Eletronuclear’s Top Five Projects
Eletronuclear Project Nr. 1

Angra 1 and Angra 2 operational safety:
Continuous improvement
Eletronuclear Project Nr. 1

Fator de Capacidade - Comparação EUCG 2017

(*) 184 Usinas comparadas

<table>
<thead>
<tr>
<th></th>
<th>1st Quartile</th>
<th>2nd Quartile</th>
<th>3rd Quartile</th>
<th>4th Quartile</th>
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</thead>
<tbody>
<tr>
<td>Min Plant</td>
<td>96.37</td>
<td>89.08</td>
<td>78.72</td>
<td>17.78</td>
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<tr>
<td>Max Plant</td>
<td>105.83</td>
<td>96.37</td>
<td>89.08</td>
<td>78.72</td>
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<tr>
<td>Average Plant</td>
<td>101.09</td>
<td>92.72</td>
<td>83.9</td>
<td>48.25</td>
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<thead>
<tr>
<th></th>
<th>Fator de Capacidade</th>
<th>Posição no Ranking(*)</th>
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<tbody>
<tr>
<td>ANGRA 1</td>
<td>74.36</td>
<td>150</td>
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<tr>
<td>ANGRA 2</td>
<td>97.48</td>
<td>38</td>
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Eletronuclear Project Nr. 2

Storage Unit for Used Fuel - UAS
Evolution of Generation of ECIs and the Need for Canisters for UAS

Quantidade de ECIs Gerados

8300 ECIs

Quantidade de Cascos

253 cascos
162 cascos
72 cascos
Eletronuclear Project Nr. 2
Eletronuclear Project Nr. 3

Angra 1 Long Term Operation
Angra 1: Integrated Ageing Management Program

AGEING
- Physical

PREPARATORY PHASE
- Pre-condition Assessment

ASSESSMENT PHASE
- RFE Criteria
- SCs Active

Effective Maintenance Monitoring Program (Maintenance Rule)

IMPLEMENTATION PHASE
- MOU - Operating Procedures
- Development of New Programs

Phase 3: IPA
- Integrated Plant Assessment
- Long Lived Passive SCs

Phase 3: IPA
- Scoping
- Screening

TLAA
- Time-Limited Ageing Analysis
- Neutron Fluency
- RPV Integrity Analysis
- Fatigue Analysis
- LBB Application

Legend:
- Concluded
- Being Developed
- Planned

Environmental Qualification Program
Obsolescence Program

Analysis Report
- EQ
- Environmental Qualification of Electrical and I&C Equipment

Eletrobras
Eletronuclear
IAEA: Safety Reports Series No.57 "Safe Long Term Operation of Nuclear Power Plants" provides information on technical aspects and activities to ensure safe operation for Extended Life Period.

USA: Regulation 10 CFR Part 54 "Requirements for Renewal of Operating Licenses for Nuclear Power Plants" defines the rules for the Process of License Renewal of the plants.

75 plants ARE already extended for 20 years / 19 plants are being evaluated
http://www.nrc.gov/reactors/operating/licensing/renewal/applications.html

BRAZIL: CNEN Standard NE-1:04 "Licensing of Nuclear Installations" admits the possibility of renewing the Operation Permit.

ELETRONUCLEAR: Taking into account that the designer of Angra 1 is the North American company Westinghouse, Eletronuclear proposed to CNEN to adopt the requirements of the US regulation as a reference for the Operation License Renewal Process for Angra 1.
Eletronuclear Project Nr. 3

Investment: ~ R$ 1,2 bi

- **1985**: Start Commercial Operation (design 40 years) / AIO: Authorization for Initial Operation
- **1994**: Operation License - 1st APO (Authorization Permanente Operation) for 30 years (until 2024)
- **2004**: First Periodic Safety Review / Procedure for implementing an Ageing Management Program
- **2010**: Operation License - 2nd APO (Authorization Permanente Operation) for 14 years (until 2024)
- **5 to 13 November, 2013**: IAEA Pre-SALTO Peer Review Mission for Angra 1 NPP
- **2014**: Second Periodic Safety Review - 2nd PSR (10 years after First PSR)
- **2019**: Dead Line Operation License Renewal Application (5 years before current License Expiration)
- **2024**: Planned Third Periodic Safety Review / Expiration of Current Operation License
- **2034**: Expected Fourth Periodic Safety Review (10 years after Third PSR)
- **2044**: Planned Expiration of Renewed License

OLR: Operation License Renewal Application
APO Renewal Process (2019 to 2024)
Preparation for APO Renewal (2010 to 2020)
Replacement of Steam Generators (2009): USD 237.7 million (USD/ R$ = 3.0032)

Objective: prevention of stress corrosion of SG tubes

Original design: tubes in Alloy 600

New design: tubes in Alloy 690
Replacement of RPV Closure Head (2013): USD 32.2 million (USD/ R$ = 3.0032)

Objective: prevention of stress corrosion at penetrations

Original design: penetrations and welds in Alloy 600/ 82/ 182

New design: penetrations and welds in Alloy 690/ 52/ 152
Application of MSIP to RPV Nozzles

Objective: Prevention of stress corrosion at RPV nozzles dissimilar welds (2019, planned)

MSIP - Mechanical Stress Improvement Process

Hydraulic tool induces compressive stresses at the inner surface of the nozzle
Eletronuclear Project Nr. 3

Main Transformers replacement
Eletronuclear Project Nr. 4

Resume Angra 3
Obras momentaneamente interrompidas

Edifício da Turbina: U M A
Edifício do Reator
U J B
Edifício de Controle: U B A
Edifício de Alimentação de Emergência: U L B
Edifício Auxiliar do Reator: U K A
Eletronuclear Project Nr. 4

Middle 2015: Construction in Progress
R$ 6.6 bi already invested

Today

- Protection Systems for Civil Structures Already Built.
- Preservation of Components and Materials.
- Studies about the Restarting the Construction.
**Requirements from Eletronuclear: What is needed**

**Technology**
Experience in design, construction, commissioning and operation of PWR NPPs.

**Resources**
Access to resources, including financing.

**Construction**
Capacity in Project and Construction Management.

**Participation**
Gradual Equity Integralization in construction and erection services.
Some Potential Partners

- Tecnologia
- Recursos
- Construção
- Participação

CNCC/SPIC-SNPTC/CGN
- EDF/Framatome
- Kepco
- Rosatom
- MHI
- Westinghouse

Eletrobras Eletronuclear
Eletronuclear Project Nr. 4

Activities Timeschedule

Cronograma de atividades Pré-Obra

- **2º Sem/2019**
  - Market Sounding
  - Publicação do Edital
  - Seleção de Parceiro

- **2º Sem/2020**
  - Assinatura SPA com Parceiro

- **1º Sem/2021**
  - Início de Operação Comercial de Angra 3
  - Mobilização de Equipes e retomada das obras

- **1º Sem/2026**

55 meses
Eletronuclear Project Nr. 4

Resume the Project and Complete the Construction of Angra 3.

2010

32% Avanço Físico
R$ 9,9 Bi

2018

62% Avanço Físico

2026

100% Avanço Físico
R$ 15 Bi
Eletronuclear Project Nr. 4

Resume the Project and Complete the Construction of Angra 3.

Angra 3 Nuclear Power Plant

Computacional Illustration
Eletronuclear Project Nr. 5

Build New NPPs in Brazil.
Eletronuclear Project Nr. 5

Brazilian Atlas for New Nuclear Power Plants

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

Southeast

Northeast

Southeast
Plans for new build in Brazil

Lessons from other countries

Public attitudes
- Government leadership
- Public opinion at the national level
- Local level opinion
- Fukushima
- Building public support
- Trust, understanding of risk, and risk governance
- Community benefit

Business Model
- Market insertion (commercialization)
- Ownership of nuclear power stations
  - State x Private
  - National x Foreigner

Financing new nuclear
- Where will the money come from?
- Barriers to raising finance
- Alternative approaches

Supply chain and skills
- Potential for bottlenecks and delays
- Opportunities for Brazilian businesses
- Skills

PWR Technology Selection
- In operation x construction x design
- FOAK x NOAK
- Passive x Active Safety
Question: What will be the Base Energy for a Clean System?

Alternatives to meet the PNE 2050 Preliminary Projections

- Nuclear Energy
- Meets COP-21 and PNE 2050
- Firm Energy / Operation in Base Load
- Clean Energy / Low Fuel Cost
- Technological Domain of the Uranium Cycle
HYDRO POTENTIAL
TECHNICAL, ENVIRONMENTAL AND ECONOMICALLY FEASIBLE
150/180 GW from 260 GW  (100 GW already used)
Thank you!

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