Monitoring report form for CDM project activity
(Version 07.0)

MONITORING REPORT		
Title of the project activity	Pesqueiro Energia Small Hydroelectric Project (PESHP)	
UNFCCC reference number of the project activity	0242	
Version number of the PDD applicable to this monitoring report	6.0	
Version number of this monitoring report	2.1	
Completion date of this monitoring report	21/01/2021	
Monitoring period number	Second monitoring period	
Duration of this monitoring period	01/10/2013 – 26/01/2017	
Monitoring report number for this monitoring period	Not applicable	
Project participants	Pesqueiro Energia S.A. Trading Emissions PLC CM Capital Markets Holding S.A. Ecopart Assessoria em Negocios Empresariais Ltda.	
Host Party	Brazil	
Applied methodologies and standardized baselines	AMS-I.D: Grid connected renewable electricity generation (version 17.0)	
Sectoral scopes	1 : Energy industries (renewable - / non-renewable sources)	
Amount of GHG emission reductions or net anthropogenic GHG removals achieved by the project activity in this monitoring period	Amount achieved before 1 January 2013	Amount achieved from 1 January 2013
	0	79,006
Amount of GHG emission reductions or net anthropogenic GHG removals estimated ex ante for this monitoring period in the PDD	59,578	

SECTION A. Description of project activity

A.1. General description of project activity

The primary objective of the PESHP is to help meet Brazil's rising demand for energy due to economic growth and to improve the supply of electricity, while contributing to environmental, social and economic sustainability by increasing the share of renewable energy in total electricity consumption for Brazil (and the Latin America and the Caribbean region's) electricity consumption.

The PESHP is located in Jaguariaíva River (South of Brazil), where the largest coal reserves are located as well as the majority of thermopower plants using this fossil fuel. The project consists of a small-hydropower plant with 12.44 MW installed capacity[1] and 0.33km² reservoir area, resulting in minor environmental impact (Figure 1 and Figure 2). PESHP is expected to generate about 80,000 MWh/year based on 9.24MW-ave assured energy (74.3% capacity factor). The project construction started in May 2001 and it was concluded in December 2002. The operation startup occurred in January 2003.

Figure 1 – Dam of the project activity

Figure 2 – PESHP reservoir

This cleaner source of electricity also provides an important contribution to environmental sustainability by reducing carbon dioxide emissions that otherwise would have occurred in the absence of the project. The project activity reduces emissions of greenhouse gas (GHG) by avoiding electricity generation from fossil fuel sources (and CO_2 emissions), which would be generated (and emitted) in the absence of the project.

PESHP is owned by Pesqueiro Energia S.A is a special purpose company (SPC) controlled by three agricultural cooperatives in its majority structure: Cooperativa de Infraestrutura de Arapoti – CERAL, Cooperativa de Eletrificação Rural Castrolanda Ltda. and Cooperativa de Eletrificação Rural de Itaí Paranapanema Avaré (changed to CERIPA Energia S.A.)[2].

[1] The registered PDD considered the rated capacity of turbines instead generators: 2 x 6.22 MW = 12.44 MW installed capacity.

[2] Information available at:
http://www2.aneel.gov.br/paracemp/apl/APL.NEW/PAE_vMKR_ParticipacaoAcionariaUsinaslist.asp

This monitoring report corresponds to the second verification of PESHP, which covers the period from 01/10/2013 to 26/01/2017. During this monitoring period, the project activity reduced 79,006 tCO_2e. Timeline of the CDM project is as follows:

Table 1 – Timeline of the CDM project activity

Date	Action
26/02/2006	CDM registration
13/07/2006	First issuance: 27/01/2003 – 31/03/2006
27/06/2008	Second issuance: 01/04/2006 – 29/02/2008
13/01/2011	Third issuance: 01/03/2008 – 26/01/2010
16/08/2012	Renewal of the crediting period
29/07/2014	First issuance: 27/01/2010 – 30/09/2013

A.2. Location of project activity

The project is located in the South of Brazil, state of Paraná, city of Jaguariaíva, and uses using the hydro potential of the Jaguariaíva River. The project geographical coordinates are: latitude 24º07'58" South and longitude 49º38'09" West[3]. The Jaguariaíva River is part of the Paraná River basin.

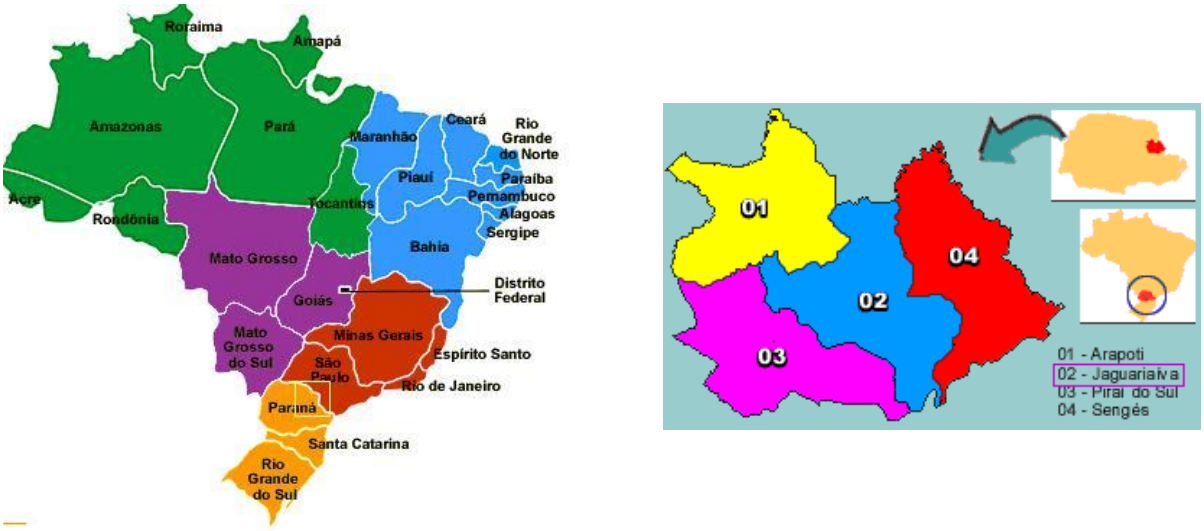

Figure 3 - Political division of Brazil showing the Paraná State and the city of Jaguariaíva (Sources: http://www.citybrazil.com.br/).

A.3. Parties and project participants

Parties involved	Project participants	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Brazil (host Party)	Private entity Pesqueiro Energia S.A.	No

[3] ANEEL Resolution nr. 61 issued on 22/03/2000.

Parties involved	Project participants	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Switzerland	Private entity Trading Emissions PLC	No
	Private entity CM Capital Markets Holding S.A.	
United Kingdom of Great Britain and Northern Ireland	Private entity Ecopart Assessoria em Negocios Empresariais Ltda.	No

A.4. References to applied methodologies and standardized baselines

PESHP applies AMS-I.D: Grid connected renewable electricity generation (version 17.0)[4].

According to the registered PDD, ACM0002 - "Consolidated baseline methodology for grid-connected electricity generation from renewable sources" (version 12.2.0) is also used to determine possible project emissions from reservoir[5].

In addition, the following tools are also applicable to the project:

- TOOL07: "Tool to calculate the emission factor for an electricity system" (version 2.2.1)[6];
- TOOL11: "Validity of the original/current baseline and to update the baseline at the renewal of a crediting period" **(**version 3.0.0)[7].

It is important mentioning that TOOL11 is not applicable to the project verification and, therefore, it is not used in this Monitoring Report.

A.5. Crediting period type and duration

2nd renewable crediting period: 27/01/2010 – 26/01/2017

7 years, 0 month

SECTION B. Implementation of project activity

B.1. Description of implemented project activity

The project construction started in May 2001 and it was concluded in December 2002. The operation startup occurred in January 2003.

[4] EB 61, Annex 17, 3 June 2011. Available at: <https://cdm.unfccc.int/methodologies/DB/W3TINZ7KKWCK7L8WTXFQQOFQQH4SBK>

[5] EB 65, Annex 16, 25 November 2011. Available at:

<https://cdm.unfccc.int/methodologies/DB/XP2LKUSA61DKUQC0PIWPGWDN8ED5PG>

[6] EB 63, Annex 19, 29 September 2011. Available at: <https://cdm.unfccc.int/EB/archives/meetings_11.html#63>

[7] EB 65, Annex 20, 25 November 2011. Available at: <https://cdm.unfccc.int/EB/archives/meetings_11.html#65>

Figure 4 – PESHP turbines and generators

Figure 5 – PESHP power house

The equipment and technology used in the PESHP Project has been successfully applied to similar projects in Brazil and around the world. The following table presents a description of the equipment installed in the plant.

Table 2 - Specifications of the equipment used at PESHP

Turbines	
Type	Simple Francis
Quantity	2
RPM	514.3
Power (kW)	6,220
Nominal Liquid Head(m)	86
Manufacturer	Möller / Alstom
Generators	
Type	SPA 1250
Quantity	2
Frequency (HZ)	60
Power (MVA)	6.8
Nominal Voltage (MW)	6.9
Manufacturer	WEG Máquinas S/A

B.2. Post-registration changes

B.2.1. Temporary deviations from the registered monitoring plan, applied methodologies, standardized baselines or other methodological regulatory documents

Not applicable. No temporary deviations were made during this crediting period.

B.2.2. Corrections

Not applicable. No corrections were made during this crediting period.

B.2.3. Changes to the start date of the crediting period

Not applicable. No changes in the starting date of the crediting period were made.

B.2.4. Inclusion of monitoring plan

Not applicable. No revisions in the monitoring plan were made during this crediting period.

B.2.5. Permanent changes to the registered monitoring plan, or permanent deviation of monitoring from the applied methodologies, standardized baselines, or other methodological regulatory documents

Not applicable. No permanent changes were made in the PDD during this crediting period.

B.2.6. Changes to project design

Not applicable. No changes in the project design were made during this crediting period.

B.2.7. Changes specific to afforestation or reforestation project activity

Not applicable. The project activity is not a afforestation or reforestation project type.

SECTION C. Description of monitoring system

The monitoring plan of the emission reductions by the project activity is in accordance with the procedures set by the methodology “AMS-I.D - Grid connected renewable electricity generation”.

The project proceeded with the necessary measures for the power control and monitoring. Through information from the Chamber of Electric Energy Commercialization (CCEE from the Portuguese “Câmara de Comercialização de Energia Elétrica”), it is possible to monitor the power generation of the project. CCEE makes feasible and regulates the electricity commercialization.

CCEE has remote access to the energy meters at the connection point through Billing Commensuration System (SMF from the Portuguese “Sistema de Medição e Faturamento”) in accordance with specifications set out by CCEE and the National Operator of the Electric System (ONS from the Portuguese Operador Nacional do Sistema Elétrico). ONS is responsible for coordinating and controlling the operation of grid-connected power plants and power utilities (transmission lines).

In the case of PESHP, the connection point to the grid is at COPEL’s substation[8]. There are two energy meters (main and backup) at the substation, which are in accordance with the specifications of the regulatory agencies. Meters are bidirectional and measurement is redundant, so that, in case the first meter fails, the second automatically replaces it. These meters calibration were scheduled to occur every two years according to ONS procedures.

[8] Located at 17 km far from the power plant, in the city of Jaguariaíva.

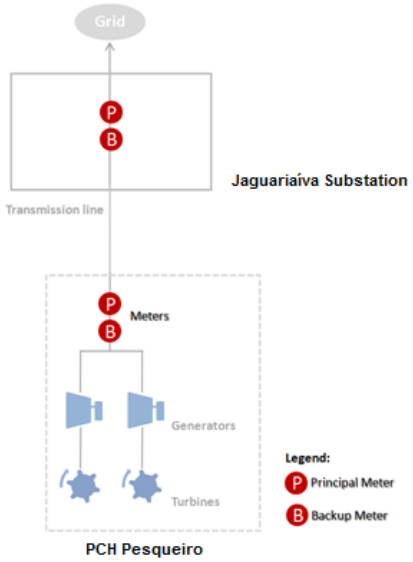

Figure 6 – Simplified diagram of the project monitoring.

The following calibrations were conducted in energy meters located at the connection point:

Table 3 – Energy meters calibration

Calibration Dt.	Validity	Certification Ref.	Type of Meter	Serial Number	Interval Error (%)		Equip. Accuracy (%)
					Min.	Max.	
15/05/2012	14/05/2014	CCR 403/12	Backup	226377	-0.0620	-0.1150	0.2
15/05/2012	14/05/2014	CCR 404/12	Main	226378	-0.0400	-0.1200	0.2
30/07/2014	29/07/2016	CCR 721/14	Backup	226377	0.0250	0.0950	0.2
30/07/2014	29/07/2016	CCR 722/14	Main	226378	0.0200	0.1100	0.2
19/10/2017	18/10/2022	RCM 1132/17	Backup	226377	0.1066	0.1224	0.2
19/10/2017	18/10/2022	RCM 1131/17	Main	226378	0.0996	0.1351	0.2

Considering table above, there are two periods not covered by calibration:

- 15/05/2014 – 29/07/2014; and
- 30/07/2016 – 26/01/2017.

Therefore, provisions established in Annex 1 of the VVS-PA v2.0 were followed in order to apply discounts due to delays in calibration. Discounts were double applied (for the electricity generation and for the electricity consumption) in order to determine the net electricity generated by the project activity and the CO_2 operating margin emission factor of the grid.

It is worth mentioning that since January 2017, ONS changed the calibration frequency from 2-year to 5-year period as can be seen in the revised version of ONS procedures[9]. Since the project monitoring period ends on 26/01/2017, it is not impacted by the ONS procedure changes.

Pesqueiro Energia S.A. is also responsible for the maintenance of the monitoring equipment located at the plant[10], for dealing with possible monitoring data adjustments and uncertainties, for review of reported results/data, for internal audits of GHG project compliance with operational

[9] Information available at < http://www.ons.org.br/paginas/sobre-o-ons/procedimentos-de-rede/vigentes>

[10] Monitoring equipment located at the substation are under the local concessionary responsibility COPEL (Companhia Paranaense de Energia).

requirements and for corrective actions. Yet, it is also responsible for the project management, as well as for organising and training of the staff in the appropriate monitoring, measurement and reporting techniques.

SECTION D. Data and parameters

D.1. Data and parameters fixed ex ante

Data/Parameter	$EF_{grid,BM,y}$
Unit	tCO_2/MWh
Description	Build margin CO_2 emission factor in year y
Source of data	Brazilian DNA
Value(s) applied	0.1458
Choice of data or measurement methods and procedures	This information is published by the Brazilian Designated Authority. According to TOOL07, $EF_{grid,BM,y}$ shall be calculated ex-ante for the second crediting period while chosen option 2.
Purpose of data/parameter	Calculation of baseline emissions.
Additional comments	-

Data/Parameter	Cap_{BL}
Unit	W
Description	Installed capacity of the hydro power plant before the implementation of the project activity
Source of data	ACM0002
Value(s) applied	0
Choice of data or measurement methods and procedures	According to ACM0002, this value is zero for new hydropower plants.
Purpose of data/parameter	Calculation of baseline and project emissions.
Additional comments	According to the methodology, parameters relevant to reservoir based hydro shall be monitored following the most recent version of ACM0002.

Data/Parameter	A_{BL}
Unit	m^2
Description	Area of the single or multiple reservoirs measured in the surface of the water, before the implementation of the project activity, when the reservoir is full
Source of data	ACM0002
Value(s) applied	0
Choice of data or measurement methods and procedures	According to ACM0002, this value is zero for new hydropower plants.
Purpose of data/parameter	Calculation of project emissions.
Additional comments	According to the methodology, parameters relevant to reservoir based hydro shall be monitored following the most recent version of ACM0002.

D.2. Data and parameters monitored

Data/Parameter	$EG_{BL,y}$
Unit	MWh
Description	Quantity of net electricity supplied to the grid as a result of the implementation of the CDM project activity in year *y*

Measured/calculated/ default	Measured
Source of data	Local measurements
Value(s) of monitored parameter	<table><tr><th>Year</th><th>$EG_{BL,y}$</th></tr><tr><td>From 01/10/2013</td><td>21,201</td></tr><tr><td>2014</td><td>83,680</td></tr><tr><td>2015</td><td>94,461</td></tr><tr><td>2016</td><td>101,364</td></tr><tr><td>Up to 26/01/2017</td><td>7,259</td></tr><tr><td>Total</td><td>307,964</td></tr></table>
Monitoring equipment	Energy meters. See meters description in $EG_{PJ,h}$ parameter table below.
Measuring/reading/recording frequency	The electricity delivered to the grid is monitored both by the project owner (seller) as well as by the energy buyer. A Brazilian government entity, CCEE – *Câmara Comercializadora de Energia Elétrica* - controls and monitors the electricity available on the national interconnected grid. The amount of electricity delivered to the grid by the project activity shall be cross-checked with the reports issued by CCEE (records for sold electricity). This parameter is hourly measured and monthly recorded by the project owner. The CCEE reports presents this information consolidated on a weekly basis. The lowest value between the project owner and CCEE was considered in order to determine the net electricity supplied to the grid by the project activity.
Calculation method (if applicable)	Discounts due to delays in calibration were double applied (electricity generation and electricity consumption) following provisions established in Annex 1 of VVS-PA v2.0.
QA/QC procedures	Energy metering QA/QC procedures are explained in section B.7.2 (the equipments used have by legal requirements extremely low level of uncertainty).
Purpose of data/parameter	Calculation of baseline emissions.
Additional comments	This parameter is equivalent to the parameter $EG_{PJ,y}$ used to calculate the operating margin CO_2 emission factor of the grid, as mentioned in TOOL07.

Data/Parameter	$EG_{PJ,h}$
Unit	MWh
Description	Electricity displaced by the project activity in hour *h* of the year *y*
Measured/calculated/ default	Measured
Source of data	Local measurements
Value(s) of monitored parameter	Massive amount of data. Information available in the ER spreadsheet.
Monitoring equipment	Energy meters <table><tr><th>Data</th><th>Main Meter</th><th>Backup Meter</th></tr><tr><td>Equipment</td><td>Energy meter</td><td>Energy meter</td></tr><tr><td>Type</td><td>SAGA 1000</td><td>SAGA 1000</td></tr><tr><td>Serial number</td><td>226378</td><td>226377</td></tr><tr><td>Accuracy class</td><td>0.2%</td><td>0.2%</td></tr><tr><td>Frequency of calibration</td><td>2 years</td><td>2 years</td></tr><tr><td>Data of the last calibration applicable to the monitoring period</td><td>30/07/2014</td><td>30/07/2014</td></tr><tr><td>Validity</td><td>29/07/2016</td><td>29/07/2016</td></tr></table>
Measuring/reading/recording frequency	Hourly generation of electricity by the plant is monitored and used to calculate the operating margin CO_2 emission factor. The electricity delivered to the grid is monitored by the project owner.
Calculation method (if applicable)	Discounts due to delays in calibration were double applied (electricity generation and electricity consumption) following provisions established in Annex 1 of VVS-PA v2.0.

QA/QC procedures	Energy metering QA/QC procedures are explained in section B.7.2 (the equipments used have by legal requirements extremely low level of uncertainty). Hourly information provided by project participants can be weekly aggregated and crosschecked with the Reports issued by CCEE.
Purpose of data/parameter	Calculation of baseline emissions.
Additional comments	See parameter $EG_{BL,y.}$

Data/Parameter	$EF_{EL,DD,h}$
Unit	tCO_2/MWh
Description	CO_2 emission factor for power units in the top of the dispatch order in hour *h* in year *y*
Measured/calculated/ default	Calculated
Source of data	Brazilian DNA website (https://antigo.mctic.gov.br/mctic/opencms/ciencia/SEPED/clima/textogeral/emissao_despacho.html)
Value(s) of monitored parameter	Massive amount of data. Information available in the ER spreadsheet.
Monitoring equipment	-
Measuring/reading/recording frequency	According to TOOL07
Calculation method (if applicable)	The selected option to calculate the operating margin was the dispatch analysis which does not permit the vintage of *ex-ante* calculation of the emission factor. Values were calculated by the Brazilian DNA following TOOL07.
QA/QC procedures	Official source of data
Purpose of data/parameter	Calculation of baseline emissions.
Additional comments	-

Data/Parameter	Cap_{PJ}
Unit	W
Description	Installed capacity of the hydro power plant after the implementation of the project activity
Measured/calculated/ default	Default
Source of data	Project site
Value(s) of monitored parameter	12,440,000
Monitoring equipment	Equipment tag
Measuring/reading/recording frequency	Annually
Calculation method (if applicable)	Not applicable.
QA/QC procedures	Data can be cross-checked with ANEEL Resolution nr. 410 dated June 29th, 2001 available at http://www.aneel.gov.br/cedoc/dsp2001410.pdf, an official data source.
Purpose of data/parameter	Calculation of project emissions.
Additional comments	-

Data/Parameter	A_{PJ}
Unit	m^2
Description	Area of the single or multiple reservoirs measured in the surface of the water, after the implementation of the project activity, when the reservoir is full

Measured/calculated/ default	Measured
Source of data	ANEEL's Geo-referenced Information Systems of the Electric Sector
Value(s) of monitored parameter	330,000
Monitoring equipment	Official source of data.
Measuring/reading/recording frequency	Yearly.
Calculation method (if applicable)	Not applicable.
QA/QC procedures	Official source of data.
Purpose of data/parameter	Calculation of project emissions.
Additional comments	-

D.3. Implementation of sampling plan

Not applicable.

SECTION E. Calculation of emission reductions or net anthropogenic removals

E.1. Calculation of baseline emissions or baseline net removals

Baseline emissions are calculated using the annual generation (project annual electricity dispatched to the grid) times the CO_2 average emission rate of the estimated baseline and correspond to the CO_2 emissions that are displaced as a consequence of the project activity, calculated as follows:

$$BE_y = EG_{BL,y} * EF_{CO2,grid,y} \quad \textbf{Equation 1}$$

Where,

BE_y = Baseline emissions in year *y* (tCO_2/yr);

$EG_{BL,y}$ = Quantity of net electricity supplied to the grid as a result of the implementation of the CDM project activity in year *y* (MWh);

$EF_{CO2,grid,y}$ = CO_2 emission factor of the grid in year *y* (tCO_2/MWh).

Net electricity dispatched to the grid by the project activity during the monitoring period is as follows:

Table 4 – Net electricity dispatched to the grid

Year	$EG_{BL,y}$
2013	21,201
2014	83,680
2015	94,461
2016	101,364
2017	7,259
TOTAL	**307,964**

Provisions established in Annex 1 of the VVS-PA v2.0 were followed in order to apply discounts due to delays in calibration. Therefore, discounts were double applied (for the electricity generation and for the electricity consumption) in order to determine the net electricity generated by the project activity. Conservatively, discounts were applied in the whole month.

According to the selected approved methodology CO_2 emission factor of the grid ($EF_{CO2,grid,y}$) is

calculated using TOOL07 (paragraph 12, option a). According to this tool, the CO_2 emission factor of the grid shall be calculated as follows.

- **STEP 1** - Identify the relevant electricity systems

According to the tool, "*If the DNA of the host country has published a delineation of the project electricity system and connected electricity systems, these delineations should be used. If such delineations are not available, project participants should define the project electricity system and any connected electricity system and justify and document their assumptions in the CDM-PDD*".

The Brazilian DNA has published the Resolution nr. 8 issued on 26th May, 2008 that defines the Brazilian Interconnected Grid as a single system that covers all the five macro-geographical regions of the country (North, Northeast, South, Southeast and Midwest). Hence, this figure is used to calculate the baseline emission factor of the grid.

- **STEP 2** - Choose whether to include off-grid power plants in the project electricity system (optional).

Option I of the tool is chosen, which includes only grid power plants in the calculation.

- **STEP 3** - Select a method to determine the operating margin (OM)

The calculation of the operating margin emission factor ($EF_{grid,OM,y}$) is based on one of the following methods:

(a) Simple OM, or
(b) Simple adjusted OM, or
(c) Dispatch data analysis OM, or
(d) Average OM.

According to the registered PDD, option c) dispatch data analysis OM is used.

- **STEP 4** - Calculate the operating margin emission factor according to the selected method

The dispatch data analysis OM emission factor ($EF_{grid,OM\text{-}DD,y}$) is determined based on the power units that are actually dispatched at the margin during each hour *h* where the project is displacing electricity. This approach is not applicable to historical data and, thus, requires annual monitoring of $EF_{grid,OM\text{-}DD,y}$. As consequence it will be calculated ex-post.

The $EF_{grid,OM\text{-}DD,y}$ will be calculated using the below formula:

$$EF_{grid,OM-DD,y} = \frac{\sum_h EG_{PJ,h} \cdot EF_{EL,DD,h}}{EG_{PJ,y}} \qquad \textbf{Equation 2}$$

Where,

$EF_{grid,OM\text{-}DD,y}$ = Dispatch data analysis operating margin CO_2 emission factor in year *y* (tCO_2/MWh);
$EG_{PJ,h}$ = Electricity displaced by the project activity in hour *h* of the year *y* (MWh);
$EF_{EL,DD,h}$ = CO_2 emission factor for power units in the top of the dispatch order in hour *h* in year *y* (tCO_2/MWh);
$EG_{PJ,y}$ = Total electricity displaced by the project activity in year *y* (MWh);
h = Hours in year *y* in which the project activity is displacing grid electricity;
y = Year in which the project activity is displacing grid electricity.

The Brazilian DNA made available $EF_{EL,DD,h}$ parameter for determination of $EF_{grid,OM\text{-}DD,y}$ using option c) dispatch data analysis OM. Detailed information on the methods and data applied can be obtained at the DNA's website:

http://antigo.mctic.gov.br/mctic/opencms/ciencia/SEPED/clima/textogeral/emissao_despacho.html

Considering hourly data from the Brazilian DNA ($EF_{EL,DD,h}$) and hourly electricity generation of the project activity ($EG_{PJ,h}$), $EF_{grid,OM\text{-}DD,y}$ was calculated as follows:

Table 5 – The Operating Margin Emission Factor

Year	$EF_{grid,OM\text{-}DD,y}$
2013	0.6012
2014	0.5816
2015	0.5590
2016	0.6222
2017	0.5578

Provisions established in Annex 1 of the VVS-PA v2.0 were followed in order to apply discounts due to delays in calibration. Therefore, discounts were double applied (for the electricity generation and for the electricity consumption) in order to determine the $EF_{grid,OM\text{-}DD,y}$ parameter.

- **STEP 5** – Calculate the build margin (BM) emission factor

The build margin emissions factor is the generation-weighted average emission factor (tCO_2/MWh) of all power units *m* during the most recent year *y* for which electricity generation data is available, calculated as follows:

$$EF_{grid,BM,y} = \frac{\sum_m EG_{m,y} \times EF_{EL,m,y}}{\sum_m EG_{m,y}} \qquad \textbf{Equation 3}$$

Where,

$EF_{grid,BM,y}$ = Build margin CO_2 emission factor in year *y* (tCO_2/MWh);
$EG_{m,y}$ = Net quantity of electricity generated and delivered to the grid by power unit *m* in year *y* (MWh);
$EF_{EL,m,y}$ = CO_2 emission factor of power unit *m* in year *y* (tCO_2/MWh);
m = Power units included in the build margin;
y = Most recent historical year for which electricity generation data is available.

According to the registered PDD, the BM emission factor is fixed ex-ante. Therefore, $EF_{grid,BM,y}$ = 0.1458 tCO_2/MWh

- **STEP 6** – Calculate the combined margin (CM) emissions factor

The calculation of the combined margin (CM) emission factor may be based on one of the following methods:

(a) Weighted average CM; or
(b) Simplified CM.

The weighted average CM method (option a) should be used as the preferred option.

The simplified CM method (option b) is not applicable since it can only be used if:

- The project activity is located in a Least Developed Country (LDC) or in a country with less than 10 registered CDM projects at the starting date of validation; and
- The data requirements for the application of step 5 above cannot be met.

(a) Weighted average CM

Under this option, the combined margin is calculated as follows:

$$EF_{grid,CM,y} = w_{OM} \cdot EF_{grid,OM,y} + w_{BM} \cdot EF_{grid,BM,y}$$ **Equation 4**

The following default values should be used for w_{OM} and w_{BM}:

- Wind and solar power generation project activities: w_{OM} = 0.75 and w_{BM} = 0.25 (owing to their intermittent and non-dispatchable nature) for the first crediting period and for subsequent crediting periods;
- All other projects: w_{OM} = 0.5 and w_{BM} = 0.5 for the first crediting period, and w_{OM} = 0.25 and w_{BM} = 0.75 for the second and third crediting period, unless otherwise specified in the approved methodology which refers to this tool.

Therefore, in accordance with the tool, the weights w_{OM} and w_{BM}, for the second crediting period, by default, are w_{BM} = 0.75 and w_{OM} = 0.25. The combined margin emission factor for each year of the monitoring period is as follows:

Table 6 – The Combined Margin Emission Factor

Year	$EF_{grid,OM,y}$	w_{OM}	$EF_{grid,BM,y}$	w_{BM}	$EF_{grid,CM,y}$
2013	0.6012	0.25	0.1458	0.75	0.2597
2014	0.5816	0.25	0.1458	0.75	0.2547
2015	0.5590	0.25	0.1458	0.75	0.2491
2016	0.6222	0.25	0.1458	0.75	0.2649
2017	0.5578	0.25	0.1458	0.75	0.2488

E.2. Calculation of project emissions or actual net removals

According to the SSC methodology, emissions from reservoirs shall be estimated considering the procedure described in the most recent version of ACM0002. According to the methodology, for *hydro power project activities that result in new single (…) reservoirs (…),* as it is the case of the proposed project activity, *project proponents shall account for CH_4 and CO_2 emissions from the reservoirs, estimated as follows*:

a) if the power density of the single or multiple reservoirs (*PD*) is greater than 4W/m^2 and less than or equal to 10W/m^2:

$$\mathrm{PE}_{\mathrm{HP,y}} = \frac{EF_{\mathrm{Res}} \cdot TEG_y}{1000}$$ **Equation 5**

Where,

$PE_{HP,y}$ = Project emissions from water reservoirs (tCO_2e/yr);
EF_{Res} = Default emission factor for emissions from reservoirs of hydro power plants in year *y* ($kgCO_2e$/MWh);
TEG_y = Total electricity produced by the project activity, including the electricity supplied to the grid and the electricity supplied to internal loads, in year *y* (MWh).

b) If power density of the project is greater than 10W/m^2, *PEy* = 0.

The power density of the project activity (*PD*) is calculated as follows:

$$PD = \frac{Cap_{PJ} - Cap_{BL}}{A_{PJ} - A_{BL}}$$ **Equation 6**

Where:

PD = Power density of the project activity (W/m^2)
Cap_{PJ} = Installed capacity of the hydro power plant after the implementation of the project

activity (W)

Cap_{BL} = Installed capacity of the hydro power plant before the implementation of the project activity (W). For new hydro power plants, this value is zero

A_{PJ} = Area of the single or multiple reservoirs measured in the surface of the water, after the implementation of the project activity, when the reservoir is full (m^2)

A_{BL} = Area of the single or multiple reservoirs measured in the surface of the water, before the implementation of the project activity, when the reservoir is full (m^2). For new reservoirs, this value is zero

The installed capacity of PESHP is 12,440,000 MW and the reservoir area is 330,000 m^2 as confirmed in ANEEL's Geo-referenced Information Systems of the Electric Sector. Hence, the power density of the plant is 37.70 W/m^2.

Therefore, project emissions are to **zero**, PE_y = 0 tCO_2e/year.

E.3. Calculation of leakage emissions

Since the energy generating equipment was not transferred from another activity, leakage is **zero**, LE_y = 0 tCO_2e/year.

E.4. Calculation of emission reductions or net anthropogenic removals

	Baseline GHG emissions or baseline net GHG removals (t CO_2e)	Project GHG emissions or actual net GHG removals (t CO_2e)	Leakage GHG emissions (t CO_2e)	GHG emission reductions or net anthropogenic GHG removals (t CO_2e)		
				Before 01/01/2013	From 01/01/2013	Total amount
Total	79,006	0	0	0	79,006	79,006

E.5. Comparison of emission reductions or net anthropogenic removals achieved with estimates in the registered PDD

Amount achieved during this monitoring period (t CO_2e)	Amount estimated ex ante for this monitoring period in the PDD (t CO_2e)
79,006	59,578

E.5.1. Explanation of calculation of "amount estimated ex ante for this monitoring period in the PDD"

The estimated ex-ante emission reductions considered for the period from 01/10/2013 to 26/01/2017 was calculated based on the same parameters used in the registered PDD in order to estimated emission reductions as presented in Table 7. Results are also presented in the ER spreadsheet.

Table 7 – Parameters used in the registered PDD for emissions reductions calculation

Parameters	2013	2014	2015	2016	2017	TOTAL
Assured energy (MW-ave)	9.24	9.24	9.24	9.24	9.24	9.24
Net electricity (MWh)	20,402	80,942	80,942	80,942	5,766	268,995
BM emission fator	0.1458	0.1458	0.1458	0.1458	0.1458	0.1458

Parameters	2013	2014	2015	2016	2017	TOTAL
(tCO_2e/MWh)						
OM emission factor (tCO_2e/MWh)	0.4487	0.4487	0.4487	0.4487	0.4487	0.4487
CM emission factor (tCO_2e/MWh)	0.2215	0.2215	0.2215	0.2215	0.2215	0.2215
Emission reductions (tCO_2e)	4,519	17,927	17,927	17,927	1,277	59,578

As presented in section E.5 above, emission reductions achieved during the monitored period are 32.6% higher than the ones estimated in the registered PDD.

Figure 7 presents comparison between emission reductions estimated in the registered PDD and monitored in a yearly basis.

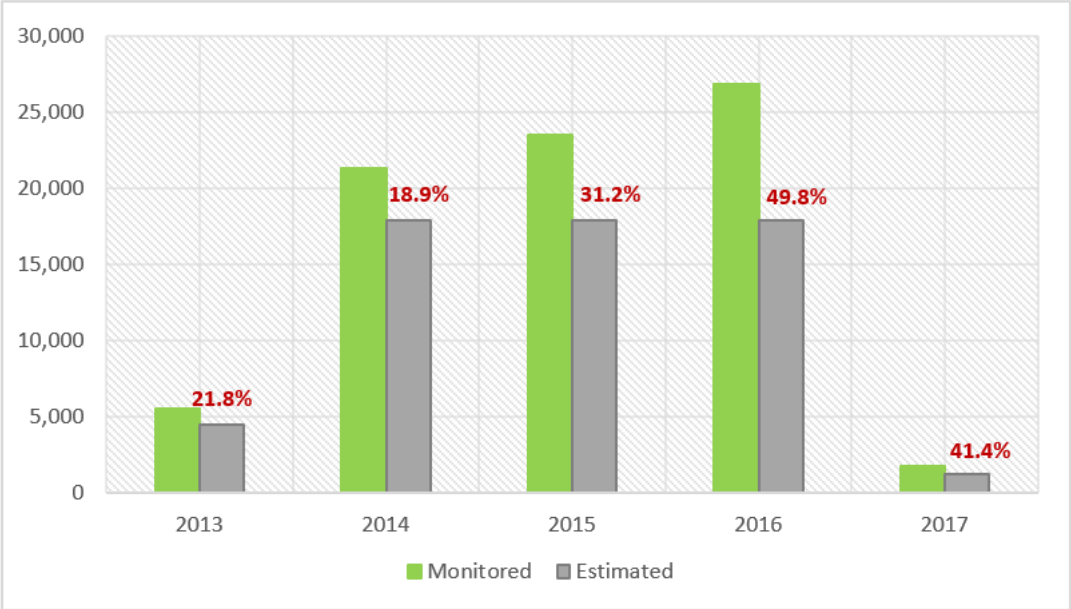

Figure 7 – Estimated and monitored emission reductions during the monitored period in tCO_2e

Remarks regarding differences between estimated and monitored values are described in section E.6.

E.6. Remarks on increase in achieved emission reductions

As described in section E.5, estimated emission reductions were 59,578tCO_2e and actual emission reductions are 79,006tCO_2e during the monitored period of PESHP. Therefore, there was an increase of 32.6% on emission reductions when comparing to the registered PDD.

Considering the 32.6% increase, the Project Participants analyzed the monitored parameters that may have impacted the emission reductions of the project activity.

→ **Electricity generation of the project delivered to grid ($EG_{facility,y}$)**

In order to estimate emission reductions, the registered PDD presented 80,942MWh/year, resulting in 268,995MWh during the monitored period. While comparing the estimated total electricity with the one monitored by the project (307,964MWh), there was a 14.5% increase.

Figure 8 presents comparison between net electricity estimated in the registered PDD and monitored in a yearly basis.

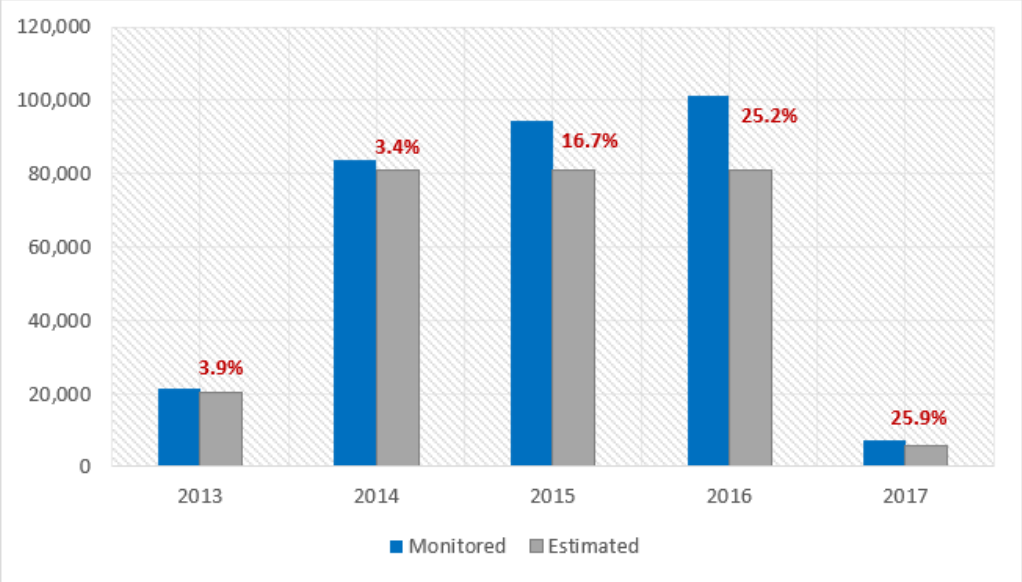

Figure 8 – Estimated and monitored electricity during the monitored period in MWh

As can be checked by DOE, there was no change in the project equipment nor design that could impact the electricity generation. Therefore, increase of net electricity is due to rainfall and river flow in Jaguariaíva River.

In addition, the estimated electricity dispatched to the grid considered in the registered PDD is based on the assured energy of the project, *i.e.* 9.24MW-ave[11]. The methodological calculation of assured energy is established by the Mines and Energy Ministry (from the Portuguese Ministério de Minas e Energia – MME) and shall be approved by ANEEL for each power utility connected to the grid.

According to ANEEL (2005) "*….the assured energy is established independently of the real electricity generation; energy assured is associated to the estimated long-term operational conditions of power plants, assuming a specific risk of electricity supply (deficit) mainly when electricity generation is related to hydrologic variability whose hydropower plants are subjected to*".

[11] Information available at ANEEL's website: <http://www.aneel.gov.br/aplicacoes/capacidadebrasil/energiaassegurada.asp>.

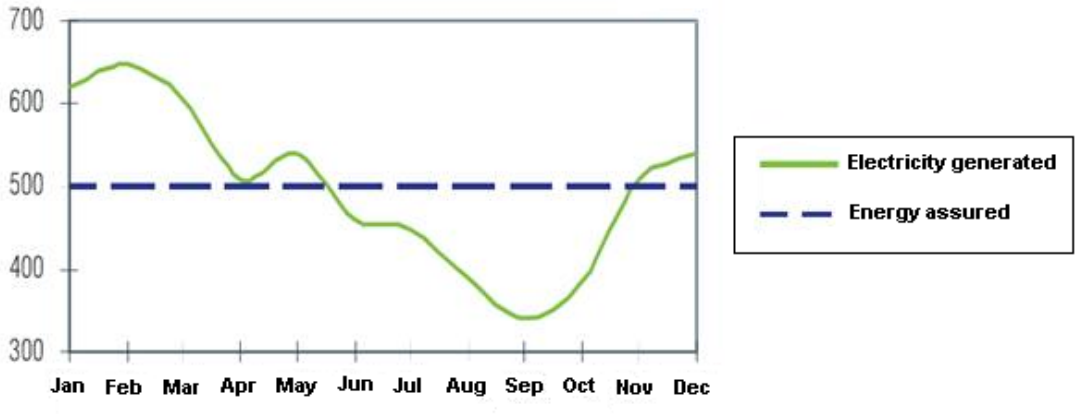

Figure 9 - Exemplification of electricity generation and energy assured of a hydropower plant
Source: ANEEL (2005) [12]

Considering explanations above, the +14.5% difference of electricity estimated and generated during the monitoring period is reasonable and acceptable in the context of electricity generation from hydropower plants, mainly from small scale projects with low capacity for water reservoir. The increase in the electricity generation impacted the resulted emission reductions of PESHP.

→ **Combined margin CO_2 emission factor for grid connected power generation ($EF_{grid,CM,y}$)**

The estimated CO_2 emission factor of the grid considered for estimative proposes in the registered PDD was 0.2215 tCO_2/MWh. While comparing to monitored values, there was 15.3% increase in the CO_2 emission factor of the grid during the monitored period.

Figure 10 presents comparison between the CO_2 emission factor of the grid estimated in the registered PDD and monitored in a yearly basis.

Figure 10 – Estimated and monitored CO_2 emission factor during the monitored period in tCO_2/MWh

Since the BM emission factor is fixed as well as weights for BM and OM, differences are related exclusively to the OM emission factor. In the registered PDD, the value for 2008 year was used for

[12] ANEEL (2005). ANEEL thematic notes (in a free translation from the Portuguese *Cadernos Temáticos ANEEL*). Assured energy. April, 2005. Available at: <http://www.aneel.gov.br/arquivos/pdf/caderno3capa.pdf>.

estimation purposes: 0.4487 tCO_2/MWh. This value is considered low while comparing to the resulted values from 2013 to 2017.

Table 8 – Estimated and monitored OM CO_2 emission factor of the grid in tCO_2/MWh

Year	Estimated (tCO_2/MWh)	Monitored (tCO_2/MWh)	Difference
2013	0.4487	0.6012	+34.0%
2014	0.4487	0.5816	+29.6%
2015	0.4487	0.5590	+24.6%
2016	0.4487	0.6222	+38.7%
2017	0.4487	0.5578	+24.3%

Brazil possesses a large share of hydroelectricity and, for this reason, it presents a low CO_2 emission factor of the grid when comparing to other Latin American countries. However, during the years when an atypical short rainy season is observed, the generation of electricity by the thermal power plants fuelled with fossil fuels rises.

It is worth mentioning that the OM emission factor calculation was based on public available data from the Brazilian DNA and CCEE, and followed equations and procedures established in TOOL07.

Considering explanations above, the +15.3% difference of the CO_2 emission factor of the grid estimated and monitored is reasonable and acceptable in the context of electricity generation in Brazil, which is mainly composed by hydropower power sources. Therefore, precipitation and climatological issues have strong influence in the electricity matrix and the CO_2 emission factor of the grid. The increase in the electricity generation impacted the resulted emission reductions of PESHP.

Conclusion

Considering the discussion presented above, the parameter that increase the emission reductions of the project activity in comparison to the estimated value presented in the registered PDD is the increase in the electricity generation (+14.5%) and the combined margin CO_2 emission factor of the grid ($EF_{grid,CM,y}$), mainly due to the OM emission factor (+30.2% increase).

The increase in both parameters resulted in a 32.6% increase on emission reductions estimated in the registered PDD. In spite of the increase, there was no change in the project configuration or layout and increase is due to hydrological and climate issues.

E.7. Remarks on scale of small-scale project activity

According to TOOL20: Assessment of debundling for small-scale project activities (v4.0), debundling is defined as the fragmentation of a large project activity into smaller parts. A small-scale project activity that is part of a large project activity is not eligible to use the simplified modalities and procedures for small-scale CDM project activities. The full project activity or any component of the full project activity shall follow the regular CDM modalities and procedures.

A proposed small-scale project activity shall be deemed to be a debundled component of a large project activity if there is a registered small-scale CDM project activity or an application to register another small-scale CDM project activity:

- With the same project participants;
- In the same project category and technology/measure; and
- Registered within the previous 2 years; and
- Whose project boundary is within 1 km of the project boundary of the proposed small-scale activity at the closest point.

Considering there are no CDM project registered within 1km from the PESHP, the project activity shall not be considered as a part of a larger project activity.

In addition, the following eligibility criteria shall be met for Type I SSC according to §119 of CDM-PS (v2.0):

> *"Type I: Renewable energy project activities with a maximum output capacity of 15 MW (or an appropriate equivalent). In this context:*
>
> *(i) "Output" is the installed/rated capacity as indicated by the manufacturer of the equipment or plant, irrespective of the actual load factor of the plant. The installed/rated capacity of renewable electricity generating units that involve turbine generator systems shall be based on the installed/rated capacity of the generator".*

According to the generator tags, the power capacity of generators is 6,800 kVa. Considering 0.92 power factor:

2 generators x 6,800 kVA capacity x 0.92 power factor = 12,512kW

It is important mentioning that installed capacity presented in the registered PDD was based on turbines rate capacity (2 x 6,220 kW = 12.44 MW) as the project capacity is limited by the turbine.

Independently of both approaches, the installed capacity of the project does not surpass the eligibility criteria of SCC project activities under type I (15MW).

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Document information

Version	*Date*	*Description*
07.0	31 May 2019	Revision to: • Ensure consistency with version 02.0 of the "CDM project standard for project activities" (CDM-EB93-A04-STAN); • Add a section on remarks on the observance of the scale limit of small-scale project activity during the crediting period; • Add "changes specific to afforestation or reforestation project activity" as a possible post-registration changes; • Clarify the reporting of net anthropogenic GHG removals for A/R project activities between two commitment periods; • Make editorial improvements.
06.0	7 June 2017	Revision to: • Ensure consistency with version 01.0 of the "CDM project standard for project activities" (CDM-EB93-A04-STAN); • Make editorial improvements.
05.1	4 May 2015	Editorial revision to correct version numbering.
05.0	1 April 2015	Revisions to: • Include provisions related to delayed submission of a monitoring plan; • Provisions related to the Host Party; • Remove reference to programme of activities; • Overall editorial improvement.
04.0	25 June 2014	Revisions to: • Include the Attachment: Instructions for filling out the monitoring report form (these instructions supersede the "Guideline: Completing the monitoring report form" (Version 04.0)); • Include provisions related to standardized baselines; • Add contact information on a responsible person(s)/ entity(ies) for completing the CDM-MR-FORM in A.6 and Appendix 1; • Change the reference number from *F-CDM-MR* to *CDM-MR-FORM*; • Editorial improvement.
03.2	5 November 2013	Editorial revision to correct table in page 1.
03.1	2 January 2013	Editorial revision to correct table in section E.5.
03.0	3 December 2012	Revision required to introduce a provision on reporting actual emission reductions or net GHG removals by sinks for the period up to 31 December 2012 and the period from 1 January 2013 onwards (EB 70, Annex 11).
02.0	13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the monitoring report form" (EB 66, Annex 20).

Version	*Date*	*Description*
01.0	28 May 2010	EB 54, Annex 34. Initial adoption.

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