero), state-owned electricity company) interconnection point in the Kamojang geothermal project area. In the absence of the proposed project activity, electricity will be supplied by the generation mix in the Jamali interconnected grid. This is the same as baseline scenario to the proposed project activity. The project activity will reduce total emissions in the Jamali grid by supplying green renewable electricity from geothermal resources in the Kamojang geothermal field, instead of utilizing typical power generation with more carbon intensive technology[2]. Total GHG emission reductions for the first crediting period (7 years) is estimated to be 1,096,683 t.CO_2e, with annual average amount of 156,669 t.CO_2e.

The project is contributing to sustainable development of the Host Country[3]. Specifically, the project:

- Increasing community development and corporate social responsibility at Kamojang geothermal field, 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 Kamojang geothermal field, 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)

[1] Technical specification documentation that was sent to PLN in October 2010, 31.8 MW is Kamojang's power output or total gross installed capacity as per turbine's nameplate. While 30 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 1.8 MW, will be covering power plant auxiliaries (referred also as the project developer's internal consumption).

[2] Sectoral scope: (1) Energy industries (renewable - / non-renewable sources)

[3] 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

A.2. Location of project activity

A.2.1. Host Party(ies)
>>
Republic of Indonesia

A.2.2. Region/State/Province etc.
>>
West Java Province.

A.2.3. City/Town/Community etc.
>>
Ibun Sub district, Bandung Regency.

A.2.4. Physical/Geographical location
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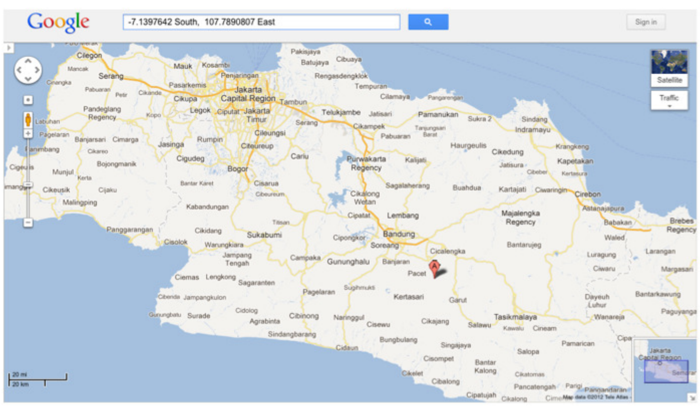
Kamojang geothermal power plant is located approximately 70 km south of Bandung, the capital of West Java province.
The exact location of the geothermal power plant is defined using GPS coordinates -7.1397642 South, 107.7890807 East.

Figure 1 – Map of Kamojang geothermal power plant (source : maps.google.com)



A.3. Technologies and/or measures

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The Project uses well-established geothermal power plant technology for electricity generation and transmission, with total gross power output of 31.8 MW and net installed capacity of 30 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 Kamojang 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

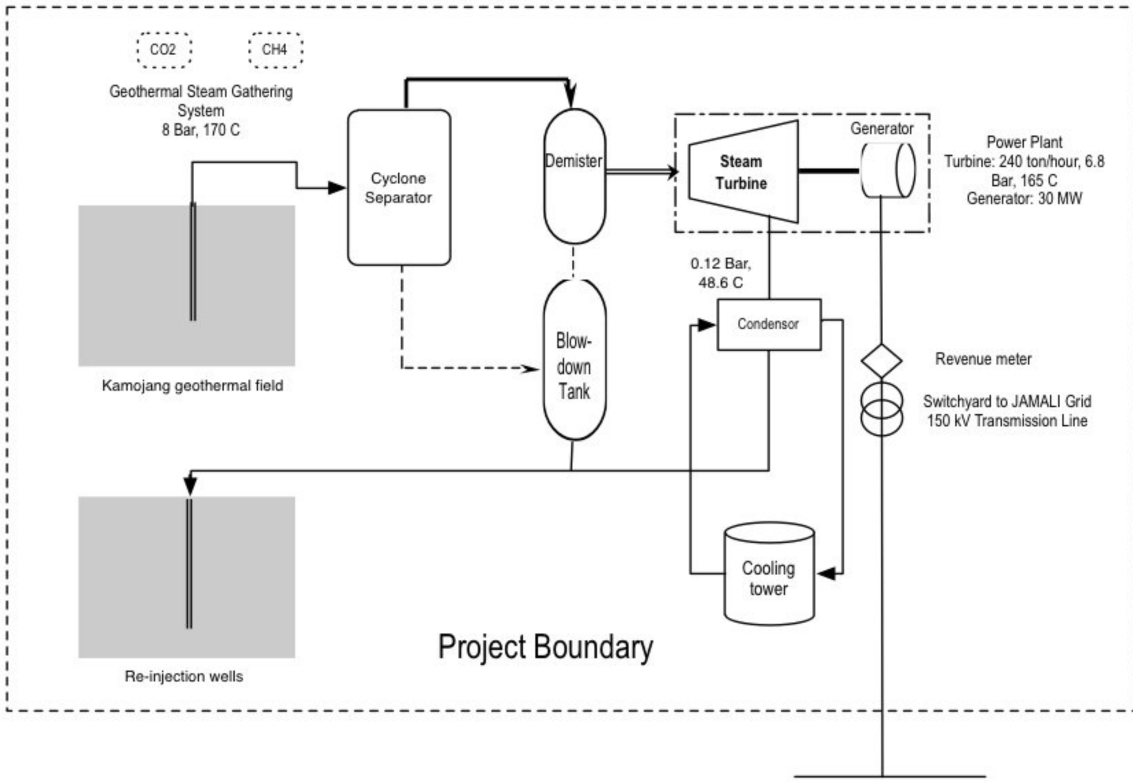
Variable	*Value*	*Source*
Turbine generator capacity (MW)	31.8	Power plant technical specification

		as sent to PLN, page D-25
Project lifetime (years)	30	Feasibility Study Report, page 12, where mentioned that PLN will be bound to have a 30 years contracted PPA
Net installed capacity (MW)	30	Feasibility Study Report, page 12
Operating time yearly (hours)	7884 (8760 x 90%)	Calculated based on 90% load factor as per Feasibility Study Report, page 12
Expected annual power generation / effective supply to the grid (MWh)	236,520	Feasibility Study Report, page 12

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 Kamojang KWK A and KWK B geothermal field is sent to the Kamojang unit V power plant, where it is separated from condensate and fed into steam turbine generator systems (direct steam expansion) as shown in **Figure 2**. 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, independently of the existing Kamojang power plants. Kamojang unit V is restricted to the Northeast area (KWK sector) from existing Kamojang field and does not share wells or pipelines with the other four previously built power plants, nor would it have any interconnection in steam flow / control system (each power plant has fully independent operation and control).

Figure 2 – Mass energy flow diagram of Kamojang geothermal field and power plant



A.4. Parties and project participants

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

A.5. Public funding of project activity

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The project does not involve public funding from any Annex 1 countries.

SECTION B. Application of selected approved baseline and monitoring methodology

B.1. Reference of methodology

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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 13.0, in effect as of 11 May 2012;
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 for demonstration and assessment of additionality used is: “Tool for demonstration and assessment of additionality”, version 06.1, in effect as of 13 September 2012.

Further information with regards to the methodology can be obtained at:
http://cdm.unfccc.int/methodologies/PAmethodologies/approved.html

B.2. Applicability of methodology

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

Table 2 – Applicability Conditions of ACM0002

Methodology ACM0002	CDM Project Activity
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 10 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.	Not applicable The project is not a capacity addition, retrofits or replacements. It is a development of new power generation facility.
In case of hydro power plants: • One of the following conditions must apply: • The project activity is implemented in an existing single	Not applicable The project is not a hydro power plant.

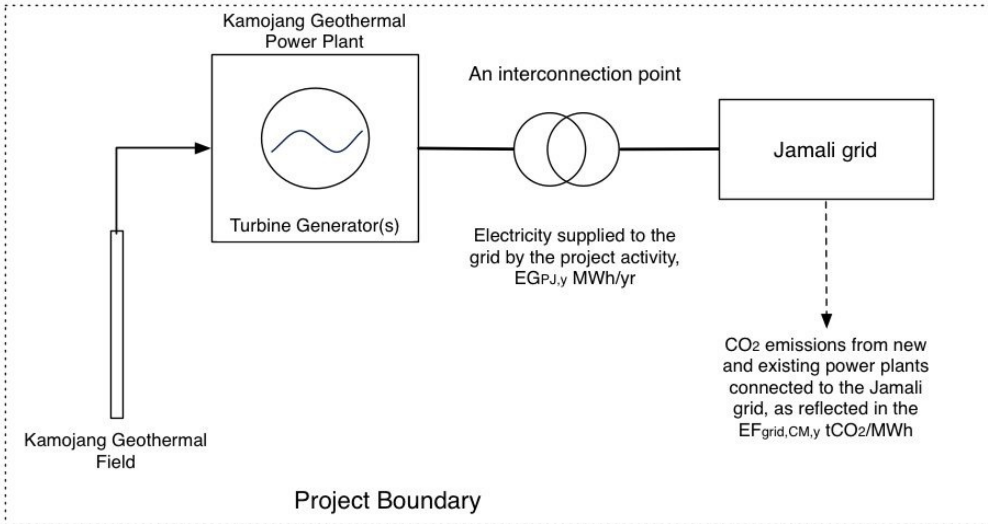
or multiple reservoirs, with no change in the volume of any of reservoirs; or • The project activity is implemented in an existing single or multiple reservoirs, where the volume of any of reservoirs is increased and the power density of each reservoir, as per the definitions given in the project emissions section, is greater than 4 W/m^2; or • The project activity results in new single or multiple reservoirs and the power density of each reservoir, as per the definitions given in the project emissions section, is greater than 4 W/m^2.	
In case of hydro power plants using multiple reservoirs where the power density of any of the reservoirs is lower than 4 W/m^2 all the following conditions must apply: • The power density calculated for the entire project activity using equation 5 is greater than 4 W/m^2; • Multiple reservoirs and hydro power plants located at the same river and where are designed together to function as an integrated project that collectively constitute the generation capacity of the combined power plant; • Water flow between multiple reservoirs is not used by any other hydropower unit which is not a part of the project activity; • Total installed capacity of the power units, which are driven using water from the reservoirs with power density lower than 4 W/m^2, is lower than 15 MW; • Total installed capacity of the power units, which are driven using water from reservoirs with power density lower than 4 W/m^2, is less than 10% of the total installed capacity of the project activity from multiple reservoirs.	Not applicable The project is not a hydro power plant
The methodology is not applicable to the following: • Project activities that involve switching from fossil fuels to renewable energy sources at the site of the project activity, since in this case the baseline may be the continued use of fossil fuels at the site; • Biomass fired power plants; • A hydro power plant that results in the creation of a new single reservoir or in the increase in an existing single reservoir where the power density of the power plant is less than 4 W/m^2.	The methodology is applicable, since it is not any of the following: • This project activity does not involve switching from fossil fuels to renewable energy sources at the site of the project activity. • This project activity is not a biomass-fired power plant. • This project activity is not a hydro power plant.
In the case of retrofits, replacements, or capacity additions, this methodology is only applicable if the most plausible baseline scenario, as a result of the identification of baseline scenario, is "the continuation of the current situation, i.e. to use the power generation equipment that was already in use prior to the implementation of the project activity and undertaking business as usual maintenance".	This project activity is not a retrofit, replacement, or capacity addition.

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

B.3. Project boundary

<table>
<tr><th colspan="2">Source</th><th>GHGs</th><th>Included?</th><th>Justification/Explanation</th></tr>
<tr><td rowspan="3">Baseline scenario</td><td rowspan="3">CO_2 emissions from electricity generation in fossil fuel fired power plants that is displaced due to the project activity</td><td>CO_2</td><td>Included</td><td>According to ACM0002 only CO_2 emissions from electricity generation should be accounted for (main emission source)</td></tr>
<tr><td>CH_4</td><td>Excluded</td><td>According to ACM0002 (minor emission source)</td></tr>
<tr><td>N_2O</td><td>Excluded</td><td>According to ACM0002 (minor emission source)</td></tr>
<tr><td rowspan="6">Project scenario</td><td rowspan="3">Fugitive emissions of CH_4 and CO_2 from non-condensable gases contained in geothermal steam</td><td>CO_2</td><td>Included</td><td>According to ACM0002: CO_2 fugitive emissions from non-condensable gases should be accounted for (main emission source)</td></tr>
<tr><td>CH_4</td><td>Included</td><td>According to ACM0002: CH_4 fugitive emissions from non-condensable gases should be accounted for (main emission source)</td></tr>
<tr><td>N_2O</td><td>Excluded</td><td>According to ACM0002 (minor emission source)</td></tr>
<tr><td rowspan="3">CO_2 emissions from combustion of fossil fuels required to operate the geothermal power plant</td><td>CO_2</td><td>Excluded</td><td>According to ACM0002 (the use of fossil fuels for the back up or emergency purposes, e.g. diesel generators, can be neglected)</td></tr>
<tr><td>CH_4</td><td>Excluded</td><td>According to ACM0002 (minor emission source)</td></tr>
<tr><td>N_2O</td><td>Excluded</td><td>According to ACM0002 (minor emission source)</td></tr>
</table>

Figure 3 – Project boundary of Kamojang geothermal project



According to the methodology ACM0002, the spatial extent of the project boundary includes the project power plant and all power plants connected physically to the electricity system that the CDM project power plant is connected to. For the Kamojang geothermal power plant, the spatial boundary covers geothermal wells supplying steam to the Kamojang power plant, the power plant site and the grid connection to Jamali grid. Diagram for project boundary is provided in **Figure 3** and equipment/system details are provided in **Figure 2** in section A.3 above.

B.4. Establishment and description of baseline scenario

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Kamojang unit V geothermal power plant is a separate, distinct unit from Kamojang units I, II, III and IV. Each power plant has a separate geothermal steam supply under different electrical Energy Sales Contracts to supply contracted amounts of geothermal steam to each power plant, i.e. Kamojang V CDM project activity unit does not influence the steam supply of existing units. The area that is encompassed by the project boundary, the Northeast KWK sectors (Blok KWK 'Kawah Kamojang', or Kamojang crater), which is situated across the Kamojang crater (or on the opposite side of Kamojang peak, from existing Kamojang field area). The available steam supply from the wells within the project boundary is 210 – 240 tonnes steam/hour (equivalent to 30 MWe). Kamojang V is restricted to the Northeast area (KWK sector) from existing Kamojang field and does not share wells or pipelines with the other four previously built power plants, nor would it have any interconnection in steam flow / control system (each power plant has fully independent operation and control).

Outside the project boundary, the nearby existing Kamojang power plant units I, II, III, and IV with a total installed capacity of 200 MW, were in operation, using steam from wells in the existing sectors of the Kamojang Geothermal Field. The production of steam from the wells in these sectors would not affect the initial wellhead pressure in the Northeast (project) sector, on the opposite side of Kamojang peak. This activity outside the project boundary is unrelated to the project activity and continues unaffected after implementation of the project activity. Furthermore, Kamojang I, II, III and IV all have the sole rights to generate and distribute electricity at the time of their implementation. They were

developed in early 1980s and commenced operation in 1983 and 1987 (Kamojang I / II-III, respectively)[4], while Kamojang IV was developed in 2006 and started operation in 2008. The Project Activity is not an increase of capacity of the previous plants, but it is a new and independent plant and it will have no impact on the operation of or the electricity generated by Kamojang I, II, III and IV.

The total capacity of Kamojang Geothermal Field and Kawah Kamojang KWK & PSJ sector is being developed for 300 MWe[5]. The project activity is a new geothermal power plant (Kamojang unit V) with gross installed capacity of 31.8 MW. Its installation does not modify or retrofit existing electricity generation facilities. The plant is expected to require about 210 – 240 tonnes steam/hour. 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 described in the Table 3 below and section B.6.1.

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

Variable	Value/Unit	Source
Operating Margin Emissions Factor	0.769 tCO_2e/MWh	Indonesian DNA website, link: http://pasarkarbon.dnpi.go.id/web/index.php/dnacdm/read/23/updates-on-emission-factors-of-electricity-interconnection-systems-2011.html
Build Margin Emissions Factor	0.712 tCO_2e/MWh	
Combined Margin Emissions Factor	0.740 tCO_2e/MWh	The Jamali Grid is calculated based on latest available data of 2008, 2009 and 2010 using the "Tool to calculate the emission factor for an electricity system", version 2.2.1.
Generation of the project in year 'y'	236,520 MWh	30 MW x 90% x 24 hours x 365 days

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

Four 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 30 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:

[4] http://www.indonesiapower.co.id/SitePages//UBP_Kamojang_Page.aspx
[5] EIA Kamojang unit V, LAPI ITB, 2012

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 Kamojang 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.

In summary, 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 30 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.

Indonesian national policy and circumstances with regard to electricity generation is described in the National Energy Policy Blueprint 2006 – 2025 by the Ministry of Energy and Mineral Resource, based on the President Decree no.5 year 2006. Later on, the National Energy Council was assigned to develop further the National Energy Policy (Kebijakan Energi Nasional, KEN). One of the targets was to increase renewable share of 6.2% in 2006 up to 15% (or 17% with new energy) in 2025. However, this does not give sufficient incentive to power plant developer since the state owned electricity company PLN is the only buyer of electricity production, and PLN cannot increase electricity selling price to customer due to government regulation limiting the highest electricity consumer price being affordable to the society (therefore cannot buy electricity produced at higher price).

Based on that, the National Energy Policy, which is an E- policy, is not considered as these have come up after 11 November 2001.

B.5. 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 PT. Pertamina (Persero), 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[6] currently in 2 major areas and 1 minor area.
The following shows the timeline of historical work on the site, pre-project activity, and project development:

Table 4 – Kamojang geothermal power plant historical progress

Activity	Date	Remarks
FS report for power plant development *(electricity generation and sales to the Grid)*	May 2010	Total investment = USD 83.2 million *(Expected electricity price = USD 90/MWh)*
Head of Agreement (HoA) between PGE & PLN (for eight geothermal areas)	17 February 2010	Head of Agreement (HoA) is an agreement between seller e.g. PGE and buyer (e.g. PLN) before both parties entered into energy sales contract or steam sales contract such as: Steam sales = Ulubelu I, Lahendong IV, Hululais, Kotamobagu I-II, Sungaipenuh Electricity sales = Ulubelu II, Karaha, Kamojang, Lahendong V, Lumutbalai I-II
PGE Board of Directors approval	12 July 2010	Minutes of Meeting described PGE Board of Directors assessment and approval to develop Kamojang unit 5 power plant
CDM Prior consideration sent to the Indonesian DNA	30 August 2010	Prior consideration published in the Indonesian DNA website as following: http://pasarkarbon.dnpi.go.id/web/index.php/komnasmpb/cat/4/database/2.html
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	12 October 2010	Prior consideration published in the UNFCCC website on 12 October 2010: http://cdm.unfccc.int/Projects/PriorCDM/notifications/index_html
Equipment mobilization to the 1st well drilled	10 January 2011	Equipment mobilization work order for Kamojang-KWK A.1
PPA signed with PLN	11 March 2011	Price = USD 8.25 cent / kWh (30 years from COD)
Environmental Impact Assessment/EIA Terms of	16 August 2011	Approval by the environmental agency of Bandung regency

[6] Only in 2008 PGE started operating its own first geothermal power plant, a registered CDM project Kamojang unit IV geothermal power plant

Reference		
CDM project development Assignment Letter	17 April 2012	PGE Director letter on the bidding result, assignment to South Pole to develop CDM.
ERPA signing between South Pole Carbon Asset Management Ltd. and PT. Pertamina Geothermal Energy	17 April 2012	ERPA is signed by South Pole Carbon Asset Management Ltd. and PT. Pertamina Geothermal Energy.
Power plant construction start	1 January 2013	Kamojang feasibility study report
Power plant operation start	1 January 2014	Kamojang feasibility study report

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 30 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 IRR without CDM financing (Alternative 1) with a suitable benchmark that considers the specific context in which the proposed project activity takes place. To estimate the return on the investment made by project participant, the return on equity shall be estimated. Thereby, IRR estimation is used for the investment analysis. The choice of benchmark is in line with the investment analysis approach, elaborated in below paragraph. Considering the post-tax return on equity benchmark (refer to the Appendix paragraph 7 and 8, of EB 62 annex 5) for appropriate comparison, the post-tax equity IRR is applied.

Benchmark

This project returns need to be compared with an appropriate benchmark. Following the "Guidelines On the Assessment of Investment Analysis (Annex 5 of EB 62)", (paragraph 12) required/expected returns on equity are appropriate benchmarks for an equity IRR. The investment analysis guidance paragraph 13 also argues that:

"In the cases of projects which could be developed by an entity other than the project participant the benchmark should be based on parameters that are standard in the market."

Refer to the appendix of the "Guidelines of the Assessment of Investment Analysis" (EB 62, Annex 5) and apply the Costs of Equity of group 1 (including energy industries) of Indonesia, which is 12.5% post-tax. This cost of equity is expressed in real terms and therefore needs to be adjusted to represent the nominal terms[7] as does the financial indicator. This is done by adjusting for the inflation at the time of the investment decision. Without the availability of sufficient inflation targets/forecast as published by the Bank of Indonesia, the 6 years averaged inflation forecast figures as published by the IMF.

$$
\begin{aligned}
1 + r_{nominal} &= (1 + \bar{r}_{real})(1 + inflation\ rate) \\
&= 1 + r_{real} + inflation\ rate + (r_{real})(inflation\ rate)
\end{aligned}
$$

Benchmark parameters	**Value**	**Source**
Real RoE	12.50 %	UNFCCC Guidance on the Investment Analysis post-tax
Inflation (available data, 5 years average)	4.808 %	IMF WEO data www.imf.org

After adjusting for inflation the post-tax benchmark was determined on 17.91%.

Sub-step 2c. Calculation and comparison of financial indicators

Upon obtaining the real post tax return on equity (RoE), 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 Kamojang power plant development. However, in March 2011 the Power Purchase

[7] Brealey Myers "Principles of Corporate Finance" (page 46)

Agreement (PPA) was finally signed with significantly lower price than expected, US$ 82.5/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$ 2,400,000/year or US$ 10.10/MWh. Specifically for Power Plant O & M costs (US$ 1,500,000/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[8], and considerably lower than in international literature[9].

Table 5 – Financial Parameters for Kamojang power plant

Financial Parameter	Unit	Value	References
Total Investment	US $	83,200,000	Feasibility Study page 20
Annual Operation and Maintenance (O & M) Costs	US $/year	2,400,000	Feasibility Study page 21
Annual power generation	MWh/year	236,520	Calculated based on net installed capacity 30 MW with capacity factor of 90%; Feasibility Study page 12, PPA page 13
Project lifetime	years	30	Feasibility Study page 12
Electricity tariff	US $/MWh	90.00	Feasibility Study page 21
Geothermal Income Taxes	%	34.00	Presidential Decree no. 49/1991, Feasibility Study page 21
Depreciation for upstream	%	10.00	10 years straight line depreciation (equals to 10% p.a. for 10 years), Feasibility Study page 21
Depreciation for downstream	%	5.00	20 year straight line depreciation (equals to 5% p.a. for 20 years), Feasibility Study page 21
Make-up wells maintenance cost in year 7	US $	13,930,000	Feasibility Study page 25
Fair value in year 30	%	10	Conservative value, 'Appraising Equipment for Structured Finance Transactions Creating Residual Value Curves to Reflect Physical Depreciation, Obsolence and Useful Life', by D. Gregg Dight, ASA, 5-16-03

Table 6 – Summary of Project Financial Analysis

	Without CDM
IRR	14.47
Benchmark	17.91

[8] Kemampuan Sumper Daya Domestik Bindang 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)

[9] "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)

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 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; d) operation and maintenance costs decreased. The results are shown in the table below. Deviations of 10% have been taken into account in the above decisive assumptions. The summary table is shown below.

Table 7 – Summary of project sensitivity analysis

Scenario	**% change**	**IRR (%)**
a) no change in original assumptions	–	14.47
b) increase in project revenues	10 %	15.90
c) decrease in investment costs	10 %	15.82
d) decrease in O & M costs	10 %	14.63

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 8.3 % 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 by high value. 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 only be increased by at the most in 17.8 % (if considering 100% load factor of total gross power output 31.8 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 24.50 % 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. In addition to that, as a comparison with other similar geothermal projects that also consider upstream and downstream costs, such as Gunung Rajabasa and Liki Pinangawan Muaralaboh (nearly USD 3,000/kW [10], both are developed as CDM projects), the Kamojang V geothermal (USD 2,773/kW) investment cost is much more lower. Besides that, based on International Energy Agency study in 2010[11], Kamojang V cost per kW is lower than their average indicative cost, which is USD 4,000/kW. Therefore decreasing investment costs by 22.40 % to breach the benchmark is quite unlikely to happen for Kamojang geothermal as the investment cost is already very low.

[10] Prof. Bambang P. S. Brodjonegoro, Government Fiscal & Financial Support on Infrastructure Project, World Export Development Forum, 15 October 2012 in Jakarta, (www.intracen.org/WEDF-2012-Parallel-session-1-Prof_-Bambang-P_S_-Brodjonegoro)

[11] Geothermal Heat and Power, International Energy Agency ETSAP, May 2010

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$ 2,400,000/year). Even with decreasing operation and maintenance costs by 100.00% the project remains still unattractive.

These results show that even under very favourable, although unreasonable, circumstances the 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) 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

Following the procedure for common practice analysis provided in the latest version of "Tool for the demonstration and assessment of additionality", common practice analysis was conducted.

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

Based on the "Tool for the demonstration and assessment of additionality", projects are considered similar if they are:
- in the same country/region: Indonesia
- of a similar scale: 31.8 MW gross installed capacity

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

Below are the steps to take the measures:

Step 1: Calculate applicable output range as +/-50% of the design output or capacity of the proposed project activity.
Gross capacity of proposed project activity is 31.8 MW. Therefore, applicable range for this measure is from 15.9 to 47.7 MW[12].

For information, existing geothermal power plant in Indonesia were :
1. PLTP Sibayak [12 MW] IPP
2. PLTP Dieng [60 MW] IPP
3. PLTP Salak 4, 5, 6 [195 MW] IPP
4. PLTP Darajat 2 [90 MW] IPP
5. CDM / PLTP Darajat 3 [110 MW] IPP
6. PLTP Wayang Windu 1 [110 MW] IPP
7. CDM / PLTP Wayang Windu 2 [117 MW] IPP

[12] Number of identified geothermal power plants (as N_{all} and N_{diff}) would not give different result by considering project selection based on either the gross or net capacity of Kamojang V project.

8. CDM / PLTP Kamojang 4 [60 MW] IPP
9. PLTP North Sulawesi Lahendong 1 [20 MW] PLN
10. CDM / PLTP North Sulawesi Lahendong 2 [20 MW] PLN
11. PLTP North Sulawesi Lahendong 3 [20 MW] PLN
12. PLTP East Nusa Tenggara Mataloko [1.8 MW] PLN
13. PLTP Indonesia Power Salak 1, 2, 3 [165 MW] PLN
14. PLTP Indonesia Power Darajat 1 [55 MW] PLN
15. PLTP Indonesia Power Kamojang 1, 2, 3 [140 MW] PLN

Step 2: In the applicable geographical area, identify all plants that deliver the same output or capacity, within the applicable output range calculated in Step 1, as the proposed project activity and have started commercial operation before the start date of the project[13] [14]. Note their number N_{all}. Registered CDM project activities and projects activities undergoing validation shall not be included in this step.
Project start date: 10 January 2011.

No.	Power Plant	Location	Capacit y	Owner	Operation	CDM ?
9	Lahendong unit 1	North Sulawesi	20 MW	PLN	2001	No
11	Lahendong unit 3	North Sulawesi	20 MW	PLN	2009	No

$N_{all} = 2$

Step 3: Within plants identified in Step 2, identify those that apply technologies different that the technology applied in the proposed project activity. Note their number N_{diff}.
With reference to the definition set in the Guidelines on Common Practice, different technologies are technologies that deliver the same output and differ by at least one of the following:
(i) Energy source/ fuel
(ii) Feed stock
(iii) Size of installation
  a. Micro
  b. Small
  c. Large
(iv) Investment climate in the date of investment decision, inter-alia
  a. Access to technology
  b. Subsidies or other financial flows
  c. Promotional policies
  d. Legal regulations
(v) Other features, inter alia:
  a. Unit cost of output

For the projects listed above, the significant difference can be attributed to the investment climate. 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

[13] While identifying similar projects, project participants may also use publically available information, for example from government departments, industry associations, international associations, on the market penetration of different technologies, etc.
[14] Other geothermal power plants operating in Indonesia were all larger than the proposed project activity : Indonesia Power owned Kamojang 1-3 (140 MW), Salak 1-3 (180 MW) and Darajat 1 (55 MW); Chevron owned Salak 4-6 (165 MW) and Darajat 2 (90 MW); Magma Nusantara owned Wayang Windu 1 (110 MW); and Geodipa owned Dieng 1 (60 MW), while other geothermal CDM project activities were Darajat 3 (110 MW), Kamojang 4 (60 MW), Wayang Windu 2 (127 MW) and Lahendong 2 (20 MW).

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 (and subsequently the Government Regulation no.59/2007) allows private companies to develop geothermal projects based on a tendering process[15].

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. Moreover, power plants built and operated by the National Utility Company PLN (a state owned company) cannot be considered to have same investment climate, since PLN main obligation is to provide electricity to the people at certain affordable price following government regulations (PLN is selling directly to individual customers). Therefore project no.9 – 11 are considered different.

$N_{diff} = 2$

Step 4: Calculate factor F = 1 – (N_{diff} / N_{all}) representing the share of plants using technology similar to the technology used in the proposed project activity in all plants that deliver the same output or capacity as the proposed project activity.

$N_{all} = 2$
$N_{diff} = 2$
$F = 1 - 2/2 = 0$
$N_{all} - N_{diff} = 0$

The proposed project activity is not common practice, since the Additionality Tool stated that the proposed project activity is a common practice within a sector in the applicable geographical area if both the following conditions are fulfilled:

(a) the factor F is greater than 0.2, and
(b) $N_{all} - N_{diff}$ is greater than 3

Outcome of step 4:
Similar activities cannot be observed, thus project activity is additional.

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).

B.6. Emission reductions

B.6.1. Explanation of methodological choices
>>

[15] Review of Indonesian Geothermal Development Regulation, University of Auckland, 2012

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 Indonesian DNA[16] has published updated emissions factor for Jamali grid on 27 March 2012 by using the latest available data 2008, 2009 and 2010. Below is the summarized parameter.

Operating Margin	0.769 (tCO_2/MWh)
Build Margin	0.712 (tCO_2/MWh)
Combined Margin	(0.769 x 0.5) + (0.712 x 0.5) = 0.740 (tCO_2/MWh)

Project Emissions

Project emissions for geothermal power plants are calculated as follows:

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

where:

PE_y	Project emissions in year *y* (tCO_2e/yr)
$PE_{FF,y}$	Project emissions from fossil fuel consumption in year *y* (tCO_2/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_2e/yr)
$PE_{HP,y}$	Project emissions from water reservoirs of hydro power plants in year y (tCO_2e/yr)

However, for Kamojang geothermal power plant, no fossil fuel is used to generate electricity. The methodology does not account for fossil fuel use for the backup or emergency purpose (this project emission can be neglected). Therefore:

$$PE_{FF,y} = 0.$$

Kamojang geothermal power plant is not a hydro project, therefore:

$$PE_{HP,y} = 0.$$

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

Emissions of non-condensable gases from the operation of geothermal power plants ($PE_{GP,y}$)

$PE_{GP,y}$ is calculated as follows:

$$PE_{GP,y} = \left(w_{steam,CO2,y} + w_{steam,CH4,y} \cdot GWP_{CH4}\right) \cdot M_{steam,y}$$

[16] Jamali EF grid published by the Indonesian DNA, http://pasarkarbon.dnpi.go.id/web/index.php/dnacdm/cat/6/other-information.html

Where:

$PE_{GP,y}$	Project emissions from the operation of geothermal power plants due to the release of non-condensable gases in year *y* (tCO_2e/yr)
$w_{steam,CO2,y}$	Average mass fraction of carbon dioxide in the produced steam in year *y* (tCO_2/t steam)
$w_{steam,CH4,y}$	Average mass fraction of methane in the produced steam in year *y* (tCH_4/t steam)
GWP_{CH4}	Global warming potential of methane valid for the relevant commitment period (tCO_2e/tCH_4)
$M_{steam,y}$	Quantity of steam produced in year *y* (t steam/yr)

Kamojang geothermal 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_2 and 0.00097278 % of steam weight for CH_4.

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_2/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_2 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_2/MWh)

<u>Calculation of $EG_{PJ,y}$</u>

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

Kamojang 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)

Kamojang geothermal power plant is not a modified, or retrofit facility nor an additional power unit at an existing grid-connected renewable power plant. Kamojang geothermal is a new grid connected renewable power plant, with a Power Purchase Agreement for its electricity sales to the Jamali 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_2e/yr)
BE_y Baseline emissions in year y (t CO_2/yr)
PE_y Project emissions in year y (t CO_2e/yr)

B.6.2. Data and parameters fixed ex ante

Following are data and parameters not monitored:

Data / Parameter	GWP_{CH4}
Unit	tCO_2 / tCH_4
Description	Global warming potential of methane, valid for the relevant commitment period
Source of data	IPCC
Value(s) applied	Default value for the first commitment period = 21 tCO_2 / tCH_4
Choice of data or Measurement methods and procedures	Data used is a default value for the first commitment period published by IPCC
Purpose of data	Project emission calculation
Additional comment	-

Data / Parameter	$EF_{grid,OM,y}$
Unit	tCO_2/MWh
Description	Operating Margin CO_2 emission factor for grid connected power generation (Jamali Interconnected Grid)
Source of data	The Indonesian DNA website as per following link: http://pasarkarbon.dnpi.go.id/web/index.php/dnacdm/read/23/updates-on-emission-factors-of-electricity-interconnection-systems-2011.html Grid calculation published by Department of Energy and Mineral Resources of Indonesia - Directorate General of Electricity and endorsed by Indonesia DNA on 27 March 2012.
Value(s) applied	0.769
Choice of data or Measurement methods and procedures	Calculated with "Tool to calculate the emission factor for an electricity system – version 2.2.1".
Purpose of data	Baseline emission calculation
Additional comment	–

Data / Parameter	$EF_{grid,BM,y}$
Unit	tCO_2/MWh
Description	Build Margin CO_2 emission factor for grid connected power generation (Jamali Interconnected Grid)
Source of data	The Indonesian DNA website as per following link: http://pasarkarbon.dnpi.go.id/web/index.php/dnacdm/read/23/updates-on-emission-factors-of-electricity-interconnection-systems-2011.html Grid calculation published by Department of Energy and Mineral Resources of Indonesia - Directorate General of Electricity and endorsed by Indonesia DNA on 27 March 2012.
Value(s) applied	0.712
Choice of data or Measurement methods and procedures	Calculated with "Tool to calculate the emission factor for an electricity system – version 2.2.1".
Purpose of data	Baseline emission calculation
Additional comment	–

Data / Parameter	$EF_{grid,CM,y}$
Unit	tCO_2/MWh
Description	Combined margin CO_2 emission factor for grid connected power generation (Jamali Interconnected Grid) in year *y* calculated using the latest version of the "Tool to calculate the emission factor for an electricity system v2.2.1"
Source of data	The Indonesian DNA website as per following link: http://pasarkarbon.dnpi.go.id/web/index.php/dnacdm/read/23/updates-on-emission-factors-of-electricity-interconnection-systems-2011.html Grid calculation published by Department of Energy and Mineral Resources of Indonesia - Directorate General of Electricity and endorsed by Indonesia DNA on 27 March 2012.
Value(s) applied	0.740
Choice of data or Measurement methods and procedures	Calculated with "Tool to calculate the emission factor for an electricity system – version 2.2.1".
Purpose of data	Baseline emission calculation
Additional comment	–

B.6.3. Ex ante calculation of emission reductions
>>
Project Emissions

$$\begin{aligned} PE_y &= PE_{GP,y} = (w_{steam,CO2,y} + w_{steam,CH4,y} \times GWP_{CH4}) \times M_{steam,y} \\ &= (0.0089467023 + 0.0000097278 \times 21) \times 2{,}005{,}690 \\ &= 18{,}355 \ \text{t.CO}_2\text{e/year} \end{aligned}$$

Leakage Emissions

$$LE_y = 0$$

Baseline Emissions

$$\begin{aligned} BE_y &= EG_{PJ,y} \times EF_{grid,CM,y} \\ &= 236{,}520 \times 0.740 \\ &= 175{,}024 \ \text{t.CO}_2\text{e/year} \end{aligned}$$

Emissions Reduction

The ex-ante emission reductions calculations are as follows

$$ER_y = BE_y - PE_y$$

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

B.6.4. Summary of ex ante estimates of emission reductions

Year	Baseline emissions (t CO_2e)	Project emissions (t CO_2e)	Leakage (t CO_2e)	Emission reductions (t CO_2e)
Year 1	175,024	18,355	0	156,669
Year 2	175,024	18,355	0	156,669
Year 3	175,024	18,355	0	156,669
Year 4	175,024	18,355	0	156,669
Year 5	175,024	18,355	0	156,669
Year 6	175,024	18,355	0	156,669
Year 7	175,024	18,355	0	156,669
Total	1,225,168	128,485	0	1,096,683
Total number of crediting years	7			
Annual average over the crediting period	175,024	18,355	0	156,669

B.7. Monitoring plan

B.7.1. Data and parameters to be monitored

Following are data and parameters to be monitored:

Data / Parameter	$M_{steam,y}$
Unit	t steam/yr
Description	Quantity of steam produced in year *y*
Source of data	Project Developer – main inlet steam flow-meter
Value(s) applied	2,005,690 ton of steam / year Steam is calculated based on gross installed capacity multiplies by 8 tonnes steam per hour (31.8 MW x 8 tonnes per hour x 8760 hour x 90%) as referred to the Feasibility Study page 9
Measurement methods and procedures	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). Pressure and temperature upstream of the venture meter is measured using the same venturi flow meter 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.
Monitoring frequency	Daily continuous measurement
QA/QC procedures	Meters will be calibrated according to the manufacturer standard. Period of calibration: every year.
Purpose of data	Project emission calculation
Additional comment	Continuous measurement, subsequently, the data will be aggregated monthly.

Data / Parameter	$w_{steam,CO2,y}$
Unit	tCO_2/t steam
Description	Average mass fraction of carbon dioxide in the produced steam in year *y*
Source of data	The NCG data is taken from sampling as prescribed in the methodology
Value(s) applied	0.0089467023 or 0.89467023 %
Measurement methods and procedures	Non-condensable gases sampling should be carried out every three months in 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) by a third independent party or internal laboratory. The CO_2 and CH_4 sampling and analysis procedure consists of collecting non-condensable gases samples from the main steam line with glass flasks, filled with sodium hydroxide solution and additional chemicals to prevent oxidation. Hydrogen sulphide (H_2S) and carbon dioxide (CO_2) dissolve in the solvent while the residual compounds remain in their gaseous phase. The gas portion is then analyzed using gas chromatography to determine the content of the residuals including CH_4. All alkanes concentrations are reported in terms of methane
Monitoring frequency	Every three months
QA/QC procedures	PGE Laboratory QA / QC Procedure
Purpose of data	Project emission calculation
Additional comment	-

Data / Parameter	$w_{steam,CH4,y}$
Unit	tCH_4/t steam
Description	Average mass fraction of methane in the produced steam in year *y*
Source of data	The NCG data is taken from sampling as prescribed in the methodology
Value(s) applied	0.0000097278 (or 0.00097278 %)
Measurement methods and procedures	Non-condensable gases sampling should be carried out every three months in 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) by a third independent party or internal laboratory. The CO_2 and CH_4 sampling and analysis procedure consists of collecting non-condensable gases samples from the main steam line with glass flasks, filled with sodium hydroxide solution and additional chemicals to prevent oxidation. Hydrogen sulphide (H_2S) and carbon dioxide (CO_2) dissolve in the solvent while the residual compounds remain in their gaseous phase. The gas portion is then analyzed using gas chromatography to determine the content of the residuals including CH_4. All alkanes concentrations are reported in terms of methane
Monitoring frequency	Every three months
QA/QC procedures	PGE Laboratory QA / QC Procedure
Purpose of data	Project emission calculation
Additional comment	-

Data / Parameter	$EG_{facility,y}$
Unit	MWh/yr
Description	Quantity of net electricity generation supplied by the project plant/unit to the grid in year *y*
Source of data	Project Developer – revenue meter (electricity sales)
Value(s) applied	236,520 MWh
Measurement methods and procedures	Electricity produced will be measured by a watt hour 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 Kamojang geothermal to the Jamali 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.
Monitoring frequency	Continuous basis with monthly reports
QA/QC procedures	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. Period of calibration: every year, based on PPA signed between PGE and PLN.
Purpose of data	Baseline emission calculation
Additional comment	Standard Operation Procedures (SOPs) or other documents, which replace the SOPs signed between PGE and PLN.

B.7.2. Sampling plan

>>

The purpose of this practice is to obtain representative samples of liquid and steam, as they exist in a pipeline transporting two-phase geothermal fluids. The liquid and steam samples are collected and properly preserved for subsequent chemical analysis in the field or an off-site analytical laboratory.

Samples are collected from a pipeline carrying two-phase geothermal fluids by using a sampling separator that separates liquid and steam phases through centrifugal force. A fraction of the separated steam is condensed and a fraction of the separated liquid is cooled. Portions of the condensed steam and cooled liquid are collected in appropriate sample containers for subsequent chemical analysis.

Sample locations vary and are dependent upon the gross quantities of each phase at the sample point. If sample ports are properly oriented on the two-phase pipeline, a certain degree of phase stratification will have occurred prior to sampling, facilitating further separation of the target phase through the sampling separator. Ports are ideally located on the top and bottom of the pipeline at least eight diameters downstream and two diameters upstream of major flow disturbances such as pipe bends, reductions, valving, etc.

Quality Control

1. Separator Operation — Carefully compare static line pressure to the separator pressure to ensure that there is no significant difference. Reduce vent and bleed flows temporarily to check for an increase in separator pressure.
2. Gas Bottle Sampling — Whenever possible, gas bottle samples are collected with back-pressure at the bottle inlet as described in the procedure, but no more than 70 kPa (10 psig).
3. Condensate Samples — Properly cleaned and prepared sample bottles are obtained from qualified laboratories and are rinsed with condensate in the field when appropriate.
4. Geothermal Liquid Samples — Properly cleaned and prepared sample bottles are obtained from qualified laboratories and are rinsed with liquid in the field when appropriate.

B.7.3. Other elements of monitoring plan
>>
This section details the steps taken to monitor on a regular basis the GHG emissions reductions from the Kamojang 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.

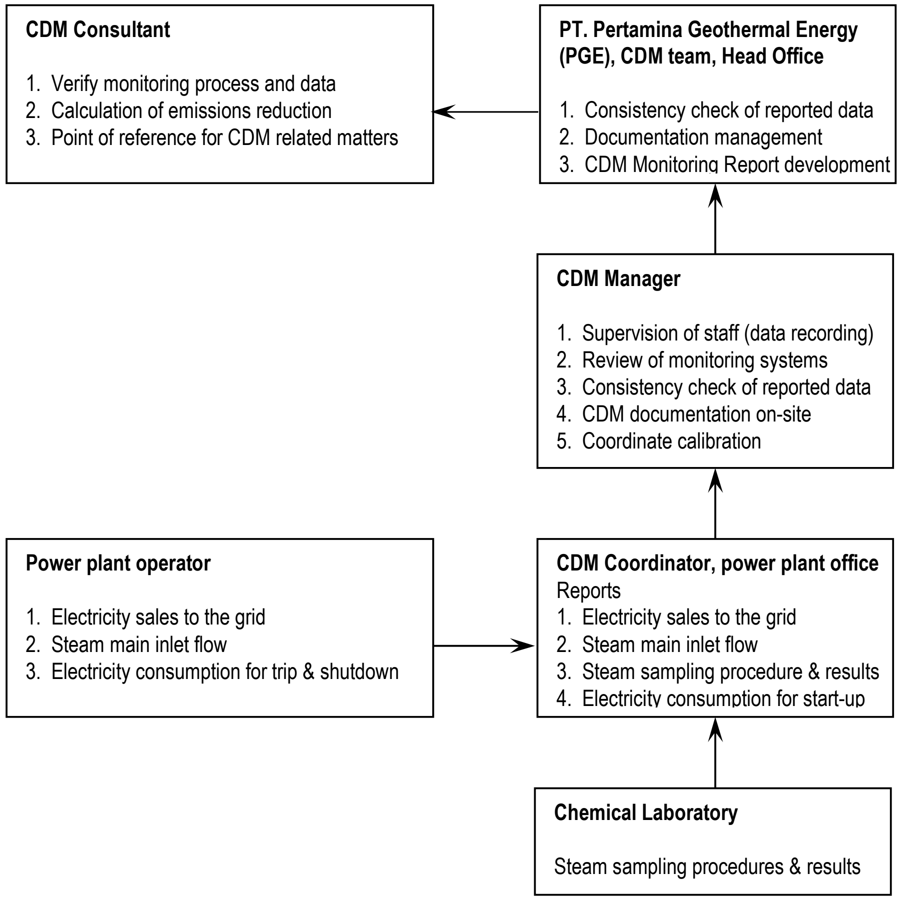

Figure 4 – Monitoring Organisation Chart

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 Kamojang 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 Kamojang 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.

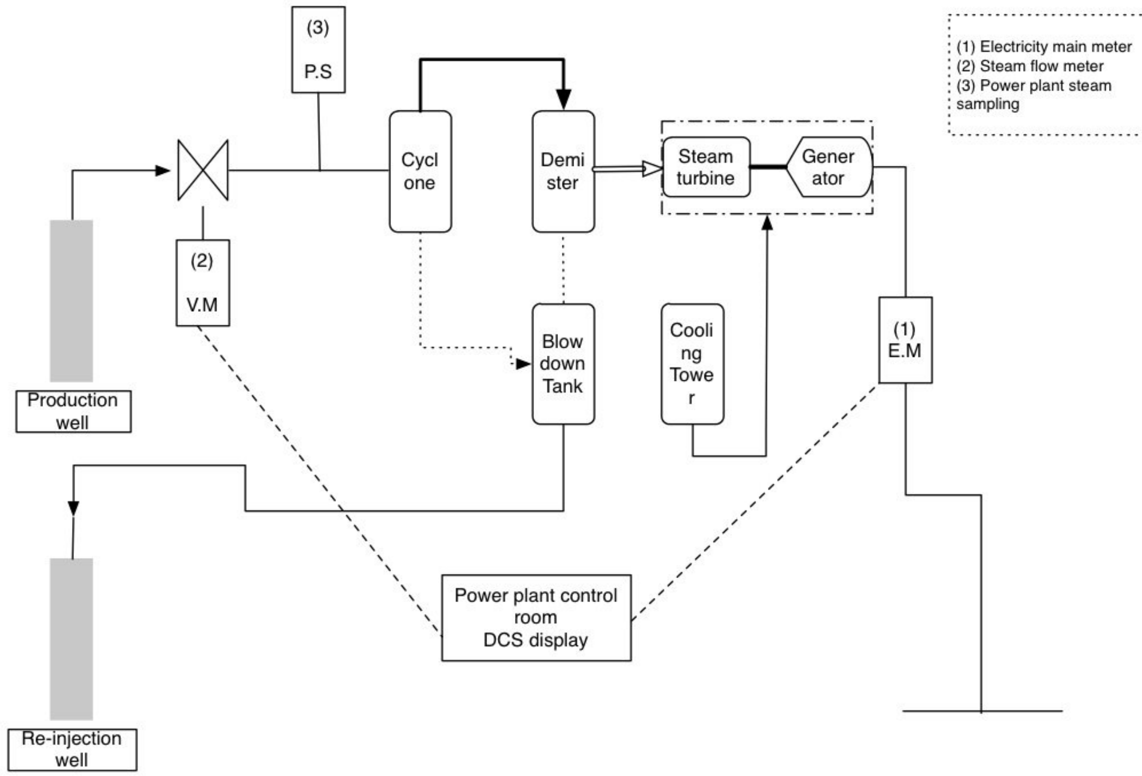

Figure 5 – Monitoring Equipments

<u>Metering of geothermal steam flow</u>

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 Kamojang for daily steam production report.

<u>Lab test of geothermal steam sampling procedure</u>

Lab officer responsible for steam sampling procedure and chemical analysis at PGE Geothermal Area laboratory. Report will be submitted to Manager of Kamojang geothermal power plant and Operations Steam Field of Area Kamojang.

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.

SECTION C. Duration and crediting period

C.1. Duration of project activity

C.1.1. Start date of project activity
>>
10/01/2011 (Date of equipment mobilization of the 1st well drilling)[17]

C.1.2. Expected operational lifetime of project activity
>>
30 years[18]

C.2. Crediting period of project activity

C.2.1. Type of crediting period
>>
Renewable, first crediting period

C.2.2. Start date of crediting period
>>
01/01/2014[19]

C.2.3. Length of crediting period
>>
7 years

[17] Work order for equipment mobilization of the 1st well (Kamojang-KWK A.1)
[18] Kamojang geothermal Power Purchase Agreement (PPA) – between PLN and Pertamina (11 March 2011)
[19] Kamojang geothermal feasibility study report

SECTION D. Environmental impacts

D.1. Analysis of environmental impacts

>>
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 30 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. A Term of References (ToR) of EIA was completed for the Kamojang V geothermal power plant (developed by PGE), approved in August 23, 2011 by the National EIA Commission (National EIA Commission no. 158 in year 2011). Full EIA had been assessed and finalized, submitted to the national authority for formalities procedure (expected to finish in the next few weeks).

The proposal for development of Kamojang V geothermal power plant was presented to the National EIA Commission in order to obtain inputs from the EIA commission. The project Developer, together with the EIA consultant, which is LAPI (Foundation for Research and Industrial Affiliation) ITB conducted a study to develop this Environmental Impact Assessment (EIA) and presented the results to the National EIA Commission. This commission invited stakeholders, among others the academics / university, related government agencies, the Environmental Health Laboratory, etc, to provide comments and input to the plan. During the consultation process, the stakeholders provided their comments to the National EIA Commission, as summarised in the letter no. B-187/BA/Komisi/Dep.I/LH/12/2011 and B-185/BA/Komisi/Dep.I/LH/12/2011 from the National EIA Commission to the project developer.

The ToR of EIA 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. Environmental impact assessment

>>
The environmental impact assessment[20] with regard to evaluation of significant impact and the objectives of environment management and monitoring plan, Kamojang geothermal field and power plant is feasible in terms of environmental aspect. There are a several activities which potentially producing significant negative impact, and those need to be managed to minimize the effect of the negative impact. In particular for the land clearing, air quality reduction, noise, and reduce of surface air quality. Besides, there are positive impact resulted from those activities. Therefore these positive activities need to improve to the optimize level for the community welfare and especially for the local people around the plant.

[20] EIA Report (ANDAL) for Kamojang V Geothermal Field and Power Plant, May 2012

SECTION E. Local stakeholder consultation

E.1. Solicitation of comments from local stakeholders

>>
PT. Pertamina Geothermal Energy hosted stakeholder consultation forum on 10 May 2012 at PGE Kamojang meeting room. Total of 44 participants from the surrounding villages and other stakeholders attended the meeting. PGE openly invited local stakeholders living around the area of Kamojang V geothermal power plant development through village offices and personal invitation on 4 May 2012 to the Indonesian DNA and other stakeholders. During the meeting, stakeholder consultation participants are varied from the Indonesian DNA representative, head of Ibun Sub District, police and military representative, local community leaders, local organizations such as non-governmental, youth and woman participation, and other villagers.

The meeting was opened with a welcoming speech by Mr. Made Budy, HSE officer of PGE headquarter and then continued with an opening speech from Head of Ibun Sub District. Subsequently, Mr. Leonardo Sidabalok from South Pole Carbon Asset Management Ltd. presents the climate change issue and Clean Development Mechanism process for the Kamojang V geothermal power plant. Session of questions and answers are followed that is hosted by PGE staff members.

E.2. Summary of comments received

>>
In general, all participated stakeholders in the forum support the development of PGE Kamojang V 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 Kamojang V geothermal power plant CDM project, especially regarding community development.

Below are the comments received by stakeholders:

1) Mr. Tito (Head of Youth Organization, Ibun Sub-District)
Comment (C1)→

a) We are happy to know that PGE will develop Kamojang V geothermal power plant development. We really hope that the Kamojang V development will give benefits to local communities e.g. employment opportunities for local people.

Question (Q1)→

a) In my opinion, development of this geothermal power plant will affect surrounding forest areas. Could you please explain which forest areas to be used and also how big will the forest be cleared due to this geothermal power plant development? Please also describe efforts will be made by PGE to reduce greenhouse gases effects due to forest clearing and where will PGE do trees planting to replace all forest areas that has been cleared?

b) With regard to the CDM scheme, PGE will use fossil-fuelled (gasoline or diesel fuel) engines during the construction of this geothermal power plant. My question is will these engines be considered as part of CDM project?

Answer: Mr. Tavip Dwikorianto (Kamojang General Manager, PGE)

a) Kamojang V geothermal power plant will be located next to the existing area of Kamojang IV geothermal power plant, which has been in operation. Thus, there will not be any new land clearing, which in the end there will be no land replacement.

b) It is true that during the construction phase of Kamojang V geothermal power plant, diesel engines will be used.

Answer: Mr. Leonardo Sidabalok (South Pole)

b) Diesel generators used during construction of Kamojang V geothermal power plant will not be considered in the CDM project boundary. However, an additional diesel generator utilized during power plant operation as part of the project boundary, except minor use for emergency power only, will be taken into account in the project emission calculation as a reduction of generated emission reductions (ERs) from the project. In addition to that, emissions emitted from fossil-fuelled engines during the power plant construction have been assessed in the Terms of Reference of the Environmental Impact Analysis (KA-ANDAL) document of Kamojang V geothermal power plant. Referring to this document, PT. PGE will continue to make efforts by land and vegetation restorations to address emissions from these engines.

2) Mrs. Dian (Teacher)

Comment (C2) →

a) I really appreciate of this CDM project development, because from this we expect very low negative impacts to local community.

Question (Q2) →

a) What is the considered-normal noise level for human ears? Because I am concerned of high noise level during wells testing activities whether it is acceptable to people live in the surrounding area.

b) I propose to have a noise level detector, so if the noise level is above the normal noise level could be accepted by human ears, we could notify the company.

c) Please also be more concern about road construction and maintenance to the Ibun Sub-district.

Answer: Mr. Tavip Dwikorianto

a) First of all, we do apologize if the noise level was considered high during the past wells testing activities. We will try our best to prevent this situation in the future. We will further improve our socialization or notification to the surrounding community during our wells testing activities.

b) For the road construction and maintenance, we will coordinate with PT. Indonesia Power (IP).

Answer: Mr. Fahmi (HSE Manager, PGE)

a) Human standard noise level for working area is 85 db(A), which will not cause a hearing problem during 8 working hours per day. While for standard noise level for school or teaching process should be lower, I estimate it is around 55 db (A), however I would need to find the justification document for my statement.

b) Actually, we do have a noise level meter, or so-called the sound level meter. During wells testing activities, we perform noise level measurement in the local neighbourhood and schools. We do this as a preventive action and also quality control of the noise level coming from our wells testing activities. If the noise level exceeds the government regulations, we inform the operation production division to minimize noise or postpone the wells testing. For your information, the noise level is influenced by wind direction. Therefore, we would expect community to actively inform us if there is a noise level increase in the surrounding area. I also apologize if we fail to properly socialize our last wells testing activities that caused discomfort for people in the surrounding area.

3) Mr. Memet (Non-Governmental Organization)

Comment (C3) →

a) I do appreciate of Kamojang Unit 5 geothermal power plant effort to be one of power plants to apply the CDM scheme in the Kamojang area.

Question (Q3)→

a) Since the geothermal potential began to be explored in 1980, perhaps some cultures among the Kamojang community might have been lost. Since the PGE project is located in the Kamojang region, please also occasionally inform to us the history of Kamojang geothermal project during the company activities.

b) How do you calculate the CERs of 160,000 tCO_2/year?

Response: Mr. Tavip Dwikorianto

a) Thank you for your input. We've done a nursery of local plants together with the surrounding community, maybe in the future we can synergize our local plants nursery so that we can quickly spread in the Kamojang region.

Answer: Mr. Tavip Dwikorianto

a) Regarding the history of Kamojang geothermal project, we can further discuss in more details, as I aware that the culture should be maintained properly.

Answer: Mr. Leonardo Sidabalok

b) We estimate the calculated value of the CER based on several parameters, which are the capacity of geothermal power plant, geothermal power plant operating hours in one year, *Jamali* grid emission factor, geothermal power plant load factor, and the assumption value of project emission. We use the methodology based on the methodology of the UNFCCC. So the calculation is :

30 MW x 90% x 8760 hours/year x 0.741 ton CO_2eq./MWh – 10% (estimated for project emission) = 157,735.188 tons CO_2eq./year
or, roughly we can say 160,000 tons CO_2eq./year.

Answer: Mr. Dicky Edwin Hindarto (Indonesian DNA)

b) Basically these calculations derived from the comparison of the emissions generated from power plants that use fossil fuels, like coal or diesel, to the emission arising from this geothermal power plant, then they figure out that number. Keep in mind that the power plants that use fossil fuels are located in Java-Bali interconnection system. So the power plant that to be built using fossil fuels to generate the electricity is now replaced by this geothermal power plant. As explained in the presentation by Mr. Leonardo, that the power plants using fossil fuels will generate emissions such as CO_2 that during their operation time the emissions will be accumulating in earth's atmosphere causing the global warming. This geothermal power plant is almost no emission generated but only hot steam that does not pollute the environment, so the geothermal power plant is much cleaner than fossil fuel power plants.

4) Mr. Dede Sutisna (Ibun Sub-district Representative)

Comment →

a) I am interested in the plan for development of Unit 5 Kamojang geothermal power plant. I as a citizen of Kamojang feel happy that this project will take the welfare of the surrounding communities.

Question →

a) I have concerns about local employment for this project could be not accommodated, so we expect the role of the PT. PGE to further enhance community development programs for the community. We are in the Ring 1 area, closest to the project site, and we have been assisted by PT.PGE, but if we may ask that PT. PGE can be more assist us in the future.

Answer: Mr. Tavip Dwikorianto

a) The Unit 5 is currently still under the project planning phase, so it's not yet commercially operated, therefore there is nothing yet to share with nearby community. During the implementaion of CSR we are working with the third party, *Dompet Dhuafa*, so there will be someone who be able to oversee the development of our CSR program in order to know the advantages and disadvantages of our program. Regards to our CSR, we have done to empowering the people for sheep farm and medicinal plants. The CSR programs that we've done has been through the stage of mapping, so we know what kind of the CSR program that should be done. For the future, if people think there is a program that is more applicable then it can be delivered to us.

5) Mr. Yunus (Head of community health center / *Puskesmas* of Sudi are)

Comment →

a) We have performed direct observation at the Ibun sub-district since 1997, where we had conducted a study of 1,000 people in the region and we are grateful for the result of no negative impacts on public health. And we make a report to our principal at the provincial level for every month mentioned the public health impact due to the operation of geothermal power plants. We also support the operation of this geothermal power plant because until now we have not received complaints from the public from the local community of RW VI and RW VII of Ibun District.

6) Mr. Yaya Mulya (Head of Kamojang village)

Question →

a) How many people who have been granted for tree nursery?
b) How many seeds are provided?

Response: Mr. Fahmi (HSE Manager, PGE)

a) I do not have the data of the exact number at the moment, but we have the receipt and I can show you that later on.

b) We have distributed 36,000 tree seedlings. Based on our survey three months ago, some of the seedlings are well maintained and some there are not maintained. In the future we will evaluate the parties that who will deserve for the tree seedlings.

7. Mrs. Wiwi (Head of Mekarwangi village)

Comment →

I would like to thank to PT. PGE, that our village has received 9,000 tree seedlings. Hopefully this can be useful for the residents of Mekarwangi village.

E.3. Report on consideration of comments received

>>

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 PGE (described in the project EIA documents).
No negative comments have been received on the project.

SECTION F. Approval and authorization

>>
Letter of Approvals from Republic of Indonesia as the Host Country and Switzerland as the Annex 1 Country are available.

- - - - -

Appendix 1: Contact information of project participants

Organization name	PT. Pertamina Geothermal Energy
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Appendix 2: Affirmation regarding public funding

The project does not involve any public funding from Annex 1 countries.

Appendix 3: Applicability of selected methodology

Please refer to PDD Section B.1 and B.2

Appendix 4: Further background information on ex ante calculation of emission reductions

Please refer to PDD Section B.4 and B.6

Appendix 5: Further background information on monitoring plan

Please refer to PDD Section B.7

Appendix 6: Summary of post registration changes

Not applicable

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History of the document

Version	Date	Nature of revision
04.1	11 April 2012	Editorial revision to change version 02 line in history box from Annex 06 to Annex 06b.
04.0	EB 66 13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the project design document form for CDM project activities" (EB 66, Annex 8).
03	EB 25, Annex 15 26 July 2006	
02	EB 14, Annex 06b 14 June 2004	
01	EB 05, Paragraph 12 03 August 2002	Initial adoption.
Decision Class: Regulatory **Document Type:** Form **Business Function:** Registration		