210 MW MUSI HYDRO POWER PLANT, BENGKULU

Document Prepared by South Pole Carbon Asset Management Ltd.

Project Title	210 MW Musi Hydro Power Plant, Bengkulu
Version	04.2
Report ID	01
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Project ID	487
Monitoring Period	01-October-2017 to 31-December-2020 (both dates included)
Prepared By	South Pole Carbon Asset Management Ltd.
Contact	Technoparkstrasse 1, 8005 Zurich, Switzerland, Tel: +41 43 501 35 50 Email: registration@southpole.com Website: www.southpole.com

CONTENTS

1 PROJECT DETAILS

1.1 Summary Description of the Implementation Status of the Project

The 210 MW Musi Hydro Power Plant (hereinafter refer to as as 'project activity') is a new type of run-of-river hydropower plant located in Bengkulu Province, Indonesia. The project start date was 19/07/2006. The total installed capacity is 210 megawatts (MW), consisting of three net 70 MW generator. The annual energy output is expected at 1,140,000 megawatt hours (MWh), harnessing a gross water head of 404.4 meters (m) by diverting water at 42.3 m^3/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.

The project activity is registered as a 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 28/02/2018.

Prior to the implementation of the project activity there had been no existing power generation at the project location. The electricity in the grid was predominantly generated from fossil fuel sources and had been solely distributed to consumers via the electrical grid.

The estimated annual carbon dioxide (CO_2) emissions reduction of the project is 953,128 tCO_2e per year. During this monitoring period (01/10/2017 – 31/12/2020 both dates included) the total emissions reduction is **2,705,815 tCO_2e** (see below):

Vintage Year	Emissions reduction (tCO_2e)
01/10/2017 – 31/12/2017	231,120
01/01/2018 – 31/12/2018	803,211
01/01/2019 – 31/12/2019	712,808
01/01/2020 – 31/12/2020	958,676
Total	**2,705,815**

The project was validated under the VCS and was initially registered on 25/08/2010 (for 1st crediting period) and final validation report for renewal of 2nd crediting period was issued on 05/03/2018. 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

Electricity generation:

Type I	Renewable energy projects
Methodology:	ACM0002: Grid-connected electricity generation from renewable sources
Sectoral Scope 1	Energy industries (renewable/non-renewable sources)
Version	17.0

This project activity is not a grouped project and is not an AFOLU project.

1.3 Project Proponent

Project owner:

Organization name	PT. PLN (Persero)
Contact person	Mr. Komang Parmita
Title	Executive Vice President (EVP) of Health, Safety, Security and Environment (HSSE)
Address	Jl. Trunojoyo Blok M – I No 135, Kebayoran Baru, Jakarta 12160, Indonesia
Telephone	+62-21-725 1234
Email	komangparmita@pln.co.id

Carbon credit buyer:

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

1.4 Other Entities Involved in the Project

No other entities are involved in this project.

1.5 Project Start Date

As per the VCS policy announcement on 10/09/2008, the project start date is the date on which the project activity began reducing or removing greenhouse gas (GHG) emissions.

The commissioning dates for the three units are as follows:

- Musi Hydro Power Plant Unit 1: 19/07/2006 (Certificate for Proper Operation or *Sertifikat Laik Operasi*)
- Musi Hydro Power Plant Unit 2: 19/07/2006 (Certificate for Proper Operation or *Sertifikat Laik Operasi*)
- Musi Hydro Power Plant Unit 3: 19/07/2006 (Certificate for Proper Operation or *Sertifikat Laik Operasi*)

Thus, the project start date is 19/07/2006, as the earliest project start date of the three units that make up the project activity.

1.6 Project Crediting Period

First crediting period: 01/08/2006 – 31/07/2016 (both dates included, 10 years)

Second crediting period: 01/08/2016 – 31/07/2026 (both dates included, 10 years).

1.7 Project Location

The project area of the Musi Hydroelectric Power Plant (HEPP) is situated in Ujan Mas Atas, Kepahiang Regency, Bengkulu Province, Indonesia, which is about 30 km northeast of Bengkulu city, the capital of the province.

The geographical coordinates of Musi HEPP is -3.618497 South Latitude and 102.457186 East Longitude.

The location of the project site is shown in the map below:

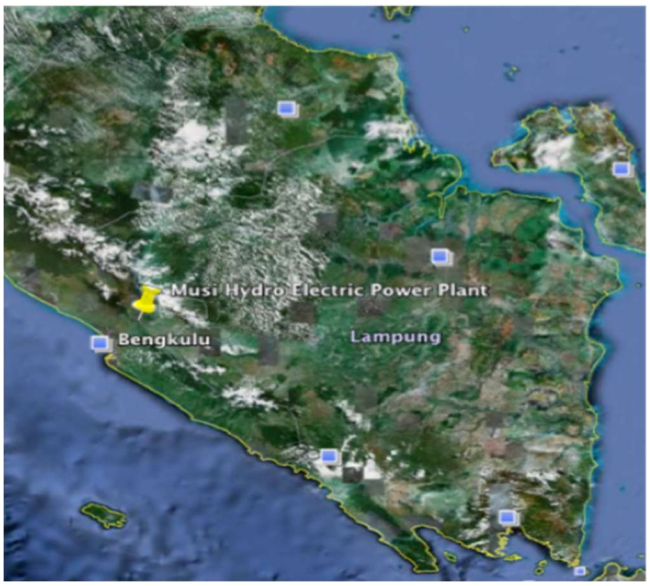

Figure 1: Location of Musi HEPP

1.8 Title and Reference of Methodology

The baseline and monitoring methodology for the project activity is defined as:

- ACM0002 – "Grid-connected electricity generation from renewable sources", version 17.0

Tool referenced in the applied methodologies:

- TOOL07 – "Tool to calculate the emission factor for an electricity system", version 06.0

1.9 Participation under other GHG Programs

The project activity is not registered under any other GHG program.

1.10 Other Forms of Credit

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 environment credit:

The project activity currently has not applied for any other type of environmental credit.

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 credit.

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

1.11 Sustainable Development

The project contributes to the sustainable development defined by the Government of Indonesia and the project partner; PT. PLN (Persero), actively monitors and report their sustainable development contribution which can be seen through several different reports as follows:

Social well-being:

- The project contributes to the development of the region by increasing community development and the corporate social responsibility of PT. PLN (Persero), for example through infrastructure development (roads, bridges); providing funds for the building of a new school, church and mosque in the region; upgrading health care facilities (a small clinic); and providing free medicines in the vicinity of the project for the benefit of the community.
- During both construction and operation, various kinds of mechanical work are required, providing employment on a regular and permanent basis.
- The social well-being is actively monitored and reported once a year which can be seen through the Implementation of environmental management and environmental monitoring report[1].

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 increasing the electricity supply and improving the availability of electricity to local consumers (villagers and suburban inhabitants). This creates new opportunities for industrial and economic activities, meaning an increase in local employment and better overall development.
- The project activity leads to the diversification of the national energy supply, which is dominated by conventional fuel-based generating units.
- The project activity contributes to economic sustainability around the plant sites and encourages economic power decentralization.

[1] the Implementation of environmental management and environmental monitoring report 2020 has been submitted to the VVB as a proof during project verification.

Environmental well-being:

- The project utilizes hydropower to generate electricity, which otherwise would have been generated through fuel- (most likely fossil fuel) based power plants. In this way, 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 do not have to deal with the issue 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.

  Based on the Implementation of environmental management and environmental monitoring report 2020, can be confirmed that monitoring and reporting of the environment has been done on an annual basis, and will continue to do so.

Technological well-being:

- The project supports high quality equipment transfer from other regions and 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.
- The Standard Operating Procedure for data monitoring has been put in place to ensure that the staff implements the monitoring plans effectively and regularly.

2 SAFEGUARDS

2.1 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 needs to undertake an Environmental Impact Assessment (EIA). The Musi Hydroelectric Power Plant project has a total installed capacity of 210 MW electricity, and thus requires an EIA.

Identified environmental impacts	Measures taken
Pre-construction phase	
Social responsibility	

Community perception related to project consultation, publicizing and resettlement	Perform discussion with local community, give proportional compensation on resettlement of village, monitor the issues that develop in the community
Construction phase	
Air and noise pollution	
Increase in air and noise pollution due to increased transportation and operation of heavy equipment	Restrict the operation of heavy equipment during the day, build a project fence to reduce noise pollution, spray water to avoid dust from construction, control vehicle emissions and noise, and use protective masks for employees
Water pollution	
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
Solid waste	
Construction waste from the transportation of soil material	Perform continuous cleaning during the construction period to remove debris and deposit of it appropriately
Biodiversity and ecosystems	
Change in biodiversity due to alteration in land and water body conditions	Reforest and restore the green lands after the construction, and maintain the minimum river flow to preserve the natural biodiversity within the river
Employment impacts	
Utilization of local human resources	Give priority to local employment and hold special training to enhance the local community's skills
Operation phase	
Water pollution	
Decrease in the quality and quantity of water due to the wastewater from plant's activity and land erosion	Operate wastewater treatment plant and reforest the watershed area
Environmental	
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 and create a waste transportation system

Spatial planning	
Change in spatial planning structure due to project activity	Control the development around project activity by enforcing the appropriate planning regulations
Regional image	
Change in regional image due to the development in the region	Planning controls will ensure sensitive development of the region
Traffic	
Increase in traffic activity due to the project's operational activity	Restore the trans-Sumatra main road and set up traffic signs
Health and Safety	
Human resources needed to operate the project and its facilities	Give employment opportunities to local human resources following high health and safety standards
Working opportunity and income	
Related to utilization of local human resources	Give priority to the admission of local human resources and hold special training sessions to enhance the local community's skills
Comfort	
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 roadside
Social responsibility	
Community perception related to project operation	Give a donation to the community, build a kindergarten in the nearest village and reforestation

With mitigation controls planned as part of the project construction and EIA process, and the contribution made by the project to sustainable development in 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.

2.2 Local Stakeholder Consultation

For the purposes of the EIA, a meeting was held on 06/05/2003 with relevant stakeholders, including the village chief and local residents within the project boundary. As documented in the EIA, local stakeholders felt that construction of the Musi HEPP had increased their social and economic 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.

Ongoing communication

Project Proponent (PP) has been reporting on the implementation of environmental management and environmental monitoring (*Laporan Implementasi Pengelolaan Lingkungan dan Pemantuan Lingkungan*) on a regular basis as part of the EIA implementation. PP also conducted a survey of the local community regarding the benefits perceived during project operations. The local community is not disturbed by the operation of the Musi HEPP. During this monitoring period, the surrounding community voiced their suggestions and expectations, for example that the Musi HEPP would help to build and repair local infrastructure (e.g., road, bridge, rice field drainage channels, and gabions).

2.3 AFOLU-Specific Safeguards

For non-AFOLU projects, this section is not required.

3 IMPLEMENTATION STATUS

3.1 Implementation Status of the Project Activity

The project was initially registered on 25/08/2010 (for 1st Crediting Period) and already completed renewal for the 2nd Crediting Period on 15/03/2018[2]. The current monitoring period is from 01/10/2017 – 31/12/2020 (both dates included). The emission reductions for this period are **2,705,815 tCO_2e** (VCUs). The implementation status of the project activity during this monitoring period was in-line with the registered PD of the 2nd Crediting Period.

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
	Rated flow	42.3 m^3/sec

[2] Referred to the "date updated" as per VCS registries; https://registry.verra.org/app/projectDetail/VCS/487

	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 factor	0.85
	Serial Number	● 03GT4501/UNIT 1 ● 03GT4601/UNIT 2 ● 03GRUN01/UNIT 3

Main transformers	**Brand**	Pauwels
	Model	Generator transformer
	Rated power	84.5 MVA
	Rated voltage	11kV/150 kV
	Rated frequency	50 Hertz
	Serial Number	● 03P0075/UNIT 1 ● 03P0074/UNIT 2 ● 03P0073/UNIT 3

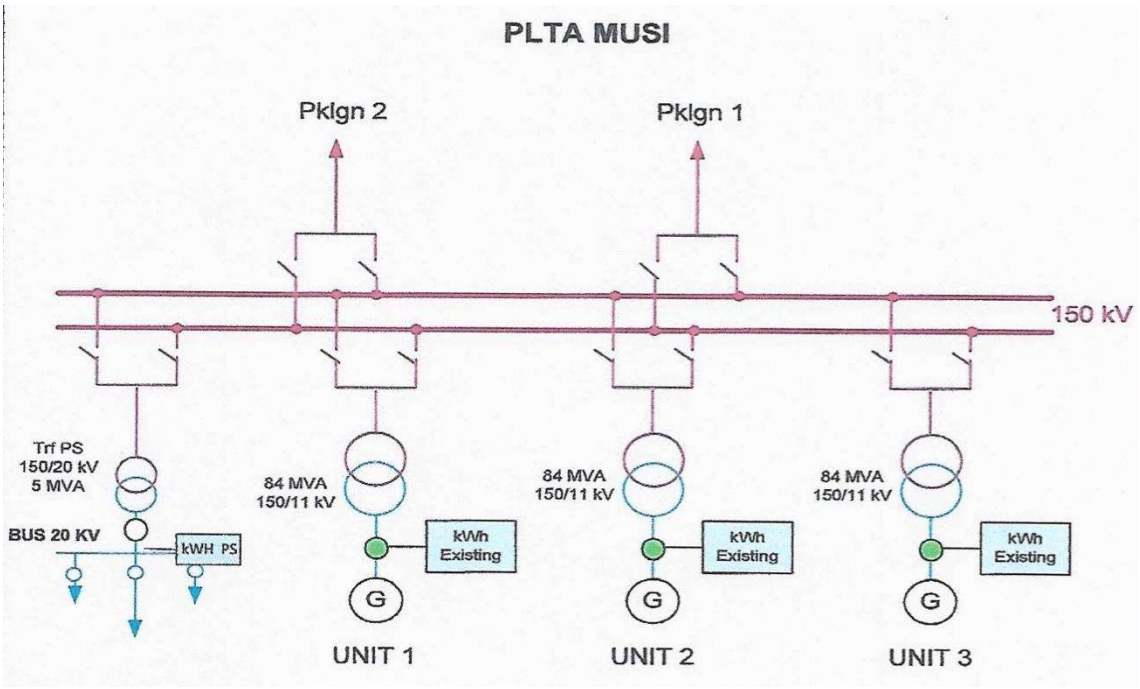

Figure 2: Single line electrical diagram

The operation of the project activity during this monitoring period (01/10/2017 – 31/12/2020 both dates included) was under normal conditions, where all of the monitoring parameters were conducted as per the registered monitoring plan. There was no change in the project activity as per the registered Project Description (PD). The equipment/machine was also maintained according to the registered PD. In case of any calibration delay, the maximum error was applied to the relevant monitoring data and conservative values were used for the calculation of emission reductions. The events that may impact the GHG emission reductions were provided in Table 2.

Table 2: The implementation status of the project activity

Date	Events
19/07/2006	Project start date
01/08/2006	First crediting period start date
25/08/2010	Initial registration with VCS
15/03/2018	Renewal of second crediting period date as per VERRA Registry (VCS program)
01/08/2016 to 30/09/2017 (both dates included)	First monitoring period under second crediting period
01/10/2017 – 31/12/2020 (both dates included)	Second monitoring period under second crediting period; refer to this report

3.2 Deviations

3.2.1 Methodology Deviations

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

3.2.2 Project Description Deviations

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

3.3 Grouped Projects

The project activity is not a grouped project.

4 DATA AND PARAMETERS

4.1 Data and Parameters Available at Validation

Data/Parameter	$EF_{grid,CM,y}$
Data unit	tCO_2/MWh

Description	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" As per the UNFCCC 'Methodological tool: Tool to calculate the emission factor for an electricity system' v06.0, the following default values should be used for wOM and wBM (for all projects except for wind and solar power generation project activities): wOM = 0.5 and wBM = 0.5 for the first crediting period, and wOM = 0.25 and wBM = 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'.
Purpose of data	Calculation of baseline emissions
Comments	-

4.2 Data and Parameters Monitored

Data/Parameter	$EG_{PJ,y}$
Data unit	MWh per year
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	kWh meter at project activity site (switchyard)

[3] Source of data for EFgrid,OM,y (0.735 tCO_2e/MWh) and EFgrid,BM,y (0.898 tCO_2e/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.

<table>
<tr><td></td><td>The electricity generation data used for monitoring is the Monthly Electricity Transfer Protocol Report (METPR) delivered to grid signed by both parties of the generation department and the transmission department.</td></tr>
<tr><td>Description of measurement methods and procedures to be applied</td><td>Electricity supplied to the grid will be measured by a watt-hour meter (connected to a digital control system and continuously monitored recorded), which can measure export and import electricity data separately. Therefore, net electricity delivered to the grid would be the difference between export and import electricity.

The measurement of electricity supplied to the grid (Joint Meter Reading/JMR) has been conducted and taken at the transaction point on a regular basis and is continuously monitored (recorded on a monthly basis in the METPR).</td></tr>
<tr><td>Frequency of monitoring/recording</td><td>Monitoring is continuous with the monthly recording of data.</td></tr>
<tr><td>Value monitored</td><td><table><tr><th>Monitoring period</th><th>Applied value</th></tr><tr><td>01/10/2017 – 31/12/2017</td><td>269,685.98</td></tr><tr><td>01/01/2018 – 31/12/2018</td><td>937,236.16</td></tr><tr><td>01/01/2019 – 31/12/2019</td><td>831,749.03</td></tr><tr><td>01/01/2020 – 31/12/2020</td><td>1,118,642.87</td></tr><tr><td>Total</td><td>3,157,314.04</td></tr></table></td></tr>
<tr><td>Monitoring equipment</td><td><u>Unit 1</u>
Type: Digital watt-hour meter type ACTARIS SL7000 (main meter)
Manufacturer/model: Actaris
Accuracy class: 0.2s
Serial number: 36027156
Calibration frequency: Every five years
Date of last calibration and validity:<table><tr><th>Calibration Date</th><th>Validity</th></tr><tr><td>25/10/2016</td><td>24/10/2021</td></tr></table><u>Unit 2</u>
Type: Digital watt-hour meter type ACTARIS SL7000 (main meter)
Manufacturer/model: Actaris
Accuracy class: 0.2s</td></tr>
</table>

	Serial number: 36027159 Calibration frequency: Every five years Date of last calibration and validity: **Calibration Date** / **Validity**: 26/10/2016 / 25/10/2021 **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 five years Date of last calibration and validity: **Calibration Date** / **Validity**: 26/10/2016 / 25/10/2021 **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 five years Date of last calibration and validity: **Calibration Date** / **Validity**: 26/10/2016 / 25/10/2021
QA/QC procedures to be applied	The QA/QC conducted a thorough crosschecking of the METPR at the transaction point, with sales electricity receipts (in the form of water tax payment receipts) issued by the North Sumatera Province Tax Office (local government). Meters at the generation unit are calibrated once every five years according to national regulations (refer to http://jdih.esdm.go.id/peraturan/Permen%20ESDM%2037%202008.pdf) The meter at the transaction point (main meter) will be read regularly and jointly by the person in

	charge from Generation unit and Transmission unit.
Purpose of data	Calculation of baseline emissions
Calculation method	Net electricity supplied to the grid is calculated as the difference between EG_{export}, EG_{import} and consideration of $EG_{Own\ Consumption}$ with formula as below: $(EG_{export} - EG_{import}) - EG_{Own\ Consumption}$
Comments	-

4.3 Monitoring Plan

This section details the steps that have been taken to regularly monitor the GHG emissions reductions from the project activity in accordance with ACM0002 version 17.0.

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

Monitoring period

The monitoring period covers 01/10/2017 – 31/12/2020 (both days inclusive).

Monitoring organization

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

All other VCS monitoring staff have clearly defined roles and responsibilities. The VCS manager manages the process of training new staff; ensuring trained staff perform the monitoring duties as necessary; and ensuring that where trained monitoring staff are absent, the integrity of the monitoring system is maintained by other trained staff.

A formal set of monitoring procedures has been established prior to the start of the verification. These procedures 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 have been developed 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.[4]

[4] The Pandan 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 tp read the Electricity Meter

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 4.2). The primary instruments include:

Metering of electricity supplied to the grid

There are three main electricity meters for establishing the net electricity delivered to the grid (detailed in section 4.2) have been installed at the Musi HEPP. These electricity meters have been the main meter (revenue meter), that measure the quantity of electricity supplied (net electricity delivered) to the grid. Net electricity delivered to the grid is the difference between electricity export and import. These meters provide the main VCS measurement and is a key part of the verification process. The main meters are located at the Musi HEPP. The main electricity meter reading records activity (Joint Meter Reading) and is then recorded on the METER.

The main electricity meter is read by representatives from PT PLN (Persero) Generation Division, (PT PLN (Persero) Musi HEPP Generation Unit) 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) is installed at the transaction point.

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

Main meter quality control

The project developer owns the meter and is responsible for its maintenance and calibration, as stated in the Standard Operating Procedure (SOP). 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 will be performed by the meter manufacturer at the request of the project developer.

The project developer specifies the QC (flow-chart) procedure for the calibration of test and measurement equipment (SOP to calibrate the Test Equipment and Measurement Equipment) to ensure the accuracy of the measurement values shown by the instrument/measuring device and test or measurement system (one of the instruments mentioned in this SOP is the electricity meter). The calibration can be done internally or

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

externally depending on the type of measuring equipment and resource capability. The electricity meter, which is located in the project area, is calibrated by the external party.

The main meter is specified to have 0.2s class. The calibration of test and measurement equipment has been conducted to ensure the measurement accuracy of the main meter. PT PLN (Persero) *Penelitian dan Pengembangan Ketenagalistrikan*, a national government approved laboratory certified 17025 and authorized by the Government of Indonesia, to conduct such calibration. Periodic calibrations have been performed at least once every five years as per applicable metering standard issued by the Minister of Energy and Mineral Resource of Republic of Indonesia.

Main electricity meter specification:

Serial Number	Type	Factory	Class	Location
Main meter (MU 1)				
36027156	SL 7000 (digital)	Actaris	0.2s	Main electricity meter 1 (MU 1) to monitor electricity supply from turbine Musi #1
Main meter (MU 2)				
36027159	SL 7000 (digital)	Actaris	0.2s	Main electricity meter 2 (MU 2) to monitor electricity supply from turbine Musi #2
Main meter (MU 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	Cod PS to monitor the power plant own consumption (in-house consumption)

The main meters are shown below:

MUSI UNIT 1: 36027156 (main meter)

MUSI UNIT 2: 36027159 (main meter)

MUSI UNIT 3: 36027158 (main meter)

MUSI Own Consumption: 35008966 (in-house consumption meter)

Figure 3: Pictures of main meters and own consumption meter (in-house consumption)

Data recording procedure

The procedures for collecting the electricity meter data is outlined in the SOP signed by the project owner and the Grid Operator (both are under PLN)[5]. All relevant data are archived electronically and backed up regularly. Uncertainty has been considered to achieve conservative results. Moreover, it has been 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.

[5] Musi HEPP is following the "Prosedur Pembuatan BA Pengiriman Energi Listrik PLTA Musi" or the 'Procedure to develop Musi aHEPP 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".

5 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

5.1 Baseline Emissions

The formula used for determination of the baseline emissions are described in section 4.3 of the registered VCS PD version 3.0 dated 28/02/2018.

Baseline emissions are calculated as follows:

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

Parameter	Description	Unit	Value	Source
BE_y	Baseline emission in the reported monitoring period	tCO_2 per year	Refer to Table 3	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 per year	Refer to Table 3	Monthly Electricity Transfer Protocol Report (METPR)
$EF_{grid,CM,y}$	Combined margin CO_2 emission factor for grid connected power generation in the reported monitoring period	tCO_2/MWh	0.857	Registered VCS PD version 3.0 dated 28/02/2018

Table 3: Detailed baseline emissions calculation for the monitoring period 01/10/2017 – 30/06/2021 (both dates included):

Vintage Year	$EG_{PJ,y}$ (MWh per year)	BE_y (tCO_2e per year)
01/10/2017 – 31/12/2017	269,685.98	231,120
01/01/2018 – 31/12/2018	937,236.16	803,211
01/01/2019 – 31/12/2019	831,749.03	712,808
01/01/2020 – 31/12/2020	1,118,642.87	958,676
Total	3,157,314.04	**2,705,815**

5.2 Project Emissions

Summary of gases and sources included in project boundary:

Source		Gas	Included?	Justification/explanation
Project	For hydropower 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_2O	No	Not applicable

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

The project does not involve for counting project emission from fossil fuel consumption because 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 $PE_{GP,y}$ is not applicable either, as the project activity is hydropower.

The project activity is a run-of-river type hydropower project. According to the methodology ("for hydropower 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 CH_4 and CO_2 emissions from the reservoirs. If the power density of the project activity (PD) is greater than 10 W/m^2, the $PE_{HP,y} = 0$. As explained in the registered PD version 3.0 dated 28/02/2018, the power density has been calculated as per equation 7 of ACM0002 version 17.0 by taking into account the capacity of the power plant(210 MW) and area of the run-of-river reservoir (1.14 km^2). From the calculation results in PD = 184.211 W/m^2. Hence, $PE_{HP,y}$ is not applicable for this project activity.

Parameter	Description	Unit	Value	Source
PE_y	Project emission in the reported monitoring period	tCO_2e per year	0	Equation (2)
$PE_{FF,y}$	Project emissions from fossil fuel consumption in the reported monitoring period	tCO_2 per year	0	"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 per year	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 per year	0	Registered VCS PD version 3.0 dated 28/02/2018

5.3 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.

$LE_y = 0$

5.4 Net GHG Emission Reductions and Removals

The annual estimated emission reduction as per registered PD is equal to 953,128 tCO_2e. For this monitoring period; 01/10/2017 to 31/12/2020, it is equal to 3 years and 92 days. Since there is only 92 days monitored in 2017. The estimated GHG emission reduction value for the monitoring period is the result of *953,128 tCO_2e/ year multiply with* $\frac{92}{365}$ *days/ year in 2017, 3 years for 2018-2020, which results in 3,099,624 tCO_2e.*

Comparing between the ex-ante emission reduction with the ex-post calculation, it was noted that the estimation is higher than the achieved emission reduction. This are reflected by number of factors i.e., the water supply in the year, maintenance, and power outage. It can be concluded that the decrease in emission reductions is not permanent and can neither be controlled nor predicted in advance.

Year	Estimated emissions or removals as per registered PD (tCO_2e)	Baseline emissions or removals (tCO_2e)	Project emissions or removals (tCO_2e)	Leakage emissions (tCO_2e)	Net GHG emission reductions or removals (tCO_2e)
01/10/2017 – 31/12/2017	240,240[6]	231,120	0	0	231,120

[6] *92 days were monitored in 2017, estimated GHG Emission Reduction value has been calculated by multiplying 953,128 tCO_2e with* $\frac{92}{365}$ *days, results in 240,240 tCO_2e*

01/01/2018 – 31/12/2018	953,128	803,211	0	0	803,211
01/01/2019 – 31/12/2019	953,128	712,808	0	0	712,808
01/01/2020 – 31/12/2020	953,128	958,676	0	0	958,676
Total	**3,099,624**	**2,705,815**	**0**	**0**	**2,705,815**