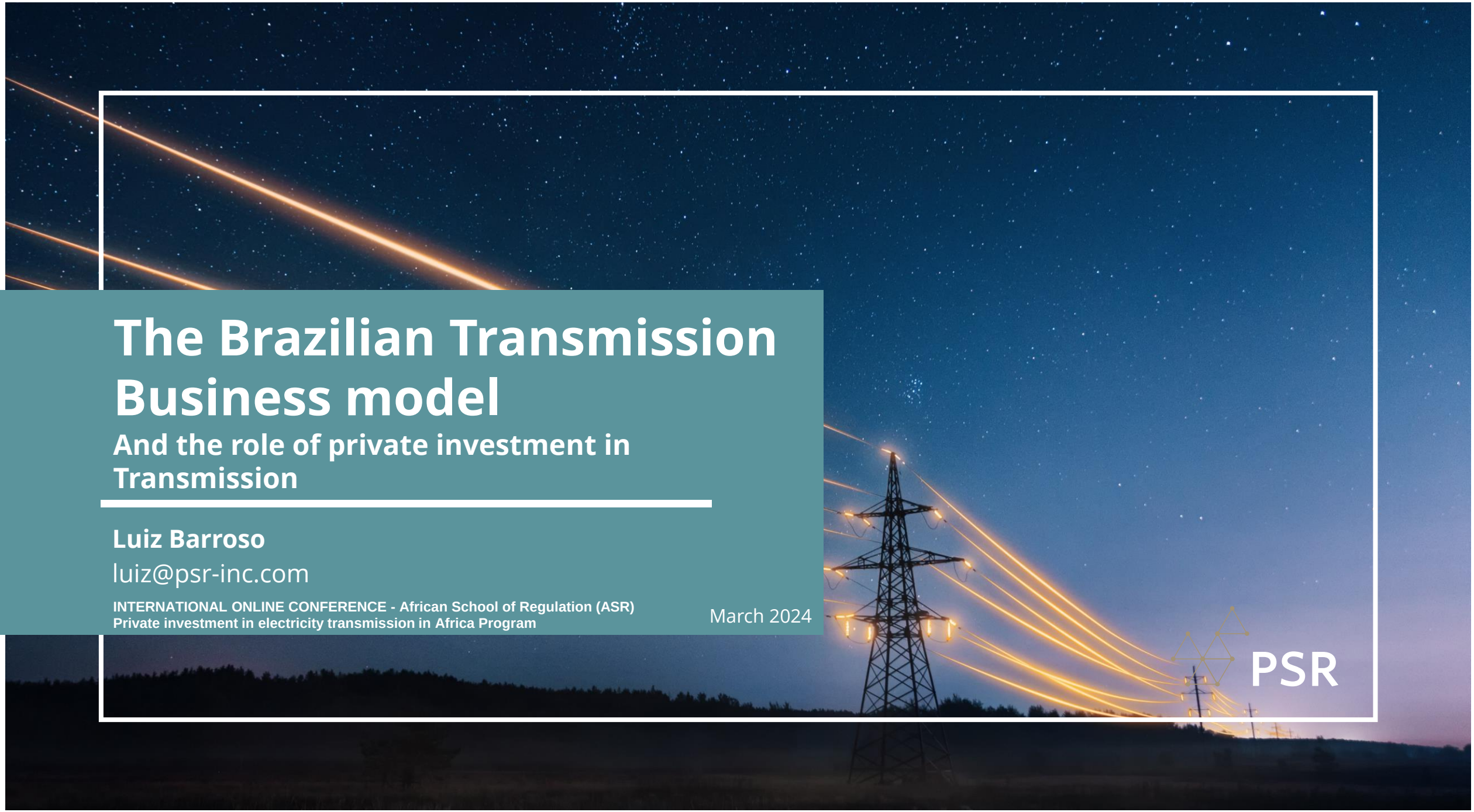


The Brazilian Transmission Business model

And the role of private investment in Transmission

Luiz Barroso
luiz@psr-inc.com

INTERNATIONAL ONLINE CONFERENCE - African School of Regulation (ASR)
Private investment in electricity transmission in Africa Program

March 2024

PSR

About PSR

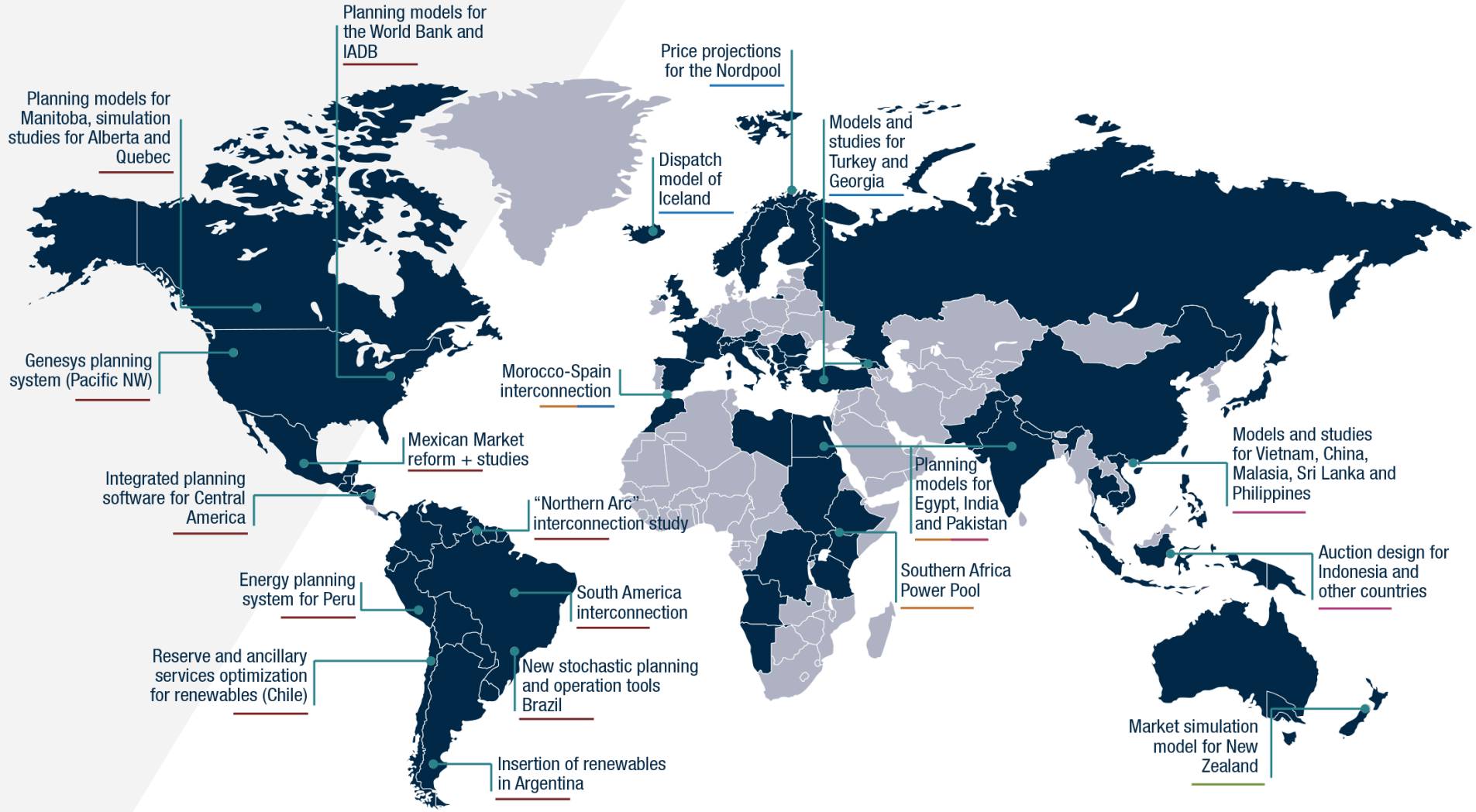
With 36 years of experience and a highly international client base, PSR is a leading global provider of advanced analytical tools and consulting services in the energy sector, including regulation and markets.

PSR contributes actively to applied research on energy systems, including planning, public policy, optimization and economic impacts.

Our team has 150 experts, with advanced degrees in engineering, optimization, regulation, economics, energy systems and IT/data science.

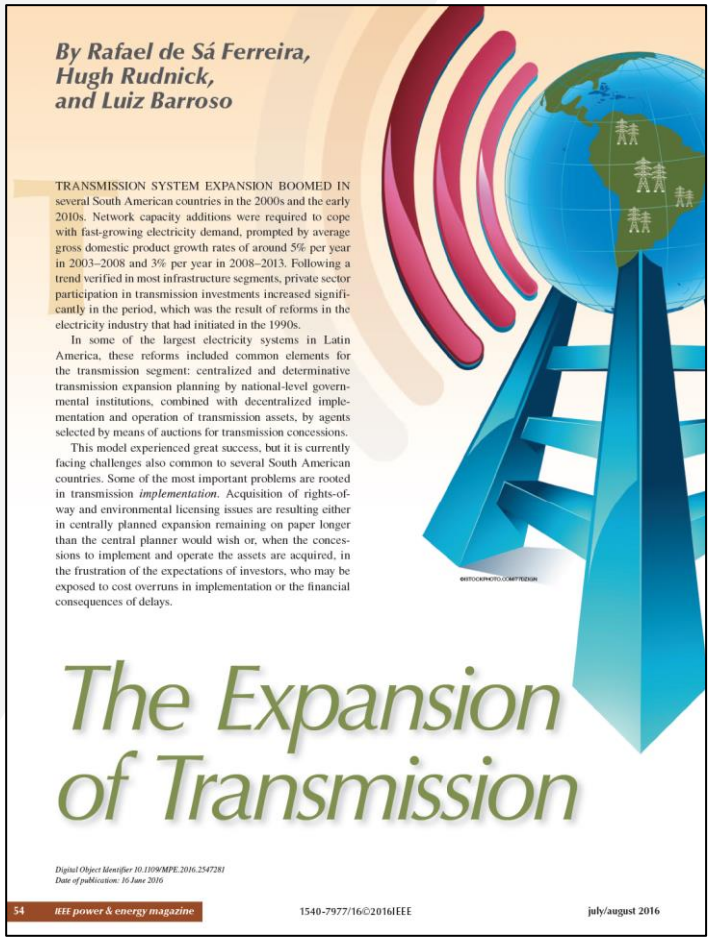
www.psr-inc.com

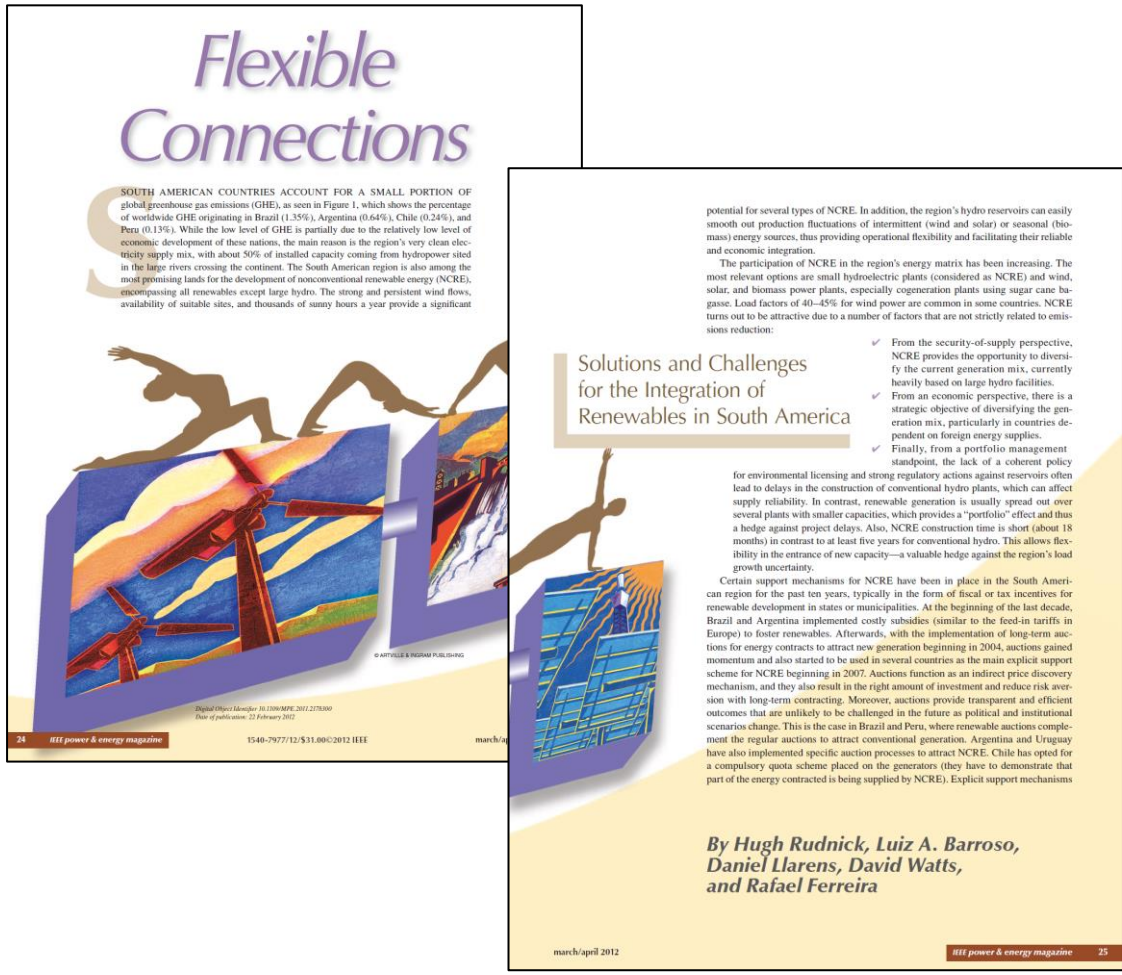
PSR operates in more than 70 countries on all continents



PSR

Some topics presented here have been well documented in the literature



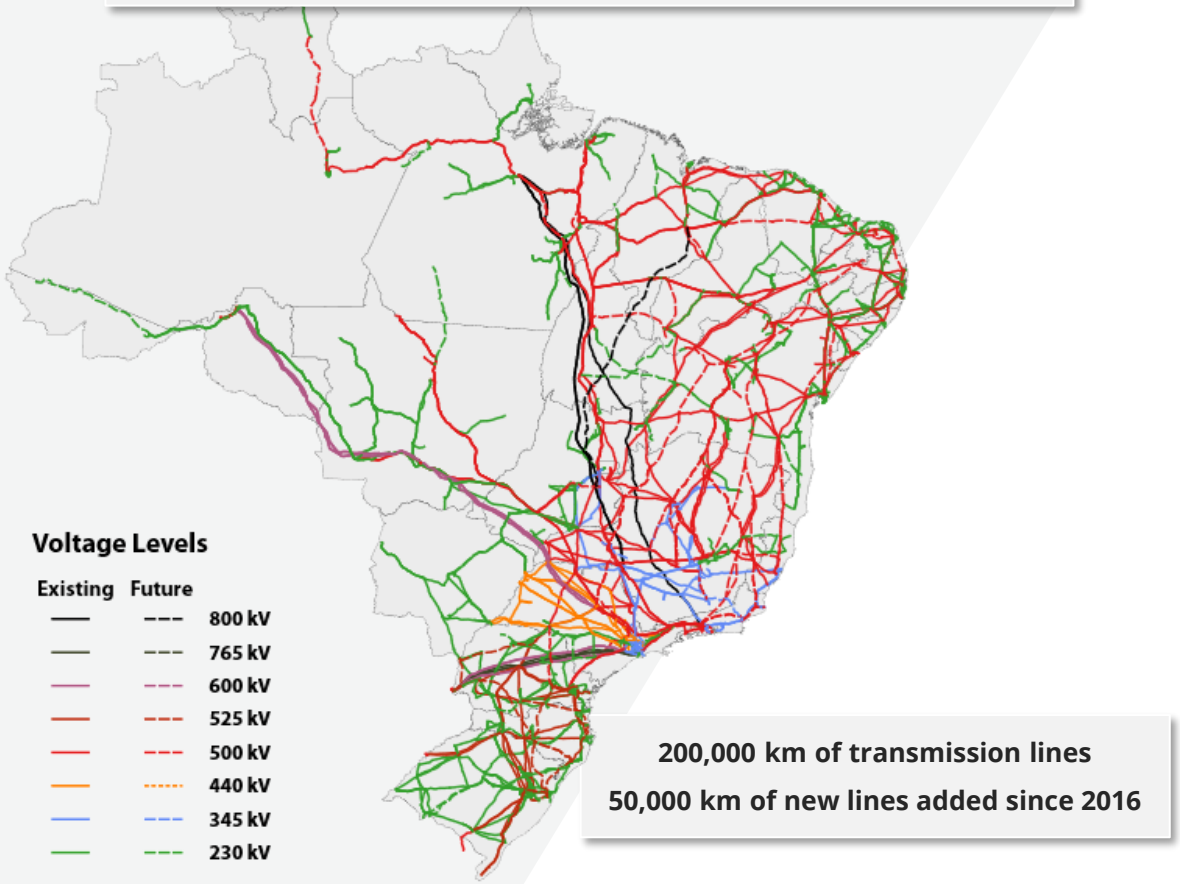


L.A. Barroso, L.M. Thomé, M.V.Pereira and F.Porrua, *Planning Large Scale Transmission Networks in Competitive Hydrothermal Systems: Technical and Regulatory Challenges*–IEEE Power & Energy Magazine, Vol. 5, 2007
R. Ferreira, H. Rudnick ; L.A.N. Barroso. *The Expansion of Transmission: The Challenges Faced in South America* – IEEE Power & Energy Magazine, v. 14, 2016
H. Rudnick, L. Barroso, D. Llarens, D. Watts, R. Ferreira, *Transmission challenges in the integration of renewables in south America* – IEEE Power & Energy Magazine, Vol.10, 2012

PSR

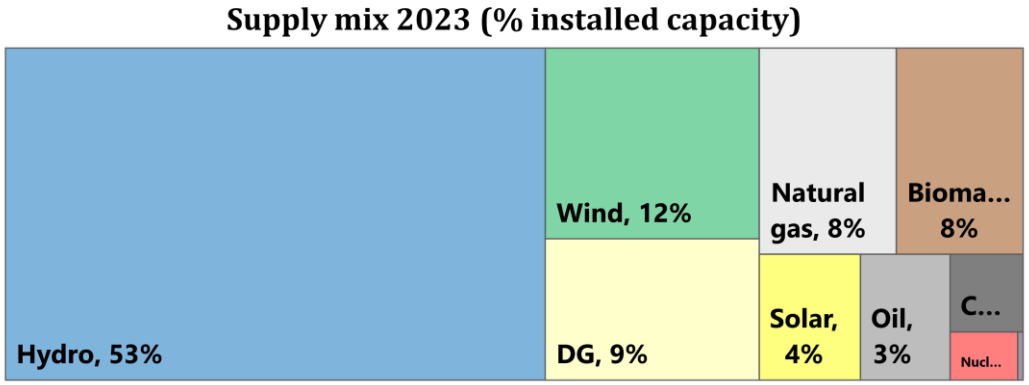
Brazil's electricity supply mix is mostly renewable and highly interconnected

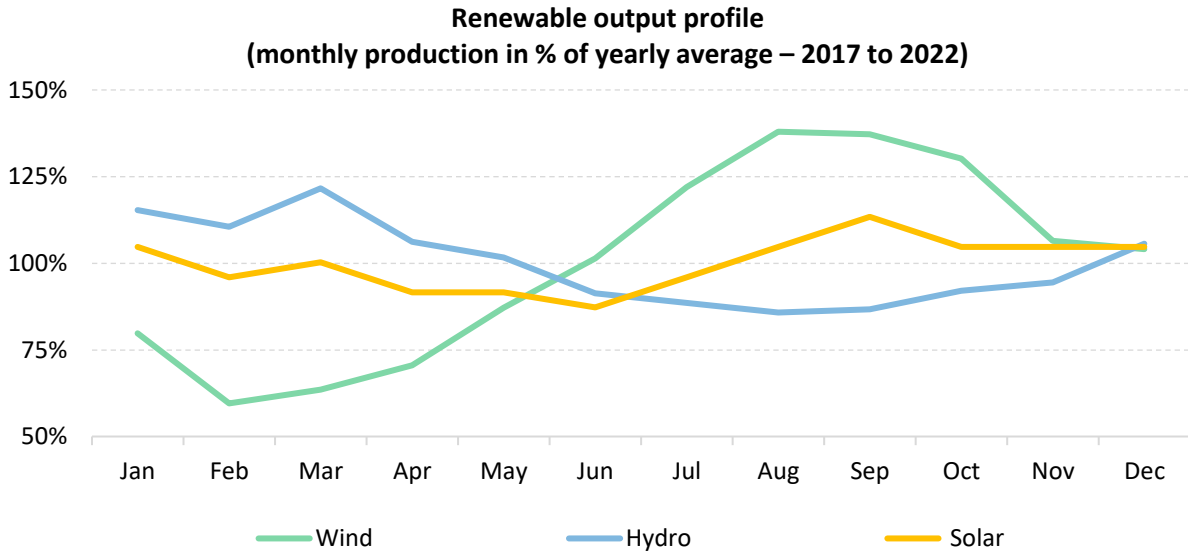
The transmission network is part of the portfolio of complementary renewable generation sources.



200,000 km of transmission lines

50,000 km of new lines added since 2016





Source: National System Operator (ONS), ANEEL

The transmission business model

The transmission, planning and operation is centralized

COORDINATION

Central planning

Least cost expansion planning

- Aim to optimize the use of system resources
- Aim to maximize systemic benefits

The implementation of assets is decentralized

EFFICIENCY

Transmission auctions

Auctions - decentralized execution:

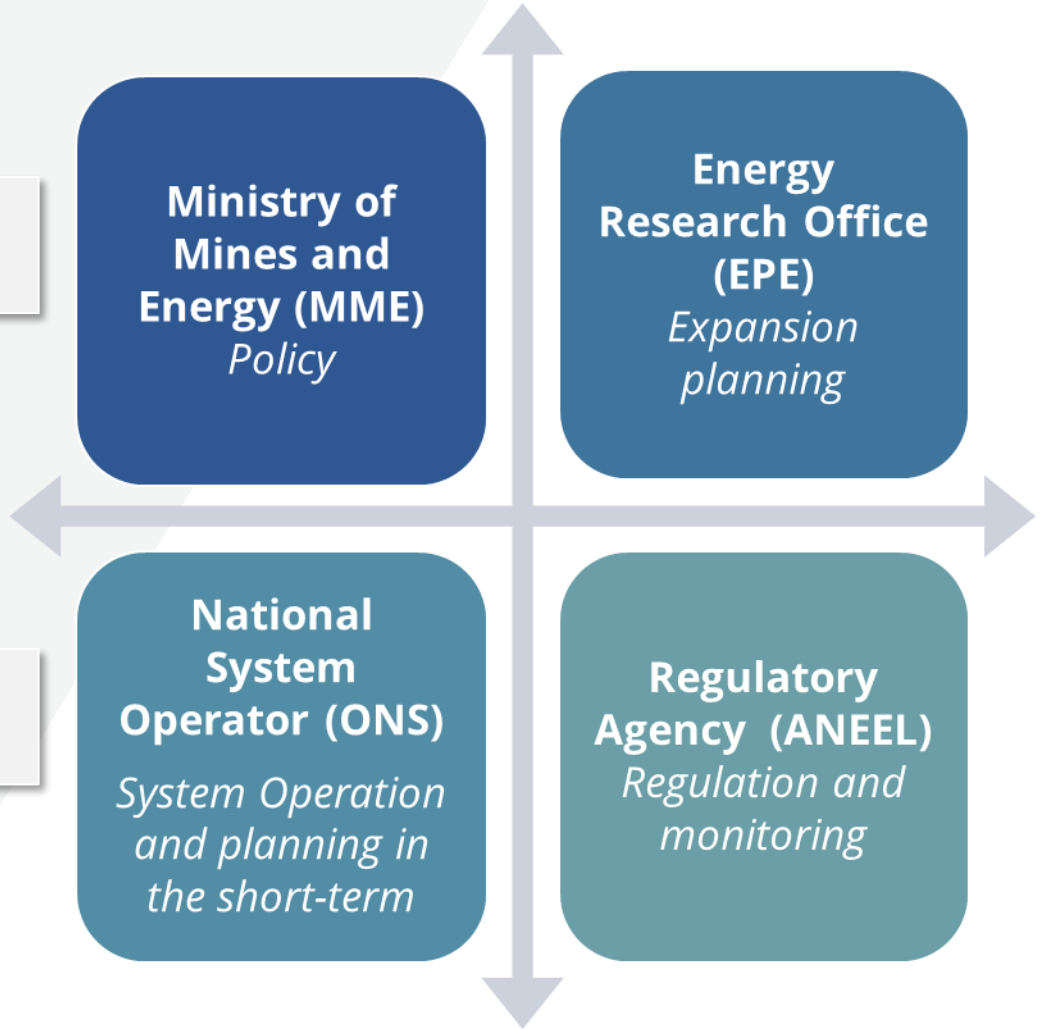
- Price discovery for the CAPEX
- Assigning responsibility for construction and O&M to transmission companies, which can be private

PSR

Institutional framework

Guidelines for policymaking

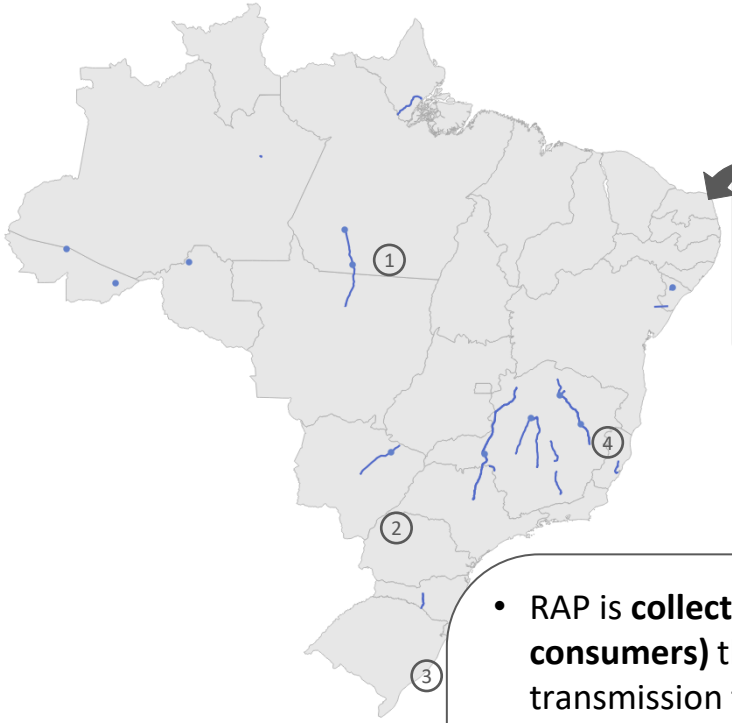
T operation + interface with planning



T planning

Organizes T auctions.

Transmission auctions as a low-risk business model: long-term concessions awarded through public auctions based on a revenue cap model



- EPE plans the expansion of the grid according to system needs.
- The (new) assets needed are divided into lots and put up for auction.

- Players compete for an annual revenue stream (RAP[1]) granted to build, maintain an operate the assets.
- ANEEL sets the auction's **cap for RAP**
- Whoever offers the **smallest** RAP, wins the right to develop the projects and becomes a "Transco"

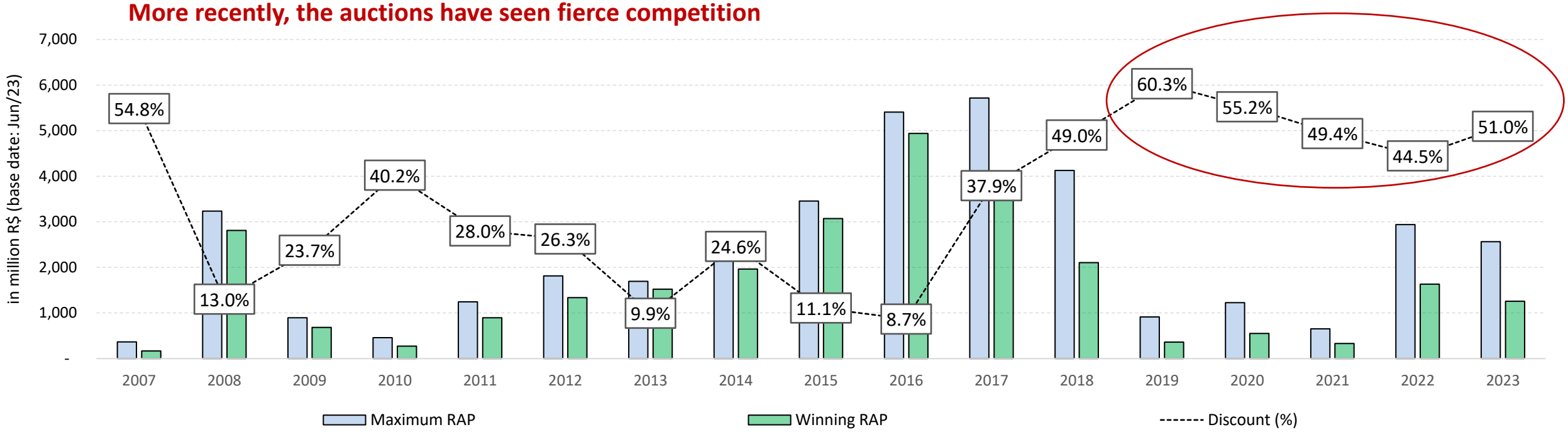
- **30-year concession** contracts are awarded.
- Transco commit to **build, maintain and operate** the assets.
- In return, they are paid a **fixed revenue stream**, starting at the asset's COD, is **adjusted for inflation** on a yearly basis, and **revised every 5 years**[2].
- Revenues are independent from the actual power flow trough the facilities (**there is no volume risk**).
- Outage events can temporarily reduce the RAP (**penalty for unavailability**).

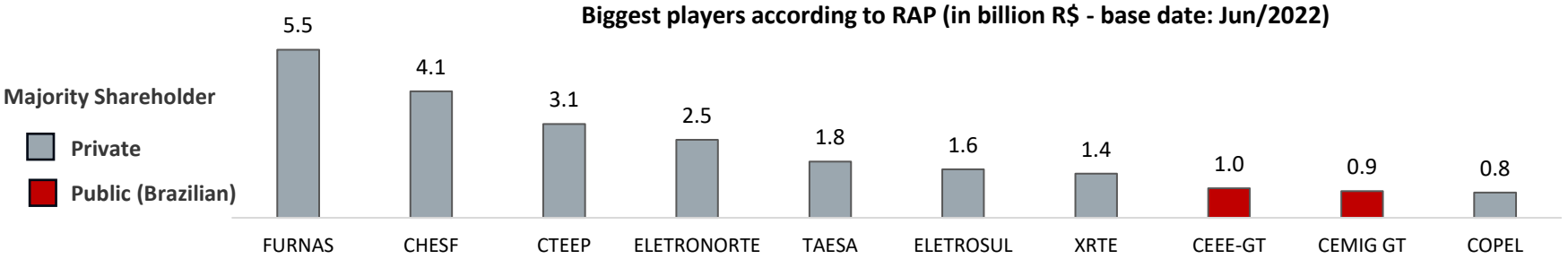
- RAP is **collected from all grid users (generators & consumers)** through a charge known as the transmission tariff (**TUST**).
- **Credit risk is negligible** due to diversification.
- ANEEL may (unilaterally) require that certain **improvements or reinforcements** are implemented, in which case it will grant an additional RAP.
- At the **end of the concession, assets are reverted** to the State but can also be renewed by ANEEL.

[1] RAP stands for Annual Allowed Revenue (*Receita Anual Permitida*, in Portuguese).
[2] Revisions, which consist in updating the regulatory cost of debt and operating & maintenance costs, are intended to share potential gains derived from technological improvements or better macroeconomic conditions with the public.

In the last 16 years, approximately 86,000 km of high-voltage lines and 223k MVA have been auctioned (~ USD 40 billion in new investments)

More recently, the auctions have seen fierce competition



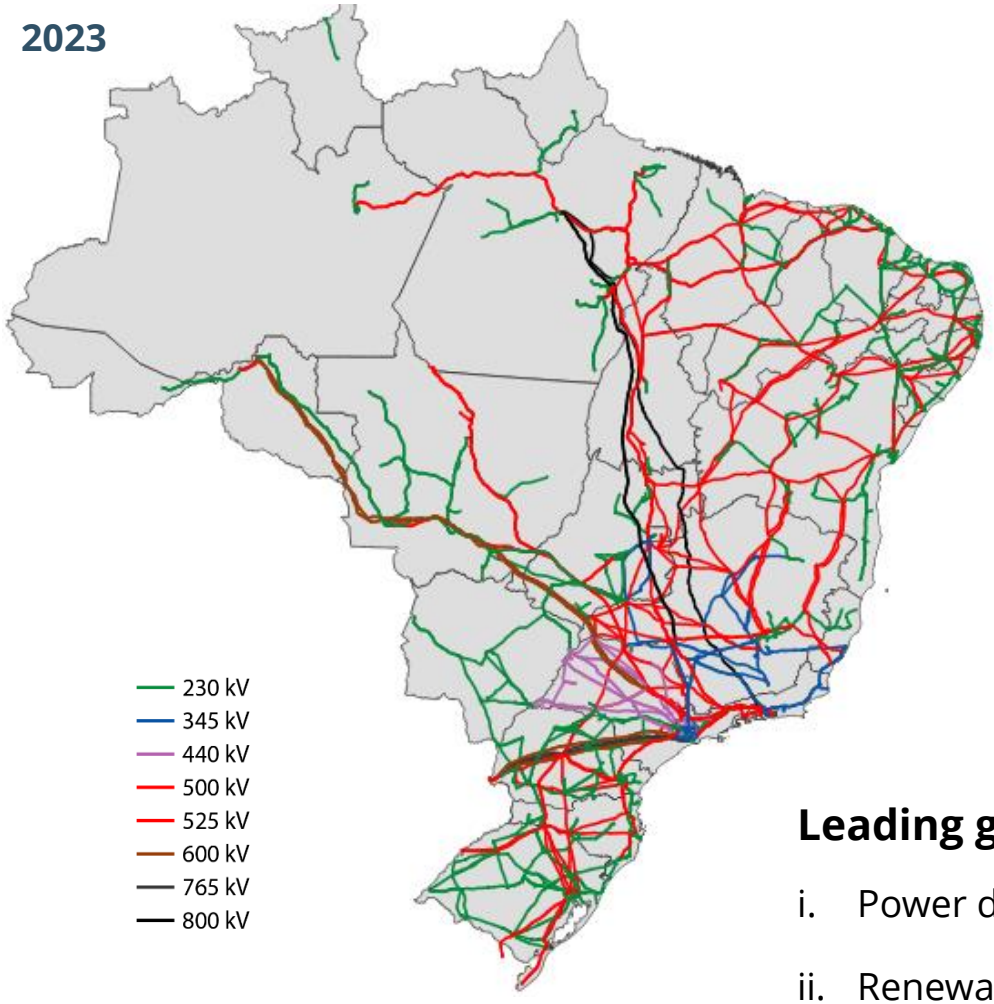


PSR

Source: ANEEL

The grid is expected to grow significantly over the next 10 years, requiring USD 20 billion of new investments

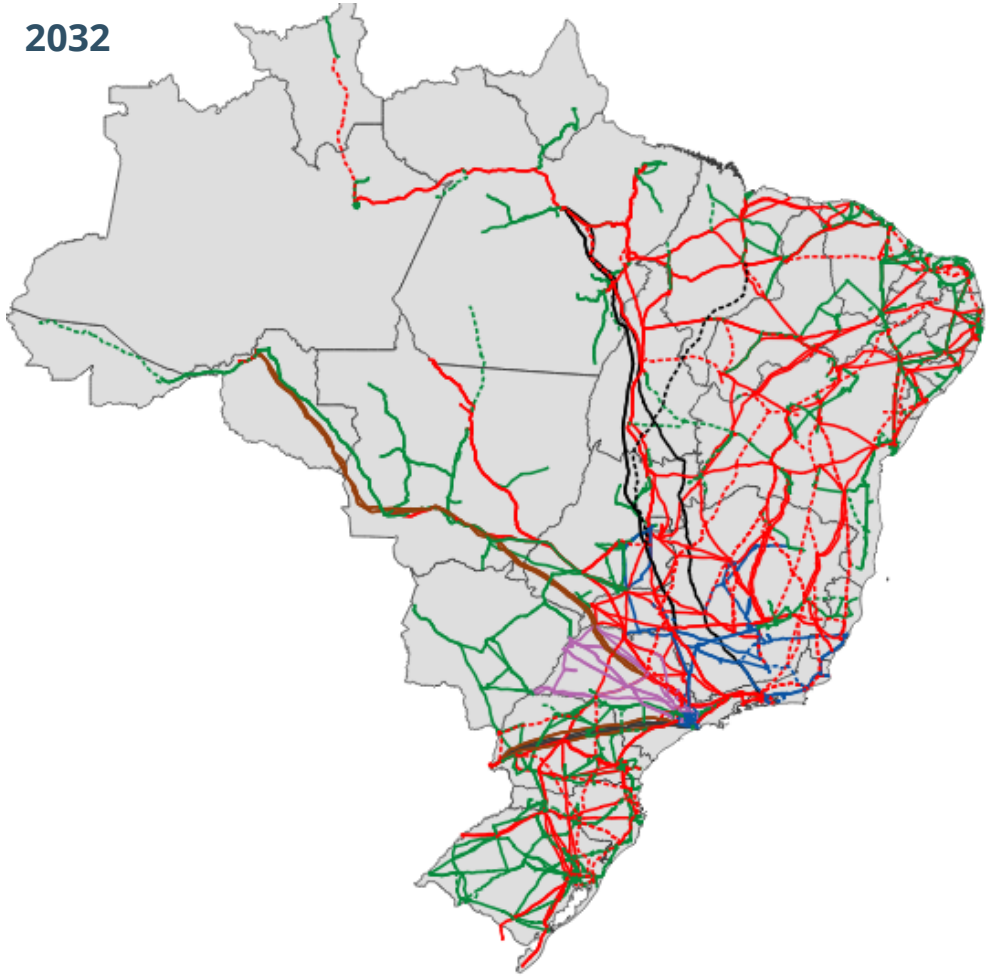
2023



41,000 km of new transmission lines

120k MVA of new transformation capacity

2032



Leading growth drivers:

i. Power demand growth

ii. Renewables' growth

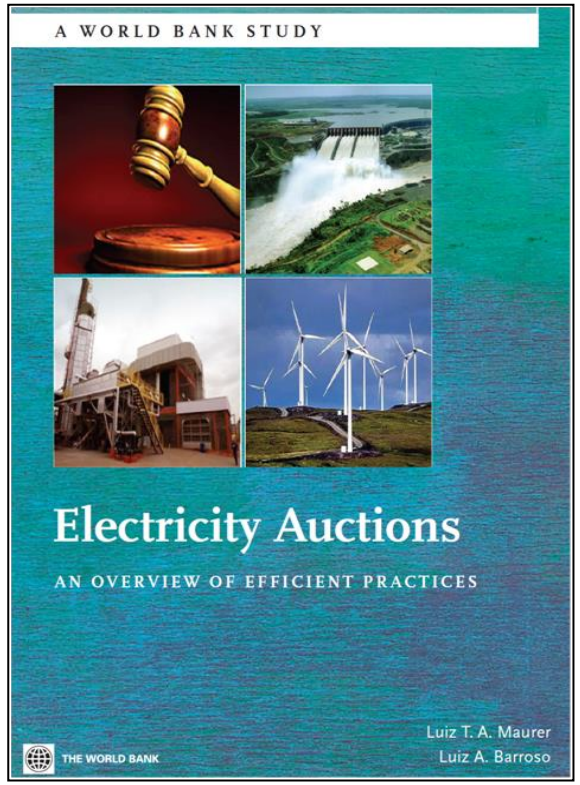
iii. Reliability & resiliency.

PSR

Source: EPE and PSR

Other topics not covered here

- How to carry out the auctions?
- Locational signals in the transmission tariffs
- How to increase competition in the auctions
- How to mitigate delays in the implementation of transmission facilities
- How to address the mismatch between generation and transmission expansion
- How to plan a transmission system with flexibility
- How to unlock renewable interconnection queues

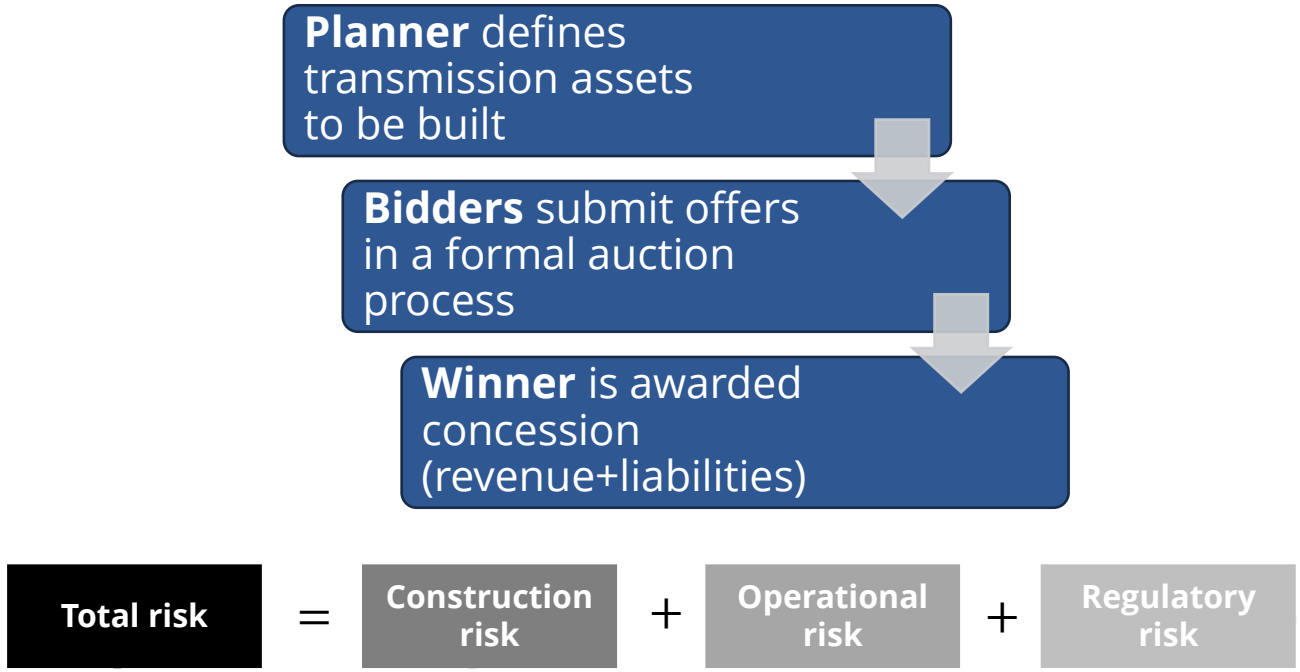


L. Barroso, L. Maurer, *Electricity auctions : an overview of efficient practices*, World Bank, 2011

Private ownership in T has been incentivized in other Latin American countries

- Transmission auctions have played an increasing role in grid expansion, coexisting with classic regulated remuneration schemes (cost-based, RPI-X, yardstick,...)

Private Ownership (%)	Generation	Transmission	Distribution
Mexico	25%	0%	0%
Colombia	60%	45%	45%
Brazil	90%	90%	90%
Peru	60%	45%	45%
Chile	100%	100%	100%
Argentina	75%	75%	75%



PSR

Some common questions

1 How do you guarantee that the annuity of the remuneration to the private investor will be guaranteed with a low risk?

There is a system of guarantees (escrow accounts, etc.) that ensures the bankability of payments. The system has never had a default since the implementation of the business model. Financing has come from private lenders, debenture holders and transmission companies have been listed in the stock exchange.

2 Does the fact that some transmission infrastructure is privately owned represent a security risk for the power system?

No. The system operator dispatches generation and transmission resources independently of ownership.

3 Has private participation in transmission made transmission more expensive than paying for it with public funds?

No. Auctions have been competitive, financing has come from public and private lenders, and public funds, instead, have been destinated to other uses.

Conclusion

1. Brazil has experience in building an extensive transmission system that allows it to integrate renewable generation and portfolio optimization

2. In the country, the regulatory framework of the transmission business has been successful – It demands a constant balance of stronger incentives, stricter rules and solid institutions to secure the enforcement

3. A good and strong regulatory framework combines security to investors while encouraging efficiency

4. Private participation has always been significant in the transmission business environment

PSR

Thank you!

www.psr-inc.com

psr@psr-inc.com

+55 21 3906-2100