Project design document form
(Version 11.0)

Complete this form in accordance with the instructions attached at the end of this form.

BASIC INFORMATION	
Title of the project activity	Wayang Windu Phase 2 Geothermal Power Project
Scale of the project activity	☒ Large-scale ☐ Small-scale
Version number of the PDD	11.0
Completion date of the PDD	11 February 2020
Project participants	Star Energy Geothermal (Wayang Windu) Ltd Sindicatum Carbon Capital Ltd
Host Party	Indonesia
Applied methodologies and standardized baselines	ACM0002 - Grid-connected electricity generation from renewable sources, version 19.0
Sectoral scopes	Sectoral scope: 1- Energy industries (renewable/ non-renewable sources)
Estimated amount of annual average GHG emission reductions	743,033 tCO_2e

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

>> The Wayang Windu Phase 2 Geothermal Power Project, is a 117MW geothermal power station, which is an additional power unit to an existing grid-connected renewable power plant.

The Wayang Windu Phase 2 geothermal power generation project, located at the Wayang Windu allotment at 40km south Bandung in West Java, Indonesia, has been constructed and operated by the same operator as Wayang Windu Phase 1, Star Energy Geothermal (Wayang Windu) Limited ("MNL"), a wholly owned subsidiary of Star Energy Holdings.

The project was developed under an Energy Sales Agreement between MNL, PT Pertamina Geothermal Energy (Persero), the Indonesian state geothermal exploration company, and PT Pembangkit Listrik Negara ("PLN"), the state-owned utility company that gives MNL the exclusive right to develop up to 400MW of electricity generating capacity on the Wayang Windu allotment.

Wayang Windu Phase 1 has been producing power since June 2000, delivering 110 MW of electricity into the national grid through a single buyer, PLN.

The installation of the additional main 117MW steam turbine and peripheral equipment were to enable the turbine to be driven by the steam produced by the Wayang Windu geothermal fields. The turbine is connected to a generator which would produce the electricity to the JAMALI grid, and hence adding the electricity capacity of the existing Wayang Windu Phase 1.

The baseline scenario for this project is the generation of electricity by the operation of grid-connected power plants and by the addition of new generation sources. In the absence of the project activity electricity will continue to be generated by the existing generation units in the JAMALI grid.

The purpose of the Project activity is the generation of power using a reliable and renewable resource in place of power generation by a more greenhouse gas intensive fuel/source. The project will reduce greenhouse gas emissions through the displacement of fossil fuel electricity generation with a clean, renewable energy source.

The project has been operational since March 2009. There are no equipment and system in operation at the project site prior to the commencement of the project activity.

Project's contribution to sustainable development

A brief description of the contribution of the project activity towards sustainable development of the local community and the host country is discussed hereunder.

Host country DNA requires Sustainable Development Criteria[1] to accomplish by every CDM project. The criteria are described as follows:

1. Environmental Sustainability – Practising natural resource conservation or diversification. Assuring and maintaining levels of local community health and safety.
2. Economic Sustainability – Assuring and maintaining local community welfare.
3. Social Sustainability – Assuring and maintaining local community participation in the project and local community social integrity.
4. Technological Sustainability – Technology transfer and enhancing the capacity and utilisation of local technology.

[1] Source: http://dna-cdm.menlh.go.id/. Accessed on Jan 9th 2009.

In addition to the above criteria and indicators for sustainable development, the Ministry of Energy and Mineral Resources (MEMR), through its Research and Development Centre for Energy and Electrical Technology has established sustainable development criteria specifically for energy-related CDM projects (Ministerial Decree No.953.K/50 2003)[2].

The energy sector's sustainable development program has established the following seven criteria with which CDM energy-related projects need to comply:

1. Provide support to implement energy diversification and conservation programs – increase utilization of non-oil resources or reduce energy utilization per production unit.
    - Implementing Wayang Windu Phase 2 will provide support to implement energy diversification and conservation programs by using geothermal energy, a non-oil resource, to produce electricity.
2. Provide support for the development of clean energy alternatives and technologies – lower concentrations of NO_x, SO_x and GHG emissions.
    - Geothermal energy is a renewable resource. The exploitation of geothermal energy does not produce NO_x or SO_x, and will produce substantially less GHG emissions compared to fossil fuel generated electricity.
3. Provide support for environmental conservation – compliance with environmental regulations.
    - Indonesian law requires that environmental impact studies are undertaken for the Project and permits issued for the construction and operation of the Project. The Project will adhere to all local, regional and federal rules and regulations.
4. Provide support for local economic growth – increase income of the local community and/or local economic activities in the vicinity of the project.
    - The vast majority of the employees at Wayang Windu Phase 2 will be Indonesian and this will provide support for local economic growth by increasing income for the local community in the form of increased business activities. Also, most procurement for the ongoing operation of the plant will be sourced locally.
5. Maintain current employment rates without cessation of employees – no layoffs as result of project.
    - The Project will result in the creation of jobs as well as maintaining current employment rates without cessation of employees.
6. Provide support for technology transfer – increase utilization of local human resources in quality and quantity, provide new roles for local workforce, provide career development plans for employees.
    - The Contractor will train the local staff for the Project, providing them with new skill sets and enabling them to choose a career in their chosen field.
7. Provide 'community development' programs – projects should provide clear and certain community development plans.
    - The Project will support community development by providing improvements to the infrastructure in surrounding communities such as water supplies and roads, and support basic and advanced education for the local school children.

[2] Source: CDM Country Guide for Indonesia, edited by the Institute for Global Environmental Strategies 2nd edition, 2006.

A.2. Location of project activity

>>

A.2.1. Host Party

>>
Republic of Indonesia

A.2.2. Region/State/Province etc.

>>
West Java

A.2.3. City/Town/Community etc.

>>
Kecamatan Pangalengan, 40km south of Bandung

A.2.4. Physical/Geographical location

>>
40km south of Bandung
7° 12′ 26.79″ S, 107° 37′ 44.12″ E

Figure 1 Location of Bandung

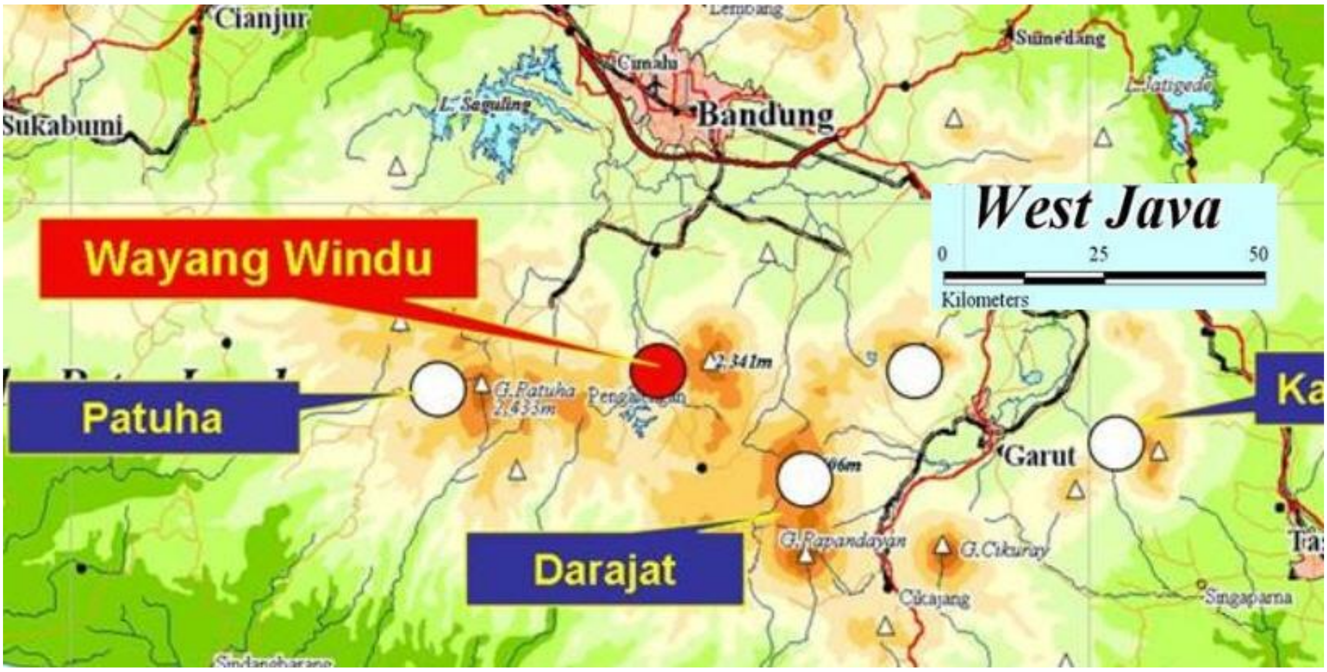

Figure 2 Location of Wayang Windu

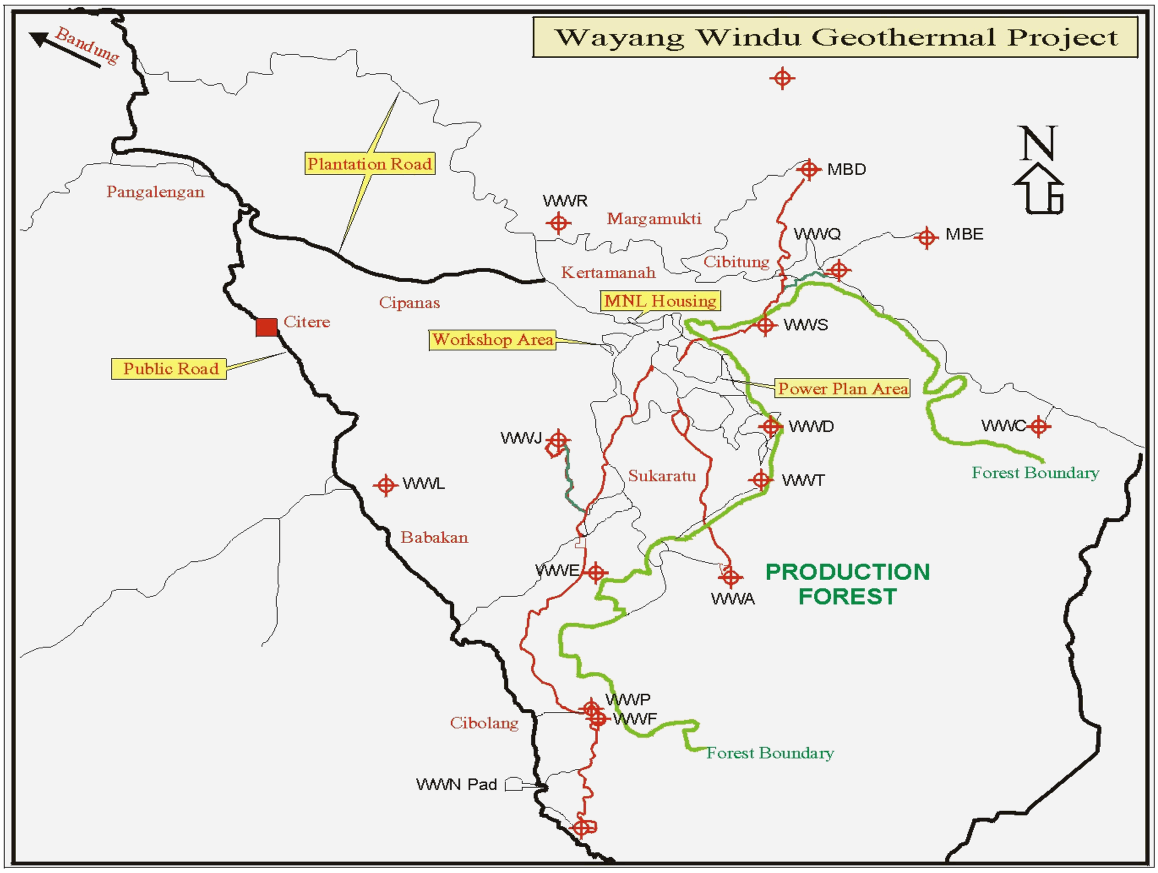

Figure 3 Wayang Windu Geothermal Plant (unit1 + unit 2)

Figure 4 Airplane Image of Wayang Windu Plant (unit 1 + unit 2)

A.3. Technologies/measures

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Wayang Windu Phase 2 Geothermal Power Plant is a flash steam geothermal power plant. Geothermal energy in Wayang Windu is stored in a steam reservoir within the earth's crust. Dry saturated steam at high pressure is produced at the surface from wells drilled into this reservoir. The steam is delivered to the power generation facilities through a steam gathering system, to move the turbine blades and drive a generator hence generating electricity. Exhaust steam from the turbine is condensed in a direct contact condenser and part of the condensed exhaust steam is re-injected into the geothermal reservoir, with the remaining being evaporated in the cooling towers. The electricity produced is transferred by the load dispatcher at the adjacent power switchyard to the transmission lines located outside the power plant.

The power plant consists of a conventional geothermal condensing steam turbine generator with a capacity of 117 MW. Energy of condensation is transferred to the circulating cooling water system in the steam exhaust condenser and is subsequently rejected to atmosphere in a conventional mechanical draught cooling tower.

List of Main Equipment and Systems:

- 117 MW steam turbine
- 17,900 m^3/hour condenser
- Cooling tower
- 137.5 MVA Main Generator
- 150kV/13.8kV Generator Transformer
- Scrubbers
- Separator
- Plant DCS (Distributed Control System)
- SAGS (Steam field Above Ground System)

This technology is technically sound and environmentally safe as is demonstrated by hundreds of similar installations around the world, including Indonesia[3]. Sumitomo Corporation, a Japanese corporation that was selected to provide technical equipment, and to perform all engineering, procurement and construction services of the Project. Knowledge transfer is ensured through a comprehensive training for Star Energy Geothermal (Wayang Windu) Limited, the Owner's

[3] Please see step 2 under section B.5. of this PDD for list of geothermal plants in Indonesia.

operation and maintenance personnel. The training covered the configuration and maintenance of all Equipment and systems of the Project designed and supplied by the Contractor.

A.4. Parties and project participants

Parties involved	Project participants	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Republic of Indonesia (host)	Private: Star Energy Geothermal (Wayang Windu) Limited (MNL)	No
United Kingdom of Great Britain and Northern Ireland	Private: Sindicatum Carbon Capital Ltd	No

A.5. Public funding of project activity

>>
There was no public funding for the Wayang Windu Phase 2 Geothermal Power Project.
The project financing portion came from Standard Chartered Bank Singapore and the equity portion came from the project owner's shareholders. Therefore, the project activity did not use any public fund.

Funding of the project has been disclosed to the DOE during the validation of the first crediting period.

A.6. History of project activity

>>
Wayang Windu Phase 2 Geothermal Power Project was registered on 2 December 2010, with reference number of 3193. This project is entering the second crediting period from 2 December 2017 – 1 December 2024.

A.7. Debundling

>>
Not applicable.

SECTION B. Application of methodologies and standardized baselines

B.1. References to methodologies and standardized baselines

>>
ACM0002 (Version 19.0) - Large-scale Consolidated Methodology: Grid-connected electricity generation from renewable sources.

This methodology uses the build margin (BM) and operating margin (OM) approaches as specified in the
"Tools to calculate the emission factor for electricity system "(Version 07.0) and also refers to the
"Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period" (Version 03.0.1)
Tools for demonstration of additionality" (Version 5.2,
"Tools to calculate project or leakage CO2 emission from fossil fuel combustion" (Version 03.0).

B.2. Applicability of methodologies and standardized baselines

>>

Applicability Condition	Applicability to the project activity

The methodology is applicable to grid-connected renewable energy power generation project activities that: (a) Install a Greenfield power plant; (b) Involve a capacity addition to (an) existing plant(s); (c) Involve a retrofit of (an) existing operation plant(s)/unit(s); (d) Involve a rehabilitation of (an) existing plant(s)/unit(s); or (e) Involve a replacement of (an) existing plant(s)/unit(s).	The project is a grid – connected renewable energy power generation that involves a capacity addition to an existing plant by installing a new power plant near the existing power plant (category b).
The project activity may include renewable energy power plant/unit of one of the following types: hydro power plant/unit with or without reservoir, wind power plant/unit, geothermal power plant/unit, solar power plant/unit, wave power plant/unit or tidal power plant/unit;	The project activity is a capacity addition to geothermal power plant
In the case of capacity additions, retrofits, rehabilitations or replacements (except for wind, solar, wave or tidal power capacity addition projects the existing plant/unit 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, retrofit, or rehabilitation of the plant/unit has been undertaken between the start of this minimum historical reference period and the implementation of the project activity	The project is a capacity addition. The existing geothermal plant (unit 1) started its commercial operation in June 2000 and the project activity commercial operation started in March 2009. Hence, the project activity started more than 5 years (minimum historical reference period) after the existing project was commercially operated, and no capacity expansion, retrofit or rehabilitation of the plant/ unit has been undertaken between the start of this minimum historical reference period and the implementation of the project activity.
In case of hydro power plants, one of the following conditions shall apply: (a) The project activity is implemented in existing single or multiple reservoirs, with no change in the volume of any of the reservoirs; or	The project is not a hydro power plant

(b) The project activity is implemented in existing single or multiple reservoirs, where the volume of the reservoir(s) is increased and the power density calculated using equation (3), is greater than 4 W/m^2; or (c) The project activity results in new single or multiple reservoirs and the power density, calculated using equation (3), is greater than 4 W/m^2; or (d) The project activity is an integrated hydro power project involving multiple reservoirs, where the power density for any of the reservoirs, calculated using equation (3), is lower than or equal to 4 W/m^2, all of the following conditions shall apply: (i) The power density calculated using the total installed capacity of the integrated project, as per equation (4), is greater than 4 W/m^2; (ii) Water flow between reservoirs is not used by any other hydropower unit which is not a part of the project activity; (iii) Installed capacity of the power plant(s) with power density lower than or equal to 4 W/m^2 shall be: a. Lower than or equal to 15 MW; and b. Less than 10 per cent of the total installed capacity of integrated hydro power project.	

In the case of integrated hydro power projects, project proponent shall: Demonstrate that water flow from upstream power plants/units spill directly to the downstream reservoir and that collectively constitute to the generation capacity of the integrated hydro power project; or Provide an analysis of the water balance covering the water fed to power units, with all possible combinations of reservoirs and without the construction of reservoirs. The purpose of water balance is to demonstrate the requirement of specific combination of reservoirs constructed under CDM project activity for the optimization of power output. This demonstration has to be carried out in the specific scenario of water availability in different seasons to optimize the water flow at the inlet of power units. Therefore, this water balance will take into account seasonal flows from river, tributaries (if any), and rainfall for minimum five years prior to implementation of CDM project activity.	The project is not a hydro power plant
The methodology is not applicable to: • 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/units.	The methodology is applicable because: The project does not involve switching from fossil fuels to renewable energy sources at the site of the project activity and the project is not a biomass fired power plant.
In the case of retrofits, rehabilitations, 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, that is to use the	The project is a capacity addition and the identification of baseline scenario is the continuation of the current situation that is 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.

power generation equipment that was already in use prior to the implementation of the project activity and undertaking business as usual maintenance”.	

B.3. Project boundary, sources and greenhouse gases (GHGs)

>>

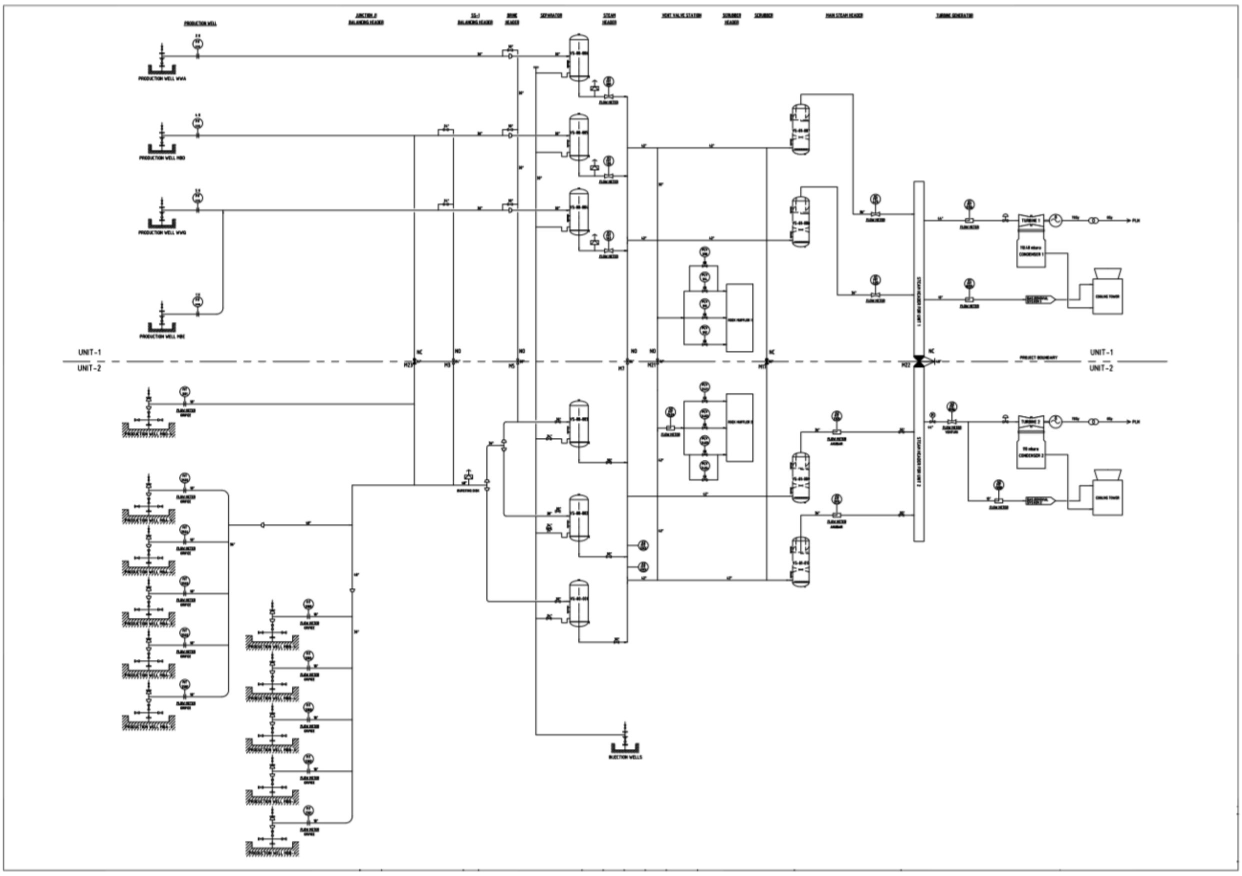

Figure 6. Simplified process flow diagram showing project boundaries

CH_4 and CO_2 will be emitted from the non-condensable gases contained in the geothermal steam. CO_2 will also be emitted from combustion of fossil fuels in the emergency diesel power generation set and diesel fire pump. Monitoring points and monitoring variables are described in Section B.7.

	Source	GHG	Included?	Justification/Explanation
Baseline	CO_2 emissions from electricity generation in fossil fuel fired power plants that are displaced due to the project activity	CO_2	Yes	Main emission source
		CH_4	No	Minor emission source
		N_2O	No	Minor emission source
Project activity	For dry or flash steam geothermal power plants, emissions of CH_4 and CO_2 from non-condensable gases contained in geothermal steam	CO_2	Yes	Main emission source
		CH_4	Yes	Main emission source
		N_2O	No	Minor emission source
	CO_2 emissions from combustion of fossil fuels for electricity generation in solar thermal power plants and geothermal power plants	CO_2	Yes	Main emission source
		CH_4	No	Minor emission source
		N_2O	No	Minor emission source

B.4. Establishment and description of baseline scenario

>>

Based on ACM0002 version 19.0, as the project activity is the installation of an additional power unit at an existing grid-connected renewable power plant/unit, the baseline scenario is the following:

In the absence of the CDM project activity, the existing facility would continue to provide electricity to the grid at historical average levels, until the time at which the generation facility would likely be replaced or retrofitted. From that point of time onwards, the baseline scenario is assumed to correspond to the project activity, and baseline electricity production is assumed to equal project electricity production, and no emission reductions are assumed to occur.

Electricity delivered to the grid by the project would have otherwise been generated by the operation of grid-connected power plants and by addition of new generation sources, as reflected in the combined margin (CM) calculations in section B.6.1 based upon the "Tool to calculate the emission factor for an electricity system." (Version 07.0)

The validity of the original/current baseline for Wayang Windu 2 renewal of the crediting period is assessed against the tool for "Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period", version 03.0.1.

Step 1.1: Assess compliance of the current baseline with relevant mandatory national and/ or sectoral policies

Current baseline of Wayang Windu 2 met all the relevant mandatory national and sectoral policies. Direktorat Jenderal Listrik under the Ministry of Energy and Mineral Resources, who has the authority over the energy related activities in Indonesia has released the new operating margin, build margin and combined margin emission factor for Jamali Interconnected Grid for the year of 2015, 2016 and 2017. The average combine margin used is 0.945 tCO_2/MWh.
The Indonesian Government has a strong commitment to accelerate the development of the renewable energy. The regulations related to the commitment are as follow:

- Presidential Regulation No. 61/2011 on National Action Plan in reducing the GHG Emission[4], Presidential Regulation No. 62/2014 on the Ratification of the Statute of the International Renewable Energy Agency,
- Minister Energy and Mineral Resources Regulation No. 50/ 2017 on the use of Renewable Energy for Electricity Supply[5]

[4] http://sipuu.setkab.go.id/PUUdoc/174141/Perpres%20Nomor%2062%20Tahun%202014%20.pdf

[5] http://jdih.esdm.go.id/peraturan/PerMen%20ESDM%20NO.%2050%20TAHUN%202017.pdf

- Ministry energy and Mineral resources Regulation No. 17/ 2014 on the Purchase of Electricity from Geothermal by PLN[6]

None of the regulations above have any impact upon the baseline scenario. Wayang Windu 2 has consistently comply with the policies and regulations to achieve the national energy and emission reduction targets.

Step 1.2: Assess the impact of circumstances

The Indonesian Government has released some regulations in order to accelerate the electric power development projects using renewable energy, gas and coal. In 2014, Ministry of Energy and Mineral Resources has released the Ministerial Regulation No. 17 / 2014 on the Purchase of Electricity from Geothermal by PLN. This shows the Government commitment to the development of clean energy particularly geothermal.

Wayang Windu 2 Project baseline scenario was the continuation of the current practice without any additional investment. As part of the company's commitment to reducing the Greenhouse Gas and supplying the clean energy, the project is continued into the second crediting period.

Since there are no new fuels or raw materials used in Wayang Windu 2 that impacted the electricity and fuel prices in the identification of the baseline emission, thus the current practice of the baseline emission is still valid.

Step 1.3: Assess whether the continuation of use of current baseline equipment(s) or an investment is the most likely scenario for the crediting period for which renewal is requested.

The baseline scenario of the project activity was the continuation of the current equipment without any additional investment before the end of the crediting period or the availability of a new technology.

The remaining technical lifetime of the equipment that would have continued to be used in the absence of the project activity exceeds the crediting period for which renewal is requested. The baseline facility of this project is Wayang Windu 1.

Step 1.4: Assess of the validity of the data and parameters

The data and parameters that were determined at the previous crediting period and not monitored during the crediting period are still valid for the subsequent crediting period except for the combine margin CO2 emission factor for Jamali grid which is 0.945 tCO2e/MWh which was previously 0.891 tCO2e/MWh.

Step 2.1: Update current baseline

Base on the latest approved version of methodology applicable to this project activity, the baseline Emission Factor is updated from 0.891 tCO2e/MWh to 0.945 tCO2e.MWh.

Step 2.2: Update the data and parameters

The updated data and parameters in the table in section B.6.2 below.

[6] https://jdih.esdm.go.id/index.php/web/result/838/detail

B.5. Demonstration of additionality

>>

Specify the methodology or standardized baseline that establish automatic additionality for the proposed project activity (including the version number and the specific paragraph, if applicable).	NA
Describe how the proposed project activity meets the criteria for automatic additionality in the relevant methodology or standardized baselines.	NA

Timeline of Events and Actions for CDM Consideration and Project Implementation

Date	CDM Activities	Project Implementation
2-Dec-1994		WW JOC between Perusahaan Pertambangan Minyak dan Gas Bumi Negara (called “Pertamina”) and Mandala Magma Nusantara, B.V (MNL)
2-Dec-1994		WW Geothermal ESC among PT PLN (Persero) and Pertambangan Minyak dan Gas Bumi Negara (called “Pertamina”) and Mandala Magma Nusantara, B.V (MNL).
May-1997		EPC contract with Sumitomo for Wayang Windu Unit 1 and 2. The contract was structured in “phases” to allow financial commitment to the project to be confirmed in steps, as the geothermal steam was proven. First Plant (or Combined) Phase of the EPC contract included basic infrastructure for both Units 1 and 2; Second Plant (or Combined) Phase of the EPC contract included the Unit 1 turbine generator facilities; Third Plant (or Combined) Phase of the EPC contract included the Unit 2 turbine generator facilities.
June-1997		Issue of Notice to Proceed for First Combined Phase of the EPC Contract. First Phase is the basic infrastructure incl roads, office, power station building.
Aug-1997		Issue of Notice to Proceed for Second Combined Phase of the EPC Contract. Second Combined Phase includes Unit 1 equipment. Sufficient steam was obtained to confirm to

		proceed with Unit 1.
Sept-1997		Decree from Indonesian Government formally advised all IPP developers to cease the development of new facilities due to the Asian Economic Crisis with the exception of Wayang Windu Unit 1 and Darajat Unit 2. The Asian Economic Crisis leads to the Crash of Rupiah currency against US Dollar. Since PLN's main contracts were in US Dollars but income was in Rupiah, the currency crash caused severe trauma for PLN and the Government of Indonesia.
Mar-1998		Formal Deletion of the Third Combined Phase of the EPC Contract. Third Combined Phase includes Unit 2 equipment[7].
Nov-1999		Deemed Performance Test Completion of Unit 1. Transmission line had not been completed by PLN, hence contract required the Owner to issue a "deemed completion".[8]
Mar-2000		Formal Settlement Agreement to close the Unit 1 EPC Contract
May-2000		Completion of Transmission lines by PLN.
June-2000		Commercial Operation of Unit 1
2000		Government of Indonesia insisted on the re-negotiation downwards of the electricity tariffs[9]
2001		Credit Suisse First Boston (CSFB) and Deutsche Bank (DB) took over MNL as debt settlement
31-Jan-02	Evidence that Wayang Windu Unit 2 participated in the CERUPT tender and subsequent correspondence showing the substantial amount of time and effort put to meet the requirements of the CERUPT program.	
24-Jun-02	Signed Consulting Services Agreement between Unocal Geothermal of Indonesia and ICF Resources to carry out the baseline study in order to meet the criteria for CDM project validation set forth by the UNFCCC.	
12-Jul-02	Signed Consulting Services Agreement	

[7] Refer to Settlement Agreement, page 3, item 2(a).

[8] Refer to Settlement Agreement, page 1, second paragraph.

[9] 3.5c/kWh of the interim tariff based on the "Interim Agreement" between PLN & MNL

	between Unocal Geothermal of Indonesia and PT Dames & Moore Indonesia to provide Unocal with services as a UNFCCC accredited validator in order to meet the criteria for CDM project validation set forth by the UNFCCC.	
22-Aug-02 and subsequent correspondence	Correspondence with Indonesian Ministry of Environment and Indonesian Ministry of Energy and Mineral resources: - Requesting the approval from Government of Indonesia for the approval of Wayang Windu Unit 2 Project Proposal - Mentioning that the CDM baseline study for Wayang Windu 2 is being audited by a validator (that is seeking accreditation by the CDM Executive Board) - Subsequent correspondence to PLN, Pertamina, CDM National Team Energy Sector about the validated baseline report for Wayang Windu Unit 2 - Reply from Indonesian Ministry of Environment that GOI approval could not be issued yet as Indonesia has not yet ratified the Kyoto Protocol	
09-Sep-02	Preliminary Validation / independent assessment of Wayang Windu 2 as a CDM project from URS (Environmental and Engineering Professional Services Provider) mentioned that the baseline study for the Wayang Windu 2 project meets the CDM requirements as set forth by the UNFCCC and CERUPT guidelines	
14-Sep-02	Letter from Indonesian Energy & Mineral Resources R&D Centre to Energy and Mineral Resources Research and Development Agency (Indonesian Department of Energy and Mineral Resources) concluding that WW2 is eligible to be processed as CDM-CERUPT Project	
23-Sep-02	Submission of CER offer to Tender Authority of Senter, Dutch Government Agency. Contractual and financing uncertainties were mentioned, and CER value is viewed as the key to overcome the barriers.	
01-Oct-02	Signed CDM Agreement between MNL and YBUL (CDM Developer)	
16-Dec-03	Withdrawal of CERUPT offer as agreement on the contents of the contract cannot be reached	
Nov-04		Star Energy acquired 100% of the ownership of MNL from CSFB, DB, and Unocal
17-Jun-05	Draft Proposed Terms of Reference from PT Pranata Energy Nusantara (PEN Consulting)	

04-July-05	Offer to develop CDM project for Wayang Windu Unit 2 Project under the Consortium of PT Pranata Energy Nusantara (PEN Consulting), Yayasan Pelangi Indonesia and EcoSecurities and the subsequent correspondence	
04-Jul-05	Senter Reaplication Letter from Magma Nusantara Ltd after the company has been purchased by Star Energy.	
11-Jul-05		Purchase contract for Tubular components for geothermal drilling
21-Nov-06		Amendment to the Wayang Windu Energy Sales Contract (ESC) and Amendment to the Wayang Windu Joint Operation Contract (JOC)
Until Dec 06	Consolidation of operations of Wayang Windu by the new owner (Star Energy) and discussion of further development potential according to existing utilisation rights for geothermal energy	
Dec-06	Environmental due diligence report from ERM	
30-Jan-07		EPC Contract for power plant and steam pipeline **(considered as the starting date of the project activity)**
04-Apr-07		Wayang Windu 2 Equity and Carbon Credit Discussion with Standard Chartered Bank
03-May-07		Accounts Agreement between the project owner and Standard Chartered Bank. Carbon credit is mentioned as parts of the receipts of the money to be received by the project owner
31-May-07 and subsequent correspondence	Letter from Ecosecurities about the possibility of offer adjustment towards MNL's carbon assets from Wayang Windu 2 & subsequent correspondence / meetings	
13-Jun-07		Financial closure with Standard Chartered Bank
14-Jun-07		Final notice to proceed to the EPC Contractor
18-July-07	Internal document regarding Position paper on Carbon Credits, mentioning that over the past 12 months MNL has formally and informally been approached by up to 10 companies related to the trading of future carbon credits. Serious considerations have been given to Ecosecurities and Climate Change Capital/Standard Chartered Bank, and the paper recommending to sign an agreement with Climate Change Capital/Standard Chartered Bank	

7-Aug-07		Utilization Request Credit Facility Arrangement
8-Aug-07 and subsequent follow-up	Draft Letter of Exclusivity from Climate Change Capital	
Oct 07	Presentation regarding Carbon Finance Support for Geothermal Development by World Bank	
Until Sept 08	Project owner was in discussion with a few CDM Consultants before finally working with Sindicatum Carbon Capital for the PDD preparation and validation.	
9 Jan 09	Start of validation process	
Mar-09		Commercial Operation Date
02-Dec-2010	Project activity is registered at UNFCCC project no : 3193	First crediting period starts
	Renewal crediting period process starts	

Evidence for the above events and actions will be available during validation.

Based on the latest Glossary of CDM terms (Version 05), starting date of a CDM Project activity is the earliest date at which either the implementation or construction or real action of a project activity begins.

The development of Wayang Windu Unit 1 was undertaken on the basis of the development of Units 1 and 2 as an integrated Engineer, Procure, and Construct (EPC) Contract with Sumitomo Corporation of Japan in 1997. The contract was structured in “phases” to allow financial commitment to the project to be confirmed in steps, as the geothermal steam was proven.

First Plant (or Combined) Phase of the EPC contract included basic infrastructure for both Units 1 and 2; Second Plant (or Combined) Phase of the EPC contract included the Unit 1 turbine generator facilities; Third Plant (or Combined) Phase of the EPC contract included the Unit 2 turbine generator facilities. In practice Phases 1 and 2 were completed but Phase 3 was never awarded due to the impact of the Asian economic crisis of 1997/98/99.[10]

The basic infrastructure conducted for Unit 2 in the period of 2000 Unit includes the Unit 2 turbine-generator foundation work (14-meter depth), foundations for the Unit 2 Cooling Tower steel materials for the Unit 2 rotor and Condenser. These foundations were integral with the power house which was needed for the Unit 1 project, and did not imply any commitment to the development of a second Unit. Unit 1 started operation as stand-alone power plant with an over dimensioned power-house and some few unused materials, a fact that increased costs without any return for the original owners.

To reinforce this, in 1997 the Government of Indonesia formally advised all IPP developers to cease the development of new facilities due to the Asian Economic Crisis with the exception of Wayang Windu Unit 1 and Darajat Unit 2[11]. This also resulted in the Government insisting on the re-negotiation downwards of the electricity tariffs. Hence, when Star Energy took over the ownership of MNL in November 2004, the first activity which had to be undertaken was the formal renegotiation of the electricity tariff. Once completed, in November 2006, MNL was then in a position to make a decision about the economics of the development of Unit 2. It is shown within the financial analysis below that - although basic infrastructure was already in place – the remaining costs for completion of unit 2 would not have enabled a profitable operation of the project activity without the consideration of CDM. All costs for joint infrastructure and preparatory

[10] Refer to Settlement Agreement dated 8 March 2000, page 3, item 2(a).

[11] Presidential Decree / KEPPRES No 39/1997 about cessation/reevaluation of projects by the government, state-owned companies, and related private companies

works have been excluded from this analysis therefore ensuring its conservativeness. Hence the project activity is considered as capacity addition to an existing power plant.

The earliest date at which the implementation, construction, and real action of the programme activity began was on 30 January 2007, when the contract for the Engineering, Procurement, and Construction of the project was signed. This is taken as the starting date of the project activity. Financial closure of the project activity was even achieved in June 2007 only, after convincing Standard Chartered Bank of the suitability of a concept including carbon revenues, and final notice to proceed to the EPC contractor was issued after the financial closure in June 2007.

Step 1: Identification of Alternatives to the Project Activity Consistent with Current Laws and Regulations

Define realistic and credible alternatives to the project activity(s) through the following Sub-steps:

Sub-step 1a: Define Alternatives to the Project Activity:

In this step, all realistic and credible alternative scenarios to the project activity will be identified. The alternatives available to the project participants

Below are the descriptions of all realistic and credible alternatives that are available to the project participants.

Alternative	Plausibility
The proposed project activity implemented without CDM financing, i.e. the construction of an additional geothermal power unit with an installed capacity of 117MW connected to the local grid, implemented without CDM revenues.	Not plausible due to the uneconomic returns.
Construction of a thermal power plant with the same installed capacity or the same annual power output.	Not plausible. Project owner has no competencies in construction and operation of thermal power plants. Hence, this is not a plausible alternative to the project owner.
Continuation of the current situation, i.e. electricity will continue to be generated by existing generation mix operating in the JAMALI grid, with capacity additions as planned.	Plausible, considered as the baseline scenario for the project.

From the above analysis, the only realistic and credible alternative to the project activity is the continuation of the current situation, i.e. electricity will continue to be generated by existing generation mix operating in the JAMALI grid, with capacity additions as planned.

Sub-step 1b: Consistency with Mandatory Laws and Regulations

The alternatives, i.e. construction of an additional geothermal power unit connected to the local grid, construction of a thermal power plant and continuation of the current situation (electricity will continue to be generated by existing generation mix operating in the JAMALI grid, with capacity additions as planned) are in compliance with all mandatory applicable legal and regulatory requirements.

Step 2: Investment Analysis

This step will demonstrate that the proposed CDM project activity is unlikely to be financially attractive by applying sub-step 2b (Option III: Apply Benchmark Analysis), sub-step 2c (Calculation and Comparison of Financial Indicators), and sub-step 2d (Sensitivity Analysis) of the *Tool for the*

Demonstration and Assessment of Additionality (Version 05.2) approved by the CDM Executive Board.

Sub-step 2a: Determine Appropriate Analysis Method

Benchmark analysis (Option III) is chosen.

Sub-step 2b: Option III. Apply Benchmark Analysis

To estimate a Required Rate of Return ("RRR"), as specified in Sub-step 2b, in the CDM Methodological Tool (Version *05.2*), a relevant weighted average cost of capital ("WACC") was selected as an appropriate benchmark. WACC is a calculation of the firm's cost of capital by proportionally weighing each source of capital (debt and equity in this case), as per starting date of the project activity, i.e. when signing the EPC contract. The cost of capital (ke) was calculated using the Capital Asset Pricing Model ("CAPM"), which is in line with the method explained in the "Investment Valuation" book by A. Damodaran ("Damodaran"). The CAPM describes the cost of equity for a company's stock as equal to the risk-free rate plus a premium that investors expect for bearing the systematic risk inherent in the stock. Systematic risk emanates from external, macroeconomic factors, which affect all assets in a particular way albeit with different magnitudes. The size of the premium is proportionate to the degree of volatility of the company's stock versus the market portfolio.

Although the project activity is a capacity addition, and therefore can only be implemented by Star Energy Geothermal (Wayang Windu) Limited (or Magma Nusantara Limited), the company internal benchmark (WACC of the project company) is not used in this project. This is because there were no project activities under similar conditions developed by the project owner by the investment decision period. Thus, no company-specific benchmark can be applied.

WACC and CAPM are expressed arithmetically by the following equation:

	Value	***Description***
r_f	4.84%[12]	Risk-free rate of return
β levered	3.36	β = βu * (1 + (1-t) *(d/e))
β unlevered	1.69[13]	Beta; investment or sector-specific risk for correlation to the market
R_P-λ	4.79%	Equity Risk premium
Λ	4.50%[14]	Country Risk Premium
Total Risk Premium	9.29%[15]	Equity Risk Premium + Country Risk Premium
Cost of Equity	36.02%	$K_e = r_f + \beta_L$ x (Risk Premium)
Cost of debt	7.59%	Unit 1 Bond Interest – Tax Rate
Debt	60%	
Equity	40%	
D/E ratio	1.50	Debt: Equity
T	34%[16]	Agreed Tax Rate
WACC	**18.96%**	(Cost of Debt * Debt) + (Cost of Equity * Equity)

[12] Source: Bloomberg US 30-year treasury bond for January 2007
[13] Source: Damodaran 2007
[14] Source: Damodaran Country Risk Premium Values for 2007 http://pages.stern.nyu.edu/~adamodar/
[15] Source: Damodaran Datasets- Risk Premiums for Other Markets for 2007 http://pages.stern.nyu.edu/~adamodar/
[16] Source: Wayang Windu Joint Operation Contract between Perusahaan Pertambangan Minyak dan Gas Bumi Negara and Mandala Magma Nusantara, B.V, article 9.1 and the Indonesian Government Decree No. 49/1991

The application of the above assumptions to the WACC resulting in a sufficient investment decision for a power business in Indonesia of **18.96%.** The detail calculation of the WACC will be available during validation.

Explanation to the assumptions used in the calculations above:

Cost of debt:
Calculated based on the pre-tax cost of debt of 11.5% which has been derived from the Bank Indonesia (BI) rate in January 2007 of 9.5% (http://www.bi.go.id/web/id/Moneter/BI+Rate/Data+BI+Rate/) increased by 2% (200 basis points) corresponding to the margin charged by the commercial banks.

Debt to equity ratio:
In accordance with the additionality tool, the financial/economic analysis shall be based on parameters that are standard in the market, considering the specific characteristics of the project type, but not linked to the subjective profitability expectation or risk profile of a particular project developer. Thus, the debt to equity ratio considered as 60:40 which is also standard debt to equity ratio in developing countries is used

Cost of equity:
The cost of equity has been determined using the Capital Asset Pricing Model (CAPM). The CAPM approach to risk analysis calculates the risk premium associated with the specific risk involved in a particular project. The riskiness is calculated by means of the beta and this beta measures the relative riskiness of the proposed project activity. The CAPM assesses risks at a market level and not by looking at an individual's risk preferences and therefore is sufficient to analyze the appropriate rate of return necessary to compensate investors for the risk faced in the proposed project activity.

Risk free rate:
The risk-free rate has been taken as the average of the 30 years US Treasury bond rates for January 2007 corresponding to the start date of the project activity and the expected lifetime of the proposed project activity. While the proposed project activity is based in Indonesia, the US risk free rate is appropriate because the project activity is almost exclusively exposed to US Dollar ("USD") transactions; both for its costs and revenues, and the forecasted cash flows used in the computation are also in nominal USD terms. The approach of using a USD denominated risk-free rate is consistent with the citation in Damodaran page 156 that states *"The risk-free rate used to come up with expected returns should be measured consistently with how the cash flows are measured. Thus, if cash flows are estimated in nominal US dollar terms, the risk-free rate will be the US Treasury bond rate. This also implies that it is not where a firm is domiciled that determines the choice of a risk-free rate, but the currency in which the cash flows on the firm are estimated."*

The quoted source in this matter is the most relevant, considering that several other components of the calculations used are derived from Damodaran's books and research.
Furthermore, when calculating the cost of equity in the proposed project activity, the country risk premium is already included in the applicable equity risk premium and therefore US Treasury Bond rate would be the most appropriate figure to be applied in this context. Using the Indonesian government bond rate, which also includes the country risk, would lead to double counting of the country risk. This concept is further explained in Damodaran on Page 167.

Beta:
The beta value for the power sector referring to the values provided by Damodaran Online (http://www.stern.nyu.edu/~adamodar/pc/archives/betas07.xls) reference Index for year 2007. The quoted source in this matter is the most relevant, considering that formula derived was quoted from his books and research.To be conservative, the beta value is referenced from the year 2007 (instead of the published 2006 data in Jan 2007); as the value selected is lower than the beta value in year 2006 of 2.05 (http://www.stern.nyu.edu/~adamodar/pc/archives/betas06.xls).
The appropriateness of using the US beta rather than using any emerging market specific beta based on following reasoning (explained in Damodaran page 189):

1. Indonesia is considered to be an emerging market, where the equity markets represent a small proportion of the overall economy and the historical returns in the market are available only for a short period.
2. The annual stock returns from the Indonesian Stock Exchange have very large standard deviations;
3. The composition of the indices for the Indonesian Stock Exchange that measure market returns are dominated by a few large companies.

Furthermore, the US power sector beta has been taken as the most appropriate reference for the power sector beta in the cost of equity calculation as the US market offers the most robust data set available. It should also be noted that betas from the comparable companies in Indonesia are not available. Jakarta Composite Index (JCI) and LQ45 (a stock market index for the Indonesian Stock Exchange) have only a single energy company namely Perusahaan Gas Negara in their composition.

As cited on page 201 of Damodaran, it is appropriate to use US power sector beta for the power sector in small or emerging markets, such as Indonesia. This is because the country risk premium has been included in the applicable equity risk premium in the calculation, and therefore has been taken into account in the calculation of the cost of equity in Indonesia.

The usage of US beta instead of using local accounting betas by practitioners has also been cited in other financial books (page 129 of "Valuation of Companies in Emerging Markets: a Practical Approach" by Luis E. Pereiro).

Further, it could be noted that the unlevered beta has been levered applying the tax rate and debt:equity ratio.

It is also to be noted that the approach and input parameters are consistent with another CDM project in Indonesia ref. no 2346 (Kabil II 11.4 MW Gas Fired Project) which was registered following a request for review which included questions on the suitability of the WACC calculation

Equity Risk premium and Country Risk premium:

The equity risk premium and the country risk premium for Indonesia have been sourced from A. Damodaran, New York University (http://www.stern.nyu.edu/~adamodar/pc/archives/ctryprem07.xls) reference Index subtitle - Discount Rate Estimation, Risk Premiums for Other markets for year 2007. The quoted source in this matter is the most relevant, considering that formula derived was quoted from A. Damodaran's books and research. These have been used to form the basis of the total risk premium (9.29%). The risk premium value is referenced from the year 2007 (instead of the published 2006 data in Jan 2007) as it has a lower value than the risk premium in year 2006 of 10.16% (http://www.stern.nyu.edu/~adamodar/pc/archives/ctryprem06.xls). Therefore the used data is more conservative. The risk premium value can be disaggregated into 2 separate elements:

1. Global Equity Risk Premium of 4.79% which is conservative to the 5% that is commonly used by financial practitioners
2. Specific Country Risk Premium of 4.5% which is appropriate to Indonesia.

This total Equity Risk Premium is considered reasonable as it measures the rate of return investors seek to compensate them for investing in higher risk equity based assets rather than risk free securities.

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

The table below exhibits the financial analysis for the project activity without CDM related income. Calculation of the IRR is established on the annual cash flow (annual revenue) of produced electricity, annual operational expenditure, and capital expenditure (initial investment cost). Following the EB Guidance the financial analysis excludes costs (drilling of 4 wells) which occurred prior to the starting date of the project activity. This approach is conservative as a lower CAPEX has to be considered.

Item	**Project Activity**
Installed capacity (MW)	117
Annual Production	953 GWh/yr

Capacity Factor	93%
Capital Expenditure (CAPEX) (US$ / MW)	US$ 1,550,000/MW
Operational Expenditure (OPEX) (USCent/kWh)	USCent 2.04/kWh
Operational Expenditure (OPEX) (US$ /year)	US$ 18,506,000/year-avg
Project Lifetime (yr)	30
Operating Hours (h/yr) (24 hours a day, 365 days a year, 93% capacity factor)	8,147
Income Tax-based on the JOC	34%
Tariff for PLN (USCent/kWh) – Levelized for 30 years including inflation	8.20
Terminal Value after 30 years	40% of CAPEX
CER price (US$ / CER)	12.00 – 1.18 Exchange Rate in '05
Resulting Project IRR	**17.62%**
Resulting project activity IRR with CERs	**20.48%**

Table 1 Data Used to Calculate IRR

Further details and explanation of the assumptions used in the investment analysis:

Total Investment Cost:
The estimated Total Investment Cost of USD 181.38 million consists of the EPC Cost, the Drilling, Total Infrastructure, and Other Costs estimated to occur after the starting date of the project activity. It is also to be noted that total investment cost is revised reflecting the change in the start date. In accordance with the "Guidance on the Assessment of Investment Analysis", all the expenses that have been incurred prior to the start date have not been used in the investment analysis. The drilling and other costs incurred during the year 2006 i.e., before the start date of the project activity have been considered as sunk costs and therefore excluded in the IRR calculation.
The total investment cost is consistent with the Information Memorandum for Refinancing of Wayang Windu Geothermal Project (unit 1) and Financing of the Wayang Windu Geothermal Expansion Project. The financing which has been agreed and approved by the Lenders is in accordance with the Unit 2 Credit Facility Agreement dated 3 May 2007.

Make up wells:
Make-up wells are required to compensate for the natural decline in output from the wells. It is also to be noted that from accounting point of view, make-up wells are additional wells being drilled for the project, and therefore are taken along with the total investment cost in the IRR calculation spreadsheets.

Number of wells needed to replace depleted well:
2 wells are needed to replace the depleted wells every 3 years - were calculated based on the estimation of the steam needed for the power plant, electricity generation potential from each well, and the steam depletion rate. The average 2 make-up wells required every 3 years is based on the following assumptions and calculations:

Assumption		
Parameter	**Value**	**Source**
Amount of steam needed for	120% of the generation capacity, i.e.	Based on the Common Terms in the Loan Agreement for the project activity.

the power plant	120% * 113.5[17] = 136.2 MW	
Electricity generation per well	15 MW / well	Calculated based on the historical data of the steam of the Wayang Windu 1 and the guaranteed steam rate design of the turbine.
Steam depletion rate	5%	Conservative value based on Wayang Windu well and resource performance analysis study conducted by Mauro Parini, advisor reservoir engineer for Unocal Geothermal and “Review of Wayang Windu Field Steam Decline - Wayang Windu Production Data Review” prepared by Sinclair Knight Merz ("SKM")

Calculation	
Depletion per year	136.2 MW*5% = 6.81 MW
Depletion for 3 years	6.81*3 = 20.43 MW
No of wells needed to replace depleted well (every 3 years)	20.43/15 = 1.362 (Rounded to 2.00)

With no other factors being taken into account, the number of wells to be replaced annually would equal 0.45 or 1 well to be replaced every two years. However, a replacement rate of 2 wells every 3 years has been assumed for the following reasons:

- As mentioned in the Wayang Windu well and resource performance analysis study conducted by Mauro Parini, the average decline rates of Wayang Windu 1 wells in 2004 were reported to be at 5.2%. The report however also mentioned that the decline rate is somewhat uncertain, with one of the wells in Wayang Windu 1 reported with a decline rate of 45%.
- Based on the report “Review of Wayang Windu Field Steam Decline - Wayang Windu Production Data Review” prepared by Sinclair Knight Merz dated 24 Nov 2009 ("SKM"); Page 1 of the report indicates that the overall depletion rate of all Unit 1 wells has increased to 8.1% and the average decline rate for Wayang Windu 2 wells are forecasted to be in the range of 5.2 to 7.8%. Also is to be considered is that the analysis of the report has been conducted with some uncertainty in the actual steam count and some assumption in the behavior of the wells due to the very short flow history of the Wayang Windu 2 wells (SKM page 21). Also has to be noted is that the reported average decline rate has been analyzed by excluding the wells with “abnormal” well behavior, i.e. well MBA-4 with wellbore problems in Wayang Windu 2 with a decline rate of 546.3% (SKM page 21). In reality, wells are bound to have problems during their lifetime which would increase the decline rate. Therefore, the actual decline rate should be higher than reported when actual conditions are being taken into the analysis.
- The decline rate of both Wayang Windu 1 and 2 wells will be higher when Wayang Windu 3 is built. This is because of the additional mass extraction and the reinjection rate due to an additional power plant (SKM page 1).
- Furthermore, make-up wells would be required when the required well repair is not successful which was evidenced by abandonment of one of the wells[18] which had already been repaired but the repair had been insufficient to resolve the issue.

Therefore, the assumption of 2 new make-up wells every 3 years calculated with the above approach (a lower average decline rate of 5% and rounding up the figure in the final step of the calculation) is considered appropriate and conservative.

Also, to be noted are the following points:

- Drilling of make-up wells requires mobilization and usage of a drilling rig, with the estimated cost of USD 1,500,000 to USD 2,000,000 on the rig mobilization, excluding the usage of the rig and the drilling cost. Therefore, it is more reasonable to drill 2 wells in 3 years instead of 1 well every 2 years, and the drilling costs estimated in the investment analysis is derived based on this assumption.

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[17] Net capacity calculated from the turbine generator capacity (117 MW) minus the house load (3.5 MW)

[18] MBE-2 plug and abandon report dated 24 Aug 2009

- Regardless of resource studies, it can take several years of production from a field before the reservoir performance can be gauged and there is always a risk of an unexpected decline in the capacity of the respective geothermal wells[19].
- Often after wells are drilled, geothermal steam production is not guaranteed. For exam-ple, for the Kamojang Geothermal project, 16 wells have been drilled, yet only 11 wells are useable in the production stage[20] for Lahendong-I only 7 out of 9 wells drilled were productive[21]

Make-up well cost:
The value of drilling a make-up well was determined from the make-up well costs conducted in 2006 for Wayang Windu 1 of USD 3.7 million as also reported in the audited financial statement in 2007. Thereby, leading to an estimation of USD 4.2 million in 2010 with escalation of 3% based on the historical average of the US CPI index.

Well repair:
Well repair of existing wells is required due to corrosion or other damage. Geothermal fluids are corrosive, with the H2S forming sulfuric acid, plus inflow of potentially acidic aquifers at depth (http://www.repp.org/geothermal/geothermal_brief_geothermal_resources.html). Hence, checks are made for corrosion in each well each year and repairs are conducted as required to avoid risk of a well blow-out which can be catastrophic. It is also to be noted that from accounting point of view, well repair costs are taken as the operating expenditure in the IRR calculation spreadsheets. The total repair well cost is based on the 'schedule repair wells' and the 'repair well cost per well'.

Schedule repair wells:
This is based on the previous experience from Wayang Windu unit 1. The investment analysis estimated that 3 wells are repaired every 3 years based on the estimation that each well will be repaired once every 10 years.

Repair well cost per well:
The value for well repair cost was derived from the work over program to fix wells in 2003 for Wayang Windu unit 1 of USD 1.5 million. Thereby, leading to an estimation of USD 1.7 million in 2009 with escalation of 3% based on the historical average of the US CPI index.

It is to be noted that the equipment used to repair a well will depend on the repair solution selected. If casing is to be replaced, it is essential to use a medium to large drilling rig. If the well is to be treated with acid injection, it may be possible to use a simple "coiled tubing unit" which is much less expensive than mobilizing a rig. Hence the cost of well repair will vary according to the solution selected. Typically, an operating company will not repair each well immediately as a problem occurs unless it results in the well being unsafe. Normally, a rig will be mobilized only when there are several jobs to be performed since the mobilization cost is a major component of the charges[22]
Since the cost of the drilling rig is directly related to the size of the rig, it is important to select the correct rig for the job. If a repair job is commenced with a small rig or coiled tubing unit, and it is found that the job actually requires a casing replacement, it will incur additional cost to mobilize a larger rig capable of handling the casing material.

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[19] Refer to registered CDM geothermal project no. 2022: http://cdm.unfccc.int/Projects/DB/DNV-CUK1218173149.57/view

[20] Refer to CDM geothermal project no. 3028: http://cdm.unfccc.int/Projects/DB/RWTUV1255101629.04/view

[21] Refer to registered CDM geothermal project no. 2876: http://cdm.unfccc.int/Projects/DB/TUEV-SUED1249404911.81/view

[22] Refer to "Geothermal Well Design, Construction and Failures" paper by James N. A. Southon, SKM for Proceedings World Geothermal Congress 2005 and "Geothermal Well Operation and Maintenance" paper by Sverrir Thorhallsson for Geothermal Training Programme of the United Nations University, Sept 2003

With this background, the well repair cost based on 2003 costs of repairing wells of Wayang Windu unit 1 taking into account escalation was used instead of taking the average well repair costs of Wayang Windu 1 from 2003 to 2010 of USD 1 million for the reasons of:

- Well repairs in 2003 involved major work, setting new casing into several wells. Hence a relatively large drilling rig was used for this (approximately $50,000 per day costs for the rig). These repairs were successful and allowed operation to continue until the makeup wells were drilled during the 2006/07 drilling program which also drilled wells for the Unit 2 development.
- Well repairs in 2008 were relatively simple, requiring only injection of water and inspection of the wells, and a simple Coiled Tubing Unit (CTU) was mobilized (approximately $5000 per day costs for the CTU). These repairs were unsuccessful and resulted in the decision to abandon a well in the next program.
- Well repairs in 2010 required more capability than a coiled tubing unit but less than a full rig, so a Snubbing Unit was mobilized (approximately $10,000 per day costs for the Snubbing Unit), and this allowed the successful abandonment of one well (MBE2) and some other minor routine work-overs to increase steam supply.
- Star Energy Geothermal (Wayang Windu) Ltd (“SEG”) as a prudent operator, budgets to undertake well repair on a regular basis as reflected in the investment analysis. The estimated cost which is used in the investment analysis is based on the cost to mobilize a small to medium drilling rig.

Further to be noted that budgeting in the investment analysis is expected for long term repair of wells and takes account of several factors:

- The number and complexity of well repairs will increase with the age of the wells.
- The basis of the estimate should allow for well abandonment of the deepest well since this is the safest solution, hence as a minimum a medium/large sized rig is required. Similar to that used in 2003.
- 1 million USD was found to be the average well repair cost for the Wayang Windu unit 1 from 2003-2010. This value is lower than that estimated for the proposed project activity because of the relative simplicity of the well repairs conducted in some of them, which led to some unsuccessful repairs and abandonment of a well. Therefore, the average well repair cost of WW1 during the period 2003-2010 are not a good reflection of the long term well repair costs for Wayang Windu 2.

The IRR of the project without CDM revenues is **17.62%** which is below the market benchmark required rate of return of **18.96%.** The IRR of the project with CDM revenues is **20.48%.** The additional revenues from the sale of CERs increase the project’s IRR to the required return for an average investor in this type of power project.

The perception of the carbon market was that the carbon price will increase over the time, and hence this was considered to balance the remaining risks. In addition to the improvement to the project’s IRR, the additional CER revenue gives a secondary stream of revenues in EURO or USD.

Therefore, the project activity only becomes financially viable if the project activity generated additional revenue from the CDM through the sale of the emission reductions.

The details of the calculation spreadsheet will be available to the DOE during validation.

Sub-step 2d: Sensitivity analysis:

Sensitivity analyses described below are performed using assumptions which are considered conservative. The ‘best-case’ conditions for the project IRR were assumed by altering the CAPEX, OPEX, electricity tariff, and electricity output parameters.

Deviations of ±10% have been taken into account in the above decisive assumptions. The summary table is shown below.

Sensitivity	w/o CER		
	-10%	0%	10%
Tariff	17.085%	17.620%	18.150%
Capacity Factor	17.191%	17.620%	18.046%
O&M and G&A	18.086%	17.620%	17.149%
CapEx (sensitized all)	19.081%	17.620%	16.356%
CapEx (sensitized w/out EPC)	18.144%	17.620%	17.130%
Terminal Value	17.615%	17.620%	17.624%

Table 2 Sensitivity Analysis

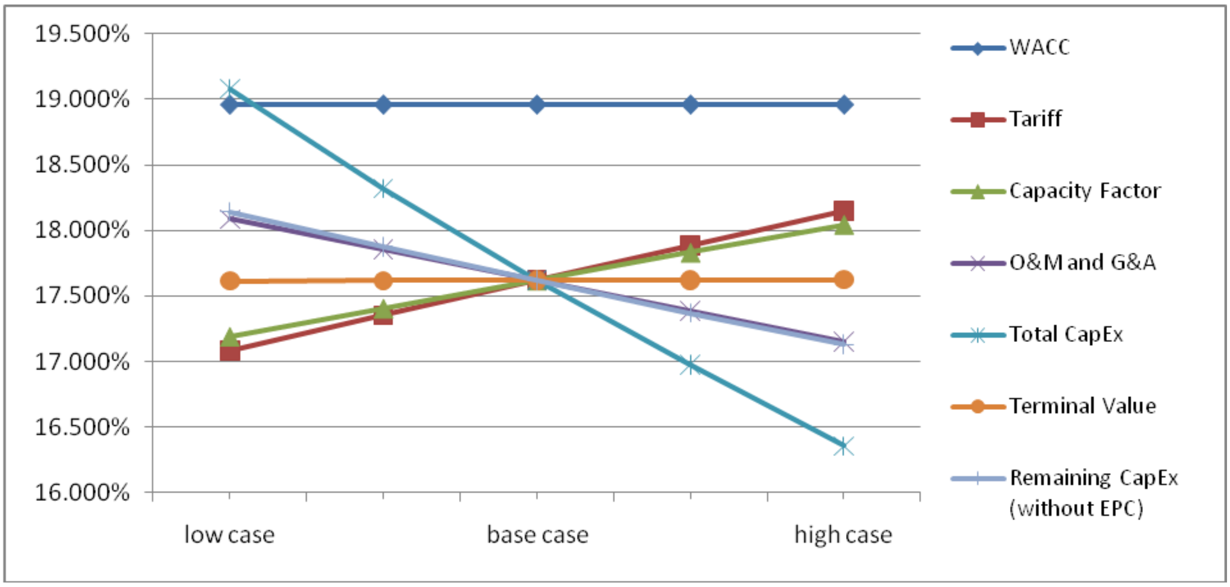

Figure 6 Diagram of the Sensitivity Analysis

As illustrated in the table above, the IRR ranges from 17.085% to 19.081% at when the economic parameters above are varied within the range of -10% to +10%. The best-case scenario generated IRR (without CDM related income) of 19.081% and will only take place when the Total CAPEX is decreased by 10%. Total CAPEX consists of EPC cost and the Drilling, Total Infrastructure, and Other Cost. The variation in the EPC cost would not be possible as the EPC contract was agreed at the time of investment and is a result of a competitive bidding conducted by MNL. Hence this cost factor has been fixed and is not variable in the presented range. Therefore, sensitivity analysis for the remaining of the construction cost (without the EPC cost) would be more relevant.
Other aspects to be considered:

- Lower OPEX is highly unlikely as the OPEX is based on the joint OPEX of unit 1 and unit 2, discounted the original OPEX of unit 1.

- For tariff, sensitivity is applied to the escalation index instead of the total escalated tariff to avoid double counting. A change in the base tariff would be highly unlikely considering that the project owner has already received an amendment of the Energy Sales Contract with the escalation factor included in the amendment. The escalation for each index is estimated based on the historical growth rate of each index from 1985 to 2005[23].

- Please note that the capacity factor changes are 91%, 93%, and 95% considering a change of 10% is not applicable), i.e. the capacity factor estimated for the project is already at 93%,

[23]The data are taken up to 2015 as this is the latest annual data available during the investment date

and cannot go above 100% and also there will be required and scheduled maintenance requiring operation down-time.

It can be observed that the project activity is financially unattractive not only in the typical situation but also in the varying scenarios as described above and hence the project activity is additional.

All financial data used to arrive at the internal rate of return of the project activity with and without CDM revenues will be available to the DOE during validation.

Step 3: Barrier Analysis

This step is not being used.

Step 4: Common Practice Analysis

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

Geothermal power development is not the first of its kind in Indonesia. Based on the statistic in 2016, the current utilization of the geothermal energy sources is only about 4.8% of the potential, with the installed capacity of 1.438,5 MW to the potential of 29.543,5 MW[24].

The operational geothermal power plants, not considered as CDM activity, were built between 1982 and 2000, and the planning of these plants therefore predates the Asian and Indonesian economic crisis of 1998 and the subsequent economic downturn.

The development in the 1990s was stimulated by electricity prices between USD 0.069 and USD 0.085, which made projects viable, and at that time there was no carbon finance or CDM available. PLN is now seeking to pay prices only under USD0.05/kWh[25]. Hence, it is hard for private developers to move forward with geothermal power project without confidence through the revenues from the CER.

Indonesia geothermal proven reserves and power plants constructed status are as followed[26]:

Power Plant[27]	Location	Capacity (MW)	Development or Construction Date	Commencement 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 Unit I, II, III[28,29],	Jawa	140 MW	1980s	Unit 1: 1982 Unit	Prior to the financial crisis	Pertamina (State-owned	PLN (State-owned company)	Without CDM Activity	No	This project was built during the

[24] Source: Renewable Energy and Energy Conservation 2016 published by Directorate General of New, Renewable Energy and Energy Conservation. http://ebtke.esdm.go.id/post/2017/03/07/1583/statistik.ebtke.2016

[25] Source: Report produced for the United States Agency for International Development (USAID ASIA) Annex 3 Indonesia Country Report, From Ideas to Action: Clean Energy Solutions, For Asia to Address Climate Change, prepared by International Resources Group, dated June 2007

[26] Source: Renewable Energy and Energy Conservation 2016 published by Directorate General of New, Renewable Energy and Energy Conservation.

[27] Source: Article "Indonesia's Geothermal Development" http://jakarta.usembassy.gov/download/geo2002.pdf Accessed on 28 November 2008.Cover story "IndoRenergy, Positioning Geothermal" from Petrominer magazine No.07/July 20,2009. Based on PLN's RUPTL (PLN's Electricity Provision Plan) 2009 – 2018 page 53-54 (http://www.pln.co.id/InfoKorporat/ChangeofRUPTL20062015/tabid/175/Default.aspx), there are a few other non-PLN geothermal power plants to be built in the future, however those are not mentioned in this list as they are of different scale and/or of expected operation date of year 2011 onwards (i.e. currently at the planning stage/construction has not been started)

[28] Source: Article "Indonesia's Geothermal Development" http://jakarta.usembassy.gov/download/geo2002.pdf Accessed on 28 November 2008

[29] Source : Kamojang Geothermal PDD, version 01, dated 29 February 2008

				2,3: 1987		company)				higher electricity tariff regime, developed & operated by state-owned company with funding from World Bank (for unit 2 and 3)
Kamojang Unit IV[30]	Jawa	1 x 60 MW	Feb 2006	Dec 2007	Post the financial crisis	Pertamina (State-owned company)	Pertamina (State-owned company)	CDM Activity	No	This project was developed & operated by state-owned companies and is a CDM Activity
Salak Phase 1[31]	Jawa	3 x 55 MW		1994 (2 units) and 1997 (1 unit)	Prior to the financial crisis	Unocal / Chevron from 2005 (IPP)	PLN (State-owned company)	Without CDM Activity	No	This project was built during the higher electricity tariff regime, developed & operated by state-owned company
Salak Phase 2[32]	Jawa	3 x 55 MW	1994	1997	Prior to the financial crisis	Unocal / Chevron from 2005 (IPP)	Unocal built and operated for 15 years and transfer operatorship to PLN under BOT (IPP transferred to State-owned company)	Without CDM Activity	No	This project was built during the higher electricity tariff regime, and transferred to state-owned company under BOT
Darajat Phase 1[33]	Jawa	55 MW	1994	1994	Prior to the financial crisis	Indonesia Power – subsidiary of PLN (State-owned company)	Chevron (IPP)	Without CDM Activity	No	This project was built during the higher electricity tariff regime
Darajat Phase 2[34]	Jawa	90 MW	1997	2000	Prior to the financial crisis	Chevron (IPP)	Chevron (IPP)	Without CDM Activity	No	This project was built during the higher electricity tariff regime
Darajat Phase 3[35]	Jawa	117 MW		4th quarter of 2006	Post the financial crisis	Chevron (IPP)	Chevron (IPP)	CDM Activity	Yes	This project is an CDM Activity
Dieng Unit 1[36]	Jawa	1 x 60 MW	1994	July 1998	Prior to the financial crisis	California Energy developed the project and then transferred to PT	California Energy developed the project and then transferred to PT Geo Dipa Energi,	Without CDM Activity	No	This project was built during the higher electricity tariff regime, and transferred to state-owned

30 Source : Kamojang Geothermal PDD, version 01, dated 29 February 2008

31 Source: Article “Indonesia’s Geothermal Development” http://jakarta.usembassy.gov/download/geo2002.pdf Accessed on 28 November 2008

32 Source: Article “Indonesia’s Geothermal Development” http://jakarta.usembassy.gov/download/geo2002.pdf Accessed on 28 November 2008

33 Source : Registered CDM Project: Darajat Unit III Geothermal Project PDD, version 3, dated 14 September 2006

34 Source : Registered CDM Project: Darajat Unit III Geothermal Project PDD, version 3, dated 14 September 2006

35 Source : Registered CDM Project: Darajat Unit III Geothermal Project PDD, version 3, dated 14 September 2006

36 Source: Article “LTP Patuha Unit 1 Berkapasitas 60 Megawatt di Pasirjambu Mulai Dioperasikan” http://jabar.tribunnews.com/2016/11/11/pltp-patuha-unit-1-berkapasitas-60-megawatt-di-pasirjambu-mulai-dioperasikan Accessed on 13 April 2017

						Geo Dipa Energi, a joint venture of Pertamina and PLN, in 2001 (IPP transferred to State-owned company)	a joint venture of Pertamina and PLN, in 2001 (IPP transferred to State-owned company)			company
Dieng Unit 2[37] and 3	Jawa	1x 55 MW 1 x 60 MW	Planning stage	Expected 2019-2023	Post the financial crisis	PT Geo Dipa Energi, a joint venture of Pertamina and PLN (State-owned company)	PT Geo Dipa Energi, a joint venture of Pertamina and PLN (State-owned company)	Without CDM Activity	No	This project was developed & operated by state-owned company and is not operational yet
Wayang Windu Phase 1[38]	Jawa	1 x 110 MW	1997	2000	Prior to the financial crisis	Mandala Magma Nusantara BV (IPP)	Mandala Magma Nusantara BV (IPP)	Without CDM Activity	No	This project was built during the higher electricity tariff regime
Patuha Unit 1[39]	Jawa	1 x 55 MW	2012	2014	Post the financial crisis	PT Geo Dipa Energi, a joint venture of Pertamina and PLN (State-owned company)	PT Geo Dipa Energi, a joint venture of Pertamina and PLN (State-owned company)	Without CDM Activity	No	This project has been commercially operated
Patuha Unit 2, 3	Jawa	2 x 55 MW	Planning Stage	Expected on 2019	Post the financial crisis	PT Geo Dipa Energi, a joint venture of Pertamina and PLN (State-owned company	PT Geo Dipa Energi	Without CDM Activity	No	This project was developed & operated by state-owned company and is not operational yet
Karaha Bodas Unit 1[40]	Jawa	1x30 MW	2015	Expected Dec 2016	Post the financial crisis	Pertamina (State-owned company)	Pertamina (State-owned company)	Without CDM Activity	No	This project was developed & operated by state-owned company and is not operational yet
Cibuni[41]	Jawa	1 x 10 MW	Planning stage	Expected 2024	Post the financial crisis	PT Yala Tekno Geothermal (IPP)	PT Yala Tekno Geothermal (IPP)	Without CDM Activity	No	This project is of different scale and is not operational yet

[37] Source: Based on PLN's RUPTL (PLN's Electricity Provision Plan) 2009 – 2018, Dieng 2 is expected to be operational in 2014 (page 53) and is currently at planning stage (page 116). Industrial experts confirm that at the current stage, the power plant has not been constructed.

[38] Source: Article "Indonesia's Geothermal Development" http://jakarta.usembassy.gov/download/geo2002.pdf Accessed on 28 November 2008

[39] Source: Based on PLN's RUPTL (PLN's Electricity Provision Plan) 2009 – 2018, Patuha is expected to be operational in 2013 (page 53) and is currently at planning stage (page 116). Industrial experts confirm that at the current stage, the power plant has not been constructed.

[40] Source: Article "Pertamina Operasikan Tiga Unit PLTP Tahun Ini" http://www.tribunnews.com/bisnis/2016/03/02/pertamina-operasikan-tiga-unit-pltp-tahun-ini dated 02 March 2016

[41] Source: Based on PLN's RUPTL (PLN's Electricity Provision Plan) 2016 – 2025 page 297, Cibuni is expected to be operational in 2024.

Bedugul[42]	Bali	10 MW	Planning stage	Expected 2025	Post the financial crisis	Pertamina (State-owned company)	Bali Energy (IPP)	Without CDM Activity	No	This project is of different scale and is not operational yet
Sibayak[43]	Sumatra	11.3 MW	Late 2005	July 2008	Post the financial crisis	Pertamina (State-owned company)	PT Dizamatara Powerindo (IPP)	CDM activity	No	This project is of different scale and is a CDM activity
Sarulla[44]	Sumatra	1 x 110 MW	1990	2017	Post the financial crisis	Consortium of Medco, Ormat Technologies, Itochu Corp, Kyushu Electric (IPP)	Consortium of Medco, Ormat Technologies, Itochu Corp, Kyushu Electric (IPP)	Without CDM Activity	No	This project was has been commercially operated
Sarulla Unit 2 and 3	Sumatra	2 x 110 MW	Construction Stage	Expected 2017-2018				Without CDM Activity		
Ulubelu[45] Unit 1, 2	Sumatra	1x55 MW, 1x55 MW	2010	2012	Post the financial crisis	PLN (State-owned company)	PLN (State-owned company)	Without CDM Activity	No	This project has been commercially operated
Ulubelu[46] Unit 3, 4	Sumatra	2 x 55 MW	Construction stage	Expected 2017	Post the financial crisis	PLN (State-owned company)	PLN (State-owned company)	Without CDM Activity	No	This project was developed & operated by state-owned company with Government-to-Government development funding (ODA)
Kerinci[47]	Sumatra	20 MW	Planning stage.	Expected 2011	Post the financial crisis	Pertamina (State-owned company)	Pertamina (State-owned company)	Without CDM Activity	No	This project is of different scale
Lahendong Unit 1[48]	Sulawesi	20 MW	2006		Prior to the financial crisis	Pertamina (State-owned company)	PLN (State-owned company)	Without CDM Activity	No	This project is of different scale and was developed & operated by state-owned company
Lahendong Unit 2[49]	Sulawesi	20 MW	2007		Post the financial crisis	Pertamina (State-owned company)	PLN (State-owned company)	CDM Activity	No	This project is of different scale, developed & operated by state-owned company, and a CDM Activity

[42] Source: Source: Source: Based on PLN's RUPTL (PLN's Electricity Provision Plan) 2016 – 2025 page 382, Bedugul is expected to be operational in 2025.

[43] Source: Sibayak Geothermal Power Plant PDD, version 01, dated 26 August 2008

[44] Source: Based on article "PLTP Sarulla Unit I Beroperasi" https://www.esdm.go.id/en/berita-unit/directorate-general-ebtke/pltp-sarulla-unit-i-beroperasi accessed on 21 March 2017.

[45] Source: Based on article "PLTP Ulubelu Beroperasi 2012" in https://www.esdm.go.id/en/media-center/news-archives/pltp-ulubelu-beroperasi-2012 accessed on 15 October 2010

[46] Source: Source: Based on PLN's RUPTL (PLN's Electricity Provision Plan) 2016 – 2025 page 297, Ulumbu 3 is expected to be operational in 2016 and Ulumbu 4 in 2017

[47] Source: Based on PLN's RUPTL (PLN's Electricity Provision Plan) 2009 – 2018, Kerinci is expected to be operational in 2011 and is currently at planning stage (page 311) http://www.vsi.esdm.go.id/gunungapiIndonesia/kerinci/umum.html, http://www.jambiekspres.co.id/index.php/radar-jambi/radar-barat/294-panas-bumi-kerinci-akan-dijadikan-energi-listrik accessed on 28 November 2008

[48] Source: Lahendong II-20 MW Geothermal Project, version 11, dated 1 July 2007

[49] Source: Lahendong II-20 MW Geothermal Project, version 11, dated 1 July 2007

Lahendong Unit 3[50]	Sulawesi	20 MW	2009		Post the financial crisis	Pertamina (State-owned company)	PLN (State-owned company)	Without CDM Activity	No	This project is of different scale, developed & operated by state-owned company
Lahendong Unit 4th	Sulawesi	20 MW	2011		Post the financial crisis	Pertamina (State-owned company)	PLN (State-owned company)	Without CDM Activity	No	This project is of different scale, developed & operated by state-owned company
Lahendong Unit 5th – 6th	Sulawesi	2 x 20 MW	Construction Stage	Expected 2017-2018	Post the financial crisis	Pertamina (State-owned company)	PLN (State-owned company)	Without CDM Activity	No	This project is of different scale, developed & operated by state-owned company
Ulumbu[51] Unit 1, 2	NTT / Flores	2 x 2.5 MW	2011	2012	Post the financial crisis	PLN (State-owned company)	PLN (State-owned company)	Without CDM Activity	No	This project is of different scale, developed & operated by state-owned company with loan from the Asian Development Bank (ADB)
Ulumbu[52] Unit 3-4	NTT / Flores	2 x 2.5 MW	2014	2016	Post the financial crisis	PLN (State-owned company)	PLN (State-owned company)	Without CDM Activity	No	This project is of different scale, developed & operated by state-owned company with loan from the Asian Development Bank (ADB)
Ulumbu[53] Unit 5-6	NTT / Flores	2 x 20 MW	Planning stage	Expected 2019, 2024	Post the financial crisis	PLN (State-owned company)	PLN (State-owned company)		No	This project is of different scale, developed & operated by state-owned company with loan from the Asian Development Bank (ADB)

Table 3 Indonesia Geothermal Proven Reserves and Power Plants

The above table shows that the only activity that is operational and is similar to the project activity (in the same defined region, rely on a broadly similar technology, are of a similar scale, and take place in a comparable environment with respect to regulatory framework and investment climate) is Darajat Phase 3 Geothermal Project, which is a registered CDM project, and therefore is excluded from the analysis.

On this basis, there is no activity similar to the proposed project activity in the defined region.

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[50] Source: Cover story "IndoRenergy, Positioning Geothermal" from Petrominer magazine No.07/July 20,2009.

[51] Source: Based on PLN's RUPTL (PLN's Electricity Provision Plan) 2009 – 2018 page 54, Ulumbu is expected to be operational in 2011,2012. http://www.adb.org/Business/Opportunities/not/archive/jul-sep05/ino1982d.asp. Government received the loan from Asian Development bank http://www.adb.org/Business/Opportunities/not/archive/jul-sep05/ino1982d.asp

[52] Source: Based on article "Ulumbu geothermal power plant in west Flores to operate all 4 units in March". https://www.rambuenergy.com/2016/02/ulumbu-geothermal-power-plant-in-west-flores-to-operate-all-4-units-in-march/ accessed on 17 February 2016.

[53] Source: Based on PLN's RUPTL (PLN's Electricity Provision Plan) 2016 – 2025 page 510, Ulumbu 5 is expected to be operational in 2019 and Ulumbu 6 in 2024.

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.

This is reinforced with the movement to coal-based generation of power plants in Indonesia during the start date of the project activity[54]. The coal-based power plants were then supported by the Fast Track Program that mandates the building of 40 coal-fired power plants[55]. With the government support, coal-fired power plants become the more popular option in Indonesia together with the better economic consideration (low cost of generation and easy availability) in comparison to other potential energy sources, i.e. geothermal.

With the above arguments, it is concluded that geothermal power development is therefore not a common practice.

B.6. Estimation of emission reductions

B.6.1. Explanation of methodological choices

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Baseline emissions include only CO_2 emissions from electricity generation in fossil fuel fired power plants that are displaced due to the project activity. The methodology assumes that all project electricity generation above baseline levels would have been generated by existing grid-connected power plants and the addition of new grid-connected power plants. The baseline emissions are to be calculated as follows:

EQUATION (1)

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

Where:

BE_y	=	Baseline emissions in year *y* (t CO_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" (t CO_2/MWh)

$EG_{PJ,y}$ is calculated as follows:

EQUATION (2)

$$EG_{PJ,y} = EG_{facility,y} - (EG_{historical} + \sigma_{historical}); until\ DATE_{BaselineRetrofit}$$

[54] Source: "Rencana Usaha Penyediaan Tenaga Listrik (RUPTL) year 2006-2015" by PT PLN (Persero) http://www.pln.co.id/ruptl/070219_perubahan_ruptl_06_10_web_.pdf accessed on 28 November 2008

[55] In pursuant to Presidential Regulation No. 71/2006

and

EQUATION (3)

$$EG_{PJ,y} = 0;\ on/after\ DATE_{BaselineRetrofit}$$

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 plants/units to the grid in year *y* (MWh/yr)
$EG_{historical}$	=	Annual average historical net electricity generation delivered to the grid by the existing renewable energy power plants/units that was operated at the project site prior to the implementation of the project activity (MWh/yr)
$\sigma_{historical}$	=	Standard deviation of the annual average historical net electricity generation delivered to the grid by the existing renewable energy power plants/units that was operated at the project site prior to the implementation of the project activity (MWh/yr)
$DATE_{BaselineRetrofit}$	=	Point in time when the existing equipment would need to be replaced in the absence of the project activity (date). This only applies to retrofit or replacement projects

In case $EG_{facility,y} < (EG_{historical} + \sigma_{historical})$ in a year y then:

EQUATION (4)

$$EG_{PJ,y} = 0$$

The $EG_{historical}$ is determined from the time span when the historical electricity delivered by existing facility i.e. Wayang Windu Phase I to the grid from the start of its operation in June 2000 up to time when Wayang Windu Phase 2 was commissioned in February 2009. As per ACM0002 version 19 para 52, option B is chosen for this project.

Calculation of EF $_{grid,CM,y}$

Step 1. Identify the relevant electricity systems

Referring to the ACM0002 version 19, the spatial extent of the project boundary includes the project power plant and all power plants connected physically to the grid. JAMALI (Jawa-Madura-Bali) grid applies for the project activity.

<u>Electricity import emission factor</u>

Electricity import emission factor is determined as 0 (zero) tCO_2/MWh because currently the JAMALI grid is not inter-connected with other provincial grids within Indonesia with no intermediate plan to do so.

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

Option I: Only grid power plants are included in the calculation.

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

The ratio of Low-cost/must-run (LCMR) in JAMALI grid over the period of 2013 – 2017 is about 67%, which is higher than 50% and the hourly loads to the grid are not available, hence, the method selected to calculate the operating margin (OM) is the Average OM method.

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

The average OM emission factor ($EF_{grid,OM-ave,y}$) is calculated as the average emission rate of all power plants serving the grid, using the methodological guidance as described under Step 4 (section 6.4.1) of the Methodological tool "Tool to calculate the emission factor for an electricity system Version 07.0".

The average OM can be calculated using either of the two following data vintages:

- Ex ante option: if the ex-ante option is chosen, the emission factor is determined once at the validation stage, thus no monitoring and recalculation of the emissions factor during the crediting period is required. For grid power plants, use a 3-year generation-weighted average, based on the most recent data available at the time of submission of the CDM-PDD to the DOE for validation. For off-grid power plants, use a single calendar year within the five most recent calendar years prior to the time of submission of the CDM-PDD for validation, or
- Ex post option: if the ex post option is chosen, the emission factor is determined for the year in which the project activity displaces grid electricity, requiring the emissions factor to be updated annually during monitoring. If the data required to calculate the emission factor for year y is usually only available later than six months after the end of 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 proceeding the previous year y-2 may be used. The same data vintage (y, y-1 or y-2) should be used throughout all crediting periods.

The data vintage chosen in this project is ex ante option.

The average OM may be calculated based on these 2 following options:

- Option A: Based on the net electricity generation and a CO2 emission factor of each power plant unit, or
- Option B: Based on the total net electricity generation of all power plants serving the system and the fuel types and total fuel consumption of the project electricity system.

The power generation data of JAMALI grid for year of 2015 to 2017 are presented in Appendix 4.

Option A is chosen since the net electricity generation and a CO2 emission factor of each power plant data is available.

Therefore, the formula applied for *($EF_{grid\ OM,y}$)* is as follows:

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

Where:

$EF_{grid,OM,simple,y}$ = Operating margin CO_2 emission factor in year y (tCO_2/MWh)

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

$EF_{EL,m,y}$ = CO2 emission factor of power unit m in year y

m = All power plants / units serving the grid in year y including low-cost / must-run power plants / units

i = All fossil fuel types combusted in power plant / unit m in year y

y = The three most recent years for which data is available at the time of submission of the CDM-PDD to the DOE for validation

The emission factor for each power units ($EF_{EL,m,y}$) is determined using option A1 since data for fuel consumption and electricity generation for all power units m are available to the Directorate General of Electricity and Energy Utilization

$$EF_{EL,m,y} = \frac{\Sigma FCi,m,y \times NCVi,y \times EFCO2,i,yi}{EGm,y}$$

Where:

FCi,m,y = Amount of fuel type *i* consumed by power unit *m* in year *y* (Mass or volume unit)

NCVi,y = Net calorific value (energy content) of fuel type *i* in year *y* (GJ/mass or volume unit)

EFCO2,i,y = CO2 emission factor of fuel type *i* in year *y* (t CO2/GJ)

EGm,y = Net quantity of electricity generated and delivered to the grid by power unit *m* in year *y* (MWh)

The *EGm,y* for the grid connected power plants are determined as per the provisions on the monitoring tables.

The $EF_{grid,OM}$ *calculated by the Directorate General of Electricity and Energy Utilization, Ministry of Energy and Mineral Resources of Indonesia are as follows:*

$EF_{grid,OM,,2015}$ = 0.860 tCO_2/MWh (Refer to Section 6.3)
$EF_{grid,OM,,2016}$ = 0.821 tCO_2/MWh (Refer to Section 6.3)
$EF_{grid,OM,,2017}$ = 0.802 tCO_2/MWh (Refer to Section 6.3)

Step 5. Calculate the Build Margin (BM) emission factor ($EF_{grid,BM,y}$)

Option 1 is chosen for the ex-ante Build Margin Emission Factor calculation.

The sample group identified of the cohort of power plant unit to be included in the build margin consists of either:

- The set of five power plants, 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 ($AEG_{SET\text{-}5\text{-}units}$, in MWh);
- The set of power capacity additions in the electricity system that comprise 20% of the system generation (in MWh) and that have been built most recently

The tool mandates the use of whichever option that comprises the larger annual generation. The identified five most recent power plants and to include power plants up to capacity additions that comprise 20% of system generations. These power plants and their corresponding generation and year built in the following Table 4 and Table 5[56].

[56] Data is composed based on baseline study report published by Department of Energy and Mineral Resources of Indonesia - Directorate General of Electricity and Energy Utilization for year 2017

Table 4 SET5 power units that have been built most recently

Name of Power Plant	Year built	Net Electricity Delivered to the Grid (MWh)
PLTGU PTCL GTG#10	2015	36,870.90
PLTU Celukan Bawang 1	2015	892,916.41
PLTU Celukan Bawang 2	2015	840,037.78
PLTU Celukan Bawang 3	2015	892,453.00
Tanjung Awar-Awar 2	2016	1,385,767.91
Total		4,048,046.00 MWh

Table 5 SET>20% and that have been built most recently

Name of Power Plant	Year built	Net Electricity Delivered to the Grid (MWh)
PLTU Rembang Unit 1	2011	1,680,667.84
PLTU Rembang Unit 2	2011	2,077,255.34
PLTU TJB#4	2012	4,809,241.00
PLTU Banten 3 Lontar #1	2012	1,650,239.00
PLTU Banten 3 Lontar #2	2012	1,908,390.00
PLTU Banten 3 Lontar #3	2012	1,680,375.00
PT PJB Ubjom Paiton	2012	4,388,969.00
PLTGU PTCL GTG#7	2012	2,030.90
Priok GT3.2	2012	972,490.95
Priok GT3.1	2012	1,061,829.77
GT#1A	2013	245,304.86
GT#1B	2013	223,708.18
PLTGU Gresik GT3.3	2013	257,769.35
Pacitan Unit 1	2013	1,403,759.21
Pacitan Unit 2	2013	1,688,342.93
UJP JPR unit 1	2013	1,544,368.00
UJP JPR unit 2	2014	1,705,221.00
UJP JPR unit 3	2014	1,853,534.00
Tanjung Awar Awar 1	2014	1,772,585.63
PLTD Bali E	2014	587.59
Pesanggrahan Blok 1 Unit 1	2015	82,236.61
Pesanggrahan Blok 1 Unit 2	2015	71,854.41
Pesanggrahan Blok 1 Unit 3	2015	70,665.75
Pesanggrahan Blok 2 Unit 4	2015	80,368.13
Pesanggrahan Blok 2 Unit 5	2015	77,197.21
Pesanggrahan Blok 2 Unit 6	2015	79,005.72
Pesanggrahan Blok 3 Unit 7	2015	79,203.51
Pesanggrahan Blok 3 Unit 8	2015	71,647.39
Pesanggrahan Blok 3 Unit 9	2015	70,126.20
Pesanggrahan Blok 4 Unit 10	2015	72,927.48
Pesanggrahan Blok 4 Unit 11	2015	75,140.04
Pesanggrahan Blok 4 Unit 12	2015	81,415.65
PLTGU PTCL GTG#10	2015	36,870.90
Celukan Bawang 1	2015	892,916.41
Celukan Bawang 2	2015	840,037.78
Celukan Bawang 3	2015	892,453.00
Tanjung Awar Awar 2	2016	1,385,767.91
Total		35,886,503.65 MWh

Wayang Windu II plant and other CDM project plants are not included in the table and hence, not included in the calculation. And as per the “Tool to calculate the emission factor for an electricity system” version 07.0, none of the above power plants are built more than 10 years ago.

The set of power units that comprises the larger annual generation is used. Hence, SET>20% value is used.

The tool allows project participant to choose between one of the following 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.

Option 1 ex-ante is chosen for the project.

The build margin is calculated using the following equation:

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

Where:

$EF_{grid,BM,y}$	=	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)
$EF_{EL,m,y}$	=	CO_2 emission factor of power unit m in year y (tCO_2/MWh)
m	=	Power units included in the build margin
y	=	Most recent historical year for which power generation data is available

The CO2 emissions from these power plants are calculated using data presented in Appendix 4
And as per the “Tool to calculate the emission factor for an electricity system” version 07.0, none of the above power plants are built more than 10 years ago. Hence,
$EF_{grid,BM,2017}$ = 0.985 tCO_2/MWh (Refer to Section 6.3)

Step 6. Calculate the combined margin emission factor ($EF_{grid,CM,y}$)

JAMALI grid baseline emissions factor (EFy) as the combined margin emissions factor ($EF_{grid\ CM,y}$) is calculated using the “tool to calculate the emission factor for an electricity system version 07.0”. It consists of the combination of operating margin ($EF_{grid\ OM,y}$) and build margin ($EF_{grid\ BM,y}$) emission factors calculated *ex-ante* using following equation:

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

Where:

$EF_{grid\ CM,y}$	= Combined margin CO_2 emission factor for JAMALI grid connected power generation for in year y (tCO_2/MWh)
$EF_{grid\ OM,y}$	= Operating margin CO_2 emission factor for JAMALI grid connected power generation in year y (tCO_2/MWh)
$EF_{grid\ BM,y}$	= Build margin CO_2 emission factor for JAMALI grid connected power generation in year y (tCO_2/MWh)
w_{OM}	= weighting for operating emission factor (25%, for second period)

w_{BM} = weighting for build margin emission factor (75%, for second period)

The $EF_{grid\ CM,y}$ *is 0.945* tCO_2/MWh

Project emissions (PE_y)

For most renewable energy power generation project activities, PE_y = 0. However, some project activities may involve project emissions that can be significant. These emissions shall be accounted for as project emissions by using the following equation:

EQUATION (5)

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

Where:

PE_y	=	Project emissions in year *y* (t CO_2e/yr)
$PE_{FF,y}$	=	Project emissions from fossil fuel consumption in year *y* (t CO_2/yr)
$PE_{GP,y}$	=	Project emissions from the operation of dry, flash steam or binary geothermal power plants in year *y* (t CO_2e/yr)
$PE_{HP,y}$	=	Project emissions from water reservoirs of hydro power plants in year *y* (t CO_2e/yr)

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

EQUATION (6)

$$PE_{GP,y} = PE_{dry\ or\ flash steam,y} + PE_{binary,y}$$

Where:

$PE_{GP,y}$	=	Project emissions from the operation of dry steam, flash steam and/or binary geothermal power plants in year *y* (t CO_2e/yr)
$PE_{dry\ or\ flash\ steam,y}$	=	Project emissions from the operation of dry steam or flash steam geothermal power plants due to release of non-condensable gases in year *y* (t CO_2e/yr)
$PE_{binary,y}$	=	Project emissions from the operation of binary geothermal power plants due to physical leakage of non-condensable gases and working fluid in year *y* (t CO_2e/yr)

(e) Project emissions from dry or flash steam geothermal power plants:

EQUATION (7)

$$PE_{dry\ or\ flash\ steam,y} = \left(w_{steam,CO2,y} + w_{steam,CH4,y} \times GWP_{CH4}\right) \times M_{steam,y}$$

Where:

$w_{steam,CO2,y}$	=	Average mass fraction of CO_2 in the produced steam in year *y* (t CO_2/t steam)
$w_{steam,CH4,y}$	=	Average mass fraction of CH_4 in the produced steam in year *y* (t CH_4/t steam)

GWP_{CH4}	=	Global warming potential of CH_4 valid for the relevant commitment period (t CO_2e/t CH_4)
$M_{steam,y}$	=	Quantity of steam produced in year *y* (t steam/yr)

Project emission from combustion of fossil fuel related to the operation of geothermal power plant is calculated as:

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

Where:

$PE_{FF,y}$ = project emissions from combustion of fossil fuels related to the operation of the geothermal power plant in year y (/yr)

$PE_{FC,j,y}$ = CO_2 emissions from fossil fuel combustion in process j during the year y (tCO_2/yr). This parameter will be calculated by the "tool to calculate project or leakage CO_2 emissions from fossil fuel combustion version 03"

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

Equation (8)

Where:

$FC_{diesel,j,y}$ = quantity of diesel combusted in emergency genset and fire pump during the historical year of Wayang Windu 1 operation (ton)

$COEF_{i,y}$ = CO_2 emission coefficient of diesel fuel (tCO2/ton)

$COEF_{i,y}$ is calculated based on net calorific value and CO_2 emission factor of diesel fuel, as follows:

$$COEF_{i,y} = NCV_{i,y} \times EF_{CO2,i,y}$$

Equation (9)

Where:

$NCV_{diesel,y}$ = weighted average net calorific value of diesel fuel (IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Vol.2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories) (GJ/ton)

$EF_{CO2,diesel,y}$ = weighted average CO_2 emission factor of diesel fuel historical (IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Vol.2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories (tCO_2/GJ)

Since project is a flash steam geothermal power, the $PE_{binary,y} = 0$

Emission reductions (ER_y)

Emission reductions are calculated as follows:

EQUATION (10)

$$ER_y = BE_y - PE_y$$

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

Data/Parameter	**GWP_{CH4}**
Data unit	t CO_2e/t CH_4
Description	Global warming potential of methane valid for the relevant commitment period
Source of data	IPCC
Value(s) applied	For the second commitment period: 25 t CO_2e/t CH_4
Choice of data or measurement methods and procedures	-
Purpose of data	Project emission calculation
Additional comment	-

Data/Parameter	$EG_{historical}$
Data unit	MWh
Description	Average of historical electricity delivered by the existing facility to the grid
Source of data	Project activity site
Value(s) applied	912,476
Choice of data or measurement methods and procedures	The average of historical electricity delivered by the existing facility (Wayang Windu Phase 1) to the grid, spanning all data from the most recent available month (Feb 2009) to the time at which the facility was operated (June 2000) expressed in MWh per year. Data is based on invoices from net electricity sales to the grid operator
Purpose of data	Baseline emission calculation
Additional comment	-

Data/Parameter	**$\sigma_{historical}$**
Data unit	MWh/yr
Description	Standard deviation of the annual average historical net electricity generation delivered to the grid by the existing renewable energy power plant that was operated at the project site prior to the implementation of the project activity
Source of data	Calculated from data used to establish $EG_{historical}$
Value(s) applied	5,952
Choice of data or measurement methods and procedures	Parameter to be calculated as the standard deviation of the annual generation data used to calculate $EG_{historical}$ for retrofit, or rehabilitation or replacement project activities
Purpose of data	Baseline emission calculation
Additional comment	

Data/Parameter	***DATE*$_{BaselineRetrofit}$**
Data unit	Date
Description	Point in time when the existing equipment would need to be replaced in the absence of the project activity
Source of data	Project activity site
Value(s) applied	01 June 2030
Choice of data or measurement methods and procedures	The technical lifetime of the existing facility, i.e. Wayang Windu Phase 1, in the absence of the project activity is taken to be 30 years. This is a conservative number, considering many of the power plants in Indonesia are operated even after its technical lifetime. Wayang Windu 1 started operation in June 2000, hence the $DATE_{BaselineRetrofit}$ is 01 June 2030.
Purpose of data	-
Additional comment	-

Data/Parameter	**$DATE_{hist}$**
Data unit	date
Description	Point in time from which the time span of historical date for retrofit, rehabilitation or replacement project activities may start
Source of data	Project activity site
Value(s) applied	June 2000
Choice of data or measurement methods and procedures	$DATE_{hist}$ is the latest point in time between: The commercial commissioning of the plant/unit; If applicable: the last capacity addition to the plant/unit; or If applicable: the last retrofit or rehabilitation of the plant/unit
Purpose of data	-
Additional comment	-

Data/Parameter	**The percentage share of total installed capacity of the specific technology**
Data unit	%
Description	The percentage share of total installed capacity of the specific technology in the total installed grid connected power generation capacity in the host country
Source of data	National statistics or other official data
Value(s) applied	1.49
Choice of data or measurement methods and procedures	-
Purpose of data	-
Additional comment	Based on figure from The Book of Electricity Statistics Number 29 - 2016 table 5 page 12 published by Directorate General of Electricity, Ministry of Energy and Mineral Resources

Data/Parameter	**The total installed capacity of the technology**
Data unit	%
Description	the total installed capacity of the technology in the host country
Source of data	National statistics or other official data
Value(s) applied	2.58
Choice of data or measurement methods and procedures	-
Purpose of data	-
Additional comment	based on figure from The Book of Electricity Statistics Number 29 - 2016 table 3 page 10 published by Directorate General of Electricity, Ministry of Energy and Mineral Resources

Data/Parameter	$EF_{grid,CM,y}$
Data unit	tCO_2/MWh
Description	Grid emission factor for JAMALI
Source of data	Grid calculation published by Department of Energy and Mineral Resources of Indonesia - Directorate General of Electricity and Energy Utilization and endorsed by Indonesia DNA for year 2015, 2016, and 2017
Value(s) applied	0.945
Choice of data or measurement methods and procedures	Refer to the data published by Department of Energy & Mineral Resources of Indonesia – Directorate General of Electricity and Energy Utilization for the ex-ante figures for year 2015, 2016 and 2017. The weighted average OM, Build Margin and Combine Margin are calculated based on "tool to calculate the emission factor for an electricity system version 07.0".
Purpose of data	Baseline emission calculation
Additional comment	Calculated once ex-ante at the start of the crediting period, using the most recent three historical years for which data is available at the time of submission of the CDM-PDD to the DOE for validation

B.6.3. Ex ante calculation of emission reductions

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Baseline emission (BE_y)

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

Where:

BE_y	=	Baseline emissions in year *y* (t CO_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" (t CO_2/MWh)

As described at section B.6.1, JAMALI grid baseline emissions factor (EFy) is calculated as the combined margin emissions factor using tool to calculate the emission factor for an electricity system version 07. The result applied 0.945 tCO_2/MWh based on the ex-ante approach for both OM and BM.

Operating margin emission factor and Build margin emission factor

The Operating Margin Emission Factor and Build Margin Emission Factor have been calculated by Department of Energy and Mineral Resources of Indonesia - Directorate General of Electricity and Energy Utilization for the following years.

For the Operating Margin Emission Factor, the calculation uses a 3-year-generation weighted average, as the project is a grid power plant, following the "Tool to calculate the emission factor for an electricity system" (version 07.0), paragraph 42 (a) which states that "For the simple OM, the simple adjusted OM and the average OM, the emissions factor can be calculated using either of the two following data vintages: (a) Ex-ante option: if the ex-ante option is chosen, the emission factor is determined once at the validation stage, thus no monitoring and recalculation of the emissions factor during the crediting period is required. For grid power plants, use a 3-year generation-weighted average, based on the most recent data available at the time of submission of the CDM-PDD to the DOE for validation.

The most recent data available of annual generation has been calculated by Department of Energy and Mineral Resources of Indonesia - Directorate General of Electricity and Energy Utilization for the following years:

Power Generation Nett – EG_m (MWh), 2015	=	162,722,468.61
Power Generation Nett – EG_m (MWh), 2016	=	172,825,586.98
Power Generation Nett – EG_m (MWh), 2017	=	178,220,872.26

Hence, using a 3-year generation weighted average, the operating margin emission factor:

$EF_{grid\ OM,2015}$	=	0.860
$EF_{grid\ OM,2016}$	=	0.821
$EF_{grid\ OM,2017}$	=	0.802
$EF_{grid\ WeightedAverage\ OM,2015\ 2016,\ 2017}$	**=**	**0.827**

Build margin emission factor:

$EF_{grid\ BM,2017}$	**=**	**0.985**

Electricity import emission factor

Electricity import emission factor is determined to 0 (zero) tCO_2/MWh because currently the JAMALI grid is not inter-connected with other provincial grids within Indonesia with no intermediate plan to do so.

Combined margin emission factor

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

$EF_{grid\ CM}$ = $EF_{grid\ Weighted\ AveOM\ 2015,2016,2017}$ x 25% + $EF_{grid\ BM,2017}$ x 75%

= 0.827 x 25% + 0.985 x 75%

= 0.2067 + 0.7388

$EF_{grid\ CM}$ = 0.945

The combined margin emission factor of the JAMALI grid for 2017 is 0.945 tCO_2/yr

Baseline emission

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

1. $EG_{PJ,y}$ is calculated as follows:

$$EG_{PJ,y} = EG_{facility,y} - (EG_{historical} + \sigma_{historical}); until\ DATE_{BaselineRetrofit}$$

and

$$EG_{PJ,y} = 0; on/after\ DATE_{BaselineRetrofit}$$

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 plants/units to the grid in year *y* (MWh/yr)
$EG_{historical}$	=	Annual average historical net electricity generation delivered to the grid by the existing renewable energy power plants/units that was operated at the project site prior to the implementation of the project activity (MWh/yr)
$\sigma_{historical}$	=	Standard deviation of the annual average historical net electricity generation delivered to the grid by the existing renewable energy power plants/units that was operated at the project site prior to the implementation of the project activity (MWh/yr)
$DATE_{BaselineRetrofit}$	=	Point in time when the existing equipment would need to be replaced in the absence of the project activity (date). This only applies to retrofit or replacement projects

2. In case $EG_{facility,y} < (EG_{historical} + \sigma_{historical})$ in a year y then:

$$EG_{PJ,y} = 0$$

Taken into account the average of historical electricity delivered by additional power unit facility (Wayang Windu Phase 2) to the grid, spanning all data from the most recent available month December 2010 to December 2017:

EG unit2, y = 872,838 MWh/ yr

Taken into account the average of historical electricity delivered by the existing facility (Wayang Windu Phase 1) to the grid, spanning all data from the most recent available month February 2009 to the time at which the facility was operated (June 2000):

$EG_{historical}$ = 912,476 MWh

$\sigma_{historical}$ = 5,952 MWh

$EG_{historical} + \sigma_{historical}$ = (912,476 + 5,952)
= 918,427 MWh

$EG_{PJ\,y}$ = ((872,838 + 912,476) - 918,427)
= 866,886 MWh/yr

BE y = 866,886 MWh/yr * 0.945 tCO_2/MWh
= 819,638 tCO_2/yr

Leakage (L_y)

Since ACM0002 version 19 does not consider the emission due to power plant construction and fuel handlings, no leakage is considered (Ly=0).

Project Emission (PE_y)

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

Where:

PE_y	=	Project emissions in year *y* (t CO_2e/yr)
$PE_{FF,y}$	=	Project emissions from fossil fuel consumption in year *y* (t CO_2/yr)
$PE_{GP,y}$	=	Project emissions from the operation of dry, flash steam or binary geothermal power plants in year *y* (t CO_2e/yr)
$PE_{HP,y}$	=	Project emissions from water reservoirs of hydro power plants in year *y* (t CO_2e/yr)

Project emission of CO_2 and CH_4 due to the release of non-condensable gases from the steam produced in the geothermal power plant is calculated as:

$$PE_{GP,y} = PE_{dry\ or\ flash\ steam,y} + PE_{binary,y}$$

Where:

$PE_{GP,y}$	=	Project emissions from the operation of dry steam, flash steam and/or binary geothermal power plants in year *y* (t CO_2e/yr)
$PE_{dry\ or\ flash\ steam,y}$	=	Project emissions from the operation of dry steam or flash steam geothermal power plants due to release of non-condensable gases in year *y* (t CO_2e/yr)
$PE_{binary,y}$	=	Project emissions from the operation of binary geothermal power plants due to physical leakage of non-condensable gases and working fluid in year *y* (t CO_2e/yr)

(a) Project emissions from dry or flash steam geothermal power plants:

$$PE_{dry\ or\ flash\ steam,y} = \left(w_{steam,CO2,y} + w_{steam,CH4,y} \times GWP_{CH4}\right) \times M_{steam,y}$$

Where:

$w_{steam,CO2,y}$	=	Average mass fraction of CO_2 in the produced steam in year *y* (t CO_2/t steam)
$w_{steam,CH4,y}$	=	Average mass fraction of CH_4 in the produced steam in year *y* (t CH_4/t steam)
GWP_{CH4}	=	Global warming potential of CH_4 valid for the relevant commitment period (t CO_2e/t CH_4)
$M_{steam,y}$	=	Quantity of steam produced in year *y* (t steam/yr)

$$PE_{dry\,or\,flash\,steam,y} = (w_{steam,CO2,y} + w_{steam,CH4,y} \times GWP_{CH4}) \times M_{steam,y}$$

$PE_{dry\,or\,flash\,steam,y}$ $= (0.0097 + 1.65.10^{-5} * 25) * 7{,}591{,}442.27$
$= 76{,}590$ tCO_2/yr

Project emission from combustion of fossil fuel related to the operation of geothermal power plant is calculated as:

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

Where:
$PEFF_y$ = project emissions from combustion of fossil fuels related to the operation of the geothermal power plant in year y (/yr)
$PE_{FC,j,y}$ = CO_2 emissions from fossil fuel combustion in process j during the year y (tCO_2/yr). This parameter will be calculated by the "tool to calculate project or leakage CO_2 emissions from fossil fuel combustion version 03"

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

Where:
$FC_{diesel,j,y}$ = quantity of diesel combusted in emergency genset and fire pump during the historical year of Wayang Windu 1 operation (ton)
$COEF_{i,y}$ = CO_2 emission coefficient of diesel fuel (tCO2/ton)

$COEF_{i,y}$ is calculated based on net calorific value and CO_2 emission factor of diesel fuel, as follows:

$$COEF_{i,y} = NCV_{i,y} \times EF_{CO2,i,y}$$

Where:
$NCV_{diesel,y}$ = weighted average net calorific value of diesel fuel (IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Vol.2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories) (GJ/ton)
$EF_{CO2,diesel,y}$ = weighted average CO_2 emission factor of diesel fuel historical (IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Vol.2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories (tCO_2/GJ)

$COEF_{i,y} = 42.73 * 0.0748$
$= 3.196204$ (tCO_2/ton)

$PE_{FC,j,y} = (5.073 * 0.87) * 3.196204$
$= 15$ (tCO_2/yr)

$PE_y = PES_y + PEFF_y$
$= 76{,}590.0 + 15.0$
$= 76{,}605.0$ (tCO_2/yr)

Emission Reduction (ER_y)

$ER_y = BE_y – PE_y – L_y$
= 819,638 – 76,605 – 0
= 743,033 tCO_2/yr

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)
2017	68,303	6,384	0	61,919
2018	819,638	76,605	0	743,033
2019	819,638	76,605	0	743,033
2020	819,638	76,605	0	743,033
2021	819,638	76,605	0	743,033
2022	819,638	76,605	0	743,033
2023	819,638	76,605	0	743,033
2024	751,335	70,221	0	681,114
Total	5,737,466	536,235	0	5,201,231
Total number of crediting years	7 years			
Annual average over the crediting period	819,638	76,605	0	743,033

B.7. Monitoring plan

Wayang Windu Unit 1 delivers electricity through its 110 MW steam turbine and peripheral equipment driven by the steam produced by the existing production wells allocated for Wayang Windu Unit 1.

The project activity, Wayang Windu Unit 2 - an additional generation capacity, delivers electricity through its 117 MW steam turbine and peripheral equipment driven by the steam produced by the 7 production wells allocated for Wayang Windu Unit 2.

The steam pipeline from Wayang Windu Unit 1 and Unit 2 are interconnected, allowing steam to flow from production wells of Wayang Windu Unit 1 to steam turbine of Wayang Windu Unit 2, and vice versa.

In regards to this, monitoring of the steam parameters for the project activity will be conducted in the conservative matter.

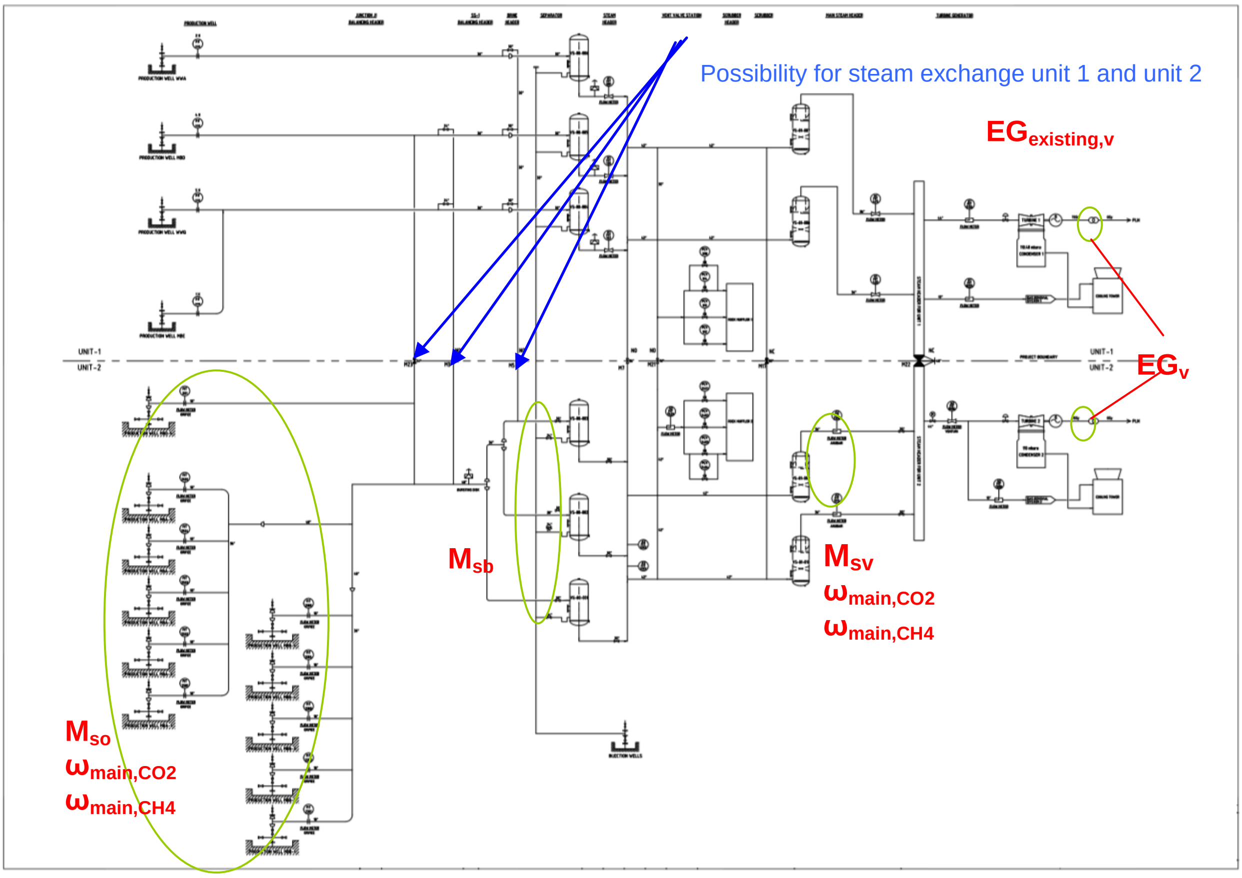

Figure 7 Simplified Process Flow Diagram for CDM Monitoring

B.7.1. Data and parameters to be monitored

Data/Parameter	$W_{steam,CO2,y}$
Data unit	t CO_2/t steam
Description	Average mass fraction of carbon dioxide in the produced steam in year *y*
Source of data	The mass fraction of CO_2 in the produced steam at the production wells and at the steam field-power plant interface analysed by the external laboratory.
Value(s) applied	0.0100
Measurement methods and procedures	Non-condensable gases sampling should be carried out in production wells and/or 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). 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. H_2S and CO_2 dissolve in the solvent while the residual compounds remain in their gaseous phase. The gas portion is then analysed using gas chromatography to determine the content of the residuals including CH_4. All alkanes concentrations are reported in terms of methane. The analysis is carried out by an external laboratory accredited under ISO 17025 by the National Accreditation Committee (KAN - Komite Akreditasi Nasional).

Monitoring frequency	Sampling, analysis, and recording are performed every 3 months.
QA/QC procedures	Detailed procedures are described in the CDM Monitoring Manual
Purpose of data	Project emission calculation
Additional comment	-

Data/Parameter	$\mathbf{w_{steam,CH4,y}}$
Data unit	t CH_4/t steam
Description	Average mass fraction of methane in the produced steam in year *y*
Source of data	The mass fraction of CH_4 in the produced steam at the production wells and at the steam field-power plant interface analysed by the external laboratory.
Value(s) applied	0.0000165
Measurement methods and procedures	The CH_4 monitoring equipment consists of gas flasks, filled with sodium hydroxide solution and additional chemicals to prevent oxidation. The gas sampling is carried out using ASTM Standard Practice E1675 for Sampling 2-Phase Geothermal Fluid for Purposes of Chemical Analysis (as applicable to sampling single phase steam only). The analysis is carried out by an external laboratory accredited under ISO 17025 by the National Accreditation Committee (KAN - Komite Akreditasi Nasional).
Monitoring frequency	Sampling, analysis, and recording are performed every 3 months.
QA/QC procedures	Detailed procedures are described in the CDM Monitoring Manual
Purpose of data	Project emission calculation
Additional comment	Applicable to dry, flash steam and binary geothermal power projects

Data/Parameter	$\mathbf{M_{steam,y}}$
Data unit	t steam/yr
Description	Quantity of steam produced in year *y*
Source of data	Continuous measurement by a Venturi flow meter ($M_{sv,y}$) located at the upstream of the Wayang Windu Unit 2 turbine and which is adjusted for losses of brine at the steam separator ($M_{sb,y}$) as well as Orifice Plates ($M_{so,i,y}$) located at the Wayang Windu Unit 2 well heads.
Value(s) applied	7,591,442.27
Measurement methods and procedures	The quantity of steam produced is recorded daily by means of a Venturi flow meter ($M_{sv,y}$) located upstream of the Wayang Windu Unit 2 turbine which is adjusted for losses of brine at the steam separator ($M_{sb,y}$) as well as Orifice Plates ($M_{so,i,y}$) located at the Wayang Windu Unit 2 well heads. In order to be conservative, the primary data will be taken from the higher values from either from the upstream metering points or the downstream metering. In case steam is transferred from unit 1 steam fields for power generation at unit 2 the upstream figure will higher. In case steam from the new steam fields at unit 2 will be transferred to the power generator of unit 1 the downfield figure will be higher. Using the higher one of the two values ensures that project emissions which are attributable to the capacity addition by unit 2 are clearly identified and accounted. Thus, the quantity of steam ($M_{steam,y}$) is given by: $M_{steam,y} = \max((M_{sv,y} + M_{sb,y}), \sum_i M_{so,y})$
Monitoring frequency	Data is monitored continuously (polling of at least every second) and condensed to half hour values. Daily figures will be built according to the methodology by accumulation of data.

QA/QC procedures	Flow meters' instruments are calibrated using internal calibrator by SEG(WW)L EC&I Supervisor. The internal calibrator is calibrated every 2 years by accredited laboratory. In accordance to the SEG(WW)L internal procedure, calibration is to be conducted every 6 months Following the industry's practice, it is acceptable for the calibration to be conducted between 6 months to 1-year period from the last calibration date. The calibration procedure is described in the CDM monitoring manual and plant routine inspection procedure, the maximum permissible error is 0.1%. The internal calibrators are calibrated every 2 years by accredited laboratory. Detailed procedures are described in the CDM Monitoring Manual.
Purpose of data	Project emission calculation
Additional comment	Applicable to dry and flash steam geothermal power projects. Since the project is a dry steam geothermal power project, $M_{steam\ outflow}$ is not measured.

Data/Parameter	**$FC_{i,j,y}$**
Data unit	m^3/yr
Description	Quantity of fuel type i combusted in process j during the year y
Source of data	Onsite measurements
Value(s) applied	5.073
Measurement methods and procedures	Measurement of diesel fuel consumption for emergency genset and fire pump multiplied with the national data of the diesel fuel density. Readings from the flowmeter at the inlet of the daily tank for emergency genset and readings from the flowmeter at the inlet diesel tank for the fire pump are recorded during the first week of the month.
Monitoring frequency	Data is collected monthly
QA/QC procedures	The consistency of measured diesel fuel consumption quantities was cross-checked by an annual energy balance that was based on engine specification fuel consumption (emergency genset and fire pump) and the working hour
Purpose of data	Project emission calculation
Additional comment	-

Data/Parameter	**$NCV_{i,y}$**
Data unit	GJ per mass or volume unit (e.g. GJ/m^3, GJ/ton)
Description	Weighted average net calorific value of fuel type i in year y
Source of data	Regional or national default values If a) is not available These sources can only be used for liquid fuels and should be based on well documented, reliable sources (such as national energy balances). The National value (Pertamina handbook – Bahan Bakar Minyak Elpiji dan BBG) is used.
Value(s) applied	42.73
Measurement methods and procedures	Measurements should be undertaken in line with national or international fuel standards
Monitoring frequency	Review appropriateness of the values annually
QA/QC procedures	Verify if the values under a), b) and c) are within the uncertainty range of the IPCC default values as provided in Table 1.2, Vol. 2 of the 2006 IPCC Guidelines. If the values fall below this range collect additional information from the testing laboratory to justify the outcome or conduct additional measurements. The laboratories in a), b) or c) should have ISO17025 accreditation or justify that they can comply with similar quality standards. Detailed procedures are described in the CDM Monitoring Manual

Purpose of data	Project emission calculation
Additional comment	-

Data/Parameter	**$EF_{CO2,i,y}$**
Data unit	tCO_2/GJ
Description	Weighted average CO_2 emission factor of fuel type i in year y
Source of data	IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in table 1.4 of Chapter1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories If a) is not available
Value(s) applied	0.0748
Measurement methods and procedures	-
Monitoring frequency	Any future revision of the IPCC Guidelines should be taken into account
QA/QC procedures	-
Purpose of data	Project emission calculation
Additional comment	-

Data/Parameter	**EG_y**
Data unit	MWh/yr
Description	Electricity supplied by the project activity to the grid (total of net electricity generated by Wayang Windu Unit 1 and Unit 2) in year y
Source of data	The reading of the electricity from the transaction meters from Wayang Windu Unit 1 and Unit 2. Primary data is sourced from the kWh meters downloaded daily from the DCS.
Value(s) applied	1,785,314
Measurement methods and procedures	Quantity of electricity supplied by the project plant to the grid and the quantity of electricity delivered from the grid to the project plant are recorded from main meter (transaction meter) and check meter.
Monitoring frequency	The meter reading is recorded every half hourly and recorded automatically at load profile at the transaction kWh meters.
QA/QC procedures	Based on the Standard Operating Procedure of Metering System of PT PLN (Persero) P3B – Jawa Bali revision A, the data from the main meter and the check meter are compared on the monthly basis and any differences greater than 0.4% (the maximum difference of the main meter of 0.2 class and check meter of 0.2 class) will be investigated further. The data is double-checked with the records of the electricity transaction. Detailed procedures are described in the CDM Monitoring Manual
Purpose of data	Baseline emission calculation
Additional comment	-

Data/Parameter	**$EG_{existing}$**
Data unit	MWh/yr
Description	Electricity supplied by the existing power generation unit to the grid (total of net electricity generated by Wayang Windu Unit 1) in year y
Source of data	The reading of the electricity from the transaction meters from Wayang Windu Unit 1 Primary data is sourced from the kWh meters downloaded daily from the DCS.
Value(s) applied	912,476
Measurement methods and procedures	Quantity of electricity supplied by the existing power generation unit (Wayang Windu Unit 1) to the grid and the quantity of electricity delivered from the grid to the existing power generation unit (Wayang Windu Unit 1) are recorded from main meter (transaction meter) and check meter.

Monitoring frequency	The meter reading is recorded every half hourly and recorded automatically at load profile at the transaction kWh meters.
QA/QC procedures	Based on the Standard Operating Procedure of Metering System of PT PLN (Persero) P3B – Jawa Bali revision A, the data from the main meter and the check meter are compared on the monthly basis and any differences greater than 0.4% (the maximum difference of the main meter of 0.2 class and check meter of 0.2 class) will be investigated further. The data is double-checked with the records of the electricity transaction. Detailed procedures are described in the CDM Monitoring Manual
Purpose of data	Baseline emission calculation
Additional comment	-

B.7.2. Sampling plan

>>Not applicable

B.7.3. Other elements of monitoring plan

>>
Purpose: To ensure that the approved monitoring methodology is correctly implemented in order to enable the accurate and transparent determination of avoided emissions.

Scope: This procedure covers the project activity described in the CDM project entitled Wayang Windu Phase 2 Geothermal Power Project.

Responsibility:
Organisation & Responsibilities
SEG(WW)L

- Wayang Windu Field Manager is responsible for supervision of overall plant operations and management responsibilities
- Production Superintendent is responsible for the preparation of monthly CDM report and supervision of plant productions
- EC&I Supervisor is responsible for maintaining the measurement devices and ensuring calibration of the measurement devices
- Senior Chemist is responsible for checking steam quality information for CDM and submission to SCC
- Chemist is responsible for steam sampling and analysis, checking and recording of steam quality
- Production Supervisor is responsible for external data collection, checking CDM information (excluding steam quality data) and weekly spreadsheet and submission to SCC
- Plant Operators are responsible for meter readings, data recording and other roles as specified by the supervisors

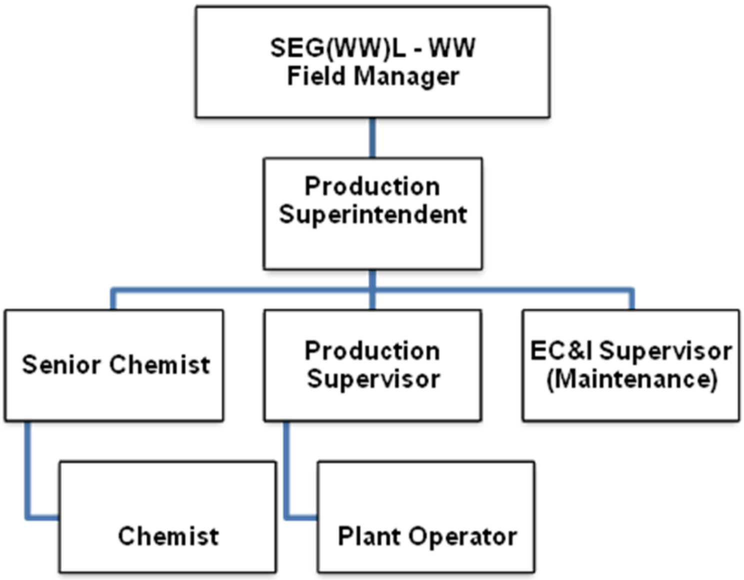

Figure 8. CDM Organization Structure SEG(WW)L

SCC

- Senior Climate Change Officer is responsible for the supervision of overall climate change monitoring of the project, initiate verification with DOE, and conducts internal audit on correct implementation MP
- Project Manager is responsible for management and checking of CDM information and reporting
- Project Officer is responsible for project coordination, implementation and liaison, data gathering and retention, completion of the CDM spreadsheet, calculation of emission reductions, preparation of monitoring report

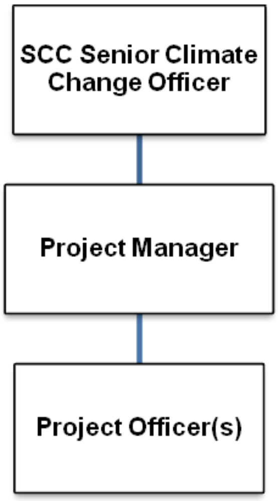

Figure 9. CDM Organization Structure SCC

Calculation of emissions reduction:

The data required to calculate baseline emissions and project emissions will be fed into a protected spreadsheet which will calculate the emission reductions according to the formulae described above, using the defined default values. Access to the spreadsheet will be controlled. The spreadsheet will be regularly audited to ensure it is operating correctly.

Quality control

Data will be compared from month to month using trend analysis to show where parameters have deviated significantly from preceding or following values. Any values identified as being unusual in this manner will be rechecked. Where preceding or following values are not available, references values may be taken from published data as appropriate such as 2006 IPCC guideline.

Accuracy and calibration of instruments

All meters are purchased and maintained to ensure a high level of accuracy. The exact specifications of each meter is determined during the detailed design of the project. Thereafter the meter accuracies will be included in this procedure and steps taken to maintain those levels of accuracy.

All key meters are subject to a quality control regime that includes regular maintenance and calibration. A record is maintained showing the location and unique identification number of each meter, the calibration status of that meter (when last calibrated, when next due for calibration) and who performs the calibration service. Calibration certificates are retained for all meters until two years after the end of the second crediting period.

Archiving of data

The monitoring team periodically archives data to a secure and retrievable storage format on a periodic e.g. weekly basis. Calibration records may be archived by scanning and storage in an accessible electronic format. These data are stored until 2 years after the end of the second crediting period.

Document Control

The Project Manager implements a document control system that ensures that the current versions of necessary documents are available at the point of use. All documents must be maintained in English with local translations because English is the formal language of the CDM.

Preparation of monitoring report

The archived / live data are used to prepare a periodic monitoring report to be submitted to the CDM EB for verification and issuance of CERs. A standard format for the monitoring report is prepared and prior to the submission of the first monitoring report. An internal technical review process is conducted and documented before such a report is submitted for verification.

Manual data recording system

The CDM Project Manager implements a manual data recording system to act as a back-up for the online system. This will involve completion of a daily log sheet that records meter readings at the start of the day (which is also the end of the previous day). Spot readings of other values (temperature and pressure) will also be recorded periodically and at the times when meter readings are taken. At least one set of manual readings will be taken directly from the meters each day, and used to check the read-outs in the control room.

These log sheets will act as a back-up and a means of estimating other essential data in the event of a prolonged failure of the on-line system (prolonged failure will constitute more than 24 hours (uninterrupted) without on-line monitoring).

Treatment of missing or corrupted data

Where data in the on-line system are corrupted or missing whilst the plant is operating, the missing data can be estimated by taking the lower of the average value for the parameter in question in the hour before the error arose or the hour immediately after the system came on-line again. If there is evidence to suggest that both of these values are un-representative, the average from the previous 24 hours will be used.

The error will be recorded in the daily log sheet and the occurrence of the error will be investigated and rectified as soon as possible. If the on-line system is compromised for more than 24 hours, data will be manually recorded.

Audit function and management review

The Project Manager will arrange for an audit of the management system periodically and at least once per year. The auditor will not be involved in the daily operation of the mine and if necessary, may be sourced from a third party. The auditor will assess the implementation of the monitoring procedure and the preparation of the monitoring report. Audit findings, and steps taken to address findings will be recorded and reviewed in a Management Review meeting (convened at least annually) at which time the effectiveness of these procedures will be reviewed and necessary changes implemented.

SECTION C. Start date, crediting period type and duration

C.1. Start date of project activity

>>

30 January 2007 (based on the date of the Engineer, Procure and Construct Agreement for the Steam field Above Ground System and Power Plant Project)

C.2. Expected operational lifetime of project activity

>>
30 years

C.3. Crediting period of project activity

C.3.1. Type of crediting period

>>
Renewable 7 years x 3

C.3.2. Start date of crediting period

>>2nd December 2017

C.3.3. Duration of crediting period

>>
7 years

SECTION D. Environmental impacts

D.1. Analysis of environmental impacts

>>
The project owner has implemented an Environmental Impact Study, which consists of ANDAL (Environmental Impact Analysis), RKL (Environmental Management Plan), and RPL (Environmental Monitoring Plan) in March 2006 to ensure that the project activity complied with the environmental regulations, e.g. Indonesian Law No. 4 of 1982, Government Regulation no 51 of 1993, Decree of Environmental Minister No. 17 of 2001.

The complete copy of the Environmental Impact Study will be available to DOE upon request. The impact evaluation includes various phases of pre-construction, construction, operational, and post-operational phases. Pre-construction phase is mainly the land clearing activities while construction phases consist of the mobilization and construction of the power plant, equipment, work forces, and material mobilization. Operational phase consists of utilization of personnel mobilization and operation, power plant operation, and power plant maintenance. Post operational phase consists of dismantling, regeneration, and personnel demobilization.

The environmental key parameters are summarized as the following:

Higher Frequency of Traffic & Infrastructure Damage
During construction and operation, higher frequency of traffic was due to mobilization of equipment that may cause local traffic. Infrastructure damage might be done due to the traffic of heavy duty vehicles and its loads. In order to manage such issue, it will be needed to limit the size, amount, and frequency of vehicles passing as well as provide an alternate route.

Air Quality
During the construction phase, the air quality decreases due to pollutants. The parameters that are increased are as following:

- Particulates 0.03%
- SO2 7.25%
- NOx 10.13%
- CO 3.03%

Despite the decline of air quality that is inevitable, the impact from the abovementioned aspect is considered minor, based on the Government Regulation no 41 /1999. During the operational

phase, gases from the cooling tower could reduce the air quality. Hence, the gases will be channeled back to the cooling tower.
Workers at the project site will be wearing masks to reduce the health impact.

Noise Intensity
During the construction phase, the noise quality of the area is reduced from 59dBA to 65-75 dBA due to the higher frequency of traffic. To manage this, a few programs will be put in place during the mobilization period, i.e. vehicle maintenance, speed limit, and truck scheduling.
During the operational phase, the noise will come from the steam vent valve, turbine, generator, cooling tower and transformer. Noise reduction measures will be placed surrounding the location and trees will be planted to reduce the noise.

Job Opportunities
The project activity will increase the job opportunities at the local area. The job opportunities during the drilling of the new wells and the construction of the power plant include the new business for accommodation for the foreign workers and catering for the staff.

Water Quality
During the construction period, it is estimated that 250 personnel will be employed. A good sanitation system will be required to manage the domestic waste water disposal to avoid the degradation of the quality of the surface water as well as to reduce the risks towards the community health. Trees will be planted at the open area to minimize the impact of the surface water quality. During the operational period, the salt water from the separator, condensate, and water separated from the mud will be put back into the injection well. In the case of the failure of the injection system, the liquid will be kept at the temporary reservoir. If the capacity is exceeding the reservoir, the power plant operation will be stopped.

In summary, no adverse environmental impacts occurred during construction and operational phase of the project activity. All related environmental impacts by implementing a robust environmental management and monitoring plan. The project activity is included as one of the clean renewable energy projects that can reduce the dependency on fossil fuel. The project activity would have long term environmental benefit for local villagers and the surroundings.

D.2. Environmental impact assessment

>>
There are no significant environmental impacts of the project

SECTION E. Local stakeholder consultation

E.1. Modalities for local stakeholder consultation

>>
According to the requirements for local stakeholders' involvement in the CDM Project, a stakeholder meeting was conducted on December 5th, 2008, at Arion Swiss - Belhotel, starting at 10am. The stakeholders participated in the event include local residents, local village representatives, interested non-governmental organizations, PT Pertamina Geothermal Energy, PT Perusahaan Listrik Negara. In addition, a public notice of the meeting was posted in the local newspaper.

The meeting started with an introduction to the project by project owner, followed by questions and comments from participants and ended at 3.30 pm.

E.2. Summary of comments received

>>
Presented below are the brief comments raised by the stakeholders regarding the project activity:
I. Ms. Bintari, Environmental Consultant from Bandung

Q. How sustainable are the activities that you are doing for the reforestation and the sustainability of the environment?

A. The activities for the sustainable environment are still going on. The fund available is even increasing year by year, although the electricity capacity is fixed yearly.

II. Mr. Deni Muhammad Abdullah, Presidium OKP Pengalengan

Q. 1. Do you have the estimation on the amount of emission that will be reduced from this project?
2. Once the CER is obtained by MNL, where will this fund be channeled to?

A. 1. Yes. The current estimation is about 700,000 CER. However, the actual emission reduction could be different from the current estimation. The actual emission reduction will be measured during the monitoring period of the project activity.
2. This project was not attractive financially. CER revenue helps to make this project becoming attractive. Hence the CER obtained will be used as one of the revenue sources to payback the project loan and to make sure the sustainability of the project.

III. Mr Ubadudin, Rekanan Lokal Pengalengan.

Q. Why a lot of the goods purchasing are ordered from outside the area? MNL is supposed to be committed to help in the sustainability of the local businesses.

A. Purchasing is done based on the tender regulation set by the Indonesian government. Hence the process is fair and just. The goods will be bought from the most suitable supplier best on the tender terms.

IV. Mr Oskar, NGO Gempita

Q. How safe is this project and are there any safety guarantee for the locals surrounding the area of the projects? Why since the starting of this project, there are some geographical changes, i.e. land cracks at Cibolang.

A. In general, geothermal projects are very safe. There are a few geothermal projects that have been running for years in Indonesia, and many around the world that have been running safely for years. MNL also applies the highest safety standard in our operation, in accordance to local and international applicable safety standards and regulations.

V. Mr Gunyan Maksus, Village Head Association, around Pangalengan, West Java

Q. What are the benefits that the CDM will bring to the low income community, the community that is affected by the project, and the community that support the project?

A. The benefits for the communities mentioned will be felt through the CSR program implemented by MNL.

VI. Mr. Muhammad Ihsan, member of DPRD Komisi C Bandung

Q. Where are you currently at the CDM process?

A. We are currently preparing the PDD. Stakeholder consultation is part of the requirement of the PDD.

VII. Mr. Rega Usmana, Pangalengan Outdoor Community

Q. 1. How do you invite the stakeholders that attend the meeting today?
2. The funds received by the Community Development are different from funds given to the Community Development. MNL should watch more on this issue.

A. 1. Some of the stakeholders were invited through invitation letter. This includes the local representatives, head of villages, local government bodies, and PLN. We have also invited the public through the Pikiran Rakyat, local newspaper.
2. Our accounting is audited regularly internally and by the third party. Hence there shall not be any funds missing in the system.

VIII. Mr. Isman Kosmantara, Gapura Community (Local Fellows Community)

Q. Going forward, will there be any job opportunities for the local fellows?

A. Yes. There will be job opportunities for the local community.

E.3. Consideration of comments received

>>

The comments received were either questions concerning the project activity and/or general statements in support of the project activity. None of the comments required any specific actions from the project developer. The participants at the meeting were satisfied with the responses received and showed their support for the project. Minutes of the meeting are available to the DOE in Bahasa Indonesia, along with a list of attendees.

SECTION F. Approval and authorization

>>

Letter of Approval from the Republic of Indonesia as the Host Country is available. As per Procedure: CDM project cycle procedure for project activities version 02.0 para 277, for the purpose of renewal of the crediting period, it is not necessary to obtain a new letter of approval from the Parties involved.

Appendix 1. Contact information of project participants

Organization name	Sindicatum Carbon Capital Limited
Country	UK
Address	33 Duke Street W1U 1JY, London
Telephone	+44 20 3008 4759
Fax	+44 20 3008 4752
E-mail	Michael.boardman@sindicatum.com
Website	www.sindicatum.com
Contact person	Mr. Michael Boardman

Organization name	Star Energy Geotherrmal (Wayang Windu) Limited
Country	Indonesia
Address	Jl. Let Jend S Parman Kav 62 – 63, 8th – 11th floor Wisma Barito Pacific, Star Energy Tower, Jakarta 12710
Telephone	+62 21 532 5828
Fax	+62 21 5366 0558
E-mail	Hendra.tan@starenergy.co.id
Website	www.starenergy.co.id
Contact person	Mr. Hendra Tan

Appendix 2. Affirmation regarding public funding

There is no public funding for the Wayang Windu Phase 2 Geothermal Power Project. The project financing portion comes from Standard Chartered Bank Singapore and the equity portion comes from the project owner's shareholders. Therefore, the project activity is not using any public fund.

Funding of the project will be disclosed to the DOE during validation.

Appendix 3. Applicability of methodologies and standardized baselines

Baseline study is reported by the Department of Energy and Mineral Resources of Indonesia - Directorate General of Electricity and Energy Utilization for the year of 2015, 2016 and 2017

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

Perhitungan Faktor Emisi
Sistem Interkoneksi Jawa-Madura-Bali

Tabel Konversi

Unit 1		Unit 2	
kWh	1	joule	3,600,000
calorie	1	joule	4.1868
SCF	1	m3	0.02831685
Btu	1	kJ	1.05506
Btu	1	kcal	0.25200
lb	1	tonne	0.0004535924
lb	1	kg	0.4535924000
MMBtu	1	TJ	0.00105506

Faktor Emisi CO_2 [1)]

Jenis Bahan Bakar	Faktor Emisi CO_2 Efektif (kg/TJ)
IDO (Industrial Diesel Oil)[1)]	73,883
HSD (High Speed Diesel)[1)]	74,433
MFO (Marine Fuel Oil)[1)]	75,167
HFO (Heavy Fuel Oil)[1)]	75,167
PPO (Pure Plant Oil)[1)]	67,100
GAS ALAM[1)]	54,300
BATUBARA[2)]	97,665

Spesifikasi Bahan Bakar

Jenis Bahan Bakar	Densitas (kg/m[3)])	GCV (TJ/Gg)	Selisih (TJ/Gg)	NCV (TJ/Gg)
IDO[4)]	880.00	44.52	2.56	41.96
HSD[4)]	845.00	45.52	2.79	42.73
MFO[4)]	990.00	43.35	2.33	41.02
HFO[4)]	990.00	43.35	2.33	41.02
PPO[3)]	900.00			13.80
GAS ALAM[3)]				46.50
BATUBARA[2)]				21.90

[1)]Sumber : Puslitbang LEMIGAS, Kementerian ESDM, 2012
[2)]Sumber : Puslitbang TEKMIRA, Kementerian ESDM, 2009
[3)]Sumber : IPCC 2006 Volume 2 Energy, Tabel 1.4, hal. 1.23-1.24
[4)]Sumber : PERTAMINA, BAHAN BAKAR MINYAK, ELPIJI dan BBG, Mei 2003

KEMENTERIAN ENERGI DAN SUMBER DAYA MINERAL
DIREKTORAT JENDERAL KETENAGALISTRIKAN

Perhitungan Faktor Emisi Ex-ante 2017
Sistem Interkoneksi Jawa-Madura-Bali

1. Identifikasi sistem interkoneksi tenaga listrik terkait
Data yang dibutuhkan :

Tahun
2015
2016
2017

2. Mengikutsertakan pembangkit *on-grid* dan *off-grid* dalam perhitungan
Opsi I : Pembangkit yang terhubung dengan sistem interkoneksi tenaga listrik *(on-grid)* diikutsertakan dalam perhitungan
~~Opsi II : Pembangkit *on-grid* dan pembangkit yang tidak terhubung dengan sistem interkoneksi tenaga listrik *(off-grid)* diikutsertakan dalam perhitungan~~

3. Menentukan metode *Operating Margin* (OM)

a. Simple OM	x
b. Simple adjusted OM	x
c. Dispatch data analysis OM	x
d. Average OM	√

4. Menghitung faktor emisi OM sesuai dengan metode yang telah ditentukan

$$EF_{grid,OMsimple,y} = \frac{\sum_{m} EG_{m,y} \cdot EF_{EL,m,y}}{\sum_{m} EG_{m,y}}$$

Average OM

Tahun	$EF_{grid,AverageOM,2017}$ (tCO_2/MWh)	*Power Generation Nett* - EG_m, (MWh)	$EF_{grid,\ Average\ OM}$, (tCO_2/MWh)
2015	0,860	162.722.468,61	0,827
2016	0,821	172.825.586,98	
2017	0,802	178.220.872,26	

5. Identifikasi kelompok unit pembangkit yang termasuk dalam *Build Margin* (BM)
~~Kelompok I : Lima pembangkit terakhir yang telah dibangun dan beroperasi yang menyalurkan energi listrik ke sistem interkoneksi tenaga listrik~~

Unit Pembangkit	Tahun Operasi	*Power Generation Nett* - $EG_{m,2017}$ (MWh)
PLTGU_PTCL_GTG#10	2015-07-11	36.870,90
PLTU CELUKAN BAWANG 1	2015-09-23	892.916,41
PLTU CELUKAN BAWANG 2	2015-09-23	840.037,78
PLTU CELUKAN BAWANG 3	2015-09-23	892.453,00
~~Cilacap #3~~	~~2016-06-10~~	~~3.284.315,00~~
TANJUNG AWAR-AWAR UNIT 2	2016-07-18	1.385.767,91
~~UJP PLTU JAWA TENGAH 2 ADIPALA~~	~~2016-09-13~~	~~1.865.680,37~~
~~PLTU LBE #1~~	~~2017-03-28~~	~~3.213.720,28~~

Total energi listrik tersalur oleh unit pembangkit	4.048.046,00	MWh
Total energi listrik tersalur ke sistem interkoneksi	178.220.872,26	MWh
Persentase	2,27%	< 20%

Kelompok II : Sejumlah pembangkit terakhir dibangun yang menyalurkan energi listrik sebesar ≥ 20% total yang disalurkan ke sistem interkoneksi tenaga listrik

Unit Pembangkit	Tahun Operasi	*Power Generation Nett* - $EG_{m,2017}$ (MWh)
PLTU Rembang Unit 1 (#20)	2011-12-13	1.680.667,84
PLTU Rembang Unit 2 (#10)	2011-12-13	2.077.255,34
PLTU TJB #4	2012-01-01	4.809.241,00
PLTU Banten 3 Lontar	2012-01-01	1.650.239,00
PLTU Banten 3 Lontar	2012-02-29	1.908.390,00
PLTU Banten 3 Lontar	2012-04-10	1.680.375,00
~~PLTU Paiton Unit 3~~	~~2012-04-12~~	~~4.768.500,00~~
PT PJB UBJOM PAITON	2012-05-09	4.388.969,00
PLTGU_PTCL_GTG#7	2012-06-07	2.030,90
~~PLTU Cirebon 1x660 MW~~	~~2012-07-27~~	~~4.041.043,70~~
PRIOK GT 3.2	2012-10-23	972.490,95
~~PRIOK ST 3.0~~	~~2012-10-23~~	~~1.181.432,33~~
PRIOK GT 3.1	2012-10-24	1.061.829,77
GT#1A	2013-01-05	245.304,86
GT#1B	2013-01-05	223.708,18
~~ST#1~~	~~2013-01-05~~	~~309.944,36~~
PLTGU GRESIK GT 3.3	2013-01-13	257.769,35
PACITAN UNIT 1	2013-06-22	1.403.759,21
PACITAN UNIT 2	2013-08-21	1.688.342,93
UJP JPR UNIT 1	2013-08-26	1.544.368,00
UJP JPR UNIT 2	2014-01-07	1.705.221,00
UJP JPR UNIT 3	2014-01-21	1.853.534,00
TANJUNG AWAR-AWAR UNIT 1	2014-01-24	1.772.585,63
PLTD E BALI	2014-08-21	587,59
~~PLTP Patuha Unit 1~~	~~2014-09-01~~	~~441.211,45~~
PLTDG Pesanggaran Blok 1 Unit 1	2015-04-04	82.236,61
PLTDG Pesanggaran Blok 1 Unit 2	2015-04-04	71.854,41
PLTDG Pesanggaran Blok 1 Unit 3	2015-04-04	70.665,75
PLTDG Pesanggaran Blok 2 Unit 4	2015-04-11	80.368,13
PLTDG Pesanggaran Blok 2 Unit 5	2015-04-11	77.197,21
PLTDG Pesanggaran Blok 2 Unit 6	2015-04-11	79.005,72
PLTDG Pesanggaran Blok 3 Unit 7	2015-05-13	79.203,51
PLTDG Pesanggaran Blok 3 Unit 8	2015-05-13	71.647,39
PLTDG Pesanggaran Blok 3 Unit 9	2015-05-13	70.126,20
PLTDG Pesanggaran Blok 4 Unit 10	2015-06-04	72.927,48
PLTDG Pesanggaran Blok 4 Unit 11	2015-06-04	75.140,04
PLTDG Pesanggaran Blok 4 Unit 12	2015-06-04	81.415,65
PLTGU_PTCL_GTG#10	2015-07-11	36.870,90
PLTU CELUKAN BAWANG 1	2015-09-23	892.916,41
PLTU CELUKAN BAWANG 2	2015-09-23	840.037,78

PLTU CELUKAN BAWANG 3	2015-09-23	892.453,00
~~Cilacap #3~~	~~2016-06-10~~	~~3.284.315,00~~
TANJUNG AWAR-AWAR UNIT 2	2016-07-18	1.385.767,91
~~UJP PLTU JAWA TENGAH 2 ADIPALA~~	~~2016-09-13~~	~~1.865.680,37~~
~~PLTU LBE #1~~	~~2017-03-28~~	~~3.213.720,28~~

Total energi listrik tersalur oleh unit pembangkit	35.886.503,65	MWh
Total energi listrik tersalur ke sistem interkoneksi	178.220.872,26	MWh
Persentase	20,14%	

6. Menghitung faktor emisi BM

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

Unit Pembangkit	*Power Generation Nett* - $EG_{m,2017}$ (MWh)	$EG_{m,2017} \times EF_{EL,m,2017}$ (tCO_2)	$EF_{grid,BM,2017}$ (tCO_2/MWh)
PLTU Rembang Unit 1 (#20)	1.680.667,84	1700137,66	
PLTU Rembang Unit 2 (#10)	2.077.255,34	2096176,12	
PLTU TJB #4	4.809.241,00	4250822,09	
PLTU Banten 3 Lontar	1.650.239,00	1754843,57	
PLTU Banten 3 Lontar	1.908.390,00	2005891,95	
PLTU Banten 3 Lontar	1.680.375,00	1.763.510,15	
PLTU Paiton Unit 3	4.768.500,00	5.287.462,86	
PT PJB UBJOM PAITON	4.388.969,00	4.782.261,61	
PLTGU_PTCL_GTG#7	2.030,90	1.572,87	
PLTU Cirebon 1x660 MW	4.041.043,70	3.936.092,04	
~~PRIOK GT 3.2~~	~~972.490,95~~	~~552.762,27~~	
PRIOK ST 3.0	1.181.432,33	0,00	
PRIOK GT 3.1	1.061.829,77	575.998,23	
GT#1A	245.304,86	247.479,61	
~~GT#1B~~	~~223.708,18~~	~~223.468,81~~	
ST#1	309.944,36	0,00	
~~PLTGU GRESIK GT 3.3~~	~~257.769,35~~	~~159.485,39~~	
PACITAN UNIT 1	1.403.759,21	1.518.977,45	
~~PACITAN UNIT 2~~	~~1.688.342,93~~	~~1.779.507,51~~	
UJP JPR UNIT 1	1.544.368,00	1.613.781,80	
UJP JPR UNIT 2	1.705.221,00	1.688.452,93	
UJP JPR UNIT 3	1.853.534,00	1.854.533,43	
TANJUNG AWAR-AWAR UNIT 1	1.772.585,63	1.921.906,21	**0,985**
PLTD E BALI	587,59	423,14	
PLTP Patuha Unit 1	441.211,45	0,00	
PLTDG Pesanggaran Blok 1 Unit 1	82.236,61	45.426,34	
~~PLTDG Pesanggaran Blok 1 Unit 2~~	~~71.854,41~~	~~39.588,99~~	
PLTDG Pesanggaran Blok 1 Unit 3	70.665,75	38.855,66	
PLTDG Pesanggaran Blok 2 Unit 4	80.368,13	44.292,51	
PLTDG Pesanggaran Blok 2 Unit 5	77.197,21	42.769,73	
PLTDG Pesanggaran Blok 2 Unit 6	79.005,72	43.254,91	
PLTDG Pesanggaran Blok 3 Unit 7	79.203,51	44.227,99	
PLTDG Pesanggaran Blok 3 Unit 8	71.647,39	39.755,85	
PLTDG Pesanggaran Blok 3 Unit 9	70.126,20	39.016,10	
PLTDG Pesanggaran Blok 4 Unit 10	72.927,48	40.113,03	
PLTDG Pesanggaran Blok 4 Unit 11	75.140,04	40.714,15	
PLTDG Pesanggaran Blok 4 Unit 12	81.415,65	45.692,13	
PLTGU_PTCL_GTG#10	36.870,90	28.498,02	
~~PLTU CELUKAN BAWANG 1~~	~~892.916,41~~	~~956.979,17~~	
PLTU CELUKAN BAWANG 2	840.037,78	902.656,72	
PLTU CELUKAN BAWANG 3	892.453,00	952.456,02	
Cilacap #3	3.284.315,00	3.341.410,94	
TANJUNG AWAR-AWAR UNIT 2	1.385.767,91	1.514.616,97	
~~UJP PLTU JAWA TENGAH 2 ADIPALA~~	~~1.865.680,37~~	~~1.785.392,65~~	
PLTU LBE #1	3.213.720,28	3.088.434,09	

7. Menghitung faktor emisi *Combined Margin* (CM)

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

$EF_{grid,OMsimple,2015,2016,2017}$ (tCO_2/MWh)	W_{OM} (%)	$EF_{grid,BM,2017}$ (tCO_2/MWh)	W_{BM} (%)	$EF_{grid,CM,2017}$ (tCO_2/MWh)
0,827	0,5	0,985	0,5	0,906
0,827	0,75	0,985	0,25	0,867

Appendix 5. Further background information on monitoring plan

Refer to section B.7.1

Appendix 6. Summary report of comments received from local stakeholders

Refer to section E.1 and E.2

Appendix 7. Summary of post-registration changes

No post registration changes

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Document information

Version	*Date*	*Description*
11.0	31 May 2019	Revision to: • Ensure consistency with version 02.0 of the “CDM project standard for project activities” (CDM-EB93-A04-STAN); • Make editorial improvements.
10.1	28 June 2017	Revision to make editorial improvement.
10.0	7 June 2017	Revision to: • Improve consistency with the “CDM project standard for project activities” and with the PoA-DD and CPA-DD forms; • Make editorial improvement.
09.0	24 May 2017	Revision to: • Ensure consistency with the “CDM project standard for project activities” (CDM-EB93-A04-STAN) (version 01.0); • Incorporate the “Project design document form for small-scale CDM project activities” (CDM-SSC-PDD-FORM); • Make editorial improvement.
08.0	22 July 2016	EB 90, Annex 1 Revision to include provisions related to automatically additional project activities.
07.0	15 April 2016	Revision to ensure consistency with the “Standard: Applicability of sectoral scopes” (CDM-EB88-A04-STAN) (version 01.0).
06.0	9 March 2015	Revision to: • Include provisions related to statement on erroneous inclusion of a CPA; • Include provisions related to delayed submission of a monitoring plan; • Provisions related to local stakeholder consultation; • Provisions related to the Host Party; • Make editorial improvement.

Version	*Date*	*Description*
05.0	25 June 2014	Revision to: • Include the Attachment: Instructions for filling out the project design document form for CDM project activities (these instructions supersede the "Guidelines for completing the project design document form" (Version 01.0)); • Include provisions related to standardized baselines; • Add contact information on a responsible person(s)/ entity(ies) for the application of the methodology (ies) to the project activity in B.7.4 and Appendix 1; • Change the reference number from F-CDM-PDD to CDM-PDD-FORM; • Make editorial improvement.
04.1	11 April 2012	Editorial revision to change version 02 line in history box from Annex 06 to Annex 06b.
04.0	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).
03.0	26 July 2006	EB 25, Annex 15
02.0	14 June 2004	EB 14, Annex 06b
01.0	03 August 2002	EB 05, Paragraph 12 Initial adoption.

Decision Class: Regulatory
Document Type: Form
Business Function: Registration
Keywords: project activities, project design document