



**Eletrobras**

**Jicable'15 Welcome Lecture**  
**Josias Matos de Araujo**  
**Eletrobras**  
**June, 2015**

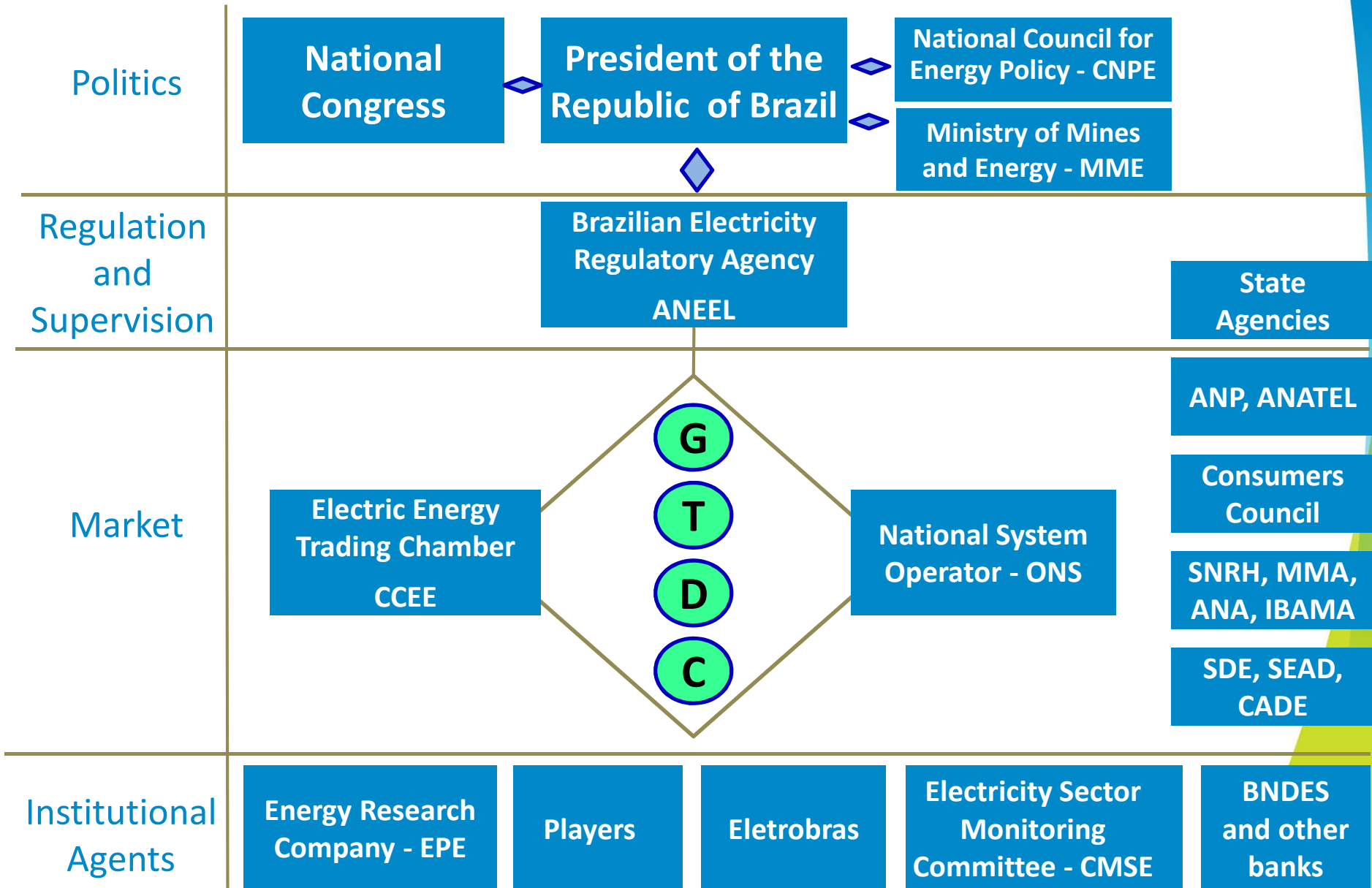


## Regulatory framework in Brazil



Eletrobras

# Regulatory Framework in Brazil





**Brazilian Electricity Market  
&  
Generation, Transmission and  
Distribution Overview**



# Electric Energy Consumption Statistics in Brazil

Population<sup>1</sup>:

201,901,000

Area:

8,514,876,599 km<sup>2</sup>

Network Energy Consumption<sup>2,3</sup>:

463,335 GWh

Energy Consumption per Capita<sup>1,2,3</sup>:

2,295 kWh/yr.

Average Energy Consumption:

64,003 aMW

Number of Consumers<sup>4</sup>:

77,069,509

Residential Consumers<sup>4</sup>:

65,928,608

Average Monthly Energy Consumption:

516,1 kWh/mo.

Average Monthly Residential Energy Consumption :

163,0 kWh/mo.



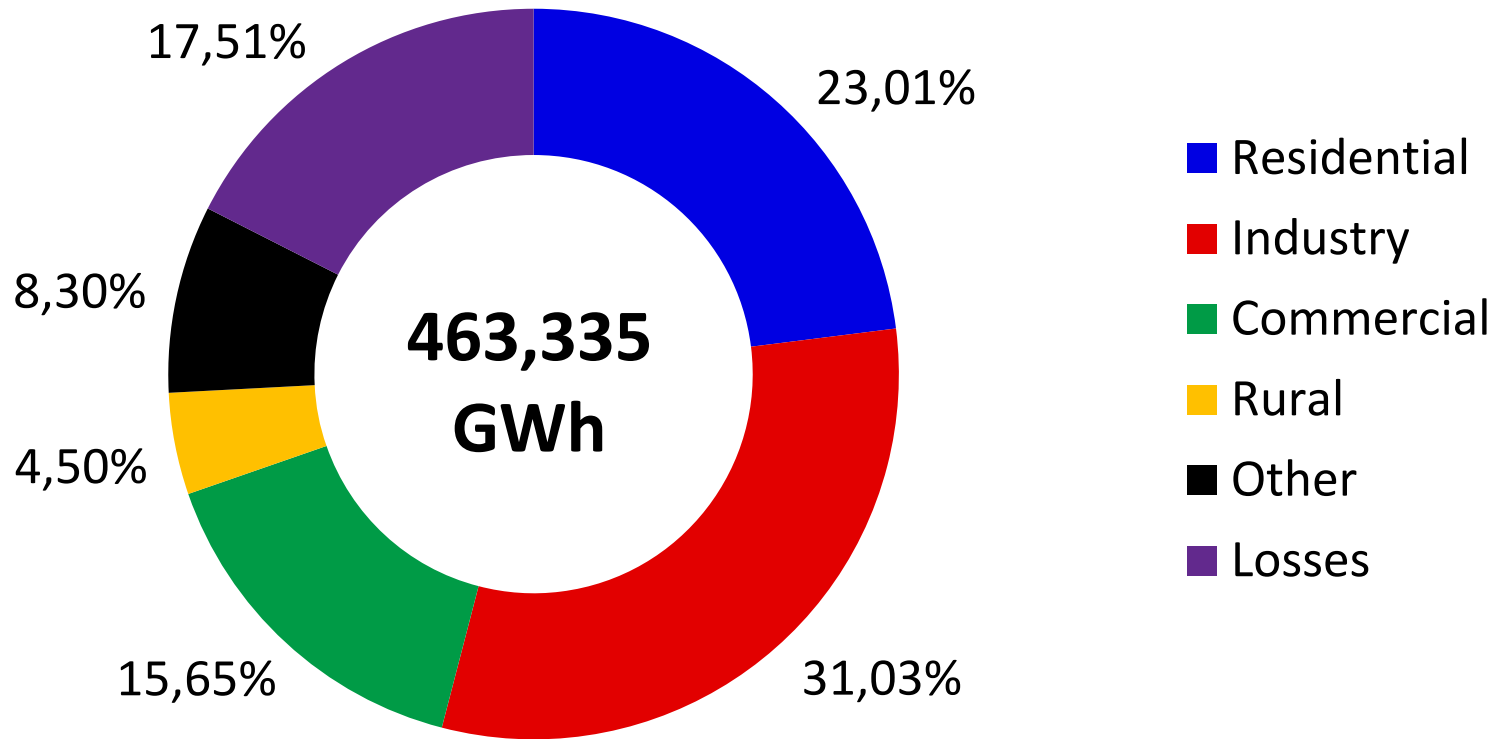
**Sources:** <sup>1</sup> IBGE (*Brazilian Institute of Geography and Statistics*), 2013

<sup>2</sup> Include self-produced energy

<sup>3</sup> EPE (*Energy Research Company*), 2013

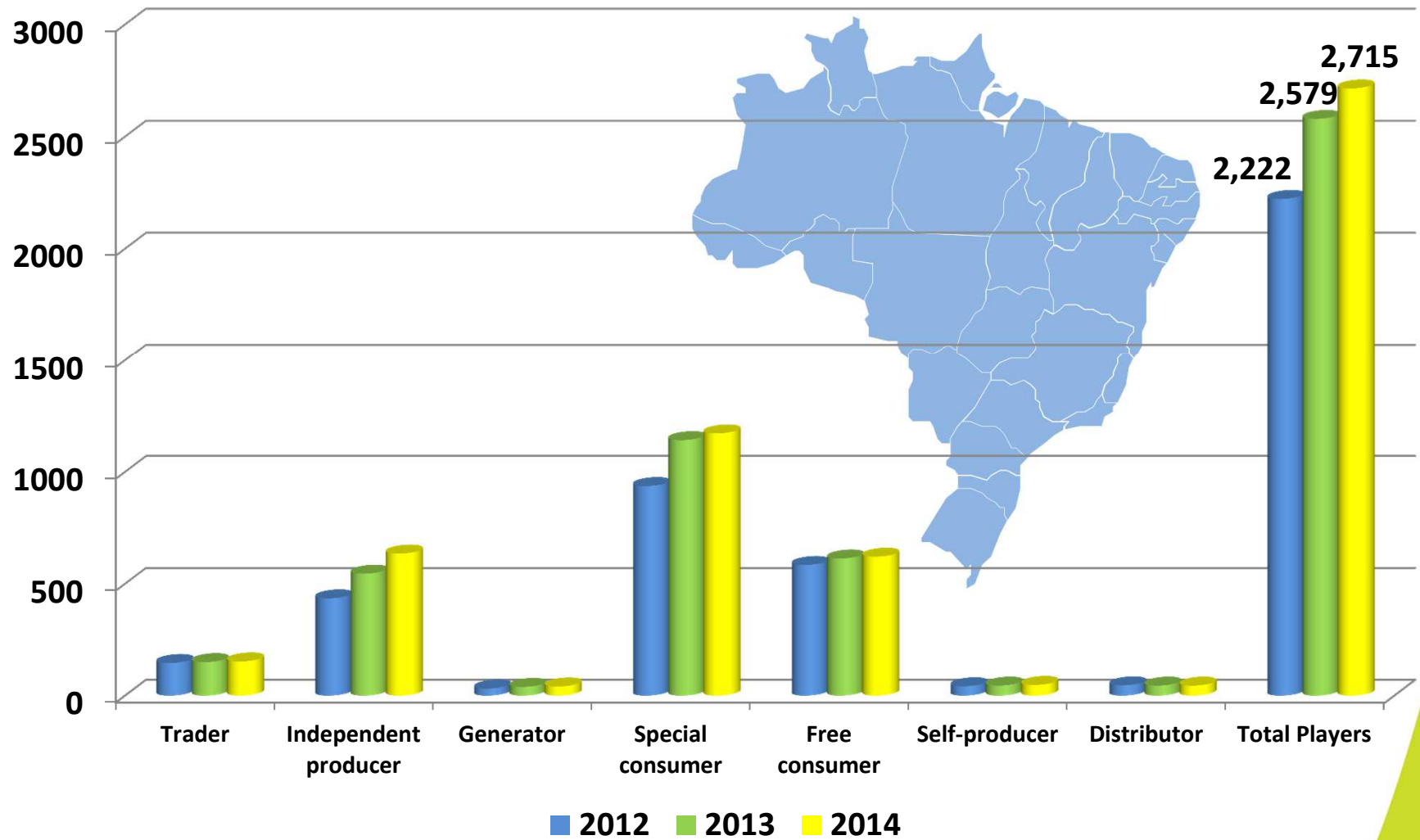
<sup>4</sup> ANEEL (*Brazilian Electricity Regulatory Agency*), 2014

# Electric Energy Consumption by Sector




Source: EPE (Energy Research Company), 2013

# Brazilian Electric Energy Market Players



Source: CCEE (Electric Energy Trading Chamber), 2015





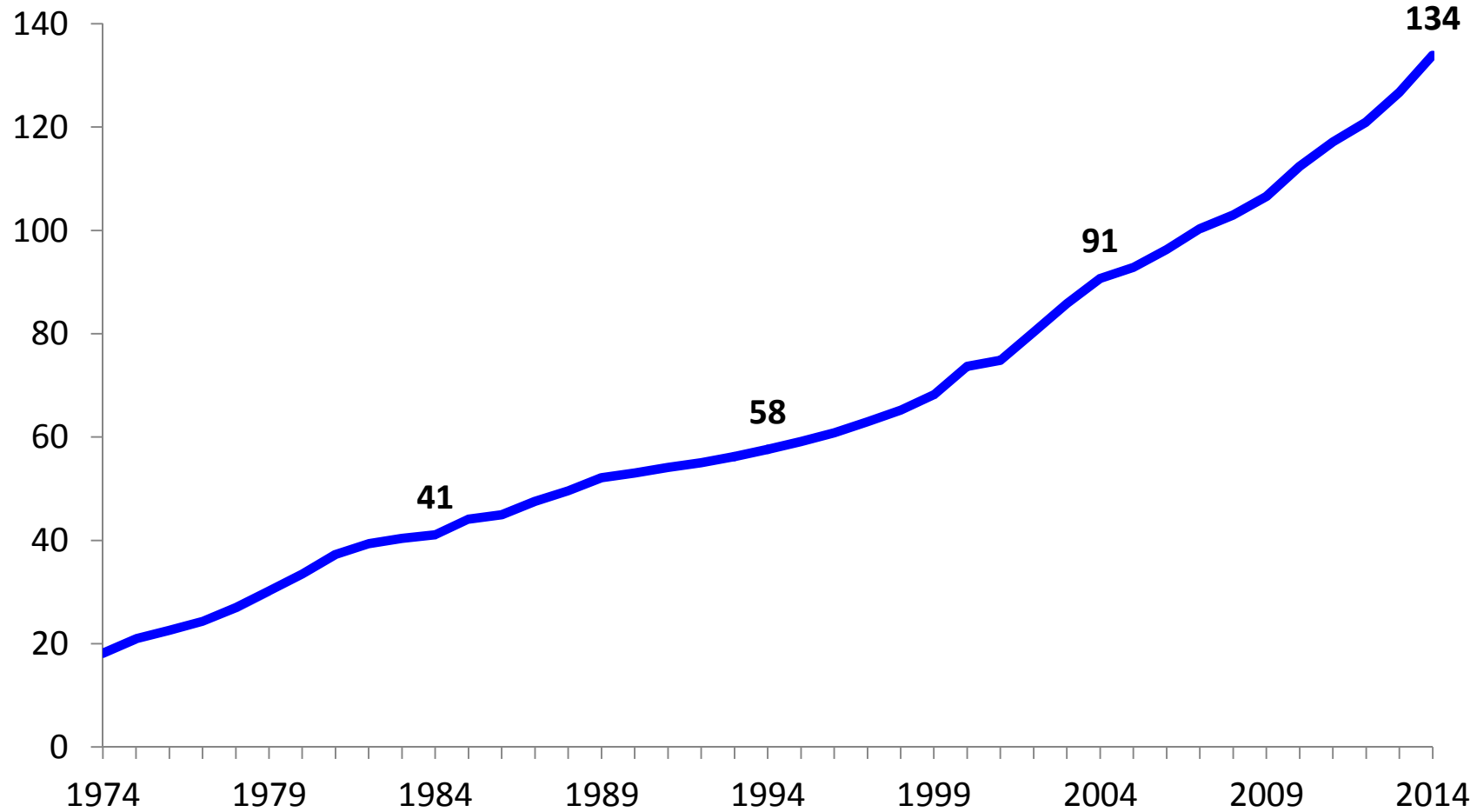
# **Generation in Brazil**

## **- Actual Status and Prospects -**



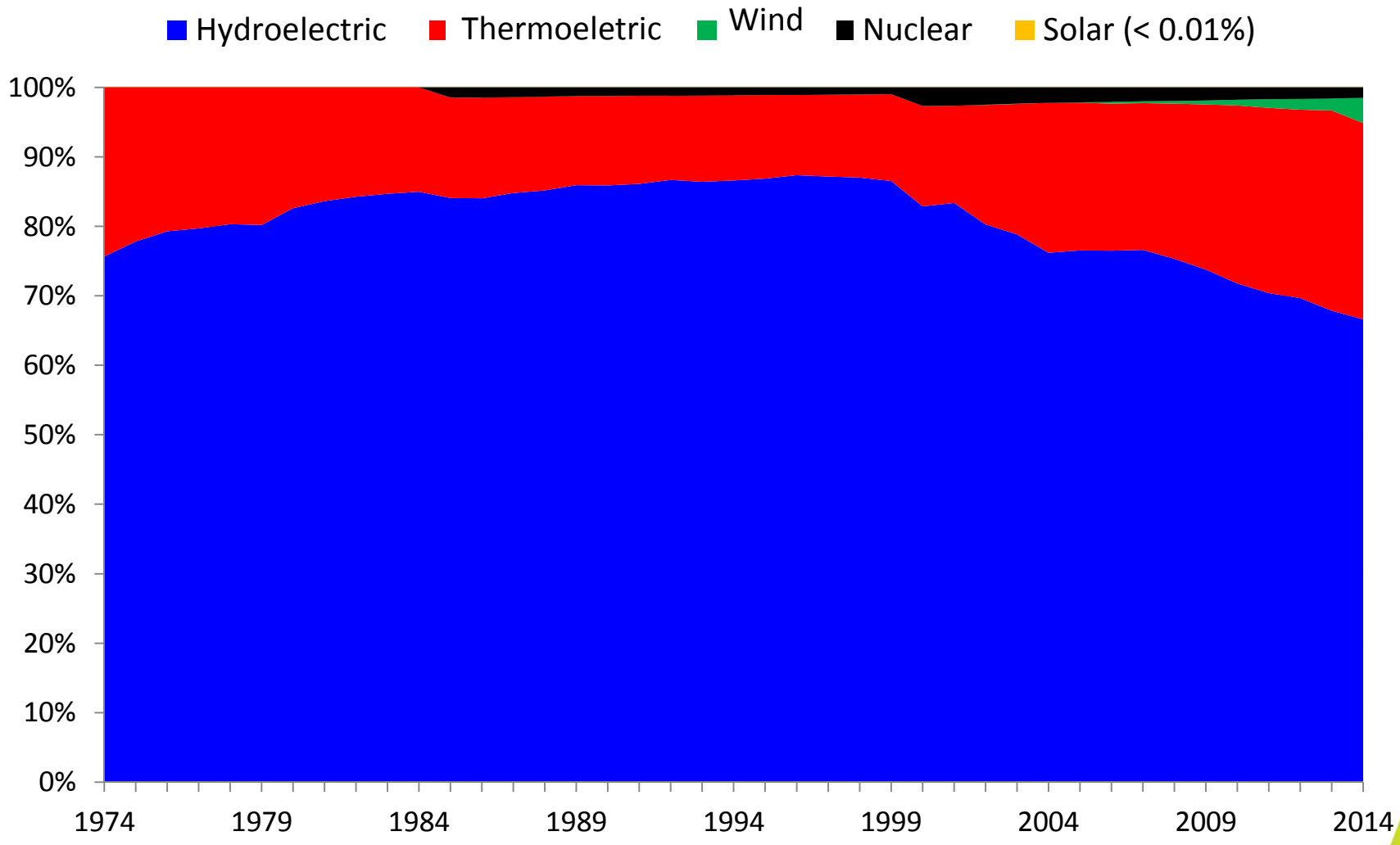


# National Installed Capacity (GW), 1974-2014



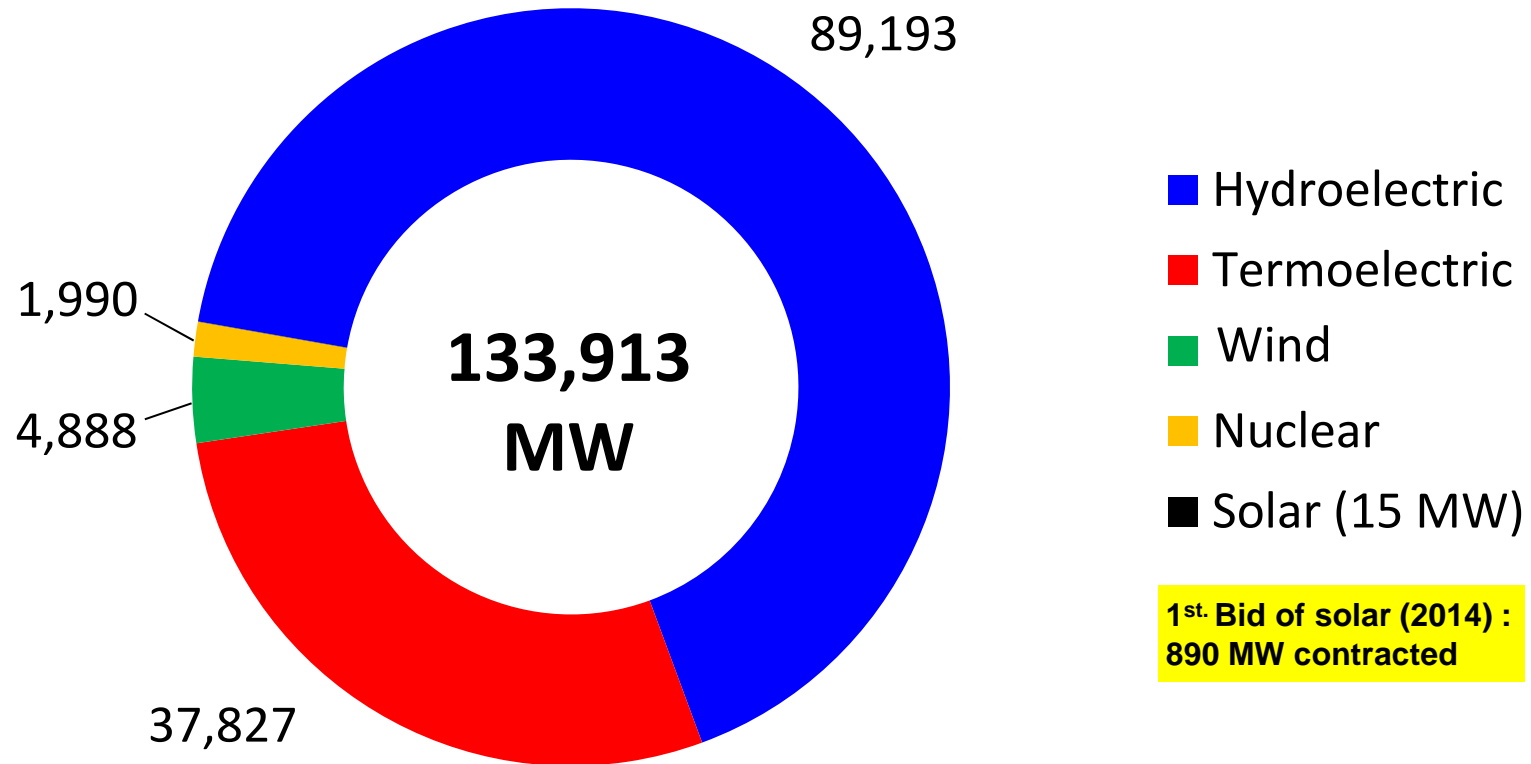
Source: National Energy Balance (BEN 2014), EPE

# Energy Generation: How the installed capacity is shared by type source? 1974 -- 2014



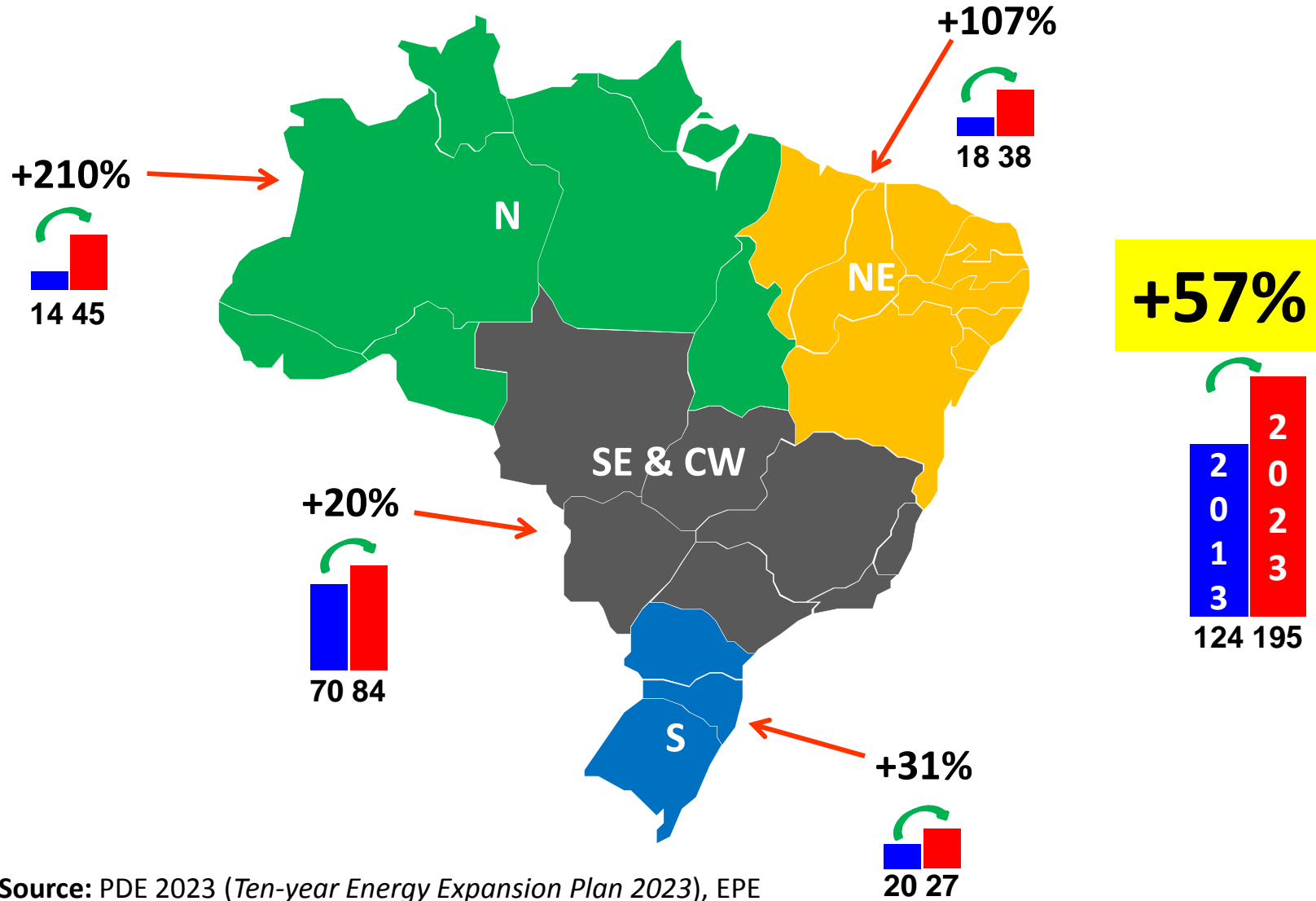
Source: National Energy Balance (BEN 2014), EPE

## National Installed Capacity (MW)



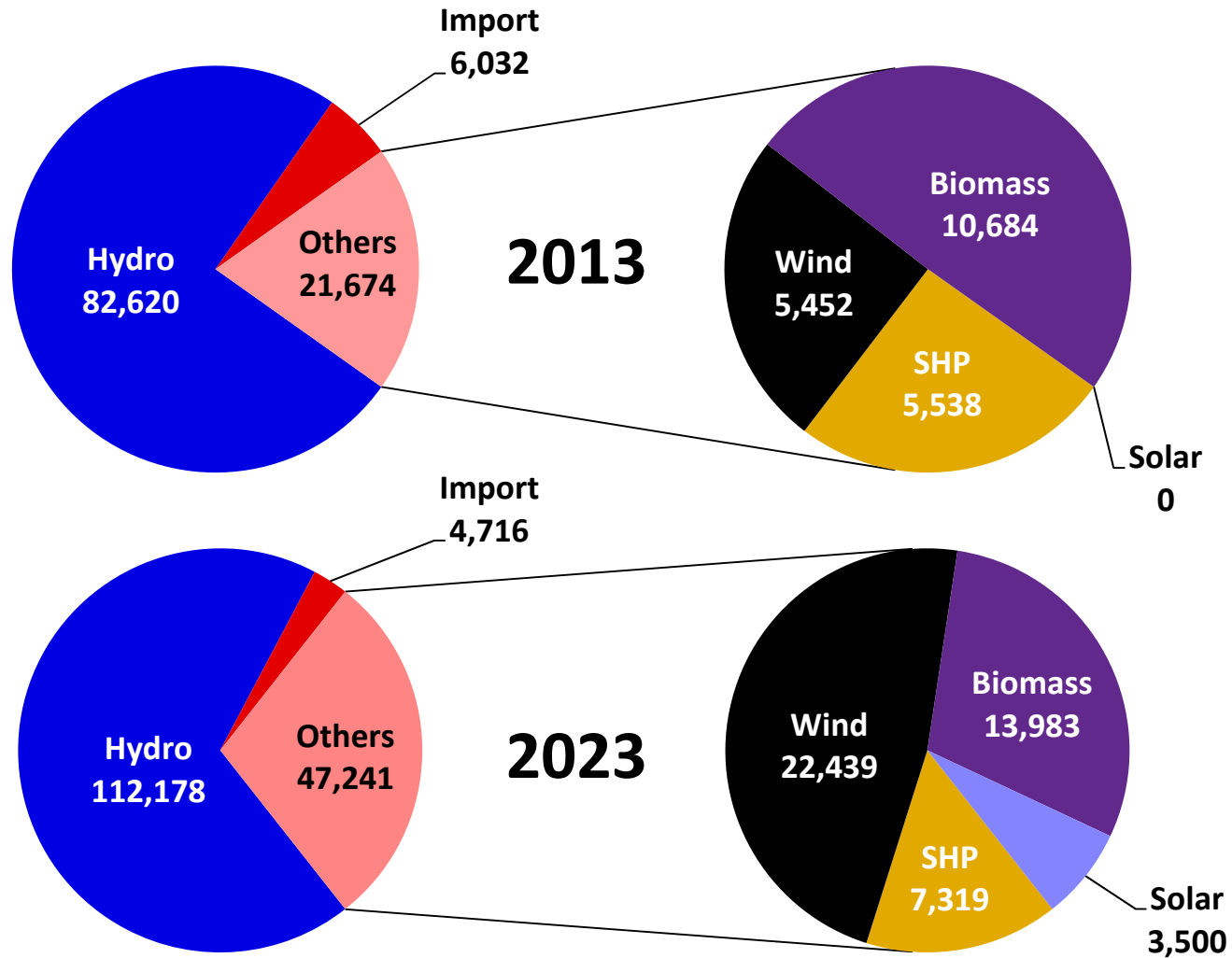
Source: National Energy Balance (BEN 2014), EPE

# Evolution of Brazilian Installed Capacity by Geographic Region (GW)



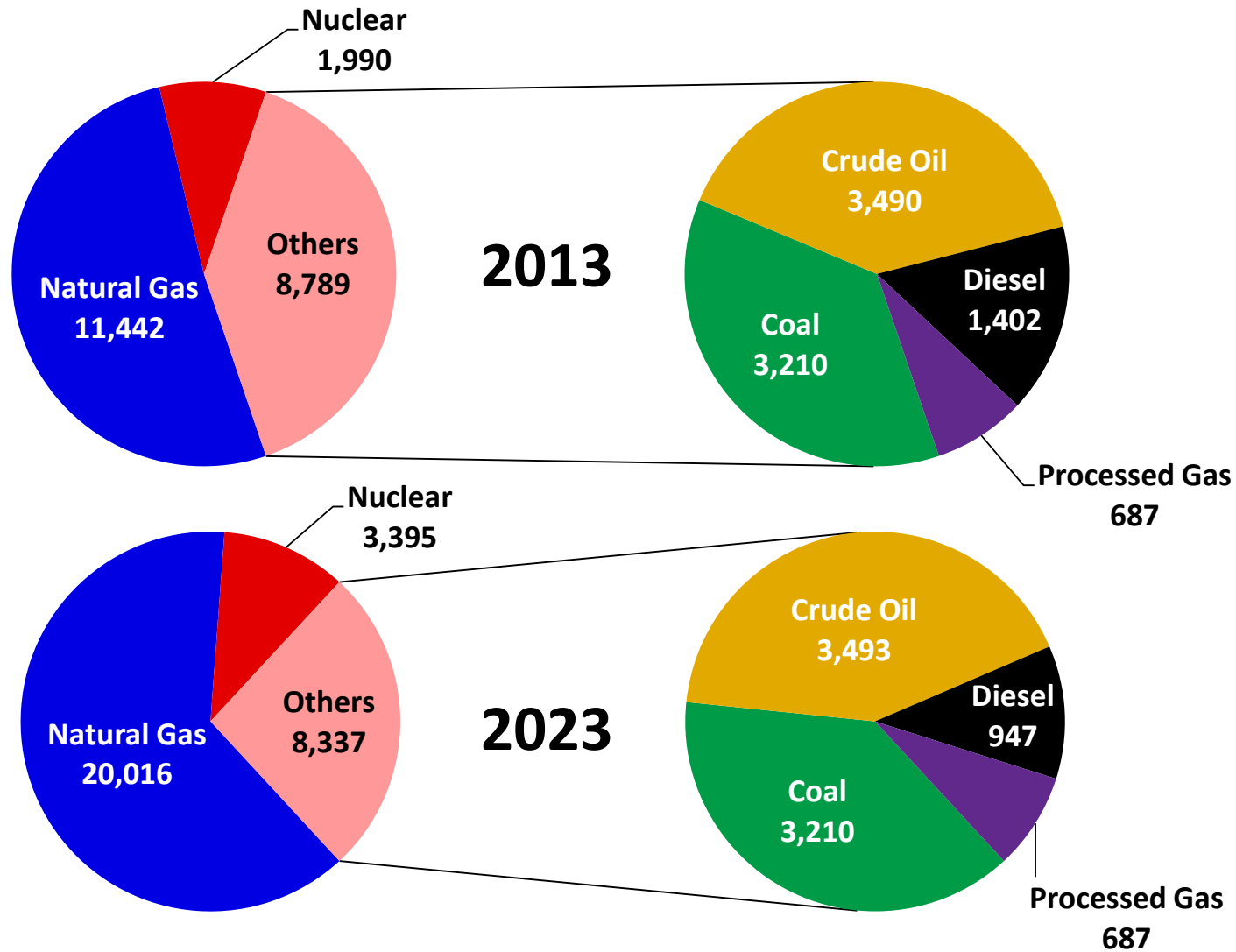
Source: PDE 2023 (Ten-year Energy Expansion Plan 2023), EPE

# Evolution of Renewable Energy Generation (MW)




Source: PDE 2023 (*Ten-year Energy Expansion Plan 2023*), EPE

# Evolution of Non-renewable Energy Generation (MW)



Source: PDE 2023 (Ten-year Energy Expansion Plan 2023), EPE



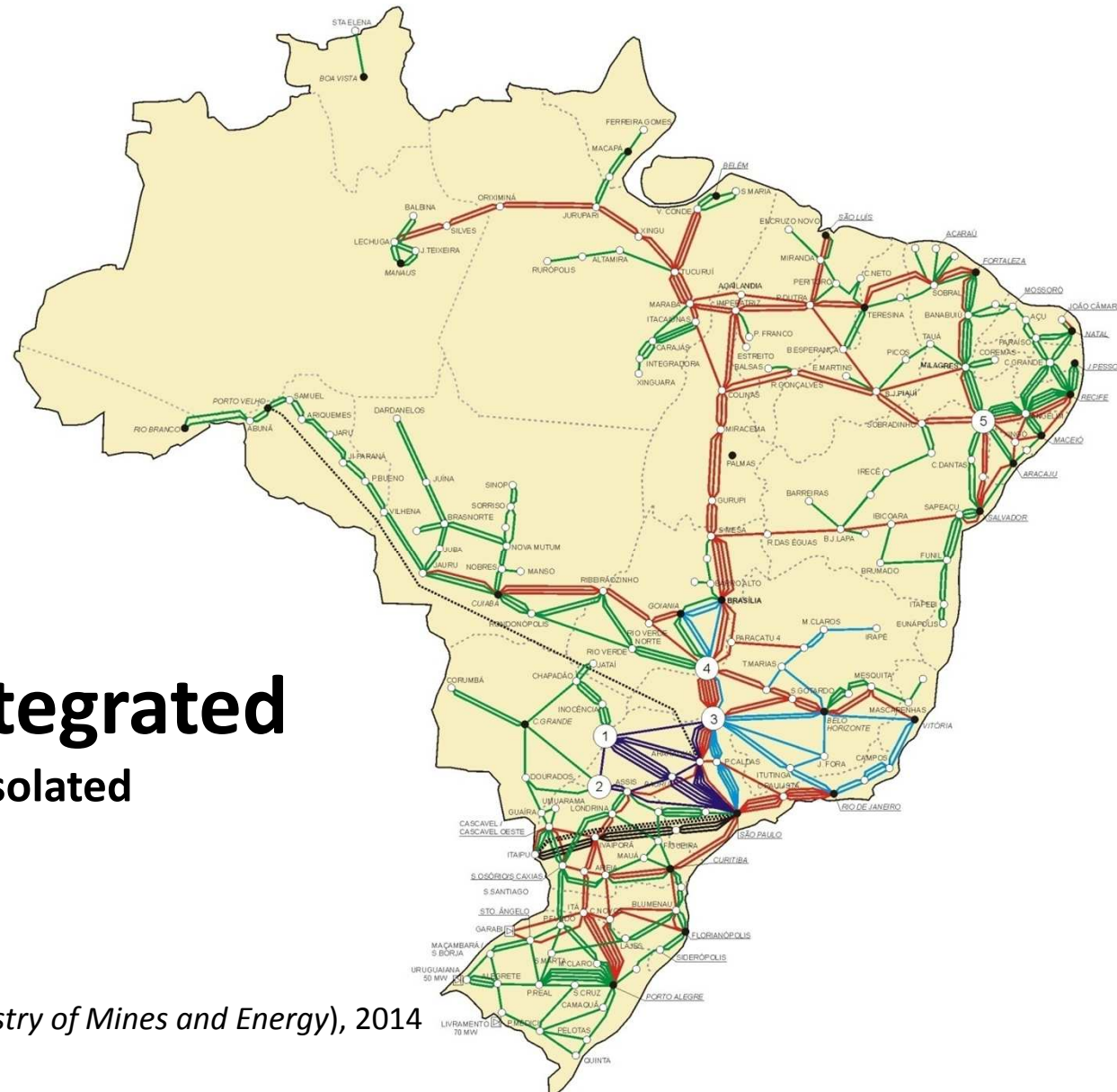
# **Transmission in Brazil**

## **- Current Status and Prospects -**





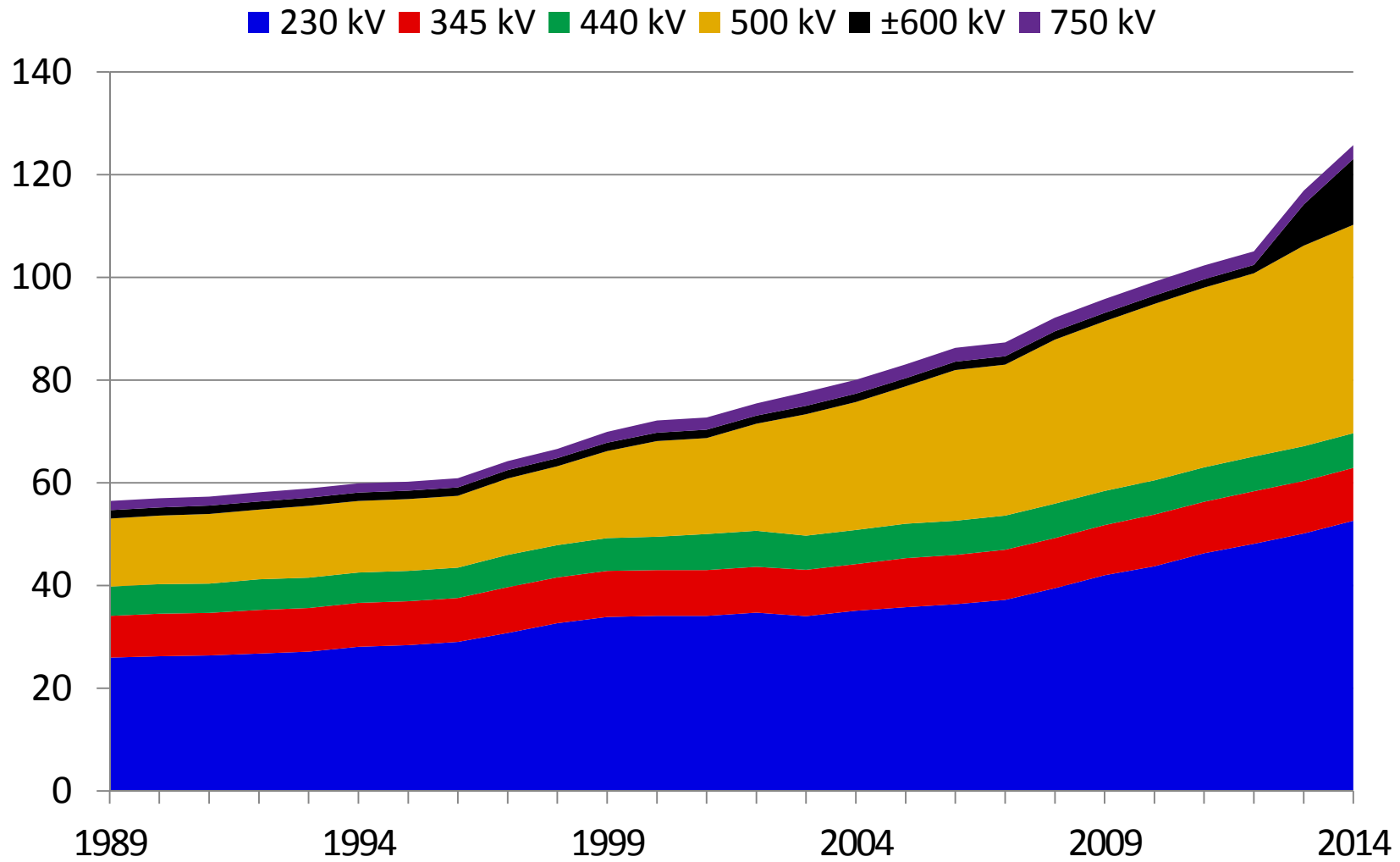
# Interconnected National System - SIN



**99% Integrated**  
**1% Isolated**

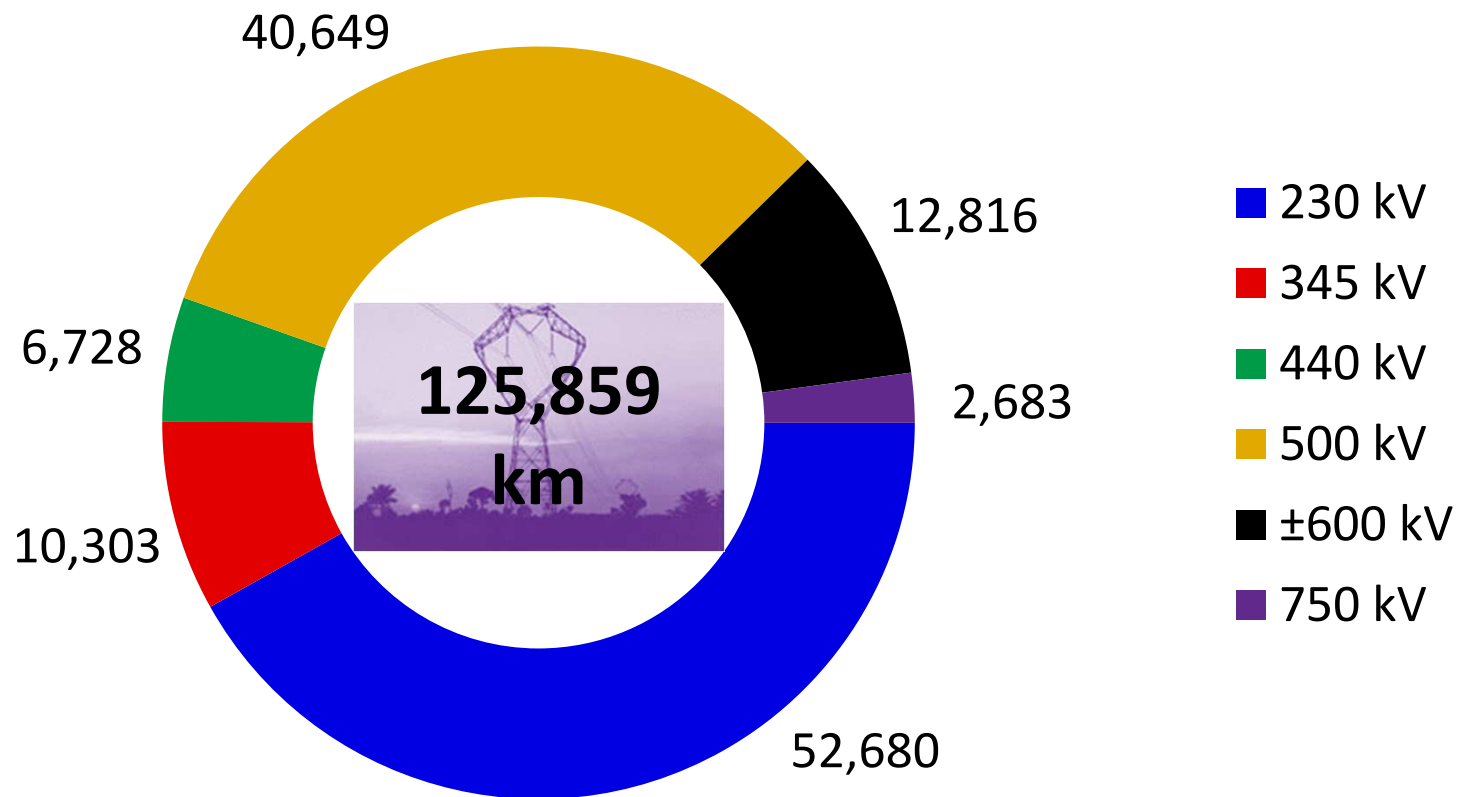
Source: MME (Ministry of Mines and Energy), 2014

# Transmission Lines (Thousand km), 1989-2014



Source: National Energy Balance (BEN 2014), EPE

# Transmission Lines (km)



Source: *Electrical System Monitoring Bulletin*, CMSE, 2014

# Madeira HVDC Link (Bipole 1)

**Voltage level:** ±600 kV

**Operation start-up:** Sept., 2013

**Capacity:** 3,150 MW

**Extension:** 2,384 km

**Towers:** approx. 4,300

**Total investment:** US\$ 1.0 billion

**Construction duration:** 38 months

**States crossed by the line:** Rondônia (RO), Mato Grosso (MT), Goiás (GO), Minas Gerais (MG), São Paulo (SP).

**Line owners:**

**Partner**

**51%**



**49%**



**Source:** ONS (National Electric System Operator)/ANEEL (Brazilian Electricity Regulatory Agency), 2014

# Madeira HVDC Link (Bipole 1)



**Source:** Internet



# Madeira HVDC Link (Bipole 2)

**Voltage level:** ±600 kV

**Operation start-up:** 2015 (prevision)

**Capacity:** 3,150 MW

**Extension:** 2,412 km

**Towers:** approx. 4,300

**Total investment:** US\$ 973 million

**Construction duration:** 50 months

**States crossed by the line:** Rondônia (RO), Mato Grosso (MT), Goiás (GO), Minas Gerais (MG), São Paulo (SP).

**Line owners:**

**Partner**

**51%**



**49%**



Source: ONS (National Electric System Operator)/ANEEL (Brazilian Electricity Regulatory Agency), 2014

# Belo Monte UHVDC Link (Bipole 1)

**Voltage level:** ±800 kV

**Under construction**

**Capacity:** 4,000 MW

**Extension:** 2,096 km

**Towers:** approx. 4,500

**Total investment:** US\$ 1.67 billion

**Construction duration:** 46 months

**States crossed by the line:** Pará (PA), Tocantins (TO), Goiás (GO), Minas Gerais (MG).

**Line owners:**

**Partner**

**51%**



**49%**



Source: ANEEL (Brazilian Electricity Regulatory Agency), 2014



## Belo Monte UHVDC Link (Bipole 2)

**Voltage level:**  $\pm 800$  kV

**Capacity:** 3,850 MW

**Extension:** 2,518 km

**Total investment:** US\$ 2.58 billion

**Prevision for commercial operation:** September, 2020.

**States crossed by the line:** Pará (PA), Tocantins (TO), Goiás (GO), Minas Gerais (MG), Rio de Janeiro (RJ).

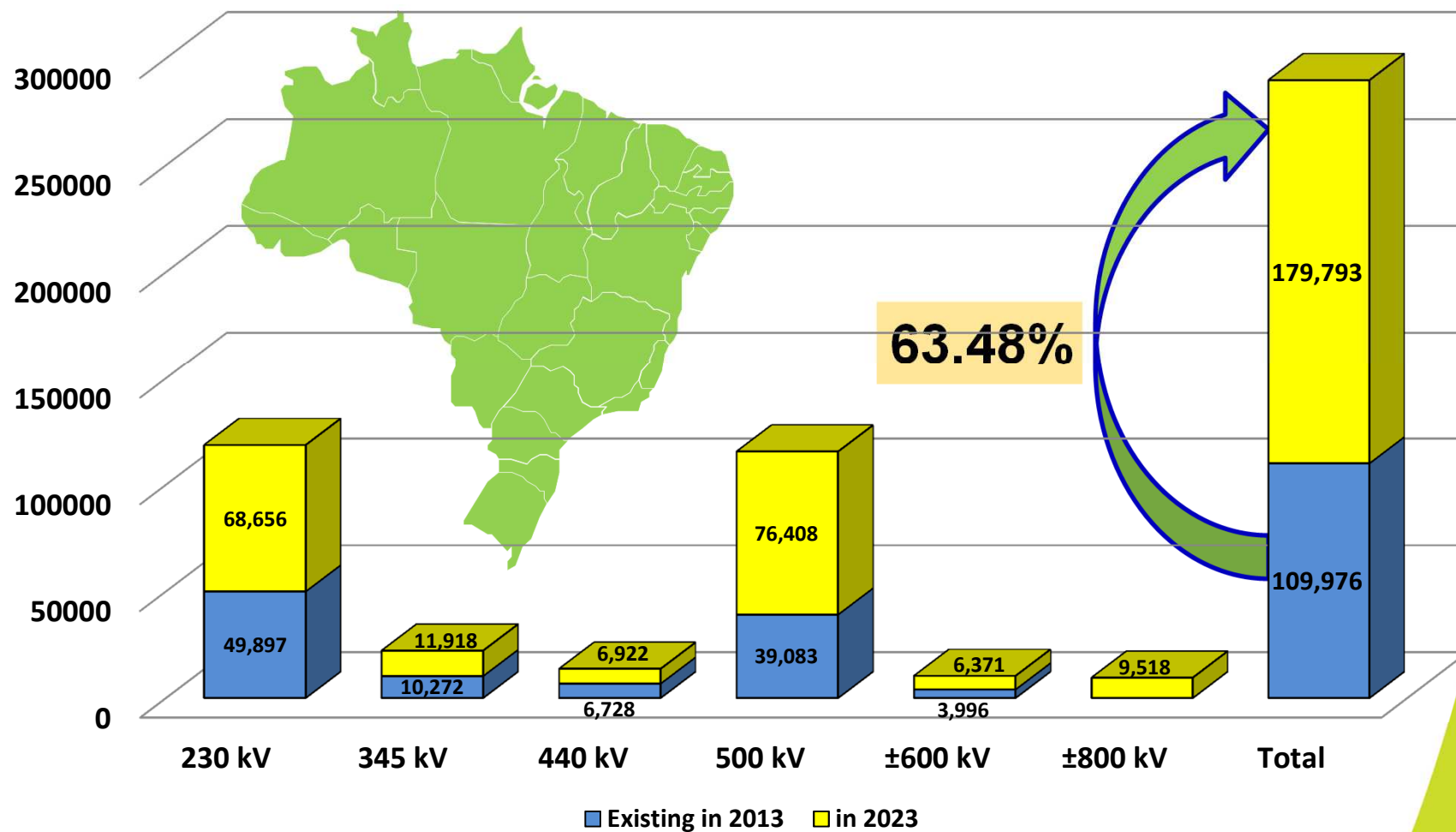
**Line owners:**

**TO BE AUCTIONED**



Source: ANEEL (*Brazilian Electricity Regulatory Agency*), 2014

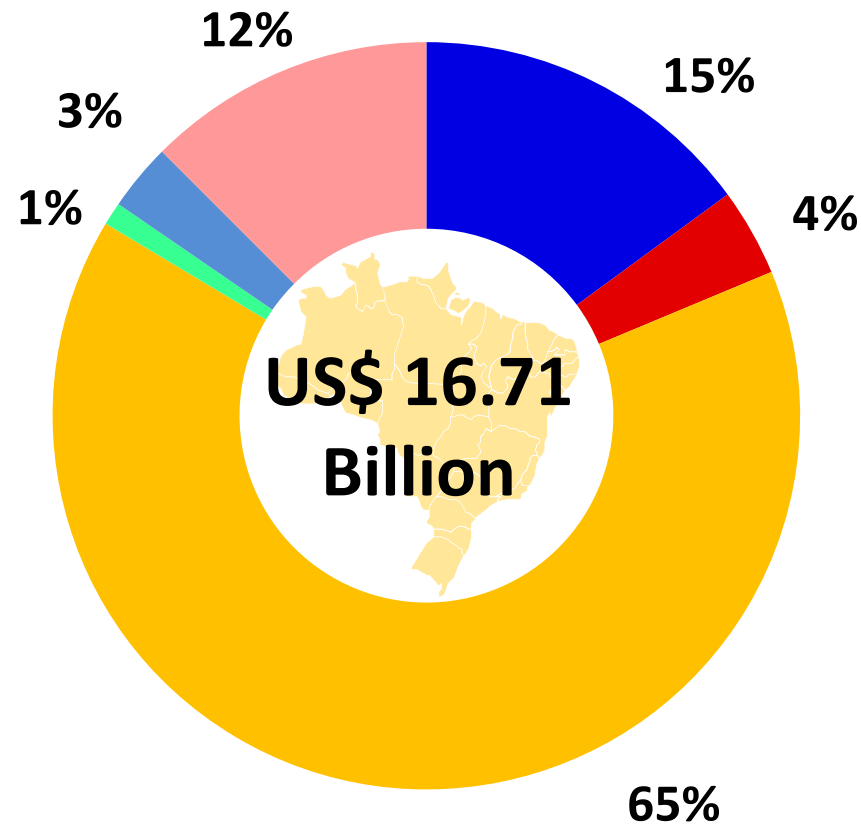
# Evolution of Transmission Lines (km)



Source: PDE 2023 (Ten-year Energy Expansion Plan 2023), EPE

# Transmission Line Investments from 2013-2023

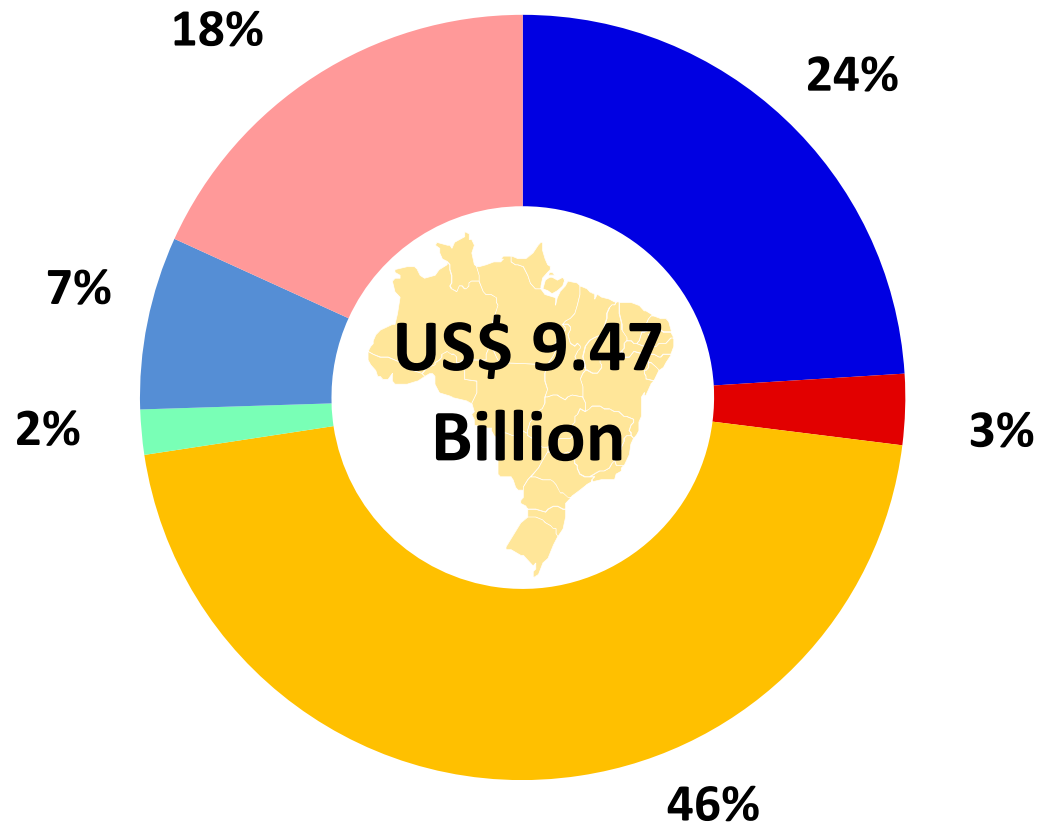
■ ±800 kV ■ ±600 kV ■ 500 kV ■ 440 kV ■ 345 kV ■ 230 kV



Source: PDE 2023 (*Ten-year Energy Expansion Plan 2023*), EPE.

# Substations Investments from 2013-2023

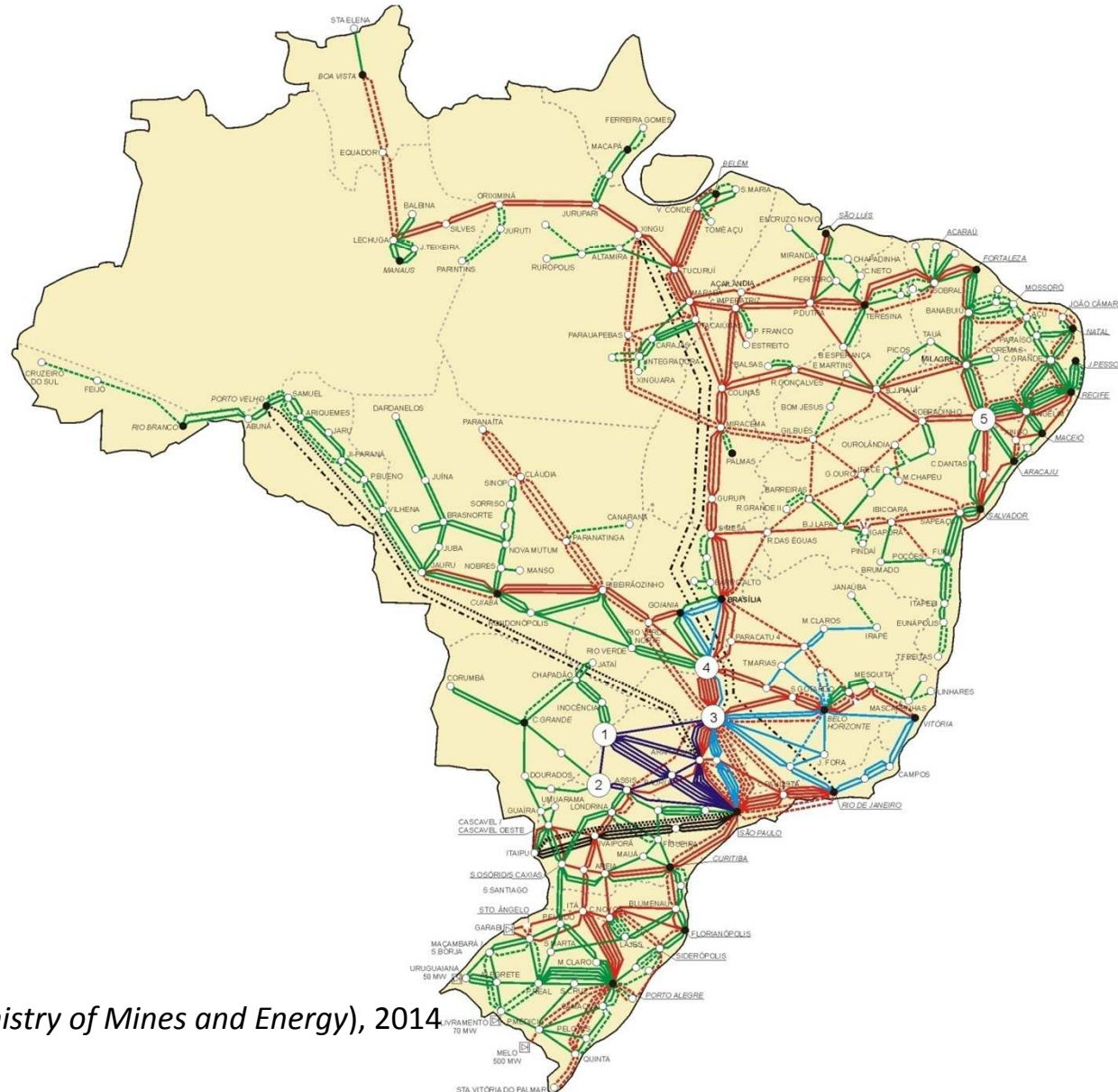
■ ±800 kV ■ ±600 kV ■ 500 kV ■ 440 kV ■ 345 kV ■ 230 kV




Source: PDE 2023 (Ten-year Energy Expansion Plan 2023), EPE.

# Evolution of the Interconnected National System – SIN, 2013-2023

2023



Source: MME (Ministry of Mines and Energy), 2014



# **Distribution in Brazil**

## **- Current Status and Prospects -**



# Distribution Utilities in Brazil



Source: ABRADÉE, 2014



## Distribution Utilities in Brazil

<b>Total Consumers</b>	<b>77.1 Million</b>
<b>Residential Consumers</b>	<b>65.9 Million</b>
<b>Nº of new consumers/Year</b>	<b>2.9 Million</b>
<b>Distribution lines (km)</b>	<b>More than 3.1 Million</b>
<b>Undergrounded transmission lines (km)</b>	<b>Almost 13,000</b>
<b>Gross Revenues</b>	<b>US\$ 56.7 Billion</b>
<b>Annual investments</b>	<b>US\$ 3.85 Billion</b>
<b>Market (free + captive)</b>	<b>432 mil GWh (343 captive)</b>

Source: ABRADÉE, ANEEL and companies sites, 2014

# Underground Distribution Systems Installed in Brazil



Porto Maravilha Region – Rio de Janeiro (RJ)



Downtown Zone – Belo Horizonte (MG)



Jardim dos Namorados System – Salvador (BA)

Before



After



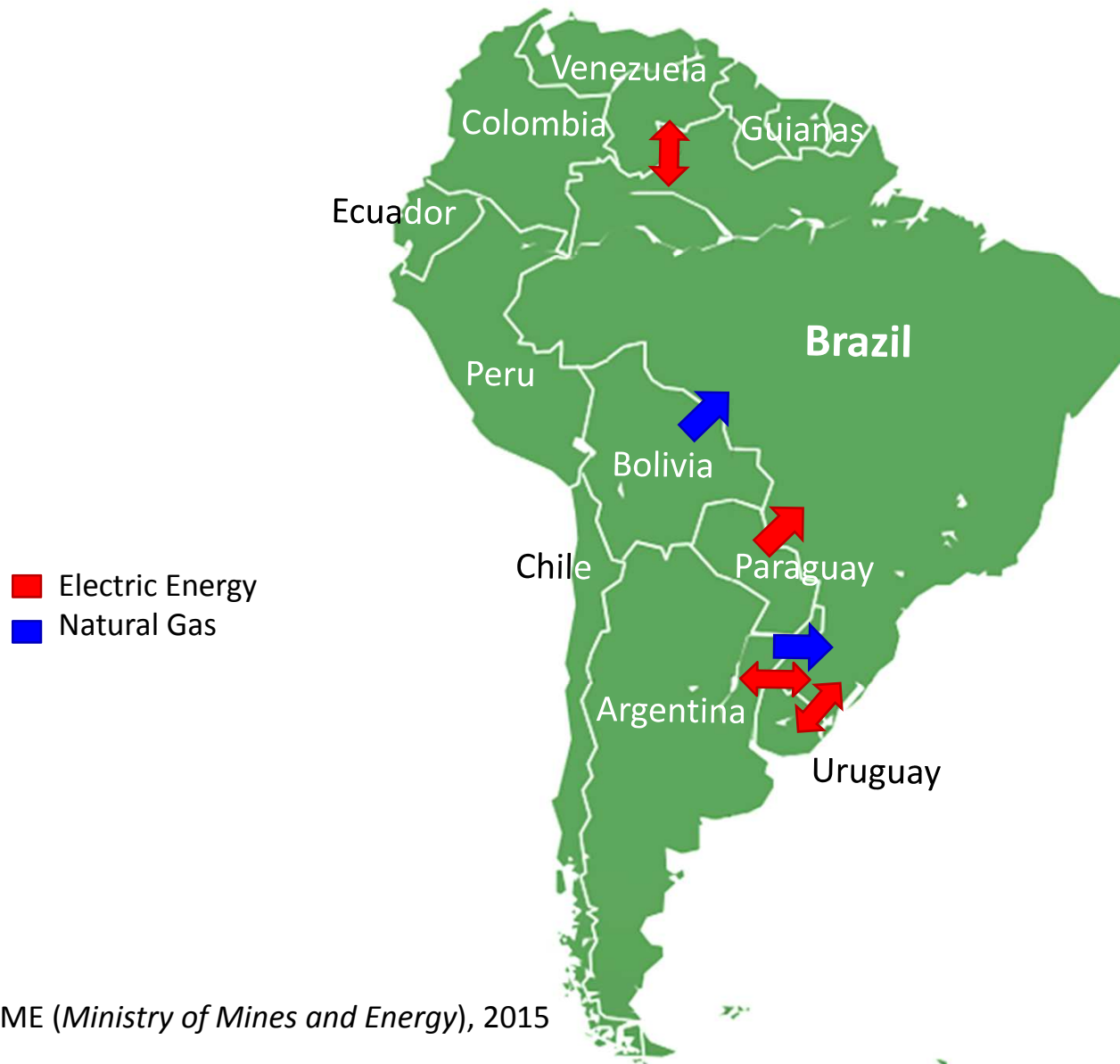
Ibirapuera Park – São Paulo (SP)



# Energy Integration in South America



# Energy import/export



Source: MME (Ministry of Mines and Energy), 2015

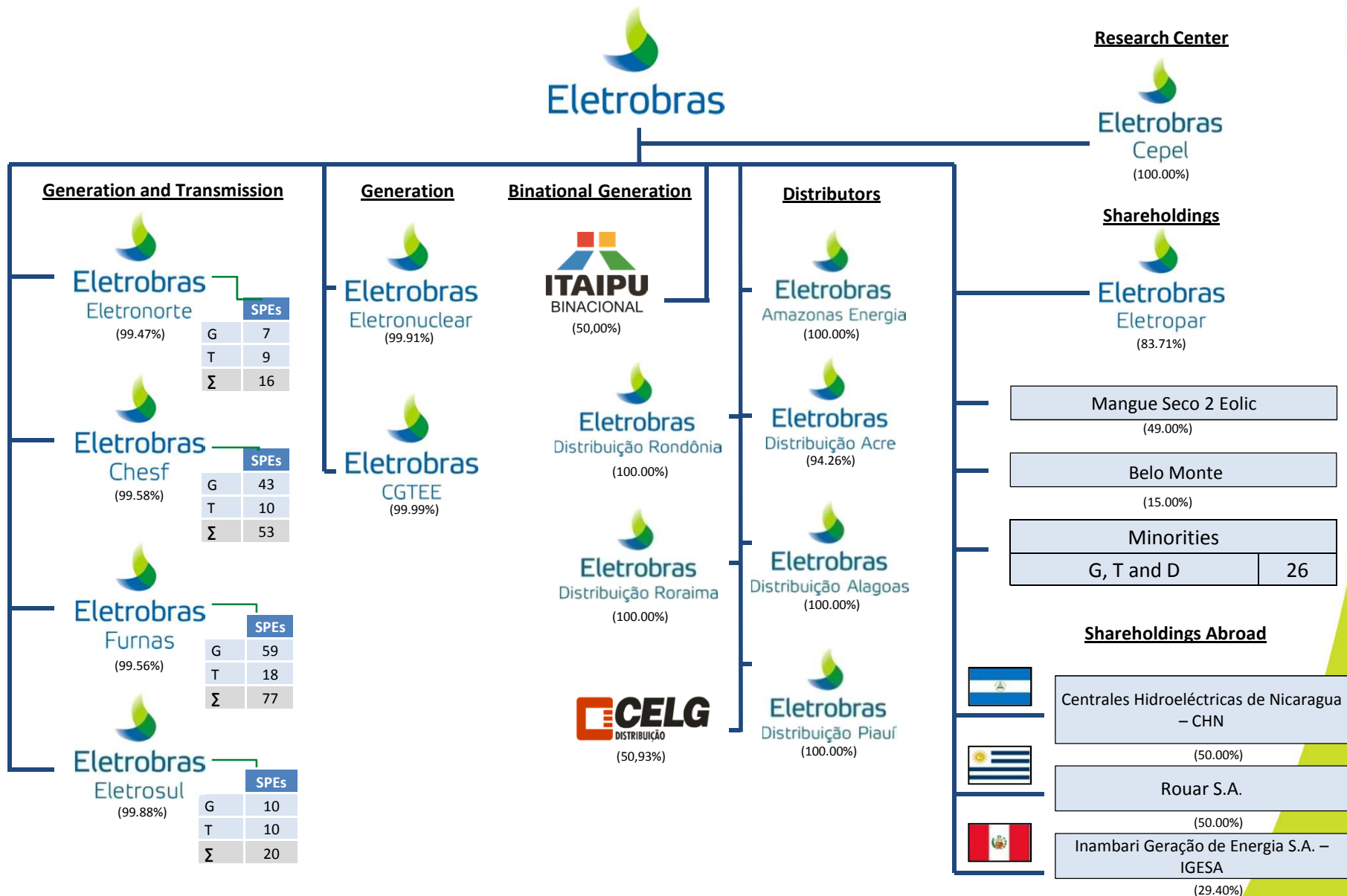




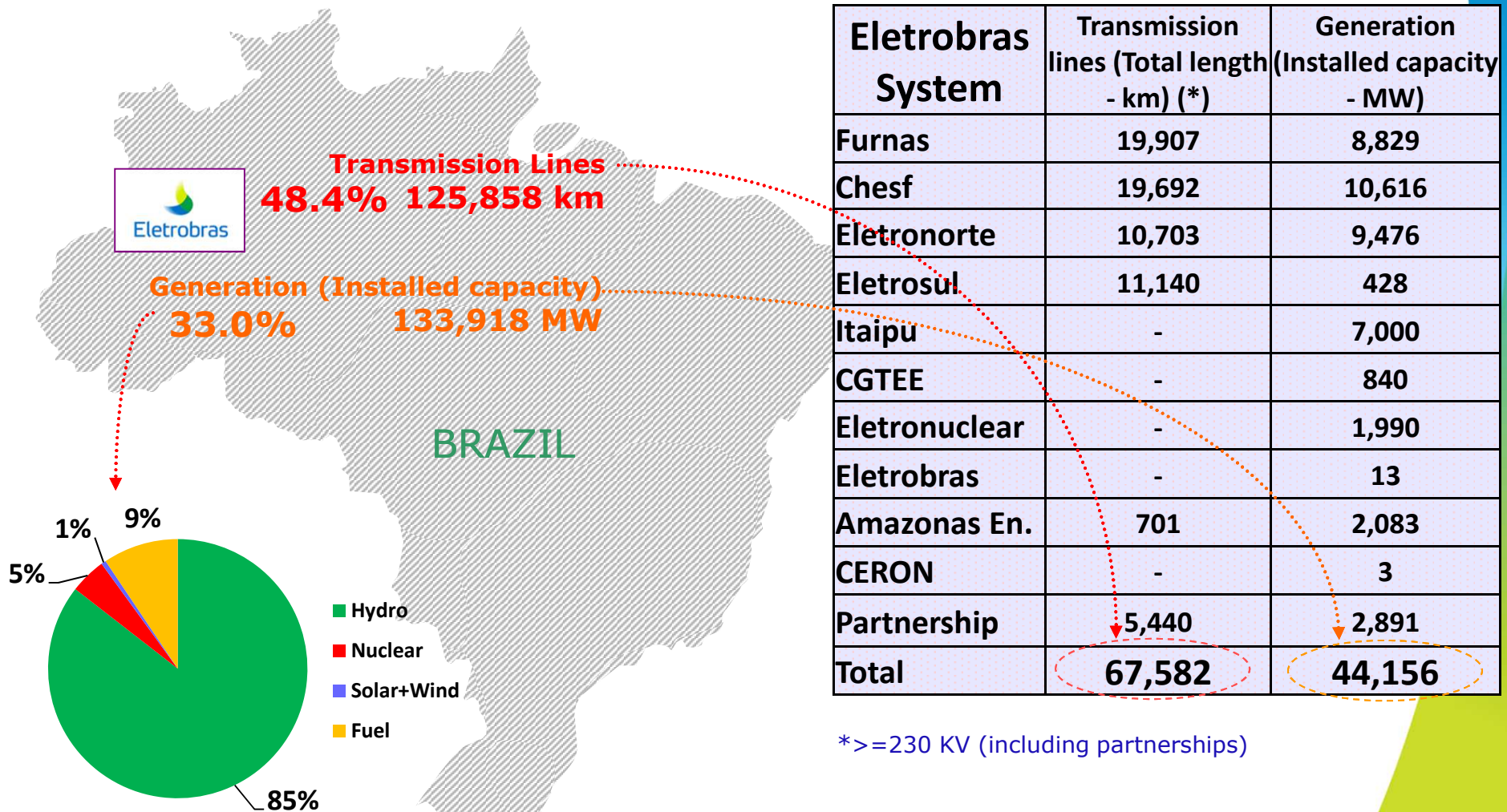
## **A brief overview of the Eletrobras System**



# Eletrobras System



# Eletrobras System

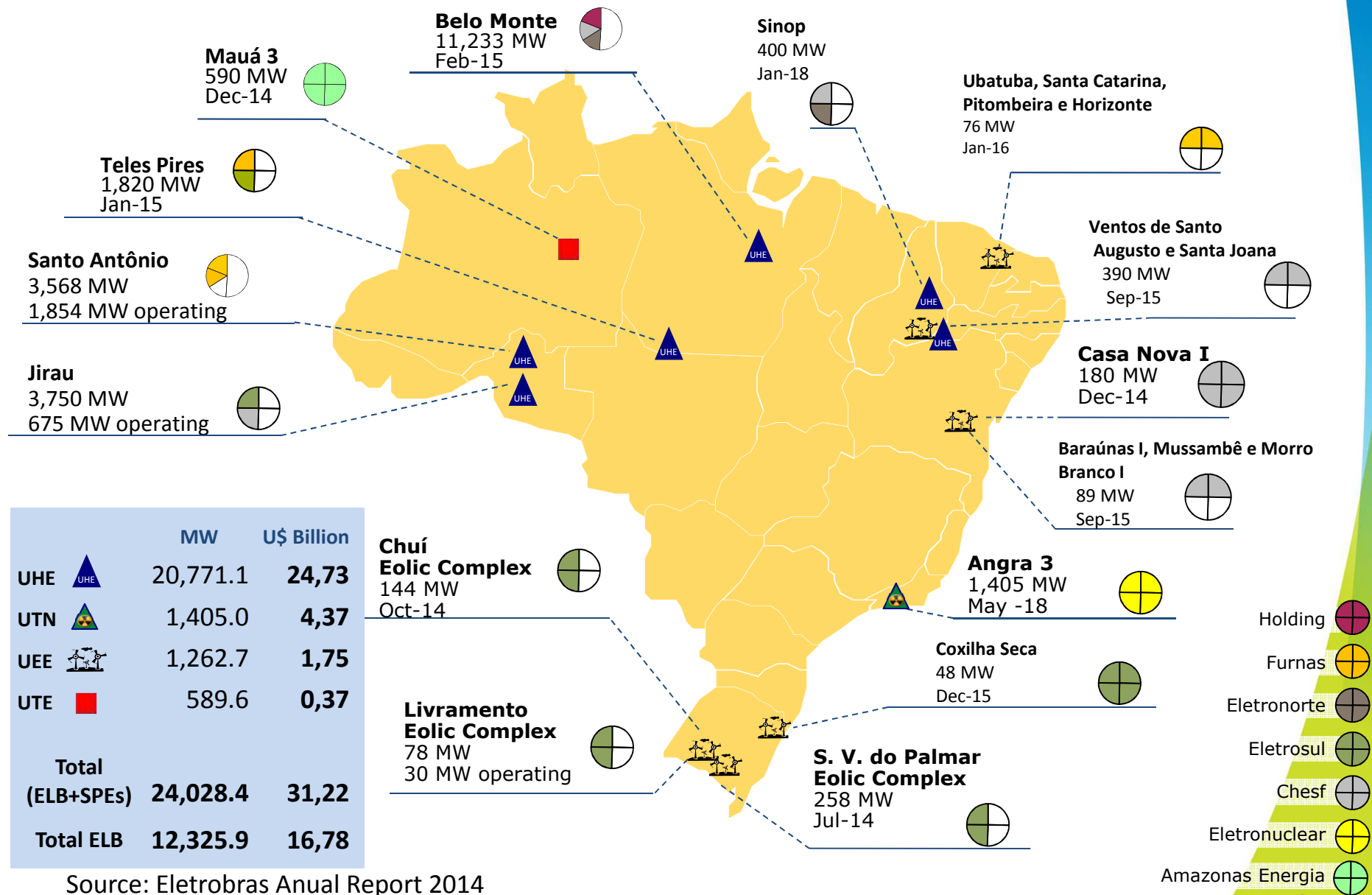


Source: Eletrobras Anual Report 2014

\*>=230 KV (including partnerships)

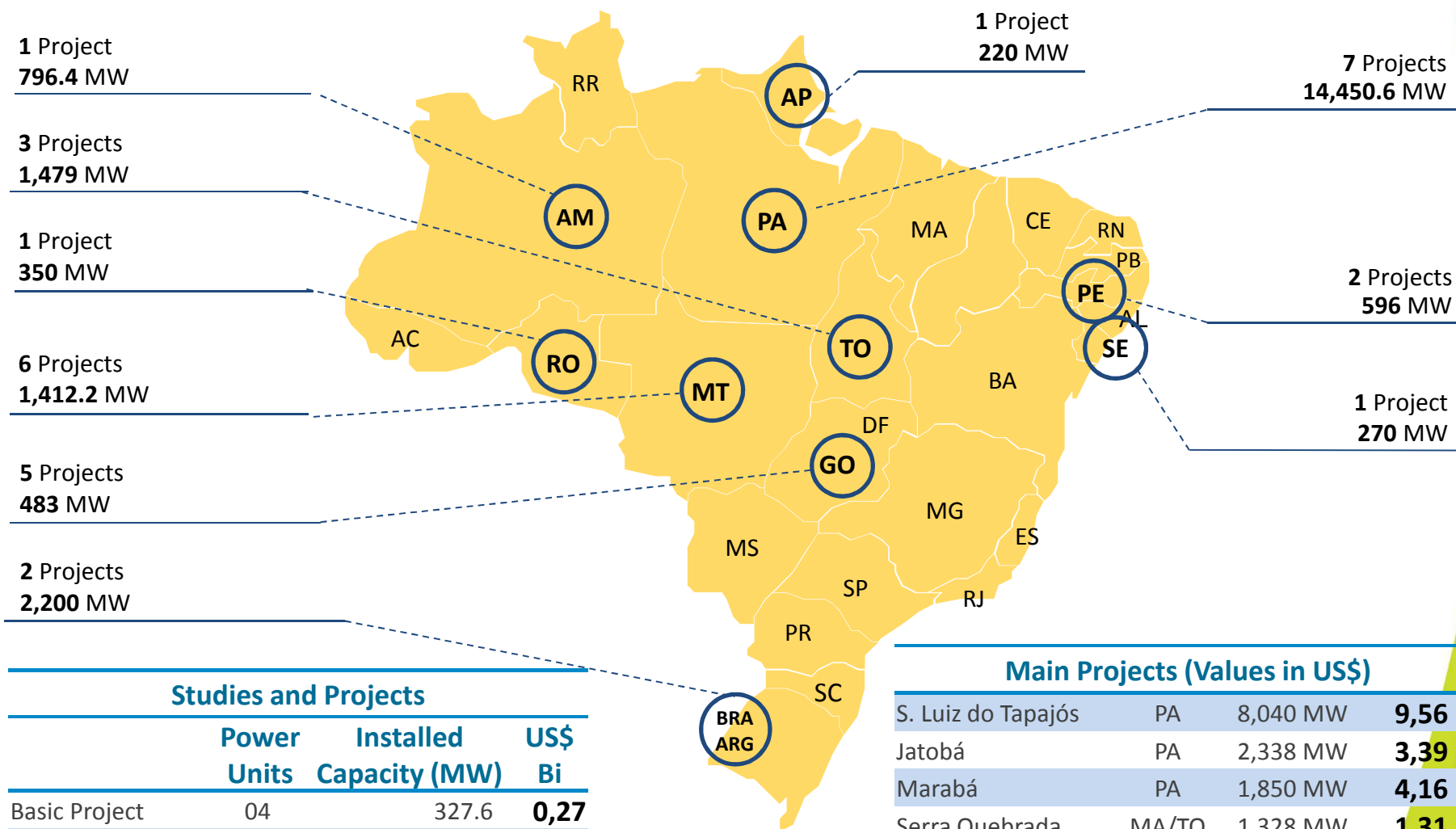


# Generation Projects Under Construction in Dec-30, 2014



Source: Eletrobras Anual Report 2014

# Basics Studies and Projects – Generation



## Studies and Projects

	Power Units	Installed Capacity (MW)	US\$ Bi
Basic Project	04	327.6	<b>0,27</b>
Feasibility Study	24	21,659.6	<b>27,58</b>
Inventory Study	01	270	
<b>Total</b>	<b>29</b>	<b>22,257.2</b>	<b>27,85</b>

## Main Projects (Values in US\$)

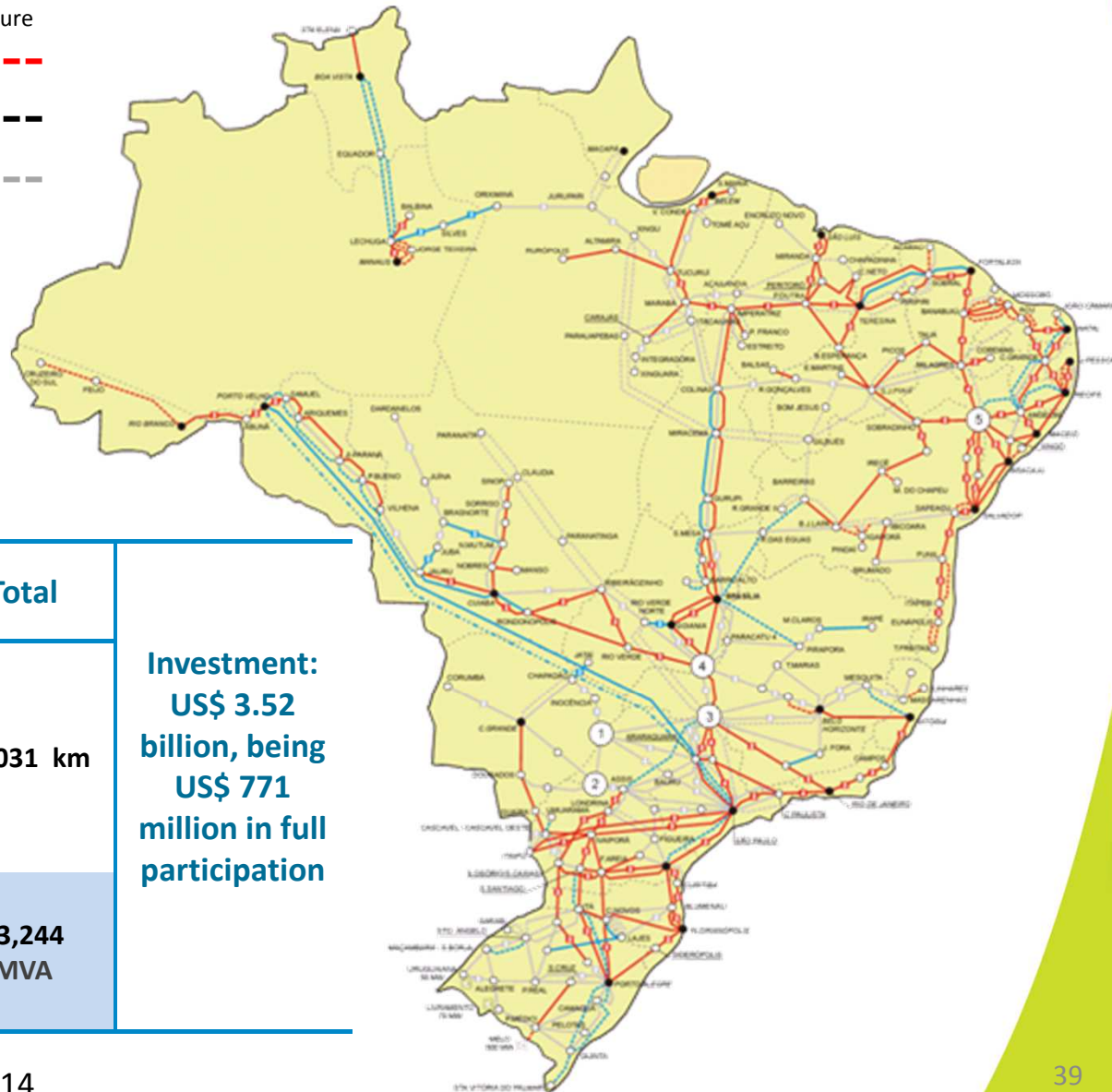
S. Luiz do Tapajós	PA	8,040 MW	<b>9,56 Bi</b>
Jatobá	PA	2,338 MW	<b>3,39 Bi</b>
Marabá	PA	1,850 MW	<b>4,16 Bi</b>
Serra Quebrada	MA/TO	1,328 MW	<b>1,31 Bi</b>
Garabi	BRA/ARG	1,152 MW	<b>1,54 Bi</b>
Panambi	BRA/ARG	1,048 MW	<b>1,41 Bi</b>
<b>Total</b>	-	<b>15,756 MW</b>	<b>21,38 Bi</b>

Source: Eletrobras Anual Report 2014

# Main Transmission Lines Projects under construction

Existing    Future  
 LTs Eletrobras System    —    - - -  
 LTs Eletrobras System with Partnership    —    - - -  
 LTs Other Companies    —    - - -

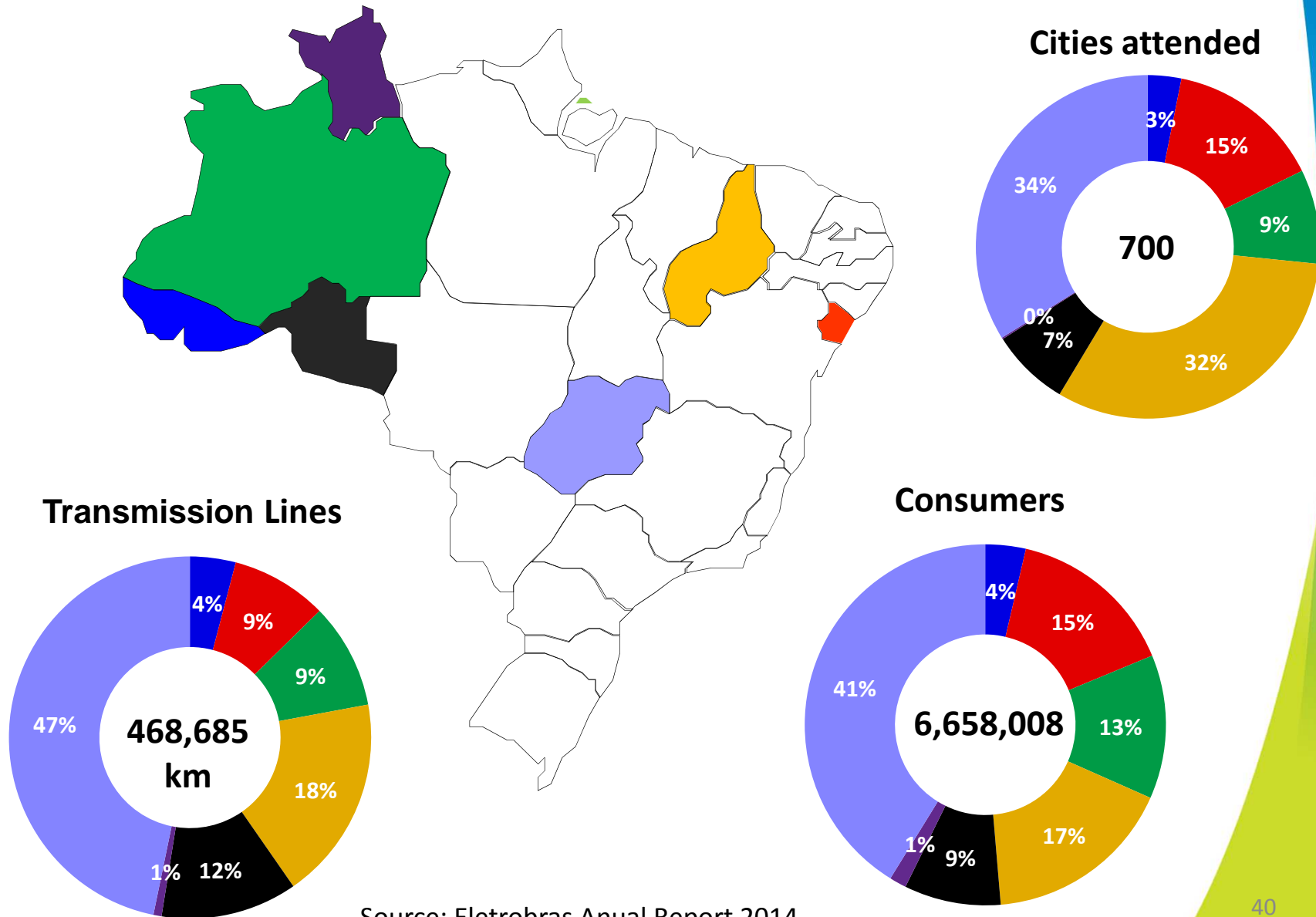
- ① Paraná River Complex
- ② Paranapanema River Complex
- ③ Grande River Complex
- ④ Paranaíba River Complex
- ⑤ Paulo Afonso Complex



Full Participation	Partnership	Total	Investment: US\$ 3.52 billion, being US\$ 771 million in full participation
2,784 km - 32 projects LTs + SEs associated	8,247 Km - 23 projects LTs + SEs associated being 4,013.3 km owned by ELB	11,031 km	
8,360 MVA	14,884 MVA being 7,237.5 MVA owned by ELB	23,244 MVA	

Source: Eletrobras Anual Report 2014

# Distribution – Eletrobras System



Source: Eletrobras Annual Report 2014



## **Electric Inclusion with Insulated Cables in Brazil**



**Eletrobras**

## Light for All Program

---



The “Light for All” program was launched by the Federal Government in November 2003, and it has as its goal to end the electric exclusion in the country in the rural ambit.

**16 million people attended**

# The Amazon Rainforest

---

The Amazon region has peculiarities that make it difficult to supply electricity to households in isolated regions.

Long stretches of forest, rivers, streams and lakes become obstacles to the construction of conventional air distribution network.

Eletrobras owns the local distribution company.

The chosen solution is the use of **underwater cables**.



# Underwater cable from Manacapuru to St. Afonso Island





# Underwater cable from Manacapuru to St. Afonso Island

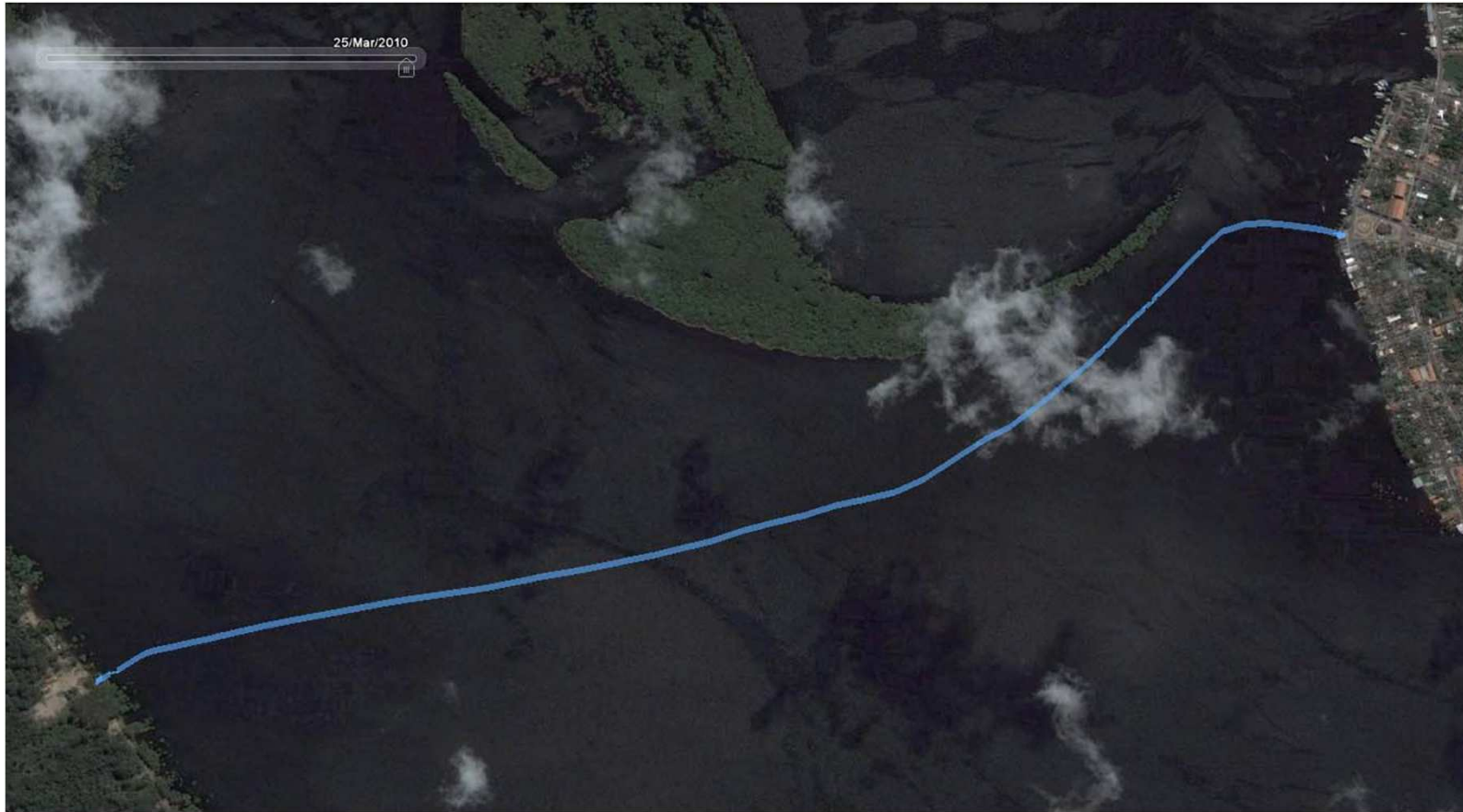


# Maués - Vera Cruz Island Crossing



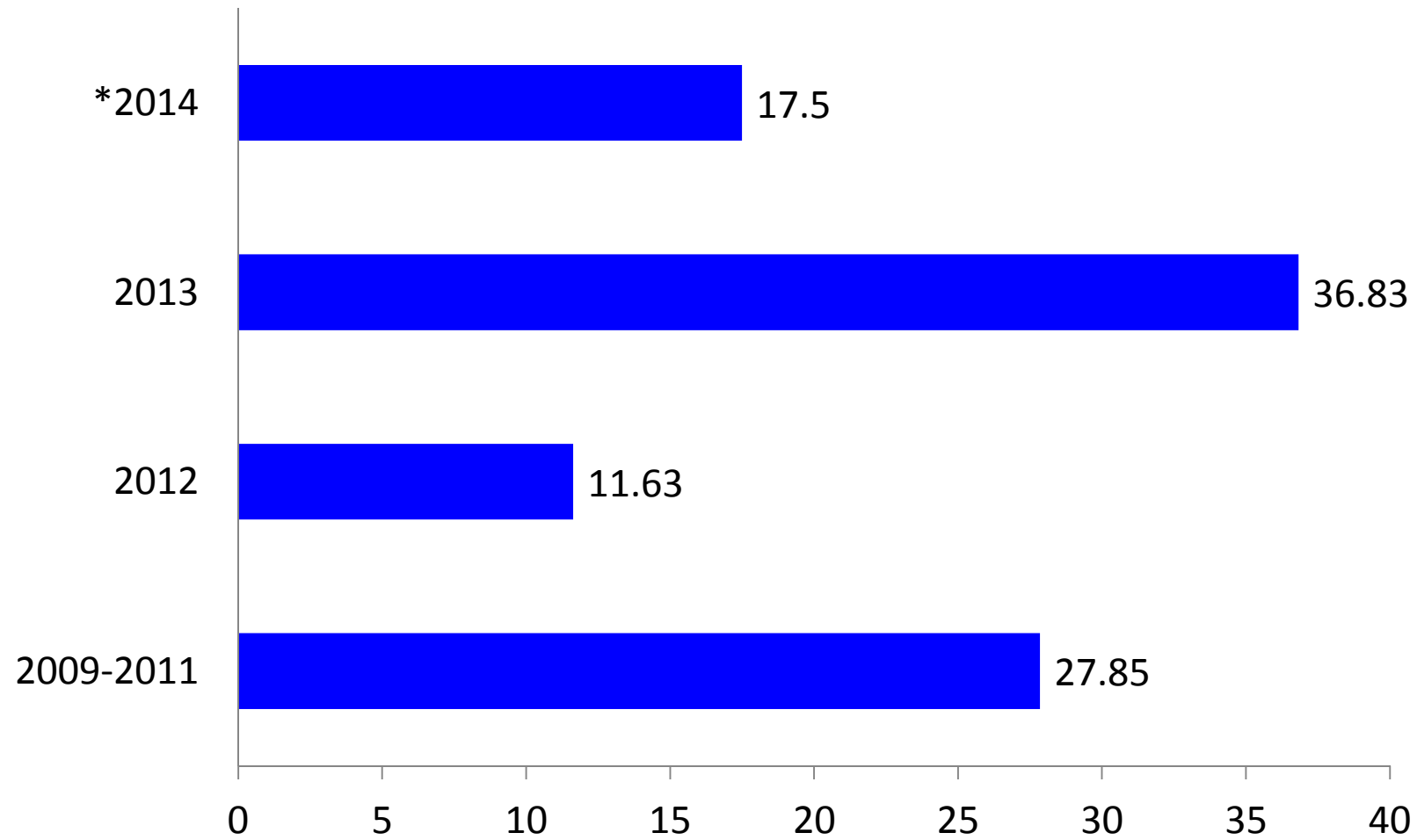


# Maués - Vera Cruz Island Crossing



**3,447.86 meters**

# Increase in underwater cable in the Amazon Region (km)



\* Estimated in 2013.

## Light for All underwater cables statistics in the Amazon region(\*)

**4.53** km is the largest river crossing located at Andirá river.

**31** cities crossed.

**67** total crossings.

**69** km of underwater cables.

**10,300** households served.

**51,500** people served.



(\*) Data between 2009-2013.

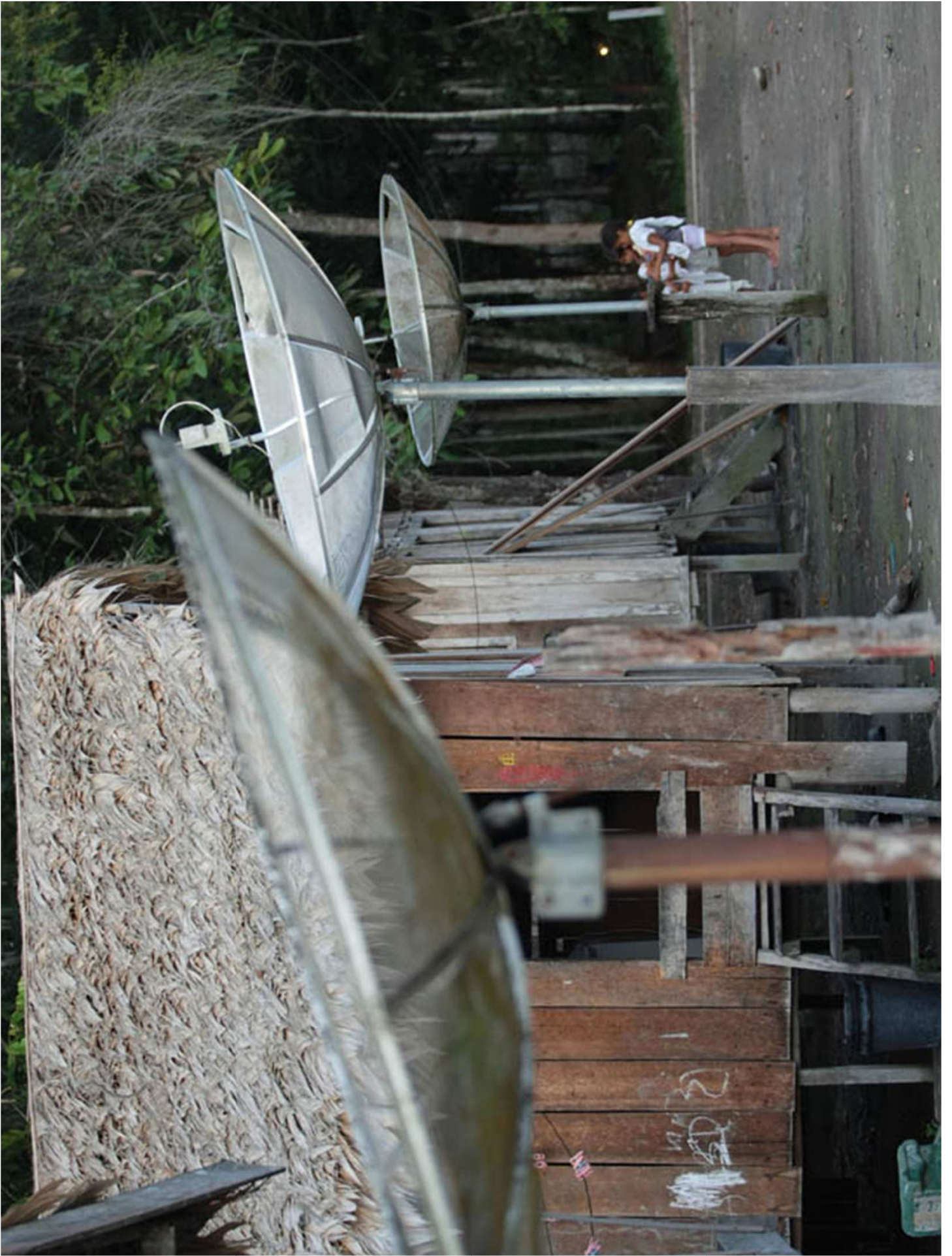


**Some of the people who are now served...**

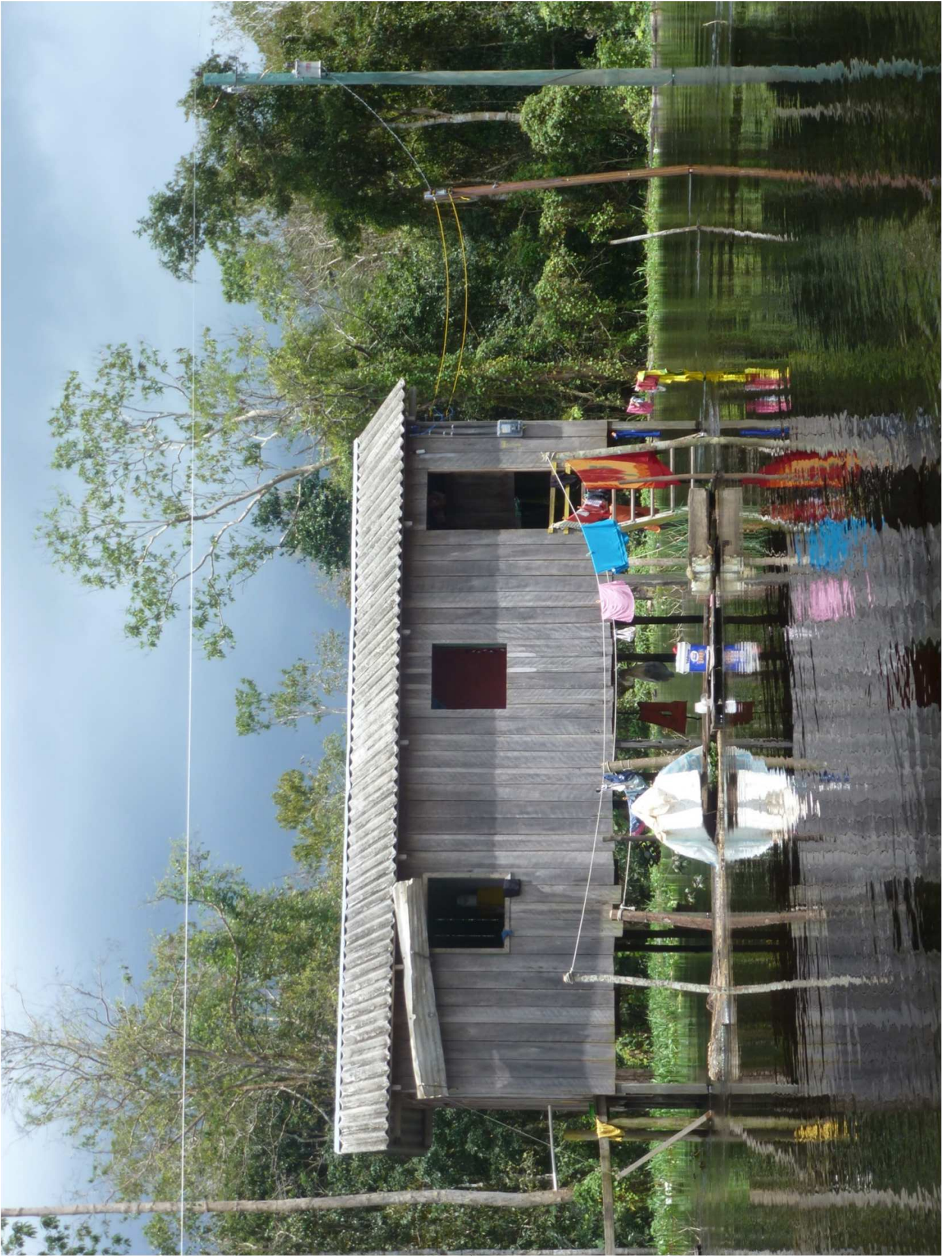


**Eletrobras**

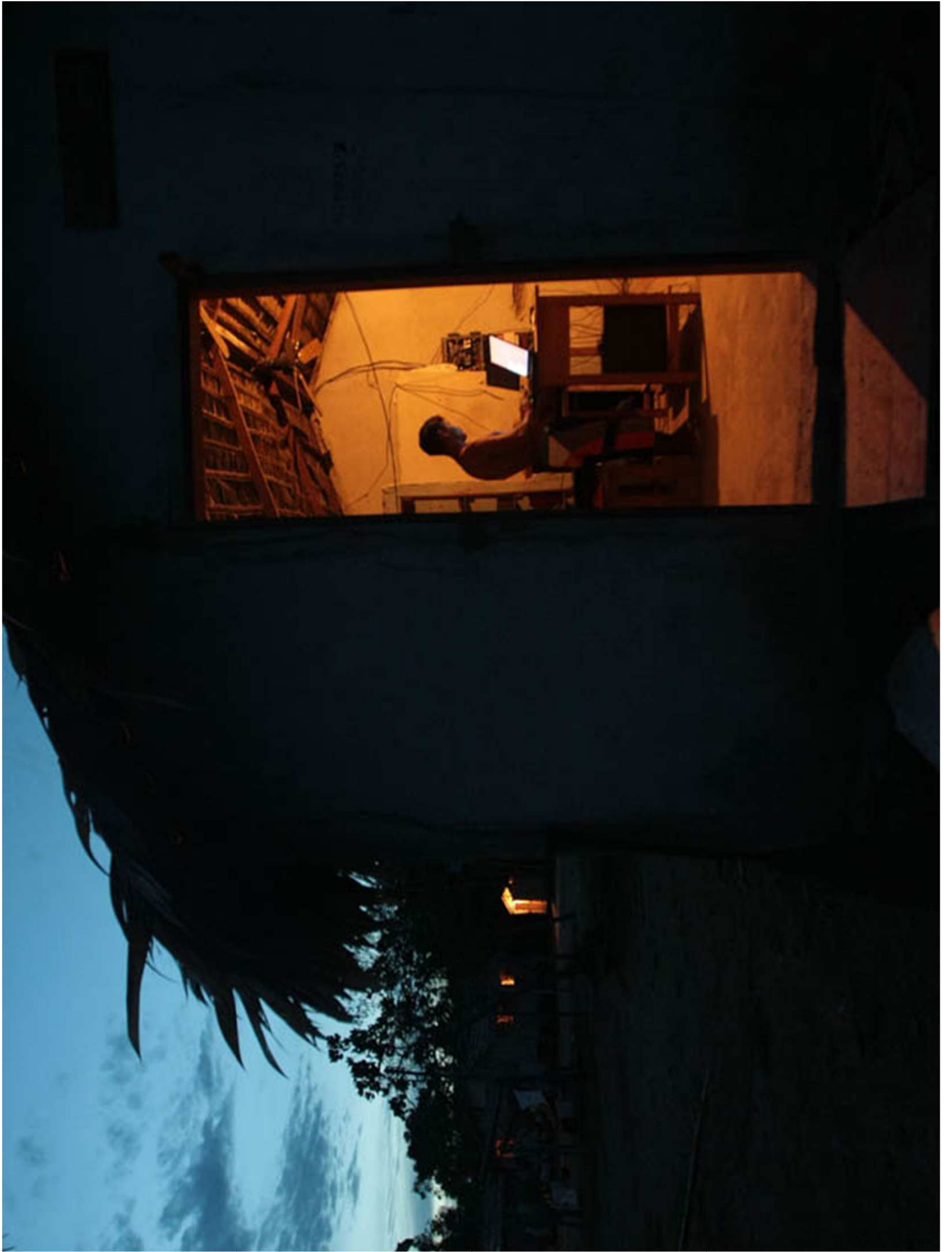














# Challenges



Eletrobras

## Challenges

---

- Huge investments in electrical infrastructure expansion in Brazil;
- Great business opportunities for generation, transmission and distribution companies from now by 2023;
  - Almost 6,000 km new transmission lines every year;
  - Almost 5,000 MW new generation every year;
  - Almost 2.9 million new consumers every year.
- Increase use of underground cables in crowded cities;
- Integrate new small plants (distributed generation) in the existent networks;
- Improve smart grids actions in distribution network;
- Promote regional integration with Latin America countries;

## Challenges

---

- Increasing and maintaining a clean generation matrix in Brazil
- Stimulate a consistent environmental protection in new power plants and transmission lines
- Work in towards a sustainable company
- Act to reduce emission level of tons of CO<sup>2</sup> every year



# The End

[josias.araujo@eletrobras.com](mailto:josias.araujo@eletrobras.com)



Eletrobras