



**Monitoring report form for CDM project activity  
(Version 07.0)**

MONITORING REPORT		
<b>Title of the project activity</b>	Sogamoso Hydroelectric Project	
<b>UNFCCC reference number of the project activity</b>	10236	
<b>Version number of the PDD applicable to this monitoring report</b>	Version 09	
<b>Version number of this monitoring report</b>	Version 01	
<b>Completion date of this monitoring report</b>	28/01/2020	
<b>Monitoring period number</b>	Third monitoring period	
<b>Duration of this monitoring period</b>	15/06/2018 - 14/06/2019 (both days included)	
<b>Monitoring report number for this monitoring period</b>	Not applicable	
<b>Project participants</b>	ISAGEN S.A. E.S.P.	
<b>Host Party</b>	Colombia	
<b>Applied methodologies and standardized baselines</b>	Sectoral scopes 1: Energy industries (renewable / nonrenewable sources)	
<b>Sectoral scopes</b>	ACM0002 "Grid-connected electricity generation from renewable sources" – version 16.0	
<b>Amount of GHG emission reductions or net anthropogenic GHG removals achieved by the project activity in this monitoring period</b>	<b>Amount achieved before 1 January 2013</b>	<b>Amount achieved from 1 January 2013</b>
	0 tCO <sub>2</sub> e	1,513,255 tCO <sub>2</sub> e
<b>Amount of GHG emission reductions or net anthropogenic GHG removals estimated ex ante for this monitoring period in the PDD</b>	1,386,355 tCO <sub>2</sub> e/year	

## SECTION A. Description of project activity

### A.1. General description of project activity

The Sogamoso Hydroelectric Project (hereafter referred to as the “Project”) developed by ISAGEN S.A. E.S.P. (hereafter referred to as ISAGEN) is a reservoir-based hydropower project located in the Santander Department of the Republic of Colombia (hereafter referred to as the “Host Country”) with a maximum total installed capacity of 874.8 MW comprised of three Francis turbines. The Project utilizes the hydrological resources of the Sogamoso River to generate low emissions electricity for the grid.

The project began its commercial operation in December 1<sup>st</sup>, 2014, contributing to sustainable development of the Host Country, Colombia, specifically in the following aspects:

#### ▪ General Aspects

- The Project launched various investment programs and employment opportunities contributing to the socio-economic development of the nearby municipalities and the Department.
- Through the “Community Information and Participation Program”, the Project contributes to the formation of the participative and self-advocating communities.
- The Project matches the criteria and guidelines established by the WCD about policies and corporate expressions of social responsibility.
- The Project contributes to the protection of natural environment of the Sogamoso river basin and the restoration, conservation and protection of the Natural National Park *Serranía de Los Yariques*<sup>1</sup>, among other programs.

- **Institutional Strengthening:** This program consists of supporting and strengthening in the provision of services such as health, education, basic sanitation, recreation, security and other aspects, which are direct competence of other government and private entities.

- **Environmental Education:** The Project contributed, during the construction stage, to promote awareness, education and training processes for educational institutions and the population located in the influence area of the Project, as well as to work's contractors, to establish conscious relationships and proper practices with the environment.

Target groups of this program included 26 educational centers in the influence area, 18 environmental groups identified in the area, Project's contractors and workers. This program was carried out with *Fundación Natura*. The main activities for this program were:

- i) Support and coordinate activities related to education and environmental management with programs of schools located in the influence area by strengthening of PRAES (Scholar Environmental Projects, in Spanish)
- ii) Promote through environmental education issues, the development of attitudes, skills and abilities for conservation, protection and proper use of natural resources by communities, promoting the PROCEDAS (Environmental Education Programs for Citizenships, in Spanish).

- **Improving of health:** Cooperation Agreement signed with the *San Juan de Dios* Hospital in the municipality of *Betulia*, to adequate and equip the Health Center, located in *Tienda Nueva*.

<sup>1</sup> Yariques Mountain range is located in the jurisdiction of municipalities of *Betulia*, *Zapatoca*, *Galán*, *El Hato*, *Simacota*, *Chima*, *Contratación*, *Guacamayo*, *Santa Helena*, *Carmen de Chucuri* and *San Vicente de Chucuri*, *Cerro de Armas* in municipality of *Landazuri*; *Cerro de la Paz* and *Cuchilla de Ramos* in the municipality of *Betulia* in the Department of Santander. This program is included in the Investment Plan of 1% approved by the Government.

- **Restitution of roads:** The replacement of some roads and bridges affected by the Project. The roads and bridges were constructed and given to the people for public service in a better condition than they have before building the Project.

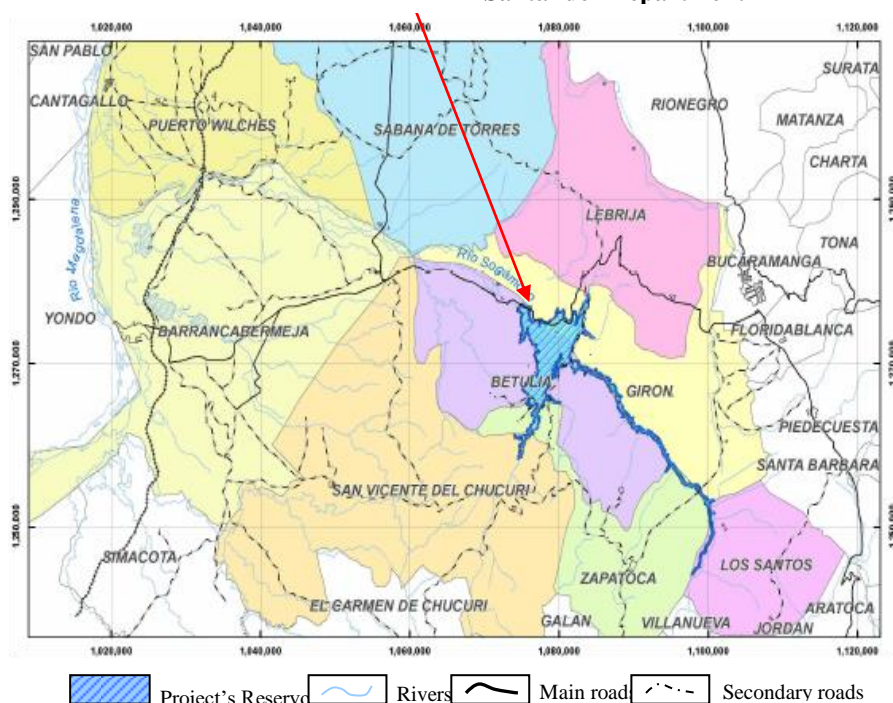
## A.2. Location of project activity

The Project is in the canyon where the Sogamoso River crosses the *La Paz* mountain range, 75 km upstream from the point where the river empties into the *Magdalena* River and 62 km downstream from the confluence of the *Suárez* and *Chicamocha* rivers in the Department of Santander (Colombia). The dam and the reservoir are located into the municipalities of *Girón*, *Betulia*, *Zapatoca*, *Lebrija*, *Los Santos* and *San Vicente de Chucurí*. The Project's coordinates according to Magna Sirgas system are 7° 6' 0.427"N, 73° 24' 26.623"W (See Figure 1).



Localization of  
Santander Department

Localization of the Sogamoso Hydroelectric project  
in Santander Department



Project's neighborhood communities

Figure 1. Location project

**A.3. Parties and project participants**

Parties involved	Project participants	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Colombia	Project's Owner - Private entity: ISAGEN S.A E.S.P.	No

**A.4. References to applied methodologies and standardized baselines**

The ACM0002-version 16.0 "Consolidated baseline methodology for grid-connected electricity generation from renewable sources" large scale is chosen as the most relevant to the project activity. This methodology, as applied in this project activity, also refers to the approved version of the tool to calculate the emission factor for an electricity system (version 4.0).

**A.5. Crediting period type and duration**

The crediting period is 7 years, type: renewable. From 15/06/2016 to 14/06/2023, (first and last days included). The third monitoring period is from 15/06/2018 - 14/06/2019 (first and last days included).

**SECTION B. Implementation of project activity****B.1. Description of implemented project activity**

The Project takes advantage of a maximum flow of 630 m<sup>3</sup>/s distributed in three (3) units of 210 m<sup>3</sup>/s each one. The concrete face rock fill dam is 190 m high and 345 m crest length; the crest's level corresponds to 330 meters above sea level. The dam has the spillway on the left side; four gates control the spillway and its discharge channel ends in a ski jump for energy dissipation.

The maximum installed capacity of the Project is 874.8 MW and its registered capacity in the Colombian electric market is 819 MW<sup>2</sup>, which corresponds to the nominal installed capacity that can yield the optimal planned average generation (5,056 GWh per year), according to the technical studies and recommendations made by designer of the Project, INGETEC<sup>3</sup>.

The generation system includes three power units driven by Francis type turbines with a maximum flow of 665 m<sup>3</sup>/s, and rated flow of 630 m<sup>3</sup>/s.

According to the last bathymetry study for the Sogamoso reservoir, the total volume is 4,825.04 million of m<sup>3</sup>, of which 2,756.31 million of m<sup>3</sup> corresponds to useful reservoir; flooded area (water mirror) is 6,886 ha, technical parameters that have been reported and approved by the National Operation Council (CNO, in Spanish)<sup>4</sup>.

Each turbine has one three-phase synchronous generator coupled to its axis; the outgoing power from the three generators passes to the three-pole switch-breaker through the isolated phase bar. Next, the power passes to each of the power transformers, which are in an independent cavern. The power is conducted from the power transformers to the output porch on the surface by power wires.

The power wires make up a set of three-phase circuits at 230 kV, which are connected to the National Transmission System by aerial lines from the output porch on the surface to Sogamoso Substation owned by ISA.

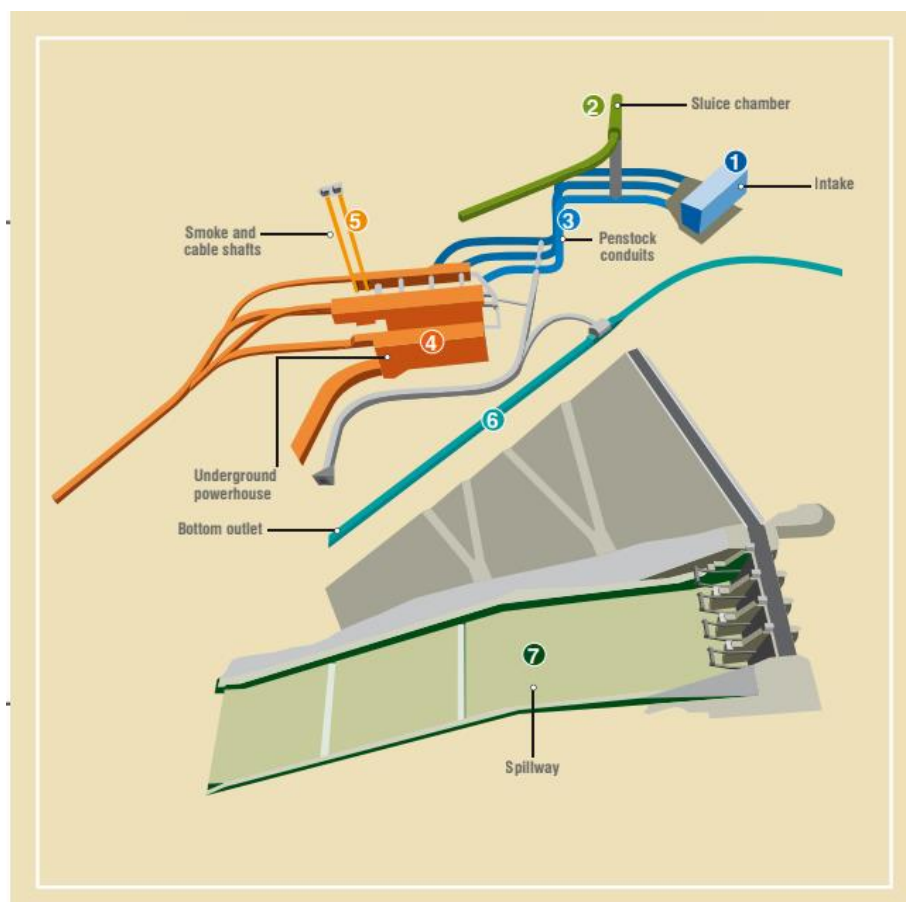
<sup>2</sup> Limited capacity by the CNO Agreement 719, December 21 of 2014

<sup>3</sup> Power plant's design documentation: INGETEC S.A., Update of tender designs and environmental impact assessment - Sogamoso Hydroelectric Project - Recommendations of installation for the power plant, rev. 1 - June

<sup>4</sup> CNO Agreement 851, March 3 of 2016

Finally, the power produced in the power plant is delivered to the Grid.

The power plant scheme is shown in the following figure.



**Figure 2.** Sogamoso Hydroelectric Project diagram.

The key technical data of the hydro turbines and the generators of the project are listed in Table 1.

**Table 1.** Technical data of the hydro turbines, generators and electric transformer

Equipment	Specification	Unit	Value
Turbines	Turbine Type	NA	Francis - vertical Axis
	Brand	NA	Andritz Hydro
	Velocity	rpm	163.64
	Flow	m <sup>3</sup> /s	210.00
	Net head	m	145.53
	Rated Power	MW	281.35
Generators	Generator type	NA	Synchronous three-phase, vertical axis
	Brand	NA	Toshiba
	Frequency	Hz	60
	Poles Number	Numbers	44
	Voltage	kV	16.5
	Rated Power	MVA	324
	Factor power	NA	0.9
Electric transformers	Type	NA	Three-phase
	Brand	NA	Siemens

Equipment	Specification	Unit	Value
	Series	NA	TP1 – 8657427 TP2 – 8691351 TP3 – 8698533 TP4 – 8711761
	Rated Power	MVA	324
	Voltage	kV	230/16.5

The Sogamoso Hydroelectric Project was constructed between 2009 and 2014. The starting date of the Project was February 4<sup>th</sup>, 2009, with the signature of the contract 46/2985 for the Construction of the Access Roads to the Work Sites of the Project.

On October 2014, main Project construction was completed, and the reservoir was up to the required level to begin Power Plant operation. On November, generator units began testing.

Finally, the Project began its commercial operation stage in December 20, 2014 with an installed capacity of 819 MW.

## **B.2. Post-registration changes**

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

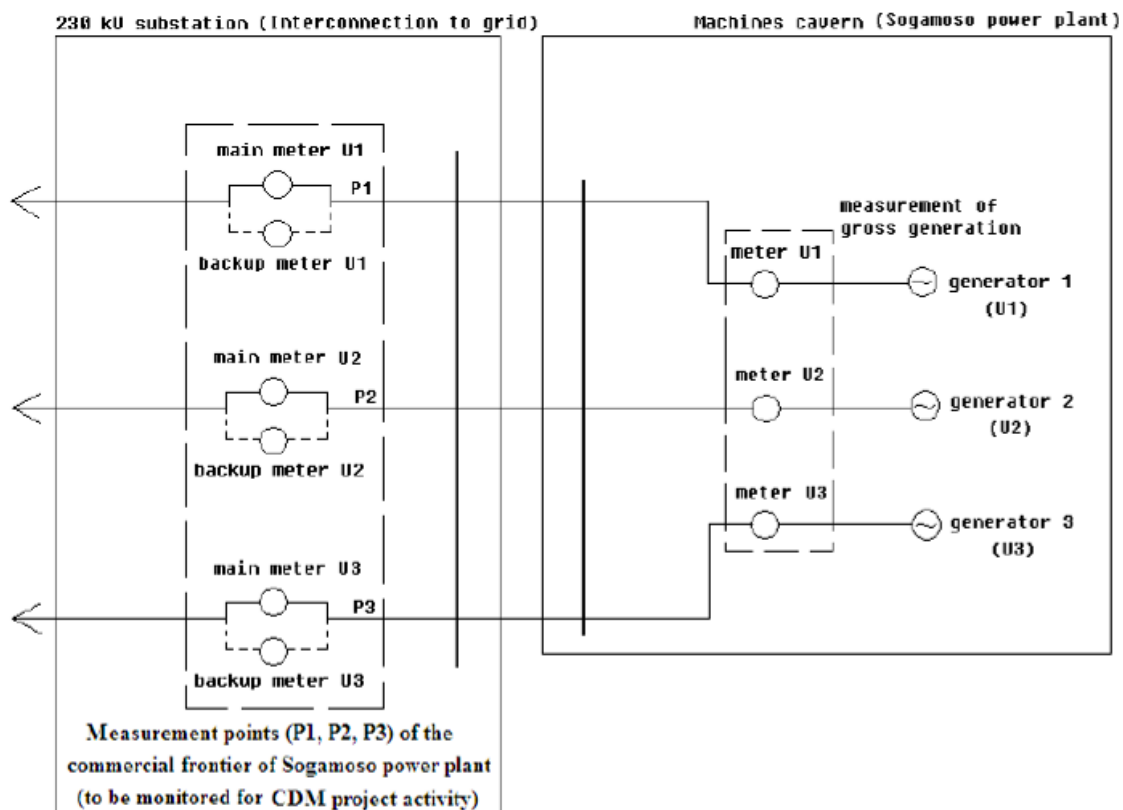
Not applicable.

### **B.2.2. Corrections**

The Board approved the following corrections with the PRC-10236-002 on December 20, 2019:

- According to numeral A.4 of the PDD (Parties and project participants), ISAGEN S.A E.S.P. is a mixed entity with public and private capital. However, as of January 13, 2016, ISAGEN S.A E.S.P. was acquired by the Canadian investment fund Brookfield Asset Management Inc. (BAM) and its new nature places it as a private company.
- In June 20<sup>th</sup>, 2018, PricewaterHouseCoopers Asesores Gerenciales Ltda was withdrawn as project participant by UNFCCC, the requested was made on June 18<sup>th</sup>, 2018 through a MoC Annex 2 (Withdraw Project Participant (Voluntary)).
- Some of the technical data of the hydraulic turbines described in the section A.3. Technologies and/or measures of the version 08 of the PDD were updated, according to the nameplate of the turbine given by the manufacturer. The updated data are Speed: 163.64 rpm instead of 163.63 rpm and Rated Power: 281.35 MW instead of 278.8 MW.
- The measurement points of the project activity (Figure 12 of the version 08 of PDD) was updated, an auxiliary services meter was not installed in the Power Plant and the scheme presented was part of a design document.

The actual measurement points of the project activity are presented below:



- The contact information was updated, accordingly to the last MoC.

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

Not applicable.

### B.2.4. Inclusion of monitoring plan

Not applicable.

### 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

The following inclusion was approved by the Board with the PRC-10236-002 on December 20, 2019:

- The way to measure the Area of the full reservoir in the surface of the water after the implementation of the Project Activity (APJ), it will be monitored using bathymetry surveys, which are more accurate than measurements using satellite pictures. And is mandatory for hydroelectric power plants in Colombia with reservoirs to use bathymetry surveys to deliver the operational parameters of the power plant to the CNO.

### B.2.6. Changes to project design

Not applicable.

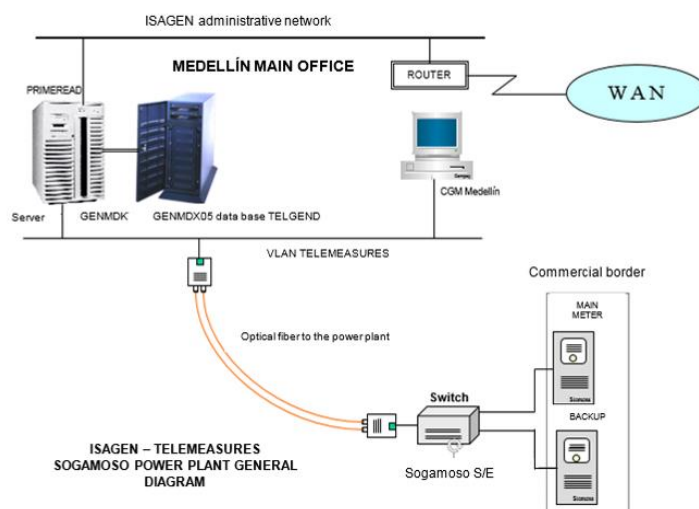
### B.2.7. Changes specific to afforestation or reforestation project activity

Not applicable.

## SECTION C. Description of monitoring system

The monitoring process focus on the project electricity generation and the displacement emission factor of the Grid.

For the monitoring of the electric power generated by the Project, the Monitoring Plan (MP) defines a baseline against which to measure the Project performance in terms of its Greenhouse Gases (GHG) emissions and emission reductions that can be monitor and verified in conformity with the modalities and procedures of the Clean Development Mechanism.



**Figure 3.** Operational and Management Structure

ISAGEN has incorporated explicitly into its internal procedures a detailed description of the activities related with the adequate management of the CDM monitoring system, that includes the roles and responsibilities associated with those activities (Eg. Internal Procedure 0029).

ISAGEN has formed a multidisciplinary team integrated by professionals of the Energy Generation Operations, Energy Generation Market and Energy Generation Projects, which are responsible for monitoring parameters, record and analyze the data used, according with methodology chosen, to calculate the operating margin and build margin emission factors every year.

As per the metering of the energy delivered to the grid, the Project is equipped with multi-function electronic metering devices, which register all information that needs to be monitor, such as exported energy, imported energy, power factor, electric tension, electric flow, etc. It is mandatory to install a backup equipment in addition to the main meter. The metering devices are located at the commercial frontier at the Sogamoso Substation. Before the starting of commercial power exchanges in the wholesale market system, the equipment needs to be certified by an authorized entity<sup>5</sup>.

ISAGEN execute a periodical maintenance and calibration program according to the codes approved by law and following recommendations by the equipment providers. Information recorded by the metering equipment is sent every 24 hours to the Commercial Exchange System, operated by the National Dispatch Center (XM). All energy transactions are recorded every hour. ISAGEN sends every day, before 8 am, the recorded values of the day before. According to that information, the National Dispatch Center (XM) processes the bills and payments for all transactions performed in the wholesale market. All this information is available to the market agents and to the system control authorities.

The data system at ISAGEN for the project is composed by software and hardware that allows for automatic recording of data collected at the meters. Using a system called PRIMEREAD, all data for outgoing and incoming energy are measured so that net electricity records are kept in files.

<sup>5</sup> Decree 2269 of 1993

For verification purposes, the data will be easily available at ISAGEN. In addition, historic records of actual energy supplied to the grid are publicly available at the XM website.

For the monitoring of the displacement emission factor of the Grid the Combined Margin CO<sub>2</sub> emission factor for Grid connected power generation was calculated, using the “Tool to calculate the emission factor for an electricity system”, based on XM and UPME as official sources of data.

Calculation of combined margin required:

- Follow up of electricity generated and delivered to the Grid by power units involved in operation margin.
- Follow up of electricity generated and delivered to the Grid by power units involved in build margin.

Calculations of combined margin required access to the XM database “Portal BI” which is available on XM Company Web-page: <http://www.xm.com.co>.

The main data used for the calculation is:

- Hourly national electricity generation by plants/units connected to the National Grid in kWh
- Hourly electricity bid price of plants/units connected to the National Grid in COP/kWh

Plants emission factors in tCO<sub>2</sub>e/MWh were also required for the calculation, the data used is available at UPME’s Mines and Energy Environmental Information System [www.siame.gov.co](http://www.siame.gov.co), specifically on of the support documents of UPME’s Resolution 624 of December 27<sup>th</sup>, 2019.

Parameters involved in this part of monitoring plan (Displacement emission factor of the Grid):

$EG_{n,h}$ ,  $EG_{m,y}$ ,  $EF_{EL,n/m,y}$  and Merit order.




## SECTION D. Data and parameters

### D.1. Data and parameters fixed ex ante

Data/Parameter	CAP <sub>BL</sub>
Unit	MW
Description	Installed capacity of the hydro power plant before the implementation of the project activity
Source of data	Not applicable
Value(s) applied	Zero because the hydropower plant is new
Choice of data or measurement methods and procedures	Not applicable
Purpose of data/parameter	Not applicable
Additional comments	Not applicable

Data/Parameter	A <sub>BL</sub>
Unit	m <sup>2</sup>
Description	Area of the reservoir measured in the surface of the water before the implementation of the project activity, when the reservoir is full
Source of data	Not applicable
Value(s) applied	Zero because the hydropower plant is new
Choice of data or measurement methods and procedures	Not applicable
Purpose of data/parameter	Not applicable
Additional comments	Not applicable

## D.2. Data and parameters monitored

Data/Parameter	CAP <sub>PJ</sub>
Unit	W
Description	Installed capacity of the hydro power plant after the implementation of the project activity (maximum installed capacity of the hydro power plant)
Measured/calculated/default	Project site
Source of data	This parameter is verified on the three synchronous generators' nameplates installed in the Project, manufactured by Toshiba Corporation.
Value(s) of monitored parameter	<p>874,800,000</p> <p>Each generator has the following characteristics:</p> <p style="text-align: center;">Toshiba generator 1017003</p>  <p style="text-align: center;">Toshiba generator 1017004</p>  <p style="text-align: center;">Toshiba generator 1017005</p> 

Monitoring equipment	Not applicable
Measuring/reading/recording frequency	At the beginning of each crediting period. This parameter was revised and verified by ICONTEC as a DOE on the CER's verification for the first monitoring period (June 15 <sup>th</sup> , 2016 to June 14, 2017)
Calculation method (if applicable)	Each generator has a generating potential of 324,000 kVA @ 60 Hz and a power factor of 0.9, which results in each generator having a capacity of 291,600 kW and an installed capacity of the Project of 874,800,000 W.
QA/QC procedures	The three generators that were installed before the commissioning date of the Project are the same ones that currently generate electricity in the Power Plant.
Purpose of data/parameter	Calculation of project emissions
Additional comments	Data will be archived during the whole crediting period and until two years after the end of the crediting period or the last issuance of CER's for this project activity, whichever occurs later.

<b>Data/Parameter</b>	A <sub>PJ</sub>
Unit	m <sup>2</sup>
Description	Area of the reservoir measured in the surface of the water, after the implementation of the project activity, when the reservoir is full
Measured/calculated/default	Calculated
Source of data	Bathymetric survey of the reservoir conducted in November 30, 2015
Value(s) of monitored parameter	68,864,864
Monitoring equipment	Not applicable
Measuring/reading/recording frequency	At the beginning of each crediting period
Calculation method (if applicable)	To guarantee the calculation and correction of latitude, longitude, altitude, heading, inclination, rolling and vertical oscillation, ISAGEN used a high-resolution sonar system capable of taking the bathymetry of the bottom of the water bodies, and an inertial positioning and orientation system (POS) assisted by GNSS (Global Satellite Navigation System).
QA/QC procedures	The area of the reservoir was registered by the CNO with a five years validity (CNO's Agreement 851 of 2016).
Purpose of data/parameter	Calculation of project emissions
Additional comments	Data will be archived during the completely crediting period and until two years after the end of the crediting period or the last issuance of CER's for this project activity, whichever occurs later.

<b>Data/Parameter</b>	EG <sub>facility,y</sub>
Unit	MWh/y
Description	Quantity of net electricity generation supplied by the project to the Grid in every hour of year y
Measured/calculated/default	Measured
Source of data	Continuous measurement by on site metering equipment at the power plant
Value(s) of monitored parameter	4,740,774

## Monitoring equipment

According to Colombian regulations, the electricity generated from each power plant connected to the Grid will be monitored using metering equipment located at the commercial frontier of every plant, for the Project the XM identification codes are Frt 23459 (Unit 1), Frt 23461 (Unit 2) and Frt 23440 (Unit 3). For the Project, this equipment is located at ISA's Sogamoso Substation 230 kV, located next to the power plant camp. This substation connects the Project to the National Interconnected System. In Colombia, the Measurement Code establishes mandatory high technical standards, procedures to read, to register and to record activities of electricity transactions performed in the Colombian energy market, according to the Resolution 038 of 2014 (Measurement Code) issued by CREG (Energy and Gas Regulation Commission, in Spanish).

The measuring equipment located at the Sogamoso Substation has the following characteristics:

## Principal Measurement Equipment Unit 1

Type/Brand	SCHNEIDER ELECTRIC
Accuracy class	Active accuracy: 0.2S Reactive accuracy: 2
Serial number	MW-1205A230-01
Calibration frequency	2 years
Previous Calibration date	19/09/2016
Validity Period	2016-2018
Calibration Certificate	ME-1609-19630
Last Calibration date	11/02/2018
Validity Period	2018-2020
Calibration Certificate	180211-64604

## Backup Measurement Equipment Unit 1

Type/Brand	SCHNEIDER ELECTRIC
Accuracy class	Active accuracy: 0.2S Reactive accuracy: 2
Serial number	MW-1205A231-01
Calibration frequency	2 years
Previous Calibration date	20/09/2016
Validity Period	2016-2018
Calibration Certificate	ME-1609-19633
Last Calibration date	12/02/2018
Validity Period	2018-2020
Calibration Certificate	180212-64609

## Principal Measurement Equipment Unit 2

Type/Brand	SCHNEIDER ELECTRIC
Accuracy class	Active accuracy: 0.2S CI reactive accuracy: 2
Serial number	MW-1205A228-01
Calibration frequency	2 years.
Previous Calibration date	19/09/2016
Validity Period	2016-2018
Calibration Certificate	ME-1609-19629
Last Calibration date	11/02/2018
Validity Period	2018-2020
Calibration Certificate	180211-64606

Monitoring equipment	Backup Measurement Equipment Unit 2	
	Type/Brand	SCHNEIDER ELECTRIC
	Accuracy class	Active accuracy: 0.2S Reactive accuracy: 2
	Serial number	MW-1205A229-01
	Calibration frequency	2 years
	Previous Calibration date	20/09/2016
	Validity Period	2016-2018
	Calibration Certificate	ME-1609-19632
	Last Calibration date	12/02/2018
	Validity Period	2018-2020
	Calibration Certificate	180221-64608
	Principal Measurement Equipment Unit 3	
	Type/Brand	SCHNEIDER ELECTRIC
	Accuracy class	Active accuracy: 0.2S Reactive accuracy: 2
	Serial number	MW-1205A225-01
	Calibration frequency	2 years.
	Previous Calibration date	19/09/2016
	Validity Period	2016-2018
	Calibration Certificate	ME-1609-19628
	Last Calibration date	11/02/2018
	Validity Period	2018-2020
	Calibration Certificate	180211-64605
	Backup Measurement Equipment Unit 3	
	Type/Brand	SCHNEIDER ELECTRIC
	Accuracy class	Active accuracy: 0.2S Reactive accuracy: 2
Serial number	MW-1205A226-01	
Calibration frequency	2 years	
Previous Calibration date	20/09/2016	
Validity Period	2016-2018	
Calibration Certificate	ME-1609-19631	
Last Calibration date	12/02/2018	
Validity Period	2018-2020	
Calibration Certificate	180212-64607	
Measuring/reading/recording frequency	Hourly measurement	
Calculation method (if applicable)	Not applicable	
QA/QC procedures	<p>ISAGEN's experience and know-how in the generation and commercialization fields will be applied to the Project measurement procedures.</p> <p>Wholesale Electricity Market has a system in which the records of all commercial transactions made within the market are archived. This database will serve to compare the records with the data provided by the Project.</p> <p>Meters will be calibrated according to the relevant standards or regulatory norms. In the same way, accuracy of meters will meet the requirements of standards and regulatory principles.</p> <p>Other way to guarantee QA/QC procedures will be taking into account maintenance processes. For more information see the explanation below.</p> <p>All metering devices used to monitor, and measure data follow rules that have been summarized in CREG 038 of 2014 Resolution. This Resolution specifies the technical characteristics measurement, telecommunications and back-up equipment to meet installation, testing, certification, operation and maintenance procedures.</p>	
Purpose of data/parameter	This information is required to calculate baseline emissions	
Additional comments	Data will be archived during the whole crediting period and until two years after the end of the crediting period or the last issuance of CER's for this project activity, whichever occurs later.	

<b>Data/Parameter</b>	EF <sub>grid,CM,y</sub>
Unit	tCO <sub>2</sub> /MWh
Description	Emission factor of the National Interconnected System (The Grid)
Measured/calculated/default	Calculated
Source of data	Mathematical calculation that incorporates the parameters EG <sub>n,h</sub> , EG <sub>m,y</sub> , EF <sub>EL,n/m,y</sub> and Merit order, which are explained in the following tables
Value(s) of monitored parameter	0.3192
Monitoring equipment	Not applicable
Measuring/reading/recording frequency	Hourly
Calculation method (if applicable)	Tool to calculate the emission factor for an electricity system version 4.0
QA/QC procedures	According to every parameter explained below
Purpose of data/parameter	Calculation of the baseline emissions year y
Additional comments	Data will be archived during the whole crediting period and until two years after the end of the crediting period or the last issuance of CER's for this project activity, whichever occurs later.

<b>Data/Parameter</b>	EG <sub>n,h</sub>
Unit	MWh
Description	Electricity generated and delivered to the Grid by power unit <i>n</i> in hour <i>h</i>
Measured/calculated/default	Measured
Source of data	Data supplied by XM, the administrator of the Grid. Access on Portal BI of XM at its website <a href="http://www.xm.com.co">www.xm.com.co</a>
Value(s) of monitored parameter	It varies by plant and hour <sup>6</sup>
Monitoring equipment	The electricity generation from each power unit connected to the Grid is monitored by and sent to XM by on site metering devices installed on each unit's commercial frontier.
Measuring/reading/recording frequency	Hourly
Calculation method (if applicable)	Not applicable
QA/QC procedures	The process of reporting each power unit electricity generated and delivered to the Grid is regulated in Colombia by the Measurement Code " <i>Código de Medida</i> " established by CREG with its Resolution 038 of 2014.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	Data will be archived during the whole crediting period and until two years after the end of the crediting period or the last issuance of CER's for this project activity, whichever occurs later.

<b>Data/Parameter</b>	EG <sub>m,y</sub>
Unit	MWh
Description	Net quantity of electricity generated and delivered to the grid by power unit <i>m</i> in year <i>y</i>

<sup>6</sup> Details on the Real\_Generation sheet of the Excel spreadsheet 10236 Sogamoso 2018-2019 - OM Dispatch\_January 28 2020

Measured/calculated/default	Measured
Source of data	Data supplied by XM, the administrator of the Grid. Access on Portal BI of XM at its website <a href="http://www.xm.com.co">www.xm.com.co</a>
Value(s) of monitored parameter	It varies by plant and hour <sup>7</sup>
Monitoring equipment	The electricity generation from each power unit connected to the Grid is monitored by and sent to XM by on site metering devices installed on each unit's commercial frontier.
Measuring/reading/recording frequency	Yearly
Calculation method (if applicable)	Not applicable
QA/QC procedures	The process of reporting each power unit electricity generated and delivered to the Grid is regulated in Colombia by the Measurement Code " <i>Código de Medida</i> " established by CREG with its Resolution 038 of 2014.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	Data will be archived during the whole crediting period and until two years after the end of the crediting period or the last issuance of CER's for this project activity, whichever occurs later.

<b>Data/Parameter</b>	$EF_{EL,n/m,y}$
Unit	tCO <sub>2</sub> /MWh
Description	CO <sub>2</sub> emission factor of grid power unit <i>n</i> or <i>m</i> in year <i>y</i>
Measured/calculated/default	Default
Source of data	UPME supplied the emission factor of each plant (support documents of Resolution 624 of 2019), that can be access at Mines and Energy Environmental Information System <a href="http://www.siame.gov.co">www.siame.gov.co</a>
Value(s) of monitored parameter	It varies by plant.  The emission factor of each power plant was calculated using the respective fuel emission factor in kg CO <sub>2</sub> /TJ provided by UPME: Fuel oil = 80,570.38 Coal = 97,257.39 Gas = 55,100.53
Monitoring equipment	Not applicable
Measuring/reading/recording frequency	Yearly
Calculation method (if applicable)	Not applicable
QA/QC procedures	UPME, as an official entity follows high quality QA/QC methods on the data supplied to the public. Therefore, the data are reliable.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	Data will be archived during the whole crediting period and until two years after the end of the crediting period or the last issuance of CER's for this project activity, whichever occurs later.

<b>Data/Parameter</b>	Merit order
Unit	Not applicable
Description	Merit order of plants that generate energy to satisfy national hourly demand

<sup>7</sup> Idem

Measured/calculated/default	Calculated.  To determine the merit order the following information was obtained from XM: <ul style="list-style-type: none"> <li>Electricity bid price of each Grid-connected power unit in the year y.</li> <li>Amount of generated electricity that was dispatched by every power unit in the system during each hour of the year y.</li> </ul>
Source of data	Data supplied by XM.
Value(s) of monitored parameter	It varies hourly <sup>8</sup>
Monitoring equipment	Not applicable
Measuring/reading/recording frequency	Hourly
Calculation method (if applicable)	Mathematical calculation and optimization program
QA/QC procedures	XM, as an official entity follows high quality QA/QC methods on the data supplied to the public. Therefore, the data are reliable.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	Data will be archived during the whole crediting period and until two years after the end of the crediting period or the last issuance of CER's for this project activity, whichever occurs later.

### D.3. Implementation of sampling plan

Data and parameters monitored in section D.2 above are not to be determined by a sampling approach.

## SECTION E. Calculation of emission reductions or net anthropogenic removals

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

According to the applied methodology ACM0002, version 16.0 baseline emissions shall be accounted for using the following equation:

$$BE_y = EG_{\text{facility},y} \times EF_{\text{grid},CM,y}$$

Where:

**BE<sub>y</sub>** = Baseline emissions in year y (tCO<sub>2</sub>e). For the period, the baseline emissions were **1,513,255 tCO<sub>2</sub>e**.

**EG<sub>facility,y</sub>** = Quantity of net electricity generation that is produced and fed into the grid as a result of the implementation of the CDM project activity in year y (MWh/yr). For the period, the electricity generated was **4,740,774 MWh/yr**.

Year	Month	Net electricity supply to the Grid (MWh)
2018	June	131,431
	July	305,063
	August	317,905
	September	373,115
	October	507,607
	November	536,478
	December	437,822
2019	January	345,576

<sup>8</sup>Details on the sheets Top\_Dispatch and Dispatch of the spreadsheet 10236 Sogamoso 2018-2019 - OM Dispatch\_January 28 2020.

Year	Month	Net electricity supply to the Grid (MWh)
	February	235,730
	March	398,738
	April	359,606
	May	531,220
	June	260,483
<b>TOTAL</b>		<b>4,740,774</b>

$EF_{grid,CM,y}$  = Combined margin CO<sub>2</sub> emission factor for grid connected power generation in year  $y$  calculated using the Tool to calculate the emission factor for an electricity system (tCO<sub>2</sub>e/MWh) in year  $y$ . For the period, the emission factor was **0.3192 tCO<sub>2</sub>e/MWh**.

The process that was carried out was:

- Determine the net electricity output of the project for the period under verification (Portal BI of XM).
- Calculate of the Operating Margin (OM) emission factor, using the dispatch data analysis, *ex-ante* calculation. For the period is **0.4640 tCO<sub>2</sub>/MWh**<sup>9</sup>.
- Calculate the Build Margin (BM) emission factor, using the Option 2, *ex-post* calculation. For the period is **0.1745 tCO<sub>2</sub>/MWh**<sup>10</sup>.
- Calculate the Combined Margin (CM) emission factor, using the weighted average method (option A). For the period is **0.3192 tCO<sub>2</sub>/MWh**<sup>11</sup>.
- Multiply the actual electricity output produced by the Project by the CM Emission Factor for the Colombian Interconnected Grid.

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

According to the applied methodology ACM0002, project emissions shall be accounted for using the following equation:

$$PE_y = PE_{FF,y} + PE_{GP,y} + PE_{HP,y}$$

Where:

$PE_y$  = Project emissions in year  $y$  (tCO<sub>2</sub>e/yr). For the period, the project emissions were **zero**.

$PE_{FF,y}$  = Project emissions from fossil fuel consumption in year  $y$  (tCO<sub>2</sub>/yr). For the period, this factor was **zero**.

$PE_{GP,y}$  = Project emissions from the operation of geothermal power plants due to the release of non-condensable gases in year  $y$  (tCO<sub>2</sub>e/yr). This factor is **zero** because the Project is a hydroelectric power plant.

$PE_{HP,y}$  = Project emissions from water reservoirs of hydro power plants in year  $y$  (tCO<sub>2</sub>e/yr). Considered (**zero**).

The process that was carried out was:

- For all renewable energy power generation project activities, emissions due to the use of fossil fuels for the backup generator can be neglected, so  $PE_{FF,y} = 0$ .
- The Project under evaluation is a hydroelectric power plant, so  $PE_{GP,y} = 0$ .

<sup>9</sup> Details of the calculation available at the sheet "OM" of the spreadsheet 10236 Sogamoso 2018-2019\_OM Summary\_January 28 2020 attached to the Monitoring Report.

<sup>10</sup> Details of the calculation available at the sheet "BM" of the spreadsheet 10236 Sogamoso 2018-2019\_CER\_BM\_January 28 2020 attached to the Monitoring Report

<sup>11</sup> Details of the calculation available at the sheet "CM" of the spreadsheet 10236 Sogamoso 2018-2019\_CER\_BM\_January 28 2020 attached to the Monitoring Report.

- The emissions associated with the reservoir are not considered (zero) because the Power Density (PD) of the Project is 12.70 W/m<sup>2</sup> (greater than 10 W/m<sup>2</sup>) using the value of A<sub>PJ</sub> (68,864,864 m<sup>2</sup>). According to the following:

$$PD = \frac{CAP_{PJ} - CAP_{BL}}{A_{PJ} - A_{BL}} = \frac{(874,800,000 - 0) \text{ W}}{(68,864,864 - 0) \text{ m}^2} = 12.70 \text{ W/m}^2$$

Also, as defined on the PDD, PE<sub>y</sub> in every year y of the crediting period are equaled to zero.

### E.3. Calculation of leakage emissions

According to the PDD, 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, and transport). These emissions sources are neglected, so L<sub>y</sub> = 0.

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

According to the applied methodology ACM0002, emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y$$

Where:

**ER<sub>y</sub>** = Emission reductions in year y (tCO<sub>2</sub>e/yr). For the period, the reductions were **1,513,255 tCO<sub>2</sub>e**.

**BE<sub>y</sub>** = Baseline emissions in year y (tCO<sub>2</sub>/yr). For the period, the baseline emissions were **1,513,255 tCO<sub>2</sub>e**.

**PE<sub>y</sub>** = Project emissions in year y (tCO<sub>2</sub>e/yr). This factor is zero in every year of the crediting period.

	Baseline GHG emissions or baseline net GHG removals (tCO <sub>2</sub> e)	Project GHG emissions or actual net GHG removals (tCO <sub>2</sub> e)	Leakage GHG emissions (tCO <sub>2</sub> e)	GHG emission reductions or net anthropogenic GHG removals (tCO <sub>2</sub> e)		
				Before 01/01/2013	From 01/01/2013	Total amount
<b>Total</b>	1,386,355	1,513,255	0	0	1,513,255	1,513,255

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

Amount achieved during this monitoring period (tCO <sub>2</sub> e)	Amount estimated ex ante for this monitoring period in the PDD (tCO <sub>2</sub> e)
1,513,255	1,386,355

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

The amount of emission reductions estimated in the PDD used the average electricity production of the Project (5,056 GWh per year) and the emission factor of the Grid (0.2742 tCO<sub>2</sub>e/MWh) approved at the validation as CDM of the Project. Multiplying both factors, 1,386,355 CER's would be obtained.

### E.6. Remarks on increase in achieved emission reductions

There was a 9.2% increase of emission reductions from the ones estimated in the PDD (1,513,255 CER's instead of 1,386,355 CER's). This is product of an increase of 16.4% of the emission factor of the Grid (0.3192 tCO<sub>2</sub>/MWh instead of 0.2742 tCO<sub>2</sub>/MWh) due to a more thermal power

generation of the Grid associated to the climatological conditions that occurred in Colombia during the analysis period.

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

Not applicable

## Document information

<i>Version</i>	<i>Date</i>	<i>Description</i>
07.0	31 May 2019	Revision to: <ul style="list-style-type: none"> <li>• Ensure consistency with version 02.0 of the “CDM project standard for project activities” (CDM-EB93-A04-STAN);</li> <li>• Add a section on remarks on the observance of the scale limit of small-scale project activity during the crediting period;</li> <li>• Add "changes specific to afforestation or reforestation project activity" as a possible post-registration changes;</li> <li>• Clarify the reporting of net anthropogenic GHG removals for A/R project activities between two commitment periods;</li> <li>• Make editorial improvements.</li> </ul>
06.0	7 June 2017	Revision to: <ul style="list-style-type: none"> <li>• Ensure consistency with version 01.0 of the “CDM project standard for project activities” (CDM-EB93-A04-STAN);</li> <li>• Make editorial improvements.</li> </ul>
05.1	4 May 2015	Editorial revision to correct version numbering.
05.0	1 April 2015	Revisions to: <ul style="list-style-type: none"> <li>• Include provisions related to delayed submission of a monitoring plan;</li> <li>• Provisions related to the Host Party;</li> <li>• Remove reference to programme of activities;</li> <li>• Overall editorial improvement.</li> </ul>
04.0	25 June 2014	Revisions to: <ul style="list-style-type: none"> <li>• Include the Attachment: Instructions for filling out the monitoring report form (these instructions supersede the "Guideline: Completing the monitoring report form" (Version 04.0));</li> <li>• Include provisions related to standardized baselines;</li> <li>• Add contact information on a responsible person(s)/ entity(ies) for completing the CDM-MR-FORM in A.6 and Appendix 1;</li> <li>• Change the reference number from <i>F-CDM-MR</i> to <i>CDM-MR-FORM</i>;</li> <li>• Editorial improvement.</li> </ul>
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).
01.0	28 May 2010	EB 54, Annex 34. Initial adoption.

<i>Version</i>	<i>Date</i>	<i>Description</i>
Decision Class: Regulatory Document Type: Form Business Function: Issuance Keywords: monitoring report		