



**Eletrobras**

# **Inventory of Greenhouse Gas Emissions**

Base year 2012

May 2013



**Inventory of Greenhouse Gas Emissions – base year 2012**

# **Eletrobras Companies**

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## **base year 2012**

**May 2013**

**Climate Strategy Work group (GT 3)**

**Environment Subcommittee (SCMA)**

**Operation, Planning, Engineering and Environment Committee  
(Copem)**

**Superior Council of the Eletrobras System (Consize)**



## **Inventory of Greenhouse Gas Emissions – base year 2012**

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**Inventory of Greenhouse Gas Emissions – base year 2012**

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## 1. Presentation

The Inventory of Greenhouse Gas Emissions – base year 2012 is one of the instruments of the Climatic Strategy of the Eletrobras companies, configured, specifically, in its instrument of systematization and disclosure of information related to GHG emissions.

In May 2012, the Climatic Strategy of the Eletrobras companies was materialized in the publication of the **Declaration of Commitment of Eletrobras on Climate Change**, which strengthens the insertion of climate change in the areas of operation of the company. Among the various commitments assumed are: the search for a unified strategy for its companies in order to adopt practices that minimize or compensate for its GHG emissions; the prioritization in its project portfolio participating in sources of renewable energy; and the fostering of studies that seek to identify and comprise the risks and opportunities related to climate change for Eletrobras companies.

This document presents the results obtained for the Inventory of GHG Emissions of the Eletrobras companies related to the year of 2012, following the guidelines of the Sustainability Policy of Eletrobras companies and of the Resolution of the Executive Board no. 1262 of 2010, which establishes the commitment of elaborating the annual inventory of its greenhouse gas emissions. The emissions of the following greenhouse gas emissions (GHG) are identified as:

- Carbon Dioxide (CO<sub>2</sub>),
- Methane (CH<sub>4</sub>),
- Nitrose Oxide (N<sub>2</sub>O),
- Sulphur Hexafluoride (SF<sub>6</sub>),
- Hydrofluorocarbons (HFC) and
- Perfluorocarbons (PFC)

These emissions were calculated based on fifteen of the Eletrobras' companies: CGTEE, Furnas, Chesf, Eletronorte, Eletronuclear, Eletrosul, Amazonas Energia, Itaipu Binacional, Cepel, Eletrobras Distribuição Rondônia, Eletrobras Distribuição Piauí, Eletrobras Distribuição Acre, Eletrobras Distribuição Alagoas, Eletrobras Distribuição Roraima and the *holding* itself.

### Inventory of Greenhouse Gas Emissions – base year 2012

This inventory follows the methodology of the IPCC (2006) and the guidelines of the *Greenhouse Gas Protocol* (WRI, 2004) - *GHG Protocol*<sup>1</sup>, therefore, the emissions identified in this inventory were:

- Of Scope 1 (direct emissions): permanent sources (thermoelectric plants, diesel-generator groups and other permanent sources - LPG and natural gas used in kitchens and laboratories); mobile sources (by road, air and waterways) and fugitive emissions (sulphur hexafluoride "SF<sub>6</sub>", refrigeration gases, emissions originating from sewage treatment stations - STS and gas consumed in the recharging of fire extinguishers) (TABLE 1);
- Of Scope 2 (indirect emissions): electricity acquired through distribution networks, losses in transmission and losses in distribution.
- Of Scope 3 (indirect emissions): emissions originating from contracts with IEPs (independent electricity producers), air travel, transport of employees and inland logistics.

According to the guidelines on the continuous increases of sources in the inventory, this year two sources of emission of Scope 1 – fugitive emissions were included:

- Refrigeration gases and
- Emissions originating from STSs

In addition, there is also the presentation of the report on the estimated emissions of NO<sub>x</sub> and SO<sub>x</sub> of the Eletrobras companies, the estimated carbon sequestration by forestry in Itaipu, and other initiatives of reforestation by the Eletrobras companies.

This inventory was verified by an independent third party and all the information and memories of calculation, besides the identification of the sources of data are filed. The assurance letter of the independent auditors was issued on May 24, 2013 by KPMG Risk Advisory Services Ltda<sup>2</sup>.

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<sup>1</sup> *GHG Protocol*: corporate standard of accounting and communication of greenhouse gas emissions, launched in 1998 and reviewed in 2004, recognised internationally and currently the tool most widely used worldwide by companies and governments to understand, quantify and manage their emissions.

<sup>2</sup> *KPMG Risk Advisory Services Ltda* is a limited liability simple company in Brazil, and a member of the KPMG network of independent member companies and affiliated to KPMG International Cooperative ("KPMG International"), a Swiss entity.

## 2. Premises and procedures adopted

- The necessary information for the elaboration of the inventory was gathered in each of the companies through its representatives in the GT 3 - Strategic Climate Work Group, created in the scope of the SCMA - Environment Subcommittee of the Eletrobras companies;
- Regarding the organizational limits, this inventory, as in previous years, was elaborated based on the operational control<sup>3</sup>;
- The emissions corresponding to losses in the transmission of electric energy were calculated based on the 2012 Report on the Index of Losses in the Transmission of the Eletrobras System (Technical Information ETPO-001/2013) supplied by the transmission area of the holding. The result of the emissions of these losses was reported for each transmission company separately;
- The companies that distribute electric energy supply the values of their technical and commercial losses for the calculation of the respective emissions;
- The emissions resulting from the thermoelectric generation originating from Independent Producers of Electricity (IPEs), whose energy is acquired by the utility companies, Eletrobras Amazonas Energia, Eletrobras Eletronorte, Eletrobras Distribuição Rondônia, Eletrobras Distribuição Acre and Eletrobras Distribuição Roraima and retailed to end consumers, are quantified in Scope 3 and, therefore, are separate from emissions related to the thermoelectric park itself of Eletrobras companies, which are considered in Scope 1;
- The factors of emission of the fuels deriving from oil in Brazil are different to those used internationally due to the compulsory addition of a fraction of alcohol from sugar cane to these fuels, which reduces the polluting potential and modifies the carbon emission on burning;
- The CO<sub>2</sub> emissions from the consumption of biofuels (biodiesel and ethanol) are reported for the part of calculation of this inventory, because these emissions are reabsorbed through photosynthesis in the cultivation of sugar cane and soy bean, among other vegetables used in the production of these fuels;

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<sup>3</sup> On addressing the operational control an organization responds for 100% of the GHG emissions of the units under its operational control, and does not respond for those originating from operations in which it only has an equity share. Having operational control of a unit/operation consists in the fact that the organization - or one of its subsidiaries - has absolute authority to introduce policies in the operation in question.

**Inventory of Greenhouse Gas Emissions – base year 2012**

- The value of the energetic content of the fuels consumed was calculated based on the factors of conversion comprised in the BEN - Balanço Energético Nacional (National Energy Balance) 2012 (base year 2011);
- For the calculation of the emissions originating from the consumption of electricity, losses in transmission and losses in distribution, the factors of emission of the Sistema Interligado Nacional (National Grid System) were used, which are calculated and published by the Ministério da Ciência, Tecnologia e Inovação - MCTI (Ministry of Science, Technology and Innovation)<sup>4</sup>;
- Despite not considering emissions that contribute directly towards global warming, the emissions of SO<sub>x</sub> and NO<sub>x</sub> of the Eletrobras companies that have a thermal park and fossil fuels are reported in a separate chapter;
- As a last edition, there is an updated estimate of the carbon sequestration by the forest area existing in the permanent protection area (APP, in Portuguese) of the UHE Itaipu (Brazilian side), adding, to this edition, other initiatives of reforestation of the Eletrobras companies;
- The emissions of the hydroelectric reservoirs of the Eletrobras companies were not considered due to there not being, until now, international scientific consensus on the methodology that allows the estimation of the GHG emissions in these reservoirs and calculation of the balance of emissions (or net emissions) of the water bodies;

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<sup>4</sup> Available at: <http://www.mct.gov.br/index.php/content/view/321144.html#ancora>.



## Inventory of Greenhouse Gas Emissions – base year 2012

**TABLE 1. History of the scopes and sources of the inventory by the Eletrobras companies**

	GHG Inventory 2008 Edition	GHG Inventory 2009 Edition	GHG Inventory 2010 Edition	GHG Inventory 2011 Edition	GHG Inventory 2012 Edition	GHG Inventory 2013 Edition
Unit	Gg CO <sub>2</sub> e	Gg CO <sub>2</sub> e	t CO <sub>2</sub> e	t CO <sub>2</sub> e	t CO <sub>2</sub> e	t CO <sub>2</sub> e
Coverage	only in 2005	from 2003 to 2008	2009	2010	2011	2012
Approach	Operational Control (GHG Protocol)	Operational Control (GHG Protocol)	Operational Control (GHG Protocol)	Operational Control (GHG Protocol)	Operational Control (GHG Protocol)	Operational Control (GHG Protocol)
Methodology	IPCC 2006	IPCC 2006	IPCC 2006	IPCC 2006	IPCC 2006	IPCC 2006
Content	Only part of <b>Scope 1</b> : direct emission from permanent sources (UTES)	Only part of <b>Scope 1</b> : direct emission from permanent sources (UTES)	<b>Scope 1</b> : Direct emissions from permanent sources (UTES), mobile sources, fugitive emissions of SF <sub>6</sub> <b>Scope 2</b> : emissions from the quantity of energy acquired from the grid	<b>Scope 1</b> : Direct emissions from permanent sources (UTES), mobile sources, fugitive emissions (SF <sub>6</sub> and extinguishers), other permanent sources (LPG, natural gas, diesel from generating groups and auxiliary boilers) <b>Scope 2</b> : emissions from the quantity of energy acquired from the grid, losses in transmission <b>Scope 3</b> : independent producers of electricity (IPes) <b>Other sources</b> : contracts of electric energy	<b>Scope 1</b> : Direct emissions from permanent sources (UTES), mobile sources, fugitive emissions (SF <sub>6</sub> and extinguishers), other permanent sources (LPG, natural gas, diesel from generating groups and auxiliary boilers) <b>Scope 2</b> : emissions from the quantity of energy acquired from the grid, losses in transmission, losses in distribution <b>Scope 3</b> : independent producers of electricity (IPes), air travel, inland logistics, transport of employees	<b>Scope 1</b> : Direct emissions from permanent sources (UTES), mobile sources, fugitive emissions (SF <sub>6</sub> and extinguishers and STS), other permanent sources (LPG, natural gas, diesel from generating groups and auxiliary boilers) <b>Scope 2</b> : emissions from the quantity of energy acquired from the grid, losses in transmission, losses in distribution <b>Scope 3</b> : independent producers of electricity (IPes), air travel, inland logistics, transport of employees
Gases	CO <sub>2</sub> CH <sub>4</sub> N <sub>2</sub> O	CO <sub>2</sub> CH <sub>4</sub> N <sub>2</sub> O	CO <sub>2</sub> CH <sub>4</sub> N <sub>2</sub> O SF <sub>6</sub>	CO <sub>2</sub> CH <sub>4</sub> N <sub>2</sub> O SF <sub>6</sub>	CO <sub>2</sub> CH <sub>4</sub> N <sub>2</sub> O SF <sub>6</sub>	CO <sub>2</sub> CH <sub>4</sub> N <sub>2</sub> O SF <sub>6</sub> PFC HFC

### 3. Results

The total GHG emission of the Eletrobras Companies in 2012 was of 11,772,144 tCO<sub>2</sub>e (TABLE 2). Of this total, 69% derive from direct emissions (scope 1), 14% from indirect emissions (scope 2), and 17% from indirect emissions of scope 3.

Considering the sum of the three scopes in the inventory, the share of "Usinas Termelétricas Próprias" (UTE - Own Thermoelectric Plants) represents 67% of the total emission, which is the highest source of GHG emission of the Eletrobras companies.

Of the total direct emissions (scope 1), 96% originate in the thermoelectric generation (UTE), while the fugitive emissions represent 3% and the mobile sources 0.38% of the emissions of scope 1.

Of scope 2, 70% of the emissions derive from the losses in transmission, 29% from losses in distribution and less than 1% are emissions from the consumption of electric energy.

The emissions of the Independent Producers of Electricity (IPE) correspond to the highest share of emissions of scope 3 (99%). The sum of the share of "air travel", "transport of employees" and "inland logistics" add up to almost 1% of this scope.

Table 3 presents CO<sub>2</sub> emissions deriving from the burning of the biofuels, ethanol and biodiesel (B-100), which are not included in the calculation of the inventory because this gas is reabsorbed in the photosynthesis process.

**Inventory of Greenhouse Gas Emissions – base year 2012**

**TABLE 2. Greenhouse Gas Emissions of the Eletrobras Companies – Base Year 2012 (tCO<sub>2</sub>e)**

COMPANY	Scope 1										Scope 2			Scope 3				SUBTOTAL PER COMPANY
	Permanent			Mobile			Fugitive				Electricity Consumption	Losses in Transmission	Losses in Distribution	IPE	Air Travel	Transport of Participants	Transport and Distribution	
	Own UTEs	Generators	Other	By Road	On Water	By Air	SF6	Refrigeration	STSs	Extinguishers								
CGTEE	3,317,889	n.a.	0	330	n.a.	n.a.	0	0	295	2	128	n.a.	n.a.	n.a.	110	525	3,634	<b>3,322,914</b>
Chesf	5,066	63	11	4,437	n.a.	347	47,561	n.avail	n.a.	16	995	239,230	n.a.	n.a.	2,354	n.a.	n.avail	<b>300,080</b>
Furnas	318,681	4	76	4,629	n.a.	8	204,347	812	677	31	2,331	615,689	n.a.	n.a.	2,751	n.a.	n.avail	<b>1,150,036</b>
Eletronorte	643,697	129	27	3,259	9	2	14,842	0	61	38	885	124,385	n.a.	200,281	2,256	309	11	<b>990,191</b>
Eletronuclear	n.a.	1,707	42	1,082	15	n.a.	n.a.	305	7	7	1,837	n.a.	n.a.	n.a.	704	1,861	19	<b>7,587</b>
Eletrosul	n.a.	54	12	1,687	n.a.	101	2,498	130	n.avail	3	658	185,442	n.a.	n.a.	140	163	2	<b>190,890</b>
Amazonas Energia	3,569,586	n.avail	n.a.	1,230	n.avail	n.avail	0	13	n.avail	6	n.a. <sup>5</sup>	n.a.	243,494	1,395,270	1,224	n.avail	n.avail	<b>5,210,824</b>
Itaipu	n.a.	19	51	514	9	n.a.	7,170	536	n.a.	4	142	n.a.	n.a.	n.a.	979	1,029	42	<b>10,494</b>
Cepel	n.a.	n.a.	44	70	n.a.	n.a.	0	0	n.a.	2	452	n.a.	n.a.	n.a.	260	468	n.a.	<b>1,295</b>
Eletrobras Holding	n.a.	n.a.	n.a.	19	n.a.	n.a.	n.a.	0	n.a.	1	389	n.a.	n.a.	n.a.	2,433	n.a.	n.a.	<b>2,842</b>
Distribuição Acre	n.a.	n.a.	247	148	n.a.	n.a.	827	0	n.a.	0	72	n.a.	14,393	118,186	285	19	234	<b>134,411</b>
Distribuição Alagoas	n.a.	2	n.a.	1,745	n.a.	n.a.	0	68	n.a.	1	274	n.a.	81,756	n.a.	219	525	1,354	<b>85,942</b>
Distribuição Rondônia	n.a.	2	143	9,383	n.a.	n.a.	0	0	n.a.	2	257	n.a.	52,763	199,328	599	n.a.	n.avail	<b>262,477</b>
Distribuição Roraima	n.a.	n.a.	n.a.	244	n.a.	n.a.	n.avail	n.avail	n.a.	0	173	n.a.	6,511	10,415	n.avail	n.a.	n.avail	<b>17,343</b>
Distribuição Piauí	n.a.	4	n.a.	1,805	n.a.	n.a.	574	n.avail	n.a.	3	266	n.a.	81,973	n.a.	195	n.a.	n.avail	<b>84,820</b>
Subtotal of Sources	<b>7,854,919</b>	<b>1,983</b>	<b>653</b>	<b>30,582</b>	<b>32</b>	<b>458</b>	<b>277,819</b>	<b>1,864</b>	<b>1,042</b>	<b>113</b>	<b>8,860</b>	<b>1,164,746</b>	<b>480,890</b>	<b>1,923,479</b>	<b>14,511</b>	<b>4,898</b>	<b>5,296</b>	<b>TOTAL</b>
Subtotal Types of Sources	<b>7,857,555</b>			<b>31,072</b>			<b>280,838</b>				<b>8,860</b>	<b>1,164,746</b>	<b>480,890</b>	<b>1,923,479</b>	<b>14,511</b>	<b>4,898</b>	<b>5,296</b>	<b>(tCO<sub>2</sub>e)</b>
Subtotal Scopes	<b>8,169,464</b>										<b>1,654,496</b>			<b>1,948,185</b>				<b>11,772,144</b>

Key: n.a. – not applicable n.avail. - data not available

<sup>5</sup> As Eletrobras Amazonas Energia generates and distributes electric energy in its area of operation, its emissions deriving from the consumption of electric energy (scope 2) are not included, since these emissions have already been considered in scope 1.

**Inventory of Greenhouse Gas Emissions – base year 2012**
**TABLE 3. Emission of CO<sub>2</sub> from the biofuels, ethanol and biodiesel (B-100) – base year 2012**

<b>Company</b>	<b>tCO<sub>2</sub></b>
CGTEE	267.20
Chesf	1,833.15
Furnas	1,352.84
Eletronorte	39,715.30
Eletronuclear	359.67
Eletrosul	214.36
Amazonas Energia	107,392.89
Itaipu	502.64
Cepel	42.24
Eletrobras Holding	50.20
Distribuição Acre	5,585.67
Distribuição Alagoas	309.40
Distribuição Rondônia	9,999.48
Distribuição Roraima	514.36
Distribuição Piauí	133.74
<b>TOTAL</b>	<b>168,273.13</b>

Table 4 presents the participation of each gas in the GHG emissions of the Eletrobras companies in tCO<sub>2</sub>e. CO<sub>2</sub> represents 97% of the total emission, followed by SF<sub>6</sub> (2%), N<sub>2</sub>O (0.26%), CH<sub>4</sub> (0.06%) and the refrigeration gases – HFCs and PFCs (0.02%).



Inventory of Greenhouse Gas Emissions – base year 2012

**TABLE 4. Greenhouse Gas Emissions of the Eletrobras Companies per type of gas (tCO<sub>2</sub>e) - Base year 2012**

COMPANY	CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	SF <sub>6</sub>	HFCs and PFCs	SUBTOTAL	(%)
CGTEE	3,305,770.85	1,094.77	16,048.10	0.00	0.00	3,322,913.72	28.23%
Chesf	252,399.47	15.82	103.28	47561.00	n.a.	300,079.57	2.55%
Furnas	943,707.78	827.94	340.78	204347.39	811.87	1,150,035.75	9.77%
Eletronorte	972,230.69	818.01	2,300.15	14841.90	0.00	990,190.75	8.41%
Eletronuclear	7,197.39	16.47	67.89	n.a.	305.20	7,586.95	0.06%
Eletrosul	188,208.12	7.57	45.98	2498.03	130.00	190,889.70	1.62%
Amazonas Energia	5,197,136.41	3,636.43	10,037.91	0.00	13.00	5,210,823.75	44.26%
Itaipu	2,746.43	4.66	37.31	7170.00	536.00	10,494.39	0.09%
Cepel	1,281.65	1.59	11.68	0.00	0.00	1,294.91	0.01%
Eletrobras Holding	2,817.41	0.70	24.39	n.a.	0.00	2,842.49	0.02%
Distribuição Acre	133,154.75	106.61	322.23	826.94	0.00	134,410.53	1.14%
Distribuição Alagoas	85,785.10	11.02	78.47	0.00	67.60	85,942.19	0.73%
Distribuição Rondônia	261,568.37	199.19	709.72	0.00	0.00	262,477.28	2.23%
Distribuição Roraima	17,299.23	10.29	33.23	n.avail.	n.avail.	17,342.75	0.15%
Distribuição Piauí	84,205.33	4.17	36.42	573.60	n.avail.	84,819.52	0.72%
SUBTOTAL	11,455,508.98	6,755.24	30,197.52	277,818.86	1,863.67	<b>TOTAL 11,772,144.26</b>	
(%)	97.31	0.06	0.26	2.36	0.02		

Key: n.a. – not applicable n.avail. - data not available

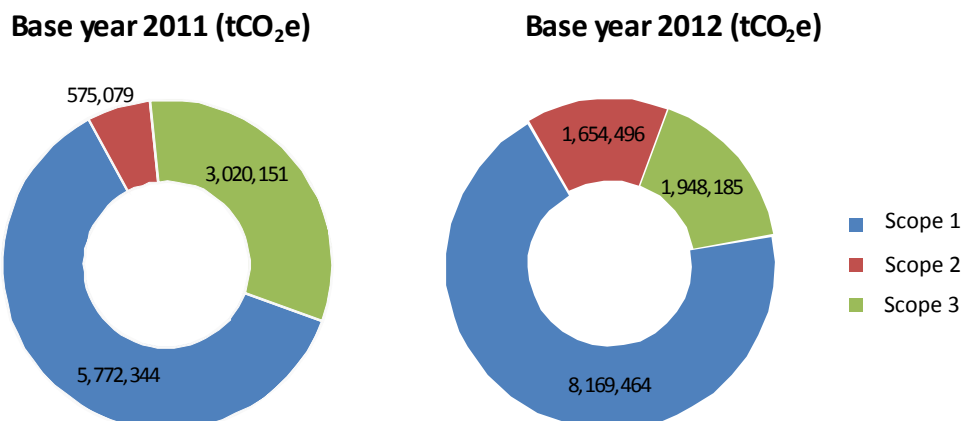
**Inventory of Greenhouse Gas Emissions – base year 2012**

In comparison to the total value of the inventory in 2011 (9,367,573 tCO<sub>2</sub>e), the total emission of the Eletrobras companies increased 25% (11,772,144 tCO<sub>2</sub>e). Most of this increment is in scope 1, which grew 41% in comparison to 2011 (FIGURE 1). Scope 2, despite having a lower burden on the division of emissions, also contributed towards the increase in the total emission of 2012, with an expansion of 187% in comparison to base year 2011. Now the emissions of scope 3 reduced 35% in comparison to those of 2011.

The highest dispatch of the thermoelectric plants by the ONS (National Power System Operator) in 2012, due to the decreased volume of water stored in the reservoirs of the hydroelectric plants, is the main factor that explains the emissions of scope 1. The GHG emission of the UTEs in 2012 increased 40% in comparison to 2011. In addition, there was the aggregation of new sources of emission of scope 1 (refrigeration gases and STS emissions), which contributed marginally towards this increase.

The emissions of all the sources of scope 2 increased in 2012 in comparison to the base year 2011: consumption of electricity (73% increase), losses in transmission (253%) and losses in distribution (100%). This increment is explained mainly by the increase of the factor of emission of the SIN (National Interconnected System) in 2012, which went from 0.029 tCO<sub>2</sub>/MWh (annual average), in 2011, to 0.065 tCO<sub>2</sub>/MWh, in 2012. In addition, in the case of consumption of electricity, the increase can also be attributed to a higher coverage of data. In the case of transmission and distribution, the increase of the technical losses is proportional to the increase of energy transported by the cables.

The emissions of scope 3 decreased mainly due to the interconnection with the SIN of some areas that used to be isolated from the Northern region of the country, which caused a reduction in the generation of thermoelectric plants operated by independent producers of electricity. This source reduced its emissions by 36%, or 1,069,815 tCO<sub>2</sub>e.

**Inventory of Greenhouse Gas Emissions – base year 2012**


**FIGURE 1. Comparative of the GHG emissions per scope of the Eletrobras Companies – base year 2011 and 2012**

In table 5 it is possible to observe the consumption of electric energy (MWh) of each Eletrobras company in the base year 2012.

**TABLE 5. Electric energy acquired by the concessionaires - base year 2012**

Company	MWh
CGTEE	1,982.57
CHESF	15,204.53
FURNAS	37,193.12
ELETRONORTE	13,704.55
ELETRONUCLEAR	28,461.12
ELETROSUL	9,950.85
AMAZONAS	n.a. <sup>6</sup>
ITAIPU	2,214.90
CEPEL	6,835.15
ELETROBRAS HOLDING	5,911.36
DISTRIBUIÇÃO ACRE	1,069.55
DISTRIBUIÇÃO ALAGOAS	4,240.97
DISTRIBUIÇÃO RONDÔNIA	3,894.13
DISTRIBUIÇÃO RORAIMA	2,484.88
DISTRIBUIÇÃO PIAUI	3,920.00
<b>Total</b>	<b>137,067.67</b>

<sup>6</sup> As Eletrobras Amazonas Energia generates and distributes electric energy in its area of operation, its emissions deriving from the consumption of electric energy (scope 2) are not included, since these emissions have already been considered in scope 1.

**Inventory of Greenhouse Gas Emissions – base year 2012**

Tables 6 and 7 show the history of the GHG inventory of the Eletrobras companies per scope and per company. The values presented show the increase of coverage of the inventory and also of the sources in the inventory.

**TABLE 6. Temporal evolution of the GHG emission of the Eletrobras companies per scope**

	GHG emission (tCO <sub>2</sub> e)							
	2009	%	2010	%	2011	%	2012	%
<b>Scope 1</b>	7,336,062	99.58	5,053,803	58.31	5,772,344	61.62	8,169,464	69.40
<b>Scope 2</b>	31,198	0.42	554,314	6.40	575,079	6.14	1,654,496	14.05
<b>Scope 3</b>	n.i.	n.i.	3,058,828	35.29	3,020,151	32.24	1,948,185	16.55
<b>Total</b>	7,367,259	100	8,666,946	100	9,367,574	100	11,772,144	100

Key: n.i. - not included in the inventory





**Inventory of Greenhouse Gas Emissions – base year 2012**

**TABLE 7. Temporal evolution of the GHG emission of the Eletrobras Companies**

<b>Company</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010*</b>	<b>2011</b>	<b>2012</b>
CGTEE	1,984,630	2,298,340	2,525,610	2,631,520	2,196,730	1,497,570	1,483,830	1,340,800	2,598,888	3,322,914
CHESF	224,730	54,280	35,460	3,560	45,090	594,070	652,680	26,084	131,059	300,080
FURNAS	394,780	170,550	149,880	4,110	24,940	144,440	114,730	105,395	399,507	1,150,036
ELETRONORTE	1,187,350	2,298,340	1,882,750	1,116,700	1,584,510	1,630,150	1,667,670	490,439	1,956,962	990,191
ELETRONUCLEAR	2,610	1,484,250	2,280	3,190	3,140	2,650	6,070	7,906	4,720	7,587
ELETROSUL	–	–	–	–	–	–	8,690	11,348	61,847	190,890
AMAZONAS ENERGIA	789,230	816,730	1,170,350	930,300	1,066,830	1,231,560	4,002,700	4,641,068	3,739,712	5,210,824
ITAIPU	–	–	–	–	–	–	16,310	9,192	10,040	10,494
CEPEL	–	–	–	–	–	–	1,070	959	832	1,295
ELETROBRAS holding	–	–	–	–	–	–	180	329	2,821	2,842
ELETROBRAS D. Rondônia	–	–	–	–	–	–	–	1,396,267	232,149	134,411
ELETROBRAS D. Acre	–	–	–	–	–	–	–	96,034	116,772	85,942
ELETROBRAS D. Piauí	–	–	–	–	–	–	–	3,391	38,967	262,477
ELETROBRAS D. Alagoas	–	–	–	–	–	–	–	–	38,323	17,343
ELETROBRAS D. Roraima	–	–	–	–	–	–	–	–	34,977	84,820
<b>ELETROBRAS Companies</b>	<b>4,583,340</b>	<b>4,826,470</b>	<b>5,766,330</b>	<b>4,689,370</b>	<b>4,921,240</b>	<b>5,100,450</b>	<b>7,366,540</b>	<b>8,666,946</b>	<b>9,367,574</b>	<b>11,772,144</b>

N.B. \* For the base year 2010 the emissions due to the losses in transmission were calculated for the group of companies (537,734.82 tCO<sub>2</sub>e); Until the base year 2008 the inventory was made of the emissions originating from the burning of fuels in thermoelectric plants, for this reason only six companies have been listed; the distribution companies started reporting their emissions from the inventory of base year 2010.

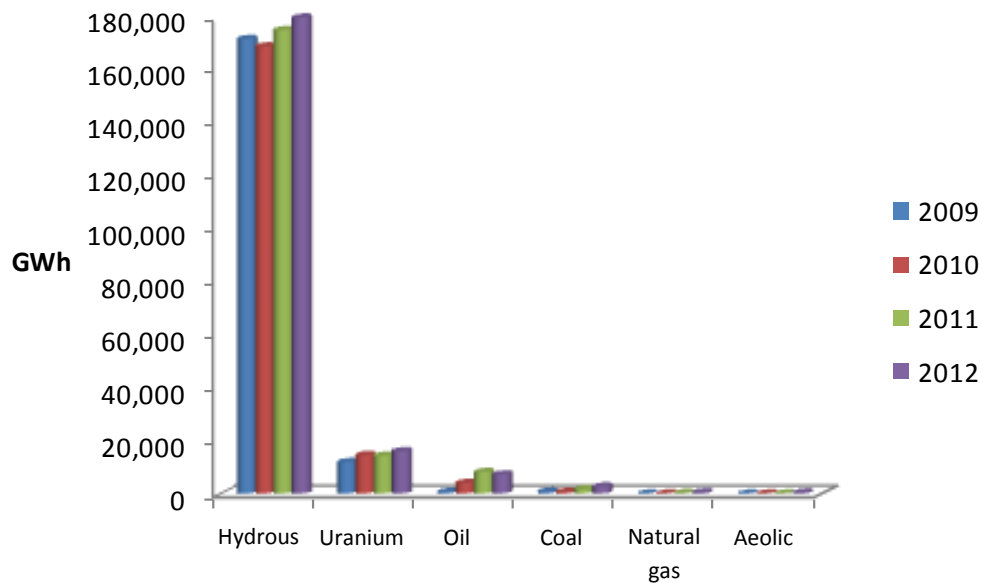
**Inventory of Greenhouse Gas Emissions – base year 2012**

The total net generation of Eletrobras companies in 2012 was of 207,405,000 MWh. Of this total, almost 86% correspond to hydroelectric generation, 8% to nuclear generation and 0.16% to aeolic generation. The GHG emission sources added together correspond to 5% of the total generation (TABLE 8 and FIGURE 2).

**TABLE 8. Temporal evolution of the primary energy generation of the Eletrobras companies per source**

Primary source of energy	Net Generation (GWh)							
	2009	%	2010	%	2011	%	2012	%
Hydrous	171,931	92.871	169,105	89.843	175,304	87.827	180,757	86.320
Uranium	11,877	6.415	14,544	7.727	14,351	7.190	16,007	7.716
Oil	586	0.317	3,956	2.102	8,135	4.076	7,159	3.415
Coal	724	0.391	613	0.325	1,620	0.812	2,677	1.291
Natural Gas	10	0.005	6	0.003	192	0.096	473	0.228
Aeolic	0	0.000	0	0.000	0	0.000	333	0.160
Total	185,128	100	188,223	100	199,602	100	207,405	100

**Net generation per primary source of energy**



**FIGURE 2. History of generation of primary energy of Eletrobras companies**

**Inventory of Greenhouse Gas Emissions – base year 2012**

The intensity of emission of Eletrobras companies in the base year 2012 was of 0.0568 tCO<sub>2</sub>e/MWh (TABLE 9). Regarding the base year 2011, this value had an increase of 20% (TABLE 10) due to the higher dispatch by the ONS of the thermoelectric plants.

**TABLE 9. Intensity of emission of the Eletrobras companies in 2012**

<b>Eletrobras Companies</b>	<b>Emissions (t CO<sub>2</sub>e)</b>	<b>Total Net Generation (MWh)</b>	<b>t CO<sub>2</sub>e/MWh</b>
CGTEE	3,322,914	2,677,000	1.2413
Chesf	300,080	50,003,000	0.0060
Furnas	1,150,036	39,786,000	0.0289
Eletronorte	990,191	42,236,000	0.0234
Eletronuclear	7,587	16,007,000	0.0005
Eletrosul	190,890	524,000	0.3643
Amazonas Energia	5,210,824	6,968,000	0.7478
Itaipu	10,494	49,144,000	0.0002
Cepel	1,295	-	-
Eletrobras Holding	2,842	46,000	0.0618
Distribuição Acre	134,411	-	-
Distribuição Alagoas	85,942	-	-
Distribuição Rondônia	262,477	-	-
Distribuição Roraima	17,343	-	-
Distribuição Piauí	84,820	-	-
<b>Total</b>	<b>11,772,144</b>	<b>207,405,000</b>	<b>0.0568</b>

**TABLE 10. Temporal evolution of the Intensity of Emission of the Eletrobras Companies**

	<b>2010</b>	<b>2011</b>	<b>2012</b>
Emissions (t CO <sub>2</sub> e)	8,666,945.79	9,367,574	11,772,144
Total Net Generation (MWh)	186,620,693	197,943,000	207,405,000
t CO <sub>2</sub> e/MWh	0.0464	0.0473	0.0568

**Inventory of Greenhouse Gas Emissions – base year 2012**

The intensity of emission of the Eletrobras companies is low when compared to the other corporations of the same sector and of equivalent size in the world (TABLE 11). This is due to the majority share of sources of low intensity of GHG emission in the main generation of the Eletrobras companies, reaching the mark of 94% of its total net generation (see TABLE 8).

**TABLE 11. Intensity of average emission (tCO<sub>2</sub>e/MWh) of the electric sector in the world in comparison to the Eletrobras Companies**

	tCO <sub>2</sub> /MWh
World <sup>1</sup>	0.520
OECD* <sup>1</sup>	0.440
Other countries <sup>1</sup>	0.600
Eletrobras Companies <sup>2</sup>	0.057

N.B.: \*The members of the OECD are high income economies with a high Human Development Index (HDI) and are considered as developed countries, except Mexico, Chile and Turkey; <sup>1</sup> Values are related to 2008. Source: International Energy Agency (IEA). Climate and Electricity Annual, 2011.;<sup>2</sup> Value related to 2012.

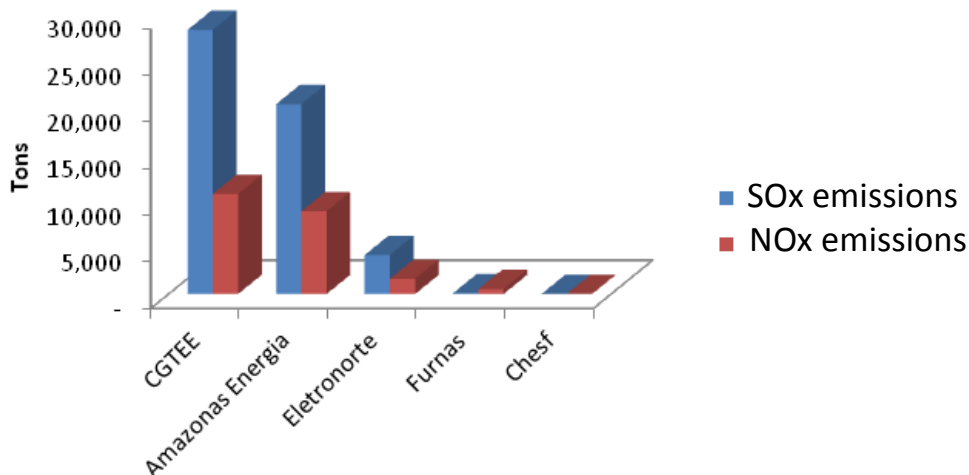
#### 4. Emissions of sulphur and nitrogen oxides (SO<sub>x</sub> and NO<sub>x</sub>)

The total estimated emission of sulphur oxides (SO<sub>x</sub>) of the Eletrobras companies, in 2012, was of 56,036 tons. This value corresponds to the emission of five of the Eletrobras companies, whereby the largest contribution for these emissions comes from CGTEE (28,370 t), followed by Amazonas Energia (20,396 t) (TABLE 12 and FIGURE 3).

**TABLE 12. Estimate of emission of the SO<sub>x</sub> and NO<sub>x</sub> gases from the Eletrobras companies in 2012**

ELETROBRAS COMPANIES	SO <sub>x</sub> (t)	NO <sub>x</sub> (t)
CGTEE	28,370.84	10,766.76
Amazonas Energia	20,396.02	8,892.05
Eletronorte	4,177.66	1,634.74
Furnas	88.21	522.17
Chesf	3.42	8.53
<b>Subtotal per Source</b>	<b>53,036.15</b>	<b>21,824.24</b>

The emissions of nitrogen oxide (NO<sub>x</sub>) totalled 21,824 tons in 2012. CGTEE is the main emitter (10,766 t), followed by Amazonas Energia (8,892 t), Eletronorte (1,634 t), Furnas (522 t), and Chesf (8 t).



**FIGURE 3. SO<sub>x</sub> and NO<sub>x</sub> Emissions of Eletrobras companies – base year 2012**

## 5. Carbon sequestration by forestry

Eletrobras companies have developed several actions that contribute towards carbon sequestration, notably in activities of reforestation. Even though these initiatives are not considered in the calculation of this inventory, they are comprised in an important stage in the compensation of GHG emissions of the Eletrobras companies.

Regarding these activities, in 2012, the Eletrobras companies were responsible for the production of almost 979 million seedlings, of which 138 million were planted voluntarily and 107 million donated.

Some examples that compose this grand total originate from the regional transmission organization of Tocantins of Eletrobras Eletronorte that voluntarily planted one thousand seedlings originating from the Programa de Germoplasma Florestal (Germplasm Forestation Program) of Eletronorte, whereby the resulting seedlings were planted in the Substations of Miracema and Colinas.

Eletrobras Chesf maintains a forestry nursery for the production and distribution of native seedlings of the region where their enterprises are implanted. Among other areas, these seedlings were used to recover 409 ha in the areas of the plants of Boa Esperança, Sobradinho, Itaparica, Complexo de Paulo Afonso and Xingó.

Eletrobras Amazonas Energia develops the Program of Restoration of Degraded Areas in Balbina that planted 7 thousand seedlings of native species, in 2012, besides the maintenance of the areas where the plantation had already been made. In addition, the company was responsible for the recovery, in 2012, of 6 ha of degraded areas in the Biological Reserve of Uatumã, totalling 18 ha of recovered area.



### **Inventory of Greenhouse Gas Emissions – base year 2012**

Since 2009, Eletrobras Eletrosul has already recovered more than one thousand hectares of Areas of Permanent Preservation located in the surrounding area of the Hydroelectric Plant Passo São João (RS), of the Small Hydroelectric Central Barra do Rio Chapéu (SC), both in operation, and of the São Domingos Plant (MS), in the final phase of implantation.

Itaipu Binacional has developed methodology to calculate the sequestered carbon in its areas of reforestation. In 2012 almost 110 thousand seedlings were planted responsible for the deployment of 274.38 tCO<sub>2</sub> in the biomass. Considering the existing and standing forest, only in 2012 all the vegetation of the area of permanent preservation on the Brazilian side of the reservoir sequestered approximately 2,384,610 tCO<sub>2</sub>.

Due to the appropriate methodological adaptations related to the specificities of each biome and to the species that are being planted by the companies in their areas of operation, this methodology of calculation of carbon sequestration by reforestation should be applied in each one of them.

## 6. Climate Strategy of the Eletrobras Companies

Year after year the Eletrobras companies have been seeking to improve their instruments and processes of corporate management in order to internalize the most recent themes related to facing climate changes.

The discussions in the scope of the United Nations Framework Convention on Climate Change (CQNUMC) and of the Intergovernmental Panel on Climate Change (IPCC), of the Brazilian Forum on Climate Change (FBMC), besides other international and national forums, have directed the efforts of the company towards handling the climate issue.

One decisive step in this sense was the beginning of the elaboration of the **Inventory of Greenhouse Emission of the Eletrobras Companies**, also in 2008, which allowed Eletrobras to have a general overview of their sources of GHG emission. This annual process of gathering data and calculation of emissions is more and more consolidated in the Eletrobras companies, once it was institutionalized by its top management, and has received support from various areas of the companies.

In 2012, the incorporation of the issue of climate change in the actions of Eletrobras companies was consolidated with the publication of the **Declaration of Commitment of Eletrobras on Climate Change**<sup>7</sup>. This document summarises the view of the Eletrobras companies on this theme, presenting its climatic strategy for the next years.

As part of the actions contained in the **Declaration of Commitment**, Eletrobras is promoting two studies with the following objectives: 1) analyse the risks, vulnerabilities and possibilities of adapting the system of generating electric energy from the Eletrobras companies to the impacts of climate change; and 2) do the sensitivity analysis of the financial impact of a possible taxation of CO<sub>2</sub> emissions for the thermoelectric generation of Eletrobras companies (study of a pilot case).

In 2013, through a joint effort of the Eletrobras companies, the targets to reduce the greenhouse gas emissions were defined and institutionalized for the mobile sources (scope 1) and consumption of electric energy (scope 2).

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<sup>7</sup> For access to the full document, visit the link:

<http://www.eletrobras.com/ELB/main.asp?Team={95ED3C87-C176-4017-812A-D8804EA50E6F}>



**Inventory of Greenhouse Gas Emissions – base year 2012**

These targets projected a reduction of GHG emission for 2015, based on the emissions of this inventory - base year 2012.

Each Eletrobras company defined its own targets, taking into account its peculiarities and potentials to reduce the emission. Therefore, effort was made to aggregate and reflect on these targets in order to enable the monitoring in the scope of the **Inventory of Greenhouse Gas Emission**. Thus, for each share, targets of reduction of emission were defined for 2015, according to table 13.

**TABLE 13. Target to reduce the GHG emissions of Eletrobras companies for 2015**

Share	Target to reduce emission (%)
<b>Mobile sources (scope 1)</b>	6.6
<b>Consumption of electric energy (scope 2)</b>	3.6

N.B.: These values were considered based on the individual targets defined by each of the Eletrobras companies. The targets refer to the projection of reduction of emission in 2015 based on the emission of each of these shares in the base year 2012.

The definition of the targets of reduction of GHG emissions consolidates a trajectory of maturity of the Eletrobras companies concerning the handling of climate change.

## Inventory of Greenhouse Gas Emissions – base year 2012

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## **Independent auditors' limited assurance report**

To the Board of Directors and Shareholders of  
Centrais Elétricas Brasileiras S.A. - Eletrobras  
Rio de Janeiro - RJ

### **Introduction**

We have been engaged by Centrais Elétricas Brasileiras S.A. – Eletrobras (Eletrobras) to present our limited assurance report on the compilation of the Information regarding “Corporate Inventory of Direct and Indirect Greenhouse Gas Emissions” of Eletrobras related to the year ended December 31<sup>st</sup>, 2012.

### **Responsibilities of Company Management**

The management of Eletrobras is responsible for preparing and adequately presenting the Information in the “Corporate Inventory of Direct and Indirect Greenhouse Gas Emissions” in accordance with the criteria of “*The Greenhouse Gas (GHG) Protocol - Corporate Accounting and Reporting Standard - Revised Edition from WRI (World Resources Institute) and WBCSD (World Business Council for Sustainable Development)*” - (2004 Revised Edition) and “*2006 IPCC (Intergovernmental Panel on Climate Change) Guidelines for National Greenhouse Gas Inventories*” and by the internal controls determined as necessary to allow the elaboration of those information free from material misstatement, even though it was resulted by fraud or error.

### **Independent auditors' responsibility**

Our responsibility is to express a conclusion about the information in the “Corporate Inventory of Direct and Indirect Greenhouse Gas Emissions” based on the limited assurance engagement conducted and prepared in accordance with NBC TO 3000 (Assurance Engagements Other Than Audits or Reviews) issued by the Federal Accounting Council – CFC, which is the equivalent to international standard ISAE 3000 issued by the International Federation of Accountants applicable to Non-Historical Information. These standards require compliance with ethical requirements, including independence ones and also that the engagement is conducted aiming to obtain limited assurance that the information in the “Corporate Inventory of Direct and Indirect Greenhouse Gas Emissions” taken as a whole is free from material misstatement.



A limited assurance engagement conducted in accordance with NBC TO 3000 (ISAE 3000) primarily consists of making enquiries to Company management and other employees involved in preparing the information in the “Corporate Inventory of Direct and Indirect Greenhouse Gas Emissions” and also applying analytical procedures to obtain evidence that permits us to make a limited assurance conclusion about the information taken as a whole. A limited assurance engagement also requires additional procedures when the independent auditor learns of issues which lead them to believe that the information in the “Corporate Inventory of Direct and Indirect Greenhouse Gas Emissions” could present material misstatement.

The selected procedures were based on our understanding of the issues related to the compilation and presentation of the information in the “Corporate Inventory of Direct and Indirect Greenhouse Gas Emissions” and other engagement circumstances and considerations about areas where material misstatement could exist. The procedures consisted of:

- (a) the planning of the work, considering the relevance, consistency, amount of quantitative and qualitative information and the operational systems and internal controls that served as a basis for preparing of the information in the “Corporate Inventory of Direct and Indirect Greenhouse Gas Emissions” of Eletrobras.
- (b) the understanding of the calculation methodology and procedures used to consolidate the indicators through interviews with the managers in charge of the preparation of the information.
- (c) the reviewing of the calculation records of greenhouse gas emissions taking into consideration Scope 1 (direct greenhouse gas emissions) amounting to 8,169,464.03 tons of CO<sub>2</sub>e, Scope 2 (Electricity indirect greenhouse gas emissions), amounting to 1,654,495.57 tons of CO<sub>2</sub>e and Scope 3 (other indirect greenhouse gas emissions), amounting to 1,948,184.66 tons of CO<sub>2</sub>e, according to the GHG Protocol.
- (d) sample-based verification of the direct and indirect energy consumption indicators used to calculate the greenhouse gas emissions.

We believe that the evidence we have obtained is sufficient and appropriate to provide a basis for our limited conclusion.

### **Scope and limitations**

The procedures applied in a limited assurance engagement are substantially less extensive than those applied in an assurance engagement aiming to express an opinion about the information in the “Corporate Inventory of Direct and Indirect Greenhouse Gas Emissions”. Due to this, it does not ensure us that we are aware of all the issues that would be identified during an assurance engagement which aims to express an opinion. If we had conducted an engagement in order to express an opinion, we might have identified other issues and possible misstatements which can be in the information presented in the “Corporate Inventory of Direct and Indirect Greenhouse Gas Emissions”. Therefore, we are not expressing an opinion about this information.

The nonfinancial data is subject to more inherent limitations than the financial data, due to the nature and diversity of the methods used to determine, calculate or estimate this data. Qualitative interpretations of the data's materiality and accuracy are subject to individual presumptions and judgments. Additionally, we did not examine data informed for prior periods or future projections and targets either.



### **Conclusion**

Based on the applied procedures, described in this report, we have not identified any relevant information that leads us to believe that the information in the “Corporate Inventory of Direct and Indirect Greenhouse Gas Emissions” of Eletrobras was not compiled, in all material respects, in accordance with the guidelines “*The Greenhouse Gas (GHG) Protocol - Corporate Accounting and Reporting Standard - Revised Edition from WRI (World Resources Institute) and WBCSD (World Business Council for Sustainable Development) - (2004 Revised Edition)*” and “*2006 IPCC (Intergovernmental Panel on Climate Change) Guidelines for National Greenhouse Gas Inventories*”.

São Paulo, June 3rd, 2013

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CRC 2SP023233/O-4

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