Monitoring report form for CDM project activity
(Version 06.0)

MONITORING REPORT		
Title of the project activity	Sogamoso Hydroelectric Project	
UNFCCC reference number of the project activity	10236	
Version number of the PDD applicable to this monitoring report	Version 08	
Version number of this monitoring report	Version 01	
Completion date of this monitoring report	29/05/2019	
Monitoring period number	Second monitoring period	
Duration of this monitoring period	15/06/2017 - 14/06/2018 (both days included)	
Monitoring report number for this monitoring report	1	
Project participants	ISAGEN S.A. E.S.P.	
Host Party	Colombia	
Sectoral scopes	Sectoral scopes 1: Energy industries (renewable / non renewable sources)	
Applied methodologies and standardized baselines	ACM0002 “Grid-connected electricity generation from renewable sources” - version 19.0	
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 tCO_2e	1,437,895 tCO_2e
Amount of GHG emission reductions or net anthropogenic GHG removals estimated ex ante for this monitoring period in the PDD	1,386,355 tCO_2e/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 1st 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 Yariguies*[1], 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 area of influence 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 area of influence, 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 area of influence 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).

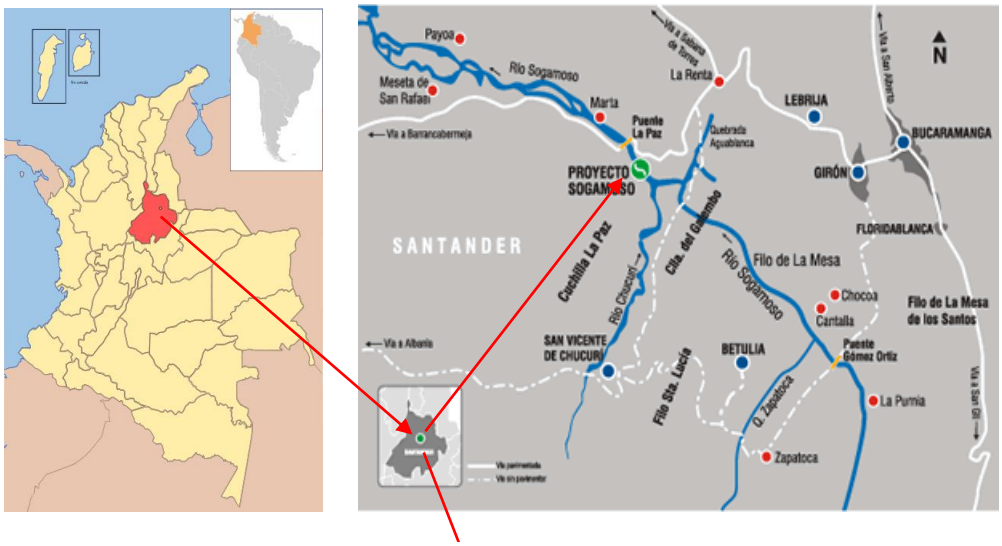
- **Improving of health:** Cooperation Agreement signed with the *San Juan de Dios* Hospital in the municipality of *Betulia*, to adequate and equip the Health Center, located in the area of *Tienda Nueva*.

[1] *Yariguies* 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 muncipality 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.

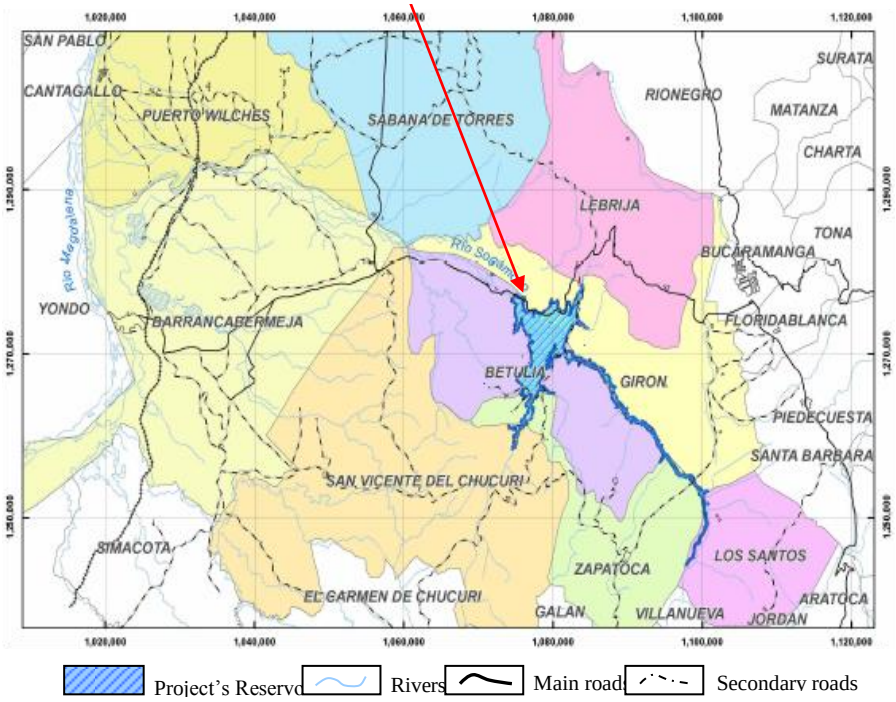
A.2. Location of project activity

The Project is located 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 Departament 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)
ISAGEN S.A E.S.P Republic of Colombia (host)	Project´s Owner - Private entity	Yes

A.4. Reference to applied methodologies and standardized baselines

The ACM0002-version 19.0 “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 7.0).

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 second monitoring period is from 15/06/2017 to 14/06/2018 (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^3/s distributed in three (3) units of 210 m^3/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[2], 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[3].

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

According to the last bathymetry study for the Sogamoso reservoir, the total volume is 4,825.04 million of m^3, of which 2,756.31 million of m^3 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)[4].

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 located 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.

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

The power plant scheme is shown in the following figure.

[2] CNO Agreement 719, December 21 of 2014

[3] 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

[4] CNO Agreement 851, March 3 of 2016

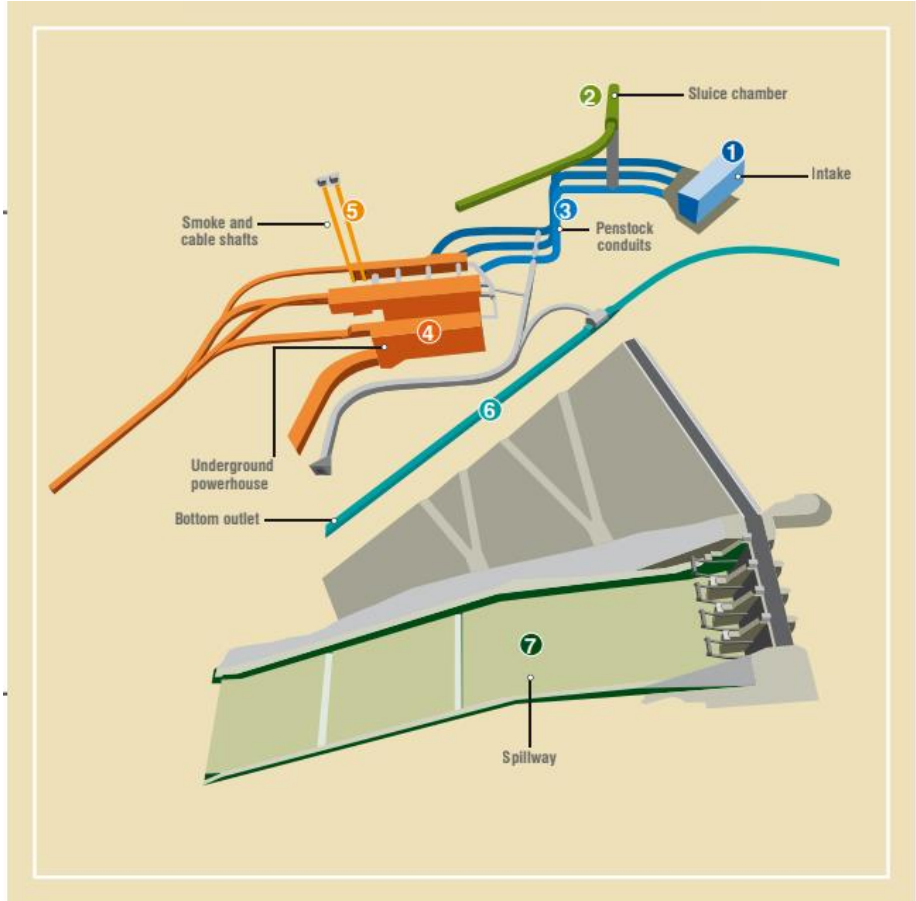


Figure 2. Sogamoso Hydroelectric Project diagram.

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^3/s	210.00
	Net head	m	145.53
	Rated Power	MW	281.35
	Impeller Diameter	mm	4,450
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
	Series	NA	TP1 – 8657427 TP2 – 8691351 TP3 – 8698533 TP4 – 8711761

Equipment	Specification	Unit	Value
	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 4th 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.

The power generated and its associated reduced emissions of CO_2 during this monitoring period were 17.65% below the expectations initially proposed in the approved PDD. This variation was due to the operation of the power plant according to the requirements of the National Interconnected Power Grid, the level of the reservoir and the availability of the hydroelectric power plant (for example: the unavailability of Unit 3 due to failures in one of the transformer connection busbar, from August to November 2016).

B.2. Post-registration changes

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

Although during the execution of the activities of the Project no significant changes have arisen in the variables of the Monitoring Plan, it is important to mention some current deviations from the preliminary designs of the Project that are described below:

- Useful capacity delivered to the network electrical was limited to 819 MW (CNO's Agreement 719 of December 21, 2014).
- Net area of the reservoir: For the parameter (A_{PJ}) "Area of the reservoir measured in the surface of the water before the implementation of the project activity" and defined in the monitoring plan of the approved PDD, the preliminary design of the project estimated an area of 7,590 ha with a measurement procedure through satellite images.
  This parameter was updated through a bathymetric survey of the reservoir. 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.
  According to this bathymetric study, conducted in November 30, 2015, the current net area of the reservoir is 6,886 ha. This technical reservoir update was registered by the CNO with a validity of 5 years (CNO's Agreement 565 of 2012).

B.2.2. Corrections

- 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 20th 2018, PriceWaterHouseCoopers Asesores Gerenciales Ltda was withdrawn as project participant by UNFCCC, the requested was made on June 18th 2018 through a MoC Annex 2 (Withdraw Project Participant (Voluntary)).
- According to the current operational characteristics of the project and the current bathymetry study (CNO's Agreement 565 of 2012), the total reservoir volume is 4,825.04 million m^3, with a reservoir area or "mirror area" of 6,886 ha and a useful volume of 2,756.31 million m^3.

- In addition to CAP_{PJ}, A_{PJ} and $EG_{facility,y}$ the data and parameters to be monitor will be $EF_{grid,OM-DD,y}$ ($EG_{PJ,h}$, $EF_{EL,DD,h}$, $EG_{PJ,y}$, $EG_{n,h}$, $EF_{EL,n,y}$ and n), $EF_{grid,BM,y}$ ($EG_{m,y}$ and $EF_{EL,m,y}$) and $EF_{grid,CM,y}$ instead of $EF_{grid,CM,y}$, $EG_{n,h}$, $EG_{m,y}$, $EF_{EL,n/m,y}$ and Merit Order, presented in the PDD version 08.

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 applied standards or tools

Not applicable

B.2.6. Changes to project design

Not applicable

SECTION C. Description of monitoring system

The monitoring process focus on the measurement and control of the variables of energy generated in the hydroelectric power station and the control of the reservoir area.

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 Gas (GHG) emissions and emission reductions that can be monitor and verified in conformity with the modalities and procedures of the Clean Development Mechanism.

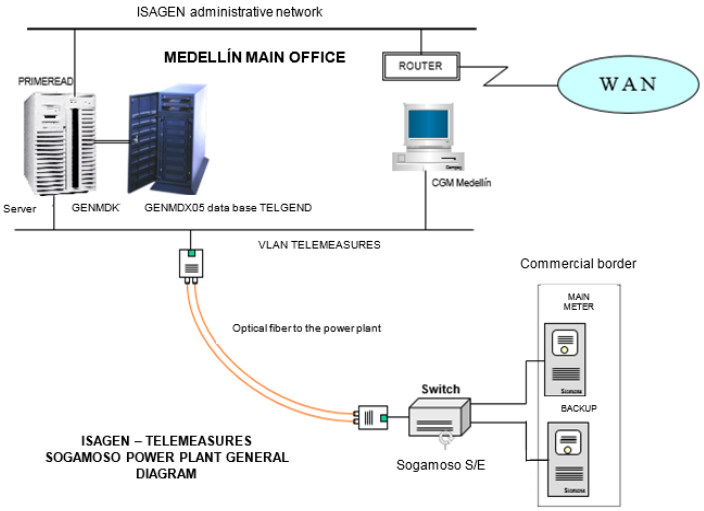


Figure 3. Operational and Management Structure

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[5].

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 register 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.

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.

SECTION D. Data and parameters

D.1. Data and parameters fixed ex ante

Data/Parameter	CAP_{BL}
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_{BL}
Unit	m^2
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

[5] Decree 2269 of 1993

D.2. Data and parameters monitored

Data/Parameter	CAP_{PJ}
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 generators' nameplate and the technical characteristics agreed with the manufacturer. Will be followed up by checking the series model of the installed equipment and by checking that, when a replacement is necessary, the nameplate characteristics of the new equipment is equivalent to the nameplate characteristics of the equipment installed previously.
Value(s) of monitored parameter	874,800,000
Monitoring equipment	Not applicable
Measuring/reading/recording frequency	At the beginning of each crediting period
Calculation method (if applicable)	Not applicable
QA/QC procedures	The best way to assure the value of data of this parameter is by assuring that the equipment installed at the beginning of the Project will keep installed during the entire crediting period or, when necessary replacing equipment, the new equipment will have the same characteristics of the equipment replaced. The first aspect will be followed up by checking the series model of the installed equipment. The second aspect will be determined by checking the equipment characteristics in the nameplates of each new generator.
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.

Data/Parameter	A_{PJ}
Unit	m^2
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	68,860,000
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 5 years validity of (CNO's Agreement 565 of 2012).
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.

<table>
<tr><td>Data/Parameter</td><td>$EG_{facility,y}$</td></tr>
<tr><td>Unit</td><td>MWh/y</td></tr>
<tr><td>Description</td><td>Quantity of net electricity generation supplied by the project to the Grid in every hour of year y</td></tr>
<tr><td>Measured/calculated/default</td><td>Measured</td></tr>
<tr><td>Source of data</td><td>Data supplied by XM</td></tr>
<tr><td>Value(s) of monitored parameter</td><td>5,022,307</td></tr>
<tr><td>Monitoring equipment</td><td>According to Colombian regulations, the electricity generate 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).

Because of the modification of the Measurement Code on May 20, 2014, ISAGEN updated its measurement equipment in order to fulfil the new regulation conditions and standardize all the measurement equipment installed in all the power plants. The measuring equipment located at the Sogamoso Substation has the following characteristics:

Principal Measurement Equipment Unit 1
<table><tr><td>Type/Brand</td><td>SCHNEIDER ELECTRIC</td></tr><tr><td>Accuracy class</td><td>Active accuracy: 0.2S
Reactive accuracy: 2</td></tr><tr><td>Serial number</td><td>MW-1205A230-01</td></tr><tr><td>Calibration frequency</td><td>2 years.</td></tr><tr><td>Last Calibration date</td><td>19/09/2016</td></tr><tr><td>Validity Period</td><td>2016-2018</td></tr><tr><td>Calibration Certificate</td><td>ME-1609-19630</td></tr></table>Backup Measurement Equipment Unit 1
<table><tr><td>Type/Brand</td><td>SCHNEIDER ELECTRIC</td></tr><tr><td>Accuracy class</td><td>Active accuracy: 0.2S
Reactive accuracy: 2</td></tr><tr><td>Serial number</td><td>MW-1205A231-01</td></tr><tr><td>Calibration frequency</td><td>2 years</td></tr><tr><td>Last Calibration date</td><td>20/09/2016</td></tr><tr><td>Validity Period</td><td>2016-2018</td></tr><tr><td>Calibration Certificate</td><td>ME-1609-19633</td></tr></table>Principal Measurement Equipment Unit 2
<table><tr><td>Type/Brand</td><td>SCHNEIDER ELECTRIC</td></tr><tr><td>Accuracy class</td><td>Active accuracy: 0.2S
CI reactive accuracy: 2</td></tr><tr><td>Serial number</td><td>MW-1205A228-01</td></tr><tr><td>Calibration frequency</td><td>2 years.</td></tr><tr><td>Last Calibration date</td><td>19/09/2016</td></tr><tr><td>Validity Period</td><td>2016-2018</td></tr><tr><td>Calibration Certificate</td><td>ME-1609-19629</td></tr></table></td></tr>
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<tr><td>Monitoring equipment</td><td>
Backup Measurement Equipment Unit 2
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<tr><td>Serial number</td><td>MW-1205A229-01</td></tr>
<tr><td>Calibration frequency</td><td>2 years</td></tr>
<tr><td>Last Calibration date</td><td>20/09/2016</td></tr>
<tr><td>Validity Period</td><td>2016-2018</td></tr>
<tr><td>Calibration Certificate</td><td>ME-1609-19632</td></tr>
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Principal Measurement Equipment Unit 3
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Reactive accuracy: 2</td></tr>
<tr><td>Serial number</td><td>MW-1205A225-01</td></tr>
<tr><td>Calibration frequency</td><td>2 years.</td></tr>
<tr><td>Last Calibration date</td><td>19/09/2016</td></tr>
<tr><td>Validity Period</td><td>2016-2018</td></tr>
<tr><td>Calibration Certificate</td><td>ME-1609-19628</td></tr>
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Backup Measurement Equipment Unit 3
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<tr><td>Type/Brand</td><td>SCHNEIDER ELECTRIC</td></tr>
<tr><td>Accuracy class</td><td>Active accuracy: 0.2S
Reactive accuracy: 2</td></tr>
<tr><td>Serial number</td><td>MW-1205A226-01</td></tr>
<tr><td>Calibration frequency</td><td>2 years</td></tr>
<tr><td>Last Calibration date</td><td>20/09/2016</td></tr>
<tr><td>Validity Period</td><td>2016-2018</td></tr>
<tr><td>Calibration Certificate</td><td>ME-1609-19631</td></tr>
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</td></tr>
<tr><td>Measuring/reading/recording frequency</td><td>Hourly measurement</td></tr>
<tr><td>Calculation method (if applicable)</td><td>Not applicable</td></tr>
<tr><td>QA/QC procedures</td><td>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.</td></tr>
<tr><td>Purpose of data/parameter</td><td>This information is required to calculate baseline emissions</td></tr>
<tr><td>Additional comments</td><td>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.</td></tr>
</table>

Data/Parameter	$EF_{grid,OM-DD,y}$
Unit	tCO_2/MWh
Description	Dispatch data analysis operating margin CO_2 emission factor in year y
Measured/calculated/default	Calculated
Source of data	Dispatch data analysis, ex-ante calculation
Value(s) of monitored parameter	0.4857
Monitoring equipment	Not applicable
Measuring/reading/recording frequency	Yearly
Calculation method (if applicable)	Tool to calculate the emission factor for an electricity system
QA/QC procedures	Not applicable
Purpose of data/parameter	Calculation of the combined margin emissions factor in year y
Additional comments	Not applicable

Data/Parameter	$EG_{PJ,h}$
Unit	MWh
Description	Electricity displaced by the project activity in hour *h* of year *y*
Measured/calculated/default	Measured
Source of data	Data supplied by XM
Value(s) of monitored parameter	It varies by hour
Monitoring equipment	Same as presented in $EG_{facility,y}$
Measuring/reading/recording frequency	Hourly
Calculation method (if applicable)	Not applicable
QA/QC procedures	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.
Purpose of data/parameter	Calculation of the dispatch data analysis operating margin CO_2 emission factor in year y
Additional comments	Not applicable

Data/Parameter	$EF_{EL,DD,h}$
Unit	tCO_2/MWh
Description	CO_2 emission factor for grid power units in the top of the dispatch order in hour *h* in year *y*
Measured/calculated/default	Calculated
Source of data	The electricity supplied by each plant was provided by XM. The emission factor of each plant was supplied by UPME (Resolution 774 of 2018)
Value(s) of monitored parameter	The electricity supplied by each plant varies by hour. The emission factor of each power plant was calculated using the respective fuel emission factor in kg CO_2/TJ: Fuel oil = 80,570.38 Coal = 97,257.39 Gas =55,100.53
Monitoring equipment	Not applicable
Measuring/reading/recording frequency	Hourly (electricity supplied)
Calculation method (if applicable)	Tool to calculate the emission factor for an electricity system
QA/QC procedures	Data given by official entities
Purpose of data/parameter	Calculation of the dispatch data analysis operating margin CO_2 emission factor in year y
Additional comments	Not applicable

Data/Parameter	$EG_{PJ,y}$
Unit	MWh
Description	Total electricity displaced by the project activity in year *y*
Measured/calculated/default	Measured
Source of data	Data supplied by XM

Value(s) of monitored parameter	5,022,307
Monitoring equipment	Same as presented in $EG_{facility,y}$
Measuring/reading/recording frequency	Hourly measurement
Calculation method (if applicable)	Not applicable
QA/QC procedures	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.
Purpose of data/parameter	Calculation of the dispatch data analysis operating margin CO_2 emission factor in year y
Additional comments	Not applicable

Data/Parameter	$EG_{n,h}$
Unit	MWh
Description	Net quantity of electricity generated and delivered to the Grid by power unit *n* in hour *h*
Measured/calculated/default	For calculate net quantity of electricity of each hour *h*, each plant's generation, was organized using the merit order. The set of plants n consists of the greater value of: • Those plants at the top of the stack, whose combined generation comprises 10% of the total generation from all plants during that hour, or • The quantity of electricity displaced by the project activity during hour *h* divided by the total electricity generation by grid power plants during that hour *h*.
Source of data	Data supplied by XM
Value(s) of monitored parameter	It varies by plant and hour
Monitoring equipment	Calculated
Measuring/reading/recording frequency	Hourly
Calculation method (if applicable)	Mathematical calculation
QA/QC procedures	Data given by the administrator of the Grid
Purpose of data/parameter	Calculation of the dispatch data analysis operating margin CO_2 emission factor in year y
Additional comments	Not applicable

Data/Parameter	$EF_{EL,n,y}$
Unit	tCO_2/MWh
Description	CO_2 emission factor of grid power unit *n* in year *y*
Measured/calculated/default	Calculated
Source of data	XM provided the electricity supplied by each plant. UPME supplied the emission factor of each plant (Resolution 774 of 2018)
Value(s) of monitored parameter	The electricity supplied by each plant varies by hour. The emission factor of each power plant was calculated using the respective fuel emission factor in kg CO_2/TJ: Fuel oil = 80,570.38 Coal = 97,257.39 Gas =55,100.53

Monitoring equipment	Not applicable
Measuring/reading/recording frequency	Hourly (electricity supplied)
Calculation method (if applicable)	Tool to calculate the emission factor for an electricity system
QA/QC procedures	Data given by official entities
Purpose of data/parameter	Calculation of the dispatch data analysis operating margin CO_2 emission factor in year y
Additional comments	Not applicable

Data/Parameter	Merit order
Unit	Not applicable
Description	Grid power units in the top of the dispatch (merit order of plants that generate energy to satisfy national hourly demand)
Measured/calculated/default	To determine the merit order of the plants for the ex-ante calculations, the following information was obtained from the CND: • Electricity bid price of each Grid-connected plant in the year *y* (from June 15 of 2017 to June 14 of 2018). • Amount of generated electricity that was dispatched by every plant in the system during each hour of the year y (from June 15 of 2017 to June 14 of 2018).
Source of data	Data supplied by XM
Value(s) of monitored parameter	It varies hourly
Monitoring equipment	Mathematical calculation
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.
Purpose of data/parameter	Calculation of CO_2 emission factor for grid power units in the top of the dispatch order
Additional comments	Not applicable

Data/Parameter	$EF_{grid,BM,y}$
Unit	tCO_2/MWh
Description	Build margin CO_2 emission factor in year *y*
Measured/calculated/default	Calculated
Source of data	Option 2, ex-post calculation
Value(s) of monitored parameter	0.0869
Monitoring equipment	Not applicable
Measuring/reading/recording frequency	Yearly
Calculation method (if applicable)	Tool to calculate the emission factor for an electricity system
QA/QC procedures	Not applicable
Purpose of data/parameter	Calculation of the combined margin emissions factor in year y
Additional comments	Not applicable

Data/Parameter	$EG_{m,y}$
Unit	MWh
Description	Net quantity of electricity generated and delivered to the grid by power unit *m* in year *y*
Measured/calculated/default	Not applicable
Source of data	Data supplied by XM
Value(s) of monitored parameter	It varies by power unit
Monitoring equipment	Not applicable
Measuring/reading/recording frequency	Yearly
Calculation method (if applicable)	Not applicable
QA/QC procedures	Data given by the administrator of the Grid
Purpose of data/parameter	Calculation of the build margin emission factor in year y
Additional comments	Not applicable

Data/Parameter	$EF_{EL,m,y}$
Unit	tCO_2/MWh
Description	CO_2 emission factor of power unit m in year y
Measured/calculated/default	Calculated
Source of data	XM provided the electricity supplied by each plant. The emission factor of each plant was supplied by UPME (Resolution 774 of 2018)
Value(s) of monitored parameter	The electricity supplied by each plant varies by year. The emission factor of each power plant was calculated using the respective fuel emission factor in kg CO_2/TJ: Fuel oil = 80,570.38 Diesel = 74,868.87 Coal = 97,257.39 Gas =55,100.53 Biogas = 84,627.13 Bagasse = 62,615.22
Monitoring equipment	Not applicable
Measuring/reading/recording frequency	Yearly
Calculation method (if applicable)	Not applicable
QA/QC procedures	Data given by official entities
Purpose of data/parameter	Calculation of the build margin emission factor in year y
Additional comments	Not applicable

Data/Parameter	$EF_{grid,CM,y}$
Unit	tCO_2/MWh
Description	Combined margin emission factor in year *y*
Measured/calculated/default	Calculated
Source of data	Weighted average method, option A
Value(s) of monitored parameter	0.2863

Monitoring equipment	Not applicable
Measuring/reading/recording frequency	Yearly
Calculation method (if applicable)	Tool to calculate the emission factor for an electricity system
QA/QC procedures	Not applicable
Purpose of data/parameter	Calculation of the baseline emissions year y
Additional comments	Not applicable

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

The Baseline emissions were calculated according to the Consolidated Baseline Methodology ACM0002 "Grid-connected electricity generation from renewable sources" - version 19.0 as follows:

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

Where:

BE_y = Baseline emissions in year "y" (tCO_2e)

$EG_{facility,y}$ = 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).

$EF_{grid,CM,y}$ = Combined margin CO_2 emission factor for grid connected power generation in year y calculated using the latest version of the Tool to calculate the emission factor for an electricity system (tCO_2e/MWh) in year "y"

Year	Month	Net electricity supply to the Grid (MWh)
2017	June	286,482
	July	567,119
	August	548,079
	September	479,210
	October	419,218
	November	350,466
	December	491,429
2018	January	266,489
	February	265,237
	March	314,412
	April	494,406
	May	434,220
	June	105,539
TOTAL (MWh)		**5,022,307**

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

Methodology:

- Determine the net electricity output of the project for the period under verification (Portal BI of

XM[6]). The output is available in kWh.

- Calculate of the Operating Margin (OM) emission factor, using the dispatch data analysis, *ex-ante* calculation. For the period is 0.4857 tCO_2/MWh[7].
- Calculate the Build Margin (BM) emission factor, using the Option 2, *ex-post* calculation. For the period is 0.0869 tCO_2/MWh[8].
- Calculate the Combined Margin (CM) emission factor, using the weighted average method (option A). For the period is 0.2863 tCO_2/MWh[9].
- Multiply the actual electricity output produced by the Project by the CM Emission Factor for the Colombian Interconnected Grid.
- Total CER's generated by the project for the period are calculated as:

$$\mathbf{ER_y = BE_y – PE_y - L_y}$$

Where:

ER_y = Emission reductions in year y (tCO_2e/yr)

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

PE_y = Project emissions in year y (tCO_2e/yr)

PE_y is the project emissions in year y and

L_y refers to leakage in year y as defined in the methodology ACM0002

According to the PDD, **PE_y** = 0 and **L_y** = 0

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).

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

	Baseline GHG emissions or baseline net GHG removals (tCO_2e)	Project GHG emissions or actual net GHG removals (tCO_2e)	Leakage GHG emissions (tCO_2e)	GHG emission reductions or net anthropogenic GHG removals (tCO_2e)		
				Before 01/01/2013	From 01/01/2013	Total amount
Total	1,386,355	1,437,895	0	0	1,437,895	1,437,895

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

Amount achieved during this monitoring period (tCO_2e)	Amount estimated ex ante (tCO_2e)
1,437,895	1,386,355

[6] Which can be accessed at http://informacioninteligente10.xm.com.co/oferta/Paginas/default.aspx

[7] Details of the calculation available at the Excel spreadsheet "Resultado" of the Workbook "Plantilla_Resumida_2017_2018_FactorResolucion" annexed to the Monitoring Report. Annex to the report also the macro file "Despacho Horario_2017_2018" in this file is the detailed calculation.

[8] Details of the calculation available at the Excel spreadsheet *10236 Sogamoso 2017-2018 - BM calculation* annexed to the Monitoring Report

[9] Details of the calculation available at the Excel spreadsheet *10236 Sogamoso 2017-2018 - CER adjusted* annexed to the Monitoring Report

E.6. Remarks on increase in achieved emission reductions

There was a 3.7% increase of emission reductions from the ones estimated in the PDD (1,437,895 CER's instead of 1,386,355 CER's). This derivate from a 0.7% decrease of electricity generated (5,022 GWh instead of 5,056 GWh) and an increase of 4.4% of the emission factor of the Grid (0.2863 tCO_2/MWh instead of 0.2742 tCO_2/MWh).

Document information

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

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