

210 MW MUSI HYDRO POWER PLANT, BENGKULU



Document Prepared By:

Mr. Leonardo Sidabalok

South Pole Carbon Asset Management Ltd.

I.sidabalok@southpole.com

Project Title	210 MW Musi Hydro Power Plant, Bengkulu
Version	Version 2.0
Report ID	-
Date of Issue	22/03/2018
Project ID	487
Monitoring Period	01/08/2016 to 30/09/2017 (1 st verification from the 2 nd crediting period)
Prepared By	Leonardo Sidabalok South Pole Carbon Asset Management Ltd.
Contact	South Pole Carbon Asset Management Ltd. Technoparkstrasse 1 Zurich 8005, Switzerland I.sidabalok@southpole.com www.southpole.com

Table of Contents

1	Project Details	3
1.1	Summary Description of the Implementation Status of the Project	3
1.2	Sectoral Scope and Project Type	4
1.3	Project Proponent	4
1.4	Other Entities Involved in the Project	5
1.5	Project Start Date	5
1.6	Project Crediting Period	5
1.7	Project Location	5
1.8	Title and Reference of Methodology	6
1.9	Other Programs	6
1.10	Sustainable Development	7
2	Implementation Status	8
2.1	Implementation Status of the Project Activity	8
2.2	Deviations	8
2.2.1	Methodology Deviations	8
2.2.2	Project Description Deviations	8
2.3	Grouped Project	8
2.4	Safeguards	8
2.4.1	No Net Harm	8
2.4.2	Local Stakeholder Consultation	10
3	Data and Parameters	10
3.1	Data and Parameters Available at Validation	10
3.2	Data and Parameters Monitored	11
3.3	Monitoring Plan	14
3.3.1	Monitoring Period	15
3.3.2	Monitoring Organization	15
3.3.3	Monitoring equipment and installation	16
4	Quantification of GHG Emission Reductions and Removals	20
4.1	Baseline Emissions	20
4.2.1	Formula used for baseline emissions calculation	20
4.2.2	Baseline emissions calculation	20
4.2	Project Emissions	21
4.2.1	Formula used for project emissions calculation	21
4.2.2	Project emissions from the consumption of fossil fuels	22
4.3	Leakage	22
4.4	Net GHG Emission Reductions and Removals	23
4.4.1	Formula used for emission reductions calculation	23
4.4.2	Emission reductions calculation	23

1 PROJECT DETAILS

1.1 Summary Description of the Implementation Status of the Project

The 210 MW Musi Hydro Power Plant (hereinafter refer to project activity) is a new run-off-river type hydropower plant located in Bengkulu Province, Indonesia. Total installed capacity is 210 MW, consist of 3 x 70 MW turbines. Annual energy output is expected at 1,140 GWh, harnessing a gross water head of 404.4 m by diverting water at 42.3 m³/sec from the Musi river to the Simpangaur river. The project is owned and developed by PT. PLN (Persero), a state-owned electricity company. The project supplies electricity to the connected Sumatra grid. Below is the technical description of the turbines and generators.

Table 1 - Technical data of the turbine / generator units (specifications are per unit)

Turbines 1, 2, & 3	Brand	VA TECH HYDRO
	Model	Francis turbine
	Rated output	73.6 MW
	Rated head	396.0 m
	Rated speed	500 rpm
	Year of Commissioning	2006
	Serial number	• MB9-146/UNIT 1 • MB9-146/UNIT 2 • MB9-146/UNIT 3

Generators 1, 2, & 3	Brand	MITSUBISHI
	Model	Mitsubishi AC Generator
	Rated output	84,500 kVA
	Rated voltage	11,000 V
	Rated current	4,435 A
	Rated frequency	50 Hertz
	Rated speed	500 rpm
	Rated power factor	0.85

The Musi Hydroelectric project was registered as VCS project with ID Number 487. Further background on this project can be found in the Verified Carbon Standard Project Description (VCS PD) version 3.0 dated 28 February 2018.

The project area of Musi Hydroelectric Power Plant is situated in Bengkulu Province about 30 km northeast of Bengkulu city, the capital of the province.

Prior to the implementation of the project activity there is no power generation existing at the project location, electricity in grid is generated mainly from fossil fuel sources and is solely distributed to consumers via the electricity grid.

The estimated annual CO₂ emissions reduction of the project is 953,128 tCO₂e per year. During this monitoring, total amount of emissions reduction is 841,084 tCO₂e with detail as below:

Vintage Year	Emissions Reduction	Unit
01 August 2016 – 31 December 2016	287,901	tCO ₂ e
01 January 2017 – 30 September 2017	553,183	tCO ₂ e
Total	841,084	tCO ₂ e

The project was validated under VCS and final report was issued on 3 May 2018. This monitoring report has been prepared in accordance with the monitoring plan contained in the validated VCS-PD. The VCS-PD will serve as the basis for the verification, certification and issuance of the emission reductions during the monitoring period.

1.2 Sectoral Scope and Project Type

Sectorial scope	: 01. Energy industries (renewable - /non-renewable sources)
Project Type	: I. Renewable energy project
Project Category	: Grid connected electricity generation from renewable sources

1.3 Project Proponent

Project proponents contact information as follows:

Project owner:

Organization name	PT. PLN (Persero)
Contact person	Jurlian Sitanggang
Title	Head of Health, Safety, Security, and Environment Division (Kepala Divisi Keselamatan Kesehatan Kerja Keamanan dan Lingkungan)
Address	Jl. Trunojoyo blok M 1/135, Kebayoran Baru, Jakarta – 12160, Indonesia
Telephone	+62-21-725 1234
Email	jurlian.sitanggang@pln.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. PLN (Persero) and South Pole Carbon Asset Management Ltd.

1.5 Project Start Date

As per the VCS policy announcement from the 10 September 2008, the project start date is the date on which the project activity began reducing or removing GHG emissions.

Following are the three units' commissioning date:

- Musi Hydro Power Plant Unit 1: 19 July 2006 (Certificate for Proper Operation or *Sertifikat Laik Operasi*)
- Musi Hydro Power Plant Unit 2: 19 July 2006 (Certificate for Proper Operation or *Sertifikat Laik Operasi*)
- Musi Hydro Power Plant Unit 3: 19 July 2006 (Certificate for Proper Operation or *Sertifikat Laik Operasi*)

Thus, the project start date where project activity starts reducing emissions is 19 July 2006, as the earliest project start date of three units at Musi Hydro Power Plant.

1.6 Project Crediting Period

- HEPP Project starting date : 19 July 2006
- VCS Crediting period start date : 01 August 2016
- VCS crediting period : 10 years (01-Aug-2016 until 31-Jul-2026)

1.7 Project Location

The project area of the Musi Hydroelectric Power Plant is situated in Bengkulu Province about 30 km northeast of Bengkulu city, the capital of the Province. It involves the inter-basin transfer of water from the Musi river in Rejang Lebong Regency to the Simpangaur river in North Bengkulu Regency through a 7.5 km long waterway and an underground powerhouse.

The geographical coordinate of Musi Hydroelectric Power Plant is located on -3.618497 South Latitude and 102.457186 East Longitude. The location of the project site is shown in the following maps:

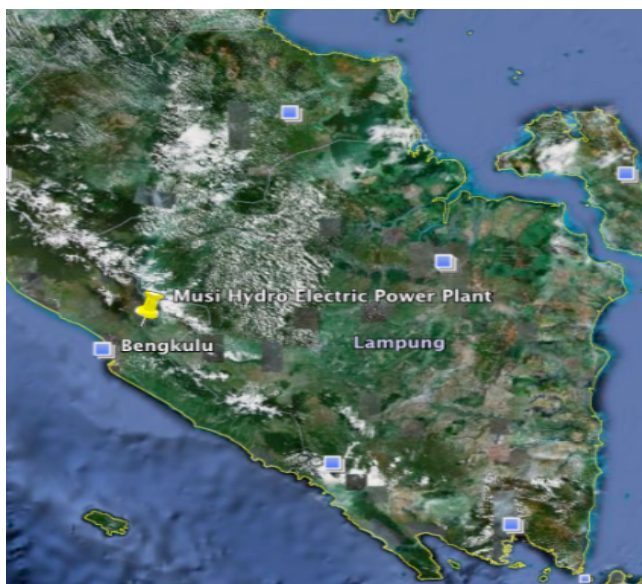


Figure 1 - Location of Musi Hydroelectric Power Plant

1.8 Title and Reference of Methodology

Approved consolidated baseline methodology ACM0002 – “Consolidated baseline methodology for grid-connected electricity generation from renewable sources”, version 17.0 (EB 47).

Sectoral scope 01 - Energy Industries (renewable-/non-renewable sources).

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 currently has not applied to any other form of environmental credits.

Projects may generate other forms of GHG-related environmental credits, such as renewable energy certificates (RECs), though GHG emission reductions and removals presented for VCU issuance shall not also be recognized as another form of GHG-related environmental credit¹.

If the project activity will be issued under any recognized program which creates GHG-related environmental credits (such as renewable energy certificates or RECs), the GHG emission reductions or removals from one verification period can be split between the VCS Program and another GHG program².

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

¹ According to VCS Standard: VCS Version 3, 21 June 2017, v3.7

² According to Registration and Issuance process: VCS Version 3, 21 June 2017, v3.8

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. PLN (Persero).
- During both construction and operation, various kinds of mechanical work are required, providing opportunities for part-time and full-time employment.

Economic well-being:

- The project activity generates employment in the local area which is a developing region.
- The generated electricity is fed into regional grids through the local grid, thereby improving the grid frequency and availability of electricity to local consumers (villagers and sub-urban inhabitants). Due to increased grid reliability, new opportunities for industries and economic activities arise along with prospects for local employment and overall development.
- The project activity 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 hydropower to generate electricity, which otherwise would have been generated through alternate fuel- (most likely fossil fuel-) based power plants. It is contributing to a reduction in specific emissions (emissions of pollutant/unit of energy generated) including GHG emissions.
- As hydroelectric power projects produce no end-products in the form of solid waste (ash, etc.), they don't have to cope with the problem of solid waste disposal encountered by most other sources of power.
- Being a renewable energy source, hydro energy is used to generate electricity that contributes to resource conservation.

Technological well-being:

- The project supports high quality equipments transfer from other regions and even other countries, and contributes to capacity building of the labor force through training and practical work.
- The project promotes local products developed in the region, when replacement of spare parts is necessary, and supports renewable technology development especially for hydroelectric power technology.

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

2 IMPLEMENTATION STATUS

2.1 Implementation Status of the Project Activity

From the validated VCS PD version 3.0, dated 28 February 2018, the 210 MW installed capacity Musi HEPP generates about 1,140,000 MWh per year. During this monitoring period, the project activity has generated power of 981,430 MWh with details as below:

- 01 August – 31 December 2016 : 335,942 MWh
- 01 January – 30 September 2017 : 645,489 MWh

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 Project Description.

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 the decree of the Ministry of Environment No. 17/2001, all hydroelectric power plants with a dam height of ≥ 15 meters, or flooded area of ≥ 200 ha or installed capacity of ≥ 50 MW need to undertake an Environmental Impact Assessment (EIA). The Musi Hydroelectric Power Plant project has an installed capacity of total 210 MW electricity, therefore this project requires an EIA.

Table 1 - Summary of EIA findings

<i>Identified Environmental impacts</i>	<i>Measures taken</i>
Pre-Construction phase	
<i>Social responsibility</i>	
Community perception related to project consultation, publicizing and resettlement.	Perform discussion with local community, monitor the issues that develop in the community.
Construction phase	

Identified Environmental impacts	Measures taken
<i>Air and noise pollution</i>	
Increase of air and noise pollution due to increased transportation and operation of heavy equipment.	Restrict the use of heavy equipment operation during the day, build project fence to reduce noise pollution, spray water to avoid dust from construction, control vehicle emission and noise, use protective masks for employees.
<i>Water pollution</i>	
Change in surface water flow due to land clearing and covering.	Create a drainage system to the nearest water body, perform a gradual land covering based on project phase, and execute land clearing only on the project site.
<i>Solid waste</i>	
Construction waste from the transportation of soil material.	Perform continuous cleaning during the construction period to remove debris and deposit them appropriately.
<i>Biodiversity and ecosystems</i>	
Change in biodiversity due to alteration in land and water body conditions.	Reforest and restore the green lands after the construction, maintain the minimum river flow to preserve the natural biodiversity within the river.
<i>Employment impacts</i>	
Utilisation of local human resources	Give priority to local employment and hold special training to enhance the local community's skills.
Operation phase	
<i>Water pollution</i>	
Decrease in the quality and quantity of water due to the wastewater from plant's activity and land erosion.	Operate wastewater treatment plant, reforest the watershed area.
<i>Environmental</i>	
Related to the project operation and its supporting facility, solid waste and wastewater from the surrounding settlement.	Build a wastewater treatment facility, execute a solid waste temporary disposal system, create a waste transportation system.
<i>Spatial planning</i>	
Changing in spatial planning structure due to project activity.	Control the development around project activity by enforcing the appropriate planning regulations.
<i>Regional image</i>	
Changing in regional image due to the development in the region.	Planning controls will ensure sensitive development of the region.
<i>Traffic</i>	

Identified Environmental impacts	Measures taken
Increase traffic activity due to the project's operational activity.	Restore the trans-Sumatra main road and set-up traffic signs.
<i>Health and Safety</i>	
Human resources needed to operate the project and its facilities.	Provide employment opportunities to local human resources following high Health and Safety standards.
<i>Working opportunity and income</i>	
Related to utilisation of local human resources.	Give priority to the admission of local human resources, hold special training to enhance the local community's skills.
<i>Comfort</i>	
Uncomfortable conditions due to vehicle's activity on the access road from and/or to the project.	Maintain the road condition by setting-up traffic signs and planting trees on the road side.
<i>Social responsibility</i>	
Community perception related to project operation	Contribution to the surrounding environment by building school and local health service.

With mitigation controls planned as part of the project construction and EIA process, and the contribution made by the project to sustainable development for 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 are subject to mitigation measures as described above.

2.4.2 Local Stakeholder Consultation

A meeting with relevant stakeholders which was held on 6 May 2003, including the village chief and people who live nearby, within the project boundary of Musi hydro power plant was conducted for the purpose of the EIA. As documented in the EIA, the local stakeholders have perceived that the construction of Musi Hydro has increased their social and economical life due to road construction, additional earning from temporary jobs, and especially due to the additional supply of electricity.

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.

3 DATA AND PARAMETERS

3.1 Data and Parameters Available at Validation

Data / Parameter	EF _{grid,CM,y}
------------------	-------------------------

Data unit	tCO ₂ /MWh
Description	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” 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 ³
Value applied	0.857
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 following the “Tool to calculate the emission factor for an electricity system” (EB 75 Annex 15).
Purpose of Data	Calculation of baseline emissions
Comments	-

3.2 Data and Parameters Monitored

Data / Parameter	EG _{PJ,y}
Data unit	MWh/yr
Description	Quantity of net electricity generation that is produced and fed into the grid as a result of the implementation of the VCS project activity in year y
Source of data	Measured by main electricity meter (Actaris type SL 7000) at the project activity site (the switchyard). Electricity Generation (EG) data used for monitoring is the monthly electricity generation delivered to grid summarized in Electricity Transfer Protocol Report signed by both parties of Generation department and Transmission department.
Description of measurement methods and procedures to be applied	The net electricity sent to the grid measured by a watt-hour meter Actaris type SL 7000 (connected to a digital control system and recorded continuously), which can measure power produced, used and delivered to the grid.

³ Source of data for EF_{grid,OM,y} (0.735 tCO₂e/MWh) and EF_{grid,BM,y} (0.898 tCO₂e/MWh) are from Indonesian government under the Directorate General of Electricity - Ministry of Energy and Mineral Resources (MEMR), based on notification letter number 1515/03/DLT.3/2017 dated on May 30th, 2017.

	The measurement of electricity generation conducted on a continuous basis, where monthly data is recorded and continuous total electricity measurement will be available. The measurement results summarized in regular production reports.												
Frequency of monitoring/recording	Monitoring is continuous with monthly recording of data.												
Value applied	<table><tr><th>Year</th><th>Net electricity supplied to the grid (MWh)</th></tr><tr><td>01 August 2016 – 31 December 2016</td><td>335,942</td></tr><tr><td>01 January 2017 – 30 September 2017</td><td>645,489</td></tr></table>	Year	Net electricity supplied to the grid (MWh)	01 August 2016 – 31 December 2016	335,942	01 January 2017 – 30 September 2017	645,489						
Year	Net electricity supplied to the grid (MWh)												
01 August 2016 – 31 December 2016	335,942												
01 January 2017 – 30 September 2017	645,489												
Monitoring equipment	Unit #1 Type: Digital Watt-hour meter type ACTARIS SL7000 (Main Meter) Manufacturer/ Model: Actaris Accuracy class: 0.2s Serial Number: 36027156 Calibration frequency: Every 5 years Date of last calibration and validity: <table><tr><th>Certificate Number</th><th>Calibration Date</th><th>Validity</th><th>Calibrator⁴</th></tr><tr><td>2004.21.BTND .349B/12.12</td><td>06/07/2012</td><td>06/07/2017</td><td>Laboratorium Kalibrasi - PT. PLN (Persero) Penelitian dan Pengembangan Ketenagalistrikan</td></tr><tr><td>2443.21.BTND .336B/16.16</td><td>25/10/2016</td><td>25/10/2021</td><td>Laboratorium Kalibrasi - PT. PLN (Persero) Penelitian dan Pengembangan Ketenagalistrikan</td></tr></table> Unit #2 Type: Digital Watt-hour meter type ACTARIS SL7000 (Main Meter) Manufacturer/ Model: Actaris Accuracy class: 0.2s	Certificate Number	Calibration Date	Validity	Calibrator ⁴	2004.21.BTND .349B/12.12	06/07/2012	06/07/2017	Laboratorium Kalibrasi - PT. PLN (Persero) Penelitian dan Pengembangan Ketenagalistrikan	2443.21.BTND .336B/16.16	25/10/2016	25/10/2021	Laboratorium Kalibrasi - PT. PLN (Persero) Penelitian dan Pengembangan Ketenagalistrikan
Certificate Number	Calibration Date	Validity	Calibrator ⁴										
2004.21.BTND .349B/12.12	06/07/2012	06/07/2017	Laboratorium Kalibrasi - PT. PLN (Persero) Penelitian dan Pengembangan Ketenagalistrikan										
2443.21.BTND .336B/16.16	25/10/2016	25/10/2021	Laboratorium Kalibrasi - PT. PLN (Persero) Penelitian dan Pengembangan Ketenagalistrikan										

⁴ Laboratorium Kalibrasi - PT. PLN (Persero) Penelitian dan Pengembangan Ketenagalistrikan (Calibration Laboratory - PT. PLN (Persero) Research and Development of Electricity) has been accredited by the National Accreditation Committee (Komite Akreditasi Nasional / KAN) with certificate number of LK-007-IDN for Laboratory of Calibration.

Serial Number: 36027159

Calibration frequency: Every 5 years

Date of last calibration and validity:

Certificate Number	Calibration Date	Validity	Calibrator
2003.21.BTND .349B/12.12	06/07/2012	06/07/2017	Laboratorium Kalibrasi - PT. PLN (Persero) Penelitian dan Pengembangan Ketenagalistrikan
2444.21.BTND .336B/16.16	26/10/2016	26/10/2021	Laboratorium Kalibrasi - PT. PLN (Persero) Penelitian dan Pengembangan Ketenagalistrikan

Unit #3

Type: Digital Watt-hour meter type ACTARIS SL7000 (Main Meter)

Manufacturer/ Model: Actaris

Accuracy class: 0.2s

Serial Number: 36027158

Calibration frequency: Every 5 years

Date of last calibration and validity:

Certificate Number	Calibration Date	Validity	Calibrator
1997.21.BTND .349B/12.12	08/07/2012	08/07/2017	Laboratorium Kalibrasi - PT. PLN (Persero) Penelitian dan Pengembangan Ketenagalistrikan
2446.21.BTND .336B/16.16	26/10/2016	26/10/2021	Laboratorium Kalibrasi - PT. PLN (Persero) Penelitian dan Pengembangan Ketenagalistrikan

Own Consumption (In-House consumption)

Type: Digital Watt-hour meter type ACTARIS SL7000 (Main Meter)

Manufacturer/ Model: Actaris

Accuracy class: 0.2s

Serial Number: 35008966

Calibration frequency: Every 5 years

	Date of last calibration and validity:												
	<table><tr><th>Certificate Number</th><th>Calibration Date</th><th>Validity</th><th>Calibrator</th></tr><tr><td>2002.21.BTND .349B/12.12</td><td>06/07/2012</td><td>06/07/2017</td><td>Laboratorium Kalibrasi - PT. PLN (Persero) Penelitian dan Pengembangan Ketenagalistrikan</td></tr><tr><td>2447.21.BTND .336B/16.16</td><td>26/10/2016</td><td>26/10/2021</td><td>Laboratorium Kalibrasi - PT. PLN (Persero) Penelitian dan Pengembangan Ketenagalistrikan</td></tr></table>	Certificate Number	Calibration Date	Validity	Calibrator	2002.21.BTND .349B/12.12	06/07/2012	06/07/2017	Laboratorium Kalibrasi - PT. PLN (Persero) Penelitian dan Pengembangan Ketenagalistrikan	2447.21.BTND .336B/16.16	26/10/2016	26/10/2021	Laboratorium Kalibrasi - PT. PLN (Persero) Penelitian dan Pengembangan Ketenagalistrikan
	Certificate Number	Calibration Date	Validity	Calibrator									
2002.21.BTND .349B/12.12	06/07/2012	06/07/2017	Laboratorium Kalibrasi - PT. PLN (Persero) Penelitian dan Pengembangan Ketenagalistrikan										
2447.21.BTND .336B/16.16	26/10/2016	26/10/2021	Laboratorium Kalibrasi - PT. PLN (Persero) Penelitian dan Pengembangan Ketenagalistrikan										
.													
QA/QC procedures to be applied	The QA/QC will be conducted through cross-checking the main meter reading report (Monthly Electricity Protocol report) at the transaction point with the Water Tax payment receipt issued by Bengkulu Province Tax Office (local government). The main meters at the transaction point will be read regularly and jointly by the person in charge from PLN Musi HEPP Generation unit and PLN Transmission unit. Meters at the transaction point are calibrated once every five-year as per required by the national regulation⁵.												
Purpose of data	Calculation of baseline emissions												
Calculation method	Net electricity supplied to grid is calculated as the difference between EG_{export}, EG_{import} and consideration of $EG_{\text{Own Consumption}}$ with formula as below : $(EG_{\text{export}} - EG_{\text{import}}) - EG_{\text{Own Consumption}}$.												
Comments	-												

3.3 Monitoring Plan

This section details the steps taken to monitor on a regular basis the GHG emissions reductions from the Musi Hydroelectric Power Plant Project in Indonesia in accordance with ACM0002 version 17.0.

⁵ The Ministry of Energy and Mineral Resource's regulation number 37 year 2008 dated November 27, 2008 on the Grid Code Sumatra Electricity Power System, the calibration of kWh meter must be done every 5 (five) years, as stated in the Metering Code section, MC 4.1.1 (Test after metering code commissioning, page 138), available from: <http://jdih.esdm.go.id/peraturan/Permen%20ESDM%2037%202008.pdf> [Accessed 26 July 2017]

The Monitoring Plan for this project has been developed to ensure that the project collects and archives complete data from the very start.

3.3.1 Monitoring Period

The monitoring period covers 01 August 2016 to 30 September 2017 (both days included)

3.3.2 Monitoring Organization

The monitoring team has been established and integrated within the existing organization structure of Musi hydropower plant prior to the start of the verification⁶. Clear roles and responsibilities are assigned to all staff involved in the VCS project and the prospect of nominating a VCS Manager have been considered. The VCS Manager has the overall responsibility for the monitoring system on this project.

All other VCS monitoring staff will have clearly defined roles and responsibilities. The VCS manager will manage the process of training new staff; ensure trained staff performs the monitoring duties as necessary; and ensure that where trained monitoring staff is absent; the integrity of the monitoring system is maintained by other trained staff.

A formal set of monitoring procedures is established prior to the start of the verification. These procedures will detail the organization, control, and the steps required for certain key monitoring system features, including:

- a) VCS staff training
- b) VCS data and record keeping arrangements
- c) Data collection
- d) VCS data quality control and quality assurance
- e) Equipment maintenance
- f) Equipment calibration
- g) Equipment failure

The procedures agreed and signed off by PT PLN (Persero) and South Pole Carbon Asset Management Ltd. Any changes to procedures need to be agreed by both parties. The VCS manager responsible for ensuring that the procedures are followed on site and for continuously improving the procedures to ensure a reliable monitoring system is established.⁷

⁶ PLN Bengkulu Sector has formed the VCS Monitoring Team through the 'Lampiran I Keputusan Manajer PT PLN (Persero) Sektor Pembangkitan Bengkulu Nomor : 007.K/432/MSBKL/2012' letter (or Management Decision Letter of PT PLN (Persero) Bengkulu Generation Sector Office No : 007.K/432/MSBKL/2012) in January 15, 2012.

⁷ The Bengkulu Sector has implemented the key monitoring system as mentioned above by having the PLN monitoring system on their management system.

As part of the PLN management system requirement, Musi HEPP has develop some SOPs as follow:

- SOP to calibrate the Test and Measurement equipment.
- SOP to develop an Electricity Transfer Monthly Protocol Report (BAP)
- SOP to read the Electricity Meter

All those SOPs are in-line with the need for VCS project at Musi HEPP. Therefore, no need to develop a new SOP for VCS Project. Musi VCS Team would continue to follow the SOP during the monitoring period. Newly developed SOP for VCS Monitoring would make available after the activation of the VCS Monitoring team.

3.3.3 Monitoring equipment and installation

Considering that the emission factor is calculated *ex-ante* and according to the Monitoring Methodology ACM0002 version 17.0, the only data to be monitored is electricity supplied to the grid by the project (detailed in section 3.2). The primary instruments include:

Metering of Electricity Supplied to the Grid

The main electricity meter for establishing the net electricity delivered to the grid (detailed in section 3.2) is installed at the Musi power plant. This electricity meter is the main meter (revenue meter), measuring the quantity of electricity supplied (net electricity delivered) to the grid from Musi Power Plant. Net electricity delivered to the grid is the difference of electricity export, electricity import and electricity own consumption. As this meter provides the main VCS measurement, it is the key part of the verification process. The main meter is located at the Musi power station. The main electricity meter reading record (Joint Meter Reading) then recorded on the Monthly Transfer Electricity Protocol Record (METPR).

The main electricity meter read together by representatives from PT PLN (Persero) Generation Division (PT PLN (Persero) Generation Unit Musi HEPP) and PT PLN (Persero) Load Dispatcher and Transmission Division (PT PLN (Persero) Tanjung Karang Transmission Unit). Since both parties are under the same Head Company (PT PLN (Persero)), no other check meter (comparison meter) installed at the transaction point.

Electricity meters should meet the relevant local standards at the time of installation and calibrated by the manufacturer before installation. The meters installed by the project according to the Indonesian standard “Standard Electricity Meter Equipment”. Records of the meter (type, make, model, and calibration documentation) will be retained in the quality control system on-site.

All equipment calibrated by the manufacturer according to relevant local regulation standards⁸ and maintained to ensure accuracy of measurements. Records of the meter (type, make, model, calibration, and maintenance documentation) retained as part of the VCS monitoring system.

Main Meter Quality Control

The project developer owns the meter and is responsible for its maintenance and calibration, as stated in the SOPs. PLN Transmission Division and its representative are entitled to be present during any test, inspection, maintenance, and replacement of any part of the metering system, which performed by the meter manufacturer on request of the project developer.

The project developer specifies the QC (flow-chart) procedure for calibration of test and measurement equipment (SOP to calibrate the Test and Measurement equipment) to ensure the measurement accuracy of values shown by the instrument / measuring device and test or a measurement system (one of the instrument mentioned on this SOP is the electricity meter). The calibration can be done internally or externally depend on the type of measuring equipment and resource capability. The electricity meter located at the Musi HEPP project site is calibrated by

⁸ The Ministry of Energy and Mineral Resource's regulation number 37 year 2008 dated November 27, 2008 on the Grid Code Sumatra Electricity Power System, the calibration of kWh meter must be done every 5 (five) years, as stated in the Metering Code section, MC 4.1.1 (Test after metering code commissioning, page 138)

external party. The calibration conducted by *PT. PLN (Persero) Penelitian dan Pengembangan Ketenagalistrikan*: Calibration Laboratory, a Certified Calibration Agency by National Accreditation Committee (*Komite Akreditasi Nasional / KAN*). The PLN Calibration Laboratory applies the Calibration Procedure B1IK0329 – 1 and IEC Standard 687 to calibrate the electricity meter. Periodic calibrations are to be done at least once every five years as per applicable metering standard issued by the Minister of Energy and Mineral Resource of Republic of Indonesia.

The Power Plant Operator periodically check if all tools and equipment work in a good condition as per the SOP⁹. In the event of any broken security seal in the metering system; or when the system fails to register, or if the measurement result is found upon testing to vary more than the allowable error from the standard meter used in the test, then an adjustment shall be made correcting all measurements of energy made by the metering system, as described in the SOP.

No check meter (comparison meter) installed at the transaction point. In case of failure of the main meter, the production meter and the plant own consumption meter (which were also located at generation site of each power generation unit) will be use as cross-check meters, measuring the quantity of electricity exported from the project. The difference between electricity produced and consumed on-site shall be valid for claiming carbon credits. In the special case of total failure of all meters no credits will be claimed during such period.

There was no metering devices breakdown or malfunction during the following monitoring period (01 August 2016 – 30 September 2017). All the meters listed above have performed well. However, any plant shut down or any other malfunctions are recorded in the logbook.

Data recording procedure

The procedures for collecting the electricity meter data is outlined in the Standard Operating Procedure as explained below.

The procedures for collecting the electricity meter data outlined in the Standard Operating Procedure signed between the project owner and the Grid Operator (both are under PLN)¹⁰. All relevant data archived electronically and backed up regularly. Uncertainty will be considered to achieve conservative results. Moreover, it will be kept for the full crediting period, plus two years after the end of the crediting period or the last issuance of VCUs for this project activity (whichever occurs later). The Monitoring Plan would develop to ensure that the project has robust data collection, processing, and archiving procedures.

Procedure for Joint Meter Reading (JMR) as per 'Procedure to develop Monthly Electricity Protocol Report' in general view (as described on the registered VCS PD, page 31):

⁹ http://kepuustakaan-presiden.pnri.go.id/uploaded_files/pdf/government_regulation/normal/UU_2_1981_soeharto.pdf

¹⁰ Musi HEPP is following the "*Prosedur Pembuatan BA Pengiriman Energi Listrik PLTA Musi*" or the 'Procedure to develop Musi HEPP Monthly Electricity Protocol Report' as the detail procedure for Electricity Transfer to the Sumatera Grid. This procedure is a further development refer to the General Operational Procedure for PLN generation unit located in the North and South Sumatera, titled "*Prosedur tetap transfer tenaga listrik antara PT PLN (Persero) Pembangkitan Sumbagut, PT PLN (Persero) Pembangkitan Sumbagsel dengan PT PLN (Persero) P3B Sumatera*"

- Joint meter reading by operator from Generation Unit (*Unit Pembangkitan / UP*) and Transmission Service Unit (*Unit Pelayanan Transmisi / UPT P3B*) conducted on the first date of each month at 10 A.M.
- Operating and maintenance supervisor (O & M supervisor) responsible for recording the amount of EG imported and exported by Generation unit as the result from kWh meter downloading.
- Operating and maintenance supervisor responsible for constructing the electricity generating protocol report, which includes calculation of net electricity delivered to PLN transmission unit. This report has to be reported and signed by Unit Manager, which further reported to the Sector Manager. VCS manager keep the copy of such report and be notified as well.
- O & M supervisor with other authorized staff from Generation unit extracted the data by downloading via computer from the kWh electronic meter and then record it in the form of Monthly Electricity Protocol (MEP), which signed by both Generating unit (PLN Musi Generation Unit) and PT. PLN P3B Pekalongan Sub-station). The joint meter reading taken at the transaction point is witnessed by the presence of P3B officials as transmission department and the PP representative as generation department.
- The MEP then rechecked by authorized person from PT. P3B (UPT Tanjung Karang / Tanjung Karang Transmission Unit) and PT PLN Generation Sector Office (Bengkulu Sector Office).

After all such information is rechecked and agreed by all related parties, the MEP is signed by all authorized parties from Generation unit and Transmission unit. The report will thus be sent to PLN KITSBS as headquarter for all power plant units in South Sumatra.

All relevant data archived electronically and backed up regularly. Uncertainty will be considered to achieve conservative results. Moreover, it will be kept for the full crediting period, plus two years after the end of the crediting period or the last issuance of VCUs for this project activity (whichever occurs later). The Monitoring Plan has been developed to ensure that the project has robust data collection, processing, and archiving procedures.

Main Electricity Meter specification:

Serial Number	Type	Factory	Class	Location
MUSI UNIT 1				
36027156	SL 7000 (Digital)	Actaris	0.2s	Main electricity meter 1 (MU 1) → to monitor electricity supply from turbine Musi #1
MUSI UNIT 2				
36027159	SL 7000 (Digital)	Actaris	0.2s	Main electricity meter 2 (MU 2) → to monitor electricity supply from turbine Musi #2
MUSI UNIT 3				
36027158	SL 7000 (Digital)	Actaris	0.2s	Main electricity meter 3 (MU 3) → to monitor electricity supply from turbine Musi #3
MUSI TRANSFORMER 150/20 kV				
35008966	SL 7000	Actaris	0.2s	Code PS to monitor the power plant own consumption (in-house consumption)

Picture of the main meters and own consumption meter (in-house consumption) are shown below:

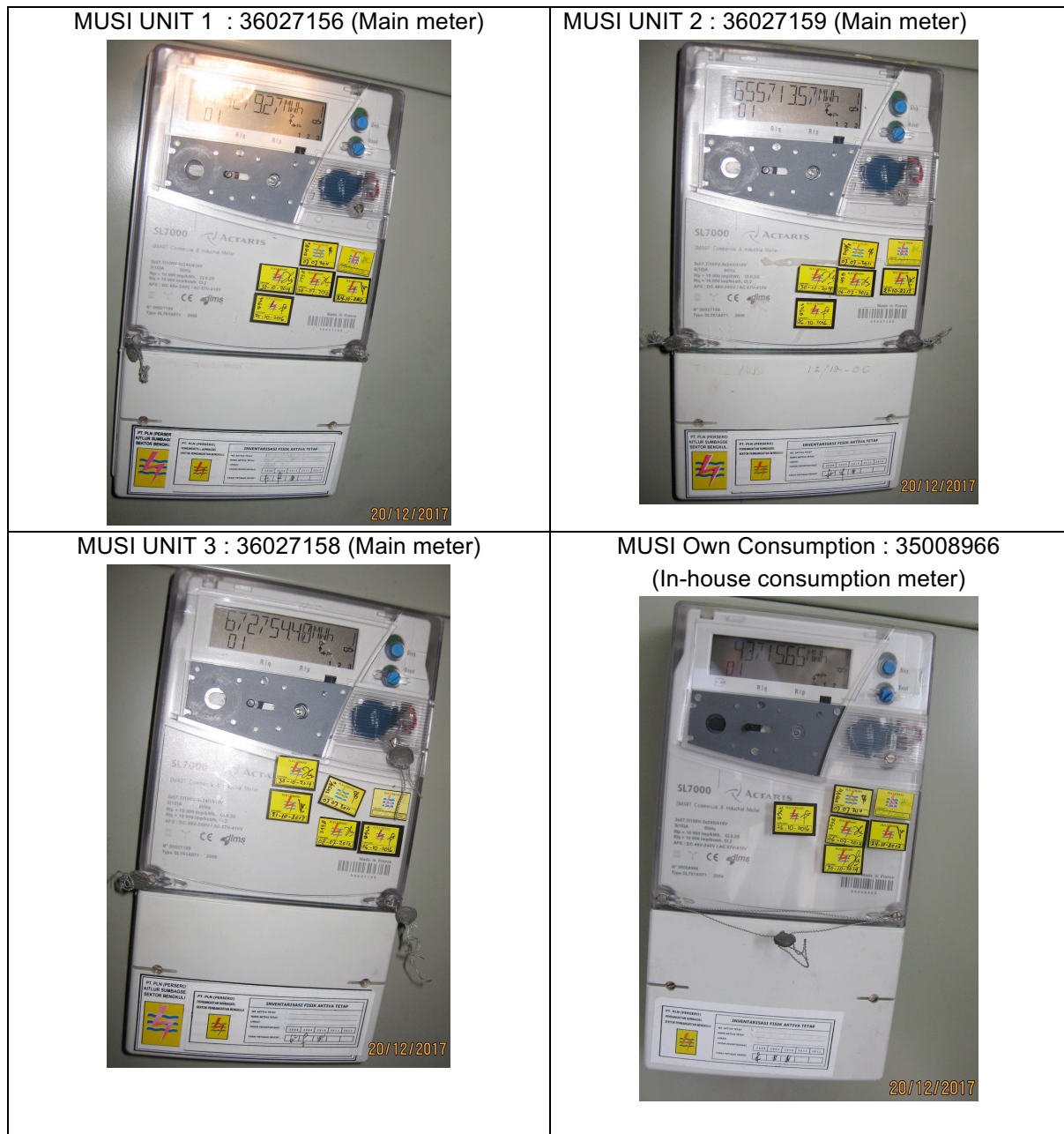


Figure 2 - Picture of main meters and own consumption meter (in-house consumption)

VCS data collection and record keeping arrangements

Every month the Operation Supervisor from Musi Generation Unit (member of VCS Team) and Transmission Sub-station read the meter together and record the data on their journal. Based on this reading, a monthly electricity generation report was signed by both the generation department (Musi HEPP Generation Unit) and the transmission department (Tragi Pekalongan).

At the end of each month the monitoring data needs to be filled electronically. The electronic files need to have CD back-up and/or print-out. The project developer needs to keep recorded Monthly Transfer Electricity Protocol Record (METPR). All written documentation such as maps, drawings, the EIA and the Feasibility study, should be stored for the crediting period and two years afterwards, and be made available to the verifier so that the reliability of the information may be checked.

4 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

4.1 Baseline Emissions

4.2.1. Formula used for baseline emissions calculation

The formula used for determination of the baseline emissions are described in section 4.3 of the registered VCS PD version 3.0 dated 28 February 2018.

Baseline emissions are calculated as follows:

$$BE_y = EG_{PJ,y} \times EF_{grid,CM,y} \quad (1)$$

Parameter	Description	Unit	Value	Source
BE_y	Baseline emission in the reported monitoring period	tCO ₂ /year	720,931	Equation (1)
$EG_{PJ,y}$	Quantity of net electricity generation that is produced and fed into the grid as a result of the implementation of the project activity in the reported monitoring period	MWh/year	841,226	Joint Meter Reading (JMR)
$EF_{grid,CM,y}$	Combined margin CO ₂ emission factor for grid connected power generation in the reported monitoring period	tCO ₂ /MWh	0.857	Calculation

4.2.2. Baseline emissions calculation

Vintage Month	$EG_{PJ,y}$ (MWh)	BE_y (tCO ₂ /year)
1 – 31 August 2016	57,642	49,399.18
1 – 30 September 2016	66,565	57,046.02
1 – 31 October 2016	71,227	61,041.38
1 – 30 November 2016	73,217	62,746.99
1 – 31 December 2016	67,291	57,668.33
TOTAL BE_y per 2016	335,942	287,901.90
TOTAL BE_y per 2016 (Round Down)	-	287,901.00

Vintage Month	EG _{PJ,y} (MWh)	BE _y (tCO ₂ /year)
1 – 31 January 2017	61,045	52,315.75
1 – 28 February 2017	59,709	51,170.71
1 – 31 March 2017	80,182	68,715.99
1 – 30 April 2017	85,966	73,672.97
1 – 31 May 2017	89,924	77,064.59
1 – 30 June 2017	76,426	65,497.46
1 – 31 July 2017	72,487	62,121.15
1 – 31 August 2017	68,313	58,544.62
1 – 30 September 2017	51,436	44,080.47
TOTAL BE_y per 2017	645,489	553,183.72
TOTAL BE_y per 2017 (Round Down)		553,183.00

4.2 Project Emissions

4.2.1. Formula used for project emissions calculation

Summary of Gases and Sources included in project boundary

Source	Gas	Included?	Justification/Explanation
Project For hydro power plants, emissions of CH ₄ from the reservoir	CO ₂	No	For all renewable energy power generation project activities, emissions due to the use of fossil fuels for the backup generator can be neglected.
	CH ₄	No	Not applicable since the project is a run-of river hydropower plant with a daily regulating pond for temporary storage.
	N ₂ O	No	Not applicable

$$PE_y = PE_{FF,y} + PE_{GP,y} + PE_{HP,y} \quad (2)$$

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

The $PE_{GP,y}$ does not apply as well as the project activity is a hydro power.

The project activity is a run-off-river type hydropower project. According to the methodology (For hydro power project activities that result in new single or multiple reservoirs and hydro power project activities that result in the increase of single or multiple existing reservoirs), project

proponents shall account for CH₄ and CO₂ emissions from the reservoirs. If the power density of the project activity (PD) is greater than 10 W/m², the PE_{HP,y} = 0.

Parameter	Description	Unit	Value	Source
PE _y	Project emission in the reported monitoring period	tCO ₂ e/yr	Calculated	Equation (2)
PE _{FF,y}	Project emissions from fossil fuel consumption in the reported monitoring period	tCO ₂ /yr	Calculated	"Tool to calculate project or leakage CO ₂ emissions from fossil fuel combustion"
PE _{GP,y}	Project emissions from the operation of geothermal power plants due to the release of non-condensable gases in the reported monitoring period	tCO ₂ /yr	0	Not applicable Project activity is not a geothermal powerplant.
PE _{HP,y}	Project emissions from water reservoirs in the reported monitoring period	tCO ₂ /yr	0	Not applicable (Power density is greater than 10 W/m ²)

4.2.2. Project emissions from the consumption of fossil fuels

Year	Fuel Consumption (Litre)	Fuel Consumption (ton)
2016 (Aug – Dec)	0	0
2017 (Jan – Sep)	0	0
TOTAL	0	0

4.3 Leakage

No leakage emissions are considered. The main emissions potentially giving rise to leakage in the context of electric sector projects are emissions arising due to activities such as power plant construction and upstream emissions from fossil fuel use (e.g. extraction, processing, transport). These emissions sources are neglected.

$$LE_y = 0$$

4.4 Net GHG Emission Reductions and Removals

4.4.1. Formula used for emission reductions calculation

Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y \quad (5)$$

Parameter	Description	Unit	Value	Source
BE_y	Baseline emissions in the period y	tCO ₂ e	Calculated	Equation (1)
PE_y	Project emissions in the period y	tCO ₂ e	Calculated	Equation (2)
ER_y	Project emission in the period y	tCO ₂ e	Calculated	Equation (3)

4.4.2. Emission reductions calculation

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: 01/08/2016 - 31/12/2016	287,901	0	0	287,901
Vintage 2017: 01/01/2017 - 30/04/2017	553,183	0	0	553,183
Total	841,084	0	0	841,084