

INDÚSTRIAS NUCLEARES DO BRASIL – INB

PERSPECTIVES FOR THE NUCLEAR FUEL CYCLE IN BRAZIL



LAS-ANS SYMPOSIUM 2022

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HEAD OF ENGINEERING

INDÚSTRIAS NUCLEARES DO BRASIL - INB

Indústrias Nucleares do Brasil - INB

- **Public Company**
Brazilian Ministry of Mines and Energy - MME
- **Products and Services on the Nuclear Fuel Cycle**
- **State Monopoly / Peaceful use of Nuclear Energy**
according to the Brazilian Federal Constitution



The Nuclear Fuel Cycle



Mining & Processing

→ Ore Extraction and Uranium Concentrate (U_3O_8) Production



Conversion → Conversion of Uranium Concentrate to UF_6



Enrichment → UF_6 Ultracentrifuge Isotopic Concentration



Reconversion → Conversion of UF_6 to UO_2 Powder



Pellets Fabrication

→ Enriched UO_2 Pelletizing



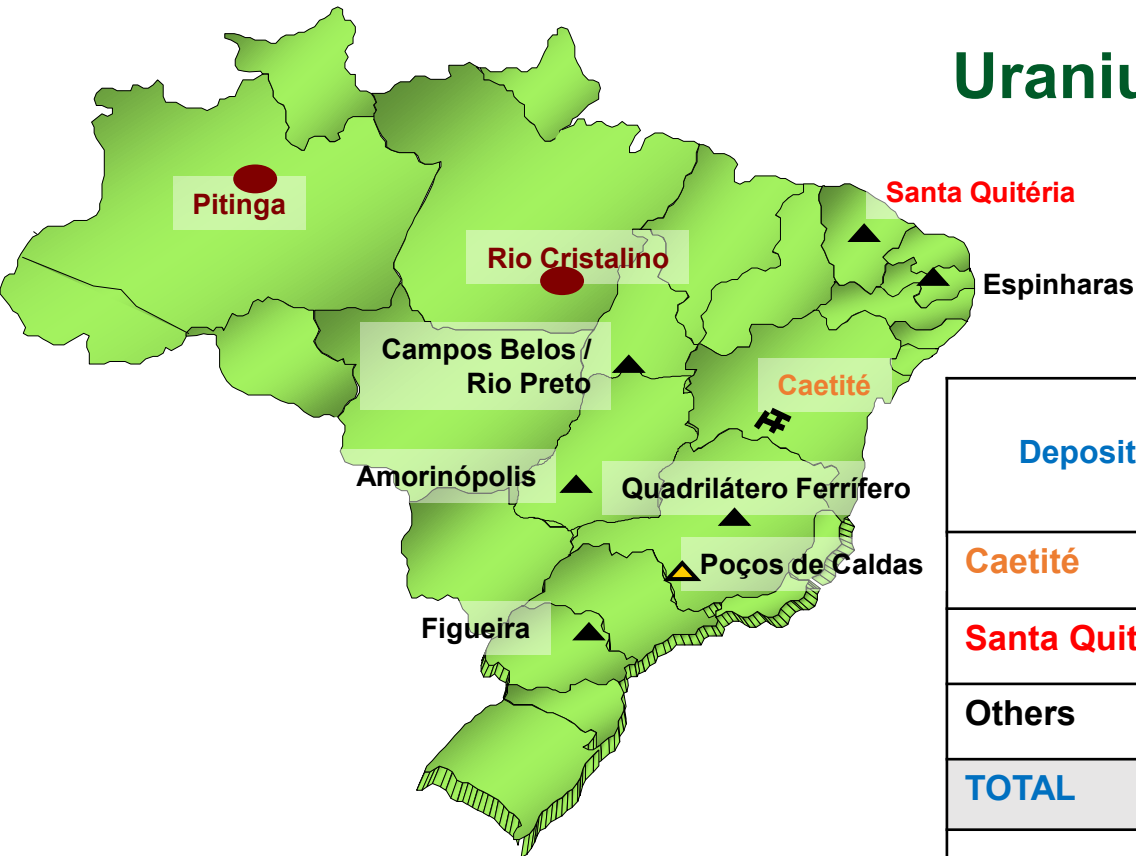
Fuel Assembly

→ Components Manufacturing and Fuel Assembly Fabrication

Uranium Mining & Mineral Processing



Uranium Resources in Brazil



Deposits	Tonnes of U ₃ O ₈ (Uranium Concentrate)		
	Measured & Indicated	Inferred	Total
Caetité	66,672	32,392	99,064
Santa Quitéria	75,010	4,614	79,624
Others	39,500	26,600	66,100
TOTAL	181,182	63,606	244,788 *
Potential:	Pitinga (AM):	+150,000 t U ₃ O ₈	
	Rio Cristalino (PA):	+150,000 t U ₃ O ₈	

* Only about 1/3 of the territory has been prospected.

INB New Mining Projects

■ Uranium concentrate production – Caetité

- Current Mine Engenho Mine (Open Pit)
- Current Capacity 260 - 360 t/y U_3O_8
- Chemical Plant Expansion up to 800 t U_3O_8 /year capacity
- Underground mine project Cachoeira Mine



■ Santa Quiteria Project – Uranium and Phosphate

- Estimated: 2,300 t U_3O_8 /year (2027)
- Ramp-up from 2024

■ Geological exploration for new deposits

- Caetité (BA), Rio Cristalino (PA), Pitinga (AM), others



Santa Quitéria Project, Ceará

Resources:

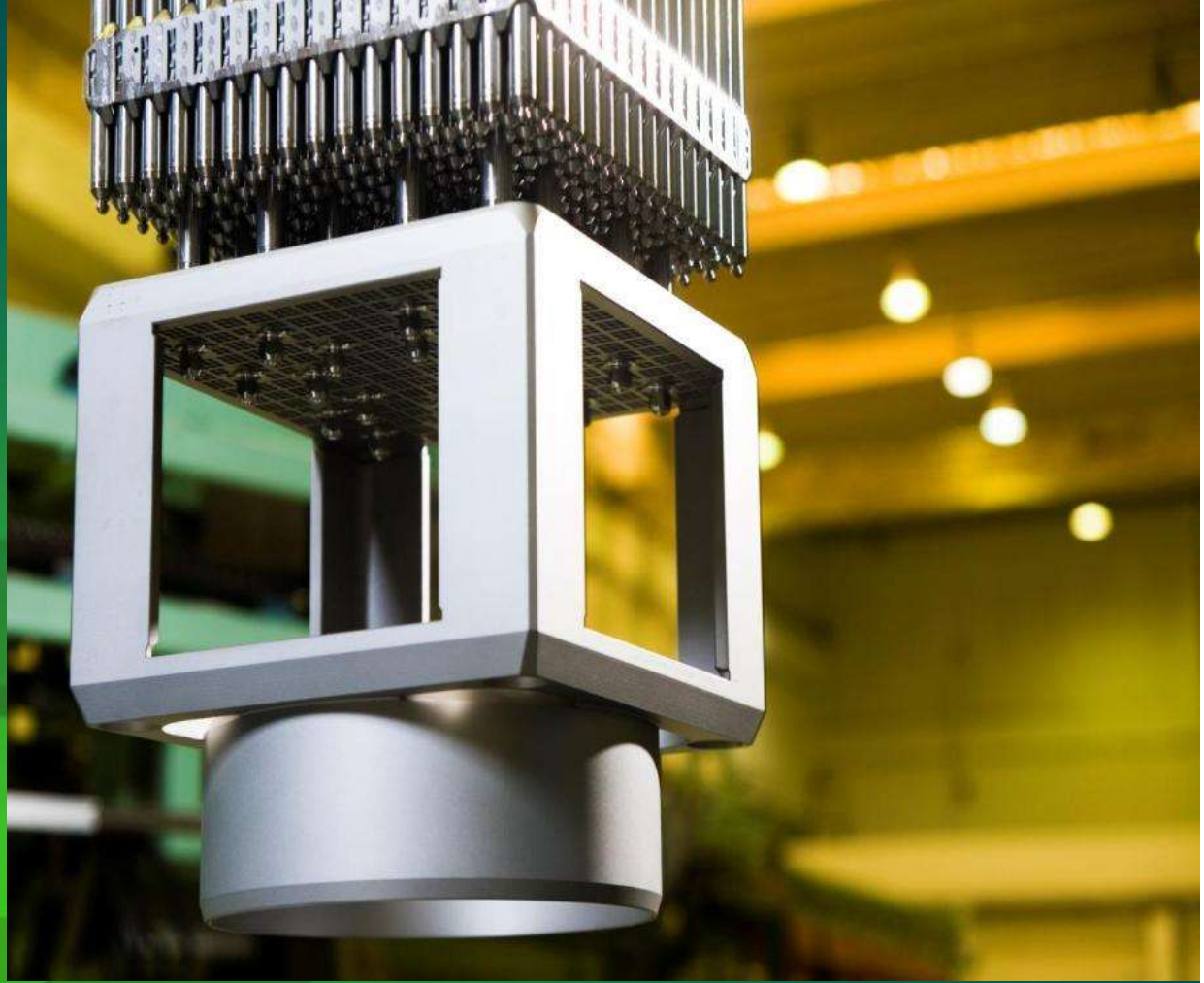
Uranium associated to Phosphate

Santa Quitéria Consortium:



- Environmental Impact Studies: March 2022
- Public Hearings: June 7 - 9, 2022

Nuclear Fuel Fabrication Plant



Nuclear Fuel Fabrication Plant

FCN - Resende, Rio de Janeiro



INB Conversion Projects

- **Commercial** → 5% of total fabrication cycle
- **Today** → conversion services performed abroad
- **International market** → supply and demand gap (~2035)
- **INB and CTMSP (*)** → cooperation on the USEXA conversion pilot plant
- **INB USICON** → conceptual basis for conversion, at the fuel assembly fabrication plant site



(*) CTMSP – Centro Tecnológico da Marinha (Brazilian Navy Technology Center)

INB Conversion & Enrichment Project

- **COMMERCIAL** → 5% of total fabrication cycle
- **TODAY** → conversion services performed abroad
- **INB USICON** → conceptual basis for conversion, at the fuel assembly fabrication plant site





CONTROL ROOM

INB Enrichment Plant Projects

- **Ultracentrifuge Technology**
Developed in Brazil by CTMSP
- **December 2022**
 - First Phase completed → 70 t SWU/year
(70% supply of Angra 1 needs)
 - 10 Cascades in 4 Modules
- **Future ~2037- UCEU (*)**
 - Ultracentrifuge fabrication expansion
 - Second Phase → 500 t SWU/year
(100% Angra 1, 2 and 3 and +)
 - 30+ Cascades in 15 Modules

(*) UCEU – Commercial Uranium Enrichment Plant



UO₂ Powder Production

Capacity: 160 t/y UO₂

UO₂ Pellet Production

Capacity: 120 t/y UO₂

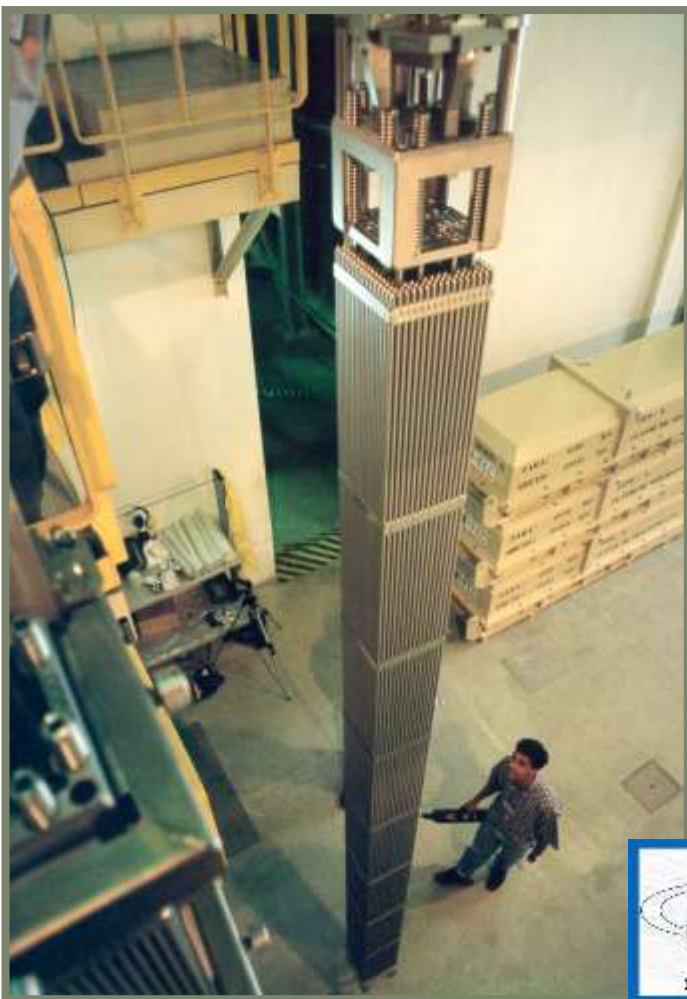
(= Angra 1, 2 and 3 Nuclear Reactors)



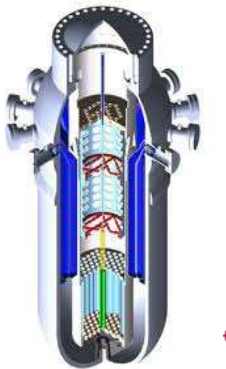
Components & Fuel Assembly

Capacity: 240 t/y UO_2

(= Angra 1, 2 and 3 Nuclear Reactors and +)



Partnerships in Nuclear Fuel Products



CAREM



▪ **UO₂ Export to Argentina**

- Atucha NPP & CAREM SMR
- Total of 8.6 tons UO₂
- 3rd transport in 2020 during Pandemic

▪ **Fuel Assembly Components**

- Westinghouse, Framatome and KNF
- 16NGF Advanced Fuel Design

Reactor floor, Refueling and Engineering Services

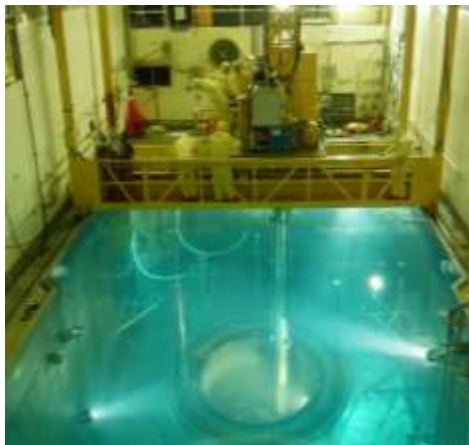
in Brazil and
abroad



Refueling Services in Brazil (Angra 1 and 2)

Since 2009

- Opening and closing reactor vessel, and internal handling
- New and irradiated fuel, and components handling
- Fuel and components visual inspection
- Up to 30 professionals, per outage



Refueling Services in USA

Since 2019

- Opening and closing reactor vessel, and internal handling
- Irradiated fuel and components handling
- Up to 11 professionals, per campaign (Fall/Spring)

Fall 2019

South Texas, TX
Praire Island, MN
Beaver Valley, PA

Spring 2020

South Texas, TX
Vogtle, GA
Beaver Valley, PA
Comanche Peak, TX

Fall 2020

Farley, AL
Comanche Peak, TX

Fall 2021

Praire Island, MN
Comanche Peak, TX
Beaver Valley, PA

Spring 2022

Farley, AL
Comanche Peak, TX



Engineering Services by INB

INB performed about 1,200 hours per year of fuel engineering services related to nuclear plants in USA (see map), Belgium, Czech Republic, Slovenia, South Africa and Taiwan

- Neutronic Design
- Fuel Rod Design
- Thermo-Hydraulic Design



PWR Plants - USA:

- 1 – Palo Verde
- 2 – D. C. Cook
- 3 – Salem
- 4 – Prairie Island
- 5 – Byron
- 6 – Braidwood
- 7 – South Texas
- 8 – Comanche Peak
- 9 – Vogtle
- 10 – V. C. Summer
- 11 – Turkey Point
- 12 – Beaver Valley
- 13 – Farley
- 14 – Diablo Canyon
- 15 – Indian Point
- 16 – Callaway
- 17 – Millstone
- 18 – Ginna
- 19 – Seabrook

PWR Plants – Other Countries:

- 20 – Krsko (Slovenia)
- 21 – Maanshan (Taiwan)
- 22 – Tihange 2 (Belgium)
- 23 – Doel 3 (Belgium)
- 24 – Temelin (Czech Republic)
- 25 – Koeberg (South Africa)

INB Strategic Plan 2017 - 2026 (Revision concluded in 2021)



MAPA ESTRATÉGICO 2017-2026



Missão

Fornecer produtos e serviços associados ao ciclo do combustível nuclear, destinados à geração de energia elétrica, com segurança, qualidade e sustentabilidade.



Visão para 2026

Ser uma empresa reconhecida internacionalmente como fornecedora no mercado de urânio, com excelência na gestão empresarial, em busca da autossuficiência.



Valores Corporativos

Ética
Cultura de segurança
Eficiência
Qualidade
Sustentabilidade
Comprometimento e reconhecimento



CLIENTES E MERCADO

Ampliar as oportunidades de negócios com urânio

Ampliar a venda de componentes e serviços.

Fornecer elemento combustível tecnologicamente atualizado.

Desenvolver parcerias estratégicas, atuando na adequação do marco regulatório onde aplicável

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