

Evaluating regulatory strategies for mitigating hydrological risk in Brazil through diversification of its electricity mix

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Outline

1. **Hydroelectricity: the backbone of the nation's electricity generation**
2. **Hydrological risk**
3. **The nexus approach: challenges and opportunities for the electricity mix strategies in Brazil**

Brazilian electricity mix

Matriz de Capacidade Instalada de Geração de Energia Elétrica - Abr/2018

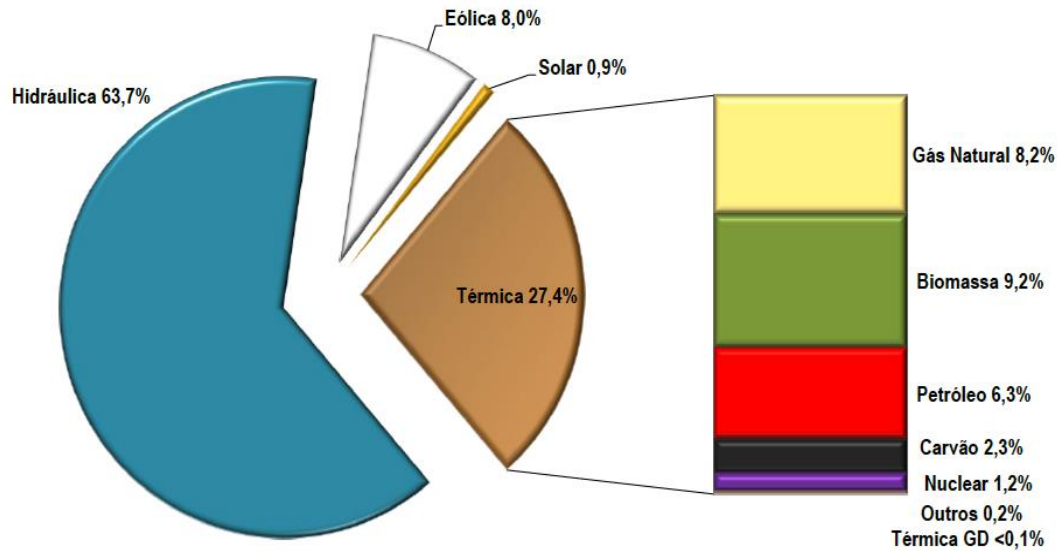


Figura 16. Matriz de capacidade instalada de geração de energia elétrica do Brasil sem importação contratada.

Fonte dos dados: ANEEL e MME

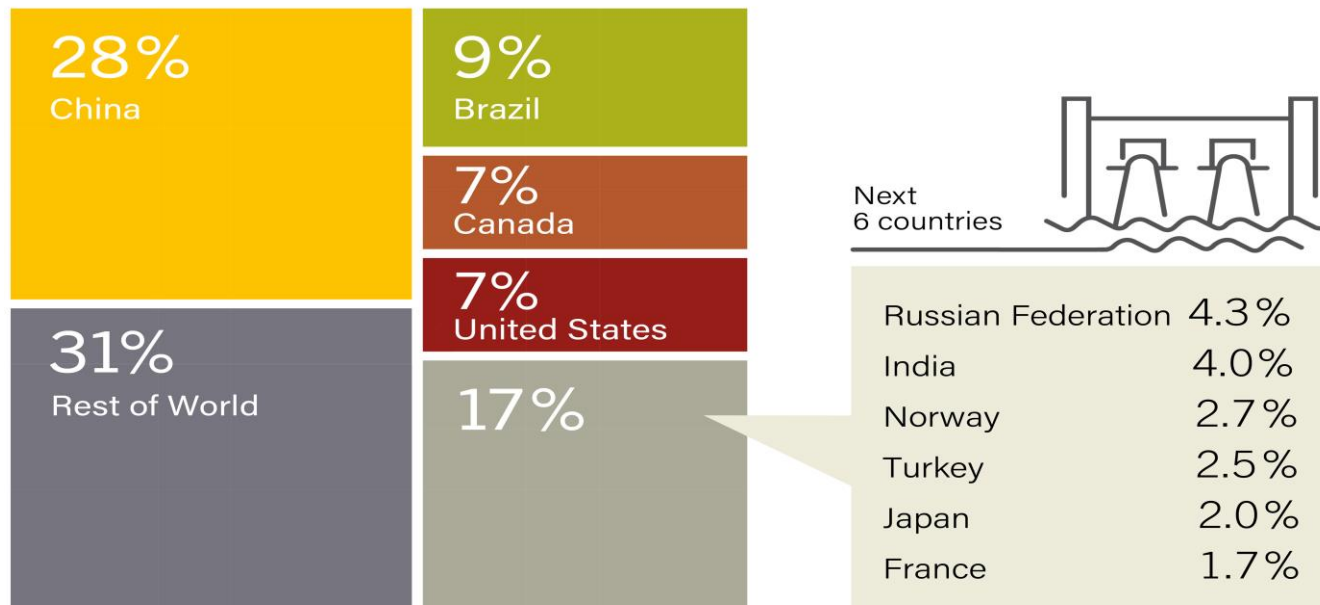
Tabela 8. Matriz de capacidade instalada de geração de energia elétrica do Brasil.

Fonte	Abr/2017	Abr/2018		
	Capacidade Instalada (MW)	Nº Usinas	Capacidade Instalada (MW)	% Capacidade Instalada
Hidráulica	98.760	1.391	101.547	63,7%
UHE	93.216	221	95.794	60,1%
PCH + CGH **	5.537	1.125	5.709	3,6%
CGH GD	7	45	43	0,03%

'Boletim Mensal de Monitoramento do Sistema Elétrico Brasileiro', Brazilian Ministry of Mining and Energy

Hydropower Global Capacity: Brazil 2nd place in the rank

Hydropower Global Capacity, Shares of Top 10 Countries and Rest of World, 2017



RENEWABLES 2018 GLOBAL STATUS REPORT

Brazilian hydroelectric plants by basin



SIGEL/ANEEL. Sistema de Informações Geográficas do Setor Elétrico, 2016

Recent Water Crisis



The Amazon effect: how deforestation is starving São Paulo of water, The Guardian, 28 November 2017

Recent Water Crisis

- **When? 2013-2017**
- **Why?**
 - **Water management**
 - **Inefficiency of use**
 - **Consecutive years of reducing precipitation**
 - **Deforestation in the Amazon for pastureland? Debatable**

Recent Water Crisis: Rivers in the sky - transpiration

“We should not transform the Amazon into pastureland,”

“The Amazon creates a movement of water. If you could follow a molecule of water you would see that most of the clouds that are over São Paulo have passed across the Amazon. If the forest is cut, we’ll be in trouble.”

Jefferson Kelman, president of São Paulo water company Sabesp

The Amazon effect: how deforestation is starving São Paulo of water, The Guardian, 28 November 2017



<http://riosvoadores.com.br/o-projeto/fenomeno-dos-rios-voadores/>

Recent Water Crisis

- **Effects**

- **Offset by thermal power production, increasing the economic costs and the greenhouse gases emissions**
- **Rationing (water supply for approx. 20 million people in the region) and tariff raises**
- **Pressures over water uses – competition amongst the users**
- **Generator's exposure in the spot market**

Hydrological risk: definition

- Broadly speaking, issues related to the quantity and quality of the water, either too much or too little, affecting the operation of a hydropower plant or other phases of the project
- More specifically, during the operation of a hydropower plant the risk of insufficient amount of water to support the expected levels of electricity generation, with potential physical and financial impacts

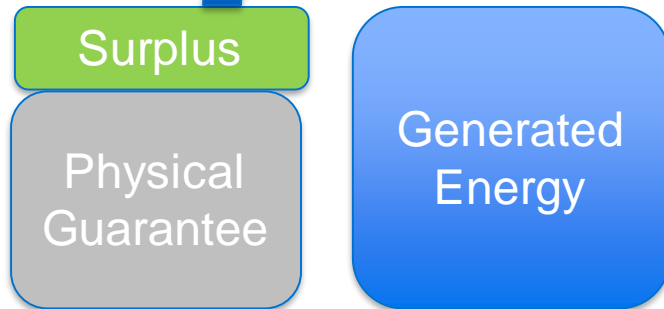
(Blomfield and Plummer, 2014)

Hydrological risk: Brazilian policy

- **Energy Reallocation Mechanism (MRE):** a compulsory hedge for the total production of all the interconnected grid hydropower plants during dry periods (Law No. 13.203/2015)
- **Objective:** optimal use of the water resources to manage hydrological risk in times of insufficient water (takes into account different patterns of energy production throughout the year) and avoid high financial exposures of the generators in the spot market
- The MRE scheme consists of the assignment of credits that consider the proportion between, on the one hand, the sum of all the energy produced within the MRE and, on the other hand, each participant's assured certificates of physical guarantee based on the amount of energy equivalent to the plant's installed capacity. This calculation of the MRE adjustment factor is known as the **Generation Scaling Factor (GSF)**.

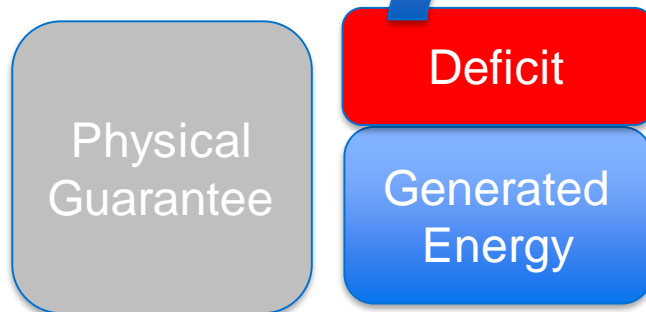
Hydrological risk: Brazilian policy

Scenario 1: Generation > Physical Guarantee



Credit in the Spot Market

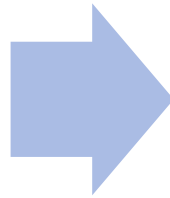
Scenario 2: Generation < Physical Guarantee



**MRE adjustment
factor Generation Scaling Factor
(GSF)
= Exposed in the Spot Market**

Hydrological risk: Brazilian policy

The problem: 'systemic risk' caused by serious drought, overall production is collectively below expected and contracted levels



Consequence: the hydropower generators were forced to purchase short-term energy at higher prices in the spot market to comply with their contractual obligations, creating a large financial deficit with billions of Brazilian *reais* at stake (negotiations on the debts and lawsuits)

Hydrological risk: under de Nexus approach

• Challenges

- Limit the solution to the financial impacts in the generators' pocket
- Overdependency in hydroelectricity in times of water scarcity

• Opportunities

- Discuss the causes from and the effects to natural resources involved in the process (forest clearance for farms causes impacts on the water cycle, floods of forest for dams)

Hydrological risk: under de Nexus lenses

• Challenges

- Energy security and sustainability
- Regulatory fragmentation
- Power asymmetries
- Competition for water resources

• Opportunities

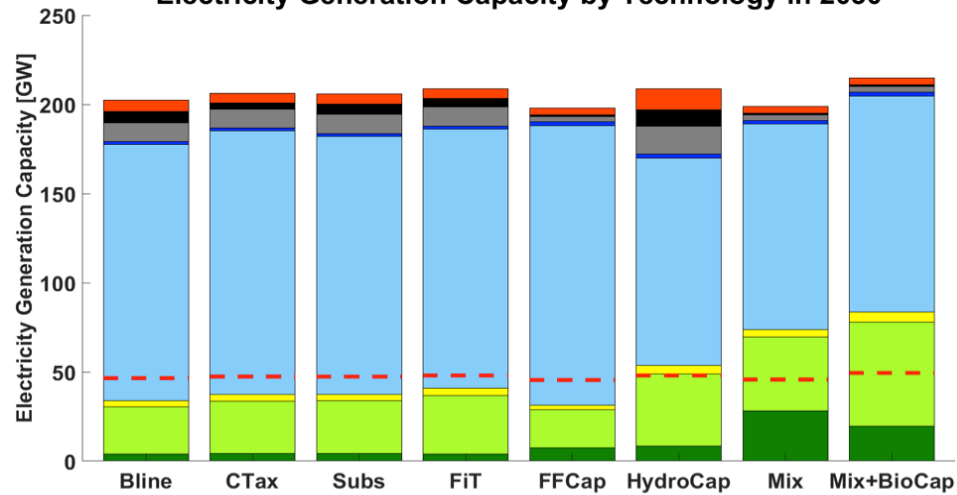
- Diversification of the electricity mix (analysis using Integrated Assessment Modelling – IAM tools to explores future macroeconomics scenarios for Brazil in the global context)
- Brazilian NDC's: **reduce** GHG emissions by 37% below 2005 levels in 2025, and **increase** by 43% below 2005 levels in 2030 renewables (other than hydropower) in the power supply to at least 23% by 2030.

Many thanks for your attention!

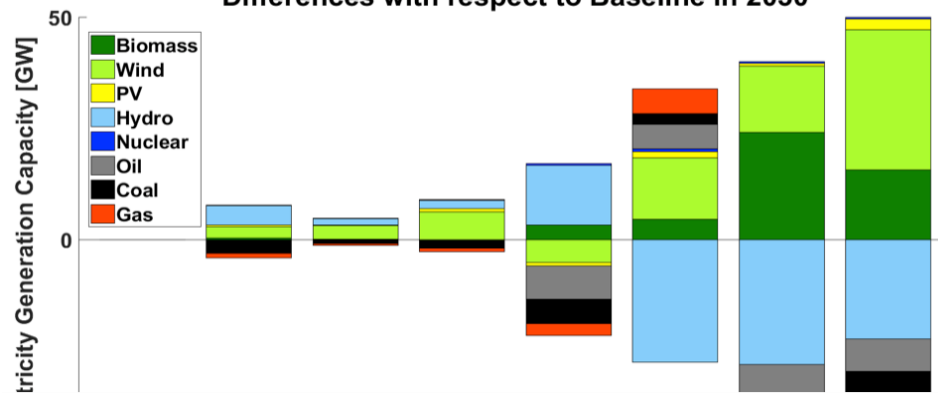
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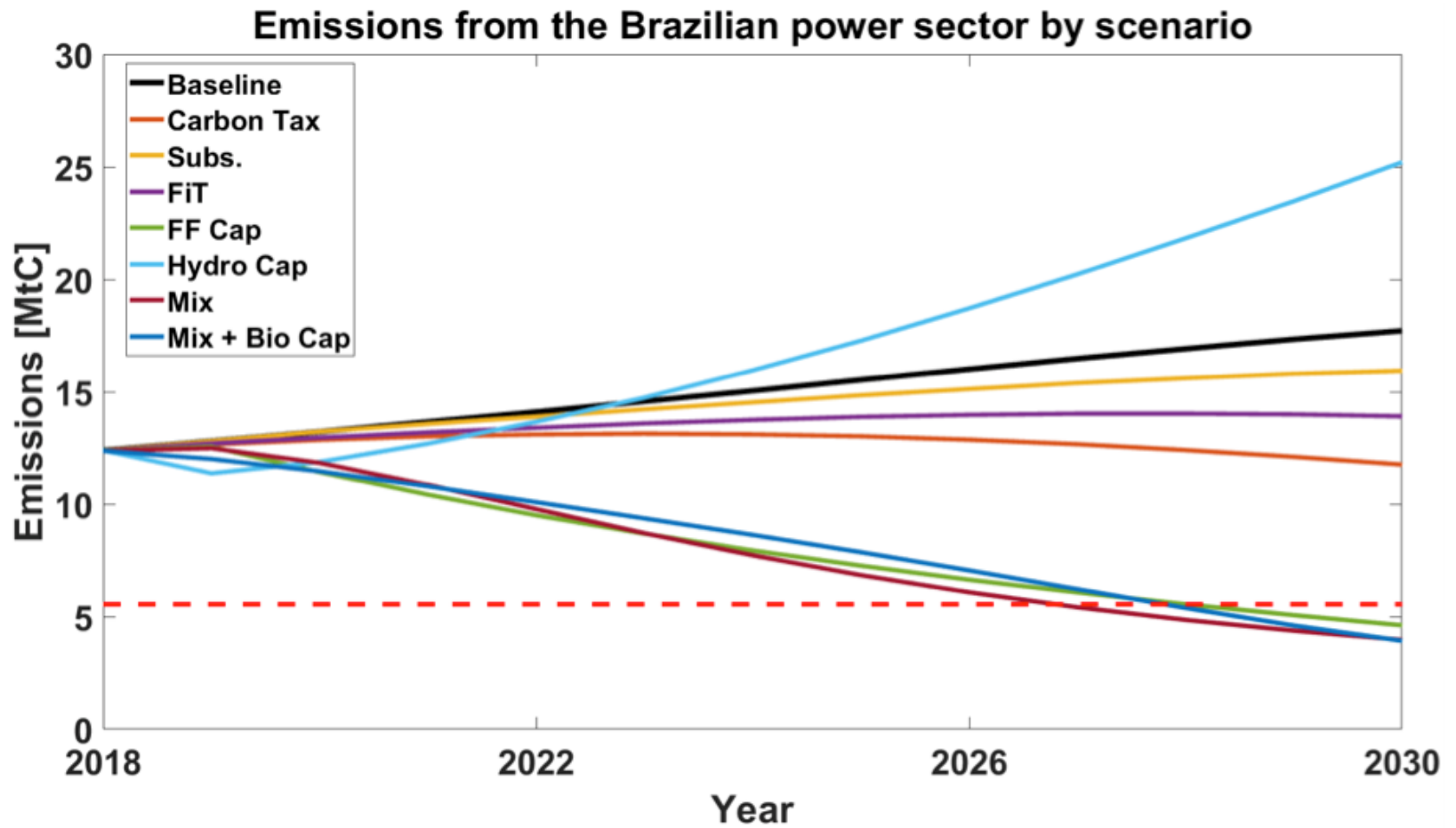
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Electricity Generation Capacity by Technology in 2030



Differences with respect to Baseline in 2030





Variation in electricity prices by scenario (w/r to baseline)

