Analysis of the determinants of the Brazilian energy mix

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February 2016

Objectives

- Compare the official planning, the *Plano Decenal de Expansão de Energia* (PDE), with the results of the energy auctions held so far.
- Analyze, by type of generation, where the greatest differences between what was planned and what was procured occurred.

Essentially, the paper seeks to answer if through the current planning and auction mechanisms, we are in fact moving towards a **strategic electric matrix mix** for the Brazilian Electricity Sector (BES).

The need for medium and long-term planning

- Electricity is an **essential commodity** for all socio-economic sectors, and its uninterrupted supply, with reliability and affordable tariffs, is crucial for the national development.

- Electricity is not directly storable in large amounts, so there is a need to meet the consumption and its generation to have an **instant balance near to zero**.

- Investments in the energy sector are also **capital-intensive with long-term maturity**.

The combination of these features brings to the sector the **need for medium and long-term planning**, becoming a fundamental and strategic activity for the BES.

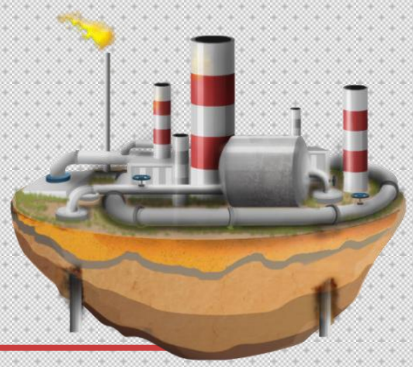
Brazilian electricity mix

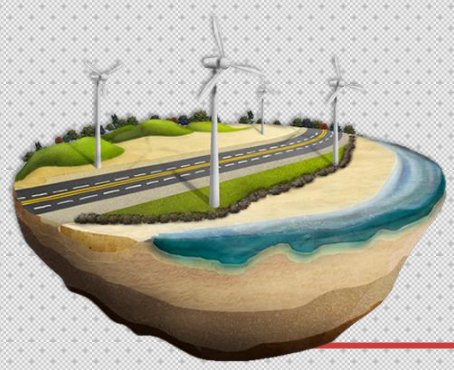
Hydro

65,14%

Thermal

29,57%



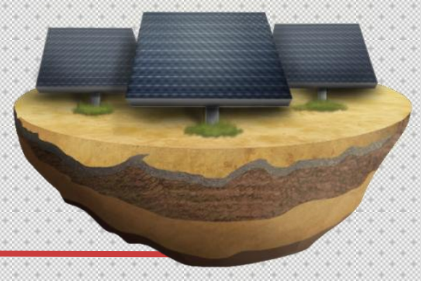


Wind

5,28%

Solar

0,02%



Source: *Agência Nacional de Energia Elétrica* (ANEEL).

Brief history of the Brazilian electricity sector

- Throughout the 20th and 21st century, the **responsibility for planning** the BES changed hands many times.
- The **regulatory framework** has undergone several **transformations** in that period, especially regarding the participation of the State.
- In the mid-1990s was implemented a liberal reform with the **privatization** of companies in the sector, beginning in the year 1995.
- The liberal model brought up the definitive **unbundling of the production chain** of the companies in the sector by separating the segments of generation, transmission, distribution and commercialization of electricity.
- The **competition** in the generation and commercialization sectors was encouraged, keeping **regulated** the distribution and transmission.

Brief history of the Brazilian electricity sector

- Until February 2000, about **65%** of the national distribution market had already been transferred to the **private sector**.
- In that time, the enforcement of energy policies and **medium and long-term planning** were **neglected**.
- The lack of planning added together with technical and environmental issues triggered a serious energy **supply crisis** in 2001.
- The crisis resulted in the need for **rationing** of 20% of the electricity consumption.
- As a result, in 2001, the Committee of Revitalization of the Electricity Sector Model was created. Its work resulted in a set of **recommendations for the BES**.

Brief history of the Brazilian electricity sector

In conclusion, the liberal reform implemented in the BES was **ineffective** in securing the main objectives of a public service, such as supply reliability, low tariffs and universality.

One of the facts that explained its inefficiency was the **lack of planning**.

As a result, it was triggered the implementation of a **new model** for the BES.

The new model brought a **reestablishment of the coordination and planning** with a more active role of the State.

The new model of the Brazilian electricity sector

- The new model, implemented between the years 2003 and 2004, modified the electric power **procurement method** and resumed the **centralized planning** in the sector.

- The new model was built upon three fundamental **objectives**:

Expansion of the installed capacity to meet demand growth

Reasonable tariffs

Universal access to electricity

The new model of the Brazilian electricity sector

In order to meet these objectives, one of the introduced changes was the creation of **two markets environment** for energy trading:

Free Market (FM)

Bilateral contracts between suppliers and free consumers; it is possible to have a greater negotiation of the supply contracts.

Regulated Market (RM)

Distribution companies purchase energy through energy auctions, observing the criterion of the lowest price.

The electricity procurement auctions

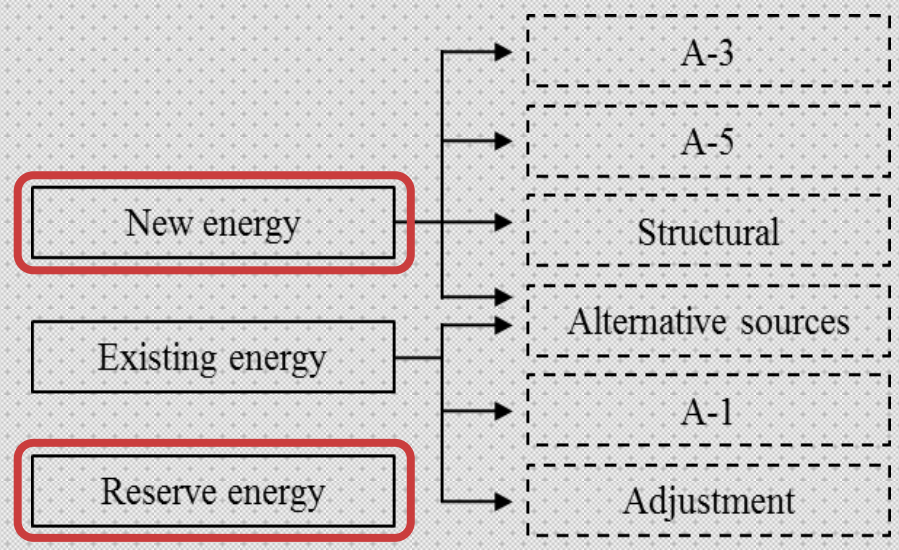
- The energy auctions are an essential tool for the **expansion and sustainability** of the BES, since it is through them that:
  - Occurs the procurement of electricity to meet the future demand from distributors;
  - It is granted the concession of new plants.
- The distributors must guarantee through the auctions the energy to meet the **total consumption** of its market in the RM
- The electricity auctions seek to procure energy to ensure **reasonable tariffs** → auction winners are based on those suppliers that offer electricity at the **lowest price per MWh**.
- The resulting contracts from auctions are **long term** and may last between **15 and 30 years** when it comes to new plants.

The electricity procurement auctions

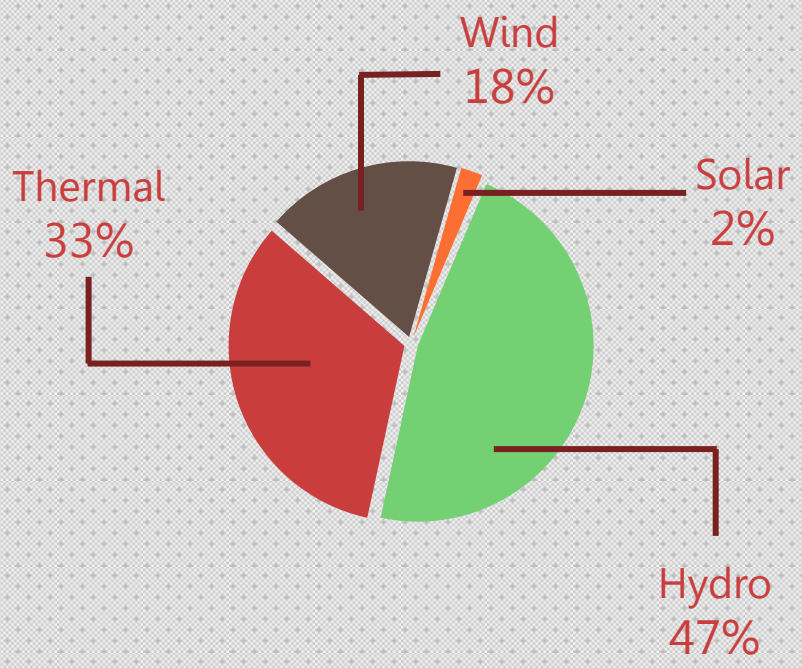
New energy	Existing energy	Reserve energy
• Procurement of energy from new power plants • Beginning of supply in three years (A-3) or five years (A-5) • The new energy auctions can also be of a structural type or for the exclusive purchase of alternative sources	• Performed each year in order to contract energy derived from plants already built • Beginning of supply in the year following its realization (A-1) • Allow an adjustment of the contracts since conditions may change	• Procurement of new plants that provide the BES a generation reserve capacity • Occur in order to increase the security of supply of electricity

The electricity procurement auctions

Types of auctions



Energy procurement in auctions that have added new installed capacity to the BES (2005-2015)



The electricity procurement auctions

- The success of the auctions is key to the **balance** between supply and power consumption and hence to reduce the deficit and rationing risks.

- It is through the new energy auctions that the government coordinates the **expansion of generating capacity** and are their winning sources that will make up the **future electricity mix**.

Auctions are an important instrument of planning in the BES.

The resumption of planning in the new model

- Another modification of utmost importance brought by the new BES's model was the **return of centralized planning** for the sector.

- In 2004 it was authorized the creation of the ***Empresa de Pesquisa Energética*** (EPE), in order to conduct studies and researches to **subsidize the energy sector planning**.

- The studies carried out by EPE cover various horizons, making projections of economic and energy scenarios to **ensure the future supply** in a safe and economically viable path for the whole society.

- One of EPE's main studies is the ***Plano Decenal de Expansão de Energia*** (PDE).

The resumption of planning in the new model

- PDE: an important tool for planning the BES -

- It is elaborated on an annual basis and makes forecasts for the expansion of supply and demand for a period of **10 years ahead**.
- Scenarios of **sustainable energy supply** are elaborated through the analysis of macro-economic, environmental, social and technological variables.
- Although the PDE indicates the future energy mix for the sector, its results are only **indicative** (except for large hydropower plants).
- Indeed, despite EPE's recommendations, the **winning bidders** in the auctions are the sources that will make up the future mix.

It is essential to evaluate whether PDE's propositions occur in reality or not.

Comparative results

- A **wide variation** between the different annual editions of PDE was found.
- On the one hand, it is understood that it is natural to have some differentiation between studies, possibly due to economic and environmental issues. However, so that the BES can benefit from an integrated long-term vision, it is essential to the planning to have a more **uniform central direction**.
- Evidently, the development of a planning with a **ten-year horizon** is not trivial. Therefore, it is expected that the forecasts for the coming years to be more realistic than those prepared with a higher timeslot.

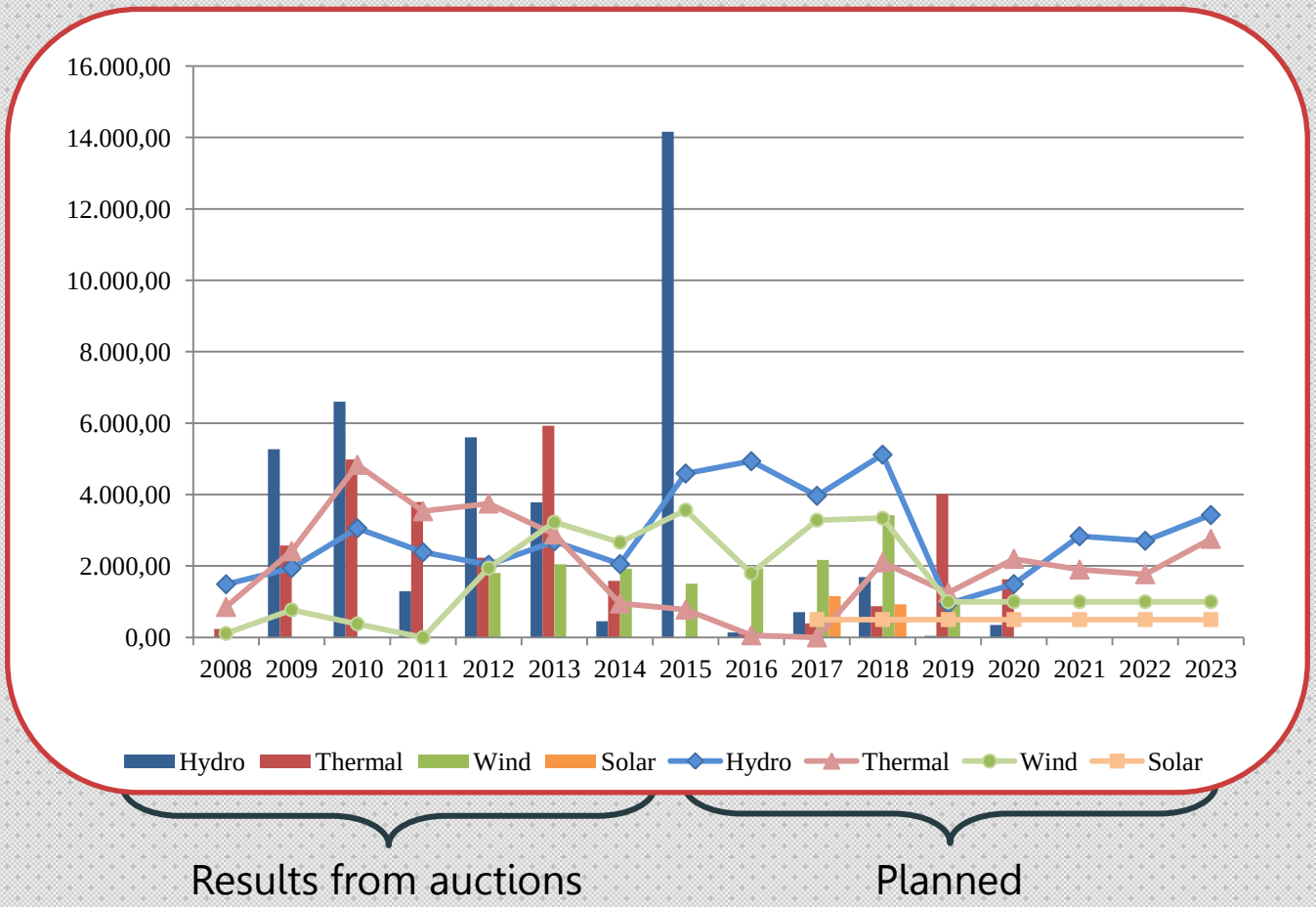
Comparative results

Increase to the installed capacity planned by the PDE vs. procurement of energy in the auctions by source (MW)

	PDE	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Hydro	2007-2016	**1.489**	912	2.661	2.047	2.059	4.982	7.046	6.963	4.608							
	2008-2017		**1.944**	**3.058**	1.887	688	2.875	2.861	5.397	7.342	6.536						
	2010-2019				**2.387**	812	2.604	1.732	5.475	6.070	3.925	4.797	8.651				
	2011-2020					**2.034**	2.371	1.147	4.521	5.123	5.739	5.277	2.522	3.899			
	2012-2021						**2.690**	1.605	4.436	4.730	4.998	4.037	2.421	3.387	5.463		
	2013-2022							**2.053**	4.182	3.665	3.921	5.048	1.785	2.855	2.815	5.568	
	2014-2023								**4.590**	**4.934**	**3.966**	**5.118**	**947**	**1.494**	**2.832**	**2.705**	**3.428**
	Auction	0	5.275	6.599	1.293	5.601	3.782	450	14.162	135	710	1.692	44	346			
Thermal	2007-2016	**855**	1.283	1.542	3.099	2.971	1.530	1.550	200	500							
	2008-2017		**2.418**	**4.833**	2.694	776	5.216	1.350	900	0	0						
	2010-2019				**3.534**	1.684	5.092	399	1.755	200	150	350	400				
	2011-2020					**3.750**	5.152	372	300	1.705	350	330	370	460			
	2012-2021						**2.885**	4.296	50	1.455	100	750	950	900	1.850		
	2013-2022							**949**	93	0	100	2.652	1.060	1.210	1.380	700	
	2014-2023								**780**	**60**	**0**	**2.103**	**1.250**	**2.200**	**1.900**	**1.770**	**2.760**
	Auction	238	2.569	4.985	3.794	2.236	5.929	1.584	0	100	389	873	4.010	1.627			
Wind	2007-2016	**112**	0	0	0	0	0	0	0	0							
	2008-2017		**771**	**378**	0	0	0	0	0	0	0						
	2010-2019				**0**	1.805	400	400	400	400	400	400	400				
	2011-2020					**1.941**	2.048	900	850	760	900	850	1.000	1.000			
	2012-2021						**3.227**	1.943	949	1.283	500	1.150	1.650	1.430	1.450		
	2013-2022							**2.663**	2.536	1.683	1.283	1.000	1.000	1.000	1.200	1.200	
	2014-2023								**3.567**	**1.797**	**3.283**	**3.340**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**
	Auction	0	0	0	1.806	2.048	1.929	1.505	1.934	2.171	3.425	926	0	0			
Solar	2007-2016																
	2008-2017																
	2010-2019																
	2011-2020																
	2012-2021																
	2013-2022																
	2014-2023							**0**	**0**	**0**	**500**	**500**	**500**	**500**	**500**	**500**	**500**
	Auction	0	0	0	0	0	0	0	0	1.154	929	0	0	0			

Comparative results

Last increase to the installed capacity planned for each year by the PDE vs. procurement in the auctions



Conclusion

- Through the creation of EPE and its plans, such as the PDE, Brazil regained its **long-term vision** when it comes to the energy mix composition.
- However, what is observed in reality is an **inconstancy** of the elaborated projections, with many modifications in relation to their various annual editions.
- Although it is understandable that there can be differences between the studies, planning generally requires a better **defined guideline**.
- Regarding the practical implementation of these plans, it was demonstrated that there is a **mismatch** between the two factors: auctions and planning.
- Since the new energy auctions are usually **generic** and its winners are defined by the criterion of the **lowest price**, what has ultimately been happening is that the definition of our future energy mix is being based only on the price issue.

Conclusion

- Price reduction to final consumers is essential to the competitiveness of the economy. However, it is essential that the sector moves towards a **strategic energy mix**, with diversified sources to mitigate risks and take full advantage of national potentials.
- The criterion of the lowest rate does not seem sufficient to achieve this goal; "reasonable tariffs" alone is not adequate to **ensure the expansion** of the system safely.
- There is a **lack of synergy** between the main pillars of the BES: reasonable tariffs and the expansion of the installed capacity to meet demand growth.
- Auctions should have a **better signaling** as to which energy sources it will procure, and that should be consistent with a well-structured **planning**.
- Moreover, **future studies** that seek to analyze in greater depth the economic pricing methodology of auctions in order to specify the necessary changes in it, can be of **great relevance**.
- Only with the use of accurate and appropriate mechanisms that we will, in fact, move towards a greater unity between planning and auctions: a **strategic mix for the BES**.

Thank you!

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