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Energy Expansion Plan (PDE 2016): Perspectives for renewables in Brazil

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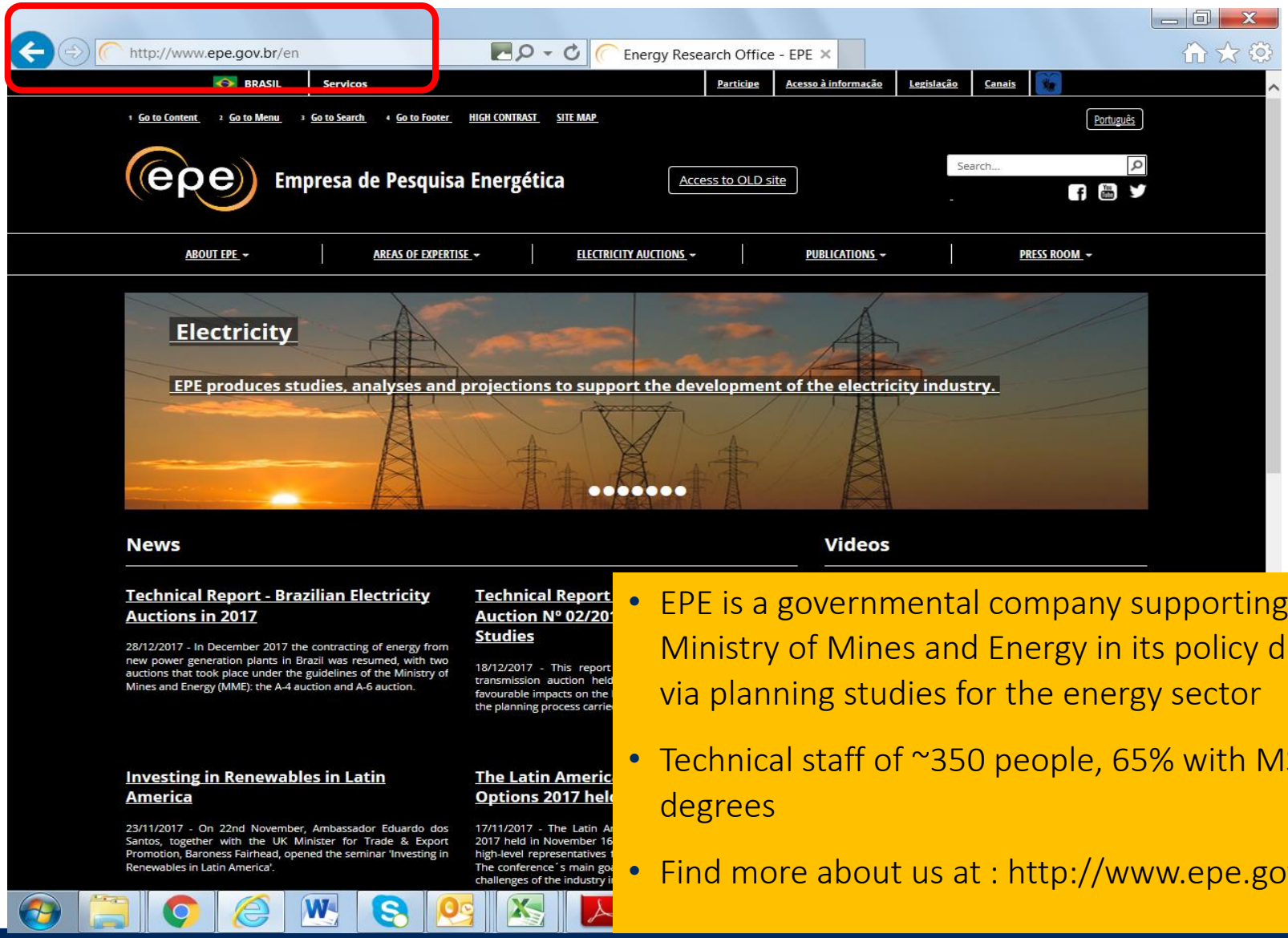
Outline

- General Overview
- Renewables in the Brazilian power system
- Business model to attract renewables
- Looking into the future
  - Part I: the 10-y expansion plan and perspectives for renewables
  - Part II: regulatory and policy enhancements
- Conclusions

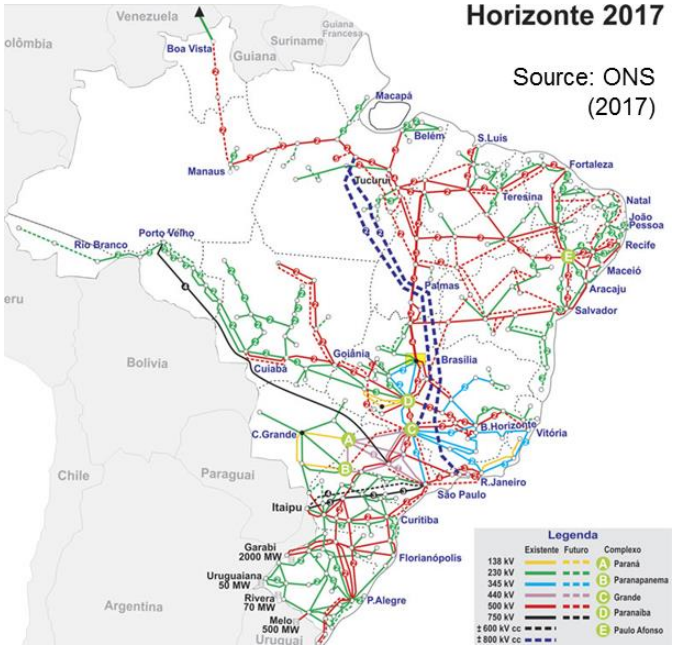
Who are we?



- EPE is a governmental company supporting the Ministry of Mines and Energy in its policy decisions, via planning studies for the energy sector
- Technical staff of ~350 people, 65% with MSc or PhD degrees
- Find more about us at : http://www.epe.gov.br/en

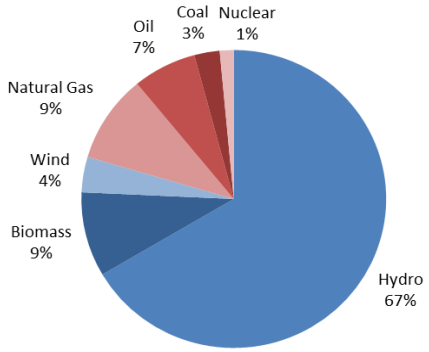
Brazil in big numbers

- Installed generation capacity: 150 GW, 65% hydro
- HV transmission system length: 130,000 km
- Average annual load growth rates:
  - 2004 – 2010: +4.3%; 2010 – 2016: +1.9%
- Private participation in G, T, D and trading
- Investment market:
  - Generation: wholesale energy market in place + auctions of long-term (20+ years) energy contracts for new capacity
  - Transmission: central planning + auctions for 30-year concessions of new transmission facilities
  - Institutions in place & regulatory framework: independent (and federal-level) regulator & ISO & market operator; current framework established in 2004



Large contribution from renewable sources already today

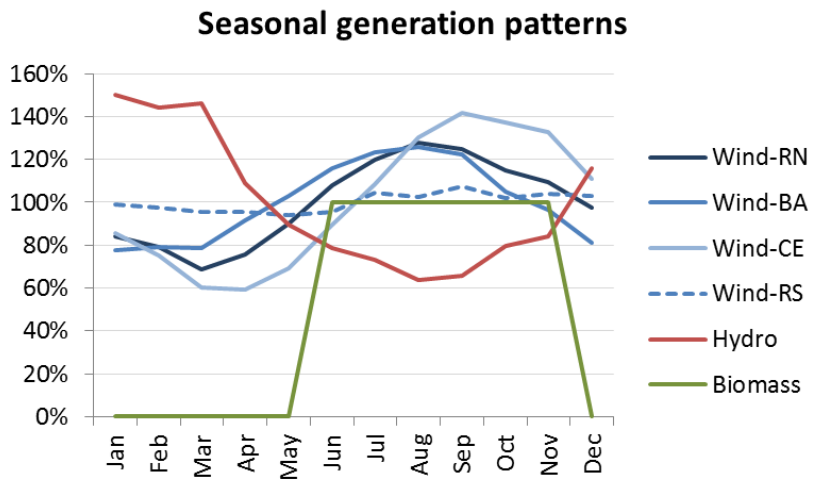
- Renewables amount to 42% of Brazilian total primary energy supply (TPES)
- Hydropower accounts for 2/3 of total installed capacity
  - Cascaded plants, with large reservoirs and multiple ownership
  - Thermal stack: gas, coal, nuclear, biomass, fuel and diesel oil
  - “new” renewables are emerging



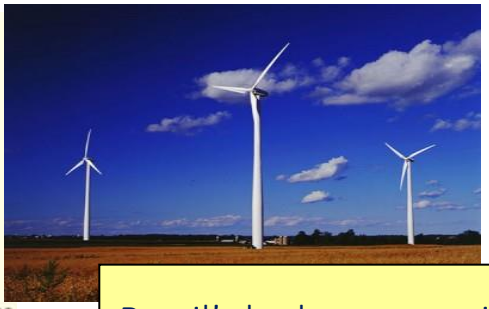



The role of the “new” renewables in the Brazilian power system

- Renewables have interesting attributes, in addition to its economic competitiveness that make them mainstream technologies for system expansion:
  - Resource potential with geographical complementarity
  - Shorter construction time: hedges load growth uncertainty
  - Location close to load centers
  - The system is well-adapted to absorb inherent fluctuations in wind generation (hydro reservoirs, transmission grid)
  - Production complementarity with hydro:
    - Hydro + bioelectricity (in the Southeast)
    - Hydro + wind (in the Northeast)
    - Wind + small hydros (in the Southeast)



Integration of hydro, solar, wind and bioelectricity



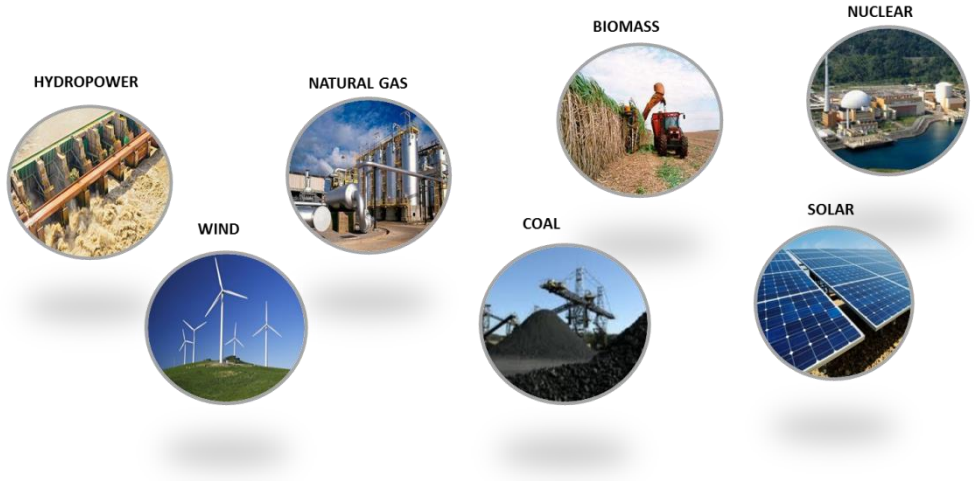
Brazil's hydro reservoirs and the countrywide transmission grid are used to modulate the seasonal production of biomass and the fluctuations of wind power and solar; the system reservoirs are used as "energy warehouses" that may "store" wind, sun and sugarcane

→ Portfolio effect, also with load and in different time scales

The "energy warehouses" of hydropower plants are essential for the economic feasibility of renewable energy sources in Brazil

Capacity expansion strategy

- Brazil needs to build new generation capacity to meet electricity load growth
  - 5,000 MW of new additions needed per year in business as usual years
- The country's resource potential is vast:



Hydro facilitates integration of RES, which are located closed to load centers and have shorter-construction time…hydro, wind, solar and biomass portfolio allows the combination of economic of scale and flexibility (dispatchability & construction time)

Business model to develop renewables (centralized generation)

- Due to the energy spot price volatility, the electricity trading in Brazil is centered on the negotiation of electricity contracts

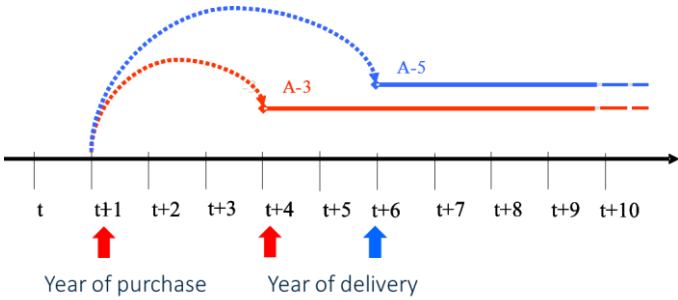
- New generation competes for long-term contracts in auctions to supply the regulated market or bilaterally negotiate their contracts to supply free (eligible) consumers

Target-market	Product	Price-setting mechanism	Who organizes	Volumes definition
Regulated consumers	Firm energy, long-term contract with a performance-incentive mechanism (product tailor-made for the technology)	Auction	Government, auctions organized yearly	Distributors
Free market	Firm energy, contract terms bilaterally defined	Bilateral	Bilateral	Free consumers or traders
Reserve energy	Long-term contract (product tailor-made for the technology)	Auction	Government, auctions organized sporadically	Government

The role of the electricity auctions

Features

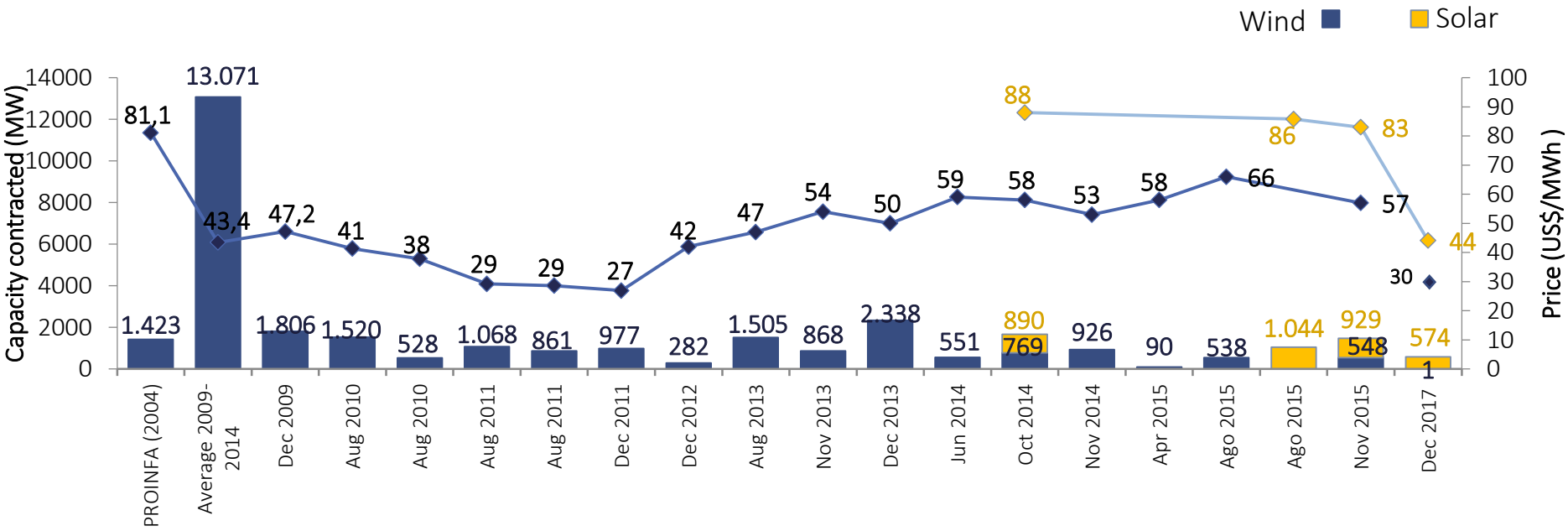
- Periodic auctions are organized every year for future delivery: “A – x”, where x is the delivery year.



- Meet the regulated consumers demand in the long term (as declared by their respective distribution utilities), are price-hedging mechanisms to consumers
- There are auctions exclusive for new generation capacity → investment market
- Provide long term energy contracts for power generators (backed by firm energy)
- Contracts are denominated in BRL and indexed to IPCA (consumer price inflation).
  - For thermal power plants, fuel purchase installments can be indexed to a basket of international fuel prices and exchange rate.
- Technology-specific products and contracts

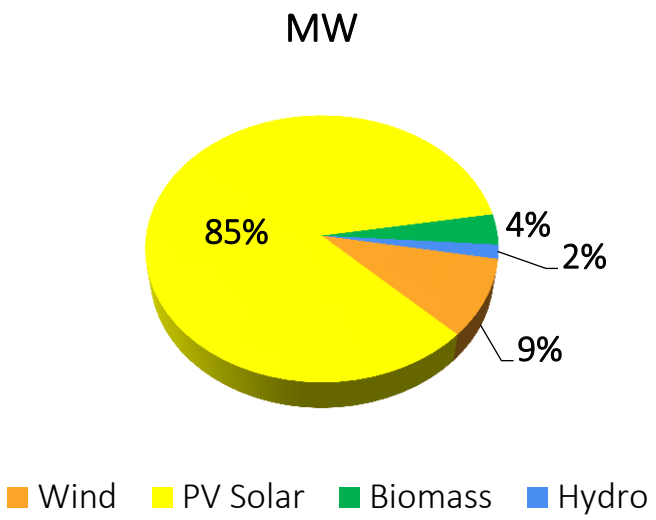
Brazilian renewable energy auctions

- The auction-based framework has provided price competitiveness and boosted the renewable energy industry in the country



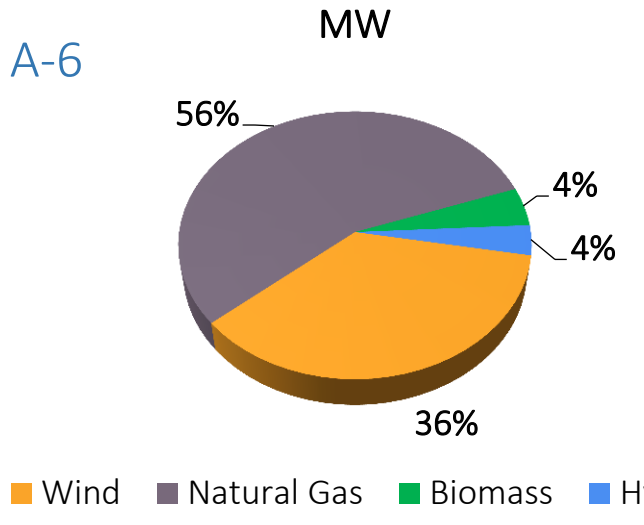
Examples: Electricity Auctions in 2017

A-4



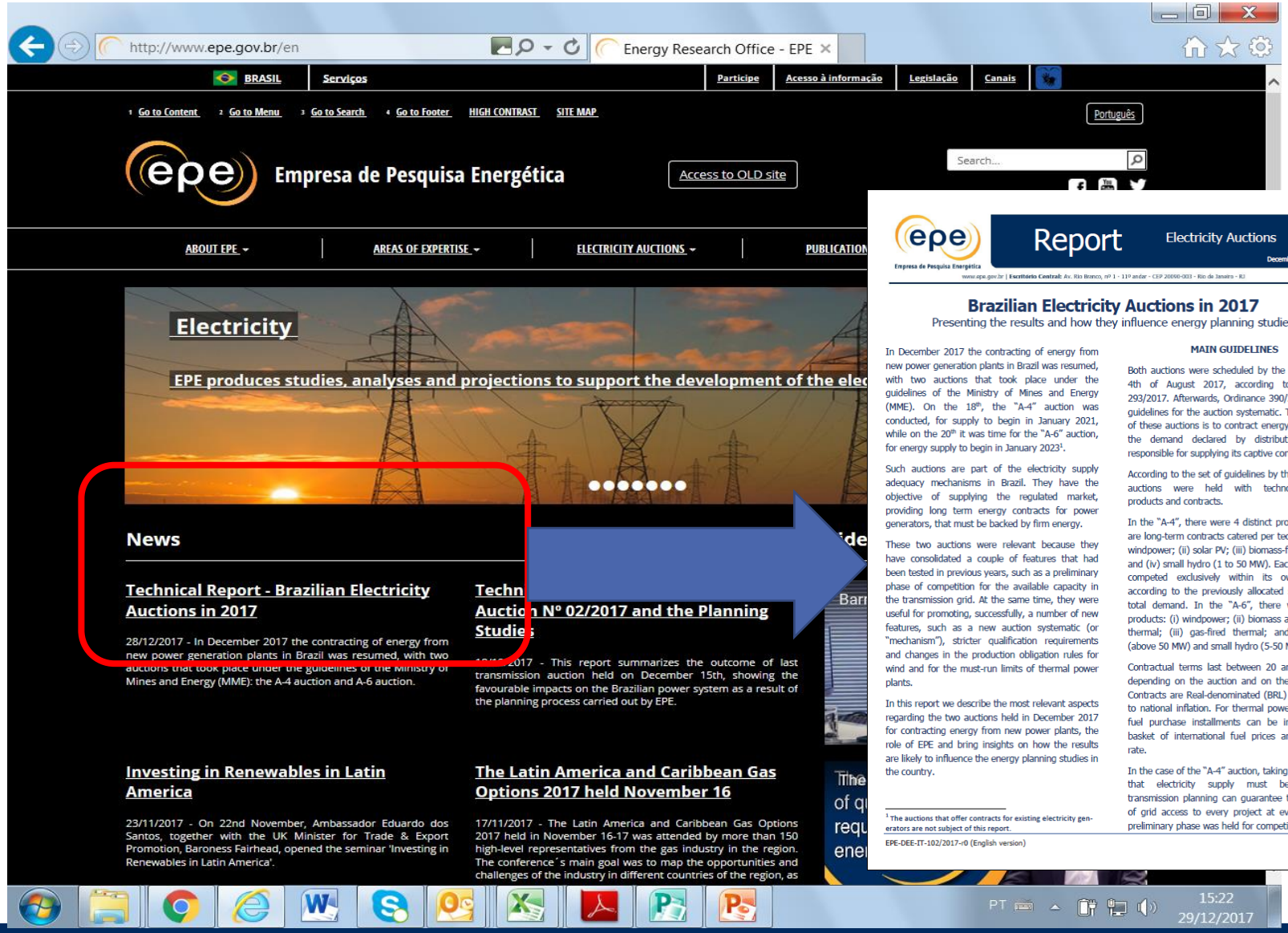
Source	Registered (MW)	Qualified (MW)	Sold (MW)	Final Price (US$/MWh)
Wind	26,604	8,907	64	32,7
PV Solar	18,352	14,030	574	44,1
Biomass	1,974	742	25	71,2
Small Hydro	1,035	616	11,5	55,0
Total	**47,965**	**24,296**	**674**	**44,1**

A-6



Source	Registered (MW)	Qualified (MW)	Sold (MW)	Final Price (US$/MWh)
Natural Gas	21,560	9,178	2,138	64,7
Coal	1,880	340	-	-
Wind	26,651	22,200	1,386	29,9
Biomass	2,068	1,197	177	65,7
Small Hydro	1,266	836	139	66,4
Total	**53,424**	**33,751**	**3,841**	**57,4**

More information about the auctions in our web



New Electricity Auctions in 2018

Main Features

- 2 New Electricity Auctions to be held in 2018.
  - "A-4" auction: supply to begin in January 2022 (scheduled for April, 4th).
  - "A-6" auction: supply to begin in January 2024 (TBA until March, 30th).
- "A-4" auction with 4 "products":
  - Wind; solar PV; biomass-fired thermal; and small hydro

Source	Number of Projects Registered	Registered Capacity (MW)	Price Cap (US$/MWh)
Wind	931	26,198	78
Hydro	3	114	88
Solar	620	20,021	95
Biomass	28	1,422	100
Total	**1,672**	**48,713**	**-**

And what about distributed RES generation?

- Brazil has a framework for distributed generation in place
- Today, solar is already competitive as DG against the retail tariff and a regulatory framework for net metering is available and functioning
  - The challenge for this market is the business model (leasing, financing, etc)
- Distribution companies may also cover up to 10% of their loads with (renewable) distributed generation where the procurement is carried out by auctions organized by the distributors themselves
  - Auction price-caps for these auctions are defined by the government and factor externalities of distributed resources
  - They were released last Tuesday by MME, distributors may now organize their auctions and DG has a new market

A look into the future

The Ten-Year Expansion Plan (PDE 2026)

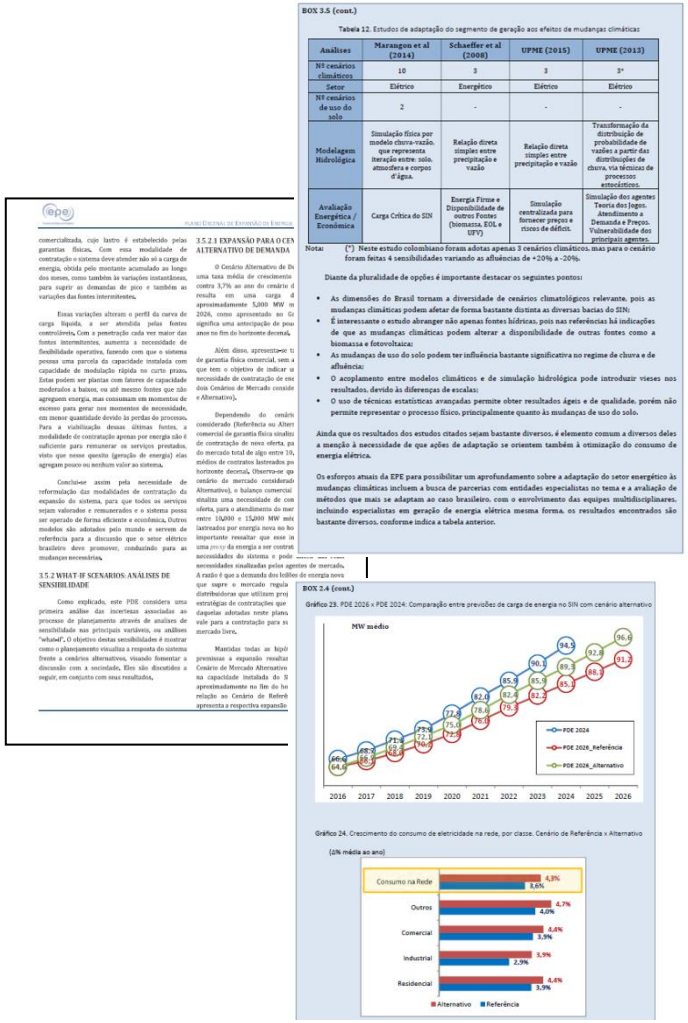
An *indicative* outlook for the future of the energy matrix of Brazil

- PDE 2026 offers an indicative outlook expansion of the energy industry in Brazil from the perspective of the Government.
- Based on an integrated view of the various energy sources, PDE 2026 serves as support for planning the energy sector over a 10-year horizon.
- The final objective is to provide a market with better information to support investors investment decisions.

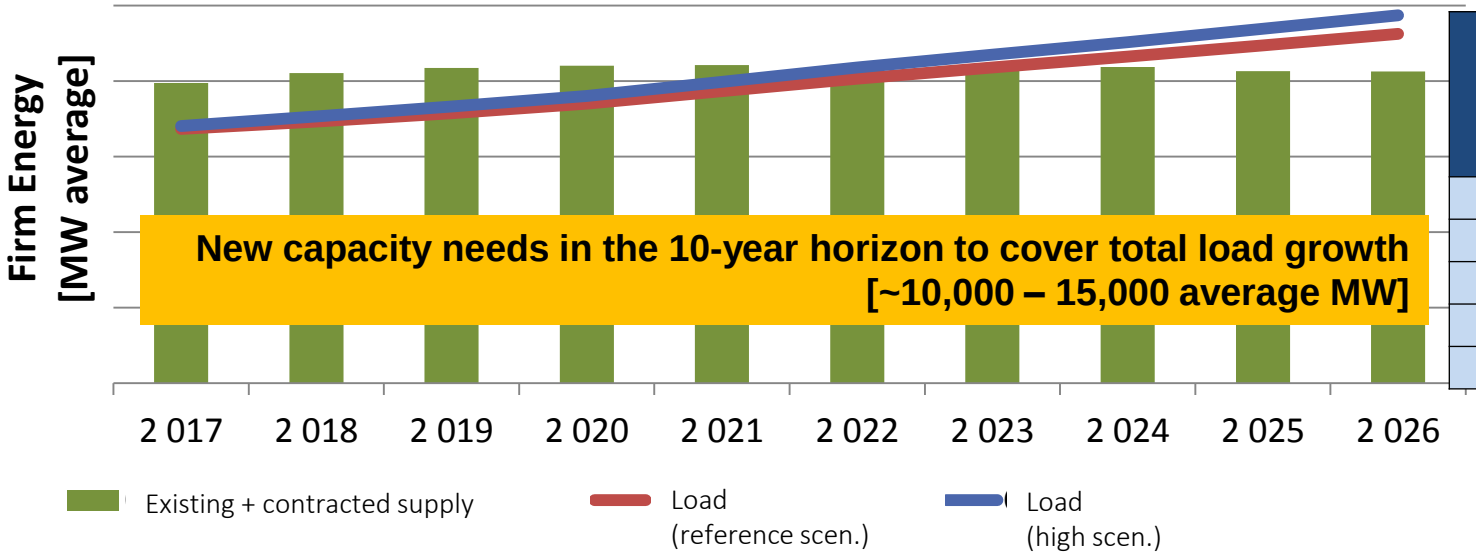
PDE 2026

An *indicative* outlook for the future of the Brazilian energy matrix

- There is much information available:
  - Supply x demand balance, long-run marginal cost, etc
  - What-if Scenarios: uncertainties in variables such as socio-environmental constraints;
  - Direct and clear messages to market about drivers for expansion
- An optimization-based approach with an investment decision tool to support the construction of the electric supply is used (transparency and reproducibility)



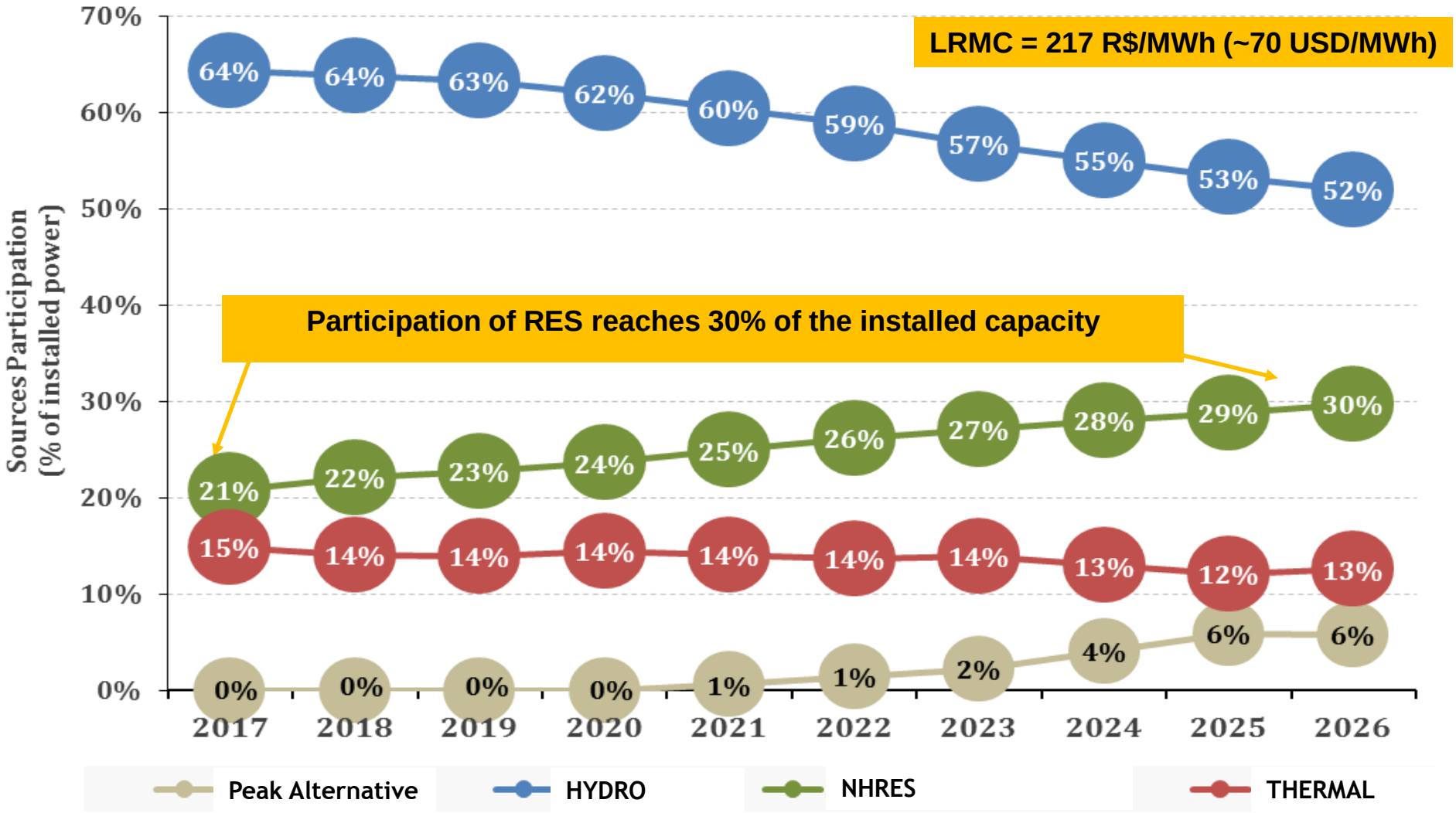
The market space for new investments



Year	GDP Growth [%/a]	
	Ref	High
2017	0.5%	1.7%
2018	1.8%	2.8%
2019	2.1%	3.1%
2020	2.7%	3.2%
2021- 2026	3.0%	3.5%

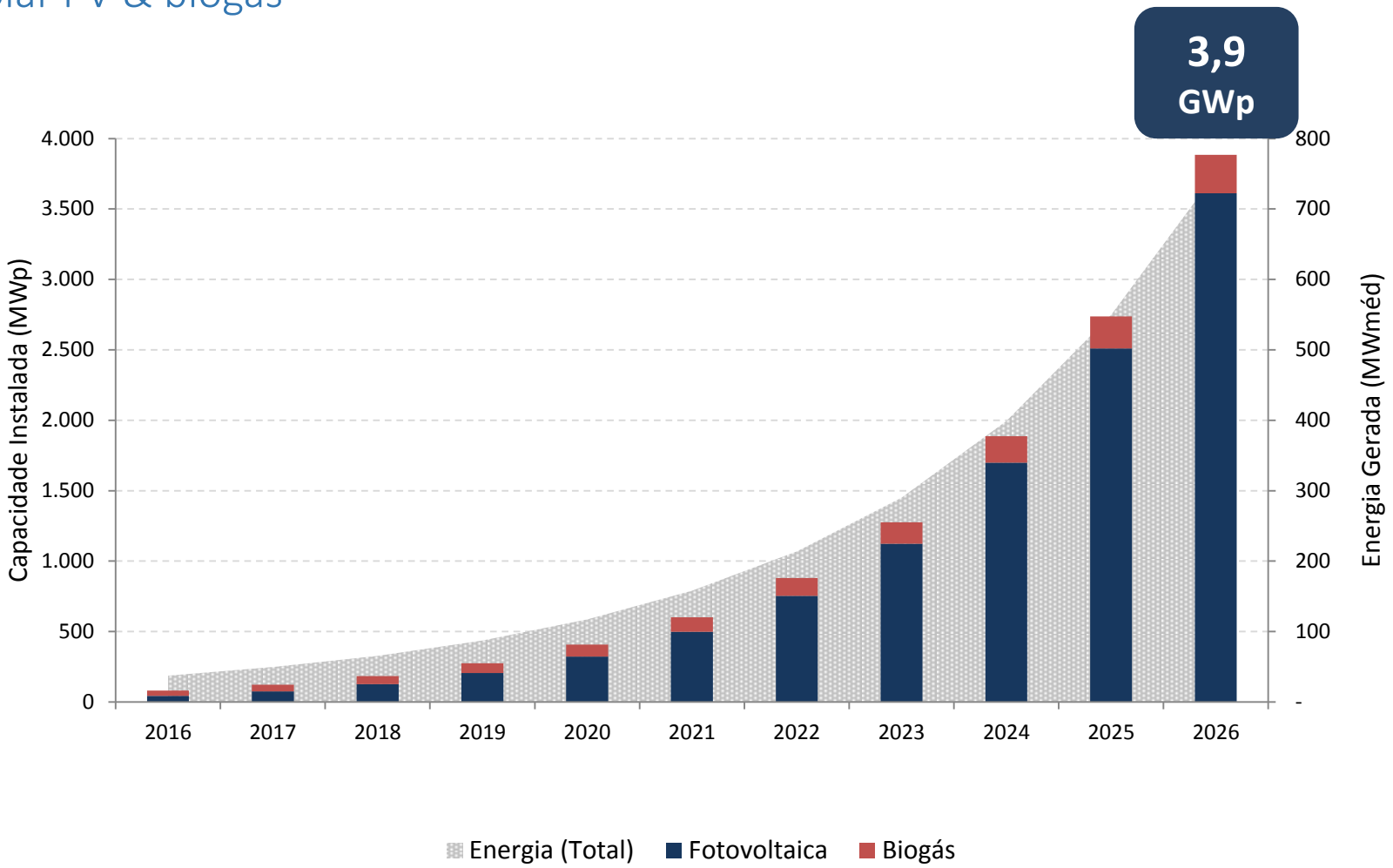
- Hydropower is not the predominant technology in the expansion anymore, reflecting the needs to revisit the hydro development process
- Renewables (Solar, Wind, Small Hydro, Biomass) are the leading technologies in the system expansion complemented by thermal generation (gas-fired)
- Commercial mechanisms to integrate this expansion were discussed before

An outlook of the matrix in the 10y horizon



Distributed generation expansion

Solar PV & biogas



Improving the regulatory framework to attract (more) investment to the country

Another round of policy innovation is happening in the country…

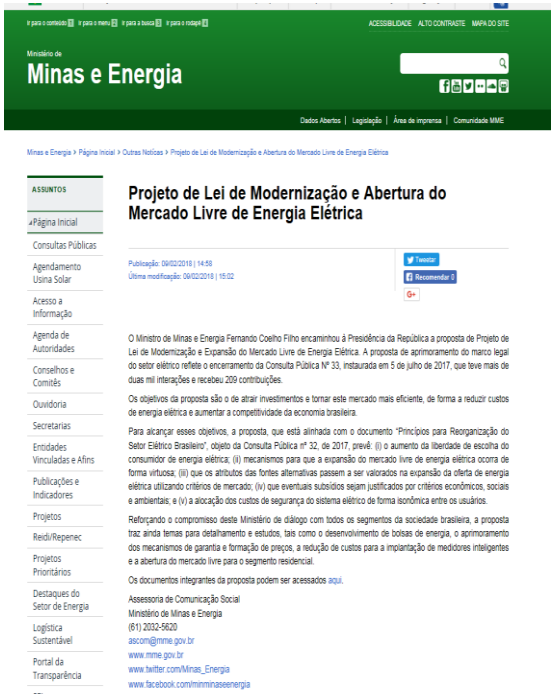
- The future of the power system is towards renewables, distributed energy resources, consumer empowerment and digitalization
- Capacity expansion did occur in Brazil in recent years but there were signals of exhaustion of the current model
  - Interventionism in resource allocation, prices
  - Centrally managing agent's risk contributed to exposure to judicial disputes
  - Market signals lost role as investment drivers
  - Lack of transparency and predictability
  - Legal and regulatory barriers to innovation
- The current legal framework needs an overhauling to be adapted for the power system of the future

Fundamental propositions for setting a long-term view were set…

- Increased incentives to efficient, decentralized decision-making
- Market signals as mechanism to align individual and societal goals with mechanisms for individual risk management
- Dialogue & public consultations were the vehicles to build a proposal
  - Improvements on spot price formation: higher granularity, incorporation of security constraints on price-formation model.
  - Separation of products (energy, reliability product, ancillary services) and use of market mechanisms to correctly price them.
  - Clean energy certificates as an replacer of the (inefficient) current incentive structure for new renewable projects (discounts on T&D tariffs)
  - Expansion of the deregulated (free) market
- Respect to property rights and contract sanctity: mechanisms to accommodate legacy as important as long-term view

MME has just released a Bill project to modernize the electricity regulatory framework

- Released on February 9th, built upon more than 200 contributions under a public consultation process
- Bill project and relevant documentation available at www.mme.gov.br
- The main proposals take into account:
  - Increase of consumer's choice options; supply adequacy mechanisms; mechanisms to deal to a sustained RES expansion; appropriate risk and cost allocation instruments.
  - Possibility for a more detailed discussion on issues such as the development of energy exchanges, the improvement of price formation mechanism, the reduction of costs for the implementation of smart meters and the liberalization conditions for the residential consumers.
- Next step is the submission of the project to the congress for a wide discussion with the society



Conclusions

Conclusions

- The future of the electricity industry in Brazil is towards keeping its low-carbon matrix and renewables are the means to meet this goal
- Although the recent economic downturn and *inertia* in commencement of operations of generation capacity contracted in the past results in some structural oversupply currently, the future prospects are positive (Brazil has scale)
- Brazil's capacity adequacy mechanism and auction-based NHRES procurement have worked properly and been of great interest to many countries
  - Provide economically efficient outcomes that are **unlikely to be challenged** in the future as political and institutional scenarios change
- The current reform package aims at bringing more efficiency, enabling the penetration of new technologies to bring benefits to all stakeholders and consumers

Integratedly with all other institutions, MME and EPE remain open to deepen these (and other!) topics with everyone

Thank you!

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