

CAPACITY UPGRADE OF GUNUNG SALAK GEOTHERMAL POWER PLANT PROJECT, INDONESIA



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Project Title	Capacity Upgrade of Gunung Salak Geothermal Power Plant Project, Indonesia
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1 PROJECT DETAILS

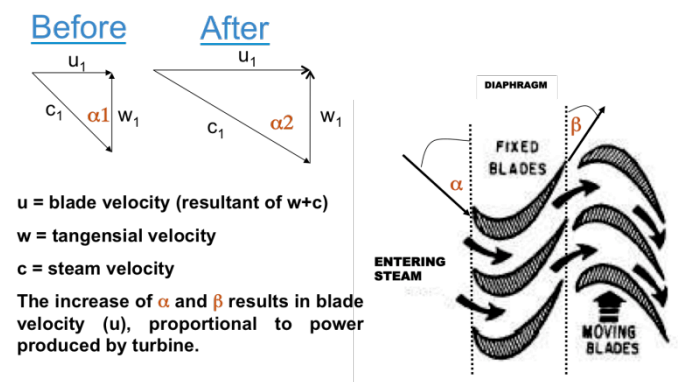
1.1 Summary Description of the Implementation Status of the Project

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



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.

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 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 tCO₂-e 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

Name of the party involved ((host) indicates a host party)	Private and/or public entity (ies) project participants (as applicable)	Kindly indicate if the party involved to be considered as project participant (Yes/No)
Indonesia (host)	PT. Indonesia Power	No
Switzerland	South Pole Carbon Asset Management Ltd. (as carbon credit buyer)	No

Project proponents contact information as follows:

Project owner:

Organization name	PT. Indonesia Power
Contact person	Artono Antonius
Title	Mr.
Address	Jl. Jenderal Gatot Subroto Kav. 18, Jakarta 12950, Indonesia
Telephone	+62-21-526 7666
Email	agcc@indonesiapower.co.id

Carbon Credit buyer:

Organization name	South Pole Carbon Asset Management Ltd.
Contact person	Renat Heuberger
Title	Mr.
Address	Technoparkstrasse 1, Zurich 8005, Switzerland
Telephone	+41-44 633 7870
Email	registration@southpolecarbon.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.

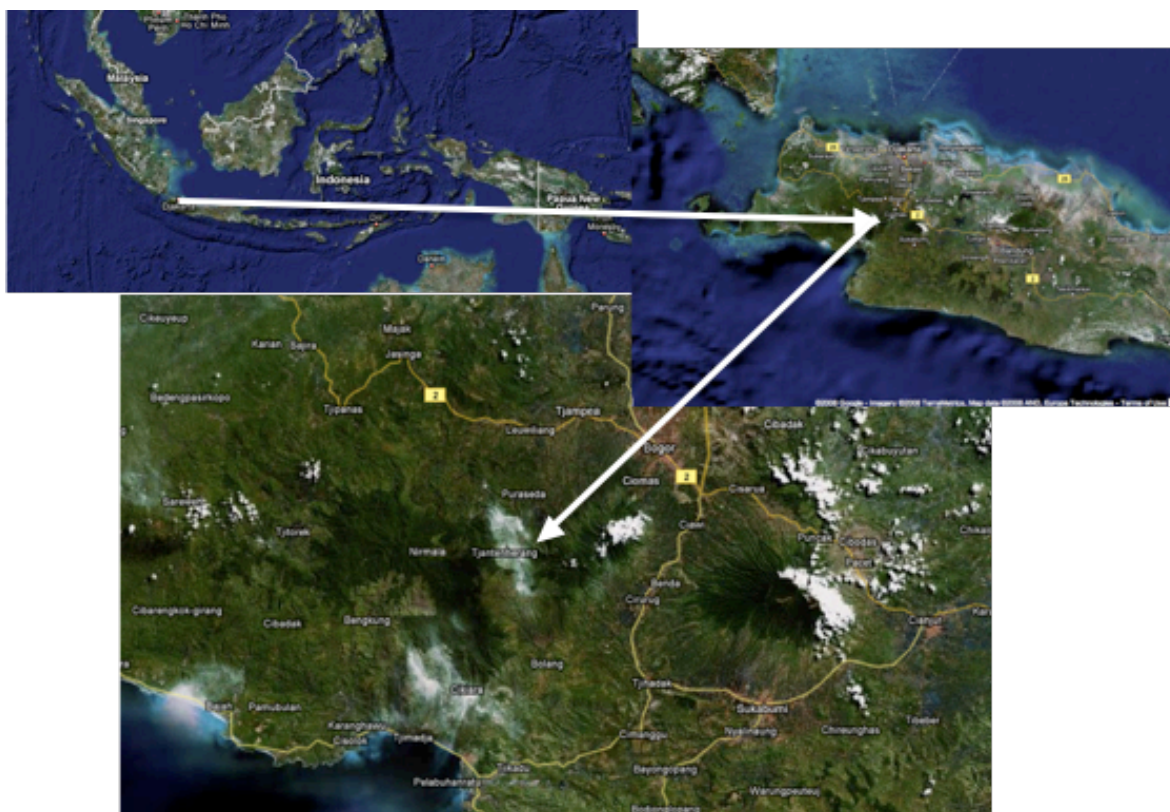
1.6 Project Crediting Period

The crediting period of this project activity is 10 years from 01/04/2006 until 31/03/2016.

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.

Figure 2. Gunung Salak geothermal power plant location



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 : 07

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 2007.1. 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.

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 5th verification period from 01/04/2014 to 31/03/2016, the power plant is in operation continuously (with outages – forced and planned). The reasons for the planned and forced outages are shown in the table below:

Table 1. Planned and forced outages from 01/04/2014 to 31/12/2014

No.	Unit #	Reasons	Period of outages	
			Start date & time	Finish date & time
1	2	Problem with the excitation electronic card	24/04/2014 09:31	26/04/2014 02:04
2	3	Problem with the PMT 150 kV	30/04/2014 15:32	30/04/2014 22:55
3	1	Earthquake	07/06/2014 07:26	07/06/2014 07:59
4	3	Earthquake	07/06/2014 07:26	07/06/2014 08:03
5	2	Maintenance Outage	15/07/2014 00:27	16/07/2014 21:11
6	3	Problem with the VSD MCWP-B	19/07/2014 11:34	19/07/2014 14:43
7	2	Problem with trafo unit 2BBT01	21/07/2014 10:08	21/07/2014 19:33
8	1	Problem with VSD-A	06/10/2014 16:30	07/10/2014 02:48
9	3	Major Inspection	25/10/2014 00:23	15/11/2014 03:58
10	1	Maintenance Outage	26/11/2014 04:00	28/11/2014 19:27

No.	Unit #	Reasons	Period of outages	
			Start date & time	Finish date & time
11	3	Problem with the MCWP #.2	04/12/2014 12:47	04/12/2014 14:28

Table 2. Planned and forced outages from 01/01/2015 to 31/12/2015

No.	Unit #	Reasons	Period of outages	
			Start date & time	Finish date & time
1	2	Problem with the condenser	20/01/2015 09:24	20/01/2015 11:08
2	3	Problem with the motor power oil #2	18/02/2015 07:24	18/02/2015 17:31
3	3	Problem with the VSD MCWP #1	25/04/2015 21:04	26/04/2015 01:56
4	1	Earthquake	08/05/2015 06:14	08/05/2015 06:30
5	2	Problem during Protective Device Test	03/06/2015 12:52	03/06/2015 13:25
6	1	Problem on the control panel	13/06/2015 15:43	13/06/2015 23:53
7	1	Earthquake	30/07/2015 22:34	30/07/2015 23:11
8	3	Problem with the MCWP #1 & 2	05/08/2015 12:08	05/08/2015 23:03
9	2	Maintenance Outage	22/08/2015 01:57	24/08/2015 23:50
10	3	Maintenance Outage	17/11/2015 00:27	22/11/2015 19:21
11	1	Problem with the Bogor Baru Substasion	28/11/2015 17:08	30/11/2015 02:53
12	2	Problem with the Bogor Baru Substasion	28/11/2015 17:08	01/12/2015 04:47
13	3	Problem with the Bogor Baru Substasion	28/11/2015 17:08	13/12/2015 03:12
14	1	Problem with the Cibinong IBT #2	02/12/2015 10:37	03/12/2015 05:50
15	2	Problem with the Cibinong IBT #2	02/12/2015 10:37	02/12/2015 21:00
16	3	Problem with the turbine bearing #4	02/12/2015 02:36	13/12/2015 03:12
17	3	Problem with the turbine bearing #4	17/12/2015 00:05	18/12/2015 16:52
18	3	Earthquake	19/12/2015 22:07	19/12/2015 23:01

Table 3. Planned and forced outages from 01/01/2016 to 31/03/2016

No.	Unit #	Reasons	Period of outages	
			Start date & time	Finish date & time
1	2	Problem with the Servo Pump	29/01/2016 15:27	29/01/2016 21:00
2	1	Problem with the Generator Air Inlet	06/03/2016 15:23	06/03/2016 22:42

Table 4. Total shutdowns and blackouts from 01/04/2014 to 31/03/2016

Year	Shutdown and blackout	
	Total (Times)	Total (Hours)
2014	11	689.42
2015	18	1,021.37
2016	2	12.87
Total 01/04/2014 - 31/03/2016	31	1,723.65

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

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

2.3 Grouped Project

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

3 DATA AND PARAMETERS

3.1 Data and Parameters Available at Validation

Data and parameters available during validation:

Data Unit / 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>411,363</td></tr> <tr> <td>Unit 2</td><td>399,102</td></tr> <tr> <td>Unit 3</td><td>394,696</td></tr> <tr> <td>Total</td><td>1,205,161</td></tr> </tbody> </table> The data above is based on an average of historical net electricity generation data recorded by PT. Indonesia Power since 1999-2004 for Unit 3 and 2000-2005 for Units 1 and 2.		EG _{historical} until DATE _{BaselineRetrofit} (MWh)	Unit 1	411,363	Unit 2	399,102	Unit 3	394,696	Total	1,205,161
	EG _{historical} until DATE _{BaselineRetrofit} (MWh)										
Unit 1	411,363										
Unit 2	399,102										
Unit 3	394,696										
Total	1,205,161										
Justification of choice of data or description of measurement methods and procedures applied	-										
Purpose of the data:	Baseline emission calculation										
Comments:	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 are summarized transparently in regular production reports. The QA/QC is conducted through cross checking with sales electricity receipts. Meters are calibrated according to the Standard Operational Procedures signed between PT. Indonesia Power and PLN (load dispatcher) or other documents, which update or replace this SOP. Data measured by meters are cross-checked by electricity sales receipt. The meter (s) is either: - be read frequently jointly by the project developer and the grid company - 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
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Data Unit / 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:	The Government Regulation No. 59 year 2007 on Geothermal Activities for 30 years average technical lifetime.														
Value applied:	<table><tr><th></th><th>Commissioning date</th><th>DATE_{BaselineRetrofit}</th></tr><tr><td>Unit 1</td><td>12/03/1994</td><td>12/03/2024</td></tr><tr><td>Unit 2</td><td>12/06/1994</td><td>12/06/2024</td></tr><tr><td>Unit 3</td><td>16/07/1997</td><td>16/07/2027</td></tr></table> The DATE_{BaselineRetrofit} comes from commissioning date of each unit added by the average technical lifetime of 30 years				Commissioning date	DATE _{BaselineRetrofit}	Unit 1	12/03/1994	12/03/2024	Unit 2	12/06/1994	12/06/2024	Unit 3	16/07/1997	16/07/2027
	Commissioning date	DATE _{BaselineRetrofit}													
Unit 1	12/03/1994	12/03/2024													
Unit 2	12/06/1994	12/06/2024													
Unit 3	16/07/1997	16/07/2027													
Justification of choice of data or description of measurement methods and procedures applied	-														
Purpose of the data:	Baseline emission calculation														
Comments:	-														

Data Unit / 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 first commitment period = 21 tCO ₂ /tCH ₄
Justification of choice of data or description of measurement methods and procedures applied	-
Purpose of the data:	Project emission calculation
Comments:	-

Data Unit / Parameter:	ρ_i
Data unit:	kg/m ³
Description:	Density of diesel fuel
Source of data:	Pertamina diesel fuel specification ²
Value applied:	0.815 kg/litre = 815 kg/m ³
Justification of choice of data or description of measurement methods and procedures applied	-
Purpose of the data:	Project emission calculation
Comments:	-

Data Unit / Parameter:	EF _{CM,y}
Data unit:	tCO ₂ /MWh
Description:	EF _{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 50% weighted average of EF _{OM,y} and EF _{BM,y}
Source of data:	PLN
Value applied:	EF _{CM,y} = 0.882 tCO ₂ /MWh
Justification of choice of data or description of measurement methods and procedures applied	-
Purpose of the data:	Baseline and project emission calculations
Comments:	No measurement required. Data is obtained based on analysis of PLN published information.

Data Unit / Parameter:	EF _{OM,y}
Data unit:	tCO ₂ /MWh
Description:	EF _{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 simple OM method for each

² Material Safety Data Sheet (MSDS) of Diesel fuel from Pertamina, <http://www.pertamina.com/index.php/detail/read/solar>, retrieved on 24/05/2012

	year in which the project generation occurs. During the crediting period, this factor is calculated based on ex-ante emissions by using year 2004, 2005 and 2006 data.
Source of data:	PLN
Value applied:	$EF_{OM,y} = 0.829 \text{ tCO}_2/\text{MWh}$
Justification of choice of data or description of measurement methods and procedures applied	-
Purpose of the data:	Baseline and project emission calculations
Comments:	No measurement required. Data is obtained based on analysis of PLN published information. All data relevant for the calculation of $EF_{OM,y}$ are updated annually. This includes each associated fuel emission factor and corresponding net calorific values, is re-defined annually.

Data Unit / Parameter:	$EF_{BM,y}$
Data unit:	tCO_2/MWh
Description:	$EF_{BM,y}$ 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 2006 data.
Source of data:	PLN
Value applied:	$EF_{BM,y} = 0.936 \text{ tCO}_2/\text{MWh}$
Justification of choice of data or description of measurement methods and procedures applied	-
Purpose of the data:	Baseline and project emission calculations
Comments:	No measurement required. Data is obtained based on analysis of PLN published information. All data relevant for the calculation of $EF_{BM,y}$ 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 Unit / Parameter:	$FC_{i,j,y}$
Data unit:	kT
Description:	Consumption of fuel type 'i', in year 'y', for power plant in group 'j', where: Group 'j' is power plants in JAMALI grid excluding the low-cost/must-run sources (Whichever is larger compare to group 'm').
Source of data:	PLN
Value applied:	Refer to: JAMALI EF grid calculation
Justification of choice of data or description of measurement methods and procedures applied	-
Purpose of the data:	Baseline and project emission calculations
Comments:	No measurement required. Data is obtained based on analysis of PLN published information.

Data Unit / Parameter:	$FC_{i,m,y}$
Data unit:	kT
Description:	Consumption of fuel type 'i', in year 'y', for power plant in group 'm', where: Group 'm' is five most recently build power plants or power plants capacity additions that comprise 20% of system generation (whichever is larger compare to group 'j').
Source of data:	PLN
Value applied:	Refer to: JAMALI EF grid calculation
Justification of choice of data or description of measurement methods and procedures applied	-
Purpose of the data:	Baseline and project emission calculations
Comments:	No measurement required. Data is obtained based on analysis of PLN published information.

Data Unit / Parameter:	$\sum_j EG_{j,y}$
Data unit:	MWh
Description:	Generation data of power plants in sample group 'j' in year 'y', where: Group 'j' is power plants in JAMALI grid excluding the low-cost/must-run sources (Whichever is larger compare to group 'm').
Source of data:	PLN
Value applied:	Refer to: JAMALI EF grid calculation
Justification of choice of data or description of measurement methods and procedures applied	-
Purpose of the data:	Baseline and project emission calculations
Comments:	No measurement required. Data is obtained based on analysis of PLN published information.

Data Unit / Parameter:	$\sum_m EG_{m,y}$
Data unit:	MWh
Description:	Generation data of power plants in sample group 'm' in year 'y', where: Group 'm' is five most recently build power plants or power plants capacity additions that comprise 20% of system generation (whichever is larger compare to group 'j').
Source of data:	PLN
Value applied:	Refer to: JAMALI EF grid calculation
Justification of choice of data or description of measurement methods and procedures applied	-
Purpose of the data:	Baseline and project emission calculations
Comments:	No measurement required. Data is obtained based on analysis of PLN published information.

Data Unit / Parameter:	NCV _i
Data unit:	TJ/kt
Description:	Net calorific value of fuel type 'i' for purpose of calculating grid emission factor and diesel fuel consumption
Source of data:	Publication from various country relevant sources or 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Workbook volume 2 chapter 1 Table 1.2, page 1.18
Value applied:	HSD & Diesel Fuel = 43 TJ/kt (= 0.043 GJ/kg) MFO = 40.4 TJ/kt Coal = 21.34TJ/kt Natural gas = 48 TJ/kt
Justification of choice of data or description of measurement methods and procedures applied	-
Purpose of the data:	Baseline and project emission calculations
Comments:	-

Data Unit / Parameter:	EF _{CO2}
Data unit:	tCO ₂ /TJ
Description:	CO ₂ emission factor of fuel type 'i' for purpose of calculating grid emission factor and diesel fuel consumption
Source of data:	2006 IPCC Guidelines for National Greenhouse Gas Inventories: Workbook volume 2 chapter 1 Table 1.4, page 1.23
Value applied:	HSD & Diesel Fuel = 74.1 tCO ₂ /TJ (= 0.074 tCO ₂ /GJ) MFO = 77.4 tCO ₂ /TJ Coal = 96.1 tCO ₂ /TJ Natural gas = 56.1 tCO ₂ /TJ
Justification of choice of data or description of measurement methods and procedures applied	-
Purpose of the data:	-
Comments:	-

3.2 Data and Parameters Monitored

Data and parameters monitored according to monitoring plan:

Data Unit / Parameter:	M _{S,y}																							
Data unit:	Tonnes																							
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 monitored:	<table><tr><th rowspan="2"></th><th colspan="3">Steam produced during the year 'y' (tons/year)</th></tr><tr><th>01/04/2014 - 31/12/2014</th><th>01/01/2015 - 31/12/2015</th><th>01/01/2016 - 31/03/2016</th></tr><tr><td>Unit 1</td><td>3,030,609.50</td><td>3,855,693.80</td><td>868,015.00</td></tr><tr><td>Unit 2</td><td>2,887,450.30</td><td>3,594,520.20</td><td>936,114.40</td></tr><tr><td>Unit 3</td><td>2,696,728.50</td><td>3,556,581.00</td><td>950,350.10</td></tr><tr><td>Total</td><td>8,614,788.30</td><td>11,006,795.00</td><td>2,754,479.50</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' (tons/year)			01/04/2014 - 31/12/2014	01/01/2015 - 31/12/2015	01/01/2016 - 31/03/2016	Unit 1	3,030,609.50	3,855,693.80	868,015.00	Unit 2	2,887,450.30	3,594,520.20	936,114.40	Unit 3	2,696,728.50	3,556,581.00	950,350.10	Total	8,614,788.30	11,006,795.00	2,754,479.50
	Steam produced during the year 'y' (tons/year)																							
	01/04/2014 - 31/12/2014	01/01/2015 - 31/12/2015	01/01/2016 - 31/03/2016																					
Unit 1	3,030,609.50	3,855,693.80	868,015.00																					
Unit 2	2,887,450.30	3,594,520.20	936,114.40																					
Unit 3	2,696,728.50	3,556,581.00	950,350.10																					
Total	8,614,788.30	11,006,795.00	2,754,479.50																					
Monitoring equipment:	Steam flow meters used from 01/08/2012 to 31/03/2016 as follows: <table><tr><th>Steam flow meter</th><th>Serial number</th><th>Accuracy</th><th>Calibration Details</th></tr><tr><td>Unit #1</td><td>H400C50109D</td><td>0.25%</td><td>Previous: 08/09/2008 13/07/2009 26/07/2010 25/07/2011 25/07/2012 25/07/2013</td></tr></table>	Steam flow meter	Serial number	Accuracy	Calibration Details	Unit #1	H400C50109D	0.25%	Previous: 08/09/2008 13/07/2009 26/07/2010 25/07/2011 25/07/2012 25/07/2013															
Steam flow meter	Serial number	Accuracy	Calibration Details																					
Unit #1	H400C50109D	0.25%	Previous: 08/09/2008 13/07/2009 26/07/2010 25/07/2011 25/07/2012 25/07/2013																					

				16/07/2014 Current: 13/07/2015 Next: 13/07/2016
	Unit #2	1594052708	0.25%	Previous: 08/09/2008 15/07/2009 27/07/2010 25/07/2011 25/07/2012 25/07/2013 16/07/2014 Current: 13/07/2015 Next: 13/07/2016
	Unit #3	D404420109D	0.25%	Previous: 08/09/2008 14/07/2009 28/07/2010 26/07/2011 26/07/2012 26/07/2013 16/07/2014 Current: 14/07/2015 Next: 14/07/2016
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 the data	Calculation of project emissions			
Calculation method:	A back up check calculation is only applicable during emergencies such as trip or scaling in the steam pipeline occurred, which steam			

	flow data could not be recorded.
Comments:	Steam flow is read continuously and logged daily. Data is entered into the Steam flow report and is checked for consistency when entered. During emergencies such as trip, scaling in the steam pipeline, etc, caused no steam flow recorded, a backup check calculation is performed conservatively replacing unavailability measured steam flow for certain period. The backup check calculation is described in more detail in the SOP Carbon Credit Gunung Salak.

Data Unit / Parameter:	W _{main,CO2}																																		
Data unit:	t CO ₂ /t steam																																		
Description:	Average mass fraction of carbon dioxide in the produced steam (non-dimensional)																																		
Source of data:	The Non-Condensable Gases (NCG) data taken from steam sampling as prescribed in the Monitoring Methodology ACM0002 version 07.																																		
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 07. The Non-Condensable Gases (NCG) sampling and analysis is performed every four 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 4 months																																		
Value monitored:	<table><tr><th rowspan="2">Anal ysis #</th><th rowspan="2">Period to be used in PES_y calculation</th><th colspan="3">CO₂ values to be used in PES_y calculation (non dimensional)</th></tr><tr><th>UNIT #1</th><th>UNIT #2</th><th>UNIT #3</th></tr><tr><td rowspan="4">1</td><td>04/2014</td><td>0.0051340</td><td>0.0037354</td><td>0.0043279</td></tr><tr><td>05/2014</td><td>0.0051340</td><td>0.0037354</td><td>0.0043279</td></tr><tr><td>06/2014</td><td>0.0051340</td><td>0.0037354</td><td>0.0043279</td></tr><tr><td>07/2014</td><td>0.0051340</td><td>0.0037354</td><td>0.0043279</td></tr><tr><td>2</td><td>08/2014</td><td>0.0034749</td><td>0.0044560</td><td>0.0042292</td></tr></table>					Anal ysis #	Period to be used in PES _y calculation	CO ₂ values to be used in PES _y calculation (non dimensional)			UNIT #1	UNIT #2	UNIT #3	1	04/2014	0.0051340	0.0037354	0.0043279	05/2014	0.0051340	0.0037354	0.0043279	06/2014	0.0051340	0.0037354	0.0043279	07/2014	0.0051340	0.0037354	0.0043279	2	08/2014	0.0034749	0.0044560	0.0042292
Anal ysis #	Period to be used in PES _y calculation	CO ₂ values to be used in PES _y calculation (non dimensional)																																	
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		10/2014	0.0034749	0.0044560	0.0042292																											
		11/2014	0.0034749	0.0044560	0.0042292																											
	3	12/2014	0.0027522	0.0047004	0.0045634																											
		01/2015	0.0027522	0.0047004	0.0045634																											
		02/2015	0.0027522	0.0047004	0.0045634																											
		03/2015	0.0027522	0.0047004	0.0045634																											
	4	04/2015	0.0033170	0.0040041	0.0045527																											
		05/2015	0.0033170	0.0040041	0.0045527																											
		06/2015	0.0033170	0.0040041	0.0045527																											
		07/2015	0.0033170	0.0040041	0.0045527																											
	5	08/2015	0.0034233	0.0041737	0.0047874																											
		09/2015	0.0034233	0.0041737	0.0047874																											
		10/2015	0.0034233	0.0041737	0.0047874																											
		11/2015	0.0034233	0.0041737	0.0047874																											
	6	12/2015	0.0038975	0.0049605	0.0047057																											
		01/2016	0.0038975	0.0049605	0.0047057																											
		02/2016	0.0038975	0.0049605	0.0047057																											
		03/2016	0.0038975	0.0049605	0.0047057																											
	7	04/2016	0.0042596	0.0049316	0.0054053																											
		05/2016	0.0042596	0.0049316	0.0054053																											
		06/2016	0.0042596	0.0049316	0.0054053																											
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NCG analysis is conducted as per 4-months schedule.																																
Monitoring equipment:	Equipment’s monitored as per Monitoring Methodology ACM0002 version 07.																															
QA/QC procedures to be applied:	Gunung Salak Geothermal Laboratory QA/QC Procedure																															
Purpose of the data	Calculation of project emissions																															
Calculation method:	-																															

Comments:	-
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Data Unit / Parameter:	$W_{\text{main,CH}_4}$																																																																								
Data unit:	t CH ₄ /t steam																																																																								
Description:	Average mass fraction of methane gas in the produced steam (non-dimensional).																																																																								
Source of data:	The Non-Condensable Gases (NCG) data taken from steam sampling as prescribed in the Monitoring Methodology ACM0002 version 07.																																																																								
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 07. The Non-Condensable Gases (NCG) sampling and analysis is performed every four 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 PES _y calculation	CH ₄ values to be used in PES _y calculation (non dimensional)																																																																							
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	5	08/2015	0.0000056700	0.0000067672	0.0000136170																										
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		11/2015	0.0000056700	0.0000067672	0.0000136170																										
		12/2015	0.0000000287	0.0000000848	0.0000000450																										
	6	01/2016	0.0000000287	0.0000000848	0.0000000450																										
		02/2016	0.0000000287	0.0000000848	0.0000000450																										
		03/2016	0.0000000287	0.0000000848	0.0000000450																										
		04/2016	0.0000002200	0.0000009116	0.0000015333																										
	7	05/2016	0.0000002200	0.0000009116	0.0000015333																										
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Monitoring equipment:	Equipment's monitored as per Monitoring Methodology ACM0002 version 07.																														
QA/QC procedures to be applied:	Gunung Salak Geothermal Laboratory QA/QC Procedure																														
Purpose of the data	Calculation of project emissions																														
Calculation method:	-																														
Comments:	-																														

Data Unit / Parameter:	EG _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 monitored:	<table><tr><th rowspan="2"></th><th colspan="3">EG_y (MWh)</th></tr><tr><th>01/04/2014 - 31/12/2014</th><th>01/01/2015 - 31/12/2015</th><th>01/01/2016 - 31/03/2016</th></tr><tr><td>Unit 1</td><td>373,963.66</td><td>472,854.65</td><td>110,634.42</td></tr><tr><td>Unit 2</td><td>367,845.36</td><td>483,078.81</td><td>120,748.42</td></tr><tr><td>Unit 3</td><td>348,401.86</td><td>472,543.48</td><td>126,100.65</td></tr><tr><td>Total</td><td>1,090,210.88</td><td>1,428,476.94</td><td>357,483.49</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 in June 2014. Based on the UNFCCC “Guidelines for assessing compliance with the calibration frequency requirements” v.01, where described that a maximum permissible error must be considered in BE_y calculation in case of the revenue meter calibration delay as per following formula: EG_{exp} = EG_{exp} x (100% - accuracy of revenue meter) = EG_{exp} x (100% - 0.2%) Therefore, net electricity generation (EG_y) values used in the ER calculation as following table: <table><tr><th rowspan="2"></th><th colspan="3">EG_y (MWh)</th></tr><tr><th>01/04/2014 - 31/12/2014</th><th>01/01/2015 - 31/12/2015</th><th>01/01/2016 - 31/03/2016</th></tr><tr><td>Unit 1</td><td>373,958.09</td><td>472,854.65</td><td>110,634.42</td></tr><tr><td>Unit 2</td><td>367,839.88</td><td>483,078.81</td><td>120,748.42</td></tr></table>		EG _y (MWh)			01/04/2014 - 31/12/2014	01/01/2015 - 31/12/2015	01/01/2016 - 31/03/2016	Unit 1	373,963.66	472,854.65	110,634.42	Unit 2	367,845.36	483,078.81	120,748.42	Unit 3	348,401.86	472,543.48	126,100.65	Total	1,090,210.88	1,428,476.94	357,483.49		EG _y (MWh)			01/04/2014 - 31/12/2014	01/01/2015 - 31/12/2015	01/01/2016 - 31/03/2016	Unit 1	373,958.09	472,854.65	110,634.42	Unit 2	367,839.88	483,078.81	120,748.42
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	Total	1,090,194.30	1,428,476.94	357,483.49
Monitoring equipment:	Revenue meters used between 01/04/2014 – 31/03/2016 are:			
	Revenue meter	Serial number	Class of Accuracy	Calibration date
	Unit #1	PT 0806A117-01	0.2	Previous: 12/09/2008
		MT-1006A500-01	0.2	Previous: 10/08/2010
		MT-1009A635-01 (PLN owned back-up meter)	0.2	Valid: 20/12/2010 Next: 20/12/2015
		PT 0806A119-01	0.2	Previous: 01/06/2012 Next: 01/06/2014
		PT 0806A119-01	0.2	Current: 03/06/2014 Next: 03/06/2016
	Unit #2	PT 0806A118-01	0.2	Previous: 12/09/2008 20/04/2011
		PT-0802A471-01 (PLN owned back-up meter)	0.2	Valid: 20/12/2010 Next: 20/12/2015
		PT 0806A118-01	0.2	Previous: 01/06/2012 Next: 01/06/2014
		PT 0806A118-01	0.2	Current: 03/06/2014 Next: 03/06/2016
	Unit #3	PT 0806A119-01	0.2	Previous:

				12/09/2008 04/11/2009 ³ 20/04/2011
		PT-0802A475-01 (PLN owned back-up meter)	0.2	Valid: 20/12/2010 Next: 20/12/2015
		MT 1006A500-01	0.2	Previous: 01/06/2012 Next: 01/06/2014
		MT 1006A500-01	0.2	Current: 03/06/2014 Next: 03/06/2016
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 regulations⁴. Data measured by meters is cross-checked by electricity sales receipt. The meter (s) is 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			

³ The reason for having only a year gap for Unit #3 revenue meter calibration is LAN communication failure, which then needed to be fixed and subsequently recalibrated. During that time, a back-up meter owned by PT. PLN (Persero) was used to measure electricity generation from Unit #3

⁴ 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.

Purpose of the data	Calculation of baseline emissions
Calculation method:	-
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 23 January 2003.

Data Unit / Parameter:	EG _{baseline}										
Data unit:	MWh										
Description:	Baseline electricity supplied to the grid in the case of modified or retrofit facilities (MWh)										
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 result is summarized transparently in regular production reports.										
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 monitored:	$EG_{baseline} = EG_{historical}, \text{until } DATE_{Baseline Retrofit}$ $EG_{baseline} = EG_y, \text{on / after Date}_{Baseline Retrofit}$ <table border="1"> <thead> <tr> <th></th><th>EG_{baseline}(MWh)</th></tr> </thead> <tbody> <tr> <td>Unit 1</td><td>411,363.29</td></tr> <tr> <td>Unit 2</td><td>399,102.44</td></tr> <tr> <td>Unit 3</td><td>394,696.30</td></tr> <tr> <td>Total</td><td>1,205,162.03</td></tr> </tbody> </table> The data above is based on 5-years historical data recorded by PT. Indonesia Power between 1999-2004 for Unit 3 and 2000-2005 for Units 1 and 2 before the project activity.		EG _{baseline} (MWh)	Unit 1	411,363.29	Unit 2	399,102.44	Unit 3	394,696.30	Total	1,205,162.03
	EG _{baseline} (MWh)										
Unit 1	411,363.29										
Unit 2	399,102.44										
Unit 3	394,696.30										
Total	1,205,162.03										

Monitoring equipment:	Revenue meters used between 1999 to 2004 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>PS 0512A040-01</td><td>0.2</td><td>1994,1999 and 2005</td></tr><tr><td>Unit #2</td><td>PS 0512A041-01</td><td>0.2</td><td>1994,1999 and 2005</td></tr><tr><td>Unit #3</td><td>PS 0512A042-01</td><td>0.2</td><td>1994,1999 and 2005</td></tr></table> The revenue meters were externally calibrated in 1994, 1999 and 2005 by Laboratorium Kalibrasi PT. PLN (Persero). Note: On 01/10/2008, the revenue meter was replaced by PT 0806A117-01 / PT 0806A118-01 / PT 0806A119-01.	Revenue meter	Serial number	Class of Accuracy	Calibration date	Unit #1	PS 0512A040-01	0.2	1994,1999 and 2005	Unit #2	PS 0512A041-01	0.2	1994,1999 and 2005	Unit #3	PS 0512A042-01	0.2	1994,1999 and 2005
Revenue meter	Serial number	Class of Accuracy	Calibration date														
Unit #1	PS 0512A040-01	0.2	1994,1999 and 2005														
Unit #2	PS 0512A041-01	0.2	1994,1999 and 2005														
Unit #3	PS 0512A042-01	0.2	1994,1999 and 2005														
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 regulations. Data measured by meters are cross-checked by electricity sales receipt. The meter (s) is 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 the data	Calculation of baseline emissions																
Calculation method:	-																
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 23 January 2003.																

Data Unit / Parameter:	EG _{imp}																							
Data unit:	MWh																							
Description:	Electricity imported from the grid																							
Source of data:	Project Owner-PLN revenue meter																							
Description of measurement methods and procedures to be applied:	Electricity imported 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 imported 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. The electricity-imported data refers to regular production spreadsheet that is recorded in electronic format.																							
Frequency of monitoring/recording:	The measurement of electricity imported is conducted on a continuous basis, where hourly and daily total electricity measurement is available.																							
Value monitored:	<table><tr><th rowspan="2"></th><th colspan="3">EG_{imp} (MWh)</th></tr><tr><th>01/04/2014 - 31/12/2014</th><th>01/01/2015 - 31/12/2015</th><th>01/01/2016 - 31/03/2016</th></tr><tr><td>Unit 1</td><td>59.06</td><td>142.22</td><td>89.21</td></tr><tr><td>Unit 2</td><td>130.71</td><td>181.63</td><td>14.74</td></tr><tr><td>Unit 3</td><td>59.36</td><td>188.53</td><td>-</td></tr><tr><td>Total</td><td>249.13</td><td>512.37</td><td>103.95</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 in June 2014. Based on the UNFCCC “Guidelines for assessing compliance with the calibration frequency requirements” v.01, where described that a maximum permissible error must be considered in BE_y calculation in case of the revenue meter calibration delay as per following formula: EG_{imp} = EG_{imp} x (100% + accuracy of revenue meter)		EG _{imp} (MWh)			01/04/2014 - 31/12/2014	01/01/2015 - 31/12/2015	01/01/2016 - 31/03/2016	Unit 1	59.06	142.22	89.21	Unit 2	130.71	181.63	14.74	Unit 3	59.36	188.53	-	Total	249.13	512.37	103.95
	EG _{imp} (MWh)																							
	01/04/2014 - 31/12/2014	01/01/2015 - 31/12/2015	01/01/2016 - 31/03/2016																					
Unit 1	59.06	142.22	89.21																					
Unit 2	130.71	181.63	14.74																					
Unit 3	59.36	188.53	-																					
Total	249.13	512.37	103.95																					

				Next: 01/06/2014
		PT 0806A118-01	0.2	Current: 03/06/2014 Next: 03/06/2016
	Unit #3	PT 0806A119-01	0.2	Previous: 12/09/2008 04/11/2009 ⁵ 20/04/2011
		PT-0802A475-01 (PLN owned back-up meter)	0.2	Valid: 20/12/2010 Next: 20/12/2015
		MT 1006A500-01	0.2	Previous: 01/06/2012 Next: 01/06/2014
		MT 1006A500-01	0.2	Current: 03/06/2014 Next: 03/06/2016
QA/QC procedures to be applied:	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 regulations.			
Purpose of the data	Calculation of baseline emissions			
Calculation method:	-			
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 23 January 2003.			

⁵ The reason for having only a year gap for Unit #3 revenue meter calibration is LAN communication failure, which then needed to be fixed and subsequently recalibrated. During that time, a back-up meter owned by PT. PLN (Persero) was used to measure electricity generation from Unit #3

Data Unit / Parameter:	FC _{i,y}																															
Data unit:	Litres/year																															
Description:	Amount of diesel fuel used in the geothermal power plant operation																															
Source of data:	Project Owner-diesel fuel operational logbook																															
Description of measurement methods and procedures to be applied:	Fuel consumption is recorded monthly, specifically for each fuel (currently only diesel consumption is available). Fuel consumption is calculated from power shutdown records (hours) and/or diesel usage by using emergency diesel genset 400 kVA/320 kWh technical specification incl. its fuel consumption specification (0.260—it depends on each diesel genset), resulted in litres then converted to tonnes using fuel specific density or scientifically proven fuel densities.																															
Frequency of monitoring/recording:	Fuel consumption is recorded monthly, specifically for each fuel (currently only diesel consumption is available).																															
Value monitored:	<table><tr><th rowspan="2">Monitoring year</th><th rowspan="2">Power shutdown/diesel usage (hours)</th><th colspan="2">Diesel specification</th><th rowspan="2">Diesel fuel (litres/year)</th></tr><tr><th>Energy (kWh)</th><th>Fuel consumption</th></tr><tr><td>01/04/2014 -31/12/2014</td><td>701.17</td><td>320</td><td>0.260</td><td>58,337.07</td></tr><tr><td>01/01/2015 -31/12/2015</td><td>1,042.23</td><td>320</td><td>0.260</td><td>86,713.81</td></tr><tr><td>01/01/2016 -31/03/2016</td><td>18.93</td><td>320</td><td>0.260</td><td>1,575.25</td></tr><tr><td>Total 01/04/2014 -31/03/2016</td><td>1,743.40</td><td></td><td></td><td>145,050.88</td></tr></table> The data above is based on actual data recorded by PT. Indonesia Power. Power shutdown data is recorded for the whole power plant. For simplification, to calculate the actual ER, project emission from total diesel consumption recorded by the Project Owner is only inserted in table ER calculation Unit #1 (while PE from diesel consumption in both Unit 2 and Unit 3 is considered zero).					Monitoring year	Power shutdown/diesel usage (hours)	Diesel specification		Diesel fuel (litres/year)	Energy (kWh)	Fuel consumption	01/04/2014 -31/12/2014	701.17	320	0.260	58,337.07	01/01/2015 -31/12/2015	1,042.23	320	0.260	86,713.81	01/01/2016 -31/03/2016	18.93	320	0.260	1,575.25	Total 01/04/2014 -31/03/2016	1,743.40			145,050.88
Monitoring year	Power shutdown/diesel usage (hours)	Diesel specification		Diesel fuel (litres/year)																												
		Energy (kWh)	Fuel consumption																													
01/04/2014 -31/12/2014	701.17	320	0.260	58,337.07																												
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01/01/2016 -31/03/2016	18.93	320	0.260	1,575.25																												
Total 01/04/2014 -31/03/2016	1,743.40			145,050.88																												
Monitoring equipment:	-																															
QA/QC procedures to be applied:	-																															

Purpose of the data	Calculation of project emissions
Calculation method:	Fuel consumption is calculated from power shutdown records (hours) and/or diesel usage by using emergency diesel genset 400 kVA/320 kWh technical specification incl. its fuel consumption specification (0.260—it depends on each diesel genset), resulted in litres then converted to tonnes using fuel specific density or scientifically proven fuel densities. Following is formulae to calculate fuel consumption: $FC_{i,j,y} = \text{Total shutdown time (hours)} \times \text{Energy (kWh)} \times \text{specific fuel consumption (0.260)}$ Example of fuel consumption calculation for 01/04/2014-31/12/2014: $FC_{i,j,y} = 701.17 \text{ hours} \times 320 \text{ kWh} \times 0.260 = 58,337.07 \text{ litres}$
Comments:	Fuel consumption only occurs in emergencies when power plant is not operational and the grid is also not available, a confluence of events which is expected to happen very rarely; at other times the plant runs on grid electricity. Emergency diesel genset 400 kVA/320 kWh is only for critical instrument/control system during turbine trip and shutdown.

Table 5. Technical details of monitoring instruments

S.No	Equipment	Description
1	Electricity Revenue Meter Unit #1 (01/04/2009 – 10/08/2010) For EG_y and EG_{imp}	Name: Static Energy Meter Manufacturer: ION Type: 8600 Unit #1: PT 0806A117-01 Class of Accuracy: 0.2 Date of Calibration: 12/09/2008 Range: 5 A; 57.7 V; 50 Hz
2	Electricity Revenue Meter Unit #1 (10/08/2010 – 16/02/2012 at 10:00 AM) For EG_y 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: 10/08/2010 Range: 2.5 A; 57 - 277 V; 50 Hz
3	PLN Owned Back Up Electricity	Name: Static Energy Meter

S.No	Equipment	Description
	Revenue Meter Unit #1 (16/02/2012 at 10:01 AM – 01/06/2012 at 10:00 AM) For EG _y and EG _{imp}	Manufacturer: Schneider Electric Type: ION 8600 Unit #1: MT-1009A635-01 Class of Accuracy: 0.2 Date of Calibration: 20/12/2010 Range: 2.5 A; 57 - 277 V; 50 Hz
4	Electricity Revenue Meter Unit #1 (01/06/2012 - 01/06/2014 at 10:00 AM) For EG _y 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: 01/06/2012 Range: 0.05 - 20 A; 57 - 277 V; 50 Hz
5	Electricity Revenue Meter Unit #1 (03/06/2014 at 10:01 AM - onwards) For EG _y 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 Range: 0.05 - 20 A; 57 - 277 V; 50 Hz
6	Electricity Revenue Meter Unit #2 (01/04/2009 - 16/02/12 at 10:00 AM) For EG _y and EG _{imp}	Name: Static Energy Meter Manufacturer: ION Type: 8600 Unit #2: PT 0806A118-01 Class of Accuracy: 0.2 Date of Calibration: 12/09/2008 & 20/04/2011 Range: 5 A; 57.7 V; 50 Hz
7	PLN Owned Back Up Electricity Revenue Meter Unit #2 (16/02/2012 at 10:01 AM – 01/06/2012 at 10:00 AM) For EG _y and EG _{imp}	Name: Static Energy Meter Manufacturer: Power Measurement Type: ION 8600 Unit #2: PT-0802A471-01 Class of Accuracy: 0.2 Date of Calibration: 20/12/2010 Range: 2.5 A; 57 - 277 V; 50 Hz
8	Electricity Revenue Meter Unit #2 (01/06/2012 - 01/06/2014 at 10:00	Name: Static Energy Meter Manufacturer: ION

S.No	Equipment	Description
	AM) For EG _y and EG _{imp}	Type: 8600 Unit #2: PT 0806A118-01 Class of Accuracy: 0.2 Date of Calibration: 01/06/2012 Range: 5 A; 57.7 V; 50 Hz
9	Electricity Revenue Meter Unit #2 (03/06/2014 at 10:01 AM - onwards) For EG _y and EG _{imp}	Name: Static Energy Meter Manufacturer: ION Type: 8600 Unit #2: PT 0806A118-01 Class of Accuracy: 0.2 Date of Calibration: 03/06/2014 Range: 5 A; 57.7 V; 50 Hz
10	Electricity Revenue Meter Unit #3 (01/04/2009 - 16/02/2012 at 10:00 AM) For EG _y and EG _{imp}	Name: Static Energy Meter Manufacturer: ION Type: 8600 Unit #3: PT 0806A119-01 Class of Accuracy: 0.2 Date of Calibration: 12/09/2008 & 04/11/2009 Range: 0.05 - 20 A; 57 - 277 V; 50 Hz
11	PLN Owned Back Up Electricity Revenue Meter Unit #3 (16/02/2012 at 10:01 AM – 01/06/2012 at 10:00 AM) For EG _y and EG _{imp}	Name: Static Energy Meter Manufacturer: Power Measurement Type: ION 8600 Unit #3: PT-0802A475-01 Class of Accuracy: 0.2 Date of Calibration: 20/12/2010 Range: 2.5 A; 57 - 277 V; 50 Hz
12	Electricity Revenue Meter Unit #3 (01/06/2012 - 01/06/2014 at 10:00 AM) For EG _y and EG _{imp}	Name: Static Energy Meter Manufacturer: Schneider Electric Type: ION 8600 Unit #3: MT-1006A500-01 Class of Accuracy: 0.2 Date of Calibration: 01/06/2012 Range: 2.5 A; 57 - 277 V; 50 Hz
13	Electricity Revenue Meter Unit #3 (03/06/2014 10:01 AM - onwards)	Name: Static Energy Meter Manufacturer: Schneider Electric Type: ION 8600

S.No	Equipment	Description
	For EG _y and EG _{imp}	Unit #3: MT-1006A500-01 Class of Accuracy: 0.2 Date of Calibration: 03/06/2014 Range: 2.5 A; 57 - 277 V; 50 Hz
14	Steam Flow Meter Unit #1 For M _{S,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: 08/09/2008, 13/07/2009, 26/07/2010, 25/07/2011, 25/07/2012, 25/07/2013, 16/07/2014, & 13/07/2015
15	Steam Flow Meter Unit #2 For M _{S,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 - Scale: 0 ~ 100 % Accuracy: 0.25 % Date of Calibration: 08/09/2008, 15/07/2009, 27/07/2010, 25/07/2011, 25/07/2012, 25/07/2013, 16/07/2014, & 13/07/2015
16	Steam Flow Meter Unit #3 For M _{S,y}	Name: Main Steam Flow Meter Transmitter Manufacturer: Endress-Hausser Model No.: FMD78 Serial No.: D404420109D Instrument No.: 3LBA01CF001-B01 Range:

S.No	Equipment	Description
		• Input: 0 ~ 200 mBar • Output: 4 ~ 20 mA DC • Scale: 0 ~ 100 % Accuracy: 0.25 % Date of Calibration: 08/09/2008, 14/07/2009, 28/07/2010, 26/07/2011, 26/07/2012, 26/07/2013, 16/07/2014, & 14/07/2015

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.

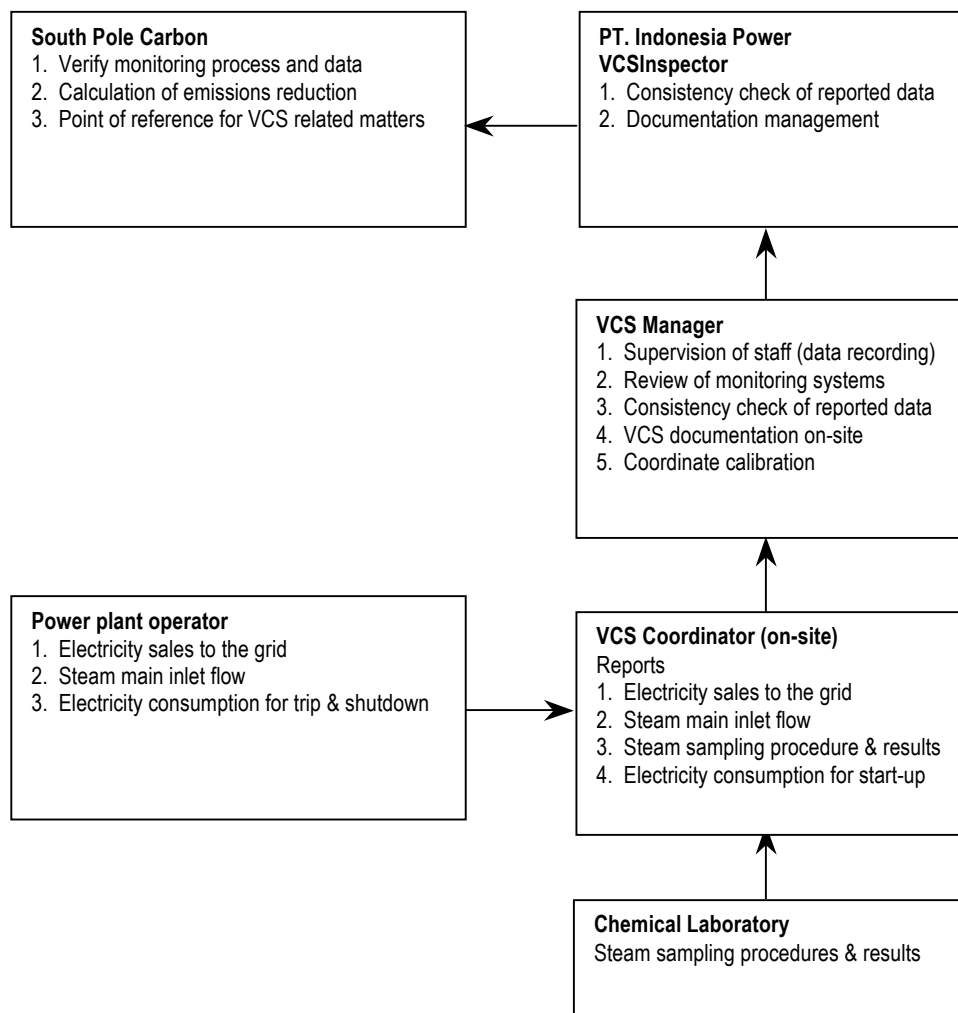
Details of Monitoring Team and Responsibilities

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 3. Gunung Salak geothermal power plant organization chart



During monitoring period from 01/04/2014 to 31/03/2016, there is a change of person in charge (PIC) due to retirement. Therefore, following table shows person in charge during monitoring period from 11/05/2015 to 31/03/2016.

Table 6. 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	Gunung Salak Site Manager	Mr. Ervan Ambarita

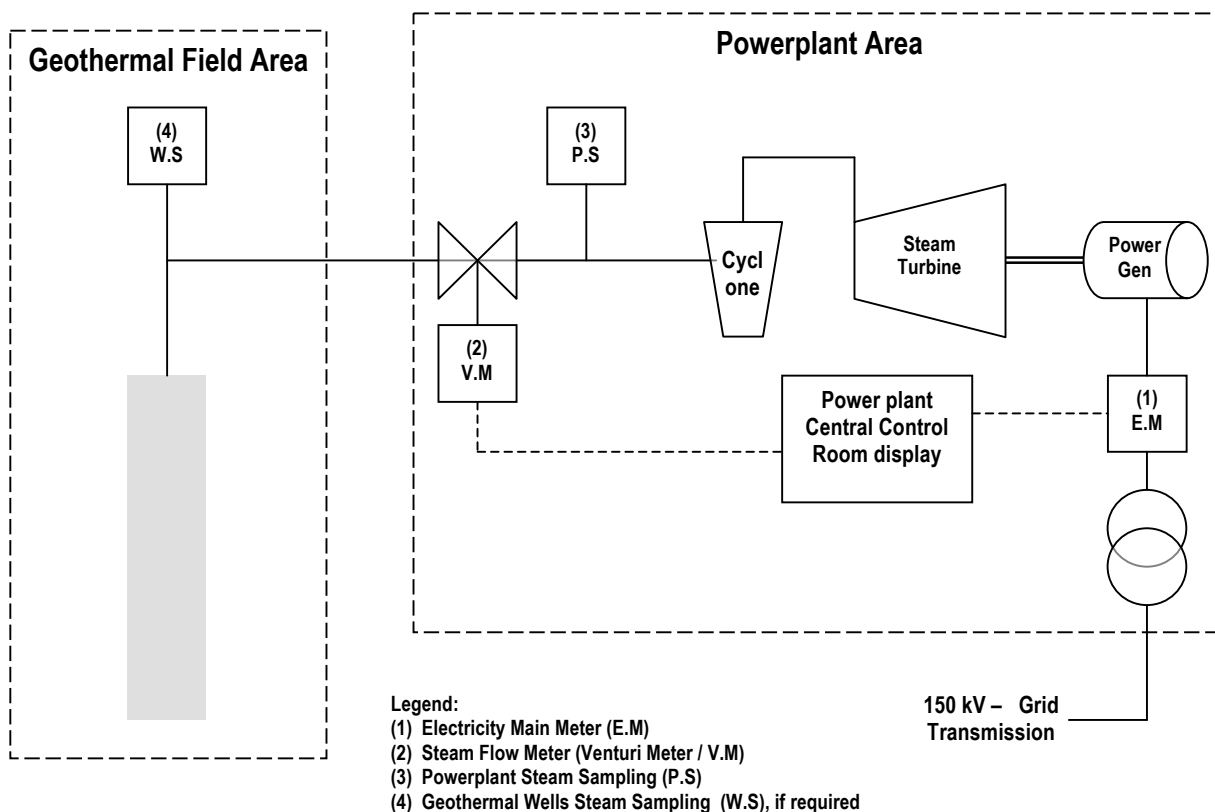
Team	Jobs and responsibilities	Position at the PT. Indonesia Power	Represented by (name)
	stored monthly report. • Prepare yearly report.		
VCS Coordinator	• Prepare monthly report in the excel sheet	AMA Renval Operation	Mr. Henrey
Power plant operator (per shift)	• Record hourly data of steam flow, 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 (four-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 4. Gunung Salak geothermal power plant monitoring equipments



4 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

4.1 Baseline Emissions

Baseline emissions as described in the ACM0002 v.07 is calculated as following:

$$BE_y = (EG_y - EG_{baseline}) EF_{grid,CM,y}$$

$$EG_{baseline} = EG_{historical}, \text{ until Date}_{Baseline Retrofit}$$

$$EG_{baseline} = EG_y, \text{ on / after Date}_{Baseline Retrofit}$$

Where:

BE_y	Baseline emissions in year y (tCO ₂ /yr)
EG_y	Electricity supplied by the project activity to the grid (MWh)
$EG_{baseline}$	Baseline electricity supplied to the grid in the case of modified or retrofit facilities (MWh). For new power plants this value is taken as zero.
$EF_{grid,CM,y}$	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”
$EG_{\text{historical}}$	Average of historical electricity delivered by the existing facility to the grid (MWh).
$DATE_{\text{BaselineRetrofit}}$	Point in time when the existing equipment would need to be replaced in the absence of the project activity (date)

The project has taken the emission factor 0.882 tCO₂/MWh for estimation of baseline emission reductions as conservative. 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 01, 19/10/2007 (EB 35). 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 2004, 2005 and 2006 data. The 2004, 2005 and 2006 Operation Margin Emission Factor is calculated as follows: 0.764, 0.854 and 0.867 tCO₂e/MWh. The average Operating Margin Emission Factor (2004, 2005 and 2006) is 0.829 tCO₂e/MWh. While the ex-ante Build Margin Emission Factor is calculated to be 0.936 tCO₂e/MWh by dividing total CO₂ emissions by the total annual generation data. The values are presented in **Table 7**.

Table 7. Emission factor of Jamali Grid as per validated VCS PD

Parameter	As per the validated VCS project data
Operating Margin (OM) in t CO ₂ / MWh	0.829
Build Margin (BM), in t CO ₂ / MWh	0.936
Combined Margin (CM) Simple average of OM and BM in t CO ₂ / MWh	0.882

BE_y Calculation for Gunung Salak unit #1

Table 8. Baseline emission (BE_y) calculation for Gunung Salak unit #1

Month/ Year		EG _y					BE _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)	EG _y	EG _{baseline}	Total
		kWh	kWh	kWh	kWh	kWh	MWh	MWh	tCO ₂
Apr-14		40,877,537	0	40,877,537	40,877,537	40,877,536.99	40,877.54	34,280.27	5,818.79
May-14		43,097,673	0	43,097,673	43,097,673	43,097,672.58	43,097.67	34,280.27	7,776.95
Jun-14		41,524,899	2,679	41,522,221	41,527,795	41,522,220.65	41,522.22	34,280.27	6,387.40
Jul-14		42,702,713	0	42,702,713	42,702,713	42,702,712.50	42,702.71	34,280.27	7,428.59
Aug-14		42,575,394	0	42,575,394	42,575,394	42,575,394.31	42,575.39	34,280.27	7,316.30
Sep-14		41,268,031	0	41,268,031	41,268,031	41,268,031.12	41,268.03	34,280.27	6,163.20
Oct-14		41,684,613	30,394	41,654,219	41,654,219	41,654,219.01	41,654.22	34,280.27	6,503.82
Nov-14		37,747,526	25,984	37,721,542	37,721,542	37,721,542.40	37,721.54	34,280.27	3,035.20
Dec-14		42,479,699	0	42,479,699	42,479,699	42,479,699.17	42,479.70	34,280.27	7,231.89
Number of months in 2014	9								
Total Apr - Dec 2014		373,958,085	59,056	373,899,029	373,904,603	373,899,028.73	373,899.03	308,522.47	57,662.13
Total Apr - Dec 2014 ROUN DUP/D OWN									57,662.00
Jan-15		42,378,677	0	42,378,677	42,378,677	42,378,677	42,378.68	34,280.27	7,142.79
Feb-15		37,976,020	0	37,976,020	37,976,020	37,976,020	37,976.02	34,280.27	3,259.65
Mar-15		41,989,685	0	41,989,685	41,989,685	41,989,685	41,989.69	34,280.27	6,799.70
Apr-15		40,648,072	0	40,648,072	40,648,072	40,648,072	40,648.07	34,280.27	5,616.40
May-15		42,123,438	1,562	42,121,876	42,121,876	42,121,876	42,121.88	34,280.27	6,916.29
Jun-15		40,275,197	20,316	40,254,882	40,254,881	40,254,882	40,254.88	34,280.27	5,269.60
Jul-15		41,946,555	2,294	41,944,261	41,944,261	41,944,261	41,944.26	34,280.27	6,759.64
Aug-15		42,193,070	0	42,193,070	42,193,070	42,193,070	42,193.07	34,280.27	6,979.09
Sep-15		40,810,746	0	40,810,746	40,810,746	40,810,746	40,810.75	34,280.27	5,759.88
Oct-15		42,181,657	0	42,181,657	421,816,567	42,181,657	42,181.66	34,280.27	6,969.02
Nov-15		37,804,701	75,350	37,729,350	37,729,351	37,729,350	37,729.35	34,280.27	3,042.08
Dec-15		22,526,829	42,696	22,484,134	22,484,133	22,484,134	22,484.13	34,280.27	-10,404.20
Number of months in 2015	12								
Total Jan - Dec		472,854,646	142,217	472,712,428	852,347,339	472,712,428	472,712	411,363	54,109.94

Month/ Year		EG _y					BE _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)	EG _y	EG _{baseline}	Total
		kWh	kWh	kWh	kWh	kWh	MWh	MWh	tCO ₂
2015									
Total Jan - Dec 2015 ROUND DOWN									54,109.00
Jan-16		30,897,233	70,745	30,826,487	30,826,488	30,826,487	30,826.49	34,280.27	-3,046.24
Feb-16		39,246,241	0	39,246,241	39,246,241	39,246,241	39,246.24	34,280.27	4,379.98
Mar-16		40,490,949	18,461	40,472,488	40,472,488	40,472,488	40,472.49	34,280.27	5,461.53
Number of months in 2016	3								
Total Jan - Mar 2016		110,634,423	89,206	110,545,217	110,545,217	110,545,217	110,545	102,841	6,795.28
Total Jan - Mar 2016 ROUND DOWN									6,795.00
TOTAL 2014- 2016 ROUND DOWN									118,566.00

BE_y Calculation for Gunung Salak unit #2

Table 9. Baseline emission (BE_y) calculation for Gunung Salak unit #2

Month/ Year		EG _y					BE _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)	EG _y	EG _{baseline}	Total
		kWh	kWh	kWh	kWh	kWh	MWh	MWh	tCO ₂
Apr-14		38,325,121	85,158	38,239,963	38,239,963	38,239,963.26	38,239.96	33,258.54	4,393.62
May-14		42,535,886	0	42,535,886	42,535,886	42,535,885.52	42,535.89	33,258.54	8,182.62
Jun-14		40,918,525	0	40,918,525	40,924,001	40,918,525.02	40,918.53	33,258.54	6,756.11
Jul-14		39,000,419	45,554	38,954,865	38,954,865	38,954,864.54	38,954.86	33,258.54	5,024.16
Aug-14		42,085,821	0	42,085,821	42,085,821	42,085,821.35	42,085.82	33,258.54	7,785.67
Sep-14		40,808,750	0	40,808,750	40,808,750	40,808,749.54	40,808.75	33,258.54	6,659.29
Oct-14		41,848,967	0	41,848,967	41,848,967	41,848,966.52	41,848.97	33,258.54	7,576.76
Nov-14		40,570,907	0	40,570,907	40,570,907	40,570,907.46	40,570.91	33,258.54	6,449.51
Dec-14		41,745,486	0	41,745,486	41,745,486	41,745,486.08	41,745.49	33,258.54	7,485.49
Number of months in 2014	9								
Total Apr - Dec 2014		367,839,882	130,712	367,709,169	367,714,646	367,709,169.29	367,709.17	299,326.83	60,313.22
Total Apr - Dec 2014 ROUN DUP/D OWN									60,313.00
Jan-15		37,624,123	30,790	37,593,333	37,593,333	37,593,333	37,593.33	33,258.54	3,823.29
Feb-15		37,218,535	18,298	37,200,238	37,200,237	37,200,238	37,200.24	33,258.54	3,476.58
Mar-15		42,372,181	0	42,372,181	42,372,181	42,372,181	42,372.18	33,258.54	8,038.23
Apr-15		40,927,558	0	40,927,558	40,927,558	40,927,558	40,927.56	33,258.54	6,764.08
May-15		42,732,200	0	42,732,200	42,732,200	42,732,200	42,732.20	33,258.54	8,355.77
Jun-15		40,733,468	1,339	40,732,129	40,732,129	40,732,129	40,732.13	33,258.54	6,591.71
Jul-15		42,140,758	0	42,140,758	42,140,758	42,140,758	42,140.76	33,258.54	7,834.12
Aug-15		38,290,508	39,101	38,251,407	38,251,407	38,251,407	38,251.41	33,258.54	4,403.71
Sep-15		41,021,185	0	41,021,185	41,021,185	41,021,185	41,021.19	33,258.54	6,846.66
Oct-15		42,278,296	0	42,278,296	42,278,296	42,278,296	42,278.30	33,258.54	7,955.43
Nov-15		36,807,579	80,822	36,726,757	36,726,757	36,726,757	36,726.76	33,258.54	3,058.97
Dec-15		40,932,419	11,277	40,921,143	40,921,142	40,921,143	40,921.14	33,258.54	6,758.42
Number of months in 2015	12								
Total Jan - Dec		483,078,811	181,626	482,897,185	482,897,183	482,897,185	482,897	399,102	73,906.97

Month/ Year		EG _y					BE _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)	EG _y	EG _{baseline}	Total
		kWh	kWh	kWh	kWh	kWh	MWh	MWh	tCO ₂
2015									
Total Jan - Dec 2015 ROUND DOWN									73,906.00
Jan-16		41,191,775	14,744	41,177,031	41,177,031	41,177,031	41,177.03	33,258.54	6,984.11
Feb-16		38,512,468	0	38,512,468	38,512,468	38,512,468	38,512.47	33,258.54	4,633.97
Mar-16		41,044,178	0	41,044,178	41,044,178	41,044,178	41,044.18	33,258.54	6,866.94
Number of months in 2016	3								
Total Jan - Mar 2016		120,748,421	14,744	120,733,677	120,733,677	120,733,677	120,734	99,776	18,485.02
Total Jan - Mar 2016 ROUND DOWN									18,485.00
TOTAL 2014- 2016 ROUND DOWN									152,704.00

BE_y Calculation for Gunung Salak unit #3

Table 10. Baseline Emission (BE_y) calculation for Gunung Salak unit #3

Month/ Year		EG _y					BE _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)	EG _y	EG _{baseline}	Total
		kWh	kWh	kWh	kWh	kWh	MWh	MWh	tCO ₂
Apr-14		40,041,882	9,260	40,032,622	40,032,622	40,032,621.65	40,032.62	32,891.36	6,298.59
May-14		41,161,778	0	41,161,778	41,161,778	41,161,778.08	41,161.78	32,891.36	7,294.51
Jun-14		41,457,325	2,245	41,455,079	41,460,605	41,455,079.37	41,455.08	32,891.36	7,553.20
Jul-14		42,776,364	5,615	42,770,748	42,770,749	42,770,748.34	42,770.75	32,891.36	8,713.62
Aug-14		43,188,755	0	43,188,755	43,188,755	43,188,754.55	43,188.75	32,891.36	9,082.30
Sep-14		41,843,960	0	41,843,960	41,843,960	41,843,960.02	41,843.96	32,891.36	7,896.19
Oct-14		32,500,473	8,251	32,492,222	32,492,222	32,492,221.92	32,492.22	32,891.36	-352.04
Nov-14		22,614,088	31,403	22,582,685	22,582,685	22,582,684.94	22,582.68	32,891.36	-9,092.25
Dec-14		42,811,710	2,589	42,809,120	42,809,121	42,809,120.25	42,809.12	32,891.36	8,747.47
Number of months in 2014	9								
Total Apr - Dec 2014		348,396,333	59,364	348,336,969	348,342,497	348,336,969.12	348,336.97	296,022.23	46,141.60
Total Apr - Dec 2014 ROUN DUP/D OWN									46,141.00
Jan-15		43,043,487	0	43,043,487	43,043,487	43,043,487	43,043.49	32,891.36	8,954.18
Feb-15		38,209,521	13,460	38,196,061	38,196,061	38,196,061	38,196.06	32,891.36	4,678.75
Mar-15		42,700,342	0	42,700,342	42,700,342	42,700,342	42,700.34	32,891.36	8,651.52
Apr-15		40,997,681	6,622	40,991,059	40,991,059	40,991,059	40,991.06	32,891.36	7,143.94
May-15		42,721,247	0	42,721,247	42,721,247	42,721,247	42,721.25	32,891.36	8,669.96
Jun-15		41,316,850	0	41,316,850	41,316,850	41,316,850	41,316.85	32,891.36	7,431.28
Jul-15		42,949,322	0	42,949,322	42,949,322	42,949,322	42,949.32	32,891.36	8,871.12
Aug-15		42,391,429	11,959	42,379,469	42,379,470	42,379,469	42,379.47	32,891.36	8,368.51
Sep-15		41,541,633	0	41,541,633	41,541,633	41,541,633	41,541.63	32,891.36	7,629.54
Oct-15		43,005,583	0	43,005,583	43,005,583	43,005,583	43,005.58	32,891.36	8,920.75
Nov-15		29,985,655	69,861	29,915,794	29,915,794	29,915,794	29,915.79	32,891.36	-2,624.45
Dec-15		23,680,731	86,624	23,594,107	23,594,107	23,594,107	23,594.11	32,891.36	-8,200.18
Number of months in 2015	12								
Total Jan - Dec 2015		472,543,479	188,526	472,354,953	472,354,955	472,354,953	472,355	394,696	68,494.93

Month/ Year		EG _y					BE _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)	EG _y	EG _{baseline}	Total
		kWh	kWh	kWh	kWh	kWh	MWh	MWh	tCO ₂
Total Jan - Dec 2015 ROUND DOWN									68,494.00
Jan-16		42,987,432	0	42,987,432	42,987,432	42,987,432	42,987.43	32,891.36	8,904.74
Feb-16		40,042,737	0	40,042,737	40,042,737	40,042,737	40,042.74	32,891.36	6,307.52
Mar-16		43,070,479	0	43,070,479	43,070,479	43,070,479	43,070.48	32,891.36	8,977.98
Number of months in 2016	3								
Total Jan - Mar 2016		126,100,648	0	126,100,648	126,100,648	126,100,648	126,101	98,674	24,190.24
Total Jan - Mar 2016 ROUND DOWN									24,190.00
TOTAL 2014- 2016 ROUND DOWN									138,825.00

4.2 Project Emissions

Project emissions as described in the ACM0002 v.07 are considered from:

- a) Fugitive carbon dioxide and methane emissions due to release of non-condensable gases from the produced steam (PES_y); and

$$PE_y = PES_y + PEFF_y$$

$$PES_y = (w_{main,CO_2} + w_{main,CH_4} \cdot GWP_{CH_4}) M_{s,y}$$

Where:

PE_y	Project emissions in year y (tCO_2/yr)
PES_y	Project emissions of carbon dioxide and methane due to the release of non-condensable gases from the steam produced in the geothermal power plant in year y (tCO_2/yr)
$PEFF_y$	Project emissions from combustion of fossil fuels related to the operation of the geothermal power plant in year y (tCO_2/yr)
W_{main,CO_2}	Average mass fraction of carbon dioxide in the produced steam (non-dimensional)
W_{main,CH_4}	Average mass fraction of methane gas in the produced steam (non-dimensional)
GWP_{CH_4}	Global warming potential of methane valid for the relevant commitment period (tCO_2/tCH_4)
$M_{S,y}$	Quantity of steam produced during the year 'y' (tonnes)

During current monitoring period from 01/03/2014 to 31/03/2016, there is no calibration delay for steam flow meter Unit #1, #2 and #3 and NCG analysis.

The CH_4 and CO_2 weight fraction values for all units that are used in the PES_y calculation are presented in **Table 11** and **Table 12**.

Table 11. CH_4 weight fraction values used in the project emission of NCG from the produced steam (PES_y) calculation

Analysis #	Period to be used in PES_y calculation	CH_4 values to be used in PES_y calculation (non dimensional)		
	Month/Year	UNIT #1	UNIT #2	UNIT #3
1	04/2014	0.0000002703	0.0000050115	0.0001529004
	05/2014	0.0000002703	0.0000050115	0.0001529004
	06/2014	0.0000002703	0.0000050115	0.0001529004
	07/2014	0.0000002703	0.0000050115	0.0001529004
2	08/2014	0.0000758611	0.0001012333	0.0001928136
	09/2014	0.0000758611	0.0001012333	0.0001928136
	10/2014	0.0000758611	0.0001012333	0.0001928136
	11/2014	0.0000758611	0.0001012333	0.0001928136
3	12/2014	0.0000006786	0.0000013965	0.0000022656
	01/2015	0.0000006786	0.0000013965	0.0000022656
	02/2015	0.0000006786	0.0000013965	0.0000022656
	03/2015	0.0000006786	0.0000013965	0.0000022656
4	04/2015	0.0000045500	0.0000089334	0.0000125616
	05/2015	0.0000045500	0.0000089334	0.0000125616
	06/2015	0.0000045500	0.0000089334	0.0000125616
	07/2015	0.0000045500	0.0000089334	0.0000125616
5	08/2015	0.0000056700	0.0000067672	0.0000136170

Analysis #	Period to be used in PES _y calculation	CH ₄ values to be used in PES _y calculation (non dimensional)		
	Month/Year	UNIT #1	UNIT #2	UNIT #3
	09/2015	0.0000056700	0.0000067672	0.0000136170
	10/2015	0.0000056700	0.0000067672	0.0000136170
	11/2015	0.0000056700	0.0000067672	0.0000136170
	12/2015	0.0000000287	0.0000000848	0.0000000450
6	01/2016	0.0000000287	0.0000000848	0.0000000450
	02/2016	0.0000000287	0.0000000848	0.0000000450
	03/2016	0.0000000287	0.0000000848	0.0000000450
7	04/2016	0.0000002200	0.0000009116	0.0000015333
	05/2016	0.0000002200	0.0000009116	0.0000015333
	06/2016	0.0000002200	0.0000009116	0.0000015333
	07/2016	0.0000002200	0.0000009116	0.0000015333

Table 12. CO₂ weight fraction values used in the project emission of NCG from the produced steam (PES_y) calculation

Analysis #	Period to be used in PES _y calculation	CO ₂ values to be used in PES _y calculation (non dimensional)		
	Month/Year	UNIT #1	UNIT #2	UNIT #3
1	04/2014	0.0051340	0.0037354	0.0043279
	05/2014	0.0051340	0.0037354	0.0043279
	06/2014	0.0051340	0.0037354	0.0043279
	07/2014	0.0051340	0.0037354	0.0043279
2	08/2014	0.0034749	0.0044560	0.0042292
	09/2014	0.0034749	0.0044560	0.0042292
	10/2014	0.0034749	0.0044560	0.0042292
	11/2014	0.0034749	0.0044560	0.0042292
3	12/2014	0.0027522	0.0047004	0.0045634
	01/2015	0.0027522	0.0047004	0.0045634
	02/2015	0.0027522	0.0047004	0.0045634
	03/2015	0.0027522	0.0047004	0.0045634
4	04/2015	0.0033170	0.0040041	0.0045527
	05/2015	0.0033170	0.0040041	0.0045527
	06/2015	0.0033170	0.0040041	0.0045527
	07/2015	0.0033170	0.0040041	0.0045527
5	08/2015	0.0034233	0.0041737	0.0047874
	09/2015	0.0034233	0.0041737	0.0047874
	10/2015	0.0034233	0.0041737	0.0047874
	11/2015	0.0034233	0.0041737	0.0047874
6	12/2015	0.0038975	0.0049605	0.0047057
	01/2016	0.0038975	0.0049605	0.0047057
	02/2016	0.0038975	0.0049605	0.0047057
	03/2016	0.0038975	0.0049605	0.0047057
7	04/2016	0.0042596	0.0049316	0.0054053
	05/2016	0.0042596	0.0049316	0.0054053

Analysis #	Period to be used in PES _y calculation	CO ₂ values to be used in PES _y calculation (non dimensional)		
	Month/Year	UNIT #1	UNIT #2	UNIT #3
	06/2016	0.0042596	0.0049316	0.0054053
	07/2016	0.0042596	0.0049316	0.0054053

PES_y calculation for Gunung Salak unit #1

Table 13. Project emission from fugitive carbon dioxide and methane emissions due to release of non-condensable gases from the produced steam (PES_y) for Gunung Salak unit #1

Month/year		PES _y			
		W _{Main,CH₄,y}	W _{Main,CO₂,y}	M _{s,y}	Total
		tCH ₄ /t _{Steam}	tCO ₂ /t _{Steam}	tonnes / month	tCO ₂
Apr-14		0.0000002703	0.0051339510	332,393.00	1,708.38
May-14		0.0000002703	0.0051339510	349,095.00	1,794.22
Jun-14		0.0000002703	0.0051339510	335,919.00	1,726.50
Jul-14		0.0000002703	0.0051339510	346,133.00	1,778.99
Aug-14		0.0000758611	0.0034749401	344,771.00	1,747.31
Sep-14		0.0000758611	0.0034749401	331,196.50	1,678.51
Oct-14		0.0000758611	0.0034749401	337,539.00	1,710.66
Nov-14		0.0000758611	0.0034749401	306,864.00	1,555.19
Dec-14		0.0000006786	0.0027522334	346,699.00	959.14
Number of months in 2014	9				
Total 2014				3,030,609.50	14,658.89
Total 2014 ROUNDUP					14,659.00
Jan-15		0.0000006786	0.0027522334	345,246.00	955.12
Feb-15		0.0000006786	0.0027522334	308,990.00	854.82
Mar-15		0.0000006786	0.0027522334	340,660.00	942.43
Apr-15		0.0000045500	0.0033169850	330,773.20	1,128.78
May-15		0.0000045500	0.0033169850	343,536.00	1,172.33
Jun-15		0.0000045500	0.0033169850	328,017.00	1,119.37
Jul-15		0.0000045500	0.0033169850	341,674.00	1,165.97
Aug-15		0.0000056700	0.0034232760	341,930.00	1,211.23
Sep-15		0.0000056700	0.0034232760	330,009.20	1,169.01
Oct-15		0.0000056700	0.0034232760	343,292.40	1,216.06
Nov-15		0.0000056700	0.0034232760	315,509.00	1,117.64
Dec-15		0.0000000287	0.0038975010	186,057.00	725.27
Number of months in 2015	12				
Total 2015				3,855,693.80	12,778.02
Total 2015 ROUNDUP					12,779.00
Jan-16		0.0000000287	0.0038975010	238,165.00	928.39

Month/year		PES _y			
		W _{Main,CH₄,y}	W _{Main,CO₂,y}	M _{s,y}	Total
		tCH ₄ /t _{Steam}	tCO ₂ /t _{Steam}	tonnes / month	tCO ₂
Feb-16	3	0.0000000287	0.0038975010	304,254.00	1,186.01
Mar-16		0.0000000287	0.0038975010	325,596.00	1,269.21
Number of months in 2016					
Total 2016				868,015.00	3,383.61
Total 2016 ROUNDUP					3,384.00
TOTAL 2014-2016 ROUNDUP					30,822.00

PES_y calculation for Gunung Salak unit #2

Table 14. Project emission from fugitive carbon dioxide and methane emissions due to release of non-condensable gases from the produced steam (PES_y) for Gunung Salak unit #2

Month/year		PES _y			
		W _{Main,CH₄,y}	W _{Main,CO₂,y}	M _{s,y}	Total
		tCH ₄ /t _{Steam}	tCO ₂ /t _{Steam}	tonnes / month	tCO ₂
Apr-14	9	0.0000050115	0.0037353810	304,878.00	1,170.92
May-14		0.0000050115	0.0037353810	338,844.00	1,301.37
Jun-14		0.0000050115	0.0037353810	324,763.00	1,247.29
Jul-14		0.0000050115	0.0037353810	315,900.00	1,213.25
Aug-14		0.0001012333	0.0044559619	347,518.00	2,287.32
Sep-14		0.0001012333	0.0044559619	323,366.00	2,128.35
Oct-14		0.0001012333	0.0044559619	313,709.00	2,064.79
Nov-14		0.0001012333	0.0044559619	305,519.00	2,010.88
Dec-14		0.0000013965	0.0047004279	312,953.30	1,480.19
Number of months in 2014					
Total 2014				2,887,450.30	14,904.37
Total 2014 ROUNDUP					14,905.00
Jan-15		0.0000013965	0.0047004279	281,457.00	1,331.22
Feb-15		0.0000013965	0.0047004279	274,903.00	1,300.22
Mar-15		0.0000013965	0.0047004279	313,629.00	1,483.39
Apr-15		0.0000089334	0.0040040910	302,620.00	1,268.49
May-15		0.0000089334	0.0040040910	313,229.00	1,312.96
Jun-15		0.0000089334	0.0040040910	303,772.00	1,273.32
Jul-15		0.0000089334	0.0040040910	313,919.00	1,315.85
Aug-15		0.0000067672	0.0041737476	284,365.00	1,227.28
Sep-15		0.0000067672	0.0041737476	305,266.00	1,317.48
Oct-15		0.0000067672	0.0041737476	317,384.00	1,369.78

Month/year		PES _y			
		W _{Main,CH₄,y}	W _{Main,CO₂,y}	M _{S,y}	Total
		tCH ₄ /t _{Steam}	tCO ₂ /t _{Steam}	tonnes / month	tCO ₂
Nov-15	12	0.0000067672	0.0041737476	275,785.20	1,190.25
Dec-15		0.0000000848	0.0049605350	308,191.00	1,529.34
Number of months in 2015					
Total 2015				3,594,520.20	15,919.59
Total 2015 ROUNDUP					15,920.00
Jan-16		0.0000000848	0.0049605350	308,325.40	1,530.01
Feb-16		0.0000000848	0.0049605350	294,762.00	1,462.70
Mar-16		0.0000000848	0.0049605350	333,027.00	1,652.59
Number of months in 2016					
Total 2016				936,114.40	4,645.30
Total 2016 ROUNDUP					4,646.00
TOTAL 2014-2016 ROUNDUP					35,471.00

PES_y calculation for Gunung Salak unit #3

Table 15. Project emission from fugitive carbon dioxide and methane emissions due to release of non-condensable gases from the produced steam (PES_y) for Gunung Salak unit #3

Month/year		PES _y			
		W _{Main,CH₄,y}	W _{Main,CO₂,y}	M _{S,y}	Total
		tCH ₄ /t _{Steam}	tCO ₂ /t _{Steam}	tonnes / month	tCO ₂
Apr-14	9	0.0001529004	0.0043279480	315,791.00	2,380.70
May-14		0.0001529004	0.0043279480	333,607.00	2,515.02
Jun-14		0.0001529004	0.0043279480	319,363.00	2,407.63
Jul-14		0.0001529004	0.0043279480	329,870.00	2,486.84
Aug-14		0.0001928136	0.0042291664	330,948.00	2,739.67
Sep-14		0.0001928136	0.0042291664	319,158.00	2,642.07
Oct-14		0.0001928136	0.0042291664	247,924.50	2,052.38
Nov-14		0.0001928136	0.0042291664	174,242.00	1,442.42
Dec-14		0.0000022656	0.0045633504	325,825.00	1,502.36
Number of months in 2014					
Total 2014				2,696,728.50	20,169.09
Total 2014 ROUNDUP					20,170.00
Jan-15		0.0000022656	0.0045633504	325,201.00	1,499.48
Feb-15		0.0000022656	0.0045633504	284,974.00	1,313.99
Mar-15		0.0000022656	0.0045633504	318,396.00	1,468.10

Month/year		PES _y			
		W _{Main,CH₄,y}	W _{Main,CO₂,y}	M _{s,y}	Total
		tCH ₄ /t _{Steam}	tCO ₂ /t _{Steam}	tonnes / month	tCO ₂
Apr-15	12	0.0000125616	0.0045526560	306,716.00	1,477.28
May-15		0.0000125616	0.0045526560	323,941.00	1,560.25
Jun-15		0.0000125616	0.0045526560	315,021.00	1,517.28
Jul-15		0.0000125616	0.0045526560	323,612.00	1,558.66
Aug-15		0.0000136170	0.0047873700	318,200.00	1,614.33
Sep-15		0.0000136170	0.0047873700	311,232.00	1,578.98
Oct-15		0.0000136170	0.0047873700	323,065.00	1,639.01
Nov-15		0.0000136170	0.0047873700	226,761.00	1,150.43
Dec-15		0.0000000450	0.0047056500	179,462.00	844.65
Number of months in 2015					
Total 2015				3,556,581.00	17,222.46
Total 2015 ROUNDUP					17,223.00
Jan-16	3	0.0000000450	0.0047056500	321,314.00	1,512.29
Feb-16		0.0000000450	0.0047056500	303,884.00	1,430.26
Mar-16		0.0000000450	0.0047056500	325,152.10	1,530.36
Number of months in 2016					
Total 2016				950,350.10	4,472.91
Total 2016 ROUNDUP					4,473.00
TOTAL 2014-2016 ROUNDUP					41,866.00

b) Carbon dioxide emissions from fossil fuel combustion (PEFF_y)

As referred to the “Tool to calculate project or leakage CO₂ emissions from fossil fuel combustion” v.01, project emissions coming from fossil fuel combustion is calculated as following:

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

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

Where:

PEFF_y Project emissions from combustion of fossil fuels related to the operation of the geothermal power plant in year y (tCO₂/yr)

PE_{FC,j,y} CO₂ emissions from fossil fuel combustion in process ‘j’ during the year ‘y’ (t CO₂ e/year). This parameter shall be calculated as per the latest version of the Tool to calculate project or leakage CO₂ emissions from fossil fuel combustion, where ‘j’ stands for the processes required for the operation of the geothermal

power plant.

$FC_{j,i,y}$	Quantity of fuel type 'i' combusted in process 'j' during the year 'y' (mass or volume unit)
$COEF_{j,y}$	CO ₂ emissions coefficient of fuel type 'i' in year 'y' (t CO ₂ e/mass or volume unit)
$NCV_{i,y}$	Weighted average net calorific value of the fuel type 'i' in year 'y' (GJ/mass or volume)
$EF_{CO_2,i,y}$	Weighted average CO ₂ emission factor of fuel type 'i' in year 'y' (t CO ₂ /GJ)

PEFF_y calculation for the whole power plant (Unit #1, #2 and #3)

Monitoring period from 01/04/2014 to 31/03/2016 as following in Table 16

Table 16. Project emission from carbon dioxide emissions from fossil fuel combustion (PEFF_y) for all units

Month/year	PEFF _y					
	$FC_{j,i,y}$			$NCV_{i,y}$	$EF_{CO_2,i,y}$	Total
	Diesel usage	Diesel density	Total			
	litre	kg/litre	tonnes			
Apr-Dec 2014	58,337.07	0.815	47.54	0.043	0.074	0.151
Jan-Dec 2015	86,713.81	0.815	70.67	0.043	0.074	0.225
Jan-Mar 2016	1,575.25	0.815	1.28	0.043	0.074	0.004
TOTAL 2014-2016						0.380

4.3 Leakage

Leakage emissions as described in the ACM0002 v.07 is 0 for retrofit project as following:

$$LE_y = 0$$

Where:

LE_y Leakage emissions in year y (tCO₂/yr)

4.4 Net GHG Emission Reductions and Removals

The emission reductions calculations as described in the ACM0002 v.07 are as follows:

$$ER_y = BE_y - PE_y - LE_y$$

Where:

ER_y Emission reductions in year y (tCO₂/yr)

BE_y Baseline emissions in year y (tCO₂/yr)

PE_y Project emissions in year y (tCO₂/yr)

LE_y Leakage emissions in year y (tCO₂/yr)

ER calculation for Gunung Salak Unit 1

Table 17. Emission reduction calculation for Gunung Salak unit #1

Month/Year	BE _y (tCO ₂)	PE _y (tCO ₂)		ER _y (tCO ₂)
		PES _y	PEFF _y	
Total Apr - Dec 2014	57,662.13	14,658.89	0.151	
Total Apr - Dec 2014 ROUNDUP/DOWN	57,662.00	14,659.00	1.00	43,002.00
Total Jan - Dec 2015	54,109.94	12,778.02	0.225	
Total Jan - Dec 2015 ROUNDUP/DOWN	54,109.00	12,779.00	1.00	41,329.00
Total Jan - Mar 2016	6,795.28	3,383.61	0.004	
Total Jan - Mar 2016 ROUNDUP/DOWN	6,795.00	3,384.00	1.00	3,410.00
TOTAL 2014-2016 ROUNDUP/DOWN	118,566.00	30,822.00	3.00	87,741.00

ER calculation for Gunung Salak Unit 2

Table 18. Emission reduction calculation for Gunung Salak unit #2

Month/Year	BE _y (tCO ₂)	PE _y (tCO ₂)		ER _y (tCO ₂)
		PES _y	PEFF _y	
Total Apr - Dec 2014	60,313.22	14,904.37	-	
Total Apr - Dec 2014 ROUNDUP/DOWN	60,313.00	14,905.00	-	45,408.00
Total Jan - Dec 2015	73,906.97	15,919.59	-	
Total Jan - Dec 2015 ROUNDUP/DOWN	73,906.00	15,920.00	-	57,986.00
Total Jan - Mar 2016	18,485.02	4,645.30	-	
Total Jan - Mar 2016 ROUNDUP/DOWN	18,485.00	4,646.00	-	13,839.00
TOTAL 2014-2016 ROUNDUP/DOWN	152,704.00	35,471.00	-	117,233.00

ER calculation for Gunung Salak Unit 3

Table 19. Emission reduction calculation for Gunung Salak unit #3

Month/Year	BE _y (tCO ₂)	PE _y (tCO ₂)		ER _y (tCO ₂)
		PES _y	PEFF _y	
Total Apr - Dec 2014	46,141.60	20,169.09	-	
Total Apr - Dec 2014 ROUNDUP/DOWN	46,141.00	20,170.00	-	25,971.00
Total Jan - Dec 2015	68,494.93	17,222.46	-	
Total Jan - Dec 2015 ROUNDUP/DOWN	68,494.00	17,223.00	-	51,271.00
Total Jan - Mar 2016	24,190.24	4,472.91	-	
Total Jan - Mar 2016 ROUNDUP/DOWN	24,190.00	4,473.00	-	19,717.00
TOTAL 2014-2016 ROUNDUP/DOWN	138,825.00	41,866.00	-	96,959.00

The summary of emission reductions for the chosen monitored period i.e. from 01/04/2014 to 31/03/2016 is provided in

Table 20. Summary of emission reduction calculation from 01/04/2014 to 31/03/2016

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 2014 : 01/04/2014- 31/12/2014	164,116	49,735	0	114,381
Vintage 2015 : 01/01/2015- 31/12/2015	196,509	45,923	0	150,586
Vintage 2016 : 01/01/2016- 31/03/2016	49,470	12,504	0	36,966
Total	410,095	108,162	0	301,933

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