



Monitoring report form (Version 03.2)

Monitoring report

Title of the project activity	Fundão-Santa Clara Energetic Complex Project (FSCECP)
Reference number of the project activity	Ref. 1279
Version number of the monitoring report	Version 01
Completion date of the monitoring report	07/04/2014
Registration date of the project activity	25/05/2008
Monitoring period number and duration of this monitoring period	4st monitoring period form 01/09/2011 to 31/12/2013
Project participant(s)	Elejor – Centrais Elétricas do Rio Jordão
Host Party(ies)	Brazil
Sectoral scope(s) and applied methodology(ies)	Sectoral Scope 1: Energy industries Methodology: ACM0002.: “Consolidated baseline methodology for grid-connected electricity generation from renewable sources”- Version 06
Estimated amount of GHG emission reductions or net anthropogenic GHG removals by sinks for this monitoring period in the registered PDD	619,698
Actual GHG emission reductions or net anthropogenic GHG removals by sinks achieved in this monitoring period	674,791
Actual GHG emission reductions or net anthropogenic GHG removals by sinks achieved during the period up to 31 December 2012(if applicable)	351,077
Actual GHG emission reductions or net anthropogenic GHG removals by sinks achieved during the period from 1 January 2013 onwards (if applicable).	323,715

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

The primary objective of the project activity is to help meet Brazil's rising demand for energy due to economic growth and to improve the supply of electricity, while contributing to the environmental, social and economic sustainability by increasing renewable energy's share of the total Brazilian electricity consumption.

This renewable source of electricity will also have an important contribution to environmental sustainability by reducing carbon dioxide emissions that would have occurred otherwise in the absence of the project. The project activity reduces emissions of greenhouse gas (GHG) by avoiding electricity generation by fossil fuel sources (and CO₂ emissions), which would be generating (and emitting) in the absence of the project.

The project is located in the southern region of Brazil in the cities of Candói, Foz do Jordão and Pinhão, all situated in Paraná state under the following geographic coordinates: 25°42' S and 52°00' W. The project consists of a hydroelectric complex, located in Jordão River, composed by Fundão and Santa Clara hydroelectric power plants, which present a small hydropower plant each. PCH1 Fundão I and PCH Santa Clara I were built at the UHE2 Fundão and UHE Santa Clara, respectively, using part of the sanitary flow of each facility to generate electricity. Fundão Complex (UHE and PCH Fundão) presents a total installed capacity of 122.643 MW and a reservoir area of 2.15 km² and Santa Clara Complex (UHE and PCH Santa Clara) presents 123.768 MW of total installed capacity and a reservoir area of 20.14 km². For the electricity generation in both complexes, it was employed Kaplan turbines and generators which specifications are described in Table 1:

Characteristics	Santa Clara Complex		Fundão Complex	
	UHE – 2 GU*	PCH	UHE – 2 GU	PCH
Turbines				
<i>Nominal Power (MW)</i>	61	3.5	61	2.5
<i>Manufacturer</i>	Impsa	Möller	Impsa	Möller
Generators				
<i>Nominal Power (MVA)</i>	66.760	4.000	66.760	2.750
<i>Power Factor</i>	0.9	0.9	0.9	0.9
<i>Nominal Power (MW)</i>	60.084	3.6	60.084	2.475
<i>Manufacturer</i>	WEG	WEG	WEG	WEG

Table 1: Turbines and generators specifications.

* GU =generating Unit

Fundão-Santa Clara Energetic Complex Project is a two phase project, consisting on the construction

¹ PCH from the Portuguese "Pequena Central Hidrelétrica", small hydro power plant.

² UHE from the Portuguese "Usina Hidrelétrica", hydro power plant.

of two power plants to produce electricity in two different sites:

- Phase 1 (2005): operation of *Santa Clara* Complex comprehending *UHE Santa Clara* (120.168MW) and *PCH Santa Clara I* (3.6 MW) started commercial operation in 2005 and;
- Phase 2 (2006): operation of *Fundão* Complex comprehending *UHE Fundão* (120.168 MW) and *PCH Fundão I* (2.475 MW) started commercial operation in 2006.

The table below summarizes the relevant dates for the project activity:

Actions	Santa Clara Complex		Fundão Complex	
	UHE (DD/MM/YYYY)	PCH (DD/MM/YYYY)	UHE (DD/MM/YYYY)	PCH (DD/MM/YYYY)
Construction Date	01/12/2002	01/12/2002	01/04/2004	01/04/2004
Commissioning Phase	03/03/2005	25/05/2005	03/02/2006	13/09/2006
Test Operation Phase ³	16/07/2005	14/07/2005	08/06/2006	17/11/2006
Commercial Operation Phase ⁴	31/07/2005	13/08/2005	23/06/2006	29/12/2006

Table 2: Important dates for the project activity.

The GHG emission reductions during the period from September, 1st 2011 to December, 31st 2013, both days included, were achieved through the dispatched electricity generated by *Fundão-Santa Clara* Complex Project which displaced a mix of electricity generation in the Brazilian South-Southeast-Midwest interconnected grid. This monitoring report presents information related to the fourth verification of project activity which covers the period from September, 1st 2011 to December, 31st 2013, both days included. The total emission reductions by the project activity over the monitored period are **674,791.80 tCO₂e**.

A.2. Location of project activity

The project activity is located in *Jordão* River, in *Candói*, *Foz do Jordão* and *Pinhão* municipalities, state of *Paraná*, Southern region of Brazil (Host Party) under the following geographic coordinates 25°42' S and 52°00' W.

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)
Brazil (host)	ELEJOR Centrais Elétricas do Rio Jordão S.A	No

³ It corresponds to the date when the first generating unit of *UHE Santa Clara* and *UHE Fundão* started its test operation phase, according to ANNEL Ordinance which will be supplied during the auditing.

⁴ It corresponds to the date when the first generating unit of *UHE Santa Clara* and *UHE Fundão* started its commercial operation phase, according to ANEEL Ordinance which will be supplied during the auditing.

A.4. Reference of applied methodology

The methodology applied to the project is ACM0002 – “Consolidated methodology for grid-connected electricity generation from renewable sources” (version 6)⁵ and the “Tool for the demonstration and assessment of additionality” (version 3)⁶.

A.5. Crediting period of project activity

The project employs the renewable crediting period (7 years). The crediting period of the project activity is from 25/05/2008 (DD/MM/YYYY) to 24/05/2015 (DD/MM/YYYY).

SECTION B. Implementation of project activity

B.1. Description of implemented registered project activity

Fundão-Santa Clara Complex Project is composed by *UHE Fundão* and *UHE Santa Clara* which present a small hydropower plant each, *PCH Fundão I* and *PCH Santa Clara I*, respectively.

Fundão Complex consists of a hydropower with 120.168 MW of installed capacity, a reservoir area of 2.15 km² and a small hydropower plant with 2.475 MW of installed capacity.

Santa Clara Complex also presents a hydropower plant and a small hydropower plant with 120.168 and 3.6 MW of installed capacity respectively.

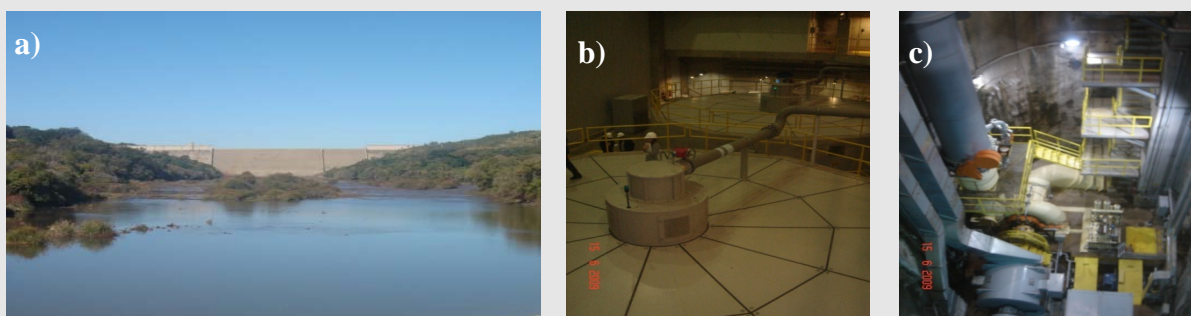


Figure 1: *Santa Clara* Complex. a) Dam of the Large Hydropower Plant *Santa Clara*, b) Large Hydropower Plant *Santa Clara* powerhouse and c) Small Hydropower Plant *Santa Clara I* equipment.

⁵ Accessed on April, 10th 2014. Available at: http://cdm.unfccc.int/filestorage/C/D/M/CDMWF_AM_BW759ID58ST5YEEV6WUCN5744MN763/eb24_repan07_ACM0002_ver06_for_web.pdf?t=N3F8bjN0dzZrfDCsDZI8ZyO1Wbs_lfESMzb

⁶ Accessed on April, 10th 2014. Available at: <http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-01-v3.pdf>

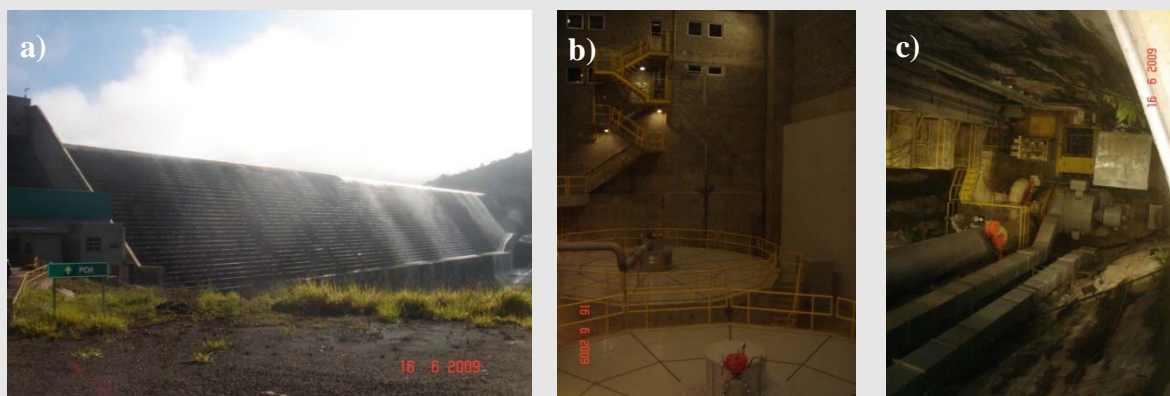


Figure 2: *Fundão* Complex. a) Dam of the Large Hydropower Plant *Fundão*, b) Large Hydropower Plant *Fundão* powerhouse and c) Small Hydropower Plant *Fundão I* powerhouse.

The production of electricity is possible using unevenness on a river which allows the use of energy associated with the waterfalls and the volume of water that will be stored in the reservoir. The implementation of a power plant on a river involves the construction of a dam to form the reservoir, the powerhouse, substation and the transmission lines. Also, there are two main structures on a dam: the penstock where the water flows to the powerhouse through the forced pipes to spin the turbines and the spillway in which the water excess flows during intense rainfalls.

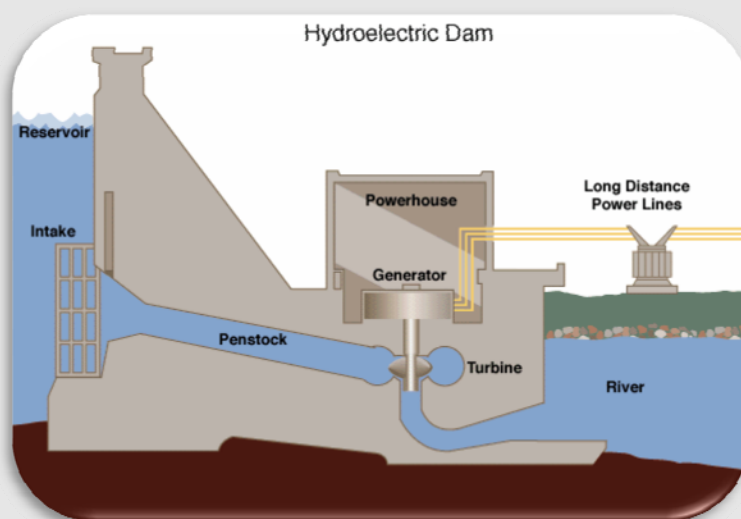


Figure 3: Schematic of a Hydroelectric Power Plant.

Some technical characteristics of the Complex are presented in the table below:

Characteristics	Santa Clara Complex		Fundão Complex	
	UHE	PCH	UHE	PCH
Installed Capacity (MW)	120.168	3.6	120.168	2.475
Reservoir area (km ²)	20.14		2.15	
Power density (W/m ²)	6.14		57.04	

Table 3: *Fundão-Santa Clara* Complex main characteristics.**B.2. Post registration changes****B.2.1. Temporary deviations from registered monitoring plan or applied methodology**

Not Applicable.

B.2.2. Corrections

Not Applicable.

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

Not Applicable.

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

A notification of changes in the PDD has been undertaken during the second monitoring period. The following changes were addressed in the registered PDD:

At the registered PDD, the installed capacity of the project activity has been described as follows:

- UHE Santa Clara: 120 MW (2 turbo-generators of 60 MW each);
- UHE Fundão: 120 MW (2 turbo-generators of 60 MW each);
- PCH Santa Clara: 3.6 MW (1 turbo-generator);
- PCH Fundão: 2.5 MW (1 turbo-generator).

Thus, the power density of the complexes was:

- Santa Clara Complex (UHE and PCH Santa Clara): 6.13 W/m² (123.6 MW of installed capacity and a reservoir area of 20.14 km²);
- Fundão Complex (UHE and PCH Fundão): 56.97 W/m² (122.5 MW of installed capacity and a reservoir area of 2.15 km²).

But in fact, the equipment that was purchased and installed at the Fundão and Santa Clara Complex since its very start is:

- UHE Santa Clara: 120.168 MW (2 turbo-generators of 60.084 MW each);
- UHE Fundão: 120.168 MW (2 turbo-generators of 60.084 MW each);
- PCH Santa Clara: 3.6 MW (1 turbo-generator);
- PCH Fundão: 2.475 MW (1 turbo-generator).

With the new values, there are also changes in the calculated power densities. The power density of the complexes is given below:

- Santa Clara Complex (UHE and PCH Santa Clara): 6.14 W/m² (123.768 MW of installed capacity and a reservoir area of 20.14 km²);
- Fundão Complex (UHE and PCH Fundão): 57.04 W/m² (122.643 MW of installed capacity and a reservoir area of 2.15 km²).

The changes had no potential to affect the ability of the project to generate emission reductions as the calculations have been made based on the assured capacity (the committed energy to be delivered to the grid) and not on the installed capacity of the project activity.

The changes were made and the PDD submitted to request the approval of changes on the project activity by the UNFCCC. The changes in the PDD were approved by UNFCCC on 13th December 2011. For this monitoring report (fourth) no changes were requested in the PDD.

B.2.5. Changes to start date of crediting period

Not Applicable.

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

Not Applicable.

SECTION C. Description of monitoring system

The monitoring report is based on electricity delivered to the grid by *Fundão-Santa Clara Energetic Complex Project*. The amount of electricity generated by the plants and delivered to the grid is verified and monitored by the following entities:

1) *ELEJOR – Centrais Elétricas do Rio Jordão S.A.* is the energy producer (seller). According to the Procedures of Management and Monitoring of Certified Emission Reductions of the CDM Project Activity, *ELEJOR* controls the energy generated by the hydropower plants through the issuance of periodic reports which they send to *COPEL*. In addition, *ELEJOR* will prepare and keep these documents until two years after the end of the crediting period. The documents sent to *COPEL* are as follows:

- Management Report of Hydro Energetic Operation Planning, Hydrometric, Billing Measurement and Energetic Accounting of *Fundão-Santa Clara Energetic Complex* (in portuguese: *Relatório Gerencial de Planejamento da Operação Hidroenergética, Hidrometria, Medição de Faturamento e Contabilização Energética do Complexo Energético Fundão- Santa Clara*);
- Billing Measurement Electronic Spreadsheets.

2) *COPEL – Companhia Paranaense de Energia* which is the local power utility. *COPEL* is the responsible for the hydroelectric complexes operation and the monitoring of the quantity of energy exported

to the grid. Also *COPEL* remotely registers the total amount of energy generated and dispatched to the grid by each plant which is informed to *CCEE* from its headquarters in *Curitiba* on a daily basis.

COPEL is also responsible for the calibration of the net energy meters which follows the procedures⁷ determined by the National Electric System Operator (from the Portuguese *Operador Nacional do Sistema Elétrico – ONS*). Section 12.3 of the procedures sets the requirements regarding the maintenance of the Billing Commensuration System (from the Portuguese, *Sistema de Medição e Faturamento - SMF*) according to which the calibration of the energy meters is to be done every two years.

National Chamber of Electric Energy Commercialization (from the Portuguese *Câmara de Comercialização de Energia Elétrica - CCEE* –) which is a state-owned company that checks and writes up the electricity delivered to the grid by all the plants and consumers connected to it, *i.e.* *CCEE* makes feasible and regulates the electricity energy commercialization in Brazil. In a process called Accounting Commensuration Aggregation (from the Portuguese, *Agregação Contábil da Medição*) *CCEE* compares the energy generation reported by every seller connected to the national grid with the consumption registered during the month under consideration.

After the adjustments due to energy losses occurring in the transmission system are made, *CCEE* issues several official reports certifying the amount of energy generated by each seller. Whenever a discrepancy or disagreement is found between the generation and consumption data informed, *CCEE* re-processes the information performing the necessary adjustments. The final results are published at *CCEE*'s website and are publicly available. Hence, *CCEE*'s information - which is an official and publicly available source - was used to cross-check information provided by the project participant.

Regarding the hydropower plants, each large hydro power plant presents two generating units (GU) and each generating unit has a meter, located in the respective powerhouse, which counts the gross energy produced. Table 4 presents the technical specifications of the meters used for gross energy measurements.

Description			Manufacturer	Type/Model	Serial Number
Hydropower Plant	Generating Unit (GU)	Meter Location			
UHE Santa Clara	1 st GU	UHE Santa Clara power house	Schneider	ION 8600	PT-0804A443-01
	2 nd GU		Schneider	ION 8600	PT-0902A052-01
UHE Fundão	1 st GU	UHE Fundão power house	Schneider	ION 8600	PT-0807A553-01
	2 nd GU		Schneider	ION 8600	PT-0901A056-01

Table 4: Gross energy meters

Furthermore, the hydropower plants presents connected to each generating unit, two meters, a principal and a backup meter, which measure the net electricity generation delivered to the grid. Therefore, each large power plant has four net electricity meters.

⁷ Metering System Maintenance for Invoicing (in a free translation from the Portuguese *Manutenção do Sistema de Medição para Faturamento*). Sub-module 12.3. Accessed on April, 10th 2014. Available at: http://www.ons.org.br/download/procedimentos/modulos/Modulo_12/Submodulo%2012.3_Rev_1.0.pdf

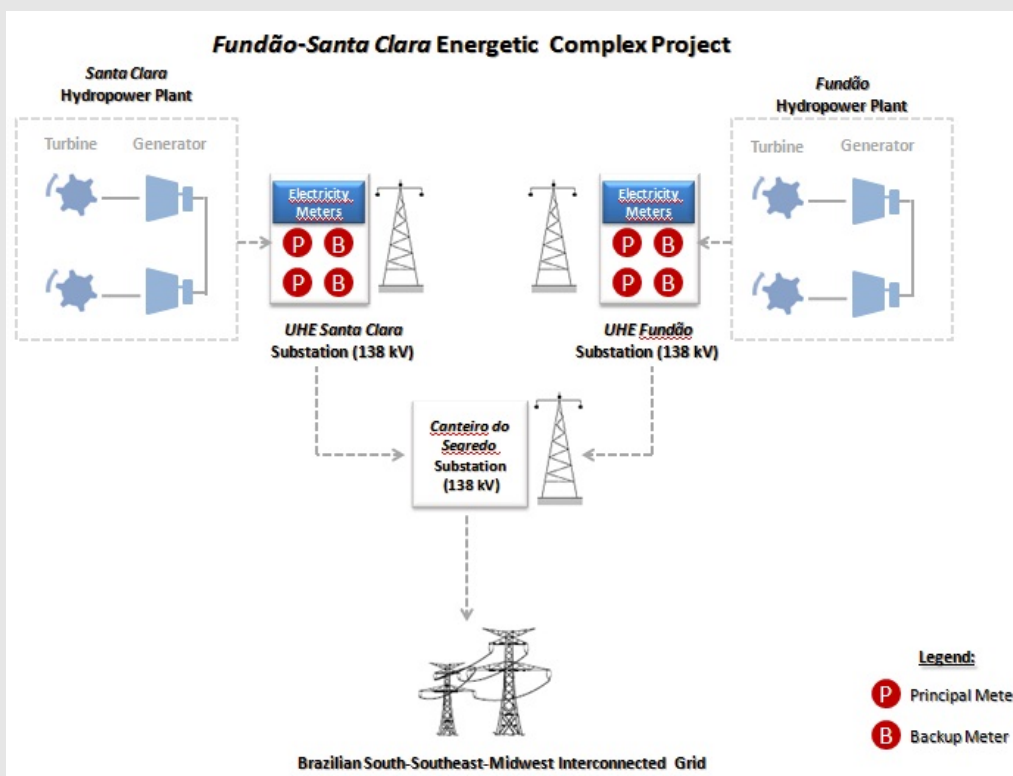
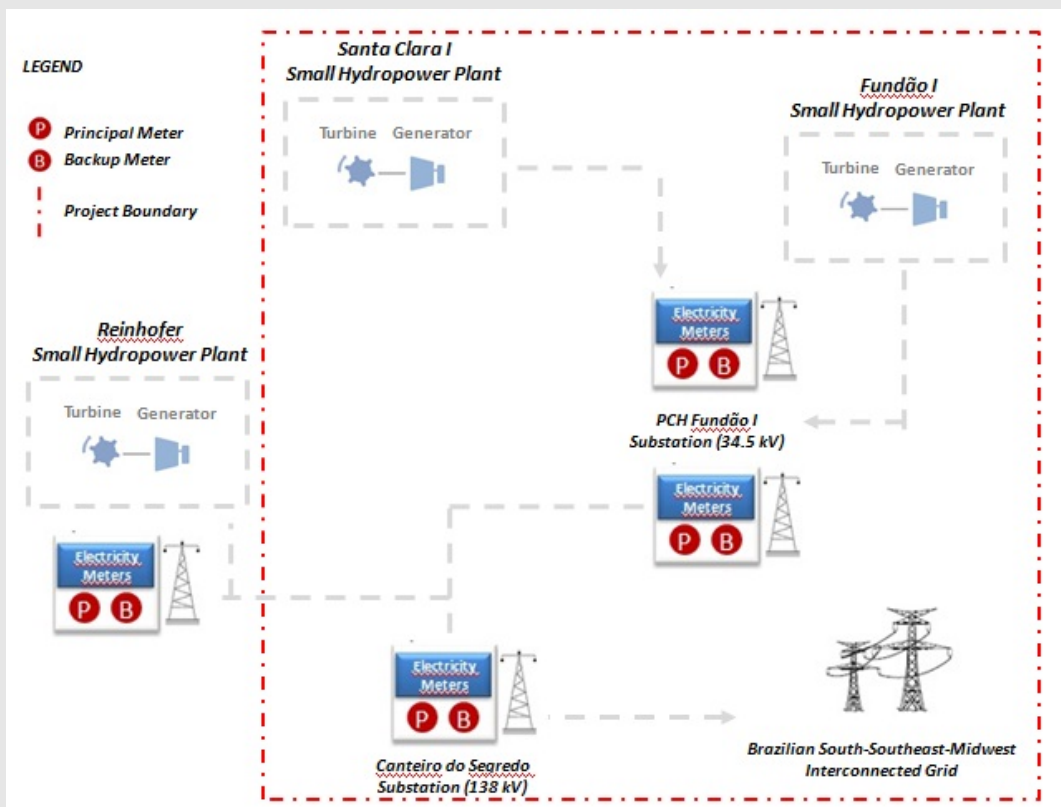


Figure 4: Illustration of the location of meters of *UHE Santa Clara* and *UHE Fundão*

The small hydro power plants present one generating unit each. It is important to mention that the *PCH Santa Clara I* meters (Principal and backup) are located in *PCH Fundão I* Substation.

It is important to mention that in September 2011 a small hydropower plant, called *CGH Reinhofer*, was connected to the 34.5 kV grid to *Canteiro do Segredo* Substation. For this reason two more meters (Principal and Backup) were installed in *PCH Fundão I* Substation to measure the total of energy generated by *PCH Fundão I* and *PCH Santa Clara I*.

To measure the net energy delivered to the national grid by the project activity, it is necessary to measure the total energy produced by *PCH Fundão I* and *PCH Santa Clara I*, minus the losses between the *PCH Fundão I* Substation and the *Canteiro do Segredo* Substation. Figures 04 and 05 represent the locations of the power plants meters.



Hence, the project activity has twelve meters which monitor the net energy generated by the plants which is dispatched to the grid. The table 6 presents the technical specifications of the meters used to measure net electricity generated and their locations.

Description				Manufacturer	Type /Model	Number
Hydropower Plant	Generating Unit (GU)	Meter	Location			
UHE Santa Clara	1 st GU	Principal	UHE Santa Clara Substation	Schneider	ION 8600	PT-0901A223-01
		Backup		Schneider	ION 8600	PT-0901A224-01
	2 nd GU	Principal		Schneider	ION 8600	PT-0902A253-01
		Backup		Schneider	ION 8600	PT-1106A693-01
PCH Santa Clara I	GU	Principal	PCH Fundão Substation	Schneider	ION 8600	PT-0901A238-01
		Backup		Schneider	ION 8600	PT-0901A240-01
UHE Fundão	1 st GU	Principal	UHE Fundão Substation	Schneider	ION 8600	PT-0808A278-01
		Backup		Schneider	ION 8600	PT-0808A286-01
	2 nd GU	Principal		Schneider	ION 8600	PT-0710A307-01
		Backup		Schneider	ION 8600	PT-0710A309-01
PCH Fundão I + PCH Santa Clara I	GU	Principal	Canteiro do Segredo Substation	Schneider	ION 8600	PT-0708A426-01
		Backup		Schneider	ION 8600	PT-0708A427-01
PCH Fundão + PCH Santa Clara + CGH Reinhofer	GU	Principal	Canteiro do Segredo Substation	Schneider	ION 8600	PT-1105A036-01
		Backup		Schneider	ION 8600	PT-1105A037-01

Table 4: Net energy meters

For each generating unit of both large and small scale hydropower plants of the complexes there are two net energy meters, one functioning as principal meter and another as the backup meter. The type, model, precision class and calibration of these equipments are in accordance with the requirements set by ONS⁸. Table 5 presents the meters used during the monitoring period and the calibration certificates number of each meter as well as the dates in which these meters were last calibrated or replaced. All of the meters possess a precision class of 0.2%.

Description	GU*	Meter	Serial Number	Date of the Last Calibration (DD/MM/YY)	Calibration Certificate Number	Date of Previous Calibration ⁹ (DD/MM/YY)	Calibration Certificate Number	Calibration delayed at the period (Yes/No)
UHE Santa Clara	1st GU	Principal	PT-0901A223-01	15/02/12	RCM-007/2012	23/03/2010	RCM-012/2010	No
		Backup	PT-0901A224-01	16/02/12	RCM-009/2012	24/03/2010	RCM-013/2010	No
	2nd GU	Principal	PT-0902A253-01	15/02/12	RCM-008/2012	24/03/2010	RCM-014/2010	No
		Backup	PT-1106A693-01	07/05/13	RCM-021/2013	-	-	No
		Replaced	PT-0901A295-01	16/02/12	RCM-010/2012	24/03/2010	RCM-015/2010	No
PCH Santa Clara I	GU	Principal	PT-0901A238-01	30/05/12	RCM-040/2012	19/08/2010	RCM-047/2010	No
		Backup	PT-0901A240-01	31/05/12	RCM-042/2010	20/08/2010	RCM-048/2010	No
UHE Fundão	1st GU	Principal	PT-0808A278-01	13/06/12	RCM-046/2012	18/08/2010	RCM-043/2010	No
		Backup	PT-0808A286-01	14/06/12	RCM-048/2012	19/08/2010	RCM-044/2010	No
	2nd GU	Principal	PT-0710A307-01	13/06/12	RCM-047/2012	18/08/2010	RCM-045/2010	No
		Backup	PT-0710A309-01	14/06/12	RCM-049/2012	24/03/2010	RCM-008/2010	No
PCH Fundão I + PCH Santa Clara I	GU	Principal	PT-0708A426-01	23/05/12	RCM-038/2012	19/08/2010	RCM-046/2010	No
		Backup	PT-0708A427-01	24/05/12	RCM-039/2012	06/07/2010	RCM-033/2010	No
PCH Fundão + PCH Santa Clara + CGH Reinholfer	GU	Principal	PT-1105A036-01	25/10/11	RCM-038/2011	PT-1105A036-01	-	No
		Backup	PT-1105A037-01	25/10/11	RCM-039/2011	PT-1105A037-01	-	No

*GU=Generation Unit

Table 5: Calibration certificates of the energy meters.

According to the registered monitoring plan and to the procedures established by ONS (Module 12.3), states that the meters should be calibrated every two years. As it can be seen from data presented in Table 5, all the meters are calibrated and no delays were found. All calibrations reports will be available to DOE at the time of verification.

⁸ National System Operator, in portuguese: "Operador Nacional do Sistema Elétrico". Available at: <http://www.ons.org.br> Accessed on April 10th, 2014.

⁹ In some cases there are two calibration certificates to ensure the calibration of a meter in the monitoring period covered. The "Date of Previous Calibrations" column will only present the dates and the certificate number when the period of the last calibration does not cover the entire monitoring period (September, 1st 2011 to December, 31st 2013). No delayed were found in this monitoring period.

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

Data / Parameter:	$EF_{Baseline, ex-ante\ 2003-2005}$
Unit:	tCO _{2e} /MWh
Description:	Combined margin CO ₂ emission factor of the grid
Source of data:	Calculated
Value(s) applied:	0.2611
Purpose of data:	This parameter is used to calculate the baseline emissions.
Additional comment:	Calculated as a weighted average of the OM and BM emission factors.

Data / Parameter:	$EF_{OM, 2003-2005y}$
Unit:	tCO _{2e} /MWh
Description:	CO ₂ Operating Margin emission factor of the grid.
Source of data:	Factor calculated with data from ONS.
Value(s) applied:	0.4349
Purpose of data:	This parameter is used to calculate the baseline emissions.
Additional comment:	Calculated <i>ex-ante</i> (2003-2005) as indicated in section B.6.1 of the registered PDD.

Data / Parameter:	$EF_{BM, 2005}$
Unit:	tCO _{2e} /MWh
Description:	CO ₂ Build Margin emission factor of the grid.
Source of data:	Factor calculated with data from ONS.
Value(s) applied:	0.0872
Purpose of data:	This parameter is used to calculate the baseline emissions.
Additional comment:	Calculated <i>ex-ante</i> (2005) as indicated in section B.6.1 of the registered PDD.

D.2. Data and parameters monitored

Data / Parameter:	EG_y
Unit:	MWh
Description:	Electricity supplied to the grid by the project.
Measured/ Calculated Default:	Measured.
Source of data:	Onsite measurements.
Value(s) of monitored parameter:	3,130,289.32

Monitoring equipment:	Please, refer to section C for monitoring equipment description. <i>COPEL</i> is responsible for the calibration of the net energy meters which follows the procedures determined by the National Electric System Operator (from the Portuguese <i>Operador Nacional do Sistema Elétrico – ONS</i>). Section 12.3 of the procedures sets the requirements regarding the maintenance of the Billing Commensuration System (from the Portuguese, <i>Sistema de Medição e Faturamento - SMF</i>) according to which the calibration of the energy meters is to be done every two years.
Measuring/ Reading/ Recording frequency:	The energy is measured continuously and aggregated every 5 minutes. Information is reported to COPEL who represents ELEJOR at CCEE. Data is recorded and consolidated by the company hourly, diary, weekly and monthly and send to CCEE. All data will be archived electronically.
Calculation method (if applicable):	Not applicable.
QA/QC procedures:	These data will be directly used for calculation of emission reductions. Sales record to the grid and other records are used to ensure the consistency.
Purpose of data:	This parameter is used to calculate the baseline and project emissions.
Additional comment:	-

D.3. Implementation of sampling plan

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

According to the methodology, baseline emissions (BE_y) are the product of the baseline emissions factor (EF_y) times the electricity supplied by the project activity to the grid (EG_y), calculated as follows:

$$BE_y = EG_y \times EF_y \quad \text{Equation 1}$$

Where:

BE_y = Baseline emissions, in tCO₂e;

EG_y = Electricity supplied by the project activity to the grid, in MWh;

EF_y = Baseline emission factor, in tCO₂e/MWh

The Monitoring Report applies the ex-ante validated emission factor for project activities connected to the Brazilian South-Southeast-Midwest interconnected grid. The CO₂ emission factor of the grid is 0.2611 tCO₂e/MWh (Table 8). This factor was calculated based on parameters that were justified during the validation as stated in the registered PDD.

Table 8: Emission factor of the Brazilian grid (tCO₂/MWh).

As mentioned above, electricity supplied to the grid by the project (EG_y) is monitored by *ELEJOR*, *COPEL* and *CCEE*. The amount of electricity generated during the monitored period by the plants comprised by this CDM project activity and the baseline emissions are presented in table 9 and 10, respectively:

Emission factors for the Brazilian South-Southeast-Midwest interconnected grid				
Baseline (including imports)	EF_{OM} [tCO ₂ /MWh]	Load [MWh]	LCMR [MWh]	Imports [MWh]
2003	0.9823	288,933,290	274,670,644	459,586
2004	0.9163	302,906,198	284,748,295	1,468,275
2005	0.8086	314,533,592	296,690,687	3,535,252
Total (2003-2005) =		906,373,081	856,109,626	5,463,113
$EF_{OM, simple-adjusted}$ [tCO ₂ /MWh]		$EF_{BM,2005}$	Lambda	
0.4349		0.0872	λ_{2003}	
Default weights		Default weights	0.5312	
$w_{OM} = 0.5$		$w_{OM} = 0.5$	λ_{2004}	
$w_{BM} = 0.5$		$w_{BM} = 0.5$	0.5055	
Default EF_y [tCO ₂ /MWh]		Default EF_y [tCO ₂ /MWh]	λ_{2005}	
0.2611		0.2611	0.5130	

Year	Months	Santa Clara Complex Energy Generation (MWh)		Fundão Complex Energy Generation (MWh)	
		Large hydro power plant	Small hydro power plant	Large hydro power plant	Small hydro power plant
2011	September	81,211.13	2,339.45	63,380.53	1,658.88
	October	78,624.29	2,192.77	78,676.47	1,580.38
	November	77,174.69	2,333.15	77,961.70	1,619.43
	December	42,029.91	2,109.39	46,209.81	1,718.35
Sub-Total 2011		279,040.01	8,974.75	266,228.51	6,577.04
2012	January	14,066.95	2,275.01	16,330.21	1,729.08
	February	19,321.21	2,164.01	20,267.18	1,549.28
	March	42,607.47	2,348.98	43,581.15	1,566.80
	April	28,003.28	2,012.56	32,420.05	1,541.71
	May	67,079.49	2,344.80	66,632.54	1,140.98
	June	80,531.07	2,282.11	77,131.13	1,664.66
	July	79,631.18	2,368.30	77,481.14	1,673.36
	August	71,899.20	2,423.43	71,816.63	1,741.14
	September	33,600.15	2,094.90	37,842.94	1,555.76
	October	15,508.52	1,921.84	19,268.90	1,556.00
	November	15,326.24	2,300.57	17,249.03	1,523.42
December	35,603.53	2,463.37	36,798.98	1,738.05	
Sub-Total 2012		503,178.30	26,999.86	516,819.87	18,816.98
2013	January	73,333.45	2,464.00	71,842.20	1,556.34
	February	37,921.14	2,128.69	42,758.79	1,438.38
	March	67,681.77	2,431.91	72,055.39	1,541.28

April	82,333.03	2,428.05	80,106.84	1,477.84
May	65,678.98	2,334.64	68,381.38	577.55
June	72,313.92	2,160.10	72,844.99	1,323.98
July	87,007.34	2,515.25	83,696.45	1,530.31
August	52,920.73	2,466.17	42,576.54	1,538.38
September	52,063.18	2,205.88	44,129.48	1,376.38
October	71,813.12	2,321.21	58,660.86	1,439.86
November	52,028.01	1,838.59	56,314.29	1,390.27
December	22,934.60	2,113.77	28,115.46	1,543.21
Sub-Total 2013	738,029.27	27,408.24	721,482.67	16,733.80
TOTAL	1,520,247.59	63,382.86	1,504,531.05	42,127.82

Table 9: Electricity dispatched to the grid by the project activity.

Year	Months	Santa Clara Complex Baseline Emissions (tCO ₂ e)		Fundão Complex Baseline Emissions (tCO ₂ e)	
		Large hydro power plant	Small hydro power plant	Large hydro power plant	Small hydro power plant
2011	September	21,204.23	610.83	16,548.66	433.13
	October	20,528.80	572.53	20,542.43	412.64
	November	20,150.31	609.19	20,355.80	422.83
	December	10,974.01	550.76	12,065.38	448.66
Sub-Total 2011		72,857.35	2,343.31	69,512.26	1,717.26
2012	January	3,672.88	594.00	4,263.82	451.46
	February	5,044.77	565.02	5,291.76	404.52
	March	11,124.81	613.32	11,379.04	409.09
	April	7,311.66	525.48	8,464.87	402.54
	May	17,514.45	612.23	17,397.76	297.91
	June	21,026.66	595.86	20,138.94	434.64
	July	20,791.70	618.36	20,230.33	436.91
	August	18,772.88	632.76	18,751.32	454.61
	September	8,773.00	546.98	9,880.79	406.21
	October	4,049.28	501.79	5,031.11	406.27
	November	4,001.68	600.68	4,503.72	397.76
	December	9,296.08	643.18	9,608.21	411.18
Sub-Total 2012		131,379.86	7,049.66	134,941.67	4,913.11
2013	January	19,147.36	643.35	18,758.00	406.36
	February	9,901.21	555.80	11,164.32	375.56
	March	17,671.71	634.98	18,813.66	402.43
	April	21,497.15	633.96	20,915.90	385.86
	May	17,148.78	609.57	17,854.38	150.80

June	18,881.16	564.00	19,019.83	345.69
July	22,717.62	656.73	21,853.14	399.56
August	13,817.60	643.92	11,116.73	401.67
September	13,593.70	575.95	11,522.21	359.37
October	18,750.41	606.07	15,316.35	375.95
November	13,584.51	480.05	14,703.66	363.00
December	5,988.22	551.90	7,340.95	402.93
Sub-Total 2013	192,699.44	7,156.28	188,379.12	4,369.20
TOTAL	396,936.65	16,549.26	392,833.06	10,999.57

Table 10: Baseline emissions over the monitored period.

A spreadsheet with all calculations will be available to the DOE at the time of the verification.

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

According to the “Thresholds and criteria for the eligibility for the hydroelectric power plants with reservoirs as CDM project activity”¹⁰, emissions from reservoirs, if there is any, shall be estimated considering the power density (W/m^2) of the plant.

$$PD = \frac{Cap_{PJ} - Cap_{BL}}{A_{PJ} - A_{BL}} \quad \text{Equation 2}$$

Where:

PD = Power density of the project activity, in W/m^2 ;

Cap_{PJ} = Installed capacity of the hydro power plant after the implementation of the project activity (W);

Cap_{BL} = Installed capacity of the hydro power plant before the implementation of the project activity (W).

For new hydro power plants, this value is zero;

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

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

The power density of *Fundão* and *Santa Clara* Complexes were calculated in the registered PDD. The result is presented in the table below:

Characteristics	<i>Fundão</i> Complex	<i>Santa Clara</i> Complex
Installed Capacity (MW)	122.643	123.768
Reservoir Area (km^2)	2.15	20.14
Power Density (W/m^2)	57.04	6.14

Table 11: Power density of *Fundão* and *Santa Clara* Complex.

¹⁰ EB 23, annex 5, available at http://cdm.unfccc.int/EB/023/eb23_repan5.pdf. Accessed on December, 14th 2011.

As it can be seen, *Santa Clara Complex* presents a power density of 6.14 W/m². Therefore, project emissions are calculated according to the equation below:

$$PE_y = EG_y \times EF_{Res} \quad \text{Equation 3}$$

Where:

PE_y = project emissions (tCO_{2e}/year);

EF_{Res} = Default emission factor for emissions from reservoirs of hydro power plants in year y (90 kgCO_{2e}/MWh).

Considering equation above, the emission factor of the project reservoir of 90 kgCO_{2e}/MWh and the electricity exported to the grid by the project, project emissions are as reported in the table below:

Year	Months	Santa Clara Complex Project Emissions (tCO _{2e})		Fundão Complex Project Emissions (tCO _{2e})	
		Large hydro power plant	Small hydro power plant	Large hydro power plant	Small hydro power plant
2011	September	7,309.00	210.55	0	0
	October	7,076.19	197.35	0	0
	November	6,945.72	209.98	0	0
	December	3,782.69	189.84	0	0
Sub-Total 2011		25,113.60	807.73	0	0
2012	January	1,266.03	204.75	0	0
	February	1,738.91	194.76	0	0
	March	3,834.67	211.41	0	0
	April	2,520.30	181.13	0	0
	May	6,037.15	211.03	0	0
	June	7,247.80	205.39	0	0
	July	7,166.81	213.15	0	0
	August	6,470.93	218.11	0	0
	September	3,024.01	188.54	0	0
	October	1,395.77	172.97	0	0
	November	1,379.36	207.05	0	0
	December	3,204.32	221.70	0	0
Sub-Total 2012		45,286.05	2,429.99	0	0
2013	January	6,600.01	221.76	0	0
	February	3,412.90	191.58	0	0
	March	6,091.36	218.87	0	0
	April	7,409.97	218.52	0	0
	May	5,911.11	210.12	0	0

	June	6,508.25	194.41	0	0
	July	7,830.66	226.37	0	0
	August	4,762.87	221.95	0	0
	September	4,685.69	198.53	0	0
	October	6,463.18	208.91	0	0
	November	4,682.52	165.47	0	0
	December	2,064.11	190.24	0	0
	Sub-Total 2013	66,422.63	2,466.74	0	0
	TOTAL	136,822.28	5,704.45	0	0

Table 12: Project emissions over the monitored period.

A spreadsheet with all calculations will be available to the DOE at the time of the verification.

E.3. Calculation of leakage

According to the applicable methodology, leakage emissions by the project activity are zero.

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

According to the registered PDD, emission reductions by the project activity (ER_y) during a given period of year y are the product of the baseline emissions factor (EF_y , in tCO₂e/MWh) multiplied by the electricity supplied by the project to the grid (EG_y , in MWh), minus the project emission (PE_y , in tCO₂e) as follows:

$$ER_y = (EF_y \times EG_y) - PE_y \quad \text{Equation 4}$$

Considering the equation above and data presented in the previous sections, emission reductions of Fundão-Santa Clara Energetic Complex Project from September, 1st 2011 to December, 31st 2013, both days included are presented below:

Time Period		Baseline emissions or baseline net GHG removals by sinks (t CO ₂ e)	Project emissions or actual net GHG removals by sinks (t CO ₂ e)	Leakage (t CO ₂ e)	Emission reductions or net anthropogenic GHG removals by sinks (t CO ₂ e)
2011	September	38,797	7,520	0	31,277
	October	42,056	7,274	0	34,783
	November	41,538	7,156	0	34,382
	December	24,039	3,973	0	20,066

2012	January	8,982	1,471	0	7,511
	February	11,306	1,934	0	9,372
	March	23,526	4,046	0	19,480
	April	16,705	2,701	0	14,003
	May	35,822	6,248	0	29,574
	June	42,196	7,453	0	34,743
	July	42,077	7,380	0	34,697
	August	38,612	6,689	0	31,923
	September	19,607	3,213	0	16,394
	October	9,988	1,569	0	8,420
	November	9,504	1,586	0	7,917
	December	19,959	3,426	0	16,533
2013	January	38,955	6,822	0	32,133
	February	21,997	3,604	0	18,392
	March	37,523	6,310	0	31,213
	April	43,433	7,628	0	35,804
	May	35,764	6,121	0	29,642
	June	38,811	6,703	0	32,108
	July	45,627	8,057	0	37,570
	August	25,980	4,985	0	20,995
	September	26,051	4,884	0	21,167
	October	35,049	6,672	0	28,377
	November	29,131	4,848	0	24,283
	December	14,284	2,254	0	12,030
TOTAL	817,318.54	142,526.74	0.00	674,791.80	

Table 13: Emission Reductions over the monitored period.

A spreadsheet with all calculations will be available to the DOE at the time of the verification.

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 (t CO ₂ e)	619,698	674,791

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

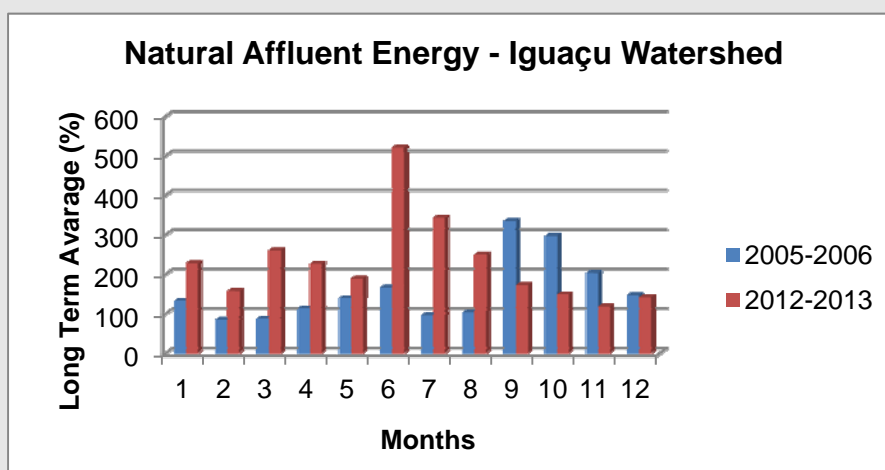
Considering the emission factor was determined during the validation of the proposed project activity (*ex-ante* option) and the emission factor used for calculate project emissions related to the reservoir is also a fixed value, the amount of emission reductions calculated during the monitored period may only differ from the values presented in the registered PDD due to a difference between the electricity generation by the plants. The total electricity generation, as estimated in the registered CDM PDD, for an equivalent monitoring period (from 1st September, 2011 until 31st December, 2013) is 2,867,666 MWh.

During the monitored period it was verified a total electricity generation equal to 3,130,289.32 MWh. This difference represents an increase of approximately 8.46% in the electricity generation. Due to this increase the emission reductions varied from 619,698 tCO₂e to 674,791.80 tCO₂e and increase of 8.89% of the emissions reductions.

In hydropower projects differences are expected to occur since the average river flow is directly dependent of any rainy season variation from year to year what also consequently impacts the water storage in the reservoirs. With the purpose of exemplifying the influence of rainy seasons and higher river flows in electricity generation, values of the Natural Affluent Energy (from the Portuguese *Energia Natural Afluente - ENA*), published by ONS, were considered.

The *ENA* represents the amount of water flowing into the reservoir that is available to electricity generation. The *ENA* is expressed in a percentage over the Long Term Average (from the Portuguese *Média de Longo Termo - MLT*) registered and is directly connected to the amount of rain feeding the river flow¹¹.

The chart below is the Natural Affluent Energy of *Iguaçu* Watershed, in which *Jordão* River is included. Comparing the data of the period monitored in this monitoring report and the same period from the two years before the baseline study, it can be observed that higher level of precipitation occurred in the fourth monitored period.



Graphic 1: Natural Affluent Energy of Iguaçu Watershed. (Source: *Operador Nacional do Sistema Elétrico – ONS*¹²).

¹¹ Available at: < http://www.abradee.com.br/glossario_conteudo.asp>. Accessed on 6th January 2012.

¹² Available at: http://www.ons.org.br/historico/energia_natural_afluente.aspx . Accessed on April, 10th 2014.

Therefore, it is reasonable to assume that the difference observed between the emission reductions calculated in the registered PDD and verified during the monitored period can be attributed to an increase in the river flow and the higher water availability where the plants are located.

Finally, it is also worth mentioning that *Fundão* and *Santa Clara* power plants are classified as Type I Power Plants¹³. This means that their programming and dispatching is directly oriented by the Electric System National Operator. In this sense, the decision to run or not the plants is made by ONS considering the entire interconnected system. In other words, the increase in electricity generation is not determined by the project owner.

E.7. Actual emission reductions or net anthropogenic GHG removals by sinks during the first commitment period and the period from 1 January 2013 onwards

Item	Actual values achieved up to 31 December 2012	Actual values achieved from 1 January 2013 onwards
Emission reductions or GHG removals by sinks (t CO ₂ e)	351,077	323,715

Document information

Version	Date	Description
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 anthropogenic GHG removals by sinks for the period up to 31 December 2012 and the period from 1 January 2013 onwards (EB70, 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	28 May 2010	EB 54, Annex 34. Initial adoption.

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¹³ http://www.ons.org.br/download/procedimentos/modulos/Modulo_26/Subm%C3%B3dulo%2026.1_Rev_1.0.pdf . Accessed on April 10th, 2014.