Eletrobras
Eletronuclear

Nuclear Power Generation in Brazil

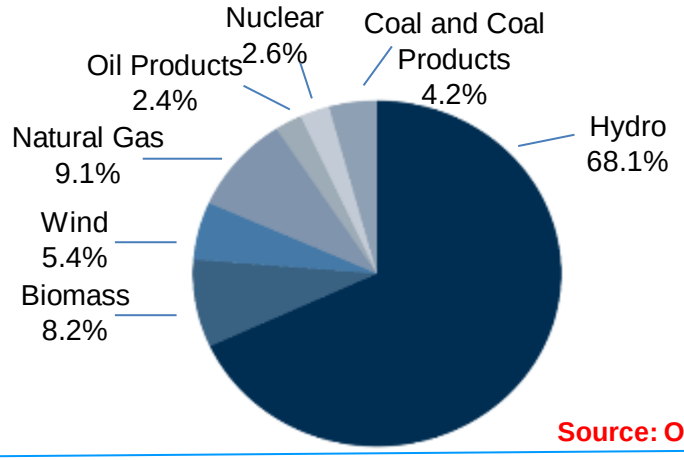
Agenda

- Electricity Market in Brazil
- Eletronuclear
- Angra 3
- Nuclear Energy in Brazilian Energy Planning
- Activities for new nuclear build

Energy Matrix & Demand

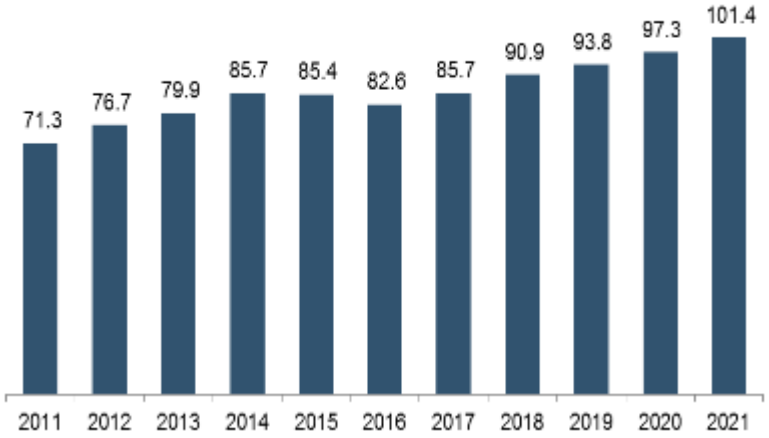
- **The Economy Upturn has an Important Impact on Energy Demand.**
- **Since Brazil has a relevant exposure to hydroelectric energy, the diversification of the sources is important.**

Domestic Electricity Supply by Source



Source: ONS

Instant Max Demand in Brazil (GW)



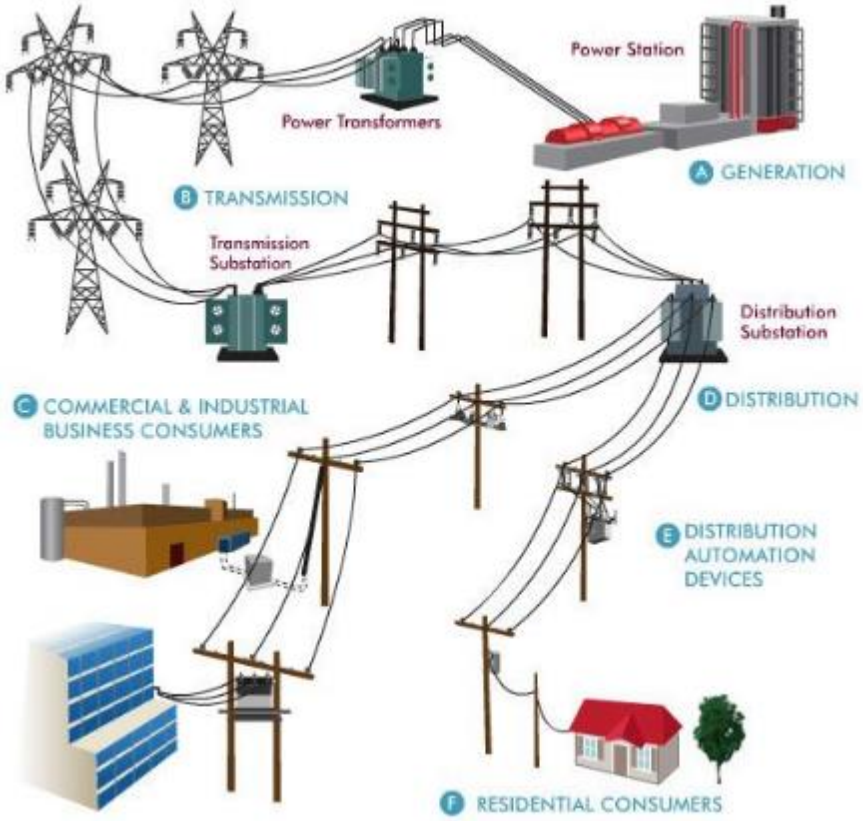
Source: ONS

- After the drop in demand in 2016 and 2017, the **consumption of energy grew in 2018 and 2019. Due to COVID-19, a negative impact on demand shall happen in 2020. On the long term however, a continued increase following economic growth is expected.**
- **Considering the dependency on hydroelectric energy and its correlation with climate, new sources of energy will have more demand in the country in the next years.**
- **Main Alternatives: Wind / Biomass / Gas / Coal / Nuclear**
- **As nuclear power is stable and clean, it has excellent prospects in the medium term.**

Brazilian Energy Market

- **In Brazil most of the Power Plants operate under PPA Contracts in a mostly regulated Energy Generation Market.**

Energy Market



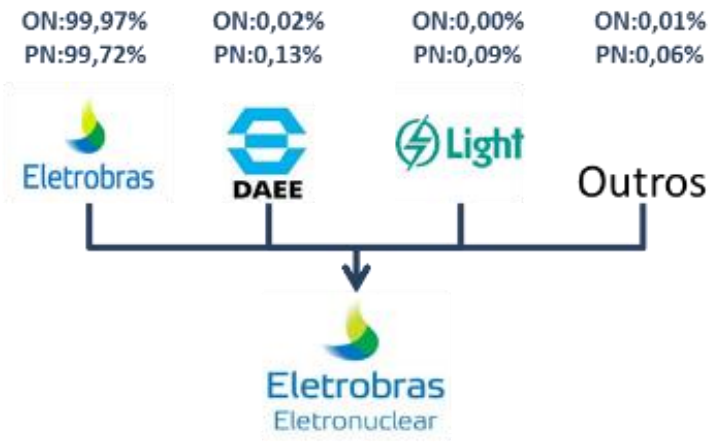
Key Highlights

- **Generation:** The Generation market in Brazil is highly regulated with most power plants operating with PPA contracts.
- **Transmission:** Transmission market is also mainly regulated. Every player of the system has a contract specifying an "Annually Allowed Revenue" (*Receita Anual Permitida – RAP)* which remunerates the transmission projects.
- **Distribution:** Every region has a Distribution Company offering this service and all them are regulated by ANEEL (National Electric Energy Agency), regarding tariff and quality of service.
- **Tariff:** The tariff increases proportionally to the use of conventional thermal energy.

Eletronuclear profile

Eletronuclear is a mixed capital company controlled by Eletrobras with minority shareholders such as Light and DAEE

Eletronuclear's Corporate Structure



Comments and Analysis

- The company is a subsidiary of Eletrobras with approximately 99%
- Eletronuclear, through its NPPs, is responsible for generating about 3% of the electricity consumed in Brazil and more than 30% of the state of RJ
- The company has an asset under construction with expected COD in Jul / 2026

Assets in Operation

Angra 1

- Installed Power: 640 MW
- Power Generation (2018): 568 MWmed
- Approved Energy Price (2019): R$ 247/ MWh

Angra 2

- Installed Power: 1,350 MW
- Generated Power (2018): 1,280 MWmed
- Approved Energy Price (2019): R$ 247/ MWh

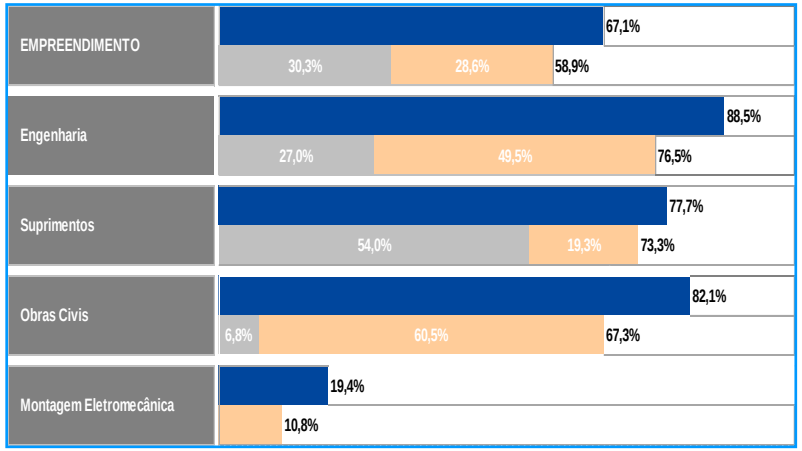
Power Plant Under Construction

Angra 3

- Installed Power: 1,405 MW
- Reference Price (2018): R$ 480 / MWh
- Status of Civil Works: 67.1%
- Investments to be made: R$ 14.5 Bn
- Additional period of construction: 55 months

Angra 3

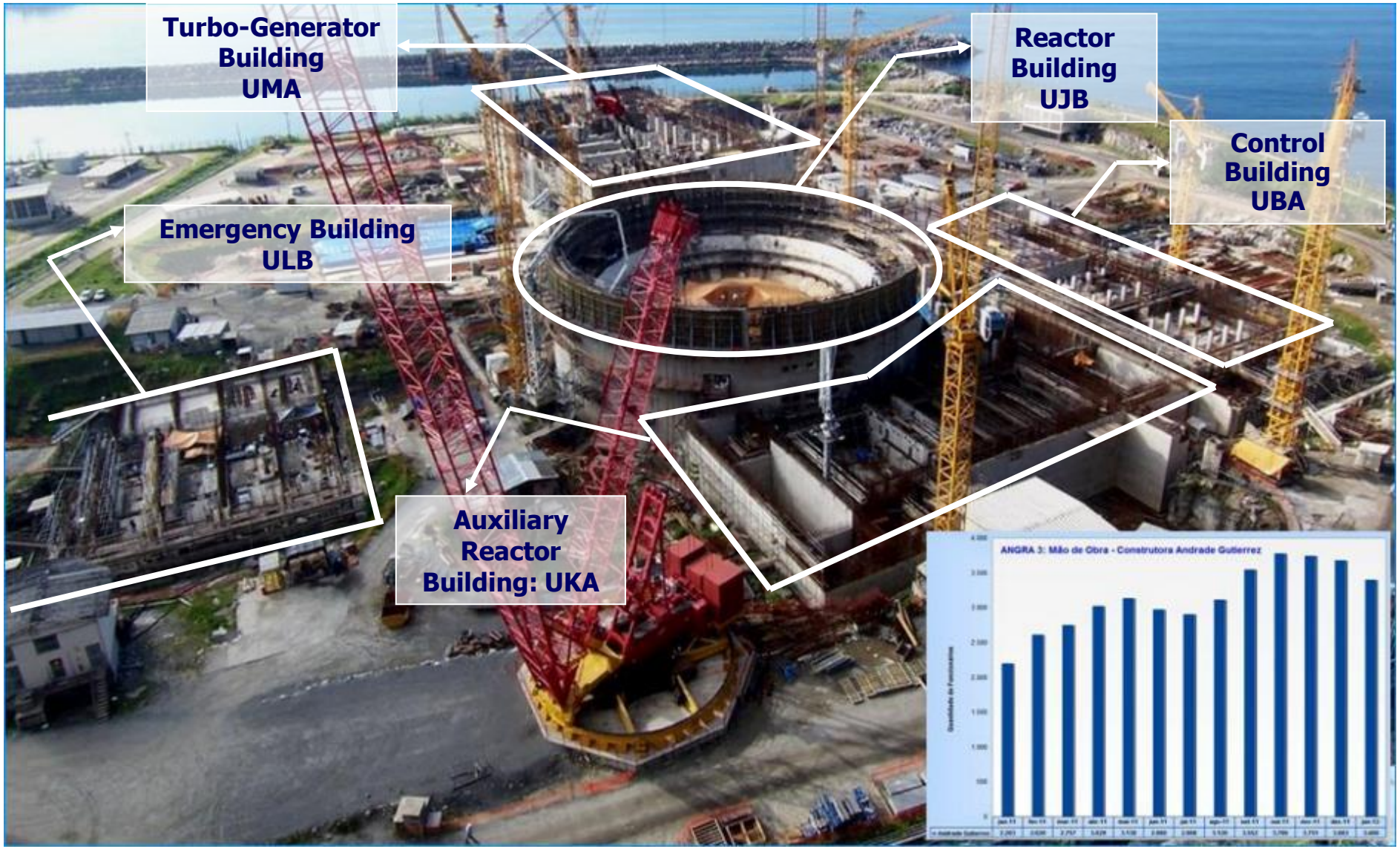
Middle 2015: Progress ~ 67%



Today

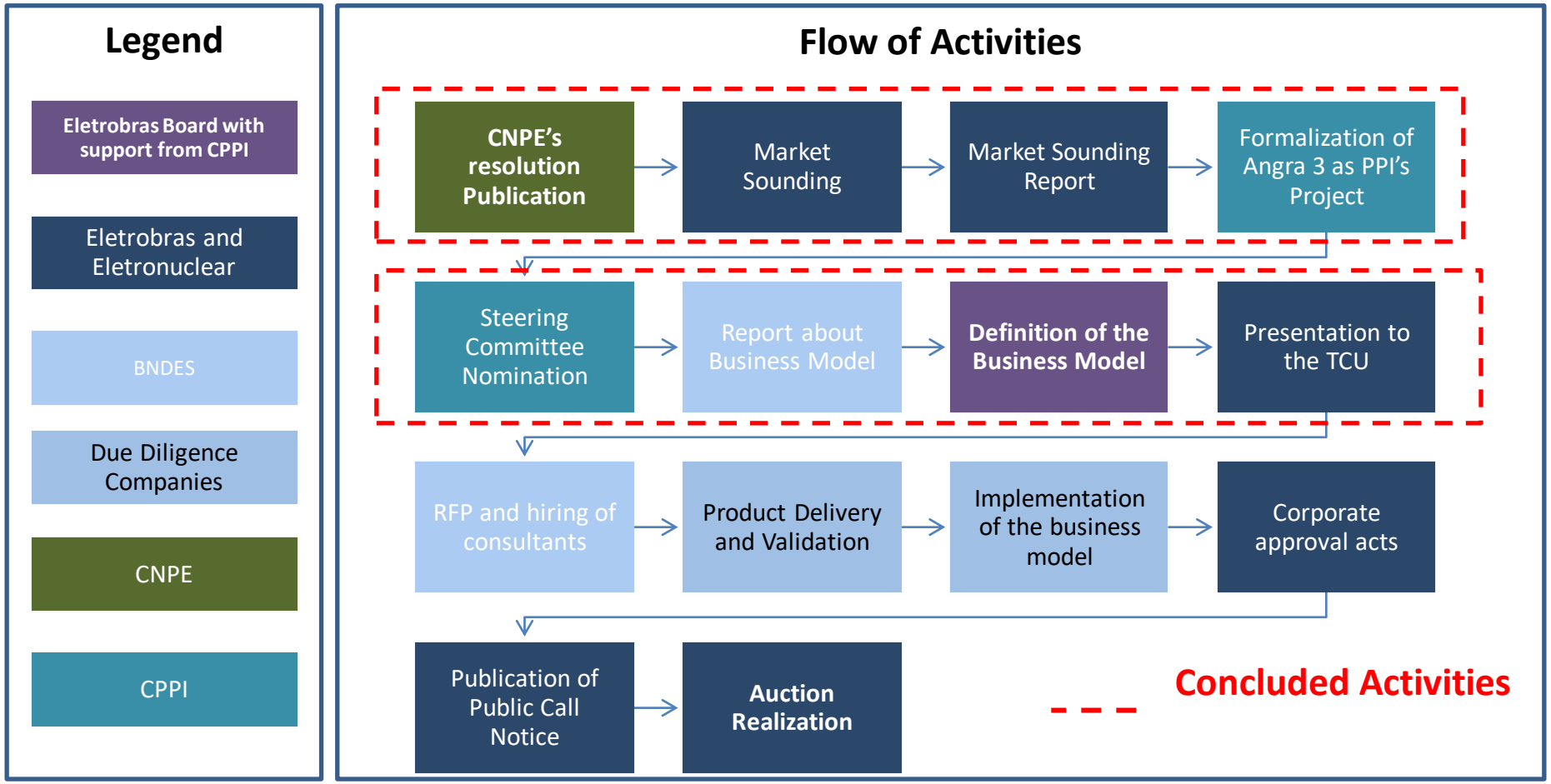
- Protection Systems for Civil Structures Already Built.
- Preservation of Components and Materials.
- Studies about the Restarting the Construction.

Angra 3


Turbo-Generator Building UMA
Reactor Building UJB
Control Building UBA
Emergency Building ULB
Auxiliary Reactor Building: UKA
ANGRA 3: Mão de Obra - Construtora Andrade Gutierrez

Resuming Angra 3

It was developed with the aid of the Investment Partnerships Program a flow of activities for the resumption of Angra 3



CPPI Resolution – June 2020

RESOLUÇÃO Nº 139, DE 10 DE JUNHO DE 2020

Aprova o relatório do Comitê Interministerial acerca do modelo jurídico e operacional para viabilização da Usina Termonuclear Angra 3.

O **CONSELHO DO PROGRAMA DE PARCERIAS DE INVESTIMENTOS**, no uso das atribuições que lhe confere o artigo 7º, **caput**, incisos I e IV, da Lei nº 13.334, de 13 de setembro de 2016, e o artigo 3º, inciso I, do Decreto nº 9.915, de 16 de julho de 2019, e

Considerando que o Conselho Nacional de Política Energética – CNPE, por meio da Resolução nº 14, de 19 de outubro de 2018, determinou ao Ministério de Minas e Energia – MME a submissão do empreendimento Usina Termonuclear Angra 3 ao Conselho do Programa de Parcerias de Investimentos – CPPI;

Considerando a qualificação no Programa de Parcerias de Investimentos – PPI da Usina Termonuclear Angra 3, por meio do Decreto nº 9.915, de 16 de julho de 2019;

Considerando que o Banco Nacional de Desenvolvimento Econômico e Social – BNDES, com base no disposto no artigo 2º, parágrafo único, do Decreto nº 9.915/2019, realizou estudos para a definição de um modelo jurídico e operacional para a conclusão do empreendimento;

Considerando que o Comitê Interministerial produziu relatório com base nos estudos realizados pelo BNDES encaminhando o modelo jurídico e operacional, que se mostrou mais adequado, para a conclusão do empreendimento ao CPPI, nos termos do art. 4 º, § 6 º, inciso I, do Decreto 9.915/2019;

Considerando que a qualificação da Usina Termonuclear Angra 3 no PPI se deu com fulcro no disposto no artigo 4º, **caput**, inciso II, da Lei nº 13.334, de 26 de setembro de 2016, que prevê a qualificação de empreendimentos públicos federais de infraestrutura no

- ✓ Approves the report prepared based on BNDES work
- ✓ Report defines the model for completion of Angra 3, separating the engineering and financial risks: Financial restructuring and EPC contract
- ✓ The National Council for Energy Policy - CNPE, will monitor the project
- ✓ Starts Phase 2 of the contract with BNDES – implementation of the model

Angra 3 – Critical Path Accel. Plan

Motivation

An alternative solution to mantain C.O.D in nov/26.

Scope

Advance civil construction and erection works, as well as mantaining critical supplies.

Start

May 2020

→ Contracting Owners Engineering and conclusion of engineering design

→ National Supplies contract renegociations

→ Debt and new supplies negotiations

March 2021 → Sign civil works ans electromechanical erection contracts.

October 2021 → Start of works on site

Nuclear Energy in the
Brazilian National Energy Plan 2050

National Energy Plan 2050
Long Term Strategies

Long Term strategy
Expand energy generation

Energy Strategy PNE 2050

Longo prazo para Expansão

Design Strategy

Definição de conjunto de recomendações e diretrizes a serem seguidas

Instrument: PNE 2050 Report

Deploy the Strategy

Desenvolver conjunto de ações coordenadas que possbilitem a implementação da estratégia

Instrument: Action Plan

Monitor the Strategy

Monitorar os efeitos e desdobrametos da estratégia

Instrument: Monitoring Plan

Fonte: PNE 2050

2005	186 milhões
2010	196 milhões
2015	205 milhões
2030	224 milhões
2040	228 milhões
2050	226 milhões

A parte de imagem com identificação de relação r...

226 MM
Inhab.
In 2050

2005	45 milhões
2010	50 milhões
2015	65 milhões
2030	82 milhões
2040	91 milhões
2050	98 milhões

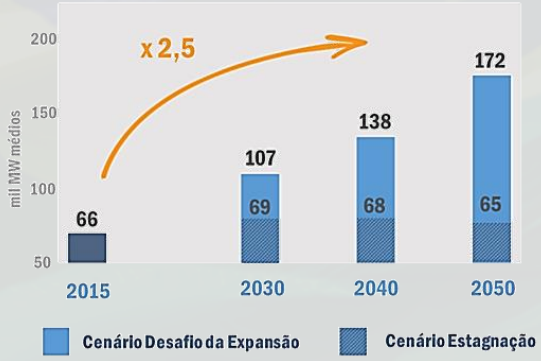
98 MM
households
In 2050

Electricity consumption evolution

x3,3
Potential growth of the use of electricity

Engloba o consumo na rede, a autoprodução, a geração descentralizada e é calculado antes dos ganhos de eficiência energética

Electricity Demand Growth



x2,5
Is the estimated growth in demand.

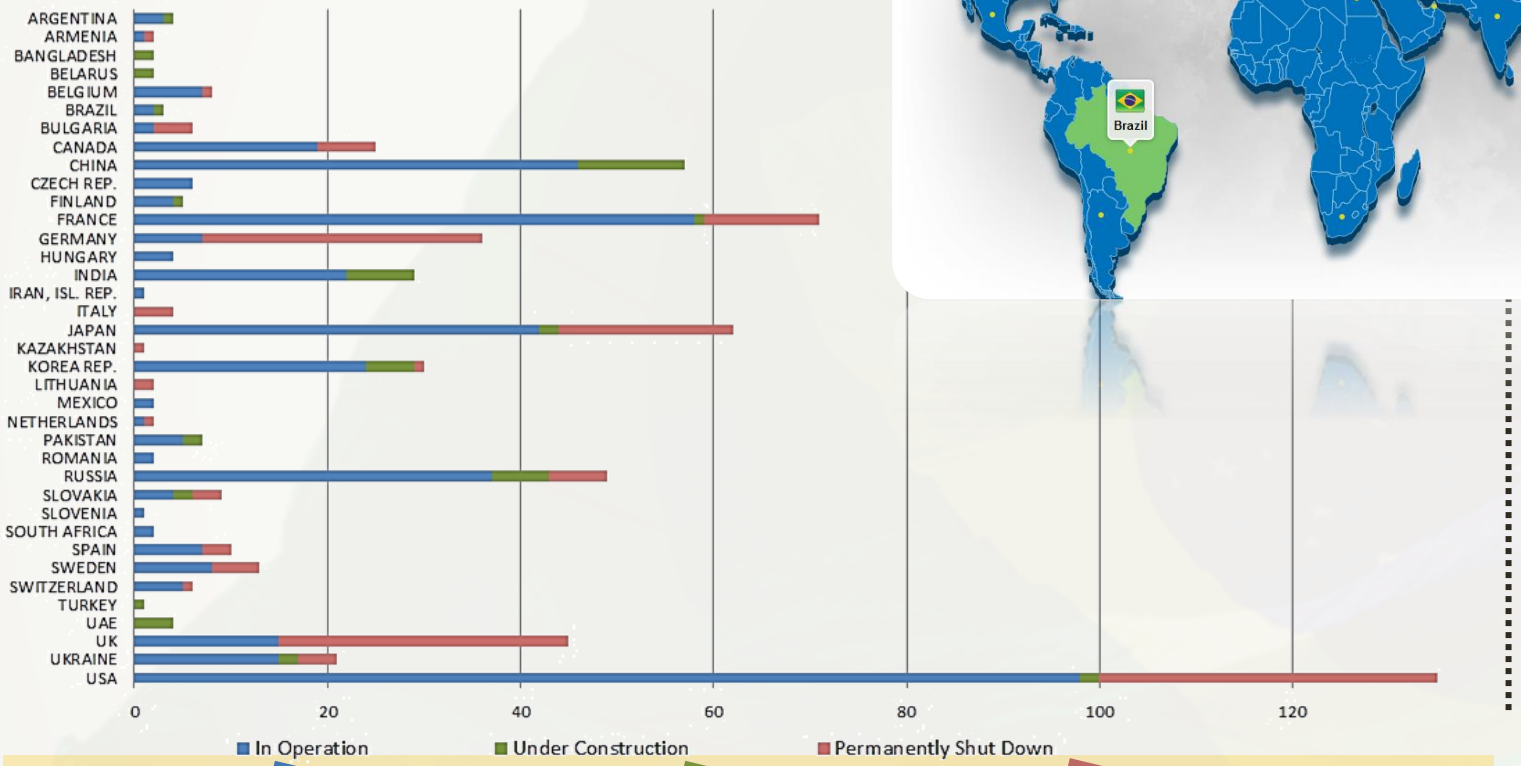
Fonte: PNE 2050

MINISTÉRIO DE MINAS E ENERGIA

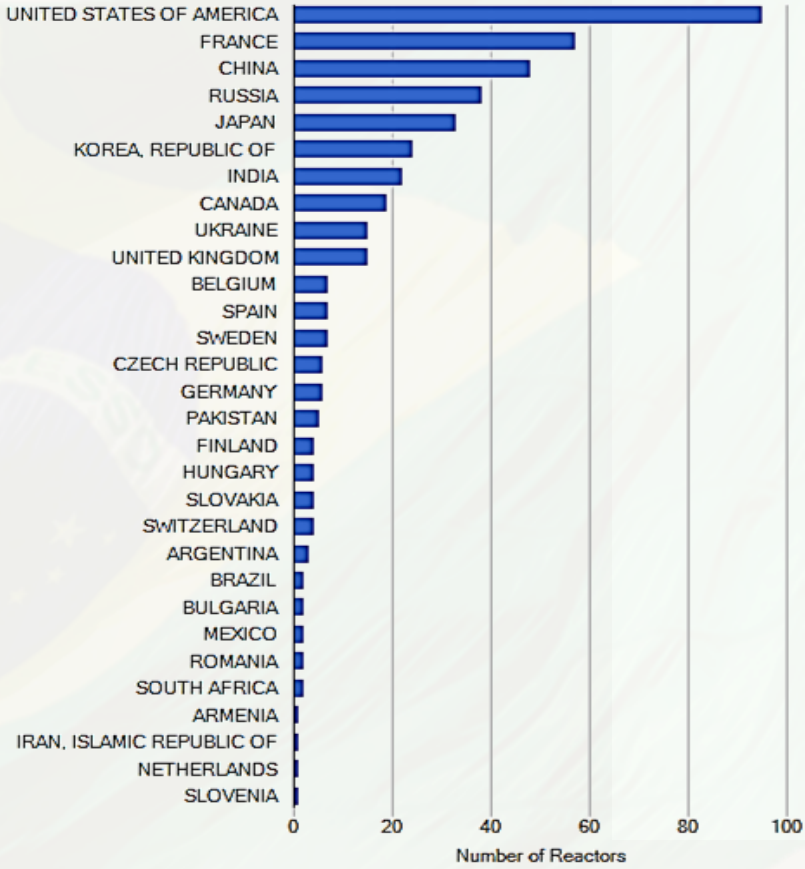
PÁTRIA AMADA BRASIL GOVERNO FEDERAL

Nuclear Energy - World Outlook - 2020

Reactors in operation and under construction



Operating Reactors



441 Nuclear Reactors in operation in June 2020

54 Nuclear reactors in construction in June-2020

186 Nuclear Reactor shutdown until 2020

Fonte: Power Reactor Information System (PRIS) - IAEA. 22/6/2020 Disponível em: https://pris.iaea.org/PRIS/home.aspx

MINISTÉRIO DE MINAS E ENERGIA

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Nuclear Energy - Technology Perspectives

Energia Nuclear
Perspectivas Tecnológicas

In the coming years (PNE 2050):

- **New reactor generation (III+)**
  - *First unities recently started comercial operation*
- **Small modular reactors (SMR)**
  - *Presently in the first stages of licensing in several countries*
- **Generation IV reactors**
  - *Still in design, no foreseable deployments in the horizon of PNE 2050*
- **Large number of plant decommissions by 2040**
  - *A large number of plnats will reach EOL*

Fonte: PNE 2050

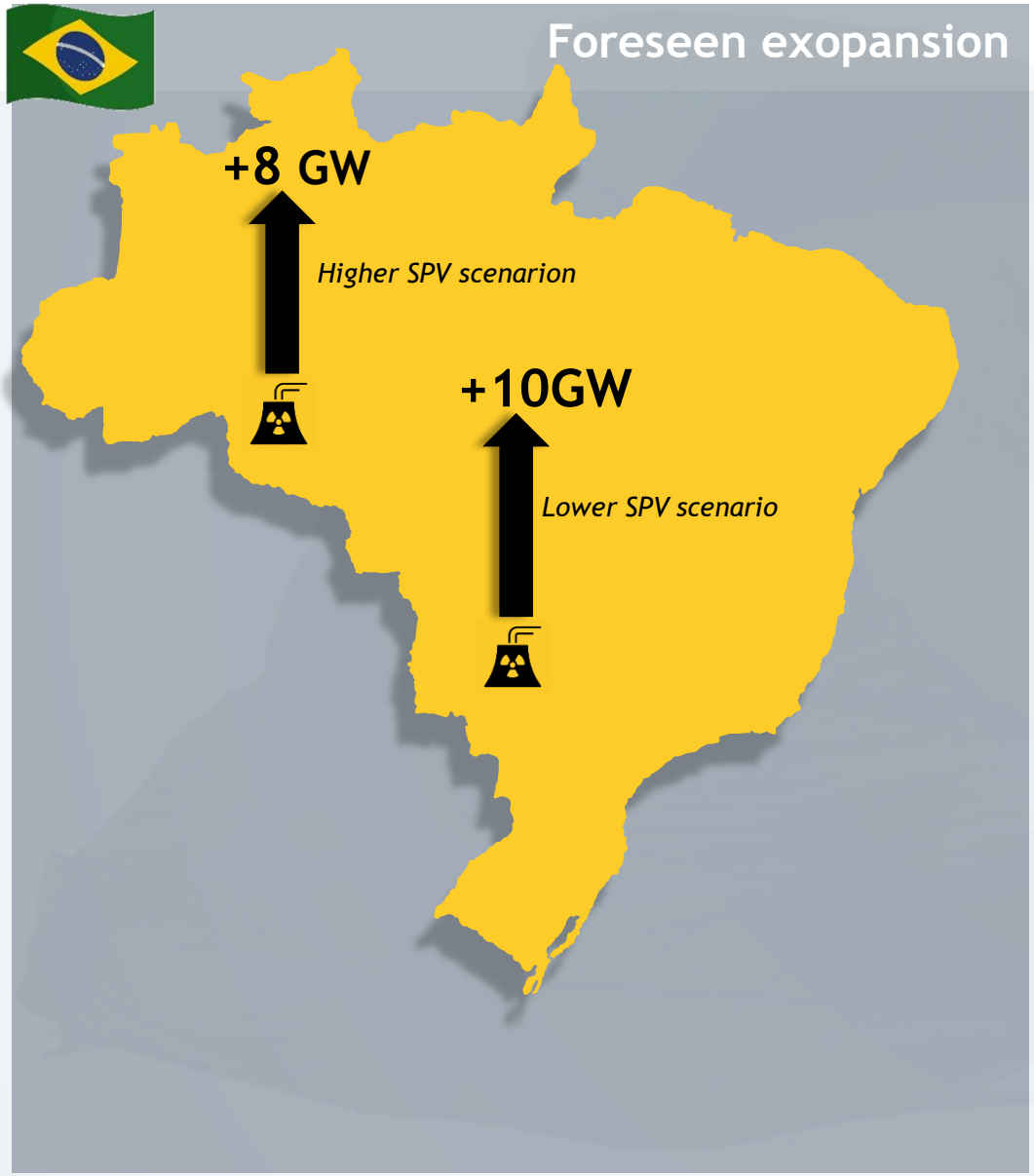
Disruptive Technologies :

Hav epotential of substantially changing the landscape

- Small Modular Reactors (SMRs)
- Nuclear Fusion

Fonte: PNE 2050

Nuclear Energy - Quantitative studies - PNE 2050



Fonte: PNE 2050

Challenges

Communication 1	Effectively communicate the role orf Nuclear Energy
Institutional 2	Promote the update of the Nuclear Infrastructure
Expansion 3	Assess the magnitude of the Nuclear Gerneration Expansion
Safety 4	Ensure the safety of all nuclear installations
Life extension 5	Extend the life of operating reactors
Uranium mining 6	Update and expand the assessment of the nuclear mineral resources in the country

Fonte: PNE 2050

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Roadmap for Nuclear Energy in Brazil

Desafios do PNE 2050		Recomendações no Horizonte do PNE 2050	2020-2030	2030-2040	2040-2050
Communication	1	Enhance communication with society, especially in candidate areas.	●	●	●
Institutional	2	Update the regulatory framework	●		
Expansion	3	Eestablish a planning methodology that takes into account the externalities of NPPs (Nuclear Policy)	●	●	
		Ptroject Statdardization	●		
		R&D and HR development	●	●	●
Safety	4	Sefety of nuclear waste	●	●	●
		Enhance nuclear safety	●		
		Fuel supply safety	●	●	●
Life Extension	5	Apply for Life Extension of operating plants	●	●	
Uranium Mining	6	Resume uranium reserves assessments	●	●	●

Fonte: PNE 2050

MINISTÉRIO DE MINAS E ENERGIA

PÁTRIA AMADA BRASIL GOVERNO FEDERAL

General Characteristics of the New NPPs to be Constructed in Brazil

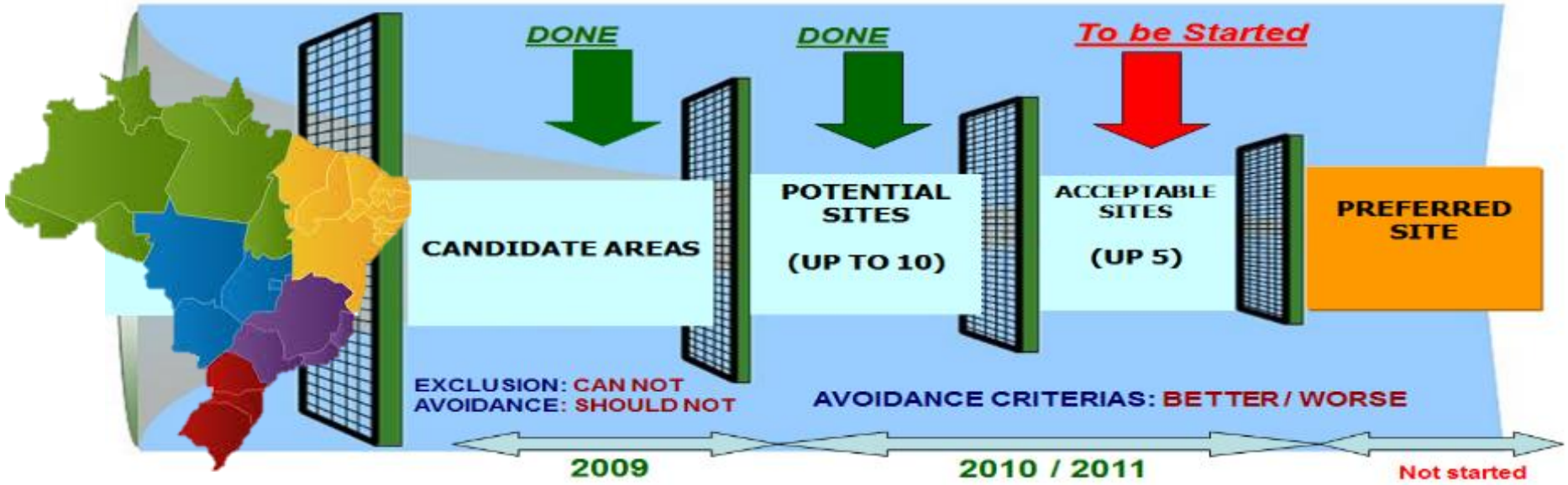
- **Technology**
  - 3rd generation NPP
- **Station Concept**
  - Fleet with 4 to 6 units at the same site
  - Benefits of Economic Scale
- **Power of each Unit** (in evaluation)
  - Two alternatives: ~ 1 GW / > 1 GW
- **Primary Circuit** (technology being evaluated)
  - Acquired in the international market
- **Secondary Circuit**
  - Standardization of the main components
  - Increase of the domestic participation

New NPPS for Brazil

National Inventory of Areas which meet the Exclusion and Avoidance Criteria for Localization of Nuclear Power Station

- **Eletronuclear**
- **EPE** ***(Energy Research Company)***
- **COPPE-UFRJ** ***(Federal University of Rio de Janeiro)***
- **GARTA** ***(Group for Analysis of Environmental Technologic Risk)***

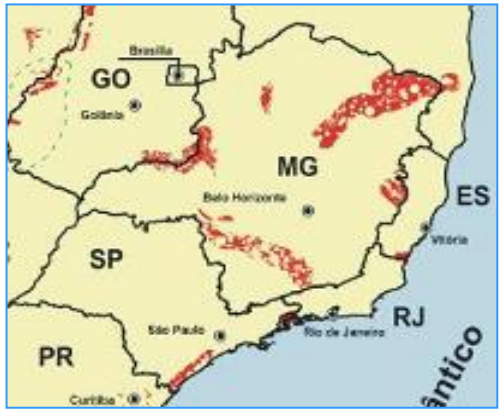
- **EPRI Site Selection Procedure** (Similar to the IAEA Methodology)
  Developed from EPRI Siting Guide: Site Selection and Evaluation Criteria for an Early Site Permit Application (Siting Guide), March 2002



Brazilian Atlas for New Nuclear Power Plants

Potential Sites: 40 Selected Areas / 8 Pre-selected Sites

Northeast



Southeast

Roadmap for New Build in Brazil

	2014	Years 1 e 2	Years 3 e 4	Year 5
Site	Brazilian Atlas for New NPPs	**S i t e** Selection of the Site(s) to be analyzed in detail	**Site Data** Field Survey and Other data	**E S P** **Early Site Permit** Site Environmental and Nuclear Licensing regardless of Technology
Site	**R F I** **Request for Information** Data Request as IAEA and NEI guides Additional Data Detailing Technology Offered	**P P E** Plant Parameter Envelope	**Licenses Applications**	
Tecnology		**Technology Qualification** Data Analysis and Specifications or the Proposed Reactors Requirements set to be met by Technology Provider		**P P A** Power Purchase Agreement
Tecnology	Feasibility Studies	**B U R** Brazilian Utility Requirements	Commercial Model	**B I D**

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As palavras "acredita", "poderá", "pode", "estima", "continua", "antecipa", "pretende", "espera" e similares têm por objetivo identificar **estimativas que necessariamente envolvem riscos e incertezas, conhecidos ou não.**

Riscos e incertezas conhecidos incluem, mas não se limitam a: **condições econômicas, regulatórias, políticas e comerciais** gerais no Brasil e no exterior, **variações nas taxas de juros, inflação e valor do Real, mudanças nos volumes e padrão de uso de energia elétrica** pelo consumidor, **condições competitivas,** nosso nível de **endividamento,** a possibilidade de recebermos **pagamentos relacionados a nossos recebíveis, mudanças nos níveis de chuvas e de água** nos reservatórios usados para operar nossas hidrelétricas, nossos **planos de financiamento e investimento de capital, regulamentações governamentais** existentes e futuras, e outros riscos descritos em nosso relatório anual e outros documentos registrados perante CVM e SEC.

Estimativas e projeções referem-se apenas à data em que foram expressas e não assumimos **nenhuma obrigação de atualizar quaisquer dessas estimativas ou projeções** em razão da ocorrência de nova informação ou eventos futuros. Os resultados futuros das operações e iniciativas das Companhias podem diferir das expectativas atuais e **o investidor não deve se basear exclusivamente nas informações aqui contidas.**

Este material contém **cálculos que podem não refletir resultados precisos devido a arredondamentos realizados.**

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