



Empresa de Pesquisa Energética

Challenges for planning Brazil's energy system

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...metrics must be constructed

considering the evolution of the
characteristics of the **BRAZILIAN ELECTRICAL SYSTEM:**



Lower hydraulic participation in the generation
park.

Growing competitiveness from others
Renewable Resources



Importance of the role of transmission.

Free market participation in expansion.



NEW CRITERION



ECONOMIC



SECURITY



ENERGY

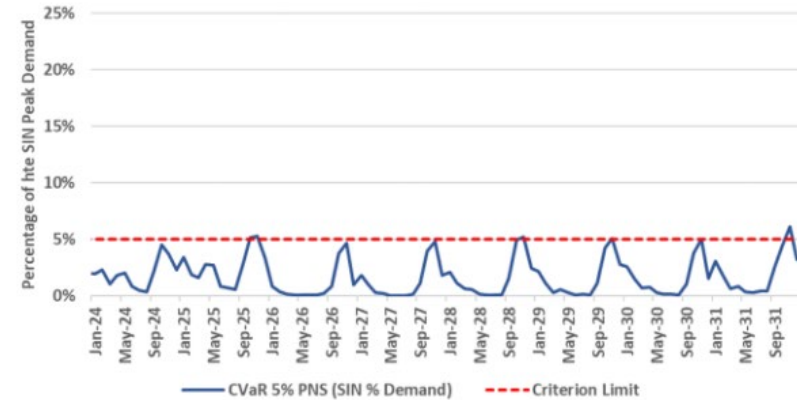
$$\text{CVaR}_{1\%}(\text{ENS}) \leq 5 [\% \text{Dem}]^{(a)}$$
$$\text{CVaR}_{10\%}(\text{CMO}) \leq 800 [\text{R\$}/\text{MWh}]^{(b)}$$



POWER

$$\text{CVaR}_{5\%}(\text{PNS}) \leq 5 [\% \text{Dem}]^{(b)}$$
$$\text{LOLP} \leq 5\% \quad (a) \quad (c)$$

(a) Annual basis (b) Monthly basis (c) Probability associated with 1.5% month

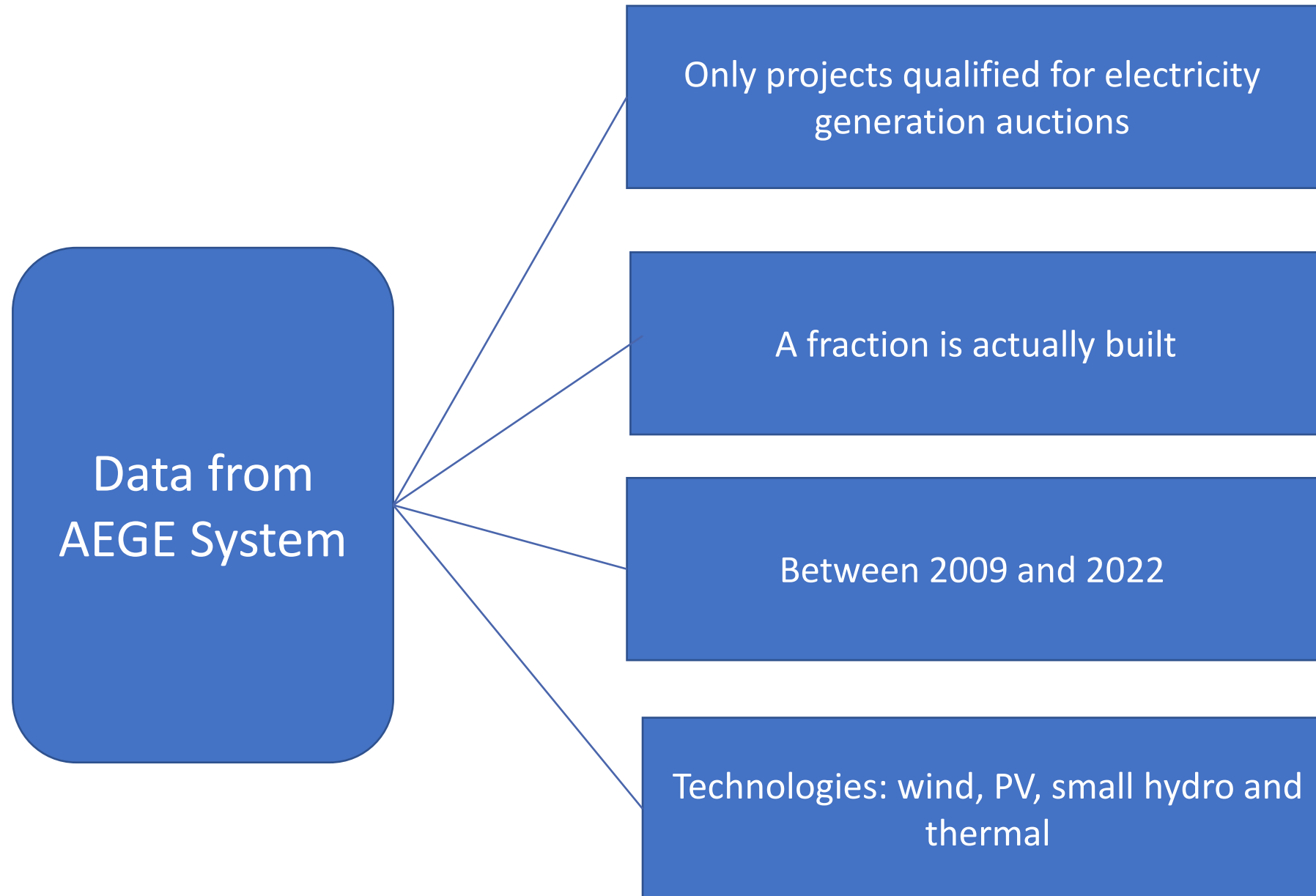


Source: Prepared by EPE.

- **CVaR – Conditioned Value at Risk** – corresponds to the expected value of the $\gamma\%$ most critical possible values for the chosen random variable.
- **LOLP – Loss of Load Probability**
- **ENS – Unsupplied Energy**
- **PNS – Power Not Supplied**
- **CMO – Marginal Cost of Operation**
- **RED – Distributed Energy Resources**
- **1.5% month** – approximately equivalent to the 10 most critical hours of each month

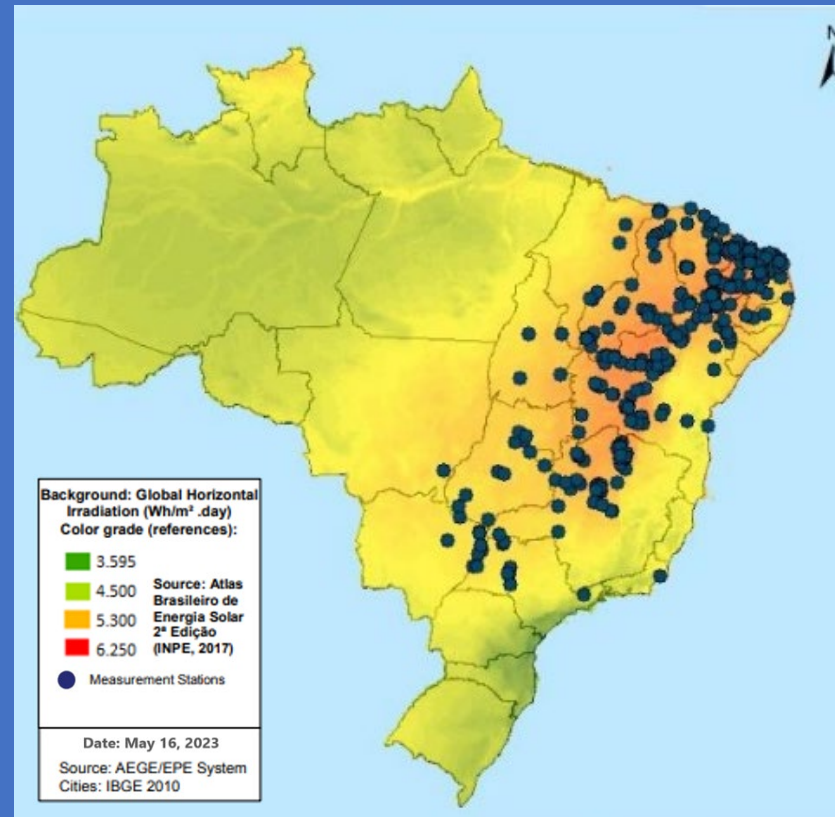
Auctions and AEGE

MONITORING OF ENERGY GENERATING PROJECTS



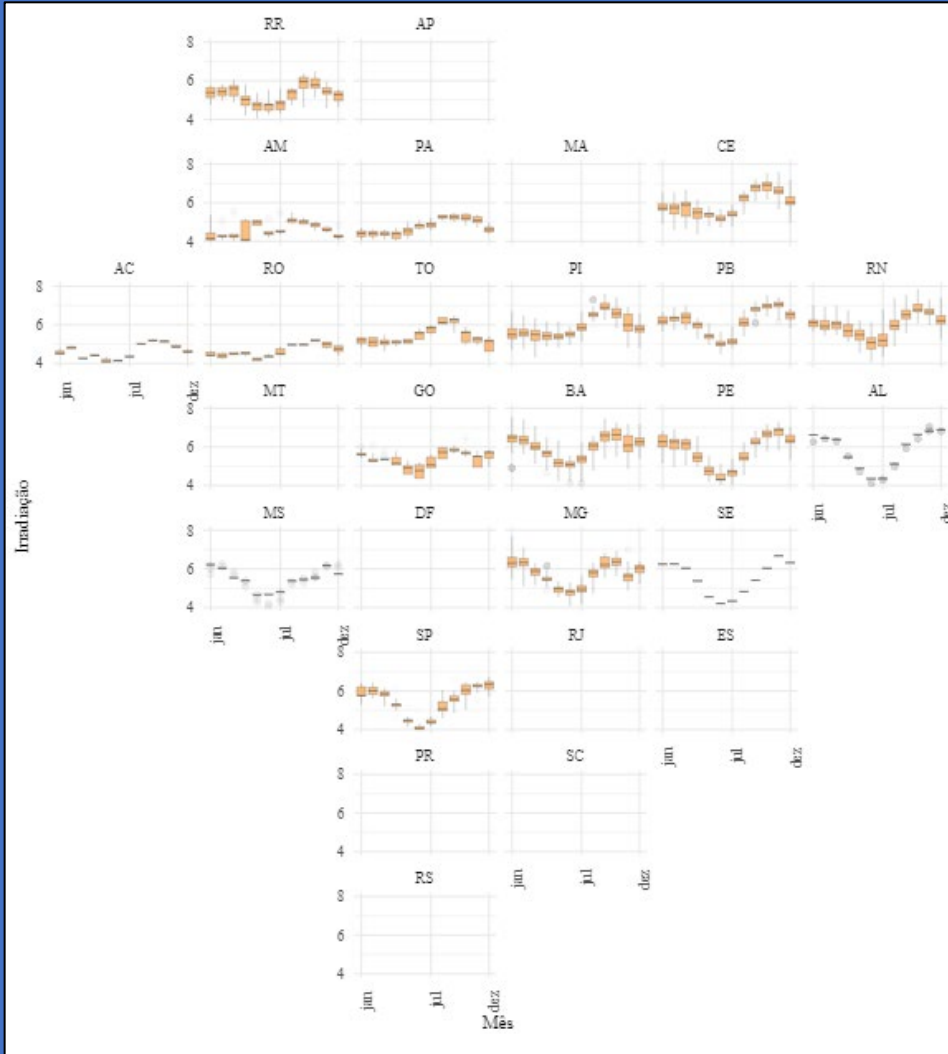
Aspects related to the energy resources (Solar PV)

- Solar resource Measurement Stations and global horizontal irradiation

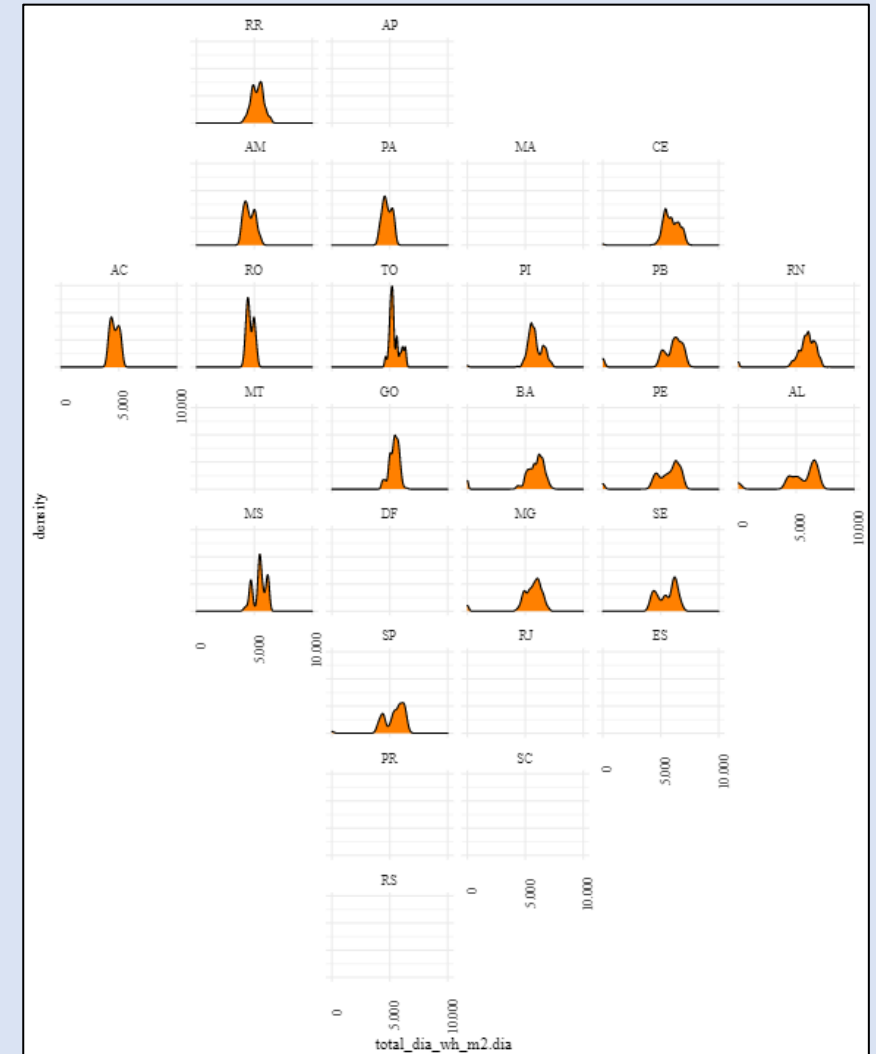


Aspects related to the energy resources (Solar PV)

➤ GHI seasonality by state



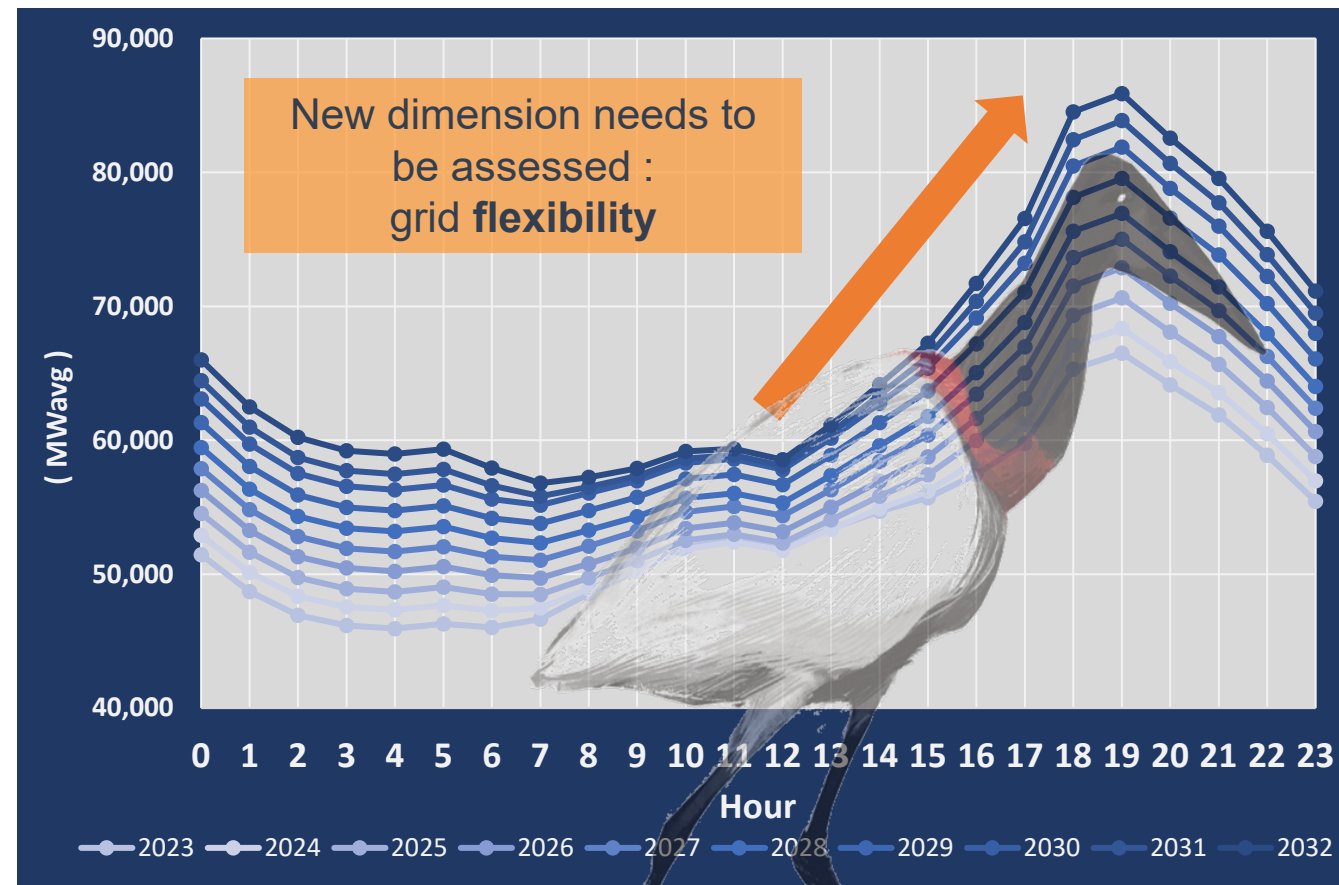
➤ GHI frequency density by state



Brazilian System Hourly Net Load Evolution

Monitor not only **average energy**, but also system **capacity** and its **fluctuations**.

In the planning horizon, the hourly **net load** (total energy demand – VRE generation) tends to have more intense intraday variations.



System requirements and their concepts

ENERGY

- Resource availability to meet **cumulative energy demand for long periods**, such as months and years.
- Unit: megawatt-hour (MWh) ou megawatt average (MWavg)

CAPACITY

- Resource availability to meet **all expected load levels instantly**, given specified capacity supply risk criteria.
- Unit: megawatt (MW).

FLEXIBILITY

- Resource availability to meet **all net load variations between two time periods**. It can include multiple time scales such as seasonal, monthly, hourly variations.
- Unit: (MW/h)

- Main objective: to support the **integration of renewable energy** and energy efficiency into the Brazilian energy system.
- The project is part of the actions of the **Brazil-Germany Cooperation** for Sustainable Development, through the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)
- The study will **simulate the impacts of future climate change scenarios on the Brazilian electrical system**, analyzing, for example, how changes in precipitation, temperature, solar radiation and wind variables could impact the planning and operation of the Brazilian electrical grid.
- Climate projections from models of the Intergovernmental Panel on Climate Change (IPCC) and projections from the National Institute for Space Research (INPE) and the National Water Agency (ANA) are being used as resources. The system operator also participates.



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Thank you