Monitoring report form for CDM project activity
(Version 07.0)

Complete this form in accordance with the instructions attached at the end of this form.

MONITORING REPORT		
Title of the project activity	Suba and Usaquen hydroelectric CDM umbrella project.	
UNFCCC reference number of the project activity	9798	
Version number of the PDD applicable to this monitoring report	04	
Version number of this monitoring report	03	
Completion date of this monitoring report	12/05/2020	
Monitoring period number	02	
Duration of this monitoring period	01/01/2016 to 31/12/2018	
Monitoring report number for this monitoring period	N/A	
Project participants	Empresa de Acueducto y Alcantarillado de Bogotá ESP (EAAB – ESP).	
Host Party	Colombia	
Applied methodologies and standardized baselines	Applied methodologies: AMS-I.D. Ver. 17 - Grid connected renewable electricity generation. Standardized baselines: no applicable.	
Sectoral scopes	1: Energy industries (renewable - / nonrenewable 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 tCO2e	21,468 tCO2e
Amount of GHG emission reductions or net anthropogenic GHG removals estimated ex ante for this monitoring period in the PDD	31,272 tCO2e	

SECTION A. Description of project activity

A.1. General description of project activity

The city of Bogotá has three principal sources of drinking water: Chingaza system, northern system and southern system. The treated water flow at the Chingaza system is conducted through the Usaquen´s alternate tunnel, which leads the treated water from the Wiesner treatment plant, located in La Calera, to Santa Ana Complex, located in north east of Bogotá, which connects to Los Rosales tunnel from where other drinking water tanks in the city of Bogotá are supplied.

In order to take advantage in height difference between the Wiesner treatment plant and Santa Ana water tank, as well as the water flow delivered to the city through the Santa Ana and Suba control structures, two hydroelectric plants (Suba and Usaquen power plants) were built between years 2011 and 2013. At each power plant, the water is derived from the main conduction pipeline (potable watersupply system) in a point adjacent to the flow control system, using an accessory that drives the water through a closed steel pipeline, to a pressurized conduction penstock and up to the distributor where the flow is directed to horizontal Francis turbines. Each turbine is hosted in a powerhouse, with their respective generator, valves and control panels. A power substation is located besides each powerhouse.

The power plant Usaquen was designed to turbine a water flow of 2.85 m3/s with an effective power rating of 1.546 MW and net head of 71.5 m; The power plant Suba was designed to turbine a water flow of 5.64 m3/s with an effective power rating of 2.230 MW and net head of 52.2 m. Both power plants could generate 27.35 GWh/year approximately. However, the implementation of different measures to increase efficiency in its use, as well as measures to ensure the required water supply for the city have reduced energy generation expectations.

The power generated by the power plants is delivered to the national interconnected system of Colombia in accordance to power market regulations and environmental and operational authorizations. A key objective of the project is to reduce greenhouse gas emissions in the grid.

The power plants began their commercial operation on April 2013 operating continuously until today. Its CDM crediting period of 7 years started on June 04, 2014 (effective registration). During second monitoring period, the power plants generated and delivered 56.33 GWh to the national interconnected system of Colombia, reducing 21,468 tCO2e.

A.2. Location of project activity

Usaquen hydroelectric plant is located at north-east of Bogotá city, Colombia, at Cartesian coordinate system:
Lat: 4.6920°
Long: -74.0381°

Suba hydroelectric plant is located at north-west of Bogotá city, Colombia, at Cartesian coordinate system:
Lat: 4.7120°
Long: -74.0836°

A.3. Parties and project participants

Party involved ((host) indicates a host Party)	Private and/or public entity(ies) project participants (as applicable)	Indicate whether the Party involved wishes to be considered as project participant (yes/no)
Colombia (host Party)	Public entity: Empresa de Acueducto y Alcantarillado de Bogotá ESP (EAAB – ESP).	No

A.4. References to applied methodologies and standardized baselines

The following approved baseline and monitoring methodology has been applied to the project activity:

AMS-I.D "Grid connected renewable electricity generation." Version 17.

The applied methodology refers the following tools:

- Tool to calculate the emission factor for an electricity system. Version 04.
- Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion. Version 02.

A.5. Crediting period type and duration

04/06/2014 – 03/06/2021 (7 years renewable).

SECTION B. Implementation of project activity

B.1. Description of implemented project activity

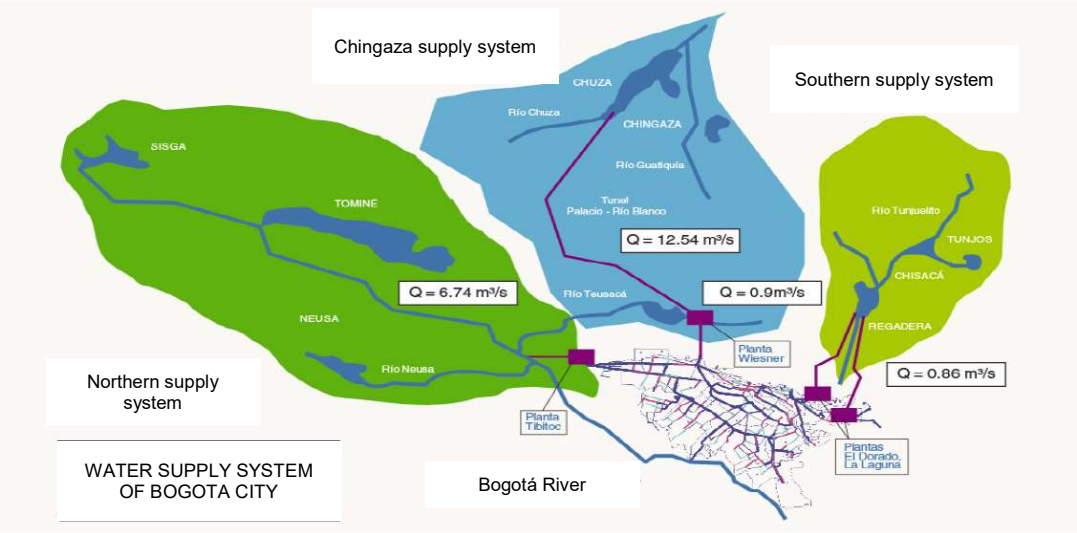
Context

The water supply system of Bogotá City also supplies surrounding municipalities as follows: to the municipalities of Gachancipá and Soacha through the direct provision scheme and through the Supply Contracts modality to the municipalities of Tocancipá, Sopó, Cajicá, Chía, La Calera, Funza, Mosquera and Madrid and to the service providers Acuopolis, Cojardín, Aguas de La Sabana and EMAR ESP.

The population served is close to 9 million people, representing nearly of 2,090,000 users and require an average daily flow of 16 m³/s of water approximately (total average for the year 2018).

The three main systems that supply water to Bogotá and surrounding municipalities are:

- The Chingaza supply system which is associated with Francisco Wiesner treatment plant.
- The northern supply system which is associated with the Tibitoc treatment plant.
- The southern supply system which is associated with El Dorado, Vitelma and Laguna treatment plants (the last two used only as a contingency system).



Source: EAAB.

The Chingaza supply system is located at northeast of the city at the top of the east mountain range. It encompasses the Chuza reservoir, some catchment wells (e.g Blanco river system) and San Rafael reservoir, which receives water from the Chuza reservoir through an overflow structure located before the Francisco Wiesner treatment plant, so as a minimum input from Teusacá River's upper basin.

The Chuza reservoir, which mainly regulates the flow of Guatiquía and Chuza rivers, is conducted to the Wiesner treatment plant through a tunnels system leading the pressurized water to a control valve, which passes the water from a regulated flow to a free flowing condition. The San Rafael reservoir is used during contingency periods, when there is suspension of supply from the Chuza reservoir, especially during inspection and maintenance operations between Chuza reservoir and the Francisco Wiesner treatment plant, whose output supplies approximately 73% of total city water demand.

The northern supply system encompasses Bogota river and a group of reservoirs that allow the regulation flow ofthis river and the Aposentos reservoir (that regulates the Teusacá river`s flow downstream). The water collected by pumping is treated at the Tibitoc plant, whose output supplies approximately 25% of total city water demand.

A group of reservoirs that regulate the Tunjuelo river flow upper basin forms the southern supply system. In this case, the water intake structure is located directly in one of the reservoirs called La Regadera. The treatment plants associated are El Dorado, Vitelma and La Laguna (the last two out of operation only to operate in contingency conditions). The output of this system supplies the remaining 2% of total city water demand[1].

The information regarding storage capacity and treatment of the water supply systems is detailed as follows:

Supply System	Reservoirs (millions of m^3)		Treatment Plants (m^3/s)	
Northern	Tominé	690	Tibitoc	10.5
	Neusa	102		
	Sisga	102		
	Aposentos	0.8		
Chingaza	Chuza	257	Francisco Wiesner	14
	San Rafael	75		
	Chisacá	6.7	El Dorado	1.6

1 The Yomasa treatment plant is also considered part of the southern supply system that captures water from a creek that bears its name and has a treatment capacity of 0.025 m3/s.

Southern	La Regadera	3.3	La Laguna	0.45
	Los Tunjos	2.4	Vitelma	1.5

Source: EAAB.

Location

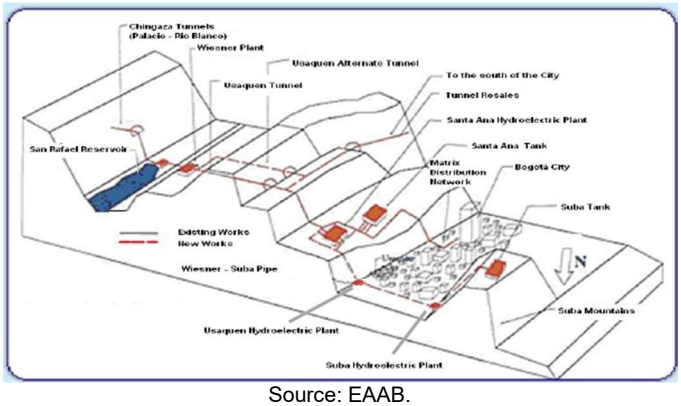
The treated water flow in the Chingaza system is conducted through a tunnel known as Usaquen´s alternate tunnel. It is a conventional concrete covered tunnel, with 2.5 km length, which leads the treated water from the Wiesner plant, located in La Calera, to the Santa Ana and Suba tanks[2], located in the north of Bogotá, and to others storage tanks located in center, south east and south west of the city, through Rosales´s tunnel.

In order to take advantage of the difference in height between Santa Ana tank and the control structures that reduce pressure at Suba and Usaquen (that structures use dissipation valves to reduce water pressure in the system and regulate the flow to the storage and distribution tanks), the power plants Suba and Usaquen were built between 2010 and 2012.

Usaquen hydroelectric plant began operations on April 15, 2013 but its crediting period started on June 4, 2014. It is located in northeast of Bogotá, at 110th Street, in a neighborhood known as Molinos Norte. Suba hydroelectric plant began operations on April 6, 2013 but its crediting period started on June 4, 2014. It is located in northwest of Bogotá, at 127th Street, in a neighborhood known as Almirante Colón.

The feeding flow for the Suba and Santa Ana control structures[3], in normal operation is approximately 70% of treated flow at the Wiesner plant, which corresponds to 55% of the city demand, and provides the aqueduct service to the north, north east and north west of Bogotá. Under optimal operating conditions, energy is generated at the Santa Ana hydroelectric plant and the Suba and Usaquen hydroelectric plants on two occasions with the same flow, which maximizes the use of the installed infrastructure.

The plants produce electric energy delivered into the national interconnected grid through local distribution system use the water flow that is normally transported by the potable water supply system of Bogotá. The following figure shows the location of the power plants.



Source: EAAB.

Implemented project activity

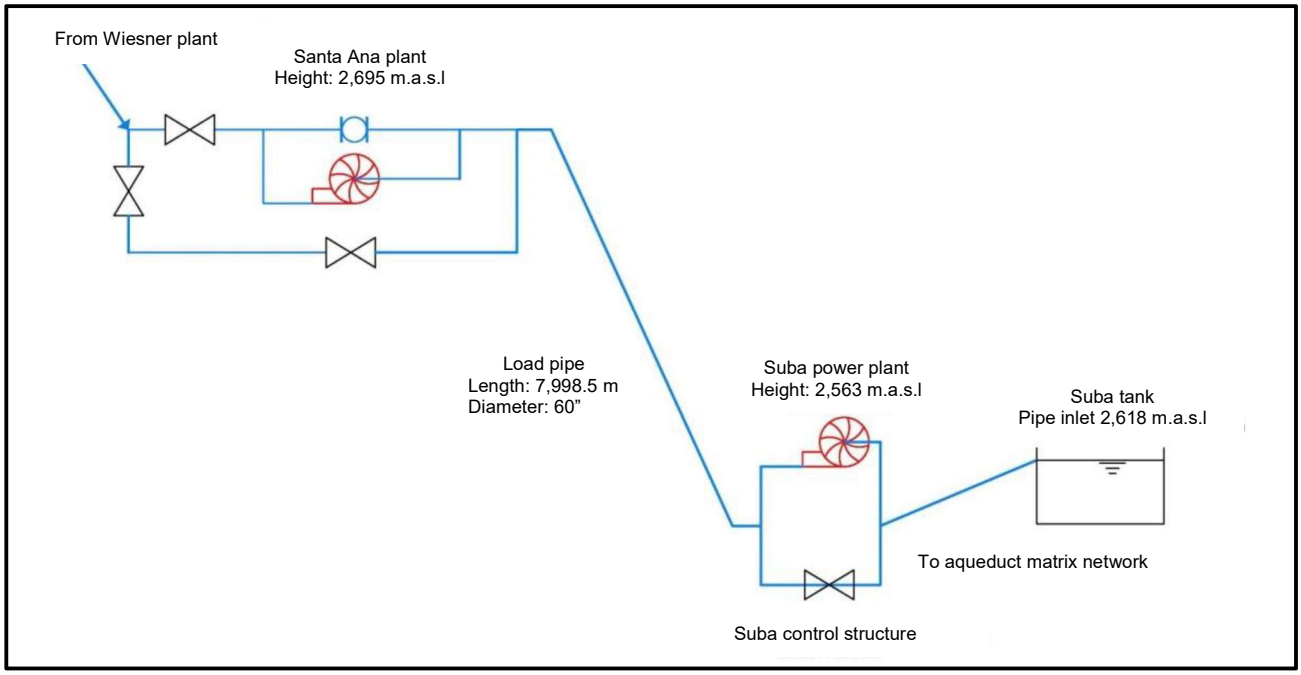
The implementation of the power plants was in a key component of the potable water supply system of Bogota (Suba and Usaquen control structures) considering all necessary precautions to ensure that the water supply service will not be affected (considering that the water supply is a priority over power generation). At each power plant installed the water is derived from the main conduction pipeline (potable water supply system) in a point adjacent to the flow control valve. The derivation is made by an accessory (derivation pipeline) installed to drive the water through a closed steel pipeline

2 The storage capacity of Santa Ana tank is 30,000 m3 and Suba tank is 90,000 m3

3 The hydroelectric plants to produce power normally use the flow required by Santa Ana and Suba tanks. However, when the turbo group in the plants is unavailable (in the event of failure, low flow or maintenance) a multijet valve installed in a parallel pipe will conduct the flow automatically. In the event that the turbo group and multijet valve are unavailable, the flow would be through a derivation of high pressure.

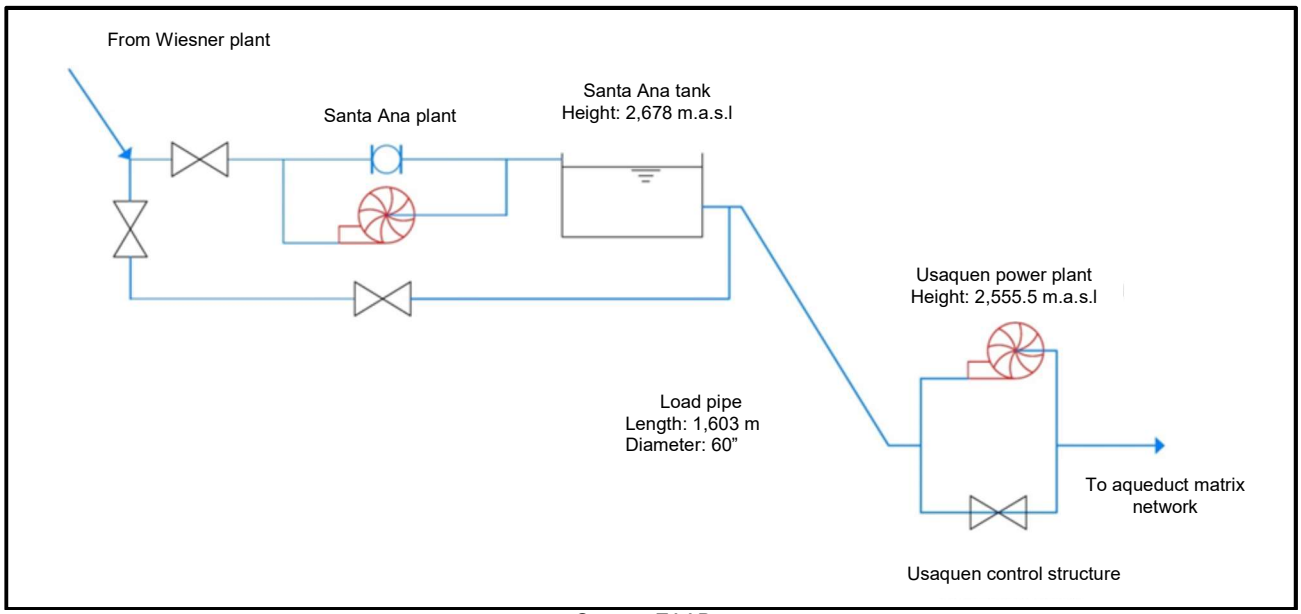
to a pressurized conduction penstock and up to the distributor where the flow is directed to the turbines intake valves.

In the case of the Suba plant, the water deviation is from the control structure upstream the Suba tank and parallel to the valves house which contains two polijet valves (the power plant was installed in parallel to the current dissipation pressure system). The plant has a pressure pipe for the conveyance of water (flow diversion), a hydraulic turbine and a return pipe to deliver the water to the original flow (acting as a by-pass). The project scheme for Suba power plant is as follows:



Source: EAAB.

In the case of the Usaquen plant, the water deviation is from the control structure Usaquen, downstream the control station Santa Ana (the power plant was installed in parallel to the current dissipation pressure system called valves house). As in the Suba control structure, the power plant Usaquen has a pressure pipe for the conveyance of water (flow diversion), a hydraulic turbine and a return pipe to deliver the water to the original flow (acting as a by-pass). The project scheme for Usaquen power plant is as follows:



Source: EAAB.

For power generation, at the end of each penstock is located the powerhouse. For Suba power plant, was required the construction of a surface powerhouse and the installation of a hydro-pneumatic control system (to handle overpressure during turbine startups). The powerhouse contains one horizontal axis Francis type turbine (hydraulic reaction turbine in which the flow exits the turbine blades in an axial direction) connected to their respective synchronous generator. The discharge is made into the original conduction pipeline. The technical specifications for the installed equipment are as follows:

Main equipment installed - Specifications		
Rated power		
Rated power turbine Gugler	2.645	kW
Rated power generator Indar	2.850	kW
Rated power isolation transformer	3.000	kVA
Efficiencies		
Turbine efficiency at nominal power	91.40	%
Generator efficiency at nominal power	95.84	%
Isolation transformer efficiency at nominal power	98.71	%
Connectivity efficiency	97.50	%
Effective power rating		
Effective power rating	2,229.90	kW

Source: EAAB.

In Usaquen power plant, as the turbine-generator is located in the site where the pumping system of Usaquen was previously located, it was not necessary to build a powerhouse but if necessary the installation of a hydropneumatics control system to ensure a smooth operation. The existing building contains one horizontal axis Francis type turbine (hydraulic reaction turbine in which the flow exits the turbine blades in an axial direction) connected to their respective synchronous generator. As in the other case, the discharge is made into the original conduction pipeline. The technical specifications for the installed equipment are as follows:

Main equipment installed - Specifications		
Rated power		
Rated power turbine Gugler	1.810	kW
Rated power generator Indar	2.000	kW
Rated power isolation transformer	2.000	kVA
Efficiencies		
Turbine efficiency at nominal power	90.50	%
Generator efficiency at nominal power	95.68	%
Isolation transformer efficiency at nominal power	98.67	%
Connectivity efficiency	99.98	%
Effective power rating		
Effective power rating	**1,546.13**	kW

Source: EAAB.

For the power delivery from the plants, each one has an electrical substation located near each plant. The substations are courtyard type with a transformer and the switching equipment necessary for the connection to the electrical network. The network connection is made through a synchronization system that can be manual or automatic.

Expected operation

The Suba and Usaquén hydroelectric Plants were designed to generate around 27.35 GWh per year. However, the flow rates for power generation at the plants depend on the magnitude and spatial distribution of the demand for drinking water from the city of Bogotá and the other municipalities served by the water supply system, as well as the operation scheme to be implemented taking into account the following factors: availability in terms of quantity and quality of water from the water sources, the optimal dispatch of the treatment plants, the maintenance program of the Chingaza

tunnels or the needs of preventive or corrective maintenance to elements of the aqueduct matrix network.

In the case of the Usaquen hydroelectric plant, the flow that is turbinated corresponds to a flow that is entirely produced in the Wiesner plant. In addition, the hydroelectric power plant is located downstream of the Santa Ana tank, so there is sufficient compensation for the continuous distribution of daily water demand.

When events occur where there are large decreases in the output flow of the Wiesner plant, what is usually done is to compensate generating reductions in the contribution of the Suba tank, in turn to increase the flow rates of the Tibitoc plant. This is possible because the Suba tank has a service area where water mixing phenomena from Wiesner and Tibitoc occur. Situation that does not occur in the service area of the Santa Ana tank, so that the flow rates of the tank are normally available, guaranteeing the continuous supply of demand, and therefore, the continuous generation in the Usaquén power plant.

In the case of the Suba hydroelectric plant, the flow that is turbinated corresponds to a flow that is entirely produced in the Wiesner plant and additionally it is used to supply a service area where the mixture between water of the Wiesner plant and Tibitoc plant is presented. For this reason, normally in the events that generate large decreases in the output flow of the Wiesner plant, a decrease in the entrance flow to the Suba tank is generated, in order to expand the service area of the Tibitoc plant. This condition has an impact on the operation of the Suba power plant.

Clearly, during the months established for maintenance of the Chingaza tunnels, it is necessary to reduce the treated flow provided by the Wiesner plant to Santa Ana and Suba tanks, limited by the ability of the San Rafael reservoir and operating conditions of the aqueduct system. This condition reduce the generation expectations of the power plants.

Due to maintenance needs and the dynamics of operation of the water supply system as well as the behaviour of the demand for drinking water[4], the generation of energy in the Suba and Usaquen power plants is reviewed annually and determined according to with the operation of the water distribution system[5].

Current operation

For the period from 01/01/2016 to 31/12/2018, the average monthly demand for potable water was 16 m^3/s approximately and produced by water supply systems as follows:

1. The Chingaza system: 9.88 m^3/s.
2. The northern system: 5.71 m^3/s.
3. The southern system: 0.31 m^3/s in Dorado plant and 0.03 m^3/s in other plants.

The following table contains the average monthly entrance flow of the Santa Ana System[6] (flow measured over the finish line to the turbine and that feeds the Santa Ana and Suba control structures and the northeast line where are located the power plants). This information is reported by Network Matrix Aqueduct Direction and prepared by Control Center Division.

Year	Month	Suba Power Plant		Usaquen Power Plant	
		Projected generation flow	Real generation flow	Projected generation flow	Real generation flow
		(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)
2016	Jan	2.8	2.8	1.3	1.1

4 Due mainly to the reduction in the trend of water consumption in the city since the late nineties, which was of 17.6 m3/ s in 1996 to about 16 m3/s in 2018.

5 Power Generation - Technical Reports (Prepared yearly). Corporate Management System Master, Network Matrix Aqueduct Direction.

6 The Santa Ana system is a drinking water pipeline that feeds three derivations: entrance to the Santa Ana tank, entrance to Suba tank and the northeast line. The first two correspond to the average flow available for generation whiles the third not. This is because the northeast line diverts around the 1.5% flow of Santa Ana system and this flow doesn´t go through the turbine because is necessary the Wiesner plant pressure to supply drinking water at the north east area of the city. The flow meter of the Santa Ana system is located between the end of the Usaquén´s alternate tunnel and Santa Ana Hydroelectric Plant.

Year	Month	Suba Power Plant		Usaquen Power Plant	
		Projected generation flow (m^3/s)	Real generation flow (m^3/s)	Projected generation flow (m^3/s)	Real generation flow (m^3/s)
	Feb	2.2	2.2	1.3	0.7
	Mar	2.2	1.3	1.3	1.0
	Apr	3.8	2.2	1.3	1.3
	May	3.8	4.2	1.3	1.4
	Jun	3.8	4.1	1.3	1.4
	Jul	2.5	4.3	1.3	0.0
	Aug	0.0	4.0	1.3	1.1
	Sep	2.2	4.2	0.0	1.4
	Oct	3.8	4.1	1.3	1.3
	Nov	3.8	4.4	1.3	1.4
	Dec	3.8	4.1	1.3	1.2
2017	Jan	3.8	4.4	1.3	1.2
	Feb	3.8	4.3	1.3	1.2
	Mar	3.8	4.2	1.3	1.3
	Apr	3.8	4.3	1.3	1.2
	May	3.8	4.1	1.3	1.3
	Jun	3.8	4.1	1.3	1.2
	Jul	2.5	2.2	1.3	1.2
	Aug	2.5	2.1	1.3	1.2
	Sep	2.5	2.2	1.3	1.1
	Oct	3.8	3.9	1.3	1.2
	Nov	3.8	3.8	1.3	1.1
	Dec	3.8	4.0	1.3	1.3
2018	Jan	2.3	1.9	1.2	1.1
	Feb	2.5	2.3	1.3	1.1
	Mar	2.3	1.6	1.2	1.0
	Apr	3.9	4.7	1.3	1.4
	May	3.9	4.7	1.3	1.4
	Jun	3.9	4.6	1.3	1.2
	Jul	2.5	3.4	1.3	0.8
	Aug	2.5	0.8	1.3	1.4
	Sep	2.5	0.0	1.3	1.3
	Oct	3.9	0.0	1.3	1.2
	Nov	3.9	0.0	1.3	1.4
	Dec	3.9	3.6	1.3	1.4

Source: EAAB, Power Generation - Technical Reports (2016, 2017, 2018)

As shown, Suba and Usaquen power plants had throughout the year flow available for generation, but this flow not necessarily was conducted through the turbines due to different problems in the technical systems or changes in the operational sceneries of the water supply system that prevented the generation, despite the availability of water. More information regarding events that affected the project operation during the period can be seen on the technical operation reports.

B.2. Post-registration changes

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

There are no temporary deviations from registered monitoring plan or applied methodology during this monitoring period.

B.2.2. Corrections

There are no corrections to the registered project during this monitoring period.

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

There are no changes to the start date of the crediting period.

B.2.4. Inclusion of monitoring plan

There are no needs to include a monitoring plan.

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

There are no permanent changes from registered monitoring plan or permanent deviation of monitoring from the applied methodology applied during this monitoring period.

B.2.6. Changes to project design

There are no changes to the project design of the project activity approved or submitted during this monitoring period.

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

The project does not consider afforestation or reforestation activities.

SECTION C. Description of monitoring system

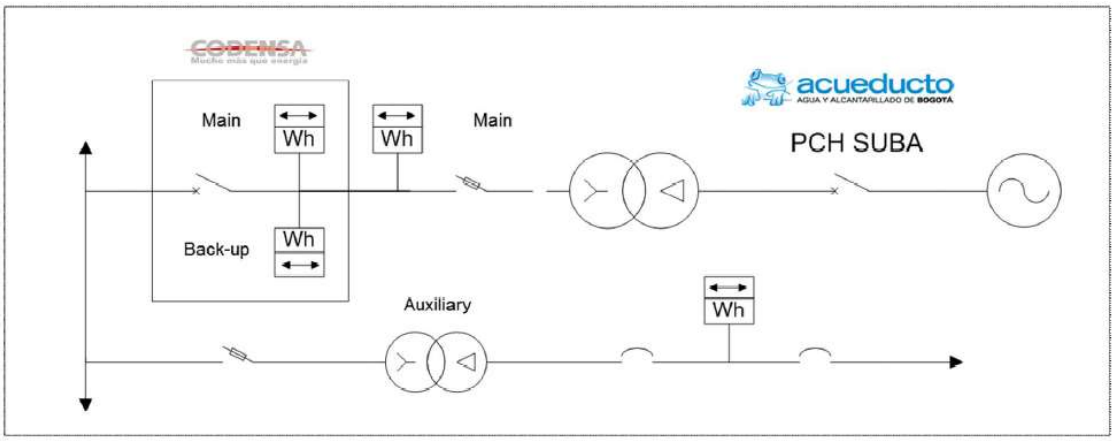
Technical operation of monitoring

The hydroelectric plants of Suba and Usaquén deliver the energy generated to the national interconnected grid through local distribution system in accordance with the grid connection contracts signed with CODENSA[7], which comply with the provisions of the applicable regulations (Resolution 003 of 1994, Resolution 025 of 1995, Resolution 070 of 1998, Resolution 106 of 2006 and Resolution 038 of 2014 issued by the Energy and Gas Regulatory Commission (CREG)[8] and include the administration, operation and maintenance of grid assets .

In the Suba hydroelectric plant, the connection to the local distribution system is made in the substation of the plant to the distribution circuit of the Morato substation (11.4 kV), owned by CODENSA. The technical specifications for the power plant connection are showed in the following figure (single line diagram):
:

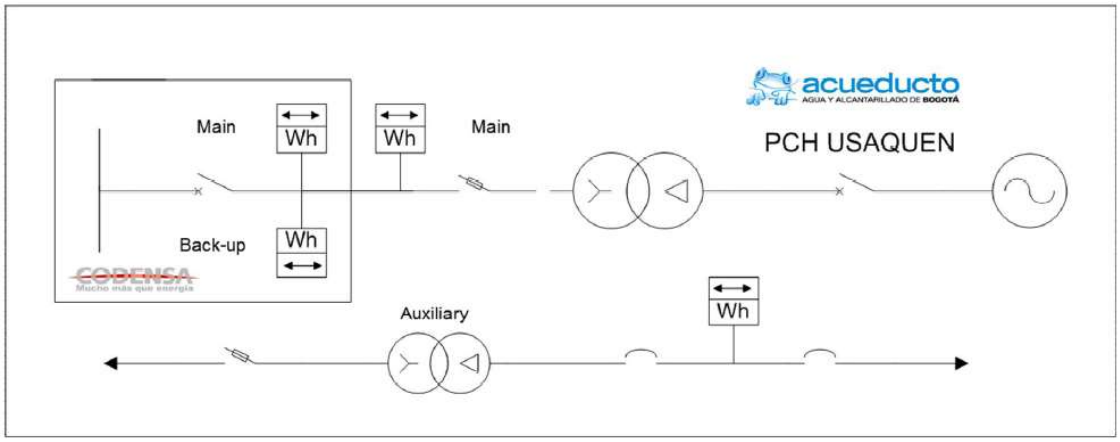
7 According to the contracts signed between EAAB – ESP and the operator of the local grid CODENSA: 1) Object: “Regulate the technical, legal, economic, administrative and commercial relations between the parties, which derive from the access made by the Usaquén hydroelectric plant owned by the EAAB to the distribution, transmission and interconnection network owned by CODENSA and which are part of the SDL and / or STR, as well as defining the scope of the obligations and responsibilities in the stages of construction, testing, commissioning, commercial exploitation, operation, maintenance and replacement by the owner of the connection goods and the connection site, according to the network code”. Start date: 06/02/2013. Duration: 25 years. 2) Object: “Regulate the technical, legal, economic, administrative and commercial relations between the parties, which are derived from the access made by the Suba hydroelectric plant (located in the area called Suba Nuevo tank, diagonal 127 A No. 64 20) owned by the EAAB to the distribution, transmission and interconnection network owned by CODENSA and that are part of the SDL and / or STR, as well as defining the scope of the obligations and responsibilities in the construction, testing, commissioning, commercial exploitation, operation stages, maintenance and replacement by the owner of the connection goods and the connection site, in accordance with the network code”. Start date: 06/02/2013. Duration: 25 years.

8 The Power and Gas Regulatory Commission (CREG) is the national authority that regulates the sector of power and gas.



Source: EAAB.

In Usaquen hydroelectric plant, the connection to the local distribution system is at the Usaquen substation (11.4 kV) owned by CODENSA (local power utility). The technical specifications for the power plant connection are showed in the following figure:



Source: EAAB.

For both power plants, the monitoring technology complies with national regulations (Resolution CREG 038 of 2014 - Measurement Code). The energy meters are installed in the substation of each power plant. Data storage is done internally in the memory of the meters. Every day the energy delivered to the grid by the plants is interrogated or obtained by telemetering of the meter. Only authorized personnel / software can handle the generation information.

The daily measurement of the power generated is realized in the electrical substations owned by CODENSA, through the energy meters located in the commercial frontier (main and backup). These meters meet all technical requirements set by the Energy and Gas Regulatory Commission (CREG) and provisions of the System Manager Exchange Commercial (ASIC).

EMGESA act as a representative of the Suba and Usaquen hydroelectric plants in the Wholesale Power Market of Colombia, as part of the marketing contract signed with EAAB[9]. The power plants began commercial operations on 2013 after official registration of the commercial frontier in the ASIC.

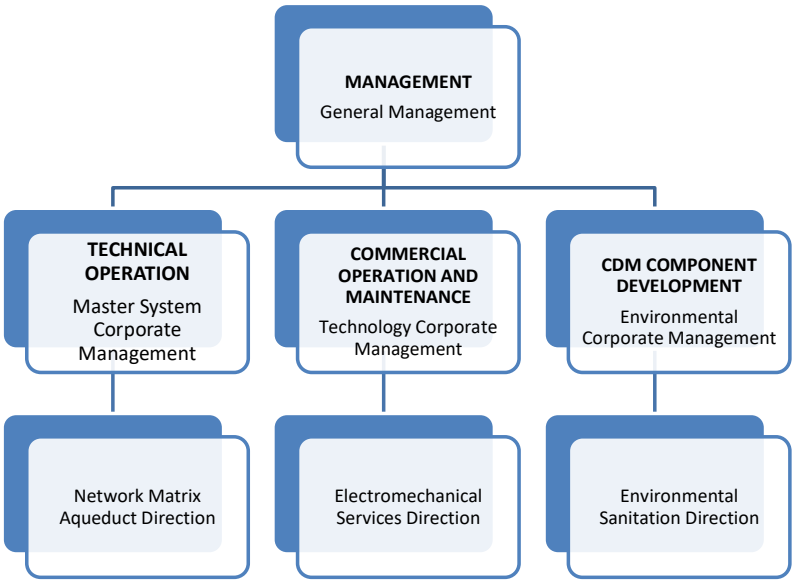
The daily registration of power generation is made by EMGESA, through the measure management center, with information obtained by automatic and electronic interrogation of the commercial frontier meters. Data is recorded by measure management center in the ASIC and it is communicated to both EAAB and CODENSA. This information is analysed independently by EMGESA, CODENSA

9 According to the contract signed between EAAB – ESP and EMGESA (Electric Power Generating Company). Contract No. 1-10-26300-0842-2011. Object: "Acquisition by EMGESA S.A. E.S.P. of all the energy generated by Santa Ana, Suba, Usaquen and Ventana Hydroelectric Plants owned by EAAB". Start date: 01/05/2012. Duration: 10 years.

and EAAB in accordance with the procedures of verification and validation defined by each entity and by Resolution CREG 006 of 2003. The data registered in the ASIC is officially published on the website of XM[10] and corresponds to the energy measured and delivered to the national grid through the local distribution system (http://www.xm.com.co). Additionally, the ASIC and other market agents checked this information, which is available for consultation in the database administered by XM[11].

Operational and administrative structure

The EAAB´s organizational structure[12] responsible of the administration, operation, maintenance and monitoring Suba and Usaquen hydroelectric CDM umbrella project is as follows:



Source: EAAB.

As an operating point of the distribution system of the city's drinking water, the Network Matrix Aqueduct Direction is responsible of the Suba and Usaquen power plants and therefore for the energy generation.

Network Matrix Aqueduct Direction heads the technical operation considering the planning, operation and maintenance of the water supply systems, as part of an Industrial Agreement signed between the Water Supply Direction and Network Matrix Aqueduct Direction.

Electromechanical Services Direction heads the commercial operation related to the sale of the generated energy. This department is responsible for monitoring the power generated and delivered to the national grid and for maintenance of electrical, electronic and mechanical components within of the framework of a Service Agreement.

Environmental Sanitation Direction heads the CDM component including the monitoring report with the support of the Electromechanical Services and Network Matrix Aqueduct Directions. The Environmental Corporate Manager is the focal point.

Procedures for quality assurance

The quality management system of EAAB is certificated under ISO 9001:2015 with the following scope: “Provision of domiciliary public water and sewerage services in the city of Bogotá D.C. and in its area of influence, supported by strategic, mission, facilitating and evaluation processes”.

10 XM (Experts Market) is a company of ISA that is created in 2005, responsible for managing the System Manager Exchange Commercial (ASIC) and the Dispatch National Centre (CND). It provides operation, administration and development services of the Wholesale Power Market of Colombia.

11 Database is operated and managed by XM, there are stored all transactions of the Wholesale Power Market of Colombia.

12 EAAB: Agreement 11 of 2007. By means of which is modified the Organizational Structure of Empresa de Acueducto y Alcantarillado de Bogotá - ESP and identify the functions of its dependencies.

Annex to scope:

1) Collection, adduction, storage and treatment of water for the supply of drinking water. Planning, design management, construction, operation, control and maintenance of the aqueduct matrix system for the conduction and distribution of drinking water in matrix networks. The management of greenhouse gas emission reduction projects in the aqueduct matrix system. The operation and maintenance of local aqueduct networks.

2) Collection, transport and disposal of rainwater and wastewater through the sanitary and storm sewer system in the city of Bogotá and its area of influence. Planning for wastewater treatment in the city of Bogotá D.C. and in his area of influence. The operation of the PTAR El Salitre of the City of Bogotá D.C.

3) Commercial management in the provision of the aqueduct and sewer service for the city of Bogotá. D.C. and its area of influence.

During monitoring period, there were several activities related to the implementation of quality management system:

A. Planning

For planning power generation the following procedure was applied:

Macro process	Process	Procedure	Instructive	Format
MPMA Aqueduct Service	MPMA05 Distribution and control of matrix networks	MPMA0518P Operation planning for water supply	-	-

B. Operation

For operation related to power generation the following procedures were applied:

Macro process	Process	Procedure	Instructive	Format
MPMA Aqueduct Service	MPMA05 Distribution and control of matrix networks	MPMA0501P Operation Coordination	MPMA0501M01 Operation manual of aqueduct matrix network	MPMA0501F15 Generation Suba and Usaquen hydroelectric plants
		MPMA0507P Power generation	MPMA0507I01 Startup and operation of small hydroelectric plants	MPMA0507F03 Generation control
			MPMA0507I02 Measurement and data analyses	
		MPMA0517P Energy generation measurement equipment control	-	-
MPFM Maintenance management	MPFM01 Electromechanical Maintenance	MPFM0101P Electromechanical preventive maintenance	MPFM0101I01 Review and management of notices and work orders in SAP	MPFM0101F02 Weekly tracking
			MPFM0101I02 Work order completion	MPFM0101F01 Maintenance work order
		MPFM0102P	MPFM0102I01	-

Macro process	Process	Procedure	Instructive	Format
		Electromechanical corrective maintenance	Job priority matrix	
MPMI Environmental management	MPMI01 Environmental management	MPMI0116P Greenhouse gas emissions management	-	MPMI0116F12 Auction

C. Documented information

For preparation and updating of documented information the following procedures were applied:

Macro process	Process	Procedures
MPFD Document management	MPFD08 Documentary production	MPFD0801 Documentary production
		MPFD0802 Process documentation

D. Continuous improvement.

In order to ensure compliance with objectives, goals and indicators the following procedures were applied:

Macro process	Process	Procedures
MPCS Follow-up, monitoring and control	MPCS01 Management follow-up	MPCS0101 Management review
		MPCS0102 Corporate control board
		MPCS0103 Corporate management reporting
		MPCS0106 Evaluation of shared services management
		MPCS0107 Monitoring and follow-up of industrial agreements
	MPCS02 Continuous improvement	MPCS0201 Internal audits
		MPCS0202 Continuous improvement
		MPCS0203 Non-conforming treatment

In addition, a certification audit was developed in order to maintain the scope of quality management system under ISO 9001_:2015.

The authority and responsibility roles of monitoring

The authority and responsibility roles for different aspects associated with the monitoring of power generation data are as follows.

Activity		Authority	Responsibility
Measurement	Internal	Electromechanical Services Office Director	Energy negotiator
	External	EMGESA	Measure management center

Activity		Authority	Responsibility
Registration	Internal	Electromechanical Services Office Director	Energy negotiator
	External	EMGESA	Measure management center
Verification	Internal	Electromechanical Services Office Director	Energy negotiator
	External	XM EMGESA CODENSA	Measure management centerCODENSA EMGESA
Report	Internal	Electromechanical Services Office Director	Energy negotiator
	External	EMGESA	Measure management center
Calibration and maintenance	Internal	Electromechanical Services Office Director	Energy negotiator
	External	EMGESA	Measure management center

Source: EAAB

Data collection

EMGESA obtains the generation data of the power plants by telemetering through the measure management center consolidates it in report formats for XM that is the National Dispatch Center. XM receives the data of the energy generated daily and publishes it on its website (http://www.xm.com.co). These data is known by the EAAB - ESP three days after the registration done by MMC, given the times estimated in Resolution 003 of 2006 issued by the Energy and Gas Regulatory Commission.

The verification and validation of the daily measurement is performed by EAAB as follows: receives the generation data that consolidates EMGESA monthly and that it sends by mail. These data are verified with another document generated by EMGESA called monthly settlement and with the data reported in XM website (it is done on the 15th of the month following the generating period).

The report of electric power generated and delivered daily by the power plants to the national interconnected system correspond to the data officially registered and available for consultation on the XM website. It is important to note that energy delivered by the power plants to the grid corresponds to the energy generated minus the energy consumed by auxiliary loads locally, technical loses and electricity imports from the grid (netted by bi-directional power meter at the grid delivery point).

The following table presents the MWh generated and net energy delivered to the national grid of Colombia during the period 01/01/2016 – 31/12/2018.

Year	Suba Energy generation (kWh)	Usaquen Energy generation (kWh)
2016	11,532,526*	6,780,117
2017	12,266,209*	8,442,770
2018	8,382,830	8,920,734
TOTAL	**32,181,564**	**24,143,621**

Source: XM, Portal BI data

*For the emissions reduction calculation the maximum error permissible has been applied (please see section E.1)

SECTION D. Data and parameters

D.1. Data and parameters fixed ex ante

(Copy this table for each data or parameter.)

Data/Parameter	**$EF_{grid,y}$** (referred in the tool to calculate the emission factor for an electricity system - version 04.0 as $EF_{grid,CM,y}$)
Unit	$kgCO_2e/KWh$.
Description	Combined margin CO_2 emission factor in year y.
Source of data	Project Design Document "Suba and Usaquen hydroelectric CDM umbrella project" registered on 04/06/2014; section B.6.2, page 28.
Value(s) applied	0.38115
Choice of data or measurement methods and procedures	Value fixed on the PDD registered.
Purpose of data/parameter	Used for calculation of baseline emissions.
Additional comments	Not applicable.

D.2. Data and parameters monitored

(Copy this table for each data or parameter.)

Data/Parameter	**$EG_{facility,y}$** (**$EG_{BL,y}$**)
Unit	MWh
Description	Net electricity generated and supplied to the grid by the project activity in the year y.
Measured/calculated/default	Measured.
Source of data	Daily records of commercial frontier meters, located in the electrical substation of each power plant.

Value(s) of monitored parameter

Reported values of energy delivered (net electricity) corresponds to the energy generated by the power plan minus auxiliary electricity consumption at the site, technical losses and electricity imports from the grid. The values of energy generation measured and reported to the National Interconnected System are:

Year	Month	Suba - Power generation (kWh)	Usaquen - Power generation (kWh)
2016	Jan	173,061*	619,881
	Feb	658,865*	423,487
	Mar	459,505*	325,968
	Apr	708,019*	742,519
	May	1,378,601*	777,796
	Jun	1,396,641*	228,164
	Jul	1,475,673*	0
	Aug	1,368,455*	606,805
	Sep	605,621*	795,081
	Oct	1,410,382*	757,554
	Nov	1,419,980*	767,373
	Dec	477,723*	735,489
2017	Jan	15,233*	694,419
	Feb	1,359,015	657,021
	Mar	1,039,327	790,435
	Apr	1,377,259	686,093
	May	1,404,905	646,940
	Jun	1,381,581	723,279
	Jul	623,810	771,329
	Aug	623,225	637,375
	Sep	651,522	732,349
	Oct	1,282,689	698,797
	Nov	1,187,275	636,437
	Dec	1,320,367	768,296
2018	Jan	551,083	669,990
	Feb	671,231	643,531
	Mar	559,140	674,152
	Apr	1,475,114	806,229
	May	1,410,063	826,046
	Jun	1,320,674	728,239
	Jul	1,020,472	484,302
	Aug	227,850	844,480
	Sep	0	824,667
	Oct	0	818,484
	Nov	0	780,064
	Dec	1,147,203	820,550
TOTAL		**32,181,564**	**24,143,621**

* Data measured with equipment during non-calibrated period (01/01/2016 to 28/01/2017), thus for the emissions reduction calculation the maximum error permissible has been applied (please see section E.1).

The national dispatch centre (CND) of Colombia is part of XM (Compañía de Expertos en Mercados S.A. E.S.P.) which is responsible for issuing plans assuring a reliable performance of the national grid. The information system Portal BI stores all information regarding the national interconnected system of Colombia (Official data published yearly). The information of power generated by the power plants can be checked in the link:

http://informacioninteligente10.xm.com.co/oferta/Paginas/HistoricoOferta.aspx?RootFolder=%2Foferta%2FHistorico%20Oferta%2FGeneraci%C3%B3n&FolderCTID=0x01200075F2CCF9F779EE4B93D2D54764CDB78A&View={9F21C71E-AD8F-4E3F-B2EA-0B38F49A9BA8}

Monitoring equipment	1) Electric power meters of commercial frontier localized in Suba electrical substation: • Manufacturer: Schneider Electric. • Type: Schneider Electric. • Model: POWER LOGIC ION8650. • Accuracy Class: 0.2S. • Serial number: Main meter serial No.MW-1203A089-01 Back up meter serial No.MW-1203A090-01. • Calibration certificates: CAM-IM1205-019533 calibration on 22/05/2012 (main meter) CAM-IM1205-019470 calibration on 19/05/2012 (back up meter) ME-1701-20379 calibration on 29/01/2017 (main meter)* ME-1701-20378 calibration on 29/01/2017 (back up meter)* • Tests performed at CAM Meters Laboratory and Veritest Ltda following the Colombian Technical Standard NTC 4856. • Tests performed start; accuracy; constant verification; operation without charge. • Test results: EVC. 2) Electric power meters of commercial frontier localized in Usaquen electrical substation: • Manufacturer: Schneider Electric. • Type: Schneider Electric. • Model: POWER LOGIC ION8650. • Accuracy Class: 0.2S. • Serial number: Main meter serial No.MW-1203A086-01 Back up meter serial No.MW-1203A087-01. • Calibration certificates: CAM-IM1205-019469 calibration on 18/05/2012 (main meter) CAM-IM1205-019047 calibration on 17/05/2012 (back up meter) CAM-IM1501-016399 calibration on 26/01/2015 (main meter)* CAM- IM1501-016399 calibration on 26/01/2015 (back up meter)* • Tests performed at CAM Meters Laboratory following the Colombian Technical Standard NTC 4856. • Tests performed start; accuracy; constant verification; operation without charge. • Test results: EVC. Note: All meters were subjected to a quality control regime including maintenance and periodic calibration, as indicated in national regulation (Measurement Code). * According with the provisions of the Measurement Code (Resolution CREG 038 of 2014), the calibration of power meters can be made each 4 years, being this the period recommended to this type of installation. In addition, in the tool to determine the “Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation” – Version 3.0, it has been stablished for monitoring of the electricity generated, that calibration frequency of the power meters can be changed if fits within the range stipulated in the national standards or requirements set by the grid operators (in our case is the consideration of 4 years recommended by regulation instead of the 2 years established in the PDD); this change do not need to be reflected in a post registration change. All data measured during the non-calibrated period has been adjusted applying the maximum error permissible.
Measuring/reading/recording frequency	Measuring frequency: Continuous (Automatic in real time) Reading frequency: Daily (data acquisition software) Recording frequency: Aggregated monthly (with annual chance).

Calculation method (if applicable)	Not applicable.
QA/QC procedures	MPMA0507P Power generation MPMA0517P Energy generation measurement equipment control
Purpose of data/parameter	Used for calculation of baseline emissions.
Additional comments	In accordance with the provisions of the Measurement Code (Resolution CREG 038 of 2014), the commercial frontier energy meters located in the electrical substations of the Suba and Usaquén hydroelectric plants were subject to five-year verification by XM through the Company APPLUS NORCONTROL LTDA and the following results were obtained: 1) Commercial frontier measurement system with report to ASIC identified PCH SUBA: verification made on 16/03/2018. Verification opinion was obtained # 0018 issued on 04/05/2018 in which it is stated that the requested commercial border PCH SUBA with SIC code: FRT20218 ID: 2017122334, whose border representative at the time of verification corresponds to EMGESA S.A.E.P. - GENERATOR, is expressly declared as CONFORM in its measurement system in accordance with the requirements of the Resolution CREG 038 of 2014. 2) Commercial border measurement system with report to the ASIC identified PCH USAQUEN: verification made on 16/03/2018. Verification opinion was obtained # 0023 issued on 04/05/2018 in which it is declared that the commercial border obtained PCH USAQUEN with SIC code: FRT20217 ID: 2017122341, whose border representative at the time of verification corresponds to EMGESA S.A.E.P. - GENERATOR, is expressly declared as CONFORM in its measurement system in accordance with the requirements of the Resolution CREG 038 of 2014.

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

The baseline is the MWh produced by Suba and Usaquen Hydroelectric Plants multiplied by the emission factor of the national interconnected grid of Colombia (measured in tCO_2e/MWh).

According to the applied methodology, the baseline emissions are the product of the energy generated and delivered by the power plan units and the emissions factor of the electricity system, as follows:

$$BE_y = EG_{BL,y} * EF_{CO_2,grid,y}$$

Where:

BE_{yy} Baseline emissions in the year *y* (tCO_2e)
$EF_{CO2,grid,y}$ CO_2 emission factor of the grid in year y (tCO_2e/MWh)
$EG_{BL,Y}$ Quantity of net electricity supplied to the grid as a result of the implementation of the CDM project activity in year *y* (MWh)

The baseline of Suba and Usaquen Hydroelectric Plants uses a fixed emission factor of national interconnected grid defined in the Project Design Project registered by the CDM Executive Board and corresponding to 0.38115 kg CO_2e/kWh.

Baseline GHG emissions	2016	2017	2018
Suba	11,532.5	12,266.2	8,382.8
Usaquén	6,780.1	8,442.7	8,920.7
(a) Total electricity generation (MWh/y)	18,312.6	20,708.9	17,303.5
(b) Emission factor (tCO2/MWh)	0.38115	0.38115	0.38115
(a) X (b) Baseline emissions (tCO2)	6,979.9	7,893.2	6,595.2
Total (tCO2)	21,468		

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

In accordance to the appropriate approved baseline methodology used in this CDM project activity, emissions by sources of GHG due to the project activity are zero.

E.3. Calculation of leakage emissions

Leakage are considered only when transferring existing renewable energy technology from another activity.

Power plants are not transferring existing renewable energy technology from another activity since the energy generation equipment for the projects were new and manufactured for specific site conditions. All of the equipment installed in the facilities can be clearly tracked by the appropriate manufacturing nameplates, specifying brand, reference and year of manufacture among others. The appropriate existing records related to manufacturing contracts and placement orders with technology suppliers support all equipment. Therefore, there is no leakage associated to the Suba and Usaquen Hydroelectric Plants.

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	21,468	0	0	0	21,468	21,468

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)
21,468	31,272

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

According to the design characteristics the energy estimated to be generated by the project power plants during this monitoring period was:

Power generation - Suba and Usaquen hydroelectric CDM umbrella project			
	2016	2017	2018
Effective power rating (MW)			
Suba	2.230	2.230	2.230
Usaquen	1.546	1.546	1.546
Total	3.776	3.776	3.776
Plant load factor (%)			
Suba	87.090%	87.090%	87.090%
Usaquen	76.320%	76.320%	76.320%
Annual power generation (MWh/y)			
Suba	17,012	17,012	17,012
Usaquen	10,337	10,337	10,337
Total	27,349	27,349	27,349

The emission reductions estimate for the project during this monitoring period were:

Emission reductions calculation - Suba and Usaquen hydroelectric CDM umbrella project			
Year	2016	2017	2018
EF (CO_2e/MWh)	0.38115	0.38115	0.38115
Baseline emissions (t CO_2e/y)	10,424	10,424	10,424
Total	31,272		

E.6. Remarks on increase in achieved emission reductions

Not applicable.

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

Not applicable.

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).
01.0	28 May 2010	EB 54, Annex 34. Initial adoption.

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