

BRICS: An electricity tariffs comparison

Nivalde J. de Castro
Roberto Brandão
Jairo de Bastos Alves
Paola Dorado

Introduction

BRICS are countries that have similar socio-economic characteristics - Large territory, large populations and significant economic growth over the last decade.

COUNTRY	TERRITORY (km2)	POPULATION (Millions)	AVERAGE REAL GROWTH 2004-2014(%)
BRAZIL	8.515.770	200,4	3,6
RUSSIA	17.098.240	143,5	3,8
INDIA	3.287.260	1.252,1	7,7
CHINA	9.562.911	1.357,4	10,0
SOUTH AFRICA	1.219.090	53,2	3,2

Banco Mundial (2015)

COUNTRY	CAPACITY 2012 (GW)	DEMAND 2012 (TWh)
BRAZIL	121,1	498,4
RUSSIA	234,4	889,3
INDIA	254,7	864,7
CHINA	1.174,3	4.467,9
SOUTH AFRICA	45	212,0

EPE (2015); EIA (2015)

In addition to the identified characteristics, BRICS countries have great generation capacity and high electricity consumption.

Introduction

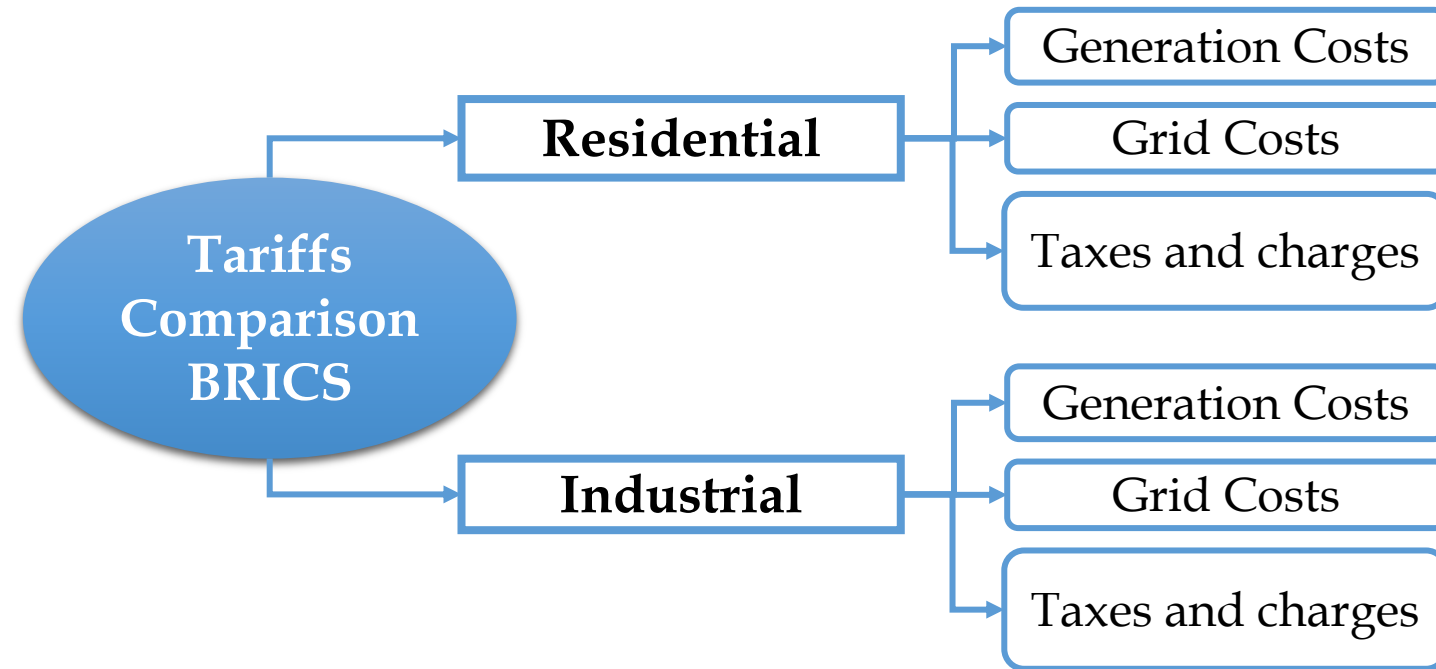
- BRICS have variety and abundance of energy resources.
- Although these countries have many similarities, the electricity tariffs are considerably different between them.

The objective of this work is to make an electricity tariffs comparison between the BRICS countries, analyzing the key factors behind these differences.

- The results of this study allow:
 - Understanding the differences between the countries, policy makers can establish better guidelines and make decisions relative to energy prices.
 - The society can have a better understanding about the tariffs and also can understand the reasons why they are not the same between countries.

Comparison Methodology

What is being compared ?



- Two kinds of final tariffs, each of one type of consumer, are studied.
- When the information is available, the total tariffs is divided between three components.
- The tariffs correspond to the year 2013

Comparison Methodology

How to make the comparison?

- ▶ An average, of the last 10 years, of the real exchange rate is used.
 - ▶ The tariffs are collected in the national currencies.
 - ▶ The national exchange rate is in relation to the American dollar.
 - ▶ The real exchange rate allows to isolate the inflation effects in each country.
 - ▶ The average of the last 10 years allows to mitigate the risk of distortions due to the exchange volatility on the short term.
- ▶ Necessary information for each country.
 - ▶ Nominal exchange rate. (2000-2013)
 - ▶ Inflation rate (2000-2013)
 - ▶ Residential tariffs (2009-2013)
 - ▶ Industrial tariffs (2009-2013)
 - ▶ Tariffs components

Comparison Methodology

➤ Data sources:

- World Bank
- International Monetary Fund
- Aneel (Brazil)
- International Energy Agency (Russia)
- The Lantau Group 2013 (China – Beijing)
- Planning Commission of India; Ministry of Power (India-Delhi)
- Eskom (South Africa)

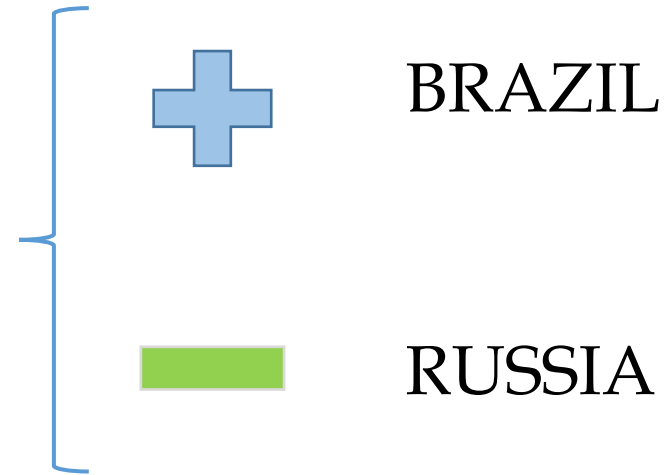
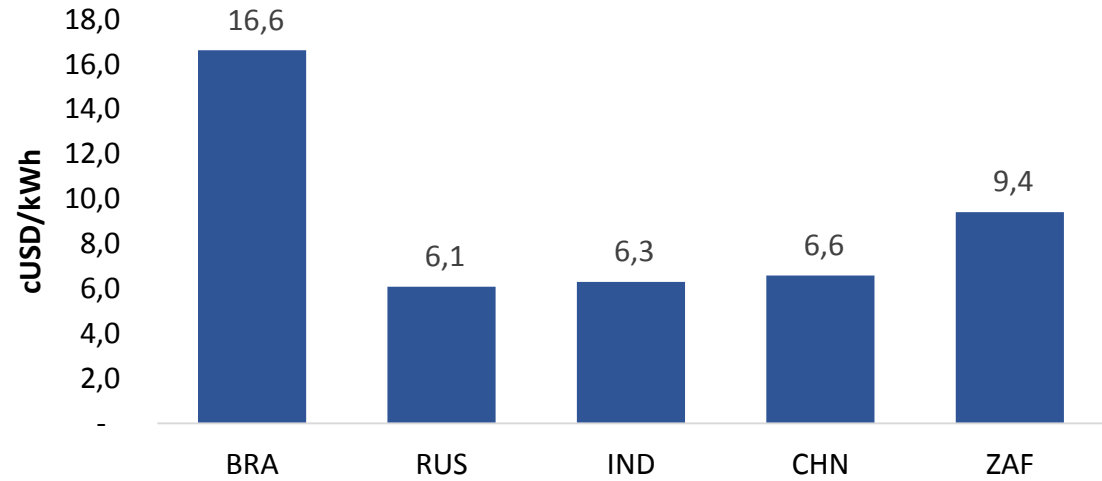
➤ Obtained information

	BRAZIL	RUSSIA	INDIA	CHINA	SOUTH AFRICA
Exchange rate					
Inflation					
Residential tariff					
Generation cost			X		
Grid cost			X		
Taxes and charges					
Industrial tariff				X	
Generation cost	X		X	X	X
Grid cost	X		X	X	X
Taxes and charges		X		X	

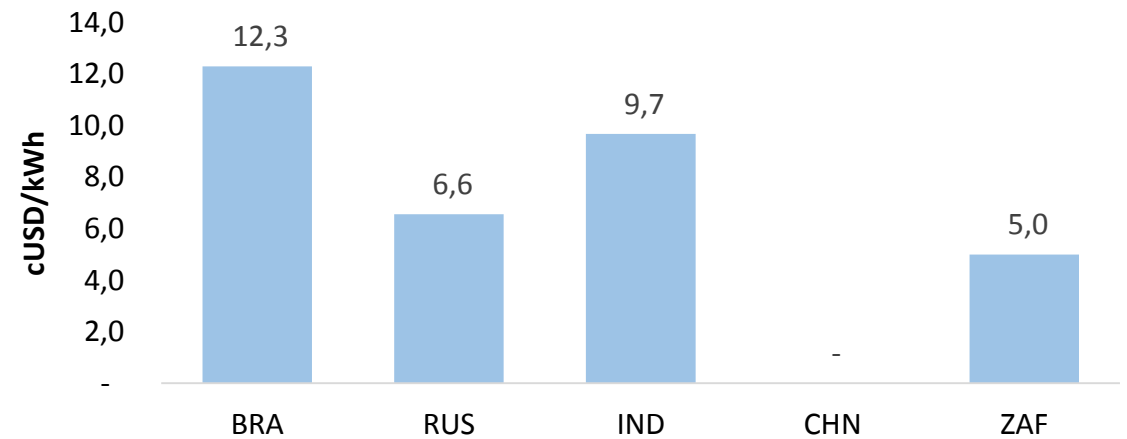
X- Non obtained information

Results

RESIDENTIAL TARIFFS 2013

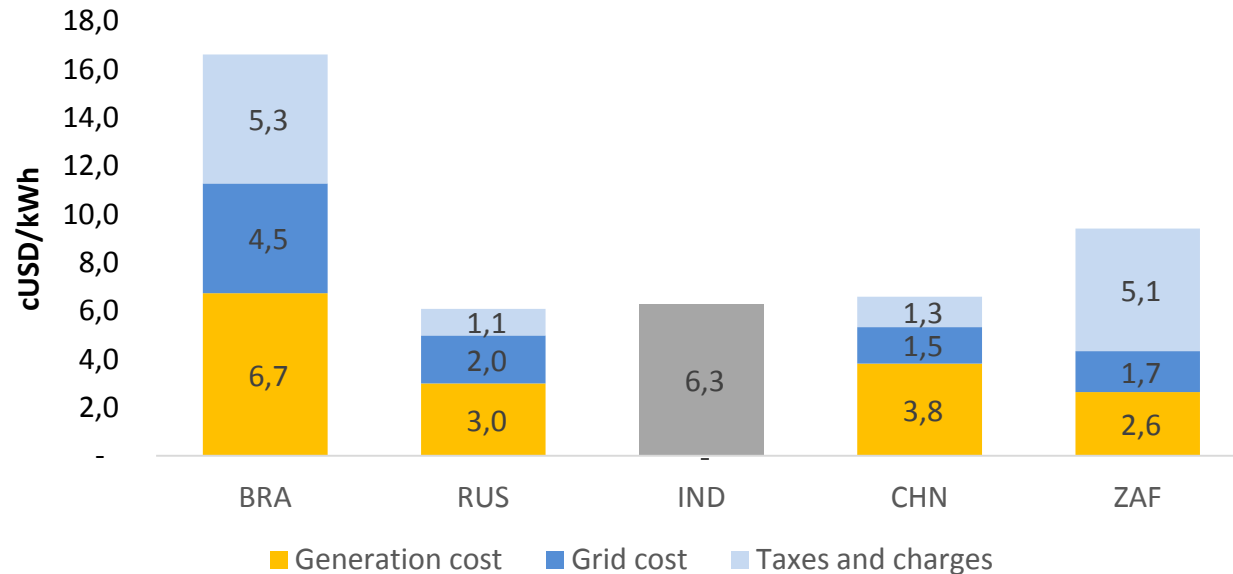


INDUSTRIAL TARIFFS 2013



Results

RESIDENTIAL TARIFFS COMPONENTS 2013



Russia has low generation and grid costs, it also has low taxes rate over the electricity tariffs.

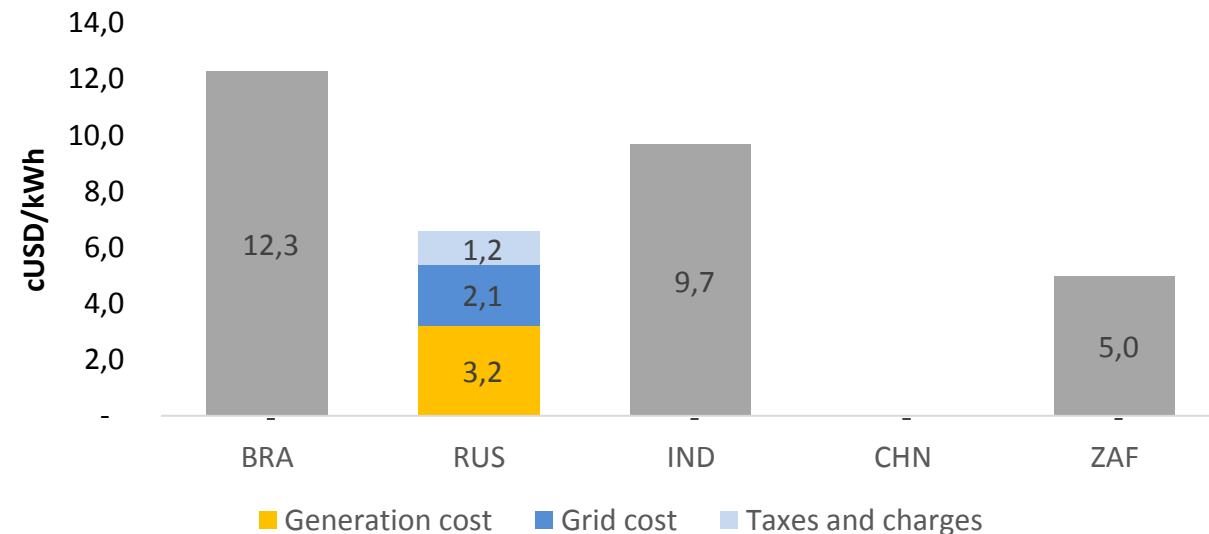
Brazil has the higher components between the BRICS.

South Africa has the lowest generation cost.

China has the lowest grid cost.

Russia has lowest taxes.

INDUSTRIAL TARIFFS COMPONENTS 2013



Factors that determine the differences between electricity tariffs.

➤ Structural factors.

- Electric matrix.
- Resources availability
- Assets age
- Grid extension.



- ## ➤ Regulatory factors
- Pricing mechanisms.

➤ Public Policies.

- Taxes and subsidies
- Market structure.
- State intervention



Factors that determine the differences between electricity tariffs- Structural: Electric Matrix

	Installed Capacity 2012 (GW)	Hydro (%)	Thermal (%)	Wind (%)	Solar (%)	Nuclear (%)	Other (%)
BRAZIL	121	69%	27%	2%	0%	2%	0%
RUSSIA	234	20%	69%	0%	0%	10%	1%
INDIA	255	17%	72%	7%	0%	2%	1%
CHINA	1.174	21%	70%	5%	0%	1%	2%
SOUTH AFRICA	45	2%	90%	0%	0%	4%	4%

EPE(2015) EIA (2015)

- ▶ All BRICS have thermal electric matrixes, excepting Brazil.
- ▶ **Hydro** needs high investment, has high sunk costs, very long repayment period and low variable cost, consequently it has lower impact on the tariff. **However**, because of the hydrologic risk, it needs complementary generation that might have more impact on the tariff.
- ▶ **Thermal** has low fix costs (investment) but high variable costs because of the fuel, consequently it has high impact on the tariff. **However**, it depends on the fuel availability, countries that have to import fuels will have higher generation costs than those countries which produce fuels.

Factors that determine the differences between electricity tariffs- Structural: Resources availability

	Hydro 2012 (GW)	Wind 2012 (GW)	Solar 2012 (GW)	Oil 2014 (1000 Bpd)	Natural Gas 2013 (Bcf)	Coal 2013 (1000 Ton)
BRAZIL	84,1	1,9	0,0	2.950	1.067	7.626
RUSSIA	47,1	-	-	10.853	23.590	388.013
INDIA	43,3	18,3	1,2	978	1.248	675.467
CHINA	249,0	61,0	3,3	4.572	3.986	4.374.940
SOUTH AFRICA	0,7	-	-	160	41	282.502

* For renewable resources it has been used the installed capacity of 2012.

*Bpd - Barrels per day

*Bcf - Billion of cubic feet

EIA (2015)

Brazil: Still has a great hydro potential on the Amazonia region, and also has wind potential on the north east of the country. About the fuels, it is estimated that oil and natural gas production will grow because of the exploration in the pre-sal.

Russia: Is a big fuel producer, and the biggest natural gas producer on the world. The domestic transportation cost of natural gas is lower than the export transportation cost, this reduces the impact on the tariff.

India: Is a big coal producer, but the coal demand is higher than the production, consequently it must import part of the coal it uses, increasing the generation cost.

China: Has a large amount of almost all energetic resources, it is the world biggest producer and consumer of coal.

South Africa: Has important coal reserves which explains why 90% of its matrix is thermal. Most of the coal companies sells exclusively for ESKOM whose generation plants are in the coal mines reducing the generation costs.

Factors that determine the differences between electricity tariffs- Structural: Grid extension

	Grid 2012 (Km)	Intensity of use (MWh/Km)	Density of use
BRAZIL	3.600.620	138,40	0,40
RUSSIA	2.452.300	301,88	0,14
INDIA	8.970.112	96,80	2,70
CHINA	4.620.144	893,50	0,48
SOUTH AFRICA	359.337	548,50	0,30

* Intensity of use - Consume (MWh) / Km of grid

* Density of use - Km of grid/ Km country's territory

Varias

- BRICS are large countries and need extensive grids increasing the transmission cost.
- A grid could be underutilized when it has a low intensity of use, this would mean a higher cost.
- The information was obtained from many different sources. However, it is a good approximation.

Intensity of use - aims to measure the grid use efficiency. The more MWh transiting through each Km of grid, lower would be the unitary cost of the grid. .

Density of use - aims to measure the km of grid existing for each km of territory.

Brazil: The grid is quite extensive, and has the second lowest intensity of use indicator. This could mean low efficiency of the grid what would tend to increment its cost.

Russia: Has a small grid extension comparing with the territory extension, and also has a high intensity of use. In this case, there are problems because of the lack of investment to expand the grid, being this very old.

India: Has the biggest grid extension between BRICS, but it also has the lowest intensity of use. This means that the assets are not being use efficiently, having impact in the grid's cost.

China: The grid is underestimated because there is only information of *State Grid*.

South Africa: Has the lowest grid extension and the biggest intensity of use, this could mean lack of investments.

Factors that determine the differences between electricity tariffs- Structural: Assets age

- ▶ The assets age is related with the investment level.
- ▶ When there is idle capacity it is not necessary to make big investments, reducing the costs. However, when the demand grows fast generally requires high investments to ensure the energy supply.
- ▶ In general the BRICS countries, excepting Russia and South Africa, have had big demand increases and, consequently, a big expansion of the installed capacity. This implies in high investment which had impact on the electricity tariffs.

	Consumption growth (2008-2012) (%)	Installed capacity growth (2008-2012) (%)
BRAZIL*	20,5	23,1
RUSSIA	2	12,8**
INDIA	40,4	43,6
CHINA	45,1	45,6
SOUTH AFRICA	-2,4	7

*From 2008 to 2013

** From 2000 to 2012

Fonte: Varias

Russia had a big idle capacity after the 1990's decade crises. So, 65% of the installed capacity is operating for more than 30 years.

South Africa: In 1998, Eskom stopped making investments, waiting for the private agents to invest. In 2007, the country had a supply crises because of the lack of capacity, this situation obligates Eskom to make emergency investments. Consequently the electricity tariff increases 78% between 2008-2011 in order to afford the investments needed.

Factors that determine the differences between electricity tariffs- Public Policies: Taxes and charges

Taxes: Includes specific sector charges and national taxes, does not includes recoverable taxes like VAT for the industrial tariffs.

Subsidies: Could be a social tariff or a subsidy for the generation resources. The tariffs showed in this study do not consider the social tariff, but the “normal” one.

	Especial taxes and charges for the sector	Cross Subsidies	Generation Fuel subsidies
BRAZIL	32% of the tariff (taxes and charges)	social tariff (residential/residential)	
RUSSIA		industrial/ residential	Regulated price for natural gas
INDIA		industrial/ residential, and also has a direct subsidy for residencies.	
CHINA			regulated price for coal
SOUTH AFRICA		Residential / residential	

Factors that determine the differences between electricity tariffs- Public Policies: Market structure

	Electric sector structure	Private agents participation
BRAZIL	Fully desverticalized (G/T/D).	Wide participation of private agents, mainly in partnership with public companies.
RUSSIA	Liberalization process reversed in 2012. The Russian State, through the different public companies, owns all the productive chain of electricity (G/T/D).	Little participation
INDIA	G/T/D activities are responsibility of the states governments. There is more than one market structure depending on the state.	Little participation
CHINA	The Chinese State, through the different public companies, owns all the productive chain of electricity.	Little participation, only in some renewable projects.
SOUTH AFRICA	Vertically integrated monopoly, ESKOM, own by the State.	Little participation

Factors that determine the differences between electricity tariffs- Public Policies: State intervention

Brazil: The main State intervention in the electricity sector is through the regulatory agency Aneel, and through the centralized planning of the system expansion that is responsibility of the public company EPE.

Russia: The State owns almost all the generation assets and all the grids. It also exists a regulator agent, the SFT, which controls all prices that should be regulated according to the law.

India: The electricity sector structure and its regulation is defined at state level and not at the national level. That is the reason why each state has its own regulator agent as well as a different market structure

China: The State owns all the assets of the production chain, through the public companies. There is not a regulator agency, but an state department, NDRC, which controls the electricity tariffs and also the prices paid to all the agents along the production chain

South Africa: The State participates along all the productive chain, through the ESKOM, there is also a regulator agent, NERSA, that regulates the energy sector

Factors that determine the differences between electricity tariffs- Regulatory: Pricing mechanism

Brazil: The pricing model considers three kind of costs: non-manageable costs, controllable costs and the financial components. There is a remuneration for the invested capital compatible with the cost of the capital in the market.

Russia: On the paper, the pricing model is based on the invested capital remuneration. But, since 2014 all monopoly prices were frozen, including the electric sector and natural gas sector.

India: The pricing mechanism is responsibility of the regulator in each state. However, the tariffs should consider all the costs, generation, transmission and distribution. But the state governments tend to keep the prices artificially low, they do not repasses all cost to the tariffs, specially generation costs.

China: The regulator, NDRC, does not necessary repasses all production costs to the tariffs. The tariffs are calculated as a “catalogue”, so there is different types of consumers for each tension level.

South Africa: The regulator establishes the price lower than expected. The tariff aims to maintain the economic and financial stability of ESKOM, but the invested capital remuneration is lower than the market

Conclusions

- First it is pointed out some characteristics of the electric sector in each BRICS country .

Brazil:

- a. The electric matrix is mainly hydro, but the country has many different renewable resources.
- b. The electric demand grows rapidly demanding investments for the system expansion.
- c. There is a high incidence of taxes and charges in electricity tariffs.
- d. The sector is fully des-verticalized. There is a wide private agents participation, and also exists competition on the generation and transmission activity.
- e. The State intervention is mainly trough the centralized planning for the system expansion, and also trough the regulator.
- f. The pricing mechanism guaranties the invested capital remuneration with rates comparable to those in the market.

Russia:

- a. The electric matrix is mainly thermal, specially natural gas. The country is a big fuel producer, being the biggest natural gas producer in the world.
- b. The generation and transmission assets are very old. And also there is a low growth of the demand.
- c. Beyond the State being the biggest natural gas producer, there is a subsidy for the natural gas used to generate electricity.
- d. The State owns almost all the generation assets and all the grid.
- e. The pricing model established by the law is not used, and since 2014 the electricity and natural gas tariffs are frozen.

Conclusões

India:

- a. The electric matrix is mainly thermal, basically coal. Although the country is a big coal producer, the demand grows faster than the production, so the difference must be imported.
- b. It has the largest and more inefficient grid between the BRICS
- c. The consume grows rapidly, and also the installed capacity.
- d. There is a cross subsidy between industries and residencies. And also there is a direct subsidy for the residential tariffs.
- e. The regulation and sector organization is responsibility of the states governments.
- f. They tried to incentive the private participation in the sector, however the public companies still have the bigger participation.
- g. The pricing mechanism determines that the tariffs should consider all costs, but the state governments keep a low tariff without passing all the generation costs.

China:

- a. The electric matrix is mainly thermal, basically coal. The country has many energetic sources and is the biggest producer and consumer of coal in the world.
- b. It has a fast growth of the installed capacity and also a rapid growth of the electric demand.
- c. The public companies own all the assets, generation and grids.
- d. The NDRC, beyond than regulating the electricity tariffs, also regulates the coal price for electricity generation.
- e. The electricity tariffs are calculated by catalogue and they do not reflect all the production costs.

Conclusões

South Africa:

- a. The electric matrix is mainly thermal, basically coal. Most of the coal companies supply exclusively to ESKOM that has its generation plants on the coal mines.
- b. Aiming to incentive the private participation in the sector, ESKOM stopped investing in 1998. Because of the lack of investment, in 2007, the country has a supply crises.
- c. Most of the population is beneficed with the social tariff.
- d. The electric sector is organized as a verticalized monopoly own by the public company ESKOM.
- e. The regulator aims the economic and financial stability of ESKOM, but the invested capital remuneration rate is lower than the market in order to keep a low tariff.

- In this second section is pointed out some general conclusions.
 - The electricity tariffs at BRICS are largely dependent of the State participation in the productive chain.
 - The electric sector liberalization advanced more in Brazil than in the other BRICS. In some countries this process was reverted.
 - The sector regulation not necessarily responds to the invested capital remuneration logic with remuneration rates comparable with the market rates, in fact just Brazil has this model.
 - The electricity tariffs at BRICS do not necessarily reflects the real production costs, being kept low artificially.
 - In general all BRICS, excepting Brazil, have some kind of subsidy or price control to the fuels used in generation.
 - In all BRICS exist some kind of social tariff.