# 82 MW LAU RENUN HYDRO POWER PLANT NORTH SUMATRA

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| | |
|---|---|
| **Project Title** | 82 MW Lau Renun Hydro Power Plant, North Sumatra |
| **Version** | Version 1.2 |
| **Report ID** | - |
| **Date of Issue** | 22/12/2017 |
| **Project ID** | 488 |
| **Monitoring Period** | 01/03/2013 to 31/08/2016 (4th verification from the 1st crediting period) |
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# 1 PROJECT DETAILS

## 1.1 Summary Description of the Implementation Status of the Project

The 82 MW Lau Renun Hydro Power Plant (hereinafter refer to project activity) is a run-off the river type hydropower plant with a daily regulating pond at the five-hour peak power generation, diverting from the Renun river main stream and eleven (11) tributaries into Lake Toba. The regulating pond has a storage capacity of 500,000 $m^3$ and a power density of 820 $W/m^2$. The total actual installed capacity of the project is 82 MW, consisting of two 41 MW turbines. 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 | Brand | KVAERNER BOVING LIMITED |
| | Model | Francis vertical shaft |
| | Rated output | 42,000 kW |
| | Rated head | 434.6 m |
| | Rated speed | 750 rpm |
| | Rated flow | $10.42^3/s$ |
| | Serial number | 6028 |

| | | |
|---|---|---|
| Generators 1 & 2 | Brand | ELIN |
| | Model | SSV 290/8 – 176 |
| | Rated output | 46,000 kW |
| | Rated voltage | 11,000 +/- 10% |
| | Rated current | 2,414 A |
| | Rated frequency | 50 Hertz |
| | Rated speed | 750 |
| | Rated factor | 0.89 |

The Lau Renun Hydroelectric project was registered as VCS project with ID Number 488. Further background on this project can be found in the Verified Carbon Standard Project Description (VCS PD).

The geographical coordinate of Lau Renun Hydroelectric Power Plant is located on 2.6500 North Latitude and 98.4094 East Longitude, Northwestern part of Lake Toba in North Sumatera Province, about 100 km South of Medan City.

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.

According to the registered VCS-PD, the record on diesel consumption taken from the generator sets operational logbook is included in the project emission calculation of the project activity. The estimated annual $CO_2$ emissions reduction of the project is 229,048 $tCO_2e$. During this monitoring, total amount of emissions reduction is 773,497 $tCO_2e$ with detail as below:

| Vintage Year | Emissions Reduction | Unit |
|---|---|---|
| 01 March 2013 – 31 December 2013 | 208,187.00 | $tCO_2e$ |
| 01 January 2014 – 31 December 2014 | 214,524.00 | $tCO_2e$ |
| 01 January 2015 – 31 December 2015 | 234,802.00 | $tCO_2e$ |
| 01 January 2016 – 31 August 2016 | 115,984.00 | $tCO_2e$ |
| **Total** | **773,497.00** | **$tCO_2e$** |

The project was validated under VCS and final report was issued on 16 November 2009. 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 two units' commissioning date:

- Renun Hydro Power Plant Unit 1: 19 December 2006 (Certificate for Proper Operation or *Sertifikat Laik Operasi*)
- Renun Hydro Power Plant Unit 2: 14 August 2006 (Certificate for Proper Operation or *Sertifikat Laik Operasi*)

Thus, the project start date where project activity starts reducing emissions is 14 August 2006, as the earliest project start date of two units at Renun Hydro Power Plant.

## 1.6 Project Crediting Period

- HEPP Project starting date : 14 August 2006
- VCS Crediting period start date : 01 September 2006
- VCS crediting period : 10 years (01-Sep-2006 until 31-Aug-2016)

## 1.7 Project Location

The project area of the Renun Hydro Power Plant is situated at Northwestern part of Lake Toba in North Sumatra Province, and it is about 100 km south of Medan city as the crow flies. It includes part of the upper-reaches of the Renun River and part of Lake Toba. The principal structures of the Renun project such as the main intake and waterway are situated in the upper-reaches of the Renun River basin and the power station on Lake Toba. The proposed main intake is situated at about 750 m downstream from the public bridge of Sidikalang-Tarutung road on the upstream reach of the Renun river at Pangiringan. The power station is located at foot of the spur of Toba Escarpment about 2 km southeast of Silalahi village. The waterway is about 24 km long, including such structures as several stream intake weirs, surge tank and the penstock line is located between the main intake site and power station.

The exact location is 2.6500 N and 98.4094 E. The location of the project site is shown in the following maps:

The location of the project site is shown in the following maps:

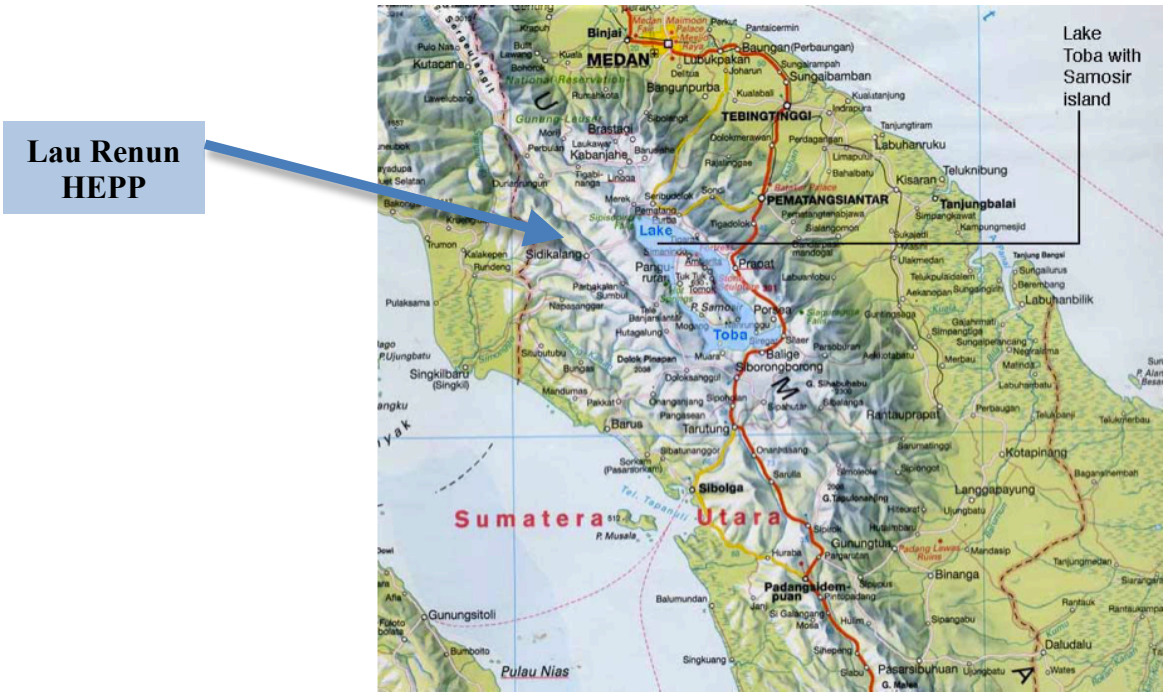



**Figure 1 - Location of Lau Renun Hydroelectric Power Plant**

## 1.8 Title and Reference of Methodology

Approved consolidated baseline methodology ACM0002 – "Consolidated baseline methodology for grid-connected electricity generation from renewable sources", version 10 (EB 47 annex 7).

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 credit[1].

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 program[2].

[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

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

## 1.10 Sustainable Development

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

Social well-being:

- The project contributes to the development of the region by increasing community development and corporate social responsibility of PT. PLN (Persero) such as infrastructure development (road, bridges); funds for building a new school, church and mosque in the region; upgrading health care facilities (a small clinic) as well as 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.

Economic well-being:

- The project activity generates direct and indirect employment for skilled and unskilled manpower during construction phase as well as during operational stage and thus helped in controlling migration from the region and alleviation of poverty in the local area.

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

- The generated electricity is fed into regional grids through the local grid, thereby improving the availability of electricity to local consumers (villagers and sub-urban inhabitants) by increasing the electricity supply. Due to increased new opportunities for industries and economic activities arise with a chance for more local employment and better overall development.

- The project activity leads to diversification of the national energy supply that is dominated by conventional fuel based generating units.

- The project activity contributes to economic sustainability around the plant sites and encourages 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.

- Thus, the project causes no negative impact on the surrounding environment since it is a run-off-river type hydropower plant with daily regulating pond; and in the end contributes to environmental well-being. The low impact on the surrounding environment shows the very high power density of regulating pond of shown to be 820 W/m2 calculated in section 2.2.

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, dated 06 November 2009, the 82 MW installed capacity Lau Renun HEPP generates about 313,500 MWh per year. During this monitoring period, the project activity has generated power of 1,041,057 MWh with details as below:

- 01 March – 31 December 2013 : 280,201 MWh
- 01 January – 31 December 2014 : 288,730 MWh
- 01 January – 31 December 2015 : 316,022 MWh
- 01 January – 31 August 2016 : 156,104 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

The project developer has requested Deviation of Monitoring Plan for following parameters with details below:

Deviation to parameter $FC_{PJ,y}$

As per validated VCS PD, PP must monitor parameter $\boldsymbol{FC_{PJ,y}}$ as described in the latest version of the "Tool to calculate project or leakage $CO_2$ emissions from fossil fuel combustion" (Version 02, 2nd August 2008, EB 41).

| Subject | Original Monitoring Plan as per validated VCS PD | Deviation of the Monitoring Plan |
|---|---|---|
| Description of measurement methods and procedures to be applied: | Fuel consumption will be recorded monthly, specifically for each fuel (currently only diesel consumption is available).<br>Fuel consumption will be calculated from static graduated level gauges on the fuel injection tanks by using emergency diesel genset, resulted in liters then converted to tonnes using fuel specific density or scientifically proven fuel densities. | Fuel consumption will be recorded monthly, specifically for each fuel (currently only diesel consumption is available).<br>Fuel consumption will be calculated based on diesel oil purchase receipt.<br>If the purchase receipt not available for particular month, the largest purchase amount during this monitoring period is taken for conservative estimation. Hence the project emission of $PE_y$ is higher and this is conservative.<br>Fuel consumption value in litres is converted to tonnage using fuel specific density or scientifically proven fuel densities. |

## 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 Renun Hydroelectric Power Plant project has an installed capacity of total 82 MW electricity in total and requires an EIA.

An EIA has been developed for this project and was completed on 2 June 1986 and approved by the Ministry of Energy and Mining in 1991. Where impacts of the project were identified, mitigation measures were suggested and defined. The EIA highlights the following impacts in connection with the project, as shown in the table below.

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

| 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 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 |
| *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 them 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, maintain the minimum river flow to preserve the natural biodiversity within the river. |
| *Employment impacts* | |
| Utilisation 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, 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, create a waste transportation system |
| *Spatial planning* | |
| Changing in spatial planning structure due to project activity | Control the development around project activity by enforcing the appropriate planning regulations |
| *Regional image* | |

| Identified environmental impacts | Measures taken |
|---|---|
| Changing in regional image due to the development in the region | Planning controls will ensure sensitive development of the region |
| *Traffic* | |
| Increase 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 utilisation of local human resources | Give priority to the admission of local human resources, hold special training 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 road side |
| *Social responsibility* | |
| Community perception related to project operation | Give donation for 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 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, including the village chief, local leaders, local organisation, and people who live nearby, within the project boundary of Renun hydro power plant was conducted for the purpose of identifying the significant impact in the region due to the project, possible positive and negative impact due to the project and to understand stakeholder perceptions due the project.

As documented, the local stakeholders have perceived that the construction of Renun 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.

The stakeholder meeting was carried out on August 24, 2005 in the village hall of the Pegagan Julu IV village. The meeting was documented and recorded. Attendance list, pictures, and other relevant documentation will be made available to the DOE and sent separately.

Outcome: No negative comments were received from the local stakeholders during the meeting. They did not object to the project activity because the project will not negatively impact the surrounding environment or people. No major issue that would affect the life of the local community or raise any environment related problems in the region by the implementation of the

project activity were identified during the discussion with stakeholders. All the minor issues were addressed.

# 3 DATA AND PARAMETERS

## 3.1 Data and Parameters Available at Validation

| Data / Parameter | $EF_{grid,CM,y}$ |
|---|---|
| Data unit | $tCO_2/MWh$ |
| Description | Grid Emission Factor of Sumatra |
| Source of data | DNA of Indonesia<br>http://pasarkarbon.dnpi.go.id/web/index.php/komnasmpb/read/14/faktor-emisi-jaringan-listrik-sumatera-dan-jamali-2008.html |
| Value applied | 0.743 |
| Justification of choice of data or description of measurement methods and procedures applied | No measurement required. Data is obtained based on analysis of DNA of Indonesia published information. |
| Purpose of Data | Calculation of baseline emissions |
| Comments | The 2008 grid emission factor has been crosschecked with the 2006 value, which was with 0.855 $tCO_2/MWh$ significantly higher and therefore less conservative. Hence, following the tool by using the most current data available at submission to validation and in terms of conservativeness the emission factor of 2008 is the appropriate value to be used in the emission reduction calculation. |

| Data / Parameter | $NCV_{i,y}$ |
|---|---|
| Data unit | GJ/kg |
| Description | Net calorific value of diesel fuel |
| Source of data | 2006 IPCC Guidelines for National Greenhouse Gas Inventories |
| Value applied | 0.043 |
| Justification of choice of data or description of measurement methods and procedures applied | - |
| Purpose of Data | Calculation of project emissions |
| Comments | - |

| Data / Parameter | $\rho_i$ |
|---|---|
| Data unit | $kg/m^3$ |

| | |
|---|---|
| Description | Density of diesel fuel |
| Source of data | Pertamina diesel fuel specification<br>http://www.pertamina.com/index.php?option=com_content&task=view&id=3262&Itemid=697 |
| Value applied | 0.815 kg/liter = 815 kg/$m^3$ |
| Justification of choice of data or description of measurement methods and procedures applied | - |
| Purpose of Data | Calculation of project emissions |
| Comments | - |

| | |
|---|---|
| Data / Parameter | $EF_{CO2,i,y}$ |
| Data unit | $tCO_2/GJ$ |
| Description | Weighted average $CO_2$ emission factor of diesel fuel in year 'y' |
| Source of data | IPCC default value is used<br>Source:<br>2006 IPCC Guidelines for National Greenhouse Gas Inventories: Workbook volume 2 chapter 1 (Table 1.4). |
| Value applied | 0.074 |
| Justification of choice of data or description of measurement methods and procedures applied | - |
| Purpose of Data | Calculation of project emissions |
| Comments | - |

## 3.2 Data and Parameters Monitored

| | |
|---|---|
| Data / Parameter | $EG_{PJ,y}$ |
| Data unit | kWh |
| Description | Net electricity supplied to the grid by the project activity during the year 'y' |
| Source of data | kWh meter at project activity site (switchyard)<br>The electricity generation data used for monitoring is the monthly electricity generation report delivered to grid signed by both parties of generation department and transmission department (Joint Meter Reading). |
| Description of measurement methods | Electricity supplied to the grid will be measured by a watt-hour meter (connected to a digital control system and continuously |

<table>
<tr><td>and procedures to be applied</td><td>monitored), which can measure export and import electricity data separately. Therefore net electricity delivered to the grid would be the difference of export and import electricity.<br>The measurement of electricity supplied to the grid will be conducted by joint meter reading taken at the transaction point on a regular basis and continuous monitoring (recorded in monthly basis). The Renun HEPP summarized the measurement results in sales electricity receipts (‘Monthly Electricity Protocol Report’ or ‘Berita Acara tentang Penyerahan dan Penerimaan kWh Penyaluran’ / BAP).</td></tr>
<tr><td>Frequency of monitoring/recording</td><td>Monitoring is continuous with monthly recording of data.</td></tr>
<tr><td>Value applied</td><td>
<table>
<tr><th>Year</th><th>Net electricity supplied to the grid (MWh)</th></tr>
<tr><td>01 March 2013 – 31 December 2013</td><td>280,201</td></tr>
<tr><td>01 January 2014 – 31 December 2014</td><td>288,730</td></tr>
<tr><td>01 January 2015 – 31 December 2015</td><td>316,518</td></tr>
<tr><td>01 January 2016 – 31 August 2016</td><td>156,419</td></tr>
</table>
<br>As per applicable metering standard issued by the Minister of Energy and Mineral Resource of Republic of Indonesia, revenue meter calibration should be conducted every 5 years. However, there was a calibration delay for revenue meter of Unit #1 and Unit #2 on 15/04/2015 until 31/08/2016. Based on the UNFCCC “CDM validation and verification standard for project activities” v.01.0, 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:<br><br>$EG_{exp}$ (Electricity exported to the grid)<br>= $EG_{exp}$ x (100% - accuracy of revenue meter)<br>= $EG_{exp}$ x (100% - 0.2%)<br><br>$EG_{imp}$ (Electricity imported from the grid)<br>= $EG_{imp}$ x (100% + accuracy of revenue meter)<br>= $EG_{imp}$ x (100% + 0.2%)</td></tr>
</table>

Therefore, net electricity generation ($EG_{PJ,y}$) values used in the ER calculation as following table:

| Year | Net electricity supplied to the grid (MWh) |
|---|---|
| 01 March 2013 – 31 December 2013 | 280,201 |
| 01 January 2014 – 31 December 2014 | 288,730 |
| 01 January 2015 – 31 December 2015 | 316,022 |
| 01 January 2016 – 31 August 2016 | 156,104 |

Note: The highlighted values in red color above are the values that have been applied for conservative approach due to delayed calibration.

**Monitoring equipment**

**Unit #1**

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

Manufacturer/ Model: Actaris

Accuracy class: 0.2s

Serial Number: 36027216

Calibration frequency: Every 5 years

Date of last calibration and validity:

| Certificate Number | Calibration Date | Validity | Calibrator[3] |
|---|---|---|---|
| 1081.21.BTND .095B/10.10 | 14/04/2010 | 14/04/2015 | *Laboratorium Kalibrasi - PT. PLN (Persero) Penelitian dan Pengembangan Ketenagalistrikan* |
| 2458.21.BTND .332B/17.17 | 06/12/2017 | 06/12/2022 | *Laboratorium Kalibrasi - PT. PLN (Persero) Penelitian dan Pengembangan Ketenagalistrikan* |

**Unit #2**

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

Manufacturer/ Model: Actaris

[3] *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.

<table>
<tr><td></td><td>Accuracy class: 0.2s<br>Serial Number: 36027222<br>Calibration frequency: Every 5 years<br>Date of last calibration and validity:<br><br>
<table>
<tr><th>Certificate Number</th><th>Calibration Date</th><th>Validity</th><th>Calibrator</th></tr>
<tr><td>1084.21.BTND .095B/10.10</td><td>14/04/2010</td><td>14/04/2015</td><td>Laboratorium Kalibrasi - PT. PLN (Persero) Penelitian dan Pengembangan Ketenagalistrikan</td></tr>
<tr><td>2457.21.BTND .332B/17.17</td><td>05/12/2017</td><td>05/12/2022</td><td>Laboratorium Kalibrasi - PT. PLN (Persero) Penelitian dan Pengembangan Ketenagalistrikan</td></tr>
</table>
.</td></tr>
<tr><td>QA/QC procedures to be applied</td><td>The QA/QC conducted through crosschecking the sales electricity receipts (Monthly Electricity Protocol Report) at the transaction point with water tax payment receipts issued by North Sumatera Province Tax Office (local government).<br>Meters at generation unit is calibrated once every five-year according to the national regulation (refer to http://prokum.esdm.go.id/permen/2008/Permen%20ESDM%2037%202008.pdf)<br><br>The meter at the Generation Unit (Main meter at the transaction point) will be read regularly and jointly by the person in charge from Generation unit and Transmission unit.</td></tr>
<tr><td>Purpose of data</td><td>Calculation of baseline emissions</td></tr>
<tr><td>Calculation method</td><td>Net electricity supplied to grid is calculated as the difference between $EG_{export}$ and $EG_{import}$ (=$EG_{export}$ – $EG_{import}$)</td></tr>
<tr><td>Comments</td><td>-</td></tr>
</table>

| | |
|---|---|
| Data / Parameter | $FC_{i,y}$ |
| Data unit | Ton |
| Description | Amount of diesel fuel used in the hydropower plant operation in the reported monitoring period.<br>Fuel consumption occurs in case of operation of two emergency diesel generator sets (DG sets) located at Power House and Main |

<table>
<tr><td></td><td>Intake.</td></tr>
<tr><td>Source of data</td><td>Calculated – Project Owner – diesel fuel purchase receipt</td></tr>
<tr><td>Description of measurement methods and procedures to be applied</td><td>Fuel consumption is calculated from the monthly diesel oil purchase receipt, then converted to ton using fuel specific density or scientifically proven fuel densities.</td></tr>
<tr><td>Frequency of monitoring/recording</td><td>Fuel consumption will be recorded monthly, specifically for each fuel (currently only diesel consumption is available).</td></tr>
<tr><td>Value applied</td><td>
<table>
<tr><th>Year</th><th>DIESEL OIL PURCHASE (based on actual Diesel Oil Purchase Receipt) [Liter]</th></tr>
<tr><td>01 March 2013 – 31 December 2013</td><td>484</td></tr>
<tr><td>01 January 2014 – 31 December 2014</td><td>339</td></tr>
<tr><td>01 January 2015 – 31 December 2015</td><td>173</td></tr>
<tr><td>01 January 2016 – 31 August 2016</td><td>200</td></tr>
</table>
<br>Based on the Project Description Deviations to parameter FC (Section 2.2.2), fuel consumption will be calculated based on diesel oil purchase receipt.<br>Due to the purchase receipt not available for particular months in year 2013, 2014, and 2015, the largest purchase amount during this monitoring period is taken for conservative estimation. Hence, 108 liter/month is taken for a few months in 2013 until 2016.<br><br>Therefore, the amount of diesel fuel ($FC_{i,y}$) values used in the ER calculation as following table:
<table>
<tr><th>Year</th><th>DIESEL OIL PURCHASE (adjustment for conservative approach) [Liter]</th></tr>
<tr><td>01 March 2013 – 31 December 2013</td><td>700</td></tr>
<tr><td>01 January 2014 – 31 December 2014</td><td>447</td></tr>
<tr><td>01 January 2015 – 31 December 2015</td><td>713</td></tr>
</table>
</td></tr>
</table>

| | |
|---|---|
| | 01 January 2016 – 31 August 2016: 200<br>Note: The highlighted values in red color above are the values that have been applied for conservative approach due to diesel oil purchase receipt not available for particular months. |
| Monitoring equipment | - |
| QA/QC procedures to be applied | No equipment is use to measure the actual diesel oil consumption. Fuel consumption calculated based on the diesel oil purchase receipt.<br>Since the purchase receipt was not available for each particular month, the largest purchase amount during this monitoring period was taken for conservative estimation. Hence the above reported figure is higher than the actual fuel consumption data.<br><br>Operator of Lau Renun HEPP recorded the diesel oil consumption assumption on the historical card, whenever they operate the DG set. The diesel oil purchase receipt will be crosschecked with this historical card. |
| Purpose of data | Calculation of project emissions |
| Calculation method | Converted from litre to ton using the density of diesel. |
| Comments | The value applies for fuel consumption calculation was taken from the diesel oil purchase receipt during period of 2013 – 2016.<br>Fuel consumption will only occur 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 will run on grid electricity. DG set usage is only for critical instrument/control system during turbine trip and shutdown. |

## 3.3 Monitoring Plan

This section details the steps taken to monitor on a regular basis the GHG emissions reductions from the Lau Renun Hydroelectric Power Plant Project in Indonesia in accordance with ACM0002 version 10.

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 March 2013 to 31 August 2016 (both days included)

### 3.3.2 Monitoring Organization

The monitoring team has been established and integrated within the existing organization structure of Lau Renun hydropower plant prior to the start of the verification[4]. 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.[5]

### 3.3.3 Monitoring equipment and installation

Considering that the emission factor is calculated *ex-ante* and according to the Monitoring Methodology ACM0002 version 10, the only data to be monitored is electricity supplied to the grid by the project (detailed in section 3.2). The primary instruments include:

[4] The PLN Pandan Sector has formed the VCS Monitoring Team (for both Lau Renun and Sipansihaporas VCS Project) through the 'Keputusan Manajer PT PLN (Persero) Sektor Pembangkitan Pandan Nomor : 067.K/MSPDN/2012' letter (or Management Decision Letter of PT PLN (Persero) Pandan Generation Sector Office No : 067.K/MSPDN/2012).

[5] 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, Lau Renun HEPP has develop some SOPs as follow:
- SOP to read the Electricity Meter
- SOP to calibrate the Test and Measurement equipment.
- SOP to develop an Electricity Transfer Monthly Protocol Report (BAP)
- SOP for Electricity Transfer
- SOP for Emergency Response

**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 Lau Renun 150 kV transmission line. This electricity meter will be the main meter (revenue meter), measuring the quantity of electricity supplied (net electricity delivered) to the grid. Net electricity delivered to the grid would be the difference of electricity export and import. As this meter provides the main VCS measurement, this is the key part of the verification process. The main meter is located at the Lau Renun power station. The main electricity meter reading record (Joint Meter Reading) then recorded on the Monthly Transfer Electricity Protocol Record (METPR) issued by Lau Renun HEPP Generation Unit.

The main electricity meter read together by representatives from PT PLN (Persero) Generation Division (PT PLN (Persero) Generation Unit Lau Renun HEPP) and PT PLN (Persero) Load Dispatcher and Transmission Division (PT PLN (Persero) Sidikalang Sub-Station).

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) retained in the quality control system on-site.

All equipment calibrated by the manufacturer according to relevant local standards at the time of installation and maintained in accordance with the manufacturer's recommendations 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 will be 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 Equipment 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, which located at the Lau Renun HEPP project site is calibrated by the external party.

The main meter is specified to have 0.2s class. The calibration of test and measurement equipment shall be conducted to ensure the measurement accuracy of the main meter. *PT. PLN (Persero) Penelitian dan Pengembangan Ketenagalistrikan*, National government approved laboratory certified 1702 and authorized by the Government of Indonesia, to conduct such calibration. 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.

**Main Electricity Meter specification:**

| Serial Number | Type | Factory | Class | Location |
|---|---|---|---|---|
| **MAIN METER (MU 1)** | | | | |
| 36027216 | SL 7000 (Digital) | Actaris | 0.2s | Main electricity meter 1 (MU 1) → to monitor electricity supply from turbine Renun #1 |
| **MAIN METER (MU 2)** | | | | |
| 36027222 | SL 7000 (Digital) | Actaris | 0.2s | Main electricity meter 2 (MU 2) → to monitor electricity supply from turbine Renun #2 |

Picture of the main meters are shown below:




**Figure 2 - Picture of main meter**

The Power Plant Operator periodically checked if all tools and equipment work in a good condition as per the SOP[6]. 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.

There was no metering devices breakdown or malfunction during the following monitoring period (01 March 2013 – 31 August 2016). All the meters listed above have performed well. In case of failure of the main meter, production meter and own consumption meter (hereinafter refer as

[6] http://kepustakaan-presiden.pnri.go.id/uploaded_files/pdf/government_regulation/normal/UU_2_1981_soeharto.pdf

cross-check meters) located at generation site of each power generation unit will be read to measure 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.

**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 will be outlined in the Standard Operating Procedure signed between the project owner and the Grid Operator (both are under PLN)[7]. All relevant data will be 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:

- 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 will then be further reported to the Sector Manager. VCS manager will have the copy of such report and be notified as well. The Sector Manager and VCS Manager have been handled by the same person during this monitoring period.
- O & M supervisor with other authorized staff from Generation unit will extract the data by downloading via computer from the kWh electronic meter and then record it in the form of Monthly Electricity Protocol (MEP), which shall be signed by both Generating unit (PLN Lau Renun Generation Unit) and PT. PLN P3B (*Tragi Sidikalang / Sidikalang 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.

[7] Lau Renun HEPP is following the "*Prosedur Pembuatan BA Pengiriman Energi Listrik PLTA Lau Renun*" or the 'Procedure to develop Lau Renun 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*"

- The MEP will be then rechecked by authorized person from PT. P3B (*UPT Pematang Siantar* / Pematang Siantar Transmission Unit) and PT PLN Generation Sector Office (Pandan Sector Office).

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

All relevant data will be 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.

**Total diesel oil consumption, from the operational of DG Set**

The Project Emission resulted from the consumption of diesel oil for the operational of Emergency Diesel Generator Set (Emergency DG Set). No equipment available on the project activity site to measure the actual diesel oil consumption ($FC_{i,y}$ monitoring parameter). Fuel consumption calculated based on the diesel oil purchase receipt. If the purchase receipt not available for particular month, the largest purchase amount during this monitoring period is taken for conservative estimation.

Operator of Lau Renun HEPP recorded the diesel oil consumption assumption on the historical card, whenever they operate the DG set. The diesel oil purchase receipt is crosschecked with this historical card.

**VCS data collection and record keeping arrangements**

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

At the end of each month the monitoring data needs to be filed electronically. The electronic files need to have CD back-up and/or print-out. 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

### 4.1.1. 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 Ver. 3 dated 6th November 2009.

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 | $tCO_2$/year | 221,174 | 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.<br>The total $EG_{PJ,y}$ during this monitoring period is 1,041,868 MWh (42 months) if without any delayed calibration conservative approach (correction factor) applied, hence averagely it is 297,677 MWh/year. | MWh/year | 297,677 | 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 | 0.743 | Indonesian DNA published grid emission factor for Sumatra. |

### 4.1.2. Baseline emissions calculation

| Vintage Month | $EG_{PJ,y}$ (MWh) | $BE_y$ ($tCO_2$/year) |
|---|---|---|
| 1 – 31 March 2013 | 29,311 | 21,778.07 |
| 1 – 30 April 2013 | 30,783 | 22,871.77 |
| 1 – 31 May 2013 | 33,202 | 24,669.09 |
| 1 – 30 June 2013 | 27,246 | 20,243.78 |
| 1 – 31 July 2013 | 25,915 | 19,254.85 |
| 1 – 31 August 2013 | 22,381 | 16,629.08 |
| 1 – 30 September 2013 | 23,687 | 17,599.44 |

| Vintage Month | $EG_{PJ,y}$ (MWh) | $BE_y$ ($tCO_2$/year) |
|---|---|---|
| 1 – 31 October 2013 | 25,733 | 19,119.62 |
| 1 – 30 November 2013 | 30,786 | 22,874.00 |
| 1 – 31 December 2013 | 31,157 | 23,149.65 |
| **TOTAL $BE_y$ per 2013** | **280,201** | **208,189.34** |
| **TOTAL $BE_y$ per 2013 (Round Down)** | **-** | **208,189.00** |
| | | |
| 1 – 31 January 2014 | 24,278 | 18,038.55 |
| 1 – 28 February 2014 | 18,079 | 13,432.70 |
| 1 – 31 March 2014 | 18,827 | 13,988.46 |
| 1 – 30 April 2014 | 26,725 | 19,856.68 |
| 1 – 31 May 2014 | 27,763 | 20,627.91 |
| 1 – 30 June 2014 | 21,474 | 15,955.18 |
| 1 – 31 July 2014 | 17,920 | 13,314.56 |
| 1 – 31 August 2014 | 19,040 | 14,146.72 |
| 1 – 30 September 2014 | 20,172 | 14,987.80 |
| 1 – 31 October 2014 | 32,736 | 24,322.85 |
| 1 – 30 November 2014 | 33,484 | 24,878.61 |
| 1 – 31 December 2014 | 28,232 | 20,976.38 |
| **TOTAL $BE_y$ per 2014** | **288,730** | **214,526.39** |
| **TOTAL $BE_y$ per 2014 (Round Down)** | **-** | **214,526.00** |
| | | |
| 1 – 31 January 2015 | 27,431 | 20,381.23 |
| 1 – 28 February 2015 | 19,738 | 14,665.33 |
| 1 – 31 March 2015 | 22,133 | 16,444.82 |
| 1 – 30 April 2015 | 28,213 | 20,962.52 |
| 1 – 31 May 2015 | 31,611 | 23,486.60 |
| 1 – 30 June 2015 | 24,496 | 18,200.30 |
| 1 – 31 July 2015 | 22,570 | 16,769.17 |
| 1 – 31 August 2015 | 26,813 | 19,922.11 |
| 1 – 30 September 2015 | 23,234 | 17,263.05 |
| 1 – 31 October 2015 | 27,603 | 20,508.66 |
| 1 – 30 November 2015 | 33,242 | 24,699.00 |
| 1 – 31 December 2015 | 28,939 | 21,501.52 |

| Vintage Month | $EG_{PJ,y}$ (MWh) | $BE_y$ ($tCO_2$/year) |
|---|---|---|
| **TOTAL $BE_y$ per 2015** | **316,022** | **234,804.32** |
| **TOTAL $BE_y$ per 2015 (Round Down)** | **-** | **234,804.00** |
| | | |
| 1 – 31 January 2016 | 20,879 | 15,513.00 |
| 1 – 28 February 2016 | 20,676 | 15,362.48 |
| 1 – 31 March 2016 | 19,995 | 14,856.11 |
| 1 – 30 April 2016 | 20,512 | 15,240.22 |
| 1 – 31 May 2016 | 22,014 | 16,356.19 |
| 1 – 30 June 2016 | 20,876 | 15,510.87 |
| 1 – 31 July 2016 | 14,682 | 10,908.97 |
| 1 – 31 August 2016 | 16,471 | 12,237.79 |
| **TOTAL $BE_y$ per 2016** | **156,104** | **115,985.64** |
| **TOTAL $BE_y$ per 2016 (Round Down)** | **-** | **115,985.00** |
| **TOTAL $BE_y$ per 2013 – 2016** | **-** | **773,504.00** |

Note: The highlighted values in red color above are the values that have been applied for conservative approach due to delayed calibration.

## 4.2 Project Emissions

### 4.2.1. Formula used for project emissions calculation

The formula used for determination of the baseline emissions are described in section 4.3 of registered VCS PD Ver. 3 dated 6th November 2009.

Project emissions are calculated as follows:

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

| Parameter | Description | Unit | Value | Source |
|---|---|---|---|---|
| $PE_y$ | Project emission in the reported monitoring period | $tCO_2e$/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 | $tCO_2$/yr | 0 | Not applicable<br>Project activity is not a geothermal powerplant. |

| | | | | |
|---|---|---|---|---|
| | non-condensable gases in the reported monitoring period | | | |
| $PE_{HP,y}$ | Project emissions from water reservoirs in the reported monitoring period | $tCO_2/yr$ | 0 | Not applicable<br>Lau Renun HEPP is a run-off river hydro powerplant. |

$PE_{FF,y} = PE_{FC,j,CO2}$ ,

$PE_{FC,j,CO2} = \Sigma FC_{i,j,y} \times COEF_{i,y}$ (3)

| Parameter | Description | Unit | Value | Source |
|---|---|---|---|---|
| $PE_{FC,j,CO2}$ | $CO_2$ emissions from fossil fuel combustion in process j during year y | $tCO_2/y$ | **7.00**<br>2013: 2.00<br>2014: 2.00<br>2015: 2.00<br>2016: 1.00 | Equation (3) |
| $FC_{i,j,y}$ | Quantity of fuel type I combusted in process j during the year y | ton/y | **1.68**<br>2013: 0.57<br>2014: 0.36<br>2015: 0.58<br>2016: 0.16 | Measured in litre than converted into ton with formula as below:<br>Fuel Consumption (litre) x Fuel Density (0.815 kg/litre) |
| $COEF_{i,y}$ | $CO_2$ emission coefficient of fossil fuel type i in year y | $tCO_2$/ton | 3.1863 | Equation (4) |
| i | Fuel types combusted in process j during year y | - | i= Diesel oil | Lau Renun HEPP |

$COEF_{i,y}$ is calculated using option B. Option B calculates $COEF_{i,y}$ based on net calorific value and $CO_2$ emission factor of fuel type i, as follows:

$COEF_{i,y} = NCV_{i,y} \times EF_{CO2,i}$ (4)

| Parameter | Description | Unit | Value | Source |
|---|---|---|---|---|
| $COEF_{i,y}$ | $CO_2$ emission coefficient of fossil fuel type i in year y | $tCO_2$ / ton fuel | 3.1863 | Equation (4) |
| $NCV_{i,y}$ | Weighted average net calorific value of fuel type i in year | TJ/ton fuel | Diesel Fuel: 0.043 | IPCC 2006 default for diesel oil |
| $EF_{CO2,i}$ | Weighted average $CO_2$ emission factor of fuel type i | $tCO_2/TJ$ | Diesel Fuel: 74.1 | IPCC 2006 default for diesel oil |

| | | | | |
|---|---|---|---|---|
| | in year y | | | |
| i | Fuel types combusted in process j during year y | - | i=Diesel oil | Lau Renun HEPP |

### 4.2.2. Project emissions from the consumption of fossil fuels

| Year | Fuel Consumption (Litre) | Fuel Consumption (ton) |
|---|---|---|
| 2013 (March – Dec) | 700 | 0.57 |
| 2014 (Jan – Dec) | 447 | 0.36 |
| 2015 (Jan – Dec) | 713 | 0.58 |
| 2016 (Jan – Aug) | 200 | 0.16 |
| TOTAL | **2,059** | **1.68** |

Note: The highlighted values in red color above are the values that have been applied for conservative approach due to diesel oil purchase receipt not available for particular months.

## 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* | $tCO_2e$ | Calculated | Equation (1) |
| $PE_y$ | Project emissions in the period *y* | $tCO_2e$ | Calculated | Equation (2) |
| $ER_y$ | Project emission in the period y | $tCO_2e$ | Calculated | Equation (3) |

### 4.4.2. Emission reductions calculation

| Year | Baseline emissions or removals ($tCO_2e$) | Project emissions or removals ($tCO_2e$) | Leakage emissions ($tCO_2e$) | Net GHG emission reductions or removals ($tCO_2e$) |
|---|---|---|---|---|
| Vintage 2013 : 01/03/2013 - 31/12/2013 | 208,189.00 | 2.00 | **0** | 208,187.00 |
| Vintage 2014 : 01/01/2014 - 31/12/2014 | 214,526.00 | 2.00 | **0** | 214,524.00 |
| Vintage 2015 : 01/01/2015 - 31/12/2015 | 234,804.00 | 2.00 | **0** | 234,802.00 |
| Vintage 2016 : 01/01/2016 - 31/08/2016 | 115,985.00 | 1.00 | **0** | 115,984.00 |
| **Total** | **773,504.00** | **7.00** | **0** | **773,497.00** |