MONITORING REPORT FORM (F-CDM-MR)
Version 02.0

MONITORING REPORT

Title of the project activity	Rio Taquesi Hydroelectric Power Project
Reference number of the project activity	1031
Version number of the monitoring report	Version 1.0 – October 24, 2012
Completion date of the monitoring report	October 24, 2012
Registration date of the project activity	June 16, 2007
Monitoring period number and duration of this monitoring period	2nd monitoring period of the 2nd crediting period: March 01, 2011 to June 30, 2012
Project participant(s)	Country / Name of the party Netherlands: • Multilateral entity: *Corporación Andina de Fomento (CAF) – as administrator of the CAF-Netherlands CDM Facility* Switzerland: • Private entity: *Tenaska International Energy LLC* Republic of Bolivia: • Private entity: *Hidroeléctrica Boliviana S.A.* • Private entity: *C-Trade – Comercializadora de Carbono Ltda.* • Public entity: *Vice Minister of Land Planning and Environment*
Host Party(ies)	BOLIVIA
Sectoral scope(s) and applied methodology(ies)	Sectoral scope 01: Energy industries (renewable/non renewable sources) Methodology: ACM0002 "Consolidated baseline methodology for grid-connected electricity generation from renewable sources" version 8, together with the Methodological "Tool to calculate the emission factor for an electricity system" version 01.1.
Estimated amount of GHG emission reductions or net anthropogenic GHG removals by sinks for this monitoring period in the registered PDD	249,802 (tCO_2e)
Actual GHG emission reductions or net anthropogenic GHG removals by sinks achieved in this monitoring period	286,329 (tCO_2e)

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

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The Rio Taquesi Hydroelectric Power Project (the "Project") with CDM registration number 1031 is a run-of-river hydroelectric development of around 90 MW, located along the Taquesi and Unduavi Rivers near the small communities of La Chojlla and Yanacachi, in the South Yungas region of Western Bolivia, at approximately 90 kilometers by road from La Paz city. The Project has been developed and is operated by Hidroeléctrica Boliviana S.A. and is aimed at providing energy to the Bolivian grid by utilizing a clean, renewable source of generation as an alternative to the natural gas fired combustion turbine generating sources that are the typical incremental generation additions to the Bolivian system. The Project has the ability to avoid the emission of several million metric tons of CO_2-e over its projected 35-year life, by displacing electricity that would otherwise be supplied to the Bolivian grid by fossil fuel power plants.

The project consists of two power plants, Yanacachi Norte and Chojlla, equipped with one Francis turbine-generator unit each, of approximately 50 MW and 39 MW of capacity, respectively. A 10 km length, 115 kV overhead transmission line transports the power output of the Project's units to Pichu substation, the closest National Interconnected Grid node. The said two plants were completed in the framework of an Engineering, Procurement and Construction contract implemented from 2000 and are in operation since June 2002, being its first Crediting Period accounted from July 1st, 2002. The second crediting period, from July 1st, 2009 to June 30, 2016, was renewed in November 2009.

The emission of 286,329 tCO_2-e to the atmosphere was avoided in the period covered by this Monitoring Report (March 01, 2011 to June 30, 2012) in accordance to the calculations done in the framework of the version of the baseline methodology ACM0002 approved in the CDM-PDD.

A.2. Location of project activity

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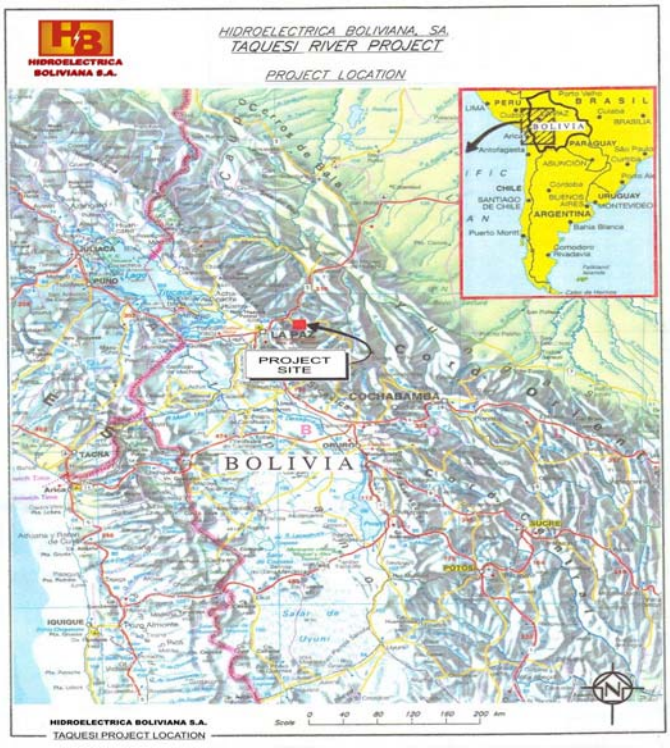
The Project is located in the Yanacachi Municipal Section of Sud Yungas, a Province of the La Paz department, some 90 km by road from La Paz city, Bolivia, South America.

Yanacachi Norte plant is located on the Unduavi River, near the town of Yanacachi, whereas Chojlla plant is located on the Taquesi River, near the town of La Chojlla.

PSAD56 coordinates for the plants are:

Yanacachi Norte:
8188023 N, 19634973 E

Chojlla:
8185577 N,19631439 E



A.3. Parties and project participant(s)

Party involved ((host) indicates a host Party)	Private and/or public entity(ies) project participants (as applicable)	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Republic of Bolivia	• Private entity: *Hidroeléctrica Boliviana S.A.* • Private entity: *C-Trade - Comercializadora de Carbono Ltda.* • Public entity: *Vice Minister of Land Planning and Environment*	Yes Yes Yes
Netherlands	• Multilateral entity: *Corporación Andina de Fomento (CAF) – as administrator of the CAF-Netherlands CDM Facility*	Yes
Switzerland	• Private entity: *Tenaska International Energy LLC*	No

A.4. Reference of applied methodology

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The approved consolidated baseline and monitoring methodology ACM0002 "Consolidated baseline methodology for grid-connected electricity generation from renewable sources" version 8 is applied to the project activity, together with the Methodological "Tool to calculate the emission factor for an electricity system" version 01.1.

A.5. Crediting period of project activity

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Start date of current crediting period: July 01, 2009
End date of current crediting period: Jun 30, 2016

SECTION B. Implementation of project activity

B.1. Description of implemented registered project activity

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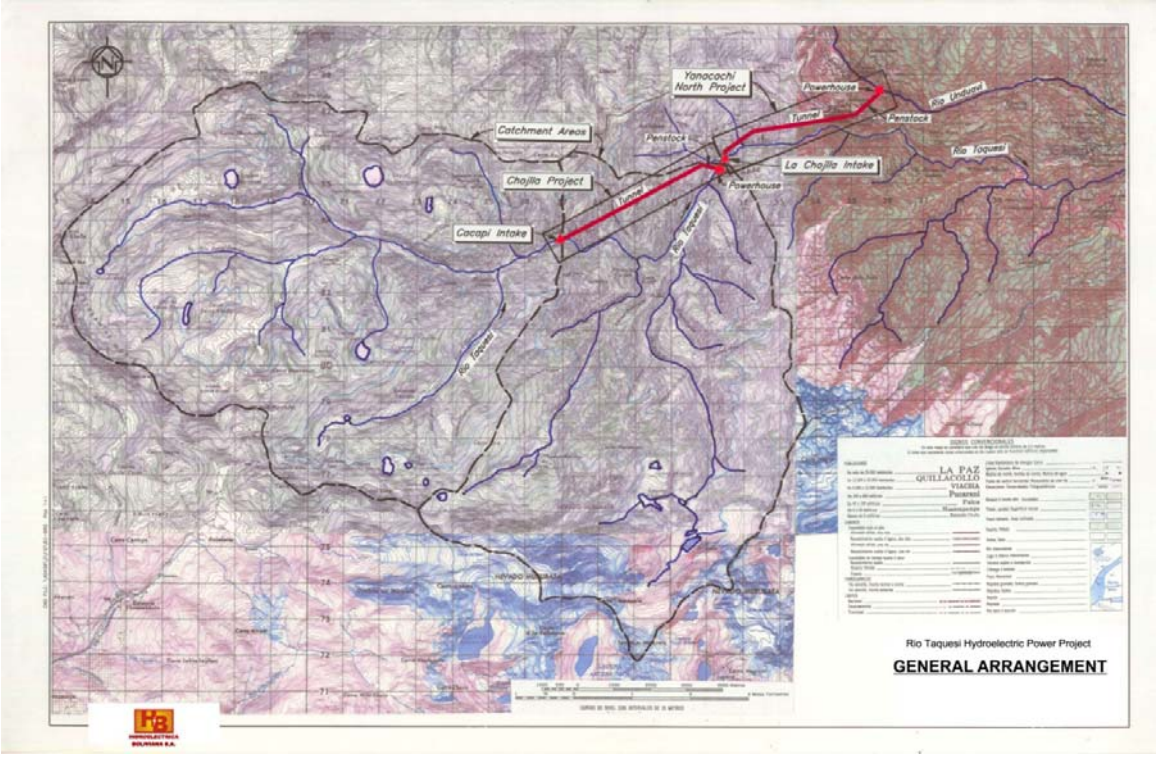
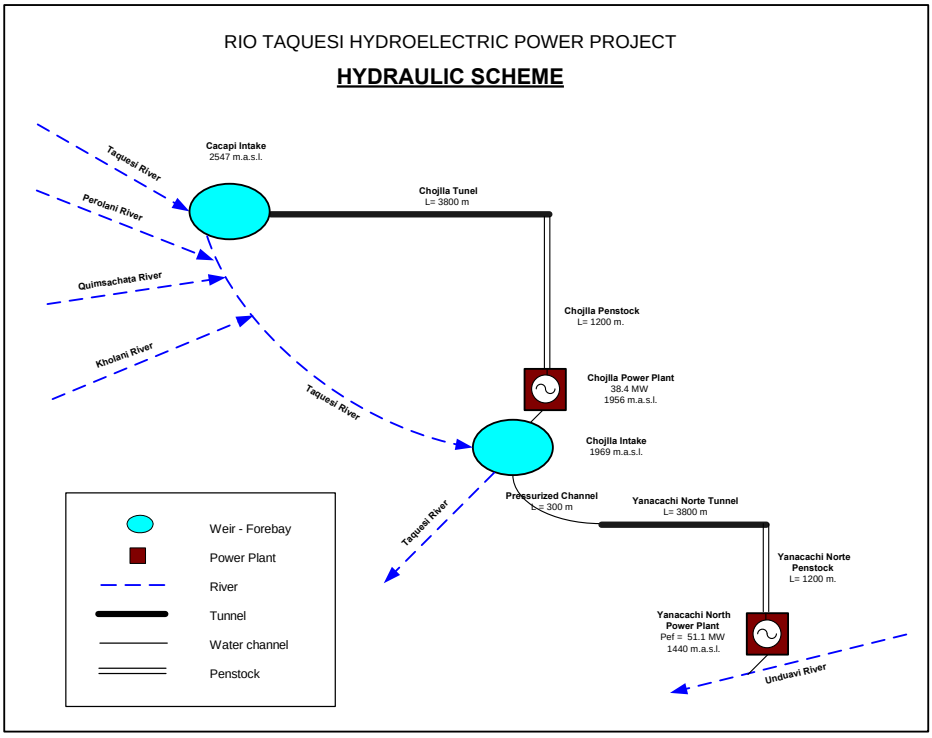
The Project makes use of known, conventional run-of-river hydroelectric generation technology, consisting of two in-cascade, run-of-river facilities, Chojlla and Yanacachi Norte plants, of 38.4 and 50 MW respectively of effective capacity. The Chojlla Plant is composed of a diversion weir, with an impounding capacity of 110,000 m3, a 3.6 km tunnel and a 1.2 km long penstock. The powerhouse at Chojlla has a single Francis turbine-generator, 580 m gross head unit. The Yanacachi Norte Plant has a weir and a daily regulation reservoir of 45,000 m3 connected to a 3.7 km long tunnel through a 400 m long covered canal. Yanacachi Norte's penstock is 1.2 km long and the plant has one single Francis turbine-generator with 520 m gross head.

The general arrangement of the hydropower system is shown in the next figure.



The hydraulic scheme of the project can be seen in the diagram below.



Compared to hydropower developments based on large river impoundments, run-of-river projects have smaller footprints and a series of environmental advantages due to their reduced areas. The footprint of the Rio Taquesi Hydroelectric Power Project is, in addition, reduced by the use of tunnels, rather than canals, and the extreme elevation gradient of the terrain that allows sufficient hydraulic head to be created within a short distance. Although similar technology has been used in other generating systems in the Country, the Project encompasses features like the use of daily instead of seasonal reservoirs on the river course, tunnels instead of canals and oil leakage prevention systems at substations for environmental reasons, for instance.

Both power plants of the project (Chojlla and Yanacachi Norte) are completely implemented and fully operational since the end of June 2002, when they have been successfully commissioned. The Project has been registered as a CDM Activity with 7-year renewable crediting periods, the first of which started on July 01, 2002 and ended on June 30, 2009. The second 7-years crediting period started on July 01, 2009 and will end on June 30, 2016.

During the reporting period, the average availability index of the plants has been 83.8%, with scheduled unavailability summing up to 14.6% and forced unavailability to 1.6% of the total period.

No events or situations with effects on the applicability of the methodology have occurred during the reporting period.

B.2. Post registration changes

B.2.1. Temporary deviations from registered monitoring plan or applied methodology

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None

B.2.2. Corrections

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None

B.2.3. Permanent changes from registered monitoring plan or applied methodology

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None

B.2.4. Changes to project design of registered project activity

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None

B.2.5. Changes to start date of crediting period

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None

B.2.6. Types of changes specific to afforestation or reforestation project activity

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None

SECTION C. Description of monitoring system

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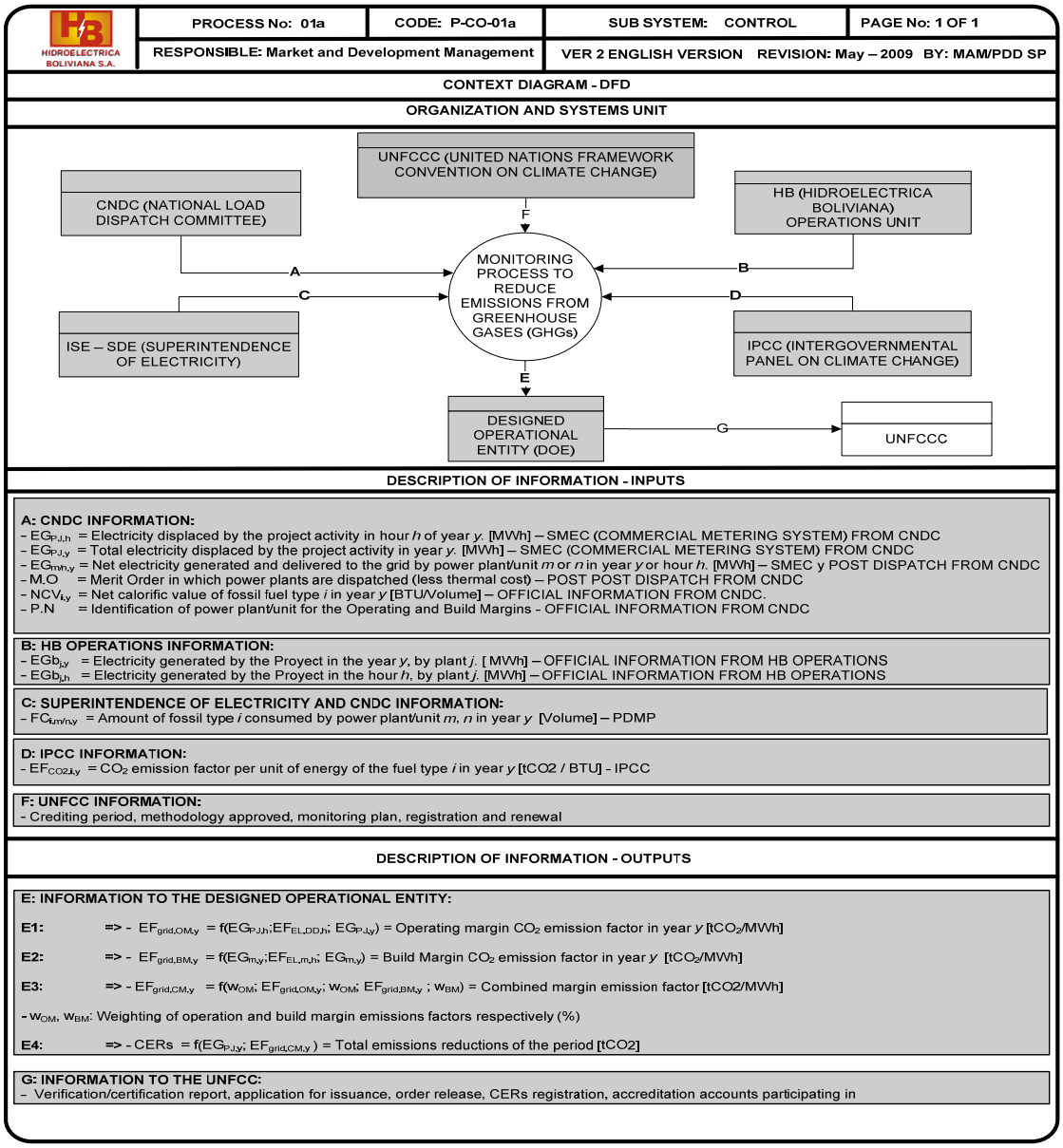
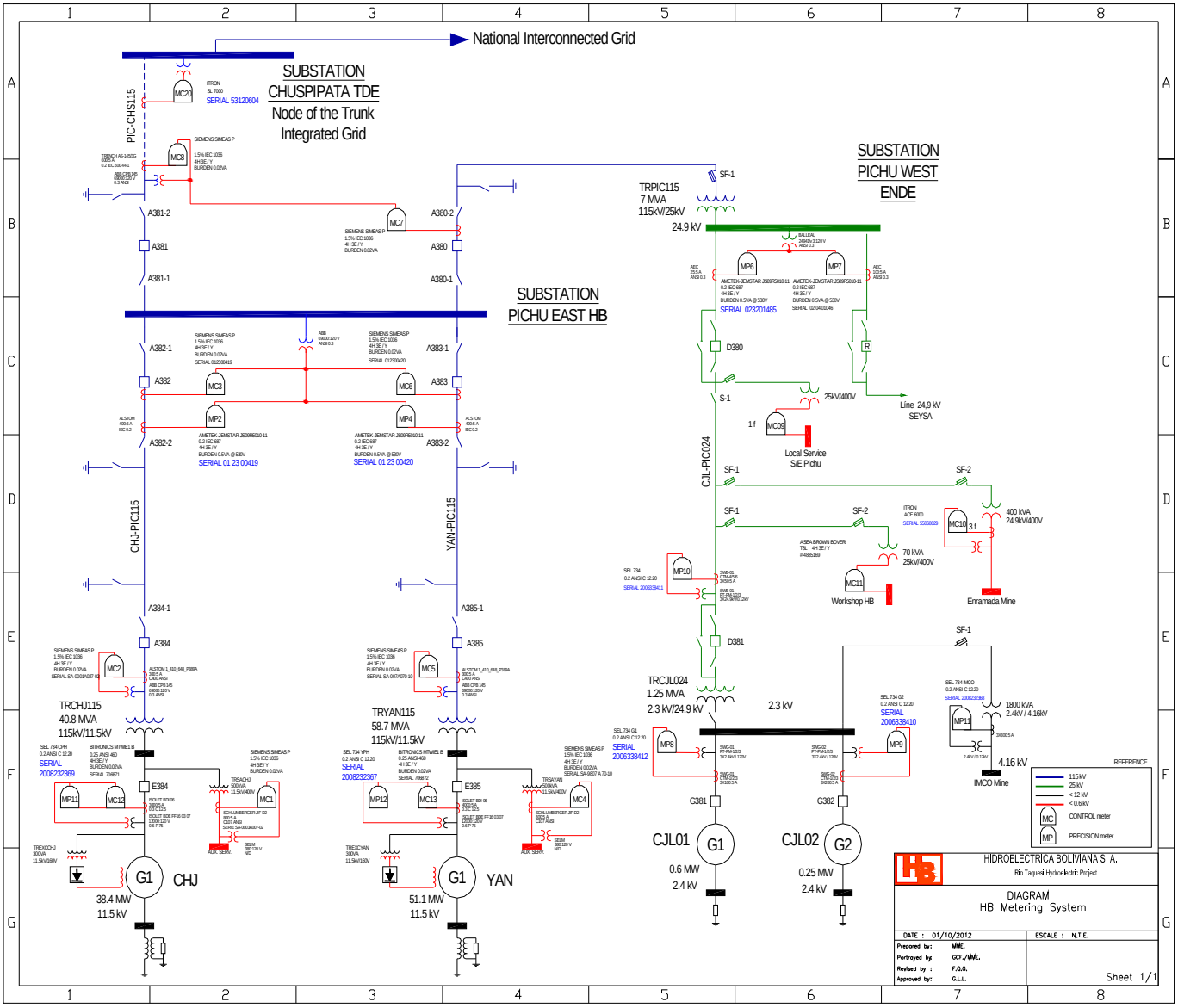
Data from CNDC and HB's O&M section is monthly collected, organized, processed and stored at individual files. Also, all information available on a yearly basis or every six months (as published by the CNDC and/ or the Social Control and Regulation Authority of the Electricity Sector) is collected, organized, processed and stored at individual files as it becomes available.

All data mentioned above is verified and reviewed before it is used for calculations purposes. When needed, clarifications and additional information is required. Calculation starts only when all data has been checked.
The next diagram shows a brief graphic description of the monitoring and CERs calculation processes.



For reference purposes, HB's metering system is shown in the figure below.


National Interconnected Grid
SUBSTATION
CHUSPIPATA TDE
Node of the Trunk
Integrated Grid
PIC-CHS115
SUBSTATION
PICHU EAST HB
SUBSTATION
PICHU WEST
ENDE
TRPIC115
7 MVA
115kV/25kV
24.9 kV
CJL-PIC024
CHJ-PIC115
YAN-PIC115
Line 24.9 kV
SEYSA
Local Service
S/E Pichu
Workshop HB
Enramada Mine
IMCO Mine
TRCHJ115
40.8 MVA
115kV/11.5kV
TRYAN115
58.7 MVA
115kV/11.5kV
TRCJL024
1.25 MVA
2.3 kV/24.9 kV
2.3 kV
4.16 kV
CJL01
G1
0.6 MW
2.4 kV
CJL02
G2
0.25 MW
2.4 kV
CHJ
38.4 MW
11.5 kV
YAN
51.1 MW
11.5 kV
400 kVA
24.9kV/400V
70 kVA
25kV/400V
1800 kVA
2.4kV / 4.16kV
25kV/400V
REFERENCE
115kV
25 kV
< 12 kV
< 0.6 kV
CONTROL meter
PRECISION meter
HIDROELECTRICA BOLIVIANA S. A.
Rio Taquesi Hydroelectric Project
DIAGRAM
HB Metering System
DATE : 01/10/2012
ESCALE : N.T.E.
Prepared by: MME.
Portrayed by GCF./MME.
Revised by : F.Q.Q.
Approved by: G.L.L.
Sheet 1/1

SECTION D. Data and parameters
D.1. Data and parameters fixed ex ante or at renewal of crediting period

Data/Parameter	**$C0_2$ to Carbon (C) molecular weight ratio**
Unit	tCO_2/TC per CO_2 mass unit
Description	Relation between CO_2 and C molecular masses in a CO_2 molecule
Source of data	Periodic table for chemical elements
Value(s) applied	3.666… = 44/12
Purpose of data	The data is used for the calculation of baseline emissions.
Additional comment	Carbon content is available in mass of C emitted per unit of energy produced by combustion of the selected fuel, and emissions are in the form of CO_2, thus a conversion from C to CO_2 is required. No measurement methods are needed.

Data/Parameter	**$EF_{grid,BM,y}$**
Unit	tCO_2/MWh
Description	Build Margin CO_2 emission factor for grid connected power generation in year *y*
Source of data	IPCC 2006 and CNDC's monthly reports
Value(s) applied	0.60
Purpose of data	The data are used for the calculation of baseline emissions.
Additional comment	According to the Methodological Tool (version 01.1), for the second Crediting Period, the Build Margin emission factor is calculated *ex-ante*, based on the most recent information available on units already built for a sample group *m* at the time of CDM-PDD submission for validation.

Data/Parameter	**$EF_{CO2,i,y}$**
Unit	tCO_2/BTU
Description	CO_2 emission factor per unit of energy of the fuel type *i* in year *y* for the Build Margin
Source of data	IPCC 2006
Value(s) applied	Natural Gas: 5.72E-08 [tCO_2/BTU] Diesel Oil: 7.66E-08 [tCO_2/BTU]
Purpose of data	The data are used for the calculation of baseline emissions.
Additional comment	The CO_2 emission factor per unit of energy of the fuel type *i* in year *y* can vary for the Operating Margin, which will be estimated ex-post, but will not change for the Build Margin, which is to be maintained unchanged during the Second Crediting Period

D.2. Data and parameters monitored

Data/Parameter	**$EG_{PJ,\ h}$**
Unit	MWh
Description	Electricity displaced by the Project activity in hour *h* of year *y*
Measured/Calculated /Default	Calculated
Source of data	Metering system readings and logbooks.
Value(s) of monitored parameter	452,317

Monitoring equipment

Type	SEL-734 (Chojlla)	SEL-734 (Yanacachi)	SEL-734 (Chojlla Antigua 1)	SEL-734 (Chojlla Antigua 2)
Accuracy	0.2 S	0.2 S	0.2 S	0.2 S
Serial number	2008232369	2008232367	2006338412	2006338410
Calibration frequency	3 - 4 years	3 - 4 years	3 - 4 years	3 - 4 years
Date of last calibration	September 2, 2008; August 31, 2010	August 27, 2008; September 01, 2010	December 18, 2006; June 08, 2011	December 12, 2006; June 09, 2011
Validity	4 years	4 years	4 years	4 years

Type	SEL-734 (Chojlla Antigua 1) (*)	SEL-734 (Chojlla Antigua 2) (*)
Accuracy	0.2 S	0.2 S
Serial number	2008232368	2006338411
Calibration frequency	3 - 4 years	3 - 4 years
Date of last calibration	August 28, 2008; April 18, 2011;	May 30, 2008; August 31, 2010
Validity	4 years	4 years

Type	JEMSTAR (Chojlla in Pichu)	JEMSTAR (Yanacachi in Pichu)	JEMSTAR (Chojlla Antigua 1&2 in Pichu)	ITRON (HB in Chuspipata)
Accuracy	0.2 S	0.2 S	0.2 S	0.2 S
Serial number	012300419	012300420	023201485	53120604
Calibration frequency	3 years	3 years	3 years	3 years
Date of last calibration	September 17, 2008; August 30, 2010	September 17, 2008; August 30, 2010	February 12, 2007; August 30, 2010	April 26, 2012
Validity	3 years	3 years	3 years	3 years

(*) These meters were used from March 01, 2011 to March 18, 2011.

Measuring/Reading/ Recording frequency

Measured continuously, recording hourly, aggregated monthly

Calculation method (if applicable)	HB's injections at node of the Trunk Integrated Grid for HB, where its billing is referred to, are measured through the Commercial Recording System. The injections of HB's non-Project's sources is calculated following the procedure described below: 1. Gross production measured at each generator terminals through HB's metering systems is used, including the Chojlla Antigua (HB's non-Project power source). 2. Project's gross production is divided by the total gross production to get the proportion of Project's generation of the total injections. 3. The above proportion is applied to the node (of the Trunk Integrated Grid) records from monthly SMEC for getting the Project's injection at that node.
QA/QC procedures	Double check by audit of sales receipt. Sales are calculated by the CNDC and reported in the Monthly Economic Transactions Report (DTE by its acronym in Spanish). The Project's metering system complies with technical specifications and CNDC standards. Registered information is compared to the information on the DTE. To prevent the use of energy from Chojlla Antigua for the emission reduction calculations, Project injections should be lower than those resulting from the energy balance done with monthly SMEC's data to calculate HB's chargeable energy (for the periods in which Chojlla Antigua effectively injects power to the grid).
Purpose of data	Data is used for the calculation of baseline emission.
Additional comment	The ITRON meter (HB in Chuspipata) was operating since May 01, 2012.

Data/Parameter	$EG_{m/n/y}$
Unit	MWh
Description	Net electricity generated and delivered to the grid by power plant/unit *m* or *n* in year *y* or hour *h*
Measured/Calculated /Default	Calculated
Source of data	Metering system readings
Value(s) of monitored parameter	Due to space restrictions, please refer to Table E.1
Monitoring equipment	Due to space restrictions, please refer to Table 1, Annex 1.
Measuring/Reading/ Recording frequency	Measured continuously, recording hourly, aggregated monthly
Calculation method (if applicable)	Measurement of energy injected by sets of units in a given plant is done through the Commercial Recording System (SMEC), a meters' system remotely accessed from the CNDC premises. Energy injections per generating unit are available at CNDC's DTrs. The DTr provides the individual estimated energy of each thermal power source and is used to determine the generation delivered to the grid by each thermal source according the CNDC's monthly SMEC registries. For OM, the data is monthly measured y and yearly recorded. For BM, in the second crediting period, only once, *ex-ante* at the start of the second crediting period.
QA/QC procedures	Commercial metering and recordings of generation is used. The QA/QC procedures consist of verifying whether the data is used by the CNDC for transactional purposes related to the electricity market.
Purpose of data	The data are used for the calculation of baseline emissions
Additional comment	

Data/Parameter	$FC_{i, m/n, y}$
Unit	ft^3 or l for natural gas and diesel, respectively
Description	Amount of fossil fuel type *i* consumed by power plant/unit *m* or *n* in year *y* or hour *h*.
Measured/Calculated /Default	Calculated
Source of data	AE's (Electricity Regulation and Social Control Authority) ISE (power sector information system) provides information on periodic – monthly and annual – fuel consumption by the thermoelectric plants and type of fuel by plant. Monthly SMEC records for injections information
Value(s) of monitored parameter	Due to space restrictions, please refer to Table E.1
Monitoring equipment	Not available
Measuring/Reading/ Recording frequency	Measured continuously, recording and aggregated monthly
Calculation method (if applicable)	This data is calculated based in each generation thermal unit and the fuel consumption of each thermoelectric plant. For OM, the data is monitored monthly and recorded yearly. For BM, in the second crediting period, only once *ex-ante* at the start of the second crediting period.
QA/QC procedures	Official information made available by AE's ISE reports is used. CNDC's reports are used for comparison ends only.
Purpose of data	The data are used for the calculation of baseline emissions
Additional comment	

Data/Parameter	MERIT ORDER
Unit	This parameter does not have dimensions or units
Description	The merit order in which power plants are dispatched
Measured/Calculated /Default	Calculated.
Source of data	CNDC's Daily Transactions report (DTr) or Post-dispatch report.
Value(s) of monitored parameter	Due to space restrictions, please refer to Table E.1
Monitoring equipment	Not applicable
Measuring/Reading/ Recording frequency	Measured continuously, recording hourly, aggregated monthly.
Calculation method (if applicable)	The merit order results from arranging all dispatched units in accordance to its marginal cost (which is at its time a combination of the heat rate, the fuel cost and the Operation & Maintenance non-fuel costs of the Units), decreasingly. For OM, merit order lists are registered hourly and recorded monthly.
QA/QC procedures	Only official information made available by CNDC has been used. CNDC establishes the merit order using models available to all agents of the power market. DTr are available from CNDC's web page and upon request.
Purpose of data	The data are used for the calculation of baseline emissions
Additional comment	

Data/Parameter	**$EG_{n/m/y\ IMPORTS}$**
Unit	MWh
Description	Electricity imports to the Project electricity system
Measured/Calculated /Default	Measured
Source of data	Not applicable
Value(s) of monitored parameter	If an interconnection to foreign grids occurs in the future, measurement will be done through the Commercial Recording System and will be available from the CNDC in accordance to the applicable Imports/Exports Regulation. AE accomplishes the function of regulating the activities of the national electric industry, and has authority to approve electricity imports.
Monitoring equipment	Not applicable
Measuring/Reading/ Recording frequency	This data will be monthly measured and yearly recorded.
Calculation method (if applicable)	
QA/QC procedures	Commercial metering and recording of generation is used. QA/QC procedures mainly consist of verifying whether the data is used by the CNDC for transactional purposes related to the electricity market. No imports occur so far because there are no international links. No such a links are under development either.
Purpose of data	The data are used for the calculation of baseline emissions
Additional comment	

<table>
<tr><td>Data/Parameter</td><td>NCV_i</td></tr>
<tr><td>Unit</td><td>Natural Gas: BTU/ft^3
Diesel oil: BTU/l</td></tr>
<tr><td>Description</td><td>Net calorific value (energy content) of fossil type i in year y</td></tr>
<tr><td>Measured/Calculated /Default</td><td>Measured</td></tr>
<tr><td>Source of data</td><td>Monthly information reported in the CNDC’s web page.</td></tr>
<tr><td>Value(s) of monitored parameter</td><td>Natural gas:
<table>
<tr><th>PLANT</th><th>NCV</th></tr>
<tr><td>Guaracachi</td><td>926 BTU/ft^3</td></tr>
<tr><td>Karachipampa</td><td>973 BTU/ft^3</td></tr>
<tr><td>Aranjuez</td><td>973 BTU/ft^3</td></tr>
<tr><td>V. Hermoso</td><td>916 BTU/ft^3</td></tr>
<tr><td>Carrasco</td><td>915 BTU/ft^3</td></tr>
<tr><td>Kenko</td><td>946 BTU/ ft^3</td></tr>
<tr><td>Bulo Bulo</td><td>921.2 BTU/ ft^3</td></tr>
<tr><td>Entre Rios</td><td>923.6 BTU/ ft^3</td></tr>
</table>
Diesel oil:
<table>
<tr><th>PLANT</th><th>NCV</th></tr>
<tr><td>Aranjuez</td><td>33,710 BTU/l</td></tr>
</table>
Data above is given only as an example for March, 2011. NCV can vary depending on the quality and properties of the fuel.</td></tr>
<tr><td>Monitoring equipment</td><td>Not available</td></tr>
<tr><td>Measuring/Reading/ Recording frequency</td><td>For OM, the data is monthly monitored and yearly recorded.
For BM, in the second crediting period, only once ex-ante at the start of the second crediting period and yearly recorded.</td></tr>
<tr><td>Calculation method (if applicable)</td><td>Not available</td></tr>
<tr><td>QA/QC procedures</td><td>Only official information made available by the CNDC is used.</td></tr>
<tr><td>Purpose of data</td><td>The data are used for the calculation of baseline emissions.</td></tr>
<tr><td>Additional comment</td><td></td></tr>
</table>

Data/Parameter	$\eta_{m,y}$
Unit	Not available
Description	Average net energy conversion efficiency of power unit *m* in year *y*
Measured/Calculated /Default	Not applicable
Source of data	Use either: • Document manufacturer's specifications (if the efficiency of the plant is not significantly increased through retrofits or rehabilitations); or • Data from the utility, the dispatch center or official records if it can be deemed reliable: or • The default values provided in the table in Annex 1: Default efficiency factors for power plants of Methodological tool (version 01) "Tool to calculate the emission factor for an electricity system"
Value(s) of monitored parameter	Not applicable
Monitoring equipment	Not applicable
Measuring/Reading/ Recording frequency	Recording and monitoring is made only once for the crediting period.
Calculation method (if applicable)	
QA/QC procedures	If the data used is significantly lower than the default value of the applicable technology, project proponents should assess the reliability of the values, and provide appropriate justification if deemed reliable. Otherwise, the default values above shall be used. Not applicable for the Project.
Purpose of data	The data are used for the calculation of baseline emissions.
Additional comment	

Data/Parameter	**Plant (unit) name**
Unit	Text – does not have units
Description	Identification of power source / plant for the Operating and Build Margins
Measured/Calculated /Default	Default
Source of data	CNDC's DTr and DTE
Value(s) of monitored parameter	Due to space restrictions, please refer to Table E.1
Monitoring equipment	Not applicable
Measuring/Reading/ Recording frequency	No measurement is applicable. Determination of power sources is done following the merit order identification process. This data is recorded yearly and kept archived during the crediting period and beyond.
Calculation method (if applicable)	Not applicable
QA/QC procedures	Only official information made available by the CNDC is used.
Purpose of data	The data are used for the calculation of baseline emissions.
Additional comment	

D.3. Implementation of sampling plan

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Not applicable

SECTION E. Calculation of emission reductions or GHG removals by sinks

E.1. Calculation of baseline emissions or baseline net GHG removals by sinks

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The methodology used to estimate baseline emissions is applied as follows, with the methodological choices described at each point:

1. Calculation of the Emission Factor Operating Margin ($EF_{grid, OM, y}$) is done using the Dispatch Data Analysis, based on data on fuel consumption and net electricity generation of each power plant/ unit (Option C of the Tool to calculate the emission factor for an electricity system. Version 01, Annex 12 of EB 35 report). The main source of information is the Load Dispatch National Committee (CNDC by its short form in Spanish) whose objective is to manage the Wholesale Electrical Market in the Interconnected Grid to assure reliability, security and minimum cost. The Dispatch Data OM emission factor is the weighted average emission rate of the generating units at the top of the merit order that produce ten percent of total system generation, varying at each hour, accumulated for each hour and averaged over the hours of the year during which the Project operates. To determine this, it is to be obtained: i) the grid system dispatch order of operation (merit order) for all power plants; ii) the energy (MWh) dispatched from each plant during each hour that the Project activity is operating, and (iii) data necessary to calculate the emission factor for each unit in the system, mainly:

Variable/Factor	Data type	Data variable	Data unit	Source
1. $EG_{PJ, h}$	Electricity quantity	Electricity displaced by the Project activity in hour *h* of year *y*.	MWh	Project meters, CNDC
2. $EF_{grid, CM, y}$	Emission factor	Combined margin CO_2 emission factor for grid connected power generation	tCO_2 / MWh	Calculated
3. $EF_{grid, OM-DD, y}$	Emission factor	Operating margin CO_2 emission factor for grid connected power generation	tCO_2 / MWh	Calculated
4. $EF_{grid, BM, y}$	Emission factor	Build margin CO_2 emission factor for grid connected power generation	tCO_2 / MWh	Calculated
5. $FC_{i, m, y}$	Fuel quantity	Amount of each fossil fuel consumed by each power source / plant	Mass or volume	CNDC and calculated
6. $EF_{CO2, i, y}$	Emission factor coefficient	CO_2 emission factor of fossil fuel type *i* in year *y*	tCO_2 / GJ	IPCC, 2006
7. $EG_{m, n, h}$	Electricity quantity	Electricity generation of each power source / plant *m* or *n*, during *h* or *y*	MWh	CNDC
8.	Plant name	Identification of power source / plant for the OM and BM	Text	CNDC

Variable/Factor	Data type	Data variable	Data unit	Source
9.	Merit order	The merit order in which power plants are dispatched	Text/spreadsheets	CNDC

The calculation requires hourly data for those hours when the Project produces electricity. The mean Operating Margin Emission Factor for the monitoring period is 0.73 tCO_2/MWh.

The formula used is:

$$EF_{grid,OM-DD,y} = \frac{\sum_h EG_{PJ,h} \times EF_{EL,DD,h}}{EG_{PJ,y}} \qquad (1)$$

Where: $EF_{grid, OM-DD, y}$ is the dispatch data analysis operating margin CO_2 emission factor in year *y* (tCO_2/MWh),
$EG_{PJ, h}$ is the electricity dispatched by the project activity in hour *h* of year *y* (MWh),
$EF_{EL, DD, h}$ is the CO_2 emission factor for the power units in the top of the dispatch order in hour *h* in year *y* (tCO_2/MWh),
$EG_{PJ, y}$ is the total electricity displaced by the project activity in year *y* (MWh),
h, refers to the hours in year *y* in which the project activity is displacing grid electricity
y, year in which the project activity is displacing grid electricity.

According to the methodology used, if hourly fuel consumption data is not available, then the hourly emissions factor is calculated based on the energy efficiency of the power unit and the type of fuel used, as follows:

$$EF_{EL,DD,h} = \frac{\sum_n EG_{n,h} \times EF_{EL,n,y}}{\sum_n EG_{n,h}} \qquad (2)$$

Where: $EF_{EL, DD, h}$ is the CO_2 emission factor for power units in the top of the dispatch order in hour *h in* year *y* (tCO_2/MWh),
$EG_{n, h}$ is the net energy generated and delivered to the grid by power unit *n* in hour *h* (MWh),
$EF_{EL, n, y}$ is the CO_2 emission factor of power unit *(n)* in year *y* (tCO_2/MWh),
n, power units in the top of the dispatch,
h, hours in year *y* in which the project activity is displacing grid electricity.

The CO_2 emission factor of the power units *(n)* should be determined as per the guidance for the simple OM method, using the options B1, B2 or B3. According to the data and parameters available in the Bolivian power system, option B1 is used to calculate the CO_2 emission factor ($EF_{EL, n, y}$).

Option B1. If for a power unit *m* data on fuel consumption and electricity generation is available, the emission factor ($EF_{EL, m, y}$) should be determined as follows:

$$EF_{EL,m,y} = \frac{\sum_i FC_{i,m,y} \times NCV_{i,y} \times EF_{CO2,i,y}}{EG_{m,y}} \qquad (3)$$

Where: $EF_{EL, m, y}$ is the CO_2 emission factor for power unit *m* in year *y* (tCO_2/MWh),
$FC_{i, m, y}$ is the amount of fossil fuel type *i* consumed by power unit *m* in year *y* (Mass or volume unit),
$NCV_{i, y}$ is the net calorific value (energy content) of fossil fuel type *i* in year *y* (GJ/mass or volume unit),
$EF_{CO2, I, y}$ is the CO_2 emission factor of fossil fuel type *i* in year *y* (tCO_2/GJ),
$EG_{m, y}$ is the net quantity of electricity generated and delivered to the grid by power unit *m* in year *y* (MWh),
m, all power units serving the grid in year *y* except low-cost / must-run power units
i, all fossil fuel types combusted in power unit *m* in year *y*,
y, either the three most recent years for which data is available at the time of submission of the CDM-PDD to the DOE for validation (ex ante option) or the applicable year during monitoring (ex post option), following the guidance on data vintage in step 2 of the baseline methodology procedure.

In this case *"m"* is replaced by *"n"*, in order to apply it in the dispatch data analysis OM method.

To determine the set of plants *(n)*, the CNDC provides: a) the grid system dispatch order of operation for each power plant of the system; and b) the energy (MWh) dispatched from all plants in the system during every hour that the Project is operating (EG_h). Every hour *h*, each plant's generation (EG_h) is stacked using merit order. The set of plants *(n)* consists of those plants at the top of the stack (i.e., having the least merit), whose combined generation (ΣEG_h) comprises 10% of the total generation from all plants during that hour.

2. Calculation of the Build Margin Emission Factor ($EF_{grid, BM, y}$). In the second crediting period, the ex-ante approach is used for calculating the Build Margin emission factor based on the most recent information available on plants already built. The group used consists of those power plants whose capacity additions represent the 20% of the total system generation (in MWh). In the case of the Bolivian power system, the generation of the five power plants that have been built most recently is lower than the injections of those capacity additions in the electricity system that comprise 20% of the system's annual energy. The resulting $EF_{grid, BM, y}$, is 0.60 tCO_2/MWh.

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

$$EF_{grid,BM,y} = \frac{\sum_m EG_{m,y} \times EF_{EL,m,y}}{\sum_m EG_{m,y}} \qquad (4)$$

Where: $EF_{grid, BM, y}$ is the build margin CO_2 emission factor in year *y* (tCO_2/MWh),
$EG_{m, y}$ is the net quantity of electricity generated and delivered to the grid by power unit in year *y* (MWh),
$EF_{EL, m, y}$ is the CO_2 emission factor of power unit *m* in year *y* (tCO_2/MWh),
m, refers to the power units included in the build margin,
y, most recent historical year for which power generation data is available

The CO_2 emission factor of each power unit *m* ($EF_{EL, m, y}$) should be determined as per the guidance for the simple OM method of operating margin emission factor, with options B1, B2 and B3, using for *y* the most recent historical year for which power generation data is available, using for *m* the power units included in the build margin.

3. Calculation of the Combined Margin Emission Factor ($EF_{grid, CM, y}$). The Combination Margin Emission Factor (or the Baseline Emission Factor as indicated in the older Version 06) is calculated as follows:

$$EF_{grid,CM,y} = (EF_{grid,OM,y} \times w_{OM}) + (EF_{grid,BM,y} \times w_{BM}) \quad (5)$$

Where: w_{OM} *is* the weighting of Operating Margin Emission Factor (%),
w_{BM} is the weighting of Build Margin Emission Factor (%),
$EF_{grid, OM, y}$ and $EF_{grid, BM, y}$ is described and calculated as portray in the corresponding steps above and expressed in tCO_2/MWh.

During the current second crediting period, the next weights are used:

w_{OM} = *25%* and w_{BM} = *75% (i.e.,* w_{OM} = *0.25* and w_{BM} =*0.75)*

The results and calculations are summarized in Table E.1, as follows:

TABLE E.1: Baseline calculations

HIDROELECTRICA BOLIVIANA S.A.

RIO TAQUESI HYDROELECTRIC PROJECT
ANNEX 3 V.1: BASELINE DATA, SECOND CREDITING PERIOD
Verified period: March 01, 2011 - June 30, 2012

TABLE A1. Specific Values

Fuel	*i*	*Convertion Factor* [TJoule/BTU]	*Carbon Content* [tC/TJoule]	*44/12* [tCO2/tC]	*EFCO2,i : Emissions Factor* [tCO2/BTU]	*EFCO2,i : Emissions Factor* [tCO2/TJoule]	*EFCO2,i : Emissions Factor* [tCO2/GJoule]
Natural Gas	NG	1.0548E-09	14.8	3.6667	5.72E-08	5.43E+01	5.43E-02
Diesel Oil	DO	1.0548E-09	19.8	3.6667	7.66E-08	7.26E+01	7.26E-02

TABLE A2. Operating Margin

Year	Period	D	E	F	G	H	I	J	K	L	M
		Generation GWh			Fuel Consumption		Emissions Top 10% tCO2		Emissions Factor Top 10% tCO2/MWh	Emissions tCO2	**OM Emissions Factor tCO2/MWh**
					MFt3	k Lt					
y		Tot Gen SIN	$\sum GEN_{10\%,h}$ *n ≥ Top 10%*	$EG_{PJ,y}$ *Project*	$FC_{i,n,y}$ *i = NG*	$FC_{i,n,y}$ *i = DO*	$\sum EF_{EL,my} \cdot EG_{n,h}$ *i = NG*	*i = DO*	$EF_{EL,DD,h}$	$EG_{PJ,h} \cdot EF_{EL,DD,h}$	$EG_{PJ,h} \cdot EF_{EL,DD,h} / EG_{PJ,y}$
									=(I+J)/E		=(L/F)/1000
9	mar/11 - jun/11	2,078.89	245.11	118.96	15,090.45	69.30	177,154.12	178.90	723.47	84,857.02	0.71
10	jul/11 - jun/12	6,623.70	757.72	333.35	50,680.62	14,860.80	522,108.83	41,893.69	744.34	245,086.21	0.74
Total		8,702.60	1,002.84	452.317	65,771.07	14,930.10	699,262.95	42,072.58	1,467.81	329,943.23	0.73

TABLE A3. Build Margin, Second Crediting Period "ex ante". Additions represents 20% of the system generation

	Starting Year	Type	N Generation GWh	O Fuel Consumption MMFt3	P Net Cal Value BTU/Ft3	Q Conver Factor TJ/BTU	R Fuel Consumption TJ	S Carbon Content tC/TJ	T tCO2/tC	U Emissions tCO2/TJ	**V BM Emission Factor tCO2/MWh**
											$(\sum EG_{my} \cdot EF_{EL,my}) / \sum EG_{my}$
							=(O*P*Q*1000000)	IPCC, 2006		=(S*T)	=(R*U/N)/1000
ARJ13	Aug/2008	Nat Gas	2.01	22.35	977.87	1.0548E-09	23.05	14.80	3.67	54.27	0.62
ARJ14	Aug/2008	Nat Gas	2.56	27.66	977.87	1.0548E-09	28.53	14.80	3.67	54.27	0.61
ARJ15	Aug/2008	Nat Gas	1.75	18.37	977.87	1.0548E-09	18.95	14.80	3.67	54.27	0.59
ANG3	Aug/2008	Hydro	1.83								
GBE1	Oct/2007	Biomas	39.40								
QHE2	Oct/2007	Hydro	1.64								
QHE1	Oct/2007	Hydro	1.64								
GCH11	Apr/2007	Nat Gas	370.41	4,315.42	960.99	1.0548E-09	4,374.34	14.80	3.67	54.27	0.64
ARJ9	Aug/2006	Nat Gas	10.30	113.71	977.87	1.0548E-09	117.29	14.80	3.67	54.27	0.62
ARJ10	Aug/2006	Nat Gas	10.40	115.19	977.87	1.0548E-09	118.81	14.80	3.67	54.27	0.62
ARJ11	Aug/2006	Nat Gas	10.28	113.93	977.87	1.0548E-09	117.52	14.80	3.67	54.27	0.62
ARJ12	Aug/2006	Nat Gas	7.67	85.76	977.87	1.0548E-09	88.46	14.80	3.67	54.27	0.63
SRO2	Jul/2006	Hydro	30.78								
SRO1	Jul/2006	Hydro	34.69								
SIS5	May/2004	Hydro	116.62								
CHJ3	Jun/2002	Hydro									
YAN1	Jun/2002	Hydro									
LAN3	Mar/2001	Hydro	10.18								
KIL3	Mar/2001	Hydro	18.00								
BUL1	Jun/2000	Nat Gas	312.34	3,021.09	926.20	1.0548E-09	2,951.48	14.80	3.67	54.27	0.51
BUL2	Jun/2000	Nat Gas	300.75	2,909.38	926.20	1.0548E-09	2,842.35	14.80	3.67	54.27	0.51
Total			**1,283.3**	**10,742.86**			**10,680.78**				
Rate m≥20%			**61.7%**								
Build Margin Emission Factor Average											**0.60**

TABLE A4. Baseline Emissions Factor

Year	Period	W Emissions Factor [tCO2/MWh]	X	Y Weights [p.u.] [p.u.]	Z	AA Baseline Emissions Factor [tCO2/MWh]
y		$EF_{OM,DD,y}$ Operation	$EF_{BM,y}$ Build	w_{OM} Operation	w_{BM} Build	*EFy*
9	mar/11 - jun/11	0.71	0.60	0.25	0.75	0.63
10	jul/11 - jun/12	0.74	0.60	0.25	0.75	0.64
Average						0.63

TABLE A5. Total Emissions Reductions

Period	AB Lifetime [years]	AC Capacity [MW]	AD Generation [GWh]	AE Capacity Factor [%]	AF Baseline Emissions Factor [tCO2/MWh]	AG Total Emissions Reductions [tCO2]
mar/11 - jun/11	0.17	88.40	118.96	92.2%	0.63	74,650
jul/11 - jun/12	1.00	88.40	333.35	43.0%	0.64	211,679
TOTAL Mar 01, 2011 - Jun 30, 2012		88.40	452.317	67.6%	0.63	**286,329**

E.2. Calculation of project emissions or actual net GHG removals by sinks

>>

The project does not emit GHG

E.3. Calculation of leakage

>>

No leakages are considered

E.4. Summary of calculation of emission reductions or net anthropogenic GHG removals by sinks

Time Period	Baseline emissions or baseline net GHG removals by sinks (tCO_2e)	Project emissions or actual net GHG removals by sinks (tCO_{2e})	Leakage (tCO_2e)	Emission reductions or net anthropogenic GHG removals by sinks (tCO_2e)
Total	286,329	0	0	286,329

E.5. Comparison of actual emission reductions or net anthropogenic GHG removals by sinks with estimates in registered PDD

Item	Values estimated in ex-ante calculation of registered PDD	Actual values achieved during this monitoring period
Emission reductions or GHG removals by sinks (tCO_2e)	March 2011-June 2011: 60,801 July 2011-June 2012: 189,001 Total: 249,802	March 2011-June 2011: 74,650 July 2011-June 2012: 211,679 Total: 286,329

E.6. Remarks on difference from estimated value in registered PDD

>>

The emission reductions value (286,329 tCO2-e) shown in E.5 is higher than the reductions estimated for the Project in the registered PDD for the period March 2011 – June 2012 that was 249,802 tCO2-e. The reasons identified for the above are: the energy produced and the emission factor for the operating margin and consequently the combined emission factor.

The larger energy produced is due to the better water availability. For projection purposes, in the PDD a figure of 409.51 GWh was used as a forecast for the electricity injections to the grid. The current monitoring period reveals that Project's injections to the grid sum up to around 450 GWh.

TABLE E.6.1: RIO TAQUESI HYDROELECTRIC POWER PROJECT: Summary of energy injected to the grid [GWh]

Item	In the PDD	Current MR
March, 2011 - June, 2011	99.67	118.96
July, 2011 - June, 2012	309.84	333.35

The fact that the emission factor for the operating margin was different from that projected in the PDD is also important while explaining the differences between the PDD expected and the actual calculated emission reductions. The said emission factor was affected by the addition and operation of thermoelectric units. These were more predominant in the daily dispatch for the current monitoring period than that expected while producing the PDD, with the consequent variation of the operating margin and also the combined emission factor.

TABLE E.6.2: RIO TAQUESI HYDROELECTRIC POWER PROJECT: Summary of mean Emission Factor values [tCO_2-e].

Item	In the PDD	Current MR
EF Build Margin	0.60	0.60
EF Operating Margin	0.64	0.73
EF Combined	0.61	0.63

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History of the document

Version	Date	Nature of revision
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01	EB 54, Annex 34 28 May 2010	Initial adoption.
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