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Brazil and the international electric integration:
Background, Current Status and Perspectives

Nivalde de Castro
Roberto Brandão
Rubens Rosental
Paola Dorado

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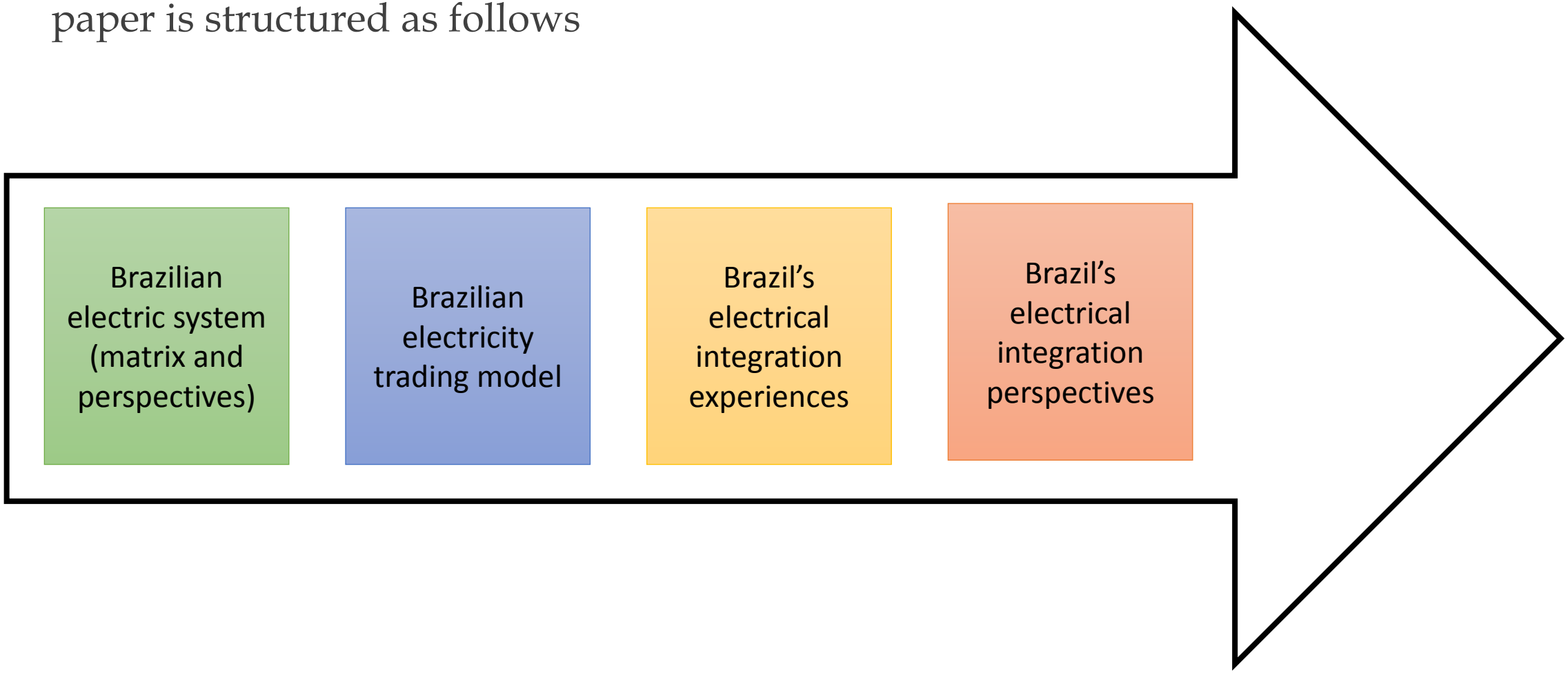
Introduction

- This article was developed for a research project supported by Itaipu Binacional.
- South American energy integration process does not follow the same path as in Europe
- There is no plan for a regional electricity market in South America. The Brazilian electricity trading model is currently not compatible with an electricity market.
- However, South America has some electric interconnections and binational projects.
- Several integration projects are being analyzed.

This paper aims to understand and analyze the electrical integration process in the South American region, positioning Brazil in the central focus of the analysis.

Methodology

- In order to understand the Brazilian role in the electrical integration process, this paper is structured as follows



Brazil Electric System - Mix

- Electric mixis **mainly hydro**
- The generation **mix is changing** due to an structural factor (**run of the river plants**). There is also an ongoing **hydrologic crisis**.
- Transmission lines were originally built to allow the optimization of hydropower generation

Installed Capacity for Generation in Brazil by source, 2014
(% of the Total and Total in GW)

SOURCE	SIN	ISOLATED SYSTEM	SELF PRODUCTION	TOTAL
Hydro (%)	73,1	21,7	8,8	68,0
Thermal (%)	21,5	78,3	91,2	27,1
Nuclear (%)	1,5		0,02	1,4
Wind (%)	3,8		0,04	3,5
Solar (%)	0,01			0,01
Total (GW)	**128,4**	**1,3**	**10,1**	**139,8**

Source. Ministry of Mines and Energy (MME) (2015, p.10)

Energy generation dispatched or programmed by ONS for the SIN: 2005-2014
(% of total)

YEAR	HYDRO	THERMAL
2005	92,4	5,1
2006	91,8	4,8
2007	92,8	4,3
2008	88,6	8,1
2009	93,3	3,7
2010	88,8	7,9
2011	91,2	5,3
2012	85,9	10,4
2013	78,7	17,2
2014	73,0	23,0

Source: ONS (2015,a)

Brazil Electric System - Perspectives

- Based on PDE 2023, prepared by EPE.
- The PDE 2023 does not consider any increasing in electricity imports.

PDE 2023 perspectives

	2023	
Consumption	780,4	TWh
New capacity	71.087	MW
Already contracted	30.043	MW
Remaining	41.044	MW

Source: EPE (2014)

Hydro	14.679 MW mainly run of the river plants.
Thermal	7.500 MW that will depend natural gas imports. National gas production will also increase.
Wind	Brazil has a potential of approx.. 350 GW. Production costs have become more competitive. 7.000 MW already contracted to begin operating until 2020.
Co-generation	Has competitive costs. Technical potential would allow to offer 7.7 GW until 2023.
Solar	There is a growing interest in developing the necessary conditions to develop this source

Source: EPE (2014)

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Brazilian electricity trading model

- Electricity trading is done through a financial mechanisms **(physical guarantee)** that do not necessarily involve physical delivery of energy.
- Physical guarantee
  - Certificates are issued by MME (Ministry of Mines and Energy)
  - Physical guarantee is calculated by modeling the optimized operation of the SIN
  - The modeling represents a closed system
- Distribution companies' electricity contracts are auctioned by the government. Generators participate in auctions, both for existing and for new power plants.
- **Long-term contracts** have predictable revenues (inflation linked)
- Project are financed using **project finance** mostly by BNDES.

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Brazil: integration experiences

- Electricity trading mechanisms in Brazil were designed for a closed system, and also planed and operated in a centralized way. **They are not suitable for a full-integrated market scheme.**
- Brazil developed special commercial arrangements to import and export energy with Paraguay, Argentina, Uruguay and Venezuela.
- The electric integration experiences have been designed to function properly in the Brazilian model both operationally and commercially.
- All projects, except Itaipu Binacional and imports from Venezuela, involve the export and import of energy on an interruptible basis.

Integration experiences of Brazil

BRAZIL WITH	PROJECT	COMMERCIAL ASPECTS	OPERATIONAL ASPECTS
Paraguay	Itaipu Binacional	Tratado Itaipu 1973	Itaipu is part of the optimized dispatch of energy on the Brazilian system
Argentina	CIEN	Contract (no longer valid)	Represented as a "thermal plant" at the frontier
Argentina	Converters: Garabi I, Garabi II Uruguayana	Interruptible electricity exchange	1. Exchange of surplus of hydropower generation to be returned without involving any cash transaction 2. Energy offers on the border of Brazil aiming the sell the energy in the spot market and being paid at short term prices
Uruguay	Converters: Garabi e Rivera	Interruptible electricity exchange	Energy offers on the border of Brazil aiming the sell the energy in the spot market and being paid at short term prices
Venezuela	LT Boa Vista	Isolated System	Firm energy imports

Outlook for import and export of electricity in Brazil

BRAZIL	POSSIBILITIES
Export	The current priority for brazilian generator is the internal market. Only surpluses are exported when the transmission lines are available
Import	**Binational power plants** using the same model as Itaipu Binational **Hydroelectric plant** dedicated in whole or in part to export energy to Brazil, will probably impose restrictions on the energy optimization needs **Thermoelectric energy** would be possible to structure a similar contractual modeling to the original scheme of import of CIEN, but with greater legal certainty

Brazil's binational power plants projects

BRAZIL WITH	PROJECT	CURRENT SITUATION
Argentina	Binational power plants (Garabi e Panambi) on the Uruguay River	Engineering and environmental studies
Bolivia	Binational power plant on the Madera River	Negociation between the countries

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Conclusions

- Brazil's PDE 2023 estimates that all the demand increase will be supplied by national resources
- Brazilian trading model has specific characteristics that clearly distinguishes it from the commercial arrangements prevailing in other Latin American countries
- Electrical integration with Brazil must respect the Brazilian electricity trading model
- Electrical integration with direct participation of Brazil is restricted to four possibilities.
  - Construction of binational hydroelectric plants based on the Itaipu Binacional experience
  - Energy imports represented as a thermoelectric at the border, as happened with CIEN contract.
  - Construction of hydroelectric plants in neighboring countries for export to Brazil. The generating unit would have to follow Brazilian trading rules.
  - Trading of electricity surpluses in trade patterns that Brazil is already practicing with Argentina and Uruguay.

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Thank you for your attention!

Roberto Brandão

robertobrandao@gmail.com

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