

CAPACITY UPGRADE OF GUNUNG SALAK GEOTHERMAL POWER PLANT PROJECT, INDONESIA



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1 PROJECT DETAILS

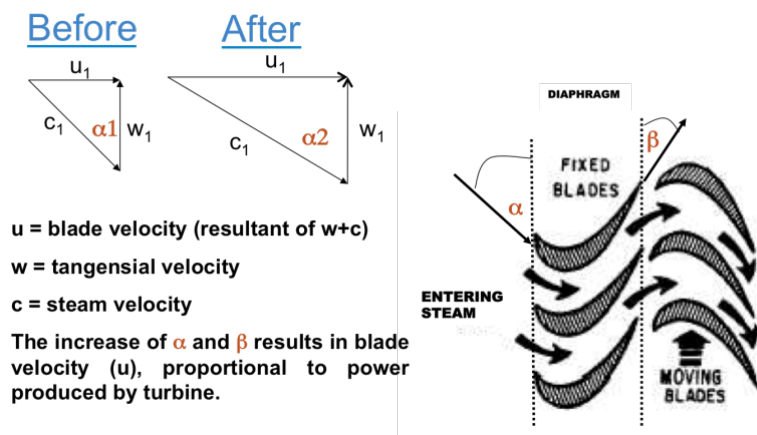
1.1 Summary Description of the Implementation Status of the Project

The project activity comprises of a capacity upgrade of Gunung Salak Geothermal Power Plant from 3 x 55 MW to 3 x 60 MW. The additional installed capacity of 15 MW at Gunung Salak Geothermal power plant generates and supplies an average of 213,959 MWh p.a. of electricity to the connected JAMALI Grid. The project is owned and developed by PT. Indonesia Power, a subsidiary company of PT. PLN (Persero), a state-owned electricity company. The proposed project will increase the utilization of renewable energy sources, in this case geothermal energy, by modifying turbines and steam gas ejectors. Steam for the project is provided by Chevron Geothermal Indonesia under an Energy Sales Contract (ESC) between PT. PLN (Persero) Pertamina, a state-owned oil and gas company, and Unocal Geothermal of Indonesia (Though today, Gunung Salak geothermal fields are owned by Chevron Geothermal Indonesia Ltd.).

The Capacity upgrade of Gunung Salak geothermal power plant project, Indonesia (referred later as the project activity) comprises of following modification¹ that has been undertaken to increase the steam flow, thus increasing the installed capacity of the power plant from 3 x 55 MW to 3 x 60 MW:

- Turbine modification, which means to modify first and second stage diaphragms by increasing nozzle size from $\alpha 1$ to $\alpha 2$ to allow steam turbine efficiency as shown in Graph 1.
- Ejector line replacement, which means to replace a smaller line of ejectors with a new design to increase the flow rate of Non-Condensable Gases (NCG) that is caused by an increase in steam flow due the project activity.

Figure 1. Nozzle increase in the diaphragms



The project does not modify and/or replace the whole power stations but only parts of their equipment. In the end, the project does not really change the established technology, which

¹ Contract for Off Shore Materials Supply for Power Up-Rating of Unit 1, 2, and 3 between PT. Indonesia Power and AnsaldoEnergiaSpA, dated on 22/07/2002.

consists of a steam turbine, electrical generators, a gas extraction system, a 150kV switchyard system, and a utility system. The project is using the same hot water-dominated steam characteristic from Gunung Salak Geothermal field, with a condensate re-injection well-system to maintain groundwater supply. However, the project utilizes a higher steam flow due to a capacity increase by modifying steam turbines.

1.2 Sectoral Scope and Project Type

According to the VCS, the project activity falls under the category of renewable energy projects (wind, PV, solar thermal, biomass, liquid bio-fuels, geothermal, and run-of-river hydro) with emission reductions between 5,000-1,000,000 tCO₂e per year. The project is not part of a grouped project.

According to the CDM UNFCCC criteria, one approved GHG program by the VCS Board, the project is classified as a large scale project, which falls under Sectoral Scope 1: Energy Industries (renewable/non-renewable).

1.3 Project Proponent

Project proponents contact information as follows:

Project owner:

Organization name	PT. Indonesia Power
Contact person	Eri Prabowo
Title	Director of Operation I
Address	Jl. Jenderal Gatot Subroto Kav. 18, Jakarta 12950, Indonesia
Telephone	+62-21-526 7666
Email	eri.prabowo@indonesiapower.co.id

Carbon Credit buyer:

Organization name	South Pole Carbon Asset Management Ltd.
Contact person	Renat Heuberger
Title	CEO
Address	Technoparkstrasse 1, Zurich 8005, Switzerland
Telephone	+41-43 501 35 50
Email	info@southpole.com

1.4 Other Entities Involved in the Project

Not applicable, as there are no other entities except PT. Indonesia Power and South Pole Carbon Asset Management Ltd.

1.5 Project Start Date

The project start date, when the power plant started to operate normally after the capacity upgrade performance test conducted by the technology provider and at the same time the project started to reduce GHG emissions:

Unit 1: 21/06/2005

Unit 2: 04/04/2005

Unit 3: 29/09/2004

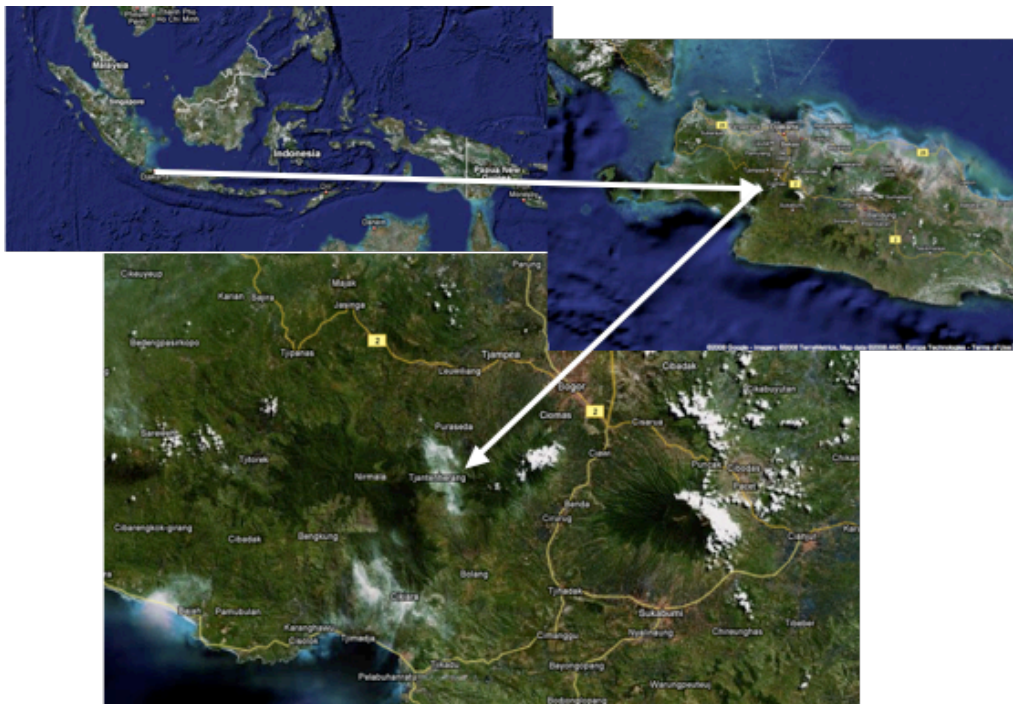
Thus, the project start date is 29/09/2004, as the earliest project start date of three units at Gunung Salak Geothermal Power Plant.

1.6 Project Crediting Period

The crediting period of this project activity is 10 years from 01/04/2016 until 31/03/2026.

1.7 Project Location

The project site is located in Awibengkok-Ratu area of Gunung Salak Geothermal field surrounded by Halimun Salak national park, which is administratively part of Bogor District and Sukabumi District, West Java Province, Indonesia. The project is located 988 m above sea level, approximately 82 km from Bogor and 58 km from Sukabumi. The exact location is 06° 44' 26" S, 106° 38' 28" E.



Source: Google Earth

1.8 Title and Reference of Methodology

The methodology applied for this project activity is

Type	:	I – Energy Industries (Renewable / Non Renewable Sources)
Category	:	ACM0002 “Consolidated methodology for grid-connected electricity generation from renewable sources”
Version	:	17.0

Further background information on the project activity can be found in the VCS Project Description (VCS PD) and associated documents, which had already been submitted for validation as per requirements of the Voluntary Carbon Standard, Version 3.7. The VCS PD and associated documents are available upon request.

1.9 Other Programs

Emission Trading Programs and Other Binding Limits: The project activity is not included in an emission trading program or any other mechanism that includes GHG allowance trading.

Other Forms of Environmental Credit: The project activity is not creating any other form of environmental credit under any specific program.

Participation under Other GHG Programs: The project activity is not registered under any other GHG program.

1.10 Sustainable Development

The project is contributing to sustainable development defined by the Government of Indonesia specifically as follows:

Social well-being:

- The project contributes to the development of the region by increasing community development and corporate social responsibility of PT. Indonesia Power.
- During the capacity upgrade and operation, there are various kinds of mechanical work, which generates employment on regular and permanent basis.

Economic well-being:

- The project activity generates employment in the local area.
- The project activity is a good investment in a developing region, which otherwise would not have happened in the absence of project activity.

- The generated electricity is fed into regional grids through the local grid, thereby improving the grid frequency and availability of electricity to the local consumers (villagers and sub-urban inhabitants), which will provide new opportunities for industries and economic activities to be setup in the area thereby resulting in greater local employment, ultimately leading to overall development.
- The project activity also leads to diversification of the national energy supply, which is dominated by conventional fuel based generating units.
- The project activity contributes to the economic sustainability around the plant sites, which is encouraging economic power decentralization.

Environmental well-being:

- The project utilizes geothermal power to generate electricity, which otherwise would have been generated through alternate fuel- (most likely fossil fuel-) based power plants, contributing to a reduction in specific emissions (emissions of pollutant/unit of energy generated) including GHG emissions.
- As geothermal power projects produce no end products in the form of solid waste (ash, etc.), they address the problem of solid waste disposal encountered by most other sources of power.
- Being a renewable energy source, geothermal energy is used to generate electricity that contributes to resource conservation.
- Thus, the project causes no negative impact on the surrounding environment; and in the end contributes to environmental well-being.

Technological well-being:

- The project supports technology transfer from other regions or even other countries, as well as contributes to capacity building of the labour force through trainings and practical works.
- The project promotes local products developed in the region, when replacement of spare parts is necessary, and supports renewable technology development especially for geothermal power technology.

In view of the above explanation, the project participants consider that the project activity profoundly contributes to sustainable development.

2 IMPLEMENTATION STATUS

2.1 Implementation Status of the Project Activity

As per VCS PD, the project activity includes Unit #1, Unit #2 and Unit #3 of Gunung Salak Geothermal Power Plant that were started to operate normally after the capacity upgrade

performance test conducted by the technology provider and at the same time the project started to reduce GHG emissions on following dates:

Unit #1: 21/06/2005

Unit #2: 04/04/2005

Unit #3: 29/09/2004

The project activity generates electricity, thus displaces electricity that would have been generated from predominantly fossil fuel based power generation.

During this 1st verification period from 01/04/2016 to 30/06/2017, the power plant is in operation continuously (with outages – forced and planned). The reasons for the planned and forced outages are due to earthquake, problem with the Bogor Baru Substation, problem with the condenser, maintenance outage, etc.

2.2 Deviations

2.2.1 Methodology Deviations

Not applicable as the project activity does not need any deviations of the methodology.

2.2.2 Project Description Deviations

Deviation of Monitoring Plan for parameter $EG_{\text{facility},y}$ due to applying Guidelines for assessing compliance with the calibration frequency requirements, (CDM VVS, Version 09.0 para 395 (a)) with details below:

As per validated VCS PD, PP must monitor parameter $EG_{\text{facility},y}$ and SOP for electricity metering scheme, revenue meter calibration should be conducted every 2 years. However, there was a calibration delay for revenue meter of Unit #1, Unit #2, and Unit #3 on 03/06/2016 until 29/07/2016. Based on Guidelines for assessing compliance with the calibration frequency requirements, (CDM VVS, Version 09.0 para 395 (a)) states that: "Applying the maximum permissible error of the instrument to the measured values, if the results of the delayed calibration do not show any errors in the measuring equipment, or if the error is smaller than the maximum permissible error;". Hence a maximum permissible error must be considered in BE_y calculation in case of the revenue meter calibration delay as per following formula:

$$\begin{aligned} & EG_{\text{exp}} \text{ (Electricity exported to the grid)} \\ &= EG_{\text{exp}} \times (100\% - \text{accuracy of revenue meter}) \\ &= EG_{\text{exp}} \times (100\% - 0.2\%) \end{aligned}$$

$$\begin{aligned} & EG_{\text{imp}} \text{ (Electricity imported from the grid)} \\ &= EG_{\text{imp}} \times (100\% + \text{accuracy of revenue meter}) \\ &= EG_{\text{imp}} \times (100\% + 0.2\%) \end{aligned}$$

2.3 Grouped Project

Not applicable as the project activity is not part of a grouped project.

2.4 Safeguards

2.4.1 No Net Harm

According to adjusted Gunung Salak geothermal power plant's Environmental Impact Assessment (EIA), a revised *RKL/RPL* (Environment Management Plan and Environment Monitoring Plan) for the additional installed capacity 3 x 5 MW.

The report clearly recognizes that impacts, if any, have been taking into account before and after the project activity as summarized in the letter No. 660.1/1801/II/2007 from the provincial Environmental Agency (*BPLHD*) of West Java to the project owner due capacity upgrade activity.

A summary of the environmental impacts of the project activity is described below:

<i>Identified Environmental impacts</i>	<i>Measures taken</i>
<i>Operational Phase</i>	
<i>Air Pollution</i>	
<i>An increase H₂S gas concentration</i>	Maintain sound operation of turbine and its system together with a fan and blower in the cooling tower.
<i>Noise Pollution</i>	
<i>An increase of noise</i>	Install a noise buffer and cover made from soundproof material for turbine and its system
<i>Water Pollution</i>	
<i>Surface water body pollution</i>	Re-inject waste water (condensates) from cooling tower to abandoned geothermal wells
<i>Post-operational phase</i>	
<i>Re-construction of power plant</i>	Will be planned 3 or 5 years before operational phase ends
<i>Transportation of ruins</i>	Will be planned 3 or 5 years before operational phase ends
<i>Re-vegetation of power plant ex-location</i>	Will be planned 3 or 5 years before operational phase ends

- Deterioration of air quality

During operational phase, some deterioration of air quality is expected to occur, especially an increase in H₂S gas released into the ambient air. The H₂S gas comes from the cooling tower during power plant operation, which emits non-condensable gases (NCG), and from the vent valve and scrubber if broken down.

To reduce this impact there will be regular maintenance and check ups for the turbine and system to prevent any H₂S gas leakage. In addition, the cooling tower must also be maintained regularly to decrease non-condensable gases (NCG) emission.

- Increased noise pollution

Increased noise pollution is expected from the turbine and its system during power plant operation.

To reduce the impact the project owner has installed a soundproof buffer and cover surrounding the turbine and its system to prevent any noise pollution to the environment.

- Deterioration of surface water quality

Minor deterioration of surface water quality due to the project activity is expected because of wastewater coming from the cooling tower.

To prevent any further increase, the project owner has managed to re-inject waste water (condensates) to abandoned geothermal wells.

Considering the mitigation controls planned as part of the project activity, EIA process and the contribution made by the project to the sustainable development of the local and national area, the project is expected to have an overall positive impact on the local and global environment. All negative environmental impacts will be described in the mitigation and monitoring plans.

2.4.2 Local Stakeholder Consultation

A meeting with relevant stakeholders, including the village chief and people who live nearby, within the project boundary of Gunung Salak geothermal power plant was conducted on September 25th, 2008 at Raudhatul Jannah Mosque, Parung Kuda, near the power plant. The stakeholder meeting was held together with the power plant's Ramadhan (fasting month) festival to inform the local stakeholders that the capacity upgrade project at the power plant would be registered as one of carbon credit projects. The local stakeholders who attended the meeting have no objections to the proposed activity. Furthermore, as documented in the revised EIA², the local stakeholders have perceived that Gunung Salak Geothermal Power Plant establishment has increased their social and economical life due to road construction, additional earning from temporary jobs, health services, and other pro-community activity.

The stakeholder meeting on September 25th, 2008 was documented and recorded like attendance list, pictures, and other relevant documentation, which will be made available to DOE and sent separately.

Outcome: No negative comments were received from the local stakeholders during the meeting. They did not object to the project activity because the project will not negatively impact the surrounding environment or people.

² The revised EIA is prepared to cover all environmental and social issue after the capacity upgrade of Gunung Salak geothermal power plant from 3x55 MW to 3x60 MW.

3 DATA AND PARAMETERS

3.1 Data and Parameters Available at Validation

Data / Parameter	EG _{historical}										
Data unit	MWh										
Description	Average net electricity delivered to the grid before the project activity until DATE _{BaselineRetrofit}										
Source of data	Project Owner-PLN revenue meter (electricity sales) Meter No. Unit #1: PS 0512A040-01 with class of accuracy 0.2 Unit #2: PS 0512A041-01 with class of accuracy 0.2 Unit #3: PS 0512A042-01 with class of accuracy 0.2 On 1 October 2008, the electricity sales flow meter was replaced by PT 0806A117-01 / PT 0806A118-01 / PT 0806A119-01.										
Value applied	<table border="1"> <thead> <tr> <th></th><th>EG_{historical} until DATE_{BaselineRetrofit} (MWh)</th></tr> </thead> <tbody> <tr> <td>Unit 1</td><td>393,791</td></tr> <tr> <td>Unit 2</td><td>380,210</td></tr> <tr> <td>Unit 3</td><td>391,623</td></tr> <tr> <td>Total</td><td>1,165,624</td></tr> </tbody> </table> The data above is based on an average of historical net electricity generation data recorded by PT. Indonesia Power since 1998-2004 for Unit 3 and 1996-2005 for Units 1 and 2.		EG _{historical} until DATE _{BaselineRetrofit} (MWh)	Unit 1	393,791	Unit 2	380,210	Unit 3	391,623	Total	1,165,624
	EG _{historical} until DATE _{BaselineRetrofit} (MWh)										
Unit 1	393,791										
Unit 2	380,210										
Unit 3	391,623										
Total	1,165,624										
Justification of choice of data or description of measurement methods and procedures applied	Electricity produced is measured by a watt-hour meter (connected to a digital control system and recorded continuously), which can measure both power delivered to the grid and received from the grid. Therefore, net electricity export is measured. The measurement of electricity generation is conducted on a continuous basis, where hourly and daily total electricity measurement will be available. The measurement results is summarised transparently in regular production reports.										
Purpose of Data	Calculation of baseline emissions										
Comments	Standard Operation Procedure signed between PT. Indonesia Power and PT PLN (load dispatcher) or other documents, which update or replace this SOP.										

Data / Parameter	$\sigma_{\text{historical}}$										
Data unit	MWh										
Description	Standard deviation of average net electricity delivered to the grid before the project activity until $\text{DATE}_{\text{BaselineRetrofit}}$										
Source of data	Statistical calculation of standard deviation of $\text{EG}_{\text{historical}}$										
Value applied	<table border="1"> <thead> <tr> <th></th><th>$\sigma_{\text{historical}}$ until $\text{DATE}_{\text{BaselineRetrofit}}$ (MWh)</th></tr> </thead> <tbody> <tr> <td>Unit 1</td><td>41,556</td></tr> <tr> <td>Unit 2</td><td>39,743</td></tr> <tr> <td>Unit 3</td><td>51,982</td></tr> <tr> <td>Total</td><td>133,281</td></tr> </tbody> </table> The data above is based on an average of historical net electricity generation data recorded by PT. Indonesia Power since 1998-2004 for Unit 3 and 1996-2005 for Units 1 and 2.		$\sigma_{\text{historical}}$ until $\text{DATE}_{\text{BaselineRetrofit}}$ (MWh)	Unit 1	41,556	Unit 2	39,743	Unit 3	51,982	Total	133,281
	$\sigma_{\text{historical}}$ until $\text{DATE}_{\text{BaselineRetrofit}}$ (MWh)										
Unit 1	41,556										
Unit 2	39,743										
Unit 3	51,982										
Total	133,281										
Justification of choice of data or description of measurement methods and procedures applied	Statistical calculation										
Purpose of Data	Calculation of baseline emissions										
Comments	-										

Data / Parameter	$\text{DATE}_{\text{BaselineRetrofit}}$
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	- Energy Sales Contract (ESC) for steam purchase contract mentioned that the project must be available to supply electricity until year of 2030 (and may elect to extend the term until year of 2040). - Geothermal industry practice is the typical average technical lifetime of geothermal power plant is 30-50 years (Matek, B. Geothermal Energy Association Issue Brief: Additional Economic Values of Geothermal Power, 2015, https://geo-energy.org/events/Geothermal%20Energy%20Association%20Issue%20Brief_Economic%20Values%202015_Final.pdf (accessed, 2017) / http://geo-energy.org/geo_basics_plant_cost.aspx (accessed, 2017))

	As a conclusion, the average technical lifetime for all units is 46 years, which means that all units will last during 46 years since its commissioning with regular and proper maintenance.												
Value applied	<table><tr><td></td><th>Commissioning Date</th><th>DATE_{BaselineRetrofit}</th></tr><tr><td>Unit 1</td><td>12 March 1994</td><td>12 March 2040</td></tr><tr><td>Unit 2</td><td>12 June 1994</td><td>12 June 2040</td></tr><tr><td>Unit 3</td><td>16 July 1997</td><td>16 July 2043</td></tr></table> The DATE_{BaselineRetrofit} comes from commissioning date of each unit added by the average technical lifetime of 46 years.		Commissioning Date	DATE _{BaselineRetrofit}	Unit 1	12 March 1994	12 March 2040	Unit 2	12 June 1994	12 June 2040	Unit 3	16 July 1997	16 July 2043
	Commissioning Date	DATE _{BaselineRetrofit}											
Unit 1	12 March 1994	12 March 2040											
Unit 2	12 June 1994	12 June 2040											
Unit 3	16 July 1997	16 July 2043											
Justification of choice of data or description of measurement methods and procedures applied	-												
Purpose of Data	Calculation of baseline emissions												
Comments	-												

Data / Parameter	GWP _{CH4}
Data unit	tCO ₂ /tCH ₄
Description	Global warming potential of methane, valid for the relevant commitment period
Source of data	IPCC
Value applied	Default value for the second commitment period = 25 tCO ₂ /tCH ₄ . (Updated required for source of global warming potentials from the IPCC's Second Assessment Report to the IPCC's Fourth Assessment Report)
Justification of choice of data or description of measurement methods and procedures applied	-
Purpose of Data	Calculation of project emissions
Comments	-

Data / Parameter	EF _{grid,OM,y}
Data unit	tCO ₂ /MWh
Description	EF _{grid,OM,y} is the average operating margin CO ₂ emission factor of power plant connected to the JAMALI electricity grid in 3 recent years available data, calculated using average OM method for each

	year in which the project generation occurs. During the crediting period, this factor is calculated based on ex-ante emissions by using year 2013, 2014 and 2015 data.
Source of data	Directorate General of Electricity - Ministry of Energy and Mineral Resources (MEMR), Republic of Indonesia
Value applied	$EF_{grid,OM,y} = 0.786 \text{ tCO}_2/\text{MWh}$
Justification of choice of data or description of measurement methods and procedures applied	No measurement required. Data is obtained based on analysis of MEMR published information.
Purpose of Data	Calculation of baseline emissions
Comments	All data relevant for the calculation of $EF_{grid,OM,y}$ are updated annually. This includes each associated fuel emission factor and corresponding net calorific values, is re-defined annually.

Data / Parameter	$EF_{grid,BM,y}$
Data unit	tCO_2/MWh
Description	$EF_{grid,BM,y}$ is the build margin CO_2 emission factor of power plants in the sample group 'm' connected to the JAMALI electricity grid in year 'y'. During the crediting period, this factor is calculated based on ex-ante emissions by using year 2015 data.
Source of data	Directorate General of Electricity - Ministry of Energy and Mineral Resources (MEMR), Republic of Indonesia
Value applied	$EF_{grid,BM,y} = 0.999 \text{ tCO}_2/\text{MWh}$
Justification of choice of data or description of measurement methods and procedures applied	No measurement required. Data is obtained based on analysis of MEMR published information.
Purpose of Data	Calculation of baseline emissions
Comments	All data relevant for the calculation of $EF_{grid,BM,y}$ are updated annually. This includes each associated fuel emission factor and corresponding net calorific values, as well as sample group "m" power plants (its associated generation and fuel consumption data), is re-defined annually.

Data / Parameter	$EF_{grid,CM,y}$
Data unit	tCO_2/MWh
Description	$EF_{grid,CM,y}$ is the combined margin CO_2 emission factor of power plants connected to the JAMALI electricity grid in year 'y', calculated ex-ante based on the weighted average of $EF_{grid,OM,y}$ and $EF_{grid,BM,y}$.

	As per UNFCCC Methodological tool: Tool to calculate the emission factor for an electricity system v05.0, the following default values should be used for w_{OM} and w_{BM} (for all projects except for wind and solar power generation project activities): $w_{OM} = 0.5$ and $w_{BM} = 0.5$ for the first crediting period, and $w_{OM} = 0.25$ and $w_{BM} = 0.75$ for the second and third crediting period, unless otherwise specified in the approved methodology which refers to this tool.
Source of data	Calculation
Value applied	$EF_{grid,CM,y} = 0.946 \text{ tCO}_2/\text{MWh}$
Justification of choice of data or description of measurement methods and procedures applied	No measurement required. Data is obtained based on analysis of MEMR published information.
Purpose of Data	Calculation of baseline emissions
Comments	-

3.2 Data and Parameters Monitored

Data / Parameter	M _{steam,y}															
Data unit	t steam															
Description	Quantity of steam produced during the year 'y'															
Source of data	Project Owner-main steam line flow meter															
Description of measurement methods and procedures to be applied	The measurement of steam quantities is conducted on a continuous basis, where hourly steam flow is available in paper format. The measurement results are summarized in electronic format as part of monitoring plan.															
Frequency of monitoring/recording	Steam flow is hourly measured and recorded in paper format. Subsequently, the data is aggregated yearly in electronic format.															
Value applied	<table><tr><td></td><td colspan="2">Steam produced during the year 'y' (t steam/year)</td></tr><tr><td></td><td>01/04/2016 - 31/12/2016</td><td>01/01/2017 - 30/06/2017</td></tr><tr><td>Unit 1</td><td>2,899,654.89</td><td>2,033,459.00</td></tr><tr><td>Unit 2</td><td>2,799,774.53</td><td>2,088,628.60</td></tr><tr><td>Unit 3</td><td>2,728,387.30</td><td>1,300,925.50</td></tr></table> Based on information of steam flow calibration details, there were no delay in performing steam flow calibration Unit #1, #2, and #3. The data above is based on Steam log sheet document under Steam flow column manually recorded by PT. Indonesia Power.		Steam produced during the year 'y' (t steam/year)			01/04/2016 - 31/12/2016	01/01/2017 - 30/06/2017	Unit 1	2,899,654.89	2,033,459.00	Unit 2	2,799,774.53	2,088,628.60	Unit 3	2,728,387.30	1,300,925.50
	Steam produced during the year 'y' (t steam/year)															
	01/04/2016 - 31/12/2016	01/01/2017 - 30/06/2017														
Unit 1	2,899,654.89	2,033,459.00														
Unit 2	2,799,774.53	2,088,628.60														
Unit 3	2,728,387.30	1,300,925.50														

	Steam quantities based on underlying project boundary (steam attributable to the project's capacity upgrade) <table><tr><td></td><td colspan="2">Steam produced during the year 'y' (t steam/year)</td></tr><tr><td></td><td>01/04/2016 - 31/12/2016</td><td>01/01/2017 - 30/06/2017</td></tr><tr><td>Unit 1</td><td>236,329.23</td><td>149,271.82</td></tr><tr><td>Unit 2</td><td>305,230.03</td><td>276,341.56</td></tr><tr><td>Unit 3</td><td>231,171.61</td><td>84,417.71</td></tr></table> Steam quantities based on underlying project boundary are calculated based on the Specific Steam Consumption (SSC).		Steam produced during the year 'y' (t steam/year)			01/04/2016 - 31/12/2016	01/01/2017 - 30/06/2017	Unit 1	236,329.23	149,271.82	Unit 2	305,230.03	276,341.56	Unit 3	231,171.61	84,417.71							
	Steam produced during the year 'y' (t steam/year)																						
	01/04/2016 - 31/12/2016	01/01/2017 - 30/06/2017																					
Unit 1	236,329.23	149,271.82																					
Unit 2	305,230.03	276,341.56																					
Unit 3	231,171.61	84,417.71																					
Monitoring equipment	<table><tr><td></td><td colspan="3">Steam flow meter</td></tr><tr><td></td><td>Type & Accuracy Class</td><td>Serial Number</td><td>Calibration Details</td></tr><tr><td rowspan="2">Unit 1</td><td> - Type: Endress+Hausser FMD78 - Accuracy Class: 0.25% </td><td>H400C50109D</td><td>Previous: 13/07/2015 13/07/2016</td></tr><tr><td> - Type: GE PanaFlow MV82 - Accuracy Class: 2% </td><td>4987429-2</td><td>Previous: 27/12/2016 Current: 30/05/2017 Next: 30/05/2018</td></tr><tr><td rowspan="2">Unit 2</td><td> - Type: ABB Kent – Taylor KDC/SJSTSLB16 2Q - M100007 - Accuracy Class: 0.25% </td><td>1594052708</td><td>Previous: 13/07/2015 13/07/2016</td></tr><tr><td> - Type: GE PanaFlow MV82 - Accuracy Class: 2% </td><td>4987429-1</td><td>Previous: 29/08/2016 Current: 30/05/2017 Next: 30/05/2018</td></tr></table>		Steam flow meter				Type & Accuracy Class	Serial Number	Calibration Details	Unit 1	- Type: Endress+Hausser FMD78 - Accuracy Class: 0.25%	H400C50109D	Previous: 13/07/2015 13/07/2016	- Type: GE PanaFlow MV82 - Accuracy Class: 2%	4987429-2	Previous: 27/12/2016 Current: 30/05/2017 Next: 30/05/2018	Unit 2	- Type: ABB Kent – Taylor KDC/SJSTSLB16 2Q - M100007 - Accuracy Class: 0.25%	1594052708	Previous: 13/07/2015 13/07/2016	- Type: GE PanaFlow MV82 - Accuracy Class: 2%	4987429-1	Previous: 29/08/2016 Current: 30/05/2017 Next: 30/05/2018
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	- Type: GE PanaFlow MV82 - Accuracy Class: 2%	4987429-2	Previous: 27/12/2016 Current: 30/05/2017 Next: 30/05/2018																				
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	- Type: GE PanaFlow MV82 - Accuracy Class: 2%	4987429-1	Previous: 29/08/2016 Current: 30/05/2017 Next: 30/05/2018																				

	<table><tr><td>Unit 3</td><td> - Type: Endress+Hausser FMD78 - Accuracy Class: 0.25% </td><td>D404420109D</td><td>Previous: 14/07/2015 Current: 13/07/2016 Next: 13/07/2017</td></tr></table>	Unit 3	- Type: Endress+Hausser FMD78 - Accuracy Class: 0.25%	D404420109D	Previous: 14/07/2015 Current: 13/07/2016 Next: 13/07/2017																																							
Unit 3	- Type: Endress+Hausser FMD78 - Accuracy Class: 0.25%	D404420109D	Previous: 14/07/2015 Current: 13/07/2016 Next: 13/07/2017																																									
QA/QC procedures to be applied	Meters is maintained and periodically calibrated internally to ensure accurate readings. As part of the QA/QC procedure a backup check calculation (to be used during emergencies such as trip, scaling in the steam pipeline, etc.) is performed in addition to the primary venturi flow meter measurement.																																											
Purpose of data	Calculation of project emissions																																											
Calculation method	- Specific Steam Consumption (SSC) calculation: $SSC = \frac{\text{Steam flowrate (t steam)}}{\text{Net power output of the plant (MWh)}}$<table><tr><th colspan="4">01/04/2016 - 31/12/2016</th></tr><tr><th></th><th>Steam flowrate (t steam)</th><th>Net power output of the plant (MWh)</th><th>SSC (t steam/MWh)</th></tr><tr><td>Unit 1</td><td>2,899,654.89</td><td>352,803.91</td><td>8.219</td></tr><tr><td>Unit 2</td><td>2,799,774.53</td><td>330,173.52</td><td>8.480</td></tr><tr><td>Unit 3</td><td>2,728,387.30</td><td>367,375.88</td><td>7.427</td></tr></table> <table><tr><th colspan="4">01/01/2017 - 30/06/2017</th></tr><tr><th></th><th>Steam flowrate (t steam)</th><th>Net power output of the plant (MWh)</th><th>SSC (t steam/MWh)</th></tr><tr><td>Unit 1</td><td>2,033,459.00</td><td>234,906.68</td><td>8.656</td></tr><tr><td>Unit 2</td><td>2,088,628.60</td><td>241,979.23</td><td>8.631</td></tr><tr><td>Unit 3</td><td>1,300,925.50</td><td>172,317.51</td><td>7.550</td></tr></table> - Steam quantities based on underlying project boundary calculation is SSC times the attributable electricity generation to VCS Project ($EG_{PJ,y}$)				01/04/2016 - 31/12/2016					Steam flowrate (t steam)	Net power output of the plant (MWh)	SSC (t steam/MWh)	Unit 1	2,899,654.89	352,803.91	8.219	Unit 2	2,799,774.53	330,173.52	8.480	Unit 3	2,728,387.30	367,375.88	7.427	01/01/2017 - 30/06/2017					Steam flowrate (t steam)	Net power output of the plant (MWh)	SSC (t steam/MWh)	Unit 1	2,033,459.00	234,906.68	8.656	Unit 2	2,088,628.60	241,979.23	8.631	Unit 3	1,300,925.50	172,317.51	7.550
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	01/04/2016 - 31/12/2016		
	SSC (t steam/MWh)	Attributable electricity generation to VCS Project (EG _{PJ,y}) (MWh)	Steam quantities based on underlying project boundary (t steam)
	Unit 1	8.219	28,731
	Unit 2	8.480	35,794
	Unit 3	7.427	31,378
	01/01/2017 - 30/06/2017		
	SSC (t steam/MWh)	Attributable electricity generation to VCS Project (EG _{PJ,y}) (MWh)	Steam quantities based on underlying project boundary (t steam)
	Unit 1	8.656	17,233
	Unit 2	8.631	32,002
	Unit 3	7.550	11,192
.			
Comments	Continuous measurement, subsequently, the data will be aggregated monthly.		

Data / Parameter	W _{steam,CO2,y}
Data unit	t CO ₂ /t steam
Description	Average mass fraction of CO ₂ in the produced steam in year y
Source of data	The Non-Condensable Gases (NCG) data taken from steam sampling as prescribed in the Monitoring Methodology ACM0002 version 17.0
Description of measurement methods	Non-condensable gases sampling should be carried out at the steam field-power plant interface using ASTM Standard Practice

and procedures to be applied	E1675 for Sampling 2-Phase Geothermal Fluid for Purposes of Chemical Analysis (as applicable to sampling phase steam only) as prescribed in the Monitoring Methodology ACM0002 version 17.0. The Non-Condensable Gases (NCG) sampling and analysis is performed every three months, after the project is validated, by PT. Geoservices (Ltd) with a supervision of Gunung Salak Geothermal Power Plant Laboratory.																																																																																						
Frequency of monitoring/recording	Every three months																																																																																						
Value applied	<table><tr><th rowspan="2">Analysis #</th><th>Period to be used in $PE_{flash\ steam,y}$ calculation</th><th colspan="3">CO₂ values to be used in $PE_{flash\ steam,y}$ calculation (non dimensional)</th></tr><tr><th>Month/Year</th><th>UNIT #1</th><th>UNIT #2</th><th>UNIT #3</th></tr><tr><td rowspan="3">1</td><td>04/2016</td><td>0.0042595960</td><td>0.0049315970</td><td>0.0054052530</td></tr><tr><td>05/2016</td><td>0.0042595960</td><td>0.0049315970</td><td>0.0054052530</td></tr><tr><td>06/2016</td><td>0.0042595960</td><td>0.0049315970</td><td>0.0054052530</td></tr><tr><td rowspan="3">2</td><td>07/2016</td><td>0.0052319300</td><td>0.0052687800</td><td>0.0061582300</td></tr><tr><td>08/2016</td><td>0.0052319300</td><td>0.0052687800</td><td>0.0061582300</td></tr><tr><td>09/2016</td><td>0.0052319300</td><td>0.0052687800</td><td>0.0061582300</td></tr><tr><td rowspan="3">3</td><td>10/2016</td><td>0.0052319300</td><td>0.0052687800</td><td>0.0061582300</td></tr><tr><td>11/2016</td><td>0.0052319300</td><td>0.0052687800</td><td>0.0061582300</td></tr><tr><td>12/2016</td><td>0.0040278960</td><td>0.0042920100</td><td>0.0048822800</td></tr><tr><td rowspan="3">4</td><td>01/2017</td><td>0.0052319300</td><td>0.0052687800</td><td>0.0061582300</td></tr><tr><td>02/2017</td><td>0.0052319300</td><td>0.0052687800</td><td>0.0061582300</td></tr><tr><td>03/2017</td><td>0.0052319300</td><td>0.0052687800</td><td>0.0061582300</td></tr><tr><td rowspan="3">5 & 5A</td><td>04/2017</td><td>0.0037977200</td><td>0.0048050500</td><td>0.0061582300</td></tr><tr><td>05/2017</td><td>0.0037977200</td><td>0.0048050500</td><td>0.0048461730</td></tr><tr><td>06/2017</td><td>0.0037977200</td><td>0.0048050500</td><td>0.0048461730</td></tr></table> Notes: <table><tr><td></td><td>Unit #1</td><td>Unit #2</td><td>Unit #3</td></tr><tr><td>Max CO₂ value</td><td>0.0052319300</td><td>0.0052687800</td><td>0.0061582300</td></tr></table> Unit #1: The highest CO ₂ weight fraction value is 0.0052319300 This value is deemed the most conservative value to be used in year 2016 (month of July, October, and November), and year 2017 (month of January until March) when there were delays in NCG analysis. Unit #2: The highest CO ₂ weight fraction value is 0.0052687800 This value is deemed the most conservative value to be used in year 2016 (month of July, October, and November), and year 2017					Analysis #	Period to be used in $PE_{flash\ steam,y}$ calculation	CO ₂ values to be used in $PE_{flash\ steam,y}$ calculation (non dimensional)			Month/Year	UNIT #1	UNIT #2	UNIT #3	1	04/2016	0.0042595960	0.0049315970	0.0054052530	05/2016	0.0042595960	0.0049315970	0.0054052530	06/2016	0.0042595960	0.0049315970	0.0054052530	2	07/2016	0.0052319300	0.0052687800	0.0061582300	08/2016	0.0052319300	0.0052687800	0.0061582300	09/2016	0.0052319300	0.0052687800	0.0061582300	3	10/2016	0.0052319300	0.0052687800	0.0061582300	11/2016	0.0052319300	0.0052687800	0.0061582300	12/2016	0.0040278960	0.0042920100	0.0048822800	4	01/2017	0.0052319300	0.0052687800	0.0061582300	02/2017	0.0052319300	0.0052687800	0.0061582300	03/2017	0.0052319300	0.0052687800	0.0061582300	5 & 5A	04/2017	0.0037977200	0.0048050500	0.0061582300	05/2017	0.0037977200	0.0048050500	0.0048461730	06/2017	0.0037977200	0.0048050500	0.0048461730		Unit #1	Unit #2	Unit #3	Max CO ₂ value	0.0052319300	0.0052687800	0.0061582300
Analysis #	Period to be used in $PE_{flash\ steam,y}$ calculation	CO ₂ values to be used in $PE_{flash\ steam,y}$ calculation (non dimensional)																																																																																					
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5 & 5A	04/2017	0.0037977200	0.0048050500	0.0061582300																																																																																			
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	Unit #1	Unit #2	Unit #3																																																																																				
Max CO ₂ value	0.0052319300	0.0052687800	0.0061582300																																																																																				

	(month of January until March) when there were delays in NCG analysis. Unit #3: The highest CO₂ weight fraction value is 0.0061582300 This value is deemed the most conservative value to be used in year 2016 (month of July, October, and November), and year 2017 (month of January until April) when there were delays in NCG analysis. As per monitoring plan of VCS PD, NCG analysis must be conducted every 3 months. Planning and realization date table as following: <table><tr><th colspan="3">NCG Analysis</th></tr><tr><th>Analysis #</th><th>Planned date</th><th>Realization date</th></tr><tr><td>1</td><td>23/03/2016</td><td>15/03/2016</td></tr><tr><td>2</td><td>23/06/2016</td><td>19/07/2016</td></tr><tr><td>3</td><td>23/09/2016</td><td>14/11/2016</td></tr><tr><td>4</td><td>23/12/2016</td><td>-</td></tr><tr><td>5 (Unit #1 & #2)</td><td>23/03/2017</td><td>10/03/2017</td></tr><tr><td>5A (Unit #3)</td><td>23/03/2017</td><td>25/04/2017</td></tr></table> NCG analysis is conducted as per 3-months schedule, except in in year 2016 (month of July, October, and November), and year 2017 (month of January until March) for Unit #1 and #2, in year 2016 (month of July, October, and November), and year 2017 (month of January until April) for Unit #3, when there were delays in NCG analysis.	NCG Analysis			Analysis #	Planned date	Realization date	1	23/03/2016	15/03/2016	2	23/06/2016	19/07/2016	3	23/09/2016	14/11/2016	4	23/12/2016	-	5 (Unit #1 & #2)	23/03/2017	10/03/2017	5A (Unit #3)	23/03/2017	25/04/2017
NCG Analysis																									
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1	23/03/2016	15/03/2016																							
2	23/06/2016	19/07/2016																							
3	23/09/2016	14/11/2016																							
4	23/12/2016	-																							
5 (Unit #1 & #2)	23/03/2017	10/03/2017																							
5A (Unit #3)	23/03/2017	25/04/2017																							
Monitoring equipment	Equipment's monitored as per Monitoring Methodology ACM0002 version 17.0.																								
QA/QC procedures to be applied	Gunung Salak Geothermal Laboratory QA/QC Procedure																								
Purpose of data	Calculation of project emissions																								
Calculation method	-																								
Comments	-																								

Data / Parameter	W _{steam,CH4,y}																																																																																		
Data unit	t CH ₄ /t steam																																																																																		
Description	Average mass fraction of CH ₄ in the produced steam in year y																																																																																		
Source of data	The Non-Condensable Gases (NCG) data taken from steam sampling as prescribed in the Monitoring Methodology ACM0002 version 17.0																																																																																		
Description of measurement methods and procedures to be applied	Non-condensable gases sampling should be carried out 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 phase steam only) as prescribed in the Monitoring Methodology ACM0002 version 17.0. The Non-Condensable Gases (NCG) sampling and analysis is performed every three months, after the project is validated, by PT. Geoservices (Ltd) with a supervision of Gunung Salak Geothermal Power Plant Laboratory.																																																																																		
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Analysis #	Period to be used in PE _{flash steam,y} calculation		CH ₄ values to be used in PE _{flash steam,y} calculation (non dimensional)																																																																																
	Month/Year	UNIT #1	UNIT #2	UNIT #3																																																																															
1	04/2016	0.0000002200	0.0000009116	0.0000015333																																																																															
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2	07/2016	0.0000986162	0.0000627210	0.0000979004																																																																															
	08/2016	0.0000246785	0.0000156145	0.0000305890																																																																															
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	Unit #1	Unit #2	Unit #3																																																																																
Max CH ₄ value	0.0000986162	0.0000627210	0.0000979004																																																																																

	Unit #1: The highest CH₄ weight fraction value is 0.0000986162 This value is deemed the most conservative value to be used in year 2016 (month of July, October, and November), and year 2017 (month of January until March) when there were delays in NCG analysis. Unit #2: The highest CH₄ weight fraction value is 0.0000627210 This value is deemed the most conservative value to be used in year 2016 (month of July, October, and November), and year 2017 (month of January until March) when there were delays in NCG analysis. Unit #3: The highest CH₄ weight fraction value is 0.0000979004 This value is deemed the most conservative value to be used in year 2016 (month of July, October, and November), and year 2017 (month of January until April) when there were delays in NCG analysis. As per monitoring plan of VCS PD, NCG analysis must be conducted every 3 months. Planning and realization date table as following: <table><tr><th colspan="3">NCG Analysis</th></tr><tr><th>Analysis #</th><th>Planned date</th><th>Realization date</th></tr><tr><td>1</td><td>23/03/2016</td><td>15/03/2016</td></tr><tr><td>2</td><td>23/06/2016</td><td>19/07/2016</td></tr><tr><td>3</td><td>23/09/2016</td><td>14/11/2016</td></tr><tr><td>4</td><td>23/12/2016</td><td>-</td></tr><tr><td>5 (Unit #1 & #2)</td><td>23/03/2017</td><td>10/03/2017</td></tr><tr><td>5A (Unit #3)</td><td>23/03/2017</td><td>25/04/2017</td></tr></table> NCG analysis is conducted as per 3-months schedule, except in in year 2016 (month of July, October, and November), and year 2017 (month of January until March) for Unit #1 and #2, in year 2016 (month of July, October, and November), and year 2017 (month of January until April) for Unit #3, when there were delays in NCG analysis.	NCG Analysis			Analysis #	Planned date	Realization date	1	23/03/2016	15/03/2016	2	23/06/2016	19/07/2016	3	23/09/2016	14/11/2016	4	23/12/2016	-	5 (Unit #1 & #2)	23/03/2017	10/03/2017	5A (Unit #3)	23/03/2017	25/04/2017
NCG Analysis																									
Analysis #	Planned date	Realization date																							
1	23/03/2016	15/03/2016																							
2	23/06/2016	19/07/2016																							
3	23/09/2016	14/11/2016																							
4	23/12/2016	-																							
5 (Unit #1 & #2)	23/03/2017	10/03/2017																							
5A (Unit #3)	23/03/2017	25/04/2017																							
Monitoring equipment	Equipment’s monitored as per Monitoring Methodology ACM0002 version 17.0.																								

QA/QC procedures to be applied	Gunung Salak Geothermal Laboratory QA/QC Procedure
Purpose of data	Calculation of project emissions
Calculation method	-
Comments	-

Data / Parameter	EG _{facility,y}																		
Data unit	MWh																		
Description	Net electricity delivered to the grid by the project activity																		
Source of data	Project Owner-PLN revenue meter (electricity sales)																		
Description of measurement methods and procedures to be applied	Electricity produced is measured by a watt-hour meter (connected to a digital control system and recorded continuously), which can measure both power delivered to the grid and received from the grid. Therefore, net electricity export is measured. The measurement of electricity generation is conducted on a continuous basis, where hourly and daily total electricity measurement is available. The measurement results are summarized transparently in electronic format as part of monitoring plan. While, electricity invoices (in this sense, the Energy Statement Transaction) are compiled in paper format.																		
Frequency of monitoring/recording	The measurement of electricity generation is conducted on a continuous basis, where hourly and daily total electricity measurement is available.																		
Value applied	<table><tr><th></th><th colspan="2">EG_{facility,y} (MWh)</th></tr><tr><th></th><th>01/04/2016 - 31/12/2016</th><th>01/01/2017 - 30/06/2017</th></tr><tr><td>Unit 1</td><td>352,804</td><td>234,907</td></tr><tr><td>Unit 2</td><td>330,174</td><td>241,979</td></tr><tr><td>Unit 3</td><td>364,229</td><td>172,305</td></tr><tr><td>Total</td><td>1,047,206</td><td>649,191</td></tr></table> As per monitoring plan of VCS PD and SOP for electricity metering scheme, revenue meter calibration should be conducted every 2 years. However, there was a calibration delay for revenue meter of Unit #1, Unit #2, and Unit #3 on 03/06/2016 until 29/07/2016. Based on the UNFCCC “CDM validation and verification standard for project activities” v.01.0, where described that a maximum		EG _{facility,y} (MWh)			01/04/2016 - 31/12/2016	01/01/2017 - 30/06/2017	Unit 1	352,804	234,907	Unit 2	330,174	241,979	Unit 3	364,229	172,305	Total	1,047,206	649,191
	EG _{facility,y} (MWh)																		
	01/04/2016 - 31/12/2016	01/01/2017 - 30/06/2017																	
Unit 1	352,804	234,907																	
Unit 2	330,174	241,979																	
Unit 3	364,229	172,305																	
Total	1,047,206	649,191																	

	permissible error must be considered in BE_y calculation in case of the revenue meter calibration delay as per following formula: EG_{exp} (Electricity exported to the grid) = EG_{exp} x (100% - accuracy of revenue meter) = EG_{exp} x (100% - 0.2%) EG_{imp} (Electricity imported from the grid) = EG_{imp} x (100% + accuracy of revenue meter) = EG_{imp} x (100% + 0.2%) Therefore, net electricity generation (EG_{facility,y}) values used in the ER calculation as following table: <table><tr><th colspan="3">EG_{facility,y} (MWh)</th></tr><tr><th></th><th>01/04/2016 - 31/12/2016</th><th>01/01/2017 - 30/06/2017</th></tr><tr><td>Unit 1</td><td>352,656</td><td>234,907</td></tr><tr><td>Unit 2</td><td>330,055</td><td>241,979</td></tr><tr><td>Unit 3</td><td>364,082</td><td>172,305</td></tr><tr><td>Total</td><td>1,046,793</td><td>649,191</td></tr></table>	EG _{facility,y} (MWh)				01/04/2016 - 31/12/2016	01/01/2017 - 30/06/2017	Unit 1	352,656	234,907	Unit 2	330,055	241,979	Unit 3	364,082	172,305	Total	1,046,793	649,191
EG _{facility,y} (MWh)																			
	01/04/2016 - 31/12/2016	01/01/2017 - 30/06/2017																	
Unit 1	352,656	234,907																	
Unit 2	330,055	241,979																	
Unit 3	364,082	172,305																	
Total	1,046,793	649,191																	
Monitoring equipment	Revenue meters used between 01/04/2016 – 30/06/2017 are: <table><tr><th>Revenue meter</th><th>Serial number</th><th>Class of Accuracy</th><th>Calibration date</th></tr><tr><td>Unit #1</td><td>PT 0806A119-01</td><td>0.2</td><td>Previous: 03/06/2014 Current: 29/07/2016 Next: 29/07/2018</td></tr><tr><td>Unit #2</td><td>PT 0806A118-01</td><td>0.2</td><td>Previous: 03/06/2014 Current: 29/07/2016 Next: 29/07/2018</td></tr><tr><td>Unit #3</td><td>MT 1006A500-01</td><td>0.2</td><td>Previous:</td></tr></table>	Revenue meter	Serial number	Class of Accuracy	Calibration date	Unit #1	PT 0806A119-01	0.2	Previous: 03/06/2014 Current: 29/07/2016 Next: 29/07/2018	Unit #2	PT 0806A118-01	0.2	Previous: 03/06/2014 Current: 29/07/2016 Next: 29/07/2018	Unit #3	MT 1006A500-01	0.2	Previous:		
Revenue meter	Serial number	Class of Accuracy	Calibration date																
Unit #1	PT 0806A119-01	0.2	Previous: 03/06/2014 Current: 29/07/2016 Next: 29/07/2018																
Unit #2	PT 0806A118-01	0.2	Previous: 03/06/2014 Current: 29/07/2016 Next: 29/07/2018																
Unit #3	MT 1006A500-01	0.2	Previous:																

				03/06/2014 Current: 29/07/2016 Next: 29/07/2018
QA/QC procedures to be applied	The QA/QC is conducted through cross checking with sales electricity receipts. Revenue meters are calibrated once per 2 years according to the PPA signed between PT. Indonesia Power and PLN (load dispatcher) or other documents, which update or replace this PPA except for PLN owned back up meters calibration, which follows PLN's internal regulations³. Data measured by meters is cross-checked by electricity sales receipt. The meter (s) will either: i) be read frequently jointly by the project developer and the grid company ii) be only read by the project developer and data will be double checked with the electricity sales receipts iii) be only read by the grid company			
Purpose of data	Calculation of baseline emissions			
Calculation method	• $EG_{\text{facility}} = EG_{\text{exp}} - EG_{\text{imp}}$ • $EG_{\text{PJ},y} = EG_{\text{facility},y} - (EG_{\text{historical}} + \sigma_{\text{historical}}); \text{until DATE}_{\text{BaselineRetrofit}}$ • In case $EG_{\text{facility},y} < (EG_{\text{historical}} + \sigma_{\text{historical}})$ in a year y then $EG_{\text{PJ},y} = 0$			
Comments	PPA signed between PT. Indonesia Power and PT PLN (load dispatcher) or other documents, which update or replace this PPA. Since June 2011, an updated SOP of Metering System is applied replacing the previous SOP dated on January 23rd, 2003.			

Table 1. Technical details of monitoring instruments

S.No	Equipment	Description
1.	Electricity Revenue Meter Unit #1	Name: Static Energy Meter

³ The calibration frequency of PLN-owned back-up meter is every 5 years. This complies with the Minister of Energy and Mineral Resources Regulation No. 3 issued in 2007 (<http://portal.djmbp.esdm.go.id/sjih/permen-esdm-03-2007.pdf>) regarding Java-Madura-Bali (JAMALI) Grid Code that described calibration period of installed meters in power plants connected to JAMALI Grid is once per 5 years.

S.No	Equipment	Description
	(03/06/2014 at 10:01 AM - onwards) For $EG_{\text{facility},y}$, EG_{exp} , and EG_{imp}	Manufacturer: Schneider Electric Type: ION 8600 Unit #1: PT 0806A118-01 Class of Accuracy: 0.2 Date of Calibration: 03/06/2014 ; 29/07/2016 Range: 0.05 - 20 A; 57 - 277 V; 50 Hz
2.	Electricity Revenue Meter Unit #2 (03/06/2014 at 10:01 AM - onwards) For $EG_{\text{facility},y}$, EG_{exp} , and EG_{imp}	Name: Static Energy Meter Manufacturer: Schneider Electric Type: ION 8600 Unit #1: PT 0806A119-01 Class of Accuracy: 0.2 Date of Calibration: 03/06/2014 ; 29/07/2016 Range: 0.05 - 20 A; 57 - 277 V; 50 Hz
3.	Electricity Revenue Meter Unit #3 (03/06/2014 at 10:01 AM - onwards) For $EG_{\text{facility},y}$, EG_{exp} , and EG_{imp}	Name: Static Energy Meter Manufacturer: Schneider Electric Type: ION 8600 Unit #1: MT 1006A500-01 Class of Accuracy: 0.2 Date of Calibration: 03/06/2014 ; 29/07/2016 Range: 0.05 - 20 A; 57 - 277 V; 50 Hz
4.	Electricity Back-up Meter Unit #1 (01/04/2016 at 10:01 AM - onwards) For back-up $EG_{\text{facility},y}$, EG_{exp} , and EG_{imp}	Name: Static Energy Meter Manufacturer: Schneider Electric Type: ION 8600 Unit #1: MT 1009A635-01 Class of Accuracy: 0.2 Date of Calibration: 05/03/2015 Range: 0.05 - 20 A; 57 - 277 V; 50 Hz
5.	Electricity Back-up Meter Unit #2 (01/04/2016 at 10:01 AM - onwards) For back-up $EG_{\text{facility},y}$, EG_{exp} , and EG_{imp}	Name: Static Energy Meter Manufacturer: Schneider Electric Type: ION 8600 Unit #1: PT 0802A471-01 Class of Accuracy: 0.2 Date of Calibration: 05/03/2015 Range: 0.05 - 20 A; 57 - 277 V; 50 Hz
6.	Electricity Back-up Meter Unit #3 (01/04/2016 at 10:01 AM - onwards)	Name: Static Energy Meter Manufacturer: Schneider Electric

S.No	Equipment	Description
	For back-up $EG_{\text{facility},y}$, EG_{exp} , and EG_{imp}	Type: ION 8600 Unit #1: PT 0802A475-01 Class of Accuracy: 0.2 Date of Calibration: 05/03/2015 Range: 0.05 - 20 A; 57 - 277 V; 50 Hz
7.	Steam Flow Meter Unit #1 (Until 27/12/2016 at 09:59 AM) For $M_{\text{steam},y}$	Name: Main Steam Flow Meter Transmitter Manufacturer: Endress-Hausser Model No.: FMD78 Serial No.: H400C50109D Instrument No.: 1LBA01CF001-B01 Range: - Input: 0 ~ 200 mBar - Output: 4 ~ 20 mA DC - Scale: 0 ~ 100 % Accuracy: 0.25 % Date of Calibration: 13/07/2015 & 13/07/2016 Replaced: 27/12/2016
8.	Steam Flow Meter Unit #1 (27/12/2016 at 10:00 AM - onwards) For $M_{\text{steam},y}$	Name: Main Steam Flow Meter Transmitter Manufacturer: General Electric (GE) Model No.: PanaFlow MV82 Serial No.: 4987429-2 Instrument No.: 1LBA01CF001-B01 Range: - Input: 0 ~ 2000 T/H - Output: 4 ~ 20 mA DC Accuracy: 2 % Date of Calibration: 27/12/2016 & 30/05/2017 Commissioned: 27/12/2016
9.	Steam Flow Meter Unit #2 (Until 29/08/2016 at 09:59 AM) For $M_{\text{steam},y}$	Name: Main Steam Flow Meter Transmitter Manufacturer: ABB Kent – Taylor Model No.: KDC/SJSTSLSB162Q - M100007 Serial No.: 1594052708 Instrument No.: 2LBA01CF001-B01 Range: - Input: 0 ~ 200 mBar - Output: 4 ~ 20 mA DC

S.No	Equipment	Description
		Scale: 0 ~ 100 % Accuracy: 0.25 % Date of Calibration: 13/07/2015 & 13/07/2016 Replaced: 29/08/2016
10.	Steam Flow Meter Unit #2 (29/08/2016 at 10:00 AM - onwards) For $M_{\text{steam},y}$	Name: Main Steam Flow Meter Transmitter Manufacturer: General Electric (GE) Model No.: PanaFlow MV82 Serial No.: 4987429-1 Instrument No.: 2LBA01CF001-B01 Range: - Input: 0 ~ 2000 T/H - Output: 4 ~ 20 mA DC Accuracy: 2 % Date of Calibration: 29/08/2016 & 30/05/2017 Commissioned: 29/08/2016
11.	Steam Flow Meter Unit #3 For $M_{\text{steam},y}$	Name: Main Steam Flow Meter Transmitter Manufacturer: Endress-Hausser Model No.: FMD78 Serial No.: D404420109D Instrument No.: 3LBA01CF001-B01 Range: - Input: 0 ~ 200 mBar - Output: 4 ~ 20 mA DC - Scale: 0 ~ 100 % Accuracy: 0.25 % Date of Calibration: 14/07/2015 & 13/07/2016

3.3 Monitoring Plan

This section presents the steps taken to monitor on regular basis the GHG emission reductions from the capacity upgrade project at Gunung Salak geothermal power plant in Indonesia.

The purpose of the monitoring plan is to present reliable and complete data and to ensure that all actual project data is well organized in term of collection and archiving.

Prior to the start of the crediting period, the organization of the monitoring team is established. Clear roles and responsibilities are assigned to all staff and the power plant manager involved in the VCS project, who have overall responsibility for the monitoring system in the project, ensuring trained staff perform the monitoring duties and that where trained monitoring staff are absent, the

integrity of the monitoring system is maintained by other trained staff. Initial training is conducted and regular checks performed to ensure adequacy of monitoring data.

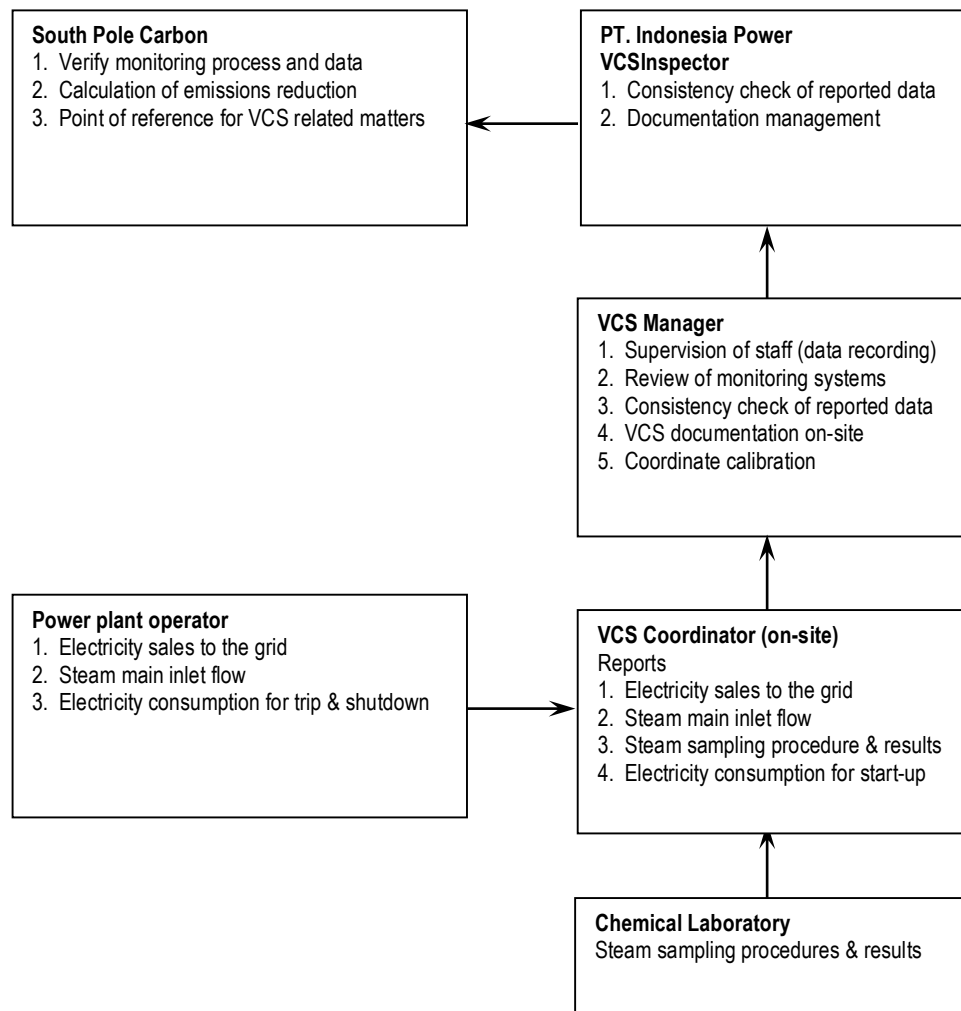
Details of Monitoring Team and Responsibilities

The electricity exported and imported together with steam flow rate and NCG characteristics required for emission reduction calculation were obtained by certain procedures set out in the monitoring plan. To address all O&M issues, the overall authority and responsibility belongs to the VCS Manager, which effectively controls and monitors the complete process in the power plant.

The Monitoring data of the equipments are recorded by the Technicians/ supervisors every shift (including the Chemical laboratory office for NCG characteristics) and submitted to the VCS Coordinator. The VCS Coordinator reports monthly to the VCS Manager. The VCS Manager submits a yearly report to the VCS Inspector, which is directly forwarded to South Pole Carbon.

Monitoring Organisation Chart

Figure 1. Gunung Salak geothermal power plant organisation chart



During monitoring period from 01/04/2016 to 30/06/2017, there is no change of person in charge (PIC).

Table 2. Gunung Salak geothermal power plant team and responsibilities

Team	Jobs and responsibilities	Position at the PT. Indonesia Power	Represented by (name)
VCS Inspector	Asses yearly report and discuss with South Pole if corrections needed in the monitoring SOP	Senior Environmental Expert	Mrs. Anna Reani
VCS Manager	- Documented and stored monthly report. - Prepare yearly report.	Gunung Salak Site Manager	Mr. Ervan Ambarita
VCS Coordinator	Prepare monthly report in the excel sheet	AMA Rernal Operation	Mr. Henrey Octavianus
Power plant operator (per shift)	Record hourly data of steam flow, EG_y, EG_{imp}, blackouts/power shutdowns and any emergencies occurred.	Operator	Operator
Chemical Laboratory	Supervise NCG sampling and analysis from the external certified Laboratory	Laboratory officer	Mr. Yuansah and Mr. Viki

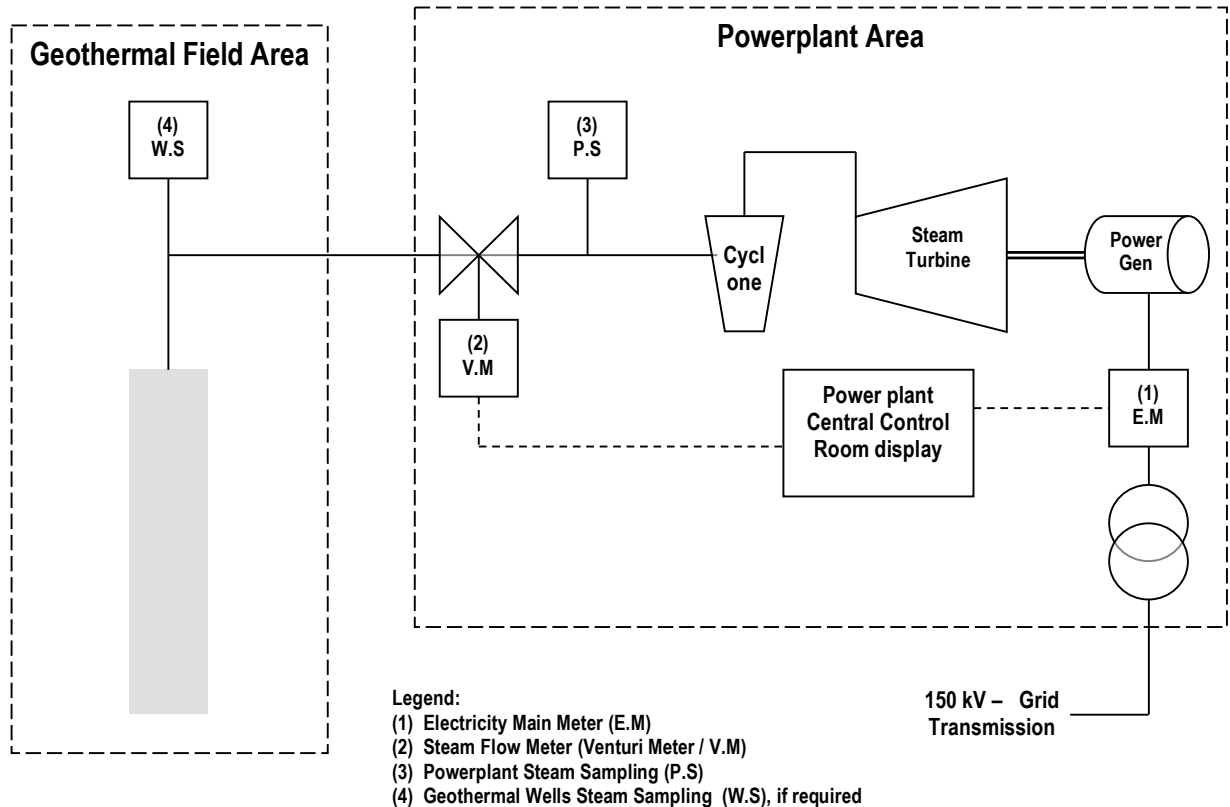
Measures to ensure the result/uncertainty analysis

The monitoring data of the equipments are recorded by supervisors for every shift and submitted to the VCS Coordinator. The VCS Coordinator compiles all daily-recorded (three-monthly assessment for NCG characteristic) data and reports monthly to the General Manager (acted as the VCS Manager). The VCS Manager documents and stores monthly report in the Project office, and then submits yearly reports to the VCS Inspector in the head office and directly forwarded to South Pole Carbon Asset Management. By this operational structure, the VCS Inspector together

with South Pole can monitor the project activity and make amendments immediately, if needed. The monitored parameters have low level of uncertainty. Therefore the possible monitoring data adjustments are not envisaged for the project. Reported results and data is compared with the previous results and data and thoroughly checked for any inconsistency.

Monitoring equipments

Figure 2. Gunung Salak geothermal power plant monitoring equipments



4 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

4.1 Baseline Emissions

Based on ACM0002 version 17.0, the baseline emission (BE_y in tCO_2) is the product of the baseline emission factor ($EF_{grid,CM,y}$ in tCO_2/MWh) times the electricity supplied by the project activity to the grid ($EG_{PJ,y}$ in MWh). $EG_{PJ,y}$ is calculated as a quantity of net electricity generation supplied by the project plants/units to the grid ($EG_{facility,y}$ in MWh) minus the sum of 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 ($EG_{historical}$ in MWh/yr) and standard deviation of the mentioned $EG_{historical}$ ($\sigma_{historical}$ in MWh/yr), as follows:

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

where:

- BE_y = Baseline emissions in year y (t CO₂/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 CO₂ 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 CO₂/MWh)

$EG_{PJ,y}$ for a retrofit or rehabilitation or replacement of an existing renewable energy power plant is calculated as follows:

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

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 $EG_{PJ,y} = 0$

The emission factor is calculated in the validated VCS PD according to the procedures prescribed in the “Tool to calculate the emission factor for an electricity system, Version 04.0 by the Indonesian government under the Directorate General of Electricity - Ministry of Energy and Mineral Resources (MEMR). According to the latest version of the tool, the JAMALI power grid is selected as the project boundary, as the regional interconnected grid covering three islands very close to each other (Java,

Madura, and Bali islands) and separated by a relatively long distance from other islands in Indonesia (no interconnection exists to other islands).

The Operating Margin is fixed ex-ante by using 3 recent years available data, which are 2013, 2014, and 2015 data. The 2013, 2014, and 2015 Operating Margin Emission Factor is calculated as follows: 0.777, 0.776, and 0.807 tCO₂e/MWh. The average Operating Margin Emission Factor (2013, 2014, and 2015) is 0.786 tCO₂e/MWh. While the ex-ante Build Margin Emission Factor is calculated to be 0.999 tCO₂e/MWh by dividing total CO₂ emissions by the total annual generation data.

As per UNFCCC Methodological tool: Tool to calculate the emission factor for an electricity system v05.0, the following default values should be used for w_{OM} and w_{BM} (for all projects except for wind and solar power generation project activities): $w_{OM} = 0.5$ and $w_{BM} = 0.5$ for the first crediting period, and $w_{OM} = 0.25$ and $w_{BM} = 0.75$ for the second and third crediting period, unless otherwise specified in the approved methodology which refers to this tool.

Therefore using the approach above, the ex-ante emission factor ($EF_{grid,CM,y}$) for Jamali Grid will be:

$$\begin{aligned}
 EF_{grid,CM,y} &= EF_{grid,OM,y} \times w_{OM} + EF_{grid,BM,y} \times w_{BM} \\
 &= (0.786 \times 0.25) + (0.999 \times 0.75) \\
 &= 0.946 \text{ tCO}_2\text{/MWh}
 \end{aligned}$$

The values are presented in Table 3.

Table 3. Emission factor of Jamali Grid as per validated VCS PD

Parameter	As per the validated VCS project data
Operating Margin (OM) in tCO ₂ e/MWh	0.786
Build Margin (BM), in tCO ₂ e/MWh	0.999
Combined Margin (CM) Simple average of OM and BM in tCO ₂ e/MWh	0.946

BE_y Calculation for Gunung Salak unit #1

Table 4. Baseline emission (BE_y) calculation for Gunung Salak unit #1

Month/ Year		EG _{facility,y}				
		Half-hourly production E _{exp}	Half-hourly production E _{imp}	Half-hourly production (E _{exp} -E _{imp})	As per invoice	Conservative (with 0.2% permissible error due to a delayed calibration schedule)
		kWh	kWh	kWh	kWh	kWh
Apr-2016		37,435,969	27,787	37,408,181	37,408,182	37,408,181
May-2016		41,004,640	-	41,004,640	41,004,640	41,004,640
Jun-2016		39,667,157	3	39,667,154	39,741,343	39,667,154
Jul-2016		40,547,006	8,029	40,538,977	40,612,597	40,538,977
Aug-2016		40,284,029	-	40,284,029	40,284,029	40,284,029
Sep-2016		33,734,017	40,479	33,693,538	33,693,538	33,693,538
Oct-2016		40,429,109	6,759	40,422,350	40,422,350	40,422,350
Nov-2016		39,312,395	15,365	39,297,030	39,297,030	39,297,030
Dec-2016		40,349,787	9,588	40,340,199	40,340,199	40,340,199
Number of months in 2016	9					
Total Apr - Dec 2016		352,764,109	108,010	352,656,099	352,803,908	352,656,099
Jan-2017		40,763,653	-	40,763,653	40,763,653	40,763,653
Feb-2017		36,761,762	-	36,761,762	36,761,762	36,761,762
Mar-2017		40,090,212	8,005	40,082,207	40,082,207	40,082,207
Apr-2017		38,057,606	43,560	38,014,046	38,014,046	38,014,046
May-2017		40,235,805	-	40,235,805	40,235,805	40,235,805
Jun-2017		39,049,210	-	39,049,210	39,049,210	39,049,210
Number of months in 2017	6					
Total Jan - Jun 2017		234,958,249	51,565	234,906,684	234,906,683	234,906,684

Month/ Year		BE _y			
		EG _{facility,y}	(EG _{historical} + ? _{historical})	EG _{facility,y} < (EG _{historical} + ? _{historical})	Total
		MWh	MWh	MWh	tCO ₂
Apr-2016		37,408	36,279	1,129	1,068.23
May-2016		41,005	36,279	4,726	4,470.48
Jun-2016		39,667	36,279	3,388	3,205.22
Jul-2016		40,539	36,279	4,260	4,029.96
Aug-2016		40,284	36,279	4,005	3,788.78
Sep-2016		33,694	36,279	-	0.00
Oct-2016		40,422	36,279	4,143	3,919.63
Nov-2016		39,297	36,279	3,018	2,855.08
Dec-2016		40,340	36,279	4,061	3,841.92
Number of months in 2016	9				

Month/ Year	BE _y				
		EG _{facility,y}	(EG _{historical} + ? _{historical})	EG _{facility,y} < (EG _{historical} + ? _{historical})	Total
		MWh	MWh	MWh	tCO ₂
Total Apr - Dec 2016		352,656	326,511	28,731	27,179.30
Total Apr - Dec 2016 ROUNDUP/DOWN					27,179.00
Jan-2017		40,764	36,279	4,485	4,242.51
Feb-2017		36,762	36,279	483	456.72
Mar-2017		40,082	36,279	3,803	3,597.86
Apr-2017		38,014	36,279	1,735	1,641.38
May-2017		40,236	36,279	3,957	3,743.16
Jun-2017		39,049	36,279	2,770	2,620.64
Number of months in 2017	6				
Total Jan - Jun 2017		234,907	217,674	17,233	16,302.26
Total Jan - Jun 2017 ROUNDUP/DOWN					16,302.00
TOTAL 2016-2017 ROUNDUP/DOWN					43,481.00

BE_y Calculation for Gunung Salak unit #2

Table 5. Baseline emission (BE_y) calculation for Gunung Salak unit #2

Month/ Year		EG _{facility,y}				
		Half-hourly production E _{exp}	Half-hourly production E _{imp}	Half-hourly production (E _{exp} -E _{imp})	As per invoice	Conservative (with 0.2% permissible error due to a delayed calibration schedule)
		kWh	kWh	kWh	kWh	kWh
Apr-2016		36,303,420	125,035	36,178,385	36,178,385	36,178,385
May-2016		27,537,660	43,409	27,494,251	27,494,251	27,494,251
Jun-2016		21,868,069	73,811	21,794,257	21,838,228	21,794,257
Jul-2016		41,106,206	-	41,106,206	41,180,688	41,106,206
Aug-2016		40,301,085	-	40,301,085	40,301,085	40,301,085
Sep-2016		39,888,421	5,821	39,882,600	39,882,600	39,882,600
Oct-2016		42,093,474	-	42,093,474	42,093,474	42,093,474
Nov-2016		41,013,381	-	41,013,381	41,013,381	41,013,381
Dec-2016		40,203,309	11,877	40,191,432	40,191,432	40,191,432
Number of months in 2016	9					
Total Apr - Dec 2016		330,315,025	259,953	330,055,072	330,173,524	330,055,072
Jan-2017		41,872,392	-	41,872,392	41,872,392	41,872,392
Feb-2017		37,719,484	-	37,719,484	37,719,484	37,719,484

Month/ Year		EG _{facility,y}				
		Half-hourly production E _{exp}	Half-hourly production E _{imp}	Half-hourly production (E _{exp} -E _{imp})	As per invoice	Conservative (with 0.2% permissible error due to a delayed calibration schedule)
		kWh	kWh	kWh	kWh	kWh
Mar-2017		40,935,694	8,441	40,927,253	40,927,253	40,927,253
Apr-2017		40,938,104	-	40,938,104	40,938,104	40,938,104
May-2017		40,820,783	-	40,820,783	40,820,783	40,820,783
Jun-2017		39,701,217	-	39,701,217	39,701,217	39,701,217
Number of months in 2017	6					
Total Jan - Jun 2017		241,987,673	8,441	241,979,232	241,979,233	241,979,232

Month/ Year		BE _y			
		EG _{facility,y}	(EG _{historical} + ? _{historical})	EG _{facility,y} < (EG _{historical} + ? _{historical})	Total
		MWh	MWh	MWh	tCO ₂
Apr-2016		36,178	34,996	1,182	1,118.41
May-2016		27,494	34,996	-	0.00
Jun-2016		21,794	34,996	-	0.00
Jul-2016		41,106	34,996	6,110	5,780.13
Aug-2016		40,301	34,996	5,305	5,018.48
Sep-2016		39,883	34,996	4,886	4,622.59
Oct-2016		42,093	34,996	7,097	6,714.08
Nov-2016		41,013	34,996	6,017	5,692.31
Dec-2016		40,191	34,996	5,195	4,914.75
Number of months in 2016	9				
Total Apr - Dec 2016		330,055	314,965	35,794	33,860.75
Total Apr - Dec 2016 ROUNDUP/DOWN					33,860.00
Jan-2017		41,872	34,996	6,876	6,504.94
Feb-2017		37,719	34,996	2,723	2,576.29
Mar-2017		40,927	34,996	5,931	5,610.84
Apr-2017		40,938	34,996	5,942	5,621.10
May-2017		40,821	34,996	5,825	5,510.12
Jun-2017		39,701	34,996	4,705	4,451.01
Number of months in 2017	6				
Total Jan - Jun 2017		241,979	209,977	32,002	30,274.28
Total Jan - Jun 2017 ROUNDUP/DOWN					30,274.00

Month/ Year	BE _y			
	EG _{facility,y}	(EG _{historical} + ? _{historical})	EG _{facility,y} < (EG _{historical} + ? _{historical})	Total
	MWh	MWh	MWh	tCO ₂
TOTAL 2016-2017 ROUNDUP/DOWN				64,134.00

BE_y Calculation for Gunung Salak unit #3

Table 6. Baseline emission (BE_y) calculation for Gunung Salak unit #3

Month/ Year		EG _{facility,y}				
		Half-hourly production E _{exp}	Half-hourly production E _{imp}	Half-hourly production (E _{exp} -E _{imp})	As per invoice	Conservative (with 0.2% permissible error due to a delayed calibration schedule)
		kWh	kWh	kWh	kWh	kWh
Apr-2016		39,317,501	15,869	39,301,633	39,301,632	39,301,633
May-2016		42,150,175	-	42,150,175	42,150,175	42,150,175
Jun-2016		38,782,731	29,485	38,753,246	38,825,538	38,753,246
Jul-2016		41,182,477	-	41,182,477	41,257,101	41,182,477
Aug-2016		40,047,096	5,468	40,041,629	43,188,755	40,041,629
Sep-2016		39,996,595	7,310	39,989,285	39,989,285	39,989,285
Oct-2016		41,651,253	6,768	41,644,484	41,644,485	41,644,484
Nov-2016		38,845,652	5,277	38,840,375	38,840,375	38,840,375
Dec-2016		42,181,065	2,533	42,178,532	42,178,532	42,178,532
Number of months in 2016	9					
Total Apr - Dec 2016		364,154,544	72,709	364,081,835	367,375,878	364,081,835
Jan-2017		42,067,457	-	42,067,457	42,067,457	42,067,457
Feb-2017		36,871,399	12,785	36,858,614	36,858,614	36,858,614
Mar-2017		-	12,348	-12,348	-12	-12,348
Apr-2017		13,404,611	38,816	13,365,795	13,365,795	13,365,795
May-2017		40,260,163	10,189	40,249,974	40,249,974	40,249,974
Jun-2017		39,776,637	960	39,775,677	39,775,677	39,775,677
Number of months in 2017	6					
Total Jan - Jun 2017		172,380,267	75,098	172,305,170	172,317,505	172,305,170

Month/ Year	BE _y			
	EG _{facility,y}	(EG _{historical} + ? _{historical})	EG _{facility,y} < (EG _{historical} + ? _{historical})	Total
	MWh	MWh	MWh	tCO ₂
Apr-2016	39,302	36,967	2,335	2,208.50
May-2016	42,150	36,967	5,183	4,903.22
Jun-2016	38,753	36,967	1,786	1,689.72
Jul-2016	41,182	36,967	4,215	3,987.78
Aug-2016	40,042	36,967	3,075	2,908.54
Sep-2016	39,989	36,967	3,022	2,859.02
Oct-2016	41,644	36,967	4,677	4,424.84
Nov-2016	38,840	36,967	1,873	1,772.15
Dec-2016	42,179	36,967	5,211	4,930.05
Number of months in 2016	9			
Total Apr - Dec 2016	364,082	332,704	31,378	29,683.81
Total Apr - Dec 2016 ROUNDUP/DOWN				29,683.00
Jan-2017	42,067	36,967	5,100	4,824.97
Feb-2017	36,859	36,967	-	0.00
Mar-2017	-12	36,967	-	0.00
Apr-2017	13,366	36,967	-	0.00
May-2017	40,250	36,967	3,283	3,105.63
Jun-2017	39,776	36,967	2,809	2,656.95
Number of months in 2017	6			
Total Jan - Jun 2017	172,305	221,802	11,192	10,587.54
Total Jan - Jun 2017 ROUNDUP/DOWN				10,587.00
TOTAL 2016-2017 ROUNDUP/DOWN				40,270.00

4.2 Project Emissions

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

where:

PE_y = Project emissions in year y (t CO₂e/yr)

PE_{FF,y} = Project emissions from fossil fuel consumption in year y (t CO₂/yr)

PE_{GP,y} = Project emissions from the operation of dry, flash steam or binary geothermal power plants in year y (t CO₂e/yr)

PE_{HP,y} = Project emissions from water reservoirs of hydro power plants in year y (t CO₂e/yr)

The project does not involve the fossil fuel consumption (as per ACM0002 version 17.0, for all renewable energy power generation project activities, emissions due to the use of fossil fuels for the backup generator can be neglected) and hydro power, so $PE_{FF,y} = 0$, $PE_{HP,y} = 0$.

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

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

where:

$PE_{GP,y}$ = Project emissions from the operation of dry, flash steam or binary geothermal power plants in year y (t CO₂e/yr)

$PE_{\text{dry or flash steam},y}$ = 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 CO₂e/yr)

$PE_{\text{binary},y}$ = 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 CO₂e/yr)

The project is the operation of flash steam geothermal power plant, so $PE_{\text{binary},y} = 0$.

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

$$PE_{\text{dry or flash steam},y} = (w_{\text{steam},\text{CO}_2,y} + w_{\text{steam},\text{CH}_4,y} \times GWP_{\text{CH}_4}) \times M_{\text{steam},y}$$

where:

$w_{\text{steam},\text{CO}_2,y}$ = Average mass fraction of CO₂ in the produced steam in year y (t CO₂/t steam)

$w_{\text{steam},\text{CH}_4,y}$ = Average mass fraction of CH₄ in the produced steam in year y (t CH₄/t steam)

GWP_{CH_4} = Global warming potential of CH₄ valid for the relevant commitment period (t CO₂e/t CH₄)

$M_{\text{steam},y}$ = Quantity of steam produced in year y (t steam/yr)

During current monitoring period from 01/04/2016 to 30/06/2017, there were calibration delay for steam flow meter Unit #1, #2 and #3 and NCG analysis, as following:

- Unit #1: in year 2016 (month of July, October, and November), and year 2017 (month of January until March)
- Unit #2: in year 2016 (month of July, October, and November), and year 2017 (month of January until March)

- Unit #3: in year 2016 (month of July, October, and November), and year 2017 (month of January until April)

The CH₄ and CO₂ weight fraction values for all units that are used in the PE_{flash steam,y} calculation are presented in **Table 7** and

Table 8.

Table 7. CO₂ weight fraction values used in the project emission of NCG from the produced steam (PE_{flash steam,y}) calculation

Analysis #	Period to be used in PE _{flash steam,y} calculation	CO ₂ values to be used in PE _{flash steam,y} calculation (non dimensional)		
	Month/Year	UNIT #1	UNIT #2	UNIT #3
1	04/2016	0.0042595960	0.0049315970	0.0054052530
	05/2016	0.0042595960	0.0049315970	0.0054052530
	06/2016	0.0042595960	0.0049315970	0.0054052530
2	07/2016	0.0052319300	0.0052687800	0.0061582300
	08/2016	0.0052319300	0.0052687800	0.0061582300
	09/2016	0.0052319300	0.0052687800	0.0061582300
3	10/2016	0.0052319300	0.0052687800	0.0061582300
	11/2016	0.0052319300	0.0052687800	0.0061582300
	12/2016	0.0040278960	0.0042920100	0.0048822800
4	01/2017	0.0052319300	0.0052687800	0.0061582300
	02/2017	0.0052319300	0.0052687800	0.0061582300
	03/2017	0.0052319300	0.0052687800	0.0061582300
5 & 5A	04/2017	0.0037977200	0.0048050500	0.0061582300
	05/2017	0.0037977200	0.0048050500	0.0048461730
	06/2017	0.0037977200	0.0048050500	0.0048461730

Table 8. CH₄ weight fraction values used in the project emission of NCG from the produced steam (PE_{flash steam,y}) calculation

Analysis #	Period to be used in PE _{flash steam,y} calculation	CH ₄ values to be used in PE _{flash steam,y} calculation (non dimensional)		
	Month/Year	UNIT #1	UNIT #2	UNIT #3
1	04/2016	0.0000002200	0.0000009116	0.0000015333
	05/2016	0.0000002200	0.0000009116	0.0000015333
	06/2016	0.0000002200	0.0000009116	0.0000015333
2	07/2016	0.0000986162	0.0000627210	0.0000979004
	08/2016	0.0000246785	0.0000156145	0.0000305890
	09/2016	0.0000246785	0.0000156145	0.0000305890
3	10/2016	0.0000986162	0.0000627210	0.0000979004

Analysis #	Period to be used in $PE_{\text{flash steam},y}$ calculation	CH ₄ values to be used in $PE_{\text{flash steam},y}$ calculation (non dimensional)		
	Month/Year	UNIT #1	UNIT #2	UNIT #3
4	11/2016	0.0000986162	0.0000627210	0.0000979004
	12/2016	0.0000986162	0.0000627210	0.0000979004
	01/2017	0.0000986162	0.0000627210	0.0000979004
	02/2017	0.0000986162	0.0000627210	0.0000979004
	03/2017	0.0000986162	0.0000627210	0.0000979004
5 & 5A	04/2017	0.0000083560	0.0000077000	0.0000979004
	05/2017	0.0000083560	0.0000077000	0.0000070227
	06/2017	0.0000083560	0.0000077000	0.0000070227

$PE_{\text{flash steam},y}$ calculation for Gunung Salak unit #1

Table 9. Project emission from fugitive carbon dioxide and methane emissions due to release of non-condensable gases from the produced steam ($PE_{\text{flash steam},y}$) for Gunung Salak unit #1

Month/ Year		$PE_{\text{dry or flash steam},y}$				
		$W_{\text{steam.CH}_4,y}$	$W_{\text{steam.CO}_2,y}$	$M_{\text{steam},y}$	$M_{\text{steam},y}$ (steam attributable to the project's capacity upgrade)	Total
		$t\text{CH}_4/t_{\text{steam}}$	$t\text{CO}_2/t_{\text{steam}}$	tonnes / month	tonnes / month	$t\text{CO}_2$
Apr-2016		0.0000002200	0.0042595960	304,512.00	9,192.02	39.20
May-2016		0.0000002200	0.0042595960	328,681.20	37,879.55	161.56
Jun-2016		0.0000002200	0.0042595960	317,157.00	27,039.47	115.33
Jul-2016		0.0000986162	0.0052319300	325,985.00	34,193.74	263.20
Aug-2016		0.0000246785	0.0052319300	326,602.00	32,470.90	189.92
Sep-2016		0.0000246785	0.0052319300	274,045.09	0.00	0.00
Oct-2016		0.0000986162	0.0052319300	338,508.00	34,697.77	267.08
Nov-2016		0.0000986162	0.0052319300	336,027.00	25,807.24	198.65
Dec-2016		0.0000986162	0.0040278960	348,137.60	35,048.53	227.58
Number of months in 2016	9					
Total Apr - Dec 2016				2,899,654.89	236,329.23	1,462.52
Total Apr - Dec 2016 ROUNDUP/DOWN						1,463.00
Jan-2017		0.0000986162	0.0052319300	355,347.00	39,094.07	300.92
Feb-2017		0.0000986162	0.0052319300	321,512.00	4,222.37	32.50
Mar-2017		0.0000986162	0.0052319300	351,770.00	33,377.97	256.92
Apr-2017		0.0000083560	0.0037977200	332,612.00	15,181.37	60.83
May-2017		0.0000083560	0.0037977200	354,301.00	34,842.32	139.60
Jun-2017		0.0000083560	0.0037977200	317,917.00	22,553.72	90.36

Month/ Year		PE _{dry or flash steam,y}				
		W _{steam.CH4,y}	W _{steam.CO2,y}	M _{steam,y}	M _{steam,y} (steam attributable to the project's capacity upgrade)	Total
		tCH ₄ /t _{steam}	tCO ₂ /t _{steam}	tonnes / month	tonnes / month	tCO ₂
Number of months in 2017	6					
Total Jan - Jun 2017				2,033,459.0 0	149,271.82	881.13
Total Jan - Jun 2017 ROUNDUP/DOW N						882.00
TOTAL 2016- 2017 ROUNDUP						2,345.00

PE_{flash steam,y} calculation for Gunung Salak unit #2

Table 10. Project emission from fugitive carbon dioxide and methane emissions due to release of non-condensable gases from the produced steam (PE_{flash steam,y}) for Gunung Salak unit #2

Month/ Year		PE _{dry or flash steam,y}				
		W _{steam.CH4,y}	W _{steam.CO2,y}	M _{steam,y}	M _{steam,y} (steam attributable to the project's capacity upgrade)	Total
		tCH ₄ /t _{steam}	tCO ₂ /t _{steam}	tonnes / month	tonnes / month	tCO ₂
Apr-2016		0.0000009116	0.0049315970	304,332.83	9,945.08	49.27
May-2016		0.0000009116	0.0049315970	230,791.00	0.00	0.00
Jun-2016		0.0000009116	0.0049315970	177,263.00	0.00	0.00
Jul-2016		0.0000627210	0.0052687800	336,857.00	49,980.22	341.70
Aug-2016		0.0000156145	0.0052687800	337,756.00	44,459.80	251.60
Sep-2016		0.0000156145	0.0052687800	335,510.00	41,107.08	232.63
Oct-2016		0.0000627210	0.0052687800	362,778.00	61,167.62	418.19
Nov-2016		0.0000627210	0.0052687800	356,037.00	52,235.67	357.13
Dec-2016		0.0000627210	0.0042920100	358,449.70	46,334.56	271.52
Number of months in 2016	9					
Total Apr - Dec 2016				2,799,774.5 3	305,230.03	1,922.05

Month/ Year		PE _{dry or flash steam,y}				
		W _{steam.CH₄,y}	W _{steam.CO₂,y}	M _{steam,y}	M _{steam,y} (steam attributable to the project's capacity upgrade)	Total
		tCH ₄ /t _{steam}	tCO ₂ /t _{steam}	tonnes / month	tonnes / month	tCO ₂
Total Apr - Dec 2016 ROUNDUP/DOW N						1,923.00
Jan-2017		0.0000627210	0.0052687800	368,081.80	60,446.13	413.26
Feb-2017		0.0000627210	0.0052687800	336,714.00	24,310.75	166.21
Mar-2017		0.0000627210	0.0052687800	357,484.80	51,806.16	354.19
Apr-2017		0.0000077000	0.0048050500	352,941.00	51,227.67	256.01
May-2017		0.0000077000	0.0048050500	361,675.00	51,606.77	257.91
Jun-2017		0.0000077000	0.0048050500	311,732.00	36,944.06	184.63
Number of months in 2017	6					
Total Jan - Jun 2017				2,088,628.6 0	276,341.56	1,632.21
Total Jan - Jun 2017 ROUNDUP/DOW N						1,633.00
TOTAL 2016- 2017 ROUNDUP						3,556.00

PE_{flash steam,y} calculation for Gunung Salak unit #3

Table 11. Project emission from fugitive carbon dioxide and methane emissions due to release of non-condensable gases from the produced steam (PE_{flash steam,y}) for Gunung Salak unit #3

Month/ Year		PE _{dry or flash steam,y}				
		W _{steam.CH₄,y}	W _{steam.CO₂,y}	M _{steam,y}	M _{steam,y} (steam attributable to the project's capacity upgrade)	Total
		tCH ₄ /t _{steam}	tCO ₂ /t _{steam}	tonnes / month	tonnes / month	tCO ₂
Apr-2016		0.0000015333	0.0054052530	299,405.00	17,785.03	96.81
May-2016		0.0000015333	0.0054052530	321,284.70	39,507.62	215.06
Jun-2016		0.0000015333	0.0054052530	296,829.00	13,655.69	74.34

Month/ Year		PE _{dry or flash steam,y}				
		W _{steam.CH₄,y}	W _{steam.CO₂,y}	M _{steam,y}	M _{steam,y} (steam attributable to the project's capacity upgrade)	Total
		tCH ₄ /t _{steam}	tCO ₂ /t _{steam}	tonnes / month	tonnes / month	tCO ₂
Jul-2016		0.0000979004	0.0061582300	316,017.00	32,288.77	277.87
Aug-2016		0.0000305890	0.0061582300	327,628.00	23,323.49	161.47
Sep-2016		0.0000305890	0.0061582300	304,549.10	23,016.51	159.34
Oct-2016		0.0000979004	0.0061582300	247,924.50	27,846.34	239.64
Nov-2016		0.0000979004	0.0061582300	294,833.00	14,220.08	122.37
Dec-2016		0.0000979004	0.0048822800	319,917.00	39,528.08	289.73
Number of months in 2016	9					
Total Apr - Dec 2016				2,728,387.3 0	231,171.61	1,636.64
Total Apr - Dec 2016 ROUNDUP/DOW N						1,637.00
Jan-2017		0.0000979004	0.0061582300	318,329.70	38,595.29	332.14
Feb-2017		0.0000979004	0.0061582300	279,002.00	0.00	0.00
Mar-2017		0.0000979004	0.0061582300	0.00	0.00	0.00
Apr-2017		0.0000979004	0.0061582300	101,670.70	0.00	0.00
May-2017		0.0000070227	0.0048461730	303,138.00	24,724.83	124.16
Jun-2017		0.0000070227	0.0048461730	298,785.10	21,097.59	105.95
Number of months in 2017	6					
Total Jan - Jun 2017				1,300,925.5 0	84,417.71	562.25
Total Jan - Jun 2017 ROUNDUP/DOW N						563.00
TOTAL 2016- 2017 ROUNDUP						2,200.00

4.3 Leakage

Leakage emissions as described in the ACM0002 v.17.0 is 0 for retrofit project as following:

$$LE_y = 0$$

Where:

$$LE_y = \text{Leakage emissions in year } y \text{ (tCO}_2\text{/yr)}$$

4.4 Net GHG Emission Reductions and Removals

$$ER_y = BE_y - PE_y - LE_y$$

Where:

ER_y = Emission reductions in year y (tCO_2/yr)

BE_y = Baseline emission in year y (tCO_2/yr)

PE_y = Project emission in year y (tCO_2/yr)

LE_y = Leakage emission in year y (tCO_2/yr)

ER calculation for Gunung Salak Unit 1

Table 12. Emission reduction calculation for Gunung Salak unit #1

Month/Year	BE_y (tCO_2)	PE_y (tCO_2)	ER_y (tCO_2)
		$PE_{dry \text{ or flash steam},y}$	
Total Apr - Dec 2016	27,179.30	1,462.52	
Total Apr - Dec 2016 ROUNDUP/DOWN	27,179.00	1,463.00	25,716.00
Total Jan - Jun 2017	16,302.26	881.13	
Total Jan - Jun 2017 ROUNDUP/DOWN	16,302.00	882.00	15,420.00
TOTAL 2016-2017 ROUNDUP/DOWN	43,481.00	2,345.00	41,136.00

ER calculation for Gunung Salak Unit 2

Table 13. Emission reduction calculation for Gunung Salak unit #2

Month/Year	BE_y (tCO_2)	PE_y (tCO_2)	ER_y (tCO_2)
		$PE_{dry \text{ or flash steam},y}$	
Total Apr - Dec 2016	33,860.75	1,922.05	
Total Apr - Dec 2016 ROUNDUP/DOWN	33,860.00	1,923.00	31,937.00
Total Jan - Jun 2017	30,274.28	1,632.21	
Total Jan - Jun 2017 ROUNDUP/DOWN	30,274.00	1,633.00	28,641.00
TOTAL 2016-2017 ROUNDUP/DOWN	64,134.00	3,556.00	60,578.00

ER calculation for Gunung Salak Unit 3

Table 14. Emission reduction calculation for Gunung Salak unit #3

Month/Year	BE _y (tCO ₂)	PE _y (tCO ₂)	ER _y (tCO ₂)
		PE _{dry or flash steam,y}	
Total Apr - Dec 2016	29,683.81	1,636.64	
Total Apr - Dec 2016 ROUNDUP/DOWN	29,683.00	1,637.00	28,046.00
Total Jan - Jun 2017	10,587.54	562.25	
Total Jan - Jun 2017 ROUNDUP/DOWN	10,587.00	563.00	10,024.00
TOTAL 2016-2017 ROUNDUP/DOWN	40,270.00	2,200.00	38,070.00

The summary of emission reductions for the chosen monitored period i.e. from 01/04/2016 to 30/06/2017 is provided in

Table 15. Summary of emission reduction calculation from 01/04/2016 to 30/06/2017

Year	Baseline emissions or removals (tCO ₂ e)	Project emissions or removals (tCO ₂ e)	Leakage emissions (tCO ₂ e)	Net GHG emission reductions or removals (tCO ₂ e)
Vintage 2016 : 01/04/2016- 31/12/2016	90,722	5,023	0	85,699
Vintage 2017 : 01/01/2017- 30/06/2017	57,163	3,078	0	54,085
Total	147,885	8,101	0	139,784

Additional information related to this Monitoring Report and ER calculation will be provided separately to the DOE.

APPENDIX 1: SPECIFIC STEAM CONSUMPTION (SSC) CALCULATION FOR EACH UNIT

SSC calculation for Gunung Salak Unit 1

Month/Year	Steam flowrate (t steam)	Net power output of the plant (MWh)	SSC (t steam/MWh)
Apr-2016	304,512.00	37,408.18	8.140
May-2016	328,681.20	41,004.64	8.016
Jun-2016	317,157.00	39,741.34	7.981
Jul-2016	325,985.00	40,612.60	8.027
Aug-2016	326,602.00	40,284.03	8.107
Sep-2016	274,045.09	33,693.54	8.133
Oct-2016	338,508.00	40,422.35	8.374
Nov-2016	336,027.00	39,297.03	8.551
Dec-2016	348,137.60	40,340.20	8.630
Total Apr – Dec 2016	2,899,654.89	352,803.91	8.219
Jan-2017	355,347.00	40,763.65	8.717
Feb-2017	321,512.00	36,761.76	8.746
Mar-2017	351,770.00	40,082.21	8.776
Apr-2017	332,612.00	38,014.05	8.750
May-2017	354,301.00	40,235.81	8.806
Jun-2017	317,917.00	39,049.21	8.141
Total Jan – Jun 2017	2,033,459.00	234,906.68	8.656

SSC calculation for Gunung Salak Unit 2

Month/Year	Steam flowrate (t steam)	Net power output of the plant (MWh)	SSC (t steam/MWh)
Apr-2016	304,332.83	36,178.39	8.412
May-2016	230,791.00	27,494.25	8.394
Jun-2016	177,263.00	21,838.23	8.117
Jul-2016	336,857.00	41,180.69	8.180
Aug-2016	337,756.00	40,301.09	8.381
Sep-2016	335,510.00	39,882.60	8.412
Oct-2016	362,778.00	42,093.47	8.618
Nov-2016	356,037.00	41,013.38	8.681
Dec-2016	358,449.70	40,191.43	8.919
Total Apr – Dec 2016	2,799,774.53	330,173.52	8.480
Jan-2017	368,081.80	41,872.39	8.791
Feb-2017	336,714.00	37,719.48	8.927
Mar-2017	357,484.80	40,927.25	8.735
Apr-2017	352,941.00	40,938.10	8.621
May-2017	361,675.00	40,820.78	8.860

Month/Year	Steam flowrate (t steam)	Net power output of the plant (MWh)	SSC (t steam/MWh)
Jun-2017	311,732.00	39,701.22	7.852
Total Jan – Jun 2017	2,088,628.60	241,979.23	8.631

SSC calculation for Gunung Salak Unit 3

Month/Year	Steam flowrate (t steam)	Net power output of the plant (MWh)	SSC (t steam/MWh)
Apr-2016	299,405.00	39,301.63	7.618
May-2016	321,284.70	42,150.18	7.622
Jun-2016	296,829.00	38,825.54	7.645
Jul-2016	316,017.00	41,257.10	7.660
Aug-2016	327,628.00	43,188.76	7.586
Sep-2016	304,549.10	39,989.29	7.616
Oct-2016	247,924.50	41,644.49	5.953
Nov-2016	294,833.00	38,840.38	7.591
Dec-2016	319,917.00	42,178.53	7.585
Total Apr – Dec 2016	2,728,387.30	367,375.88	7.427
Jan-2017	318,329.70	42,067.46	7.567
Feb-2017	279,002.00	36,858.61	7.570
Mar-2017	0.00	-0.01	0.000
Apr-2017	101,670.70	13,365.80	7.607
May-2017	303,138.00	40,249.97	7.531
Jun-2017	298,785.10	39,775.68	7.512
Total Jan – Jun 2017	1,300,925.50	172,317.51	7.550