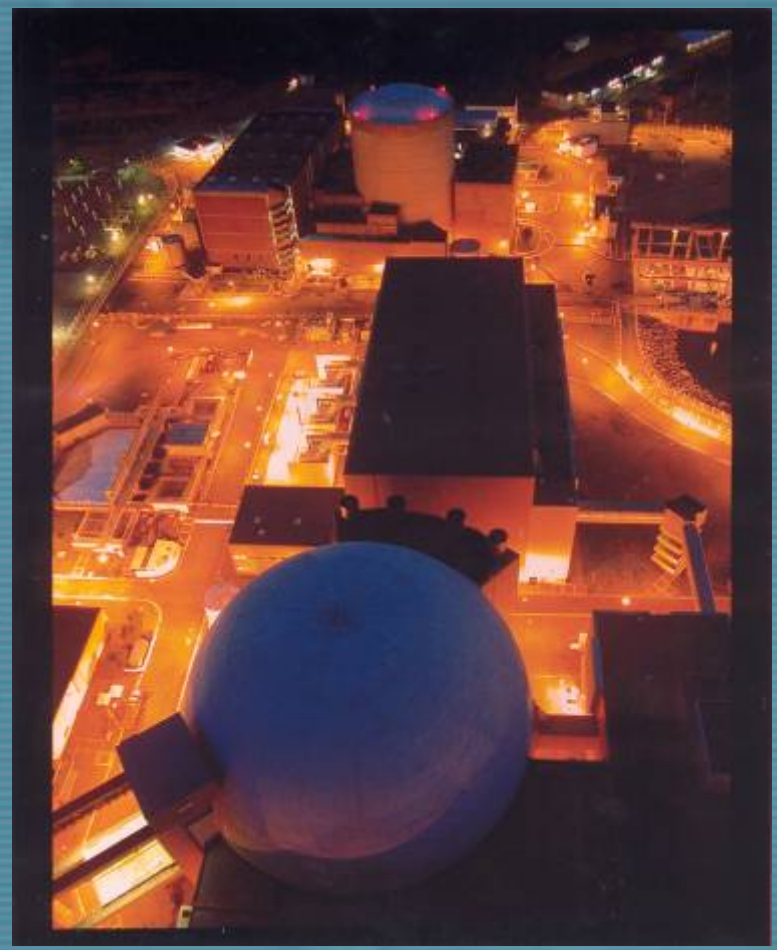
# New Framework for the Utilization of Nuclear Energy in the 21st Century

*Special Event at the*
*50th IAEA General Conference*
19 – 21 September 2006

## *SECTION 2.A*
## *Assurances of Supply*

ELETRONUCLEAR

# Brazilian utility perspective



Vienna, September 20th 2006

Leonam dos Santos Guimarães

# There is a Brazil that many people know

**Amazon forest** **Football** **Carnival** **Coffee**




## It keeps being successful, but there is still more to know

# and another Brazil that you must know

**Innovation, technology, competitiveness and productivity**

# including the Nuclear Brazilian Industry

Mining & Milling | Conversion | Enrichment | UO2 powder | Pellets | Fuel Elements | Generation







**A synergic mix of:**

- **large uranium reserves**
- **fuel cycle technology**
- **PWR technology**
- **Non-proliferation**

**Could give an important contribution to**

***Assurances of supply***

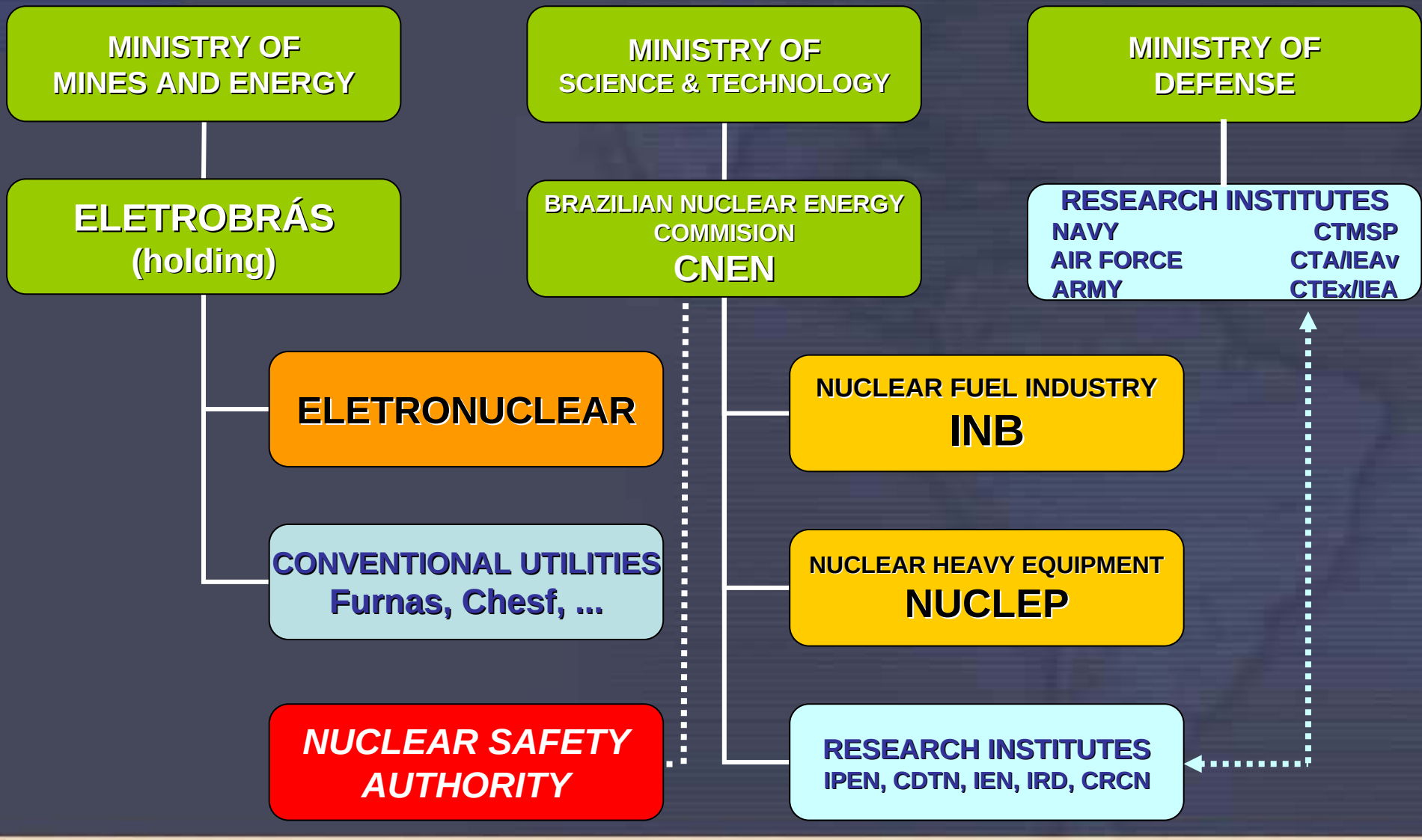
✓**Locally and Globally**

# SUMMARY

1. Nuclear power in Brazilian Electric System
   - Brazilian nuclear industry and ELETRONUCLEAR
   - unique role: complementing hydro power
2. The future of nuclear power in Brazil
   - assuring electric system Renewability & Reliability
3. Brazilian nuclear fuel industry current status
   - fortunate combination of uranium and technology
   - full application of NPT regime: a unique case
4. Assurance of supply and non-proliferation
   - future of Brazilian nuclear fuel industry
   - Brazilian contribution for IAEA policies

# BRAZILIAN NUCLEAR INDUSTRY

## MONOPOLY ESTABLISHED BY CONSTITUTION



# ELETRONUCLEAR MISSION

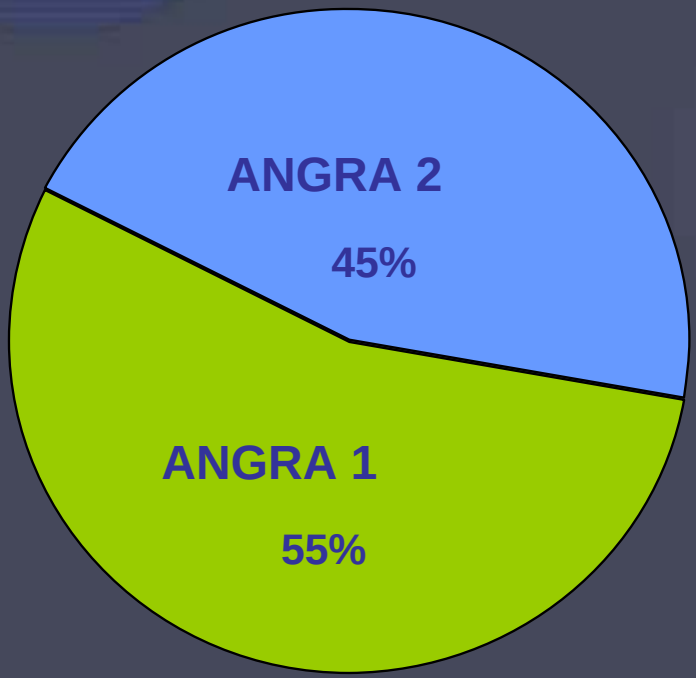
## WORKING ON 3 TIME FRAMES

ELETRONUCLEAR

1. *TODAY : Operation & Maintenance*
   - *Angra 1 (PWR 657 MW)*
   - *Angra 2 (PWR 1350 MW)*
2. *TOMORROW: Engineering, Procurement, Construction & Commissioning*
   - *Angra 3 (PWR 1350 MW)*
3. *FUTURE: Research & Development*
   - *New NPPs (national PWR concept)*

# 100 MILLION MWH GENERATED

## MILESTONE REACHED ON FEBRUARY 2006




*1997-2005*

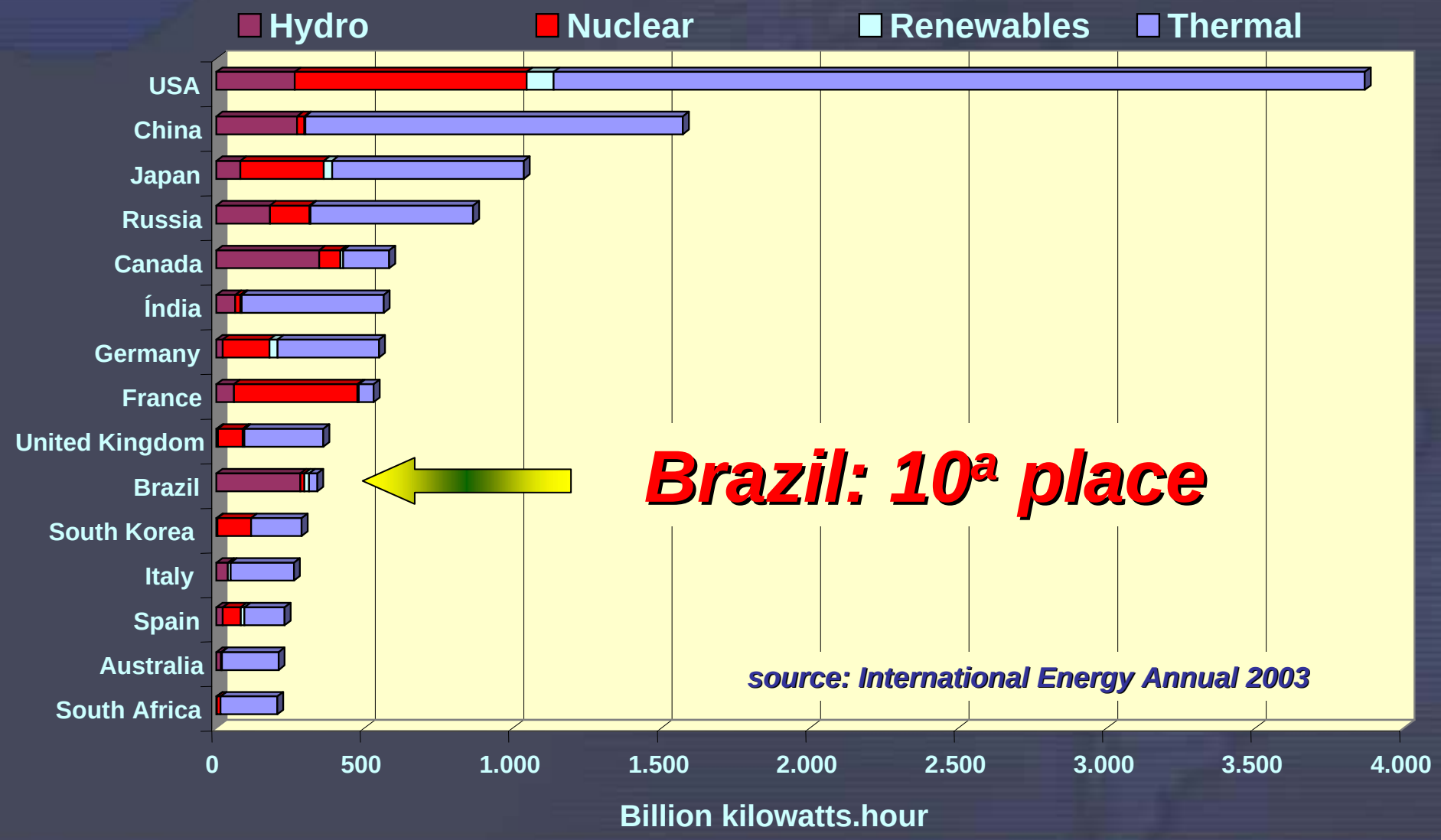
*Availability factors:*

*Angra 1: 82,44%*

*Angra 2: 82,97%*

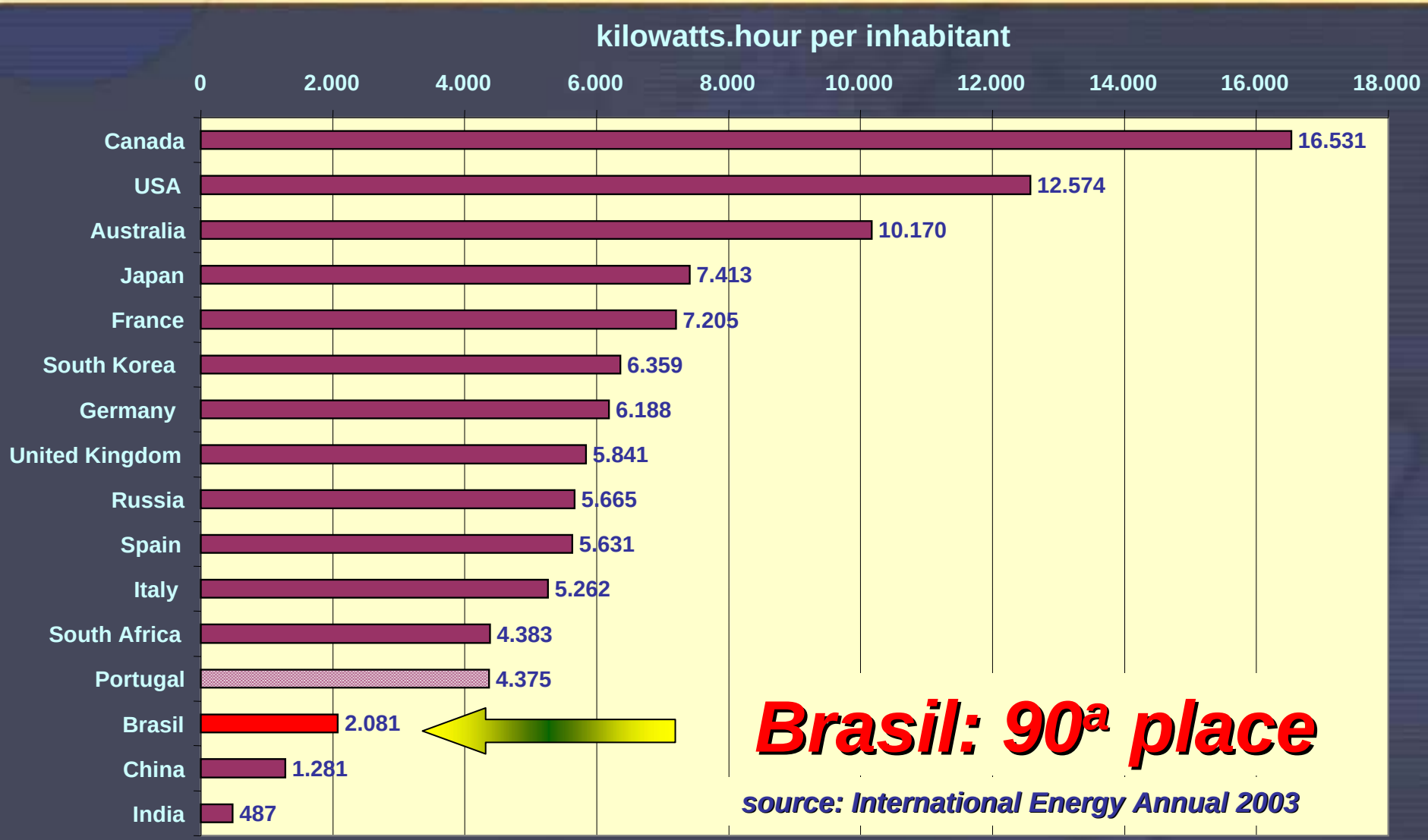
# TOP 15 WORLD ELECTRIC GENERATORS

## BRAZIL IS ONE OF THE MAIN WORLD ELECTRICITY PRODUCERS



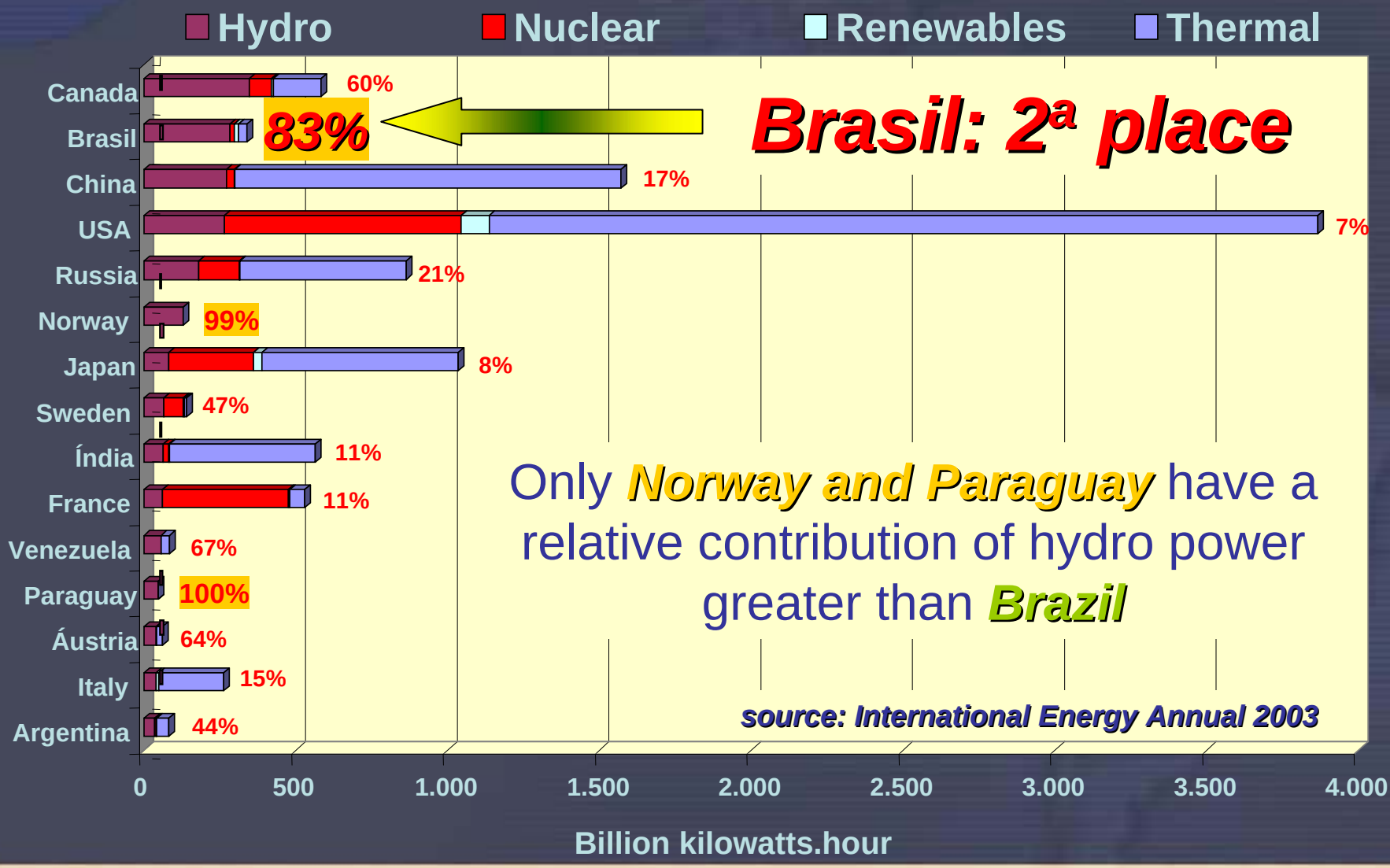
# TOP 15 WORLD ELECTRIC GENERATORS

## but its consumption per inhabitant is very low



# TOP 15 WORLD HYDRO GENERATORS

## *GREATEST CONTRIBUTION OF HYDRO POWER*




**Brasil: 2ª place**

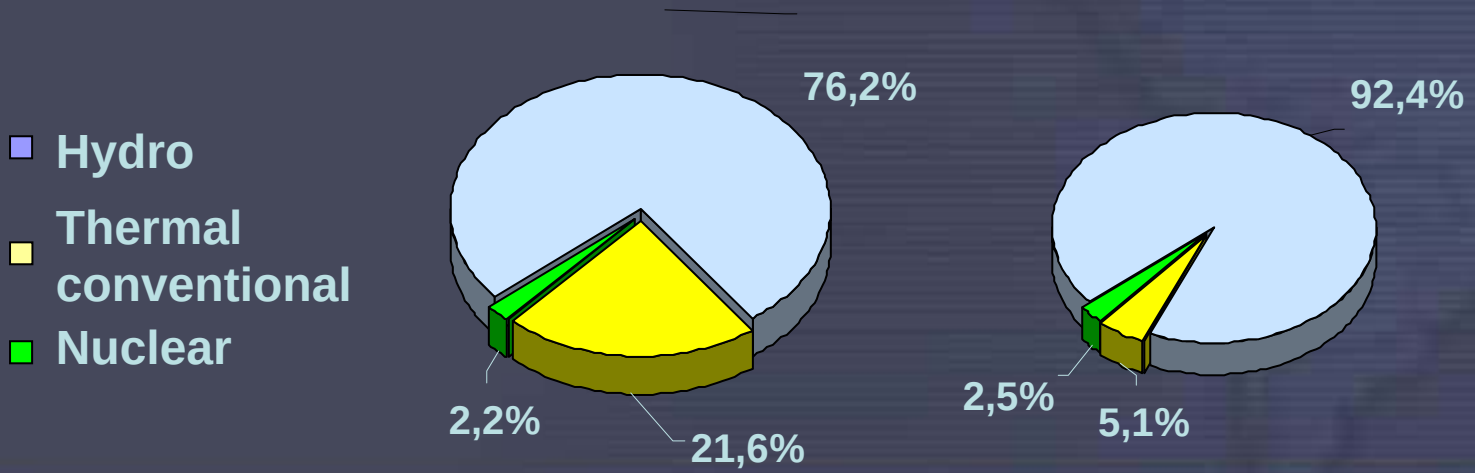
Only ***Norway and Paraguay*** have a relative contribution of hydro power greater than ***Brazil***

***source: International Energy Annual 2003***

# ELECTRICITY GENERATION IN BRAZIL

## *an unique renewable matrix*

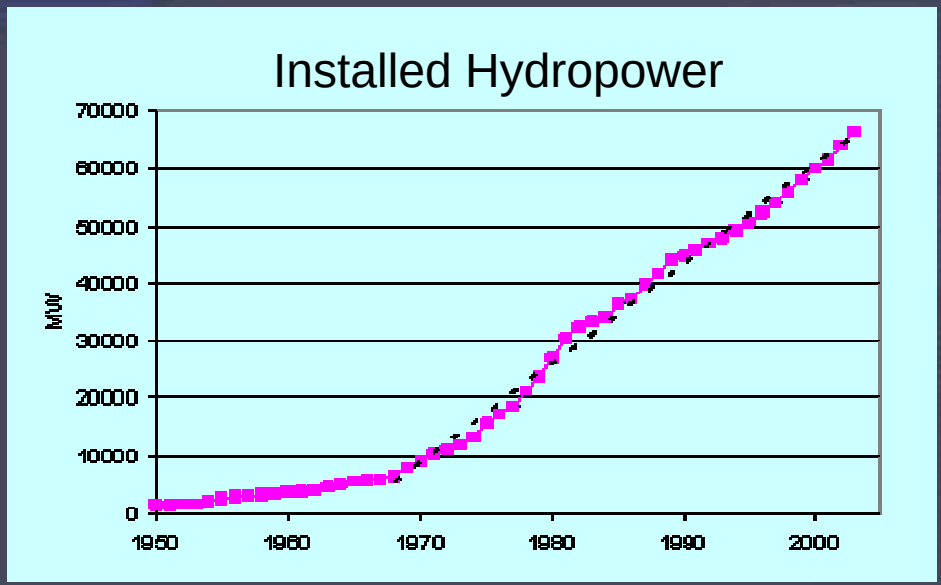
| Source | Installed capacity (DEC/2005) | | Generation (2005) | |
|---|---|---|---|---|
| | MW | % | MWavg | % |
| Hydro | 69.631 | 76,2 | 42.272 | 92,4 |
| Thermal conventional | 19.778 | 21,6 | 2.329 | 5,1 |
| Nuclear | 2.007 | 2,2 | 1.125 | 2,5 |
| Total | 91.416 | 100,0 | 45.726 | 100,0 |



# HYDROPOWER REQUIRES SYSTEM INTEGRATION

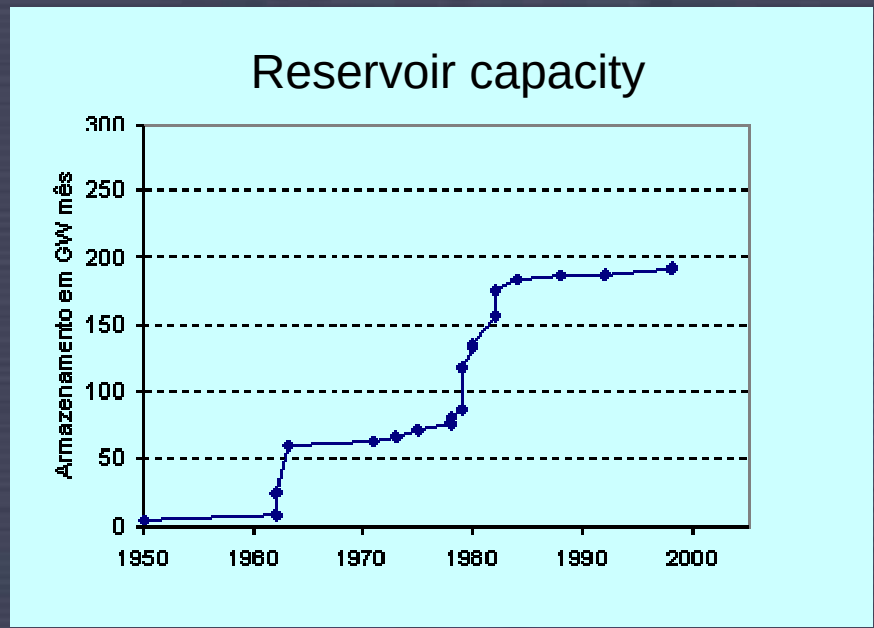
## HAVING CONTINENTAL DIMENSIONS EQUIVALENT TO EUROPE

# ELECTRIC SYSTEM EVOLUTION IN THE 90´s
## NEED FOR THERMAL REGULATION

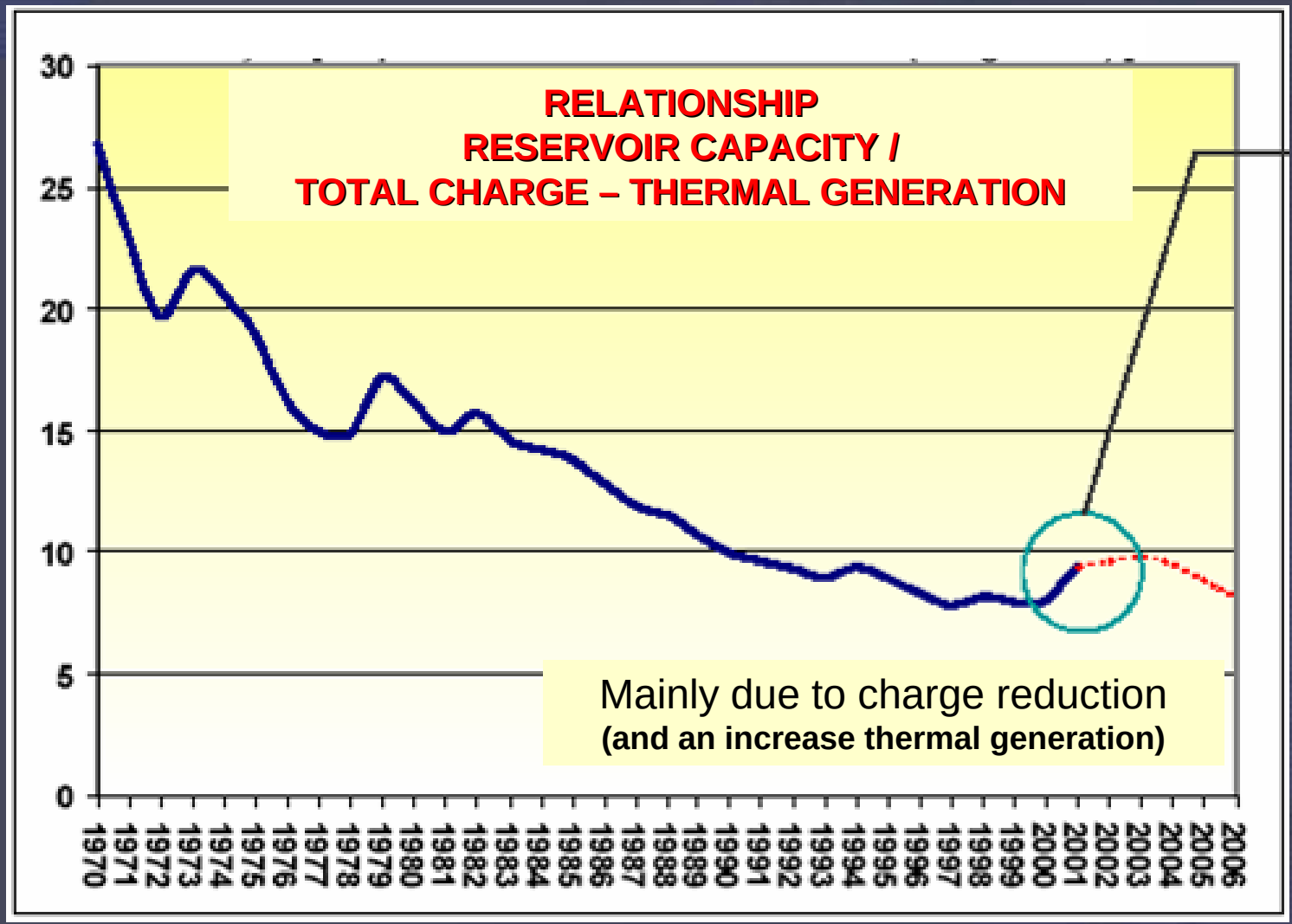



*installed hydro capacity increasing …*

*… but without a proportional increase in the water stock*



# ELECTRIC SYSTEM EVOLUTION IN THE 90´s
## NEED FOR THERMAL REGULATION




**2001**

**SUPPLY CRISE**

# ELECTRIC SYSTEM EVOLUTION IN THE 90´s
## NEED FOR THERMAL REGULATION


***This tendency will be amplificated by new projects in Amazon Bassin***


- Current average hydro capacity factor: **55%**
- Future average Amazon hydro capacity factor: **20-25%**

**Project AHE MADEIRA 6.500 MW**

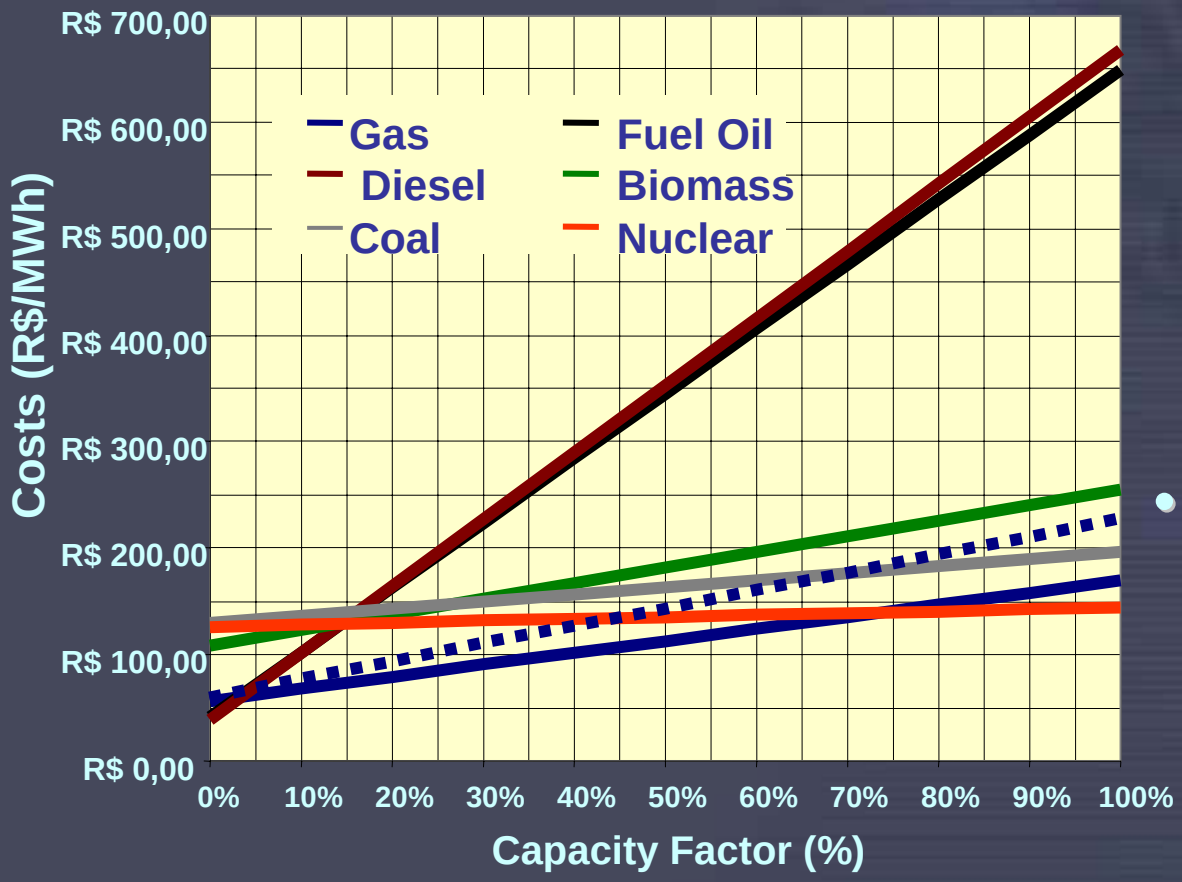
**Project AHE BELO MONTE 11.000 MW**

# BRAZILIAN THERMAL OPTIONS

**The main thermal fuels available in the country**

1. ***Coal***
2. ***Biomass***
3. ***Natural Gas***
4. ***Crude Oil***
5. ***Uranium***

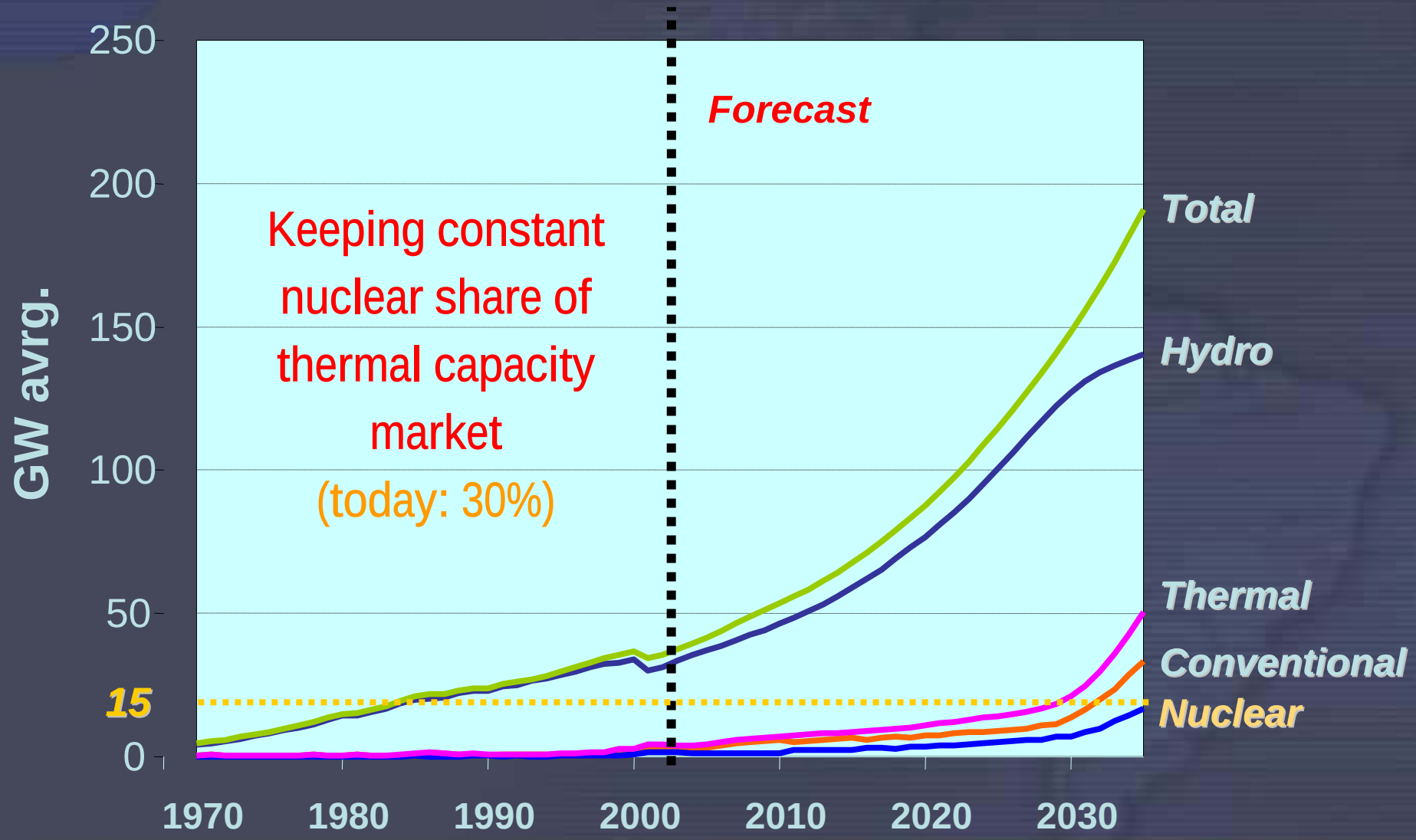
# ELECTRIC SYSTEM EVOLUTION IN THE 90´s
## NEED FOR THERMAL REGULATION




- There will be a place for all thermal options
  - Minimum cost according capacity factor range
- But costs are not the only decision factor:
  - ❑ *Price volatility*
  - ❑ *Assurance of supply*

**must be considered too**

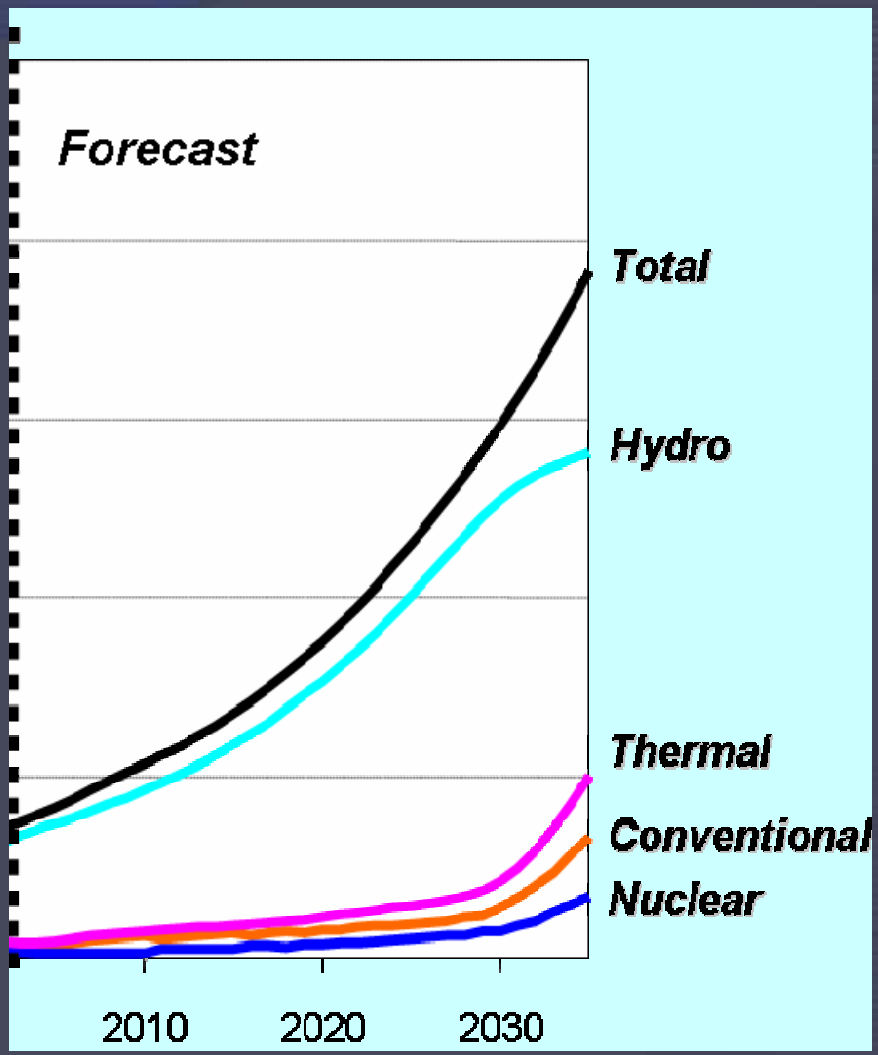
# ELECTRIC SYSTEM EVOLUTION IN THE 90´s
## NEED FOR THERMAL REGULATION



# NEXT STEP: ANGRA 3

## TO BE CONNECTED TO THE GRID IN 2013

# BEYOND ANGRA 3

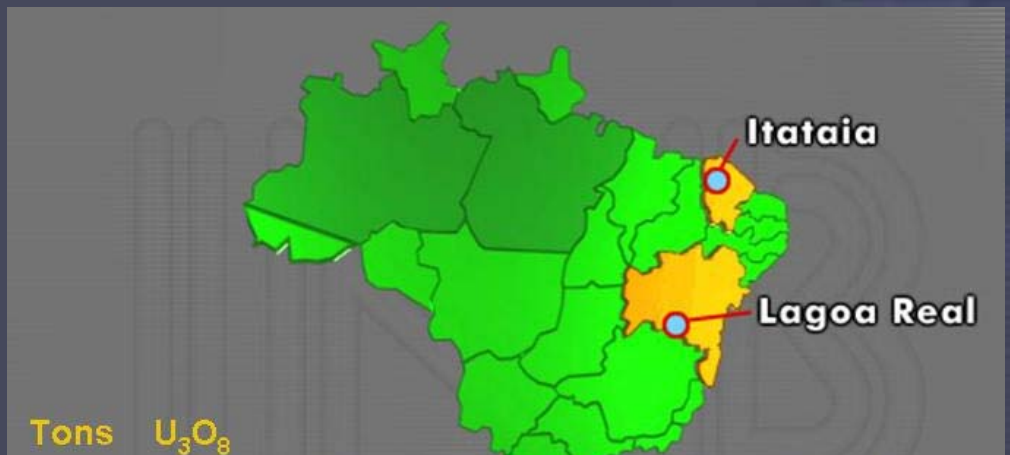



2006
2.000 MW INSTALLED

**2035**
**15.000 MW INSTALLED**

**13.000 MW IN 30 YEARS**

# BRAZILIAN URANIUM RESOURCES
## ONE OF THE MAIN RESERVES IN THE WORLD




Tons $U_3O_8$

| DEPOSITS | Measured and Indicated | Inferred | TOTAL |
|---|---|---|---|
| LAGOA REAL (BA) | 94,000 | 6,700 | 100,770 |
| ITATAIA (CE) | 91,200 | 51,300 | 142,500 |
| OTHERS | 39,500 | 26,600 | 66,100 |
| TOTAL | 224,700 | 84,670 | 309,370 |

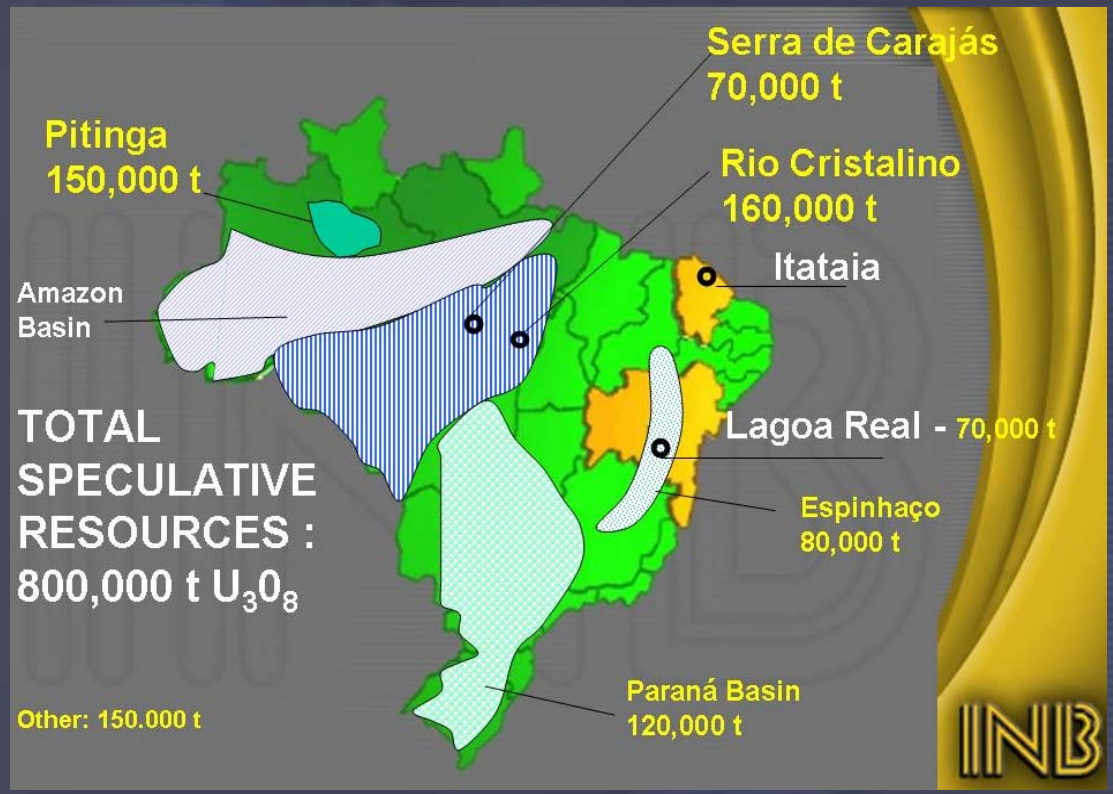
**Prospected area:**

***only 30% of national territory* up to 100 meters deep**

***6th. WORLD RESERVE***

# BRAZILIAN URANIUM RESOURCES
## ONE OF THE MAIN RESERVES IN THE WORLD

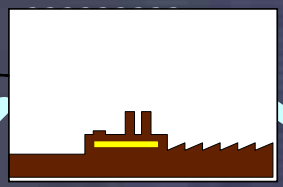
**After prospected all the national territory, probably *Brazil should be among the 3 MAJOR WORLD RESERVES***



# NUCLEAR FUEL INDUSTRY IN BRAZIL
## URANIUM + TECHNOLOGICAL CAPABILITIES

USEXA - NAVY
(CONSTRUCTION)

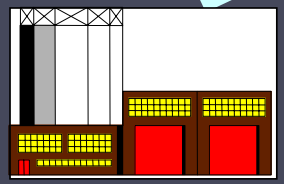
INB



*CONVERSION*
*(PROJECT)*

LEI and USIDE - NAVY
(OPERATION)

INB



*URANIUM MINNING*
*AND MILLING*

*LAGOA REAL*
*(OPERATION)*

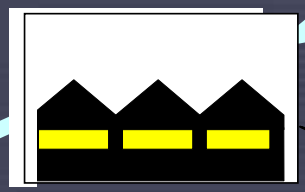
***One of the few countries having both:***

1. ***large uranium reserves***
2. ***full technological capability for local fuel production***

INB

*ENRICHMENT*
*RESENDE*
*(CONSTRUCTION)*

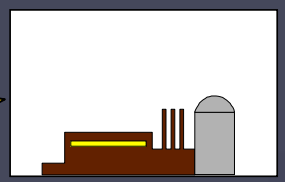
INB



*FUEL FABRICATION*
*RESENDE*

*(OPERATION)*

ELETRONUCLEAR



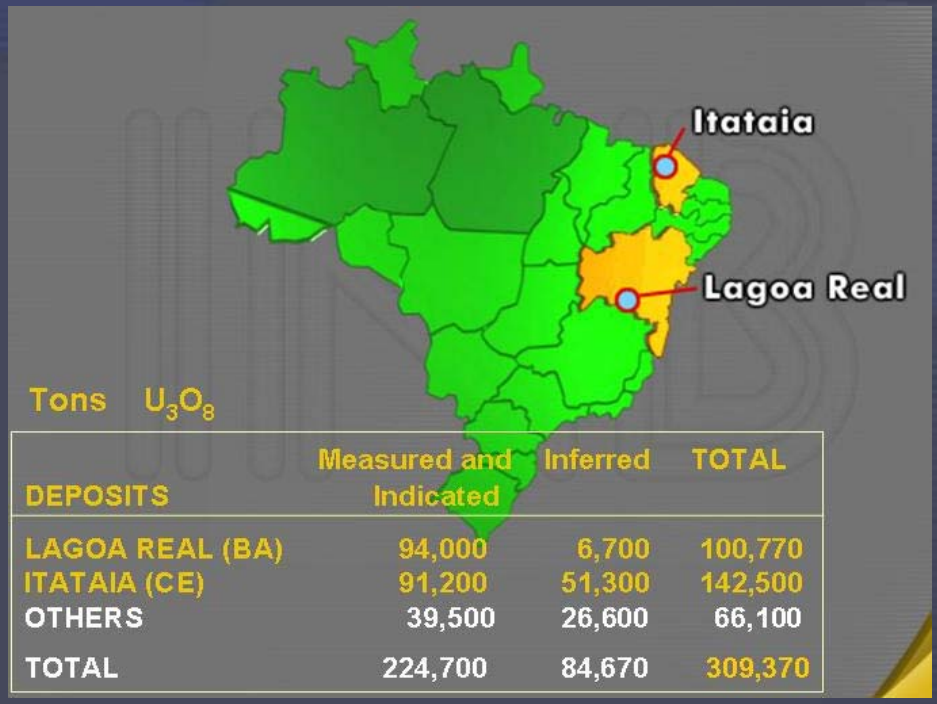
*ANGRA 1/2/3*
*PWR*

LABGENE
NAVY
(CONSTRUCTION)

LABMAT and LADICON -
NAVY
(OPERATION)

# NUCLEAR FUEL INDUSTRY IN BRAZIL

## MEDIUM TERM VISION




Tons $U_3O_8$

| DEPOSITS | Measured and Indicated | Inferred | TOTAL |
|---|---|---|---|
| LAGOA REAL (BA) | 94,000 | 6,700 | 100,770 |
| ITATAIA (CE) | 91,200 | 51,300 | 142,500 |
| OTHERS | 39,500 | 26,600 | 66,100 |
| TOTAL | 224,700 | 84,670 | 309,370 |

- ***Lagoa Real*** **mine assures supply for Angra NPPs and at least 3 new ones**
- ***Itataia*** **mine (phosphate and uranium production) should be developed *for international markets***

# NUCLEAR FUEL INDUSTRY IN BRAZIL

## MEDIUM TERM VISION

The profits obtained through Itataia should be invested in industrial development:

1. Prospecting
2. Conversion
3. Enrichment

Aiming to achieve

1. auto-sufficiency
2. added value exports

USEXA

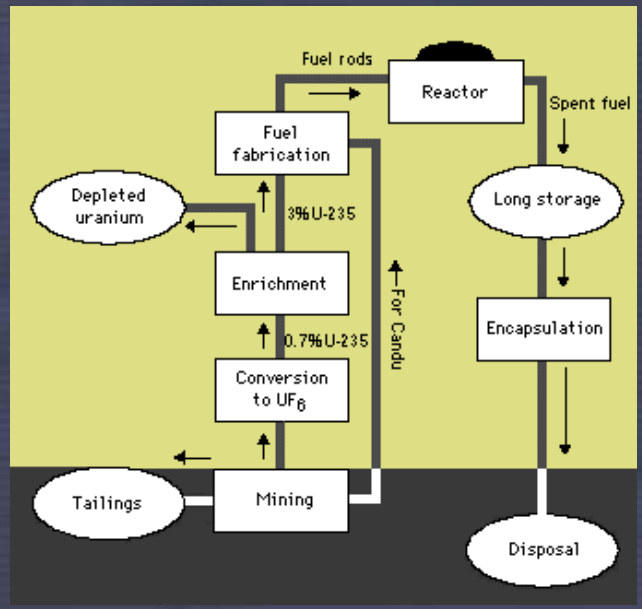
RESENDE Enrichment facility

# NUCLEAR FUEL INDUSTRY IN BRAZIL

## LONG TERM VISION

### Continental integration

1. Mercosur
2. South America
3. Latin America

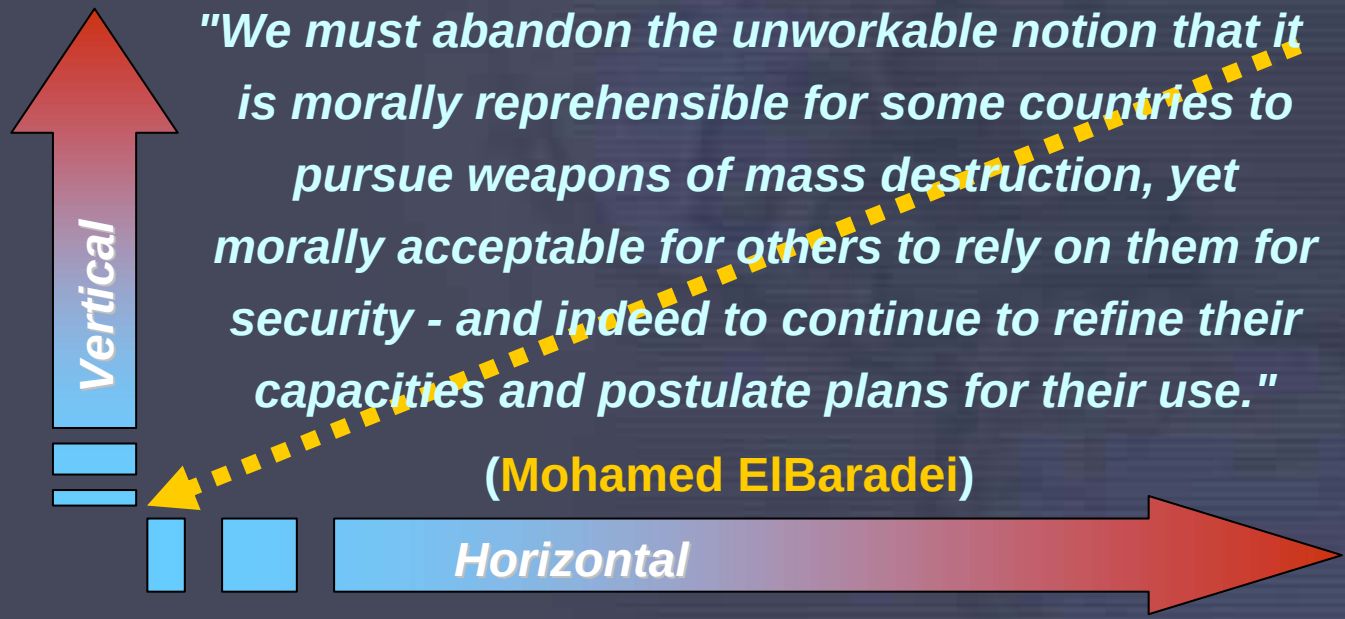




### Assuring regional supply

1. Uranium supplier
2. Integral nuclear fuel services supplier (open cycle)

**FULL SCOPE SAFEGUARDS**

# NON PROLIFERATION IN BRAZIL
## UNIQUE SUCCESS EXPERIENCE

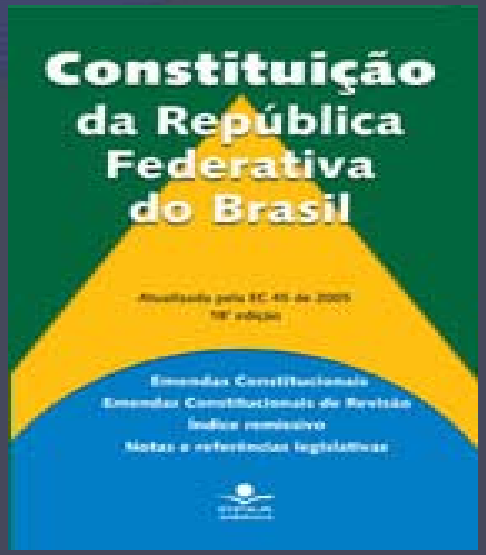



*"We must abandon the unworkable notion that it is morally reprehensible for some countries to pursue weapons of mass destruction, yet morally acceptable for others to rely on them for security - and indeed to continue to refine their capacities and postulate plans for their use."*

**(Mohamed ElBaradei)**

- ***Over and above this paradox, Brazil is making an irreprehensible "homework" in non proliferation issues***

# NON PROLIFERATION IN BRAZIL
## UNIQUE SUCCESS EXPERIENCE




- ***Brazilian Constitution proscribe all non-pacific uses of nuclear energy***
  - ***Member of NPT***
  - ***Member of Tlatelolco Treaty***

- **All nuclear installations fully safeguarded**
  - **Multilateral agreements (1990 + 1994) (Brazil – Argentina – ABACC) + IAEA**
    - *ABACC – bilateral regional agency*
  - **IAEA full escope (NPT - 1997)**

***A remarkable record of more than 25 years without technical deviations or suspicious events***

# NON PROLIFERATION IN BRAZIL
## UNIQUE SUCCESS EXPERIENCE


- ✓ As Japan, Germany and Holland, has 2+1 enrichment plants fully safeguarded
- ✓ Brazilian centrifuge program was never suspected being “proliferant” neither part of any international “black-marketing”
- ✓ Has produced 20% batches for research reactor fuel under full scope safeguards

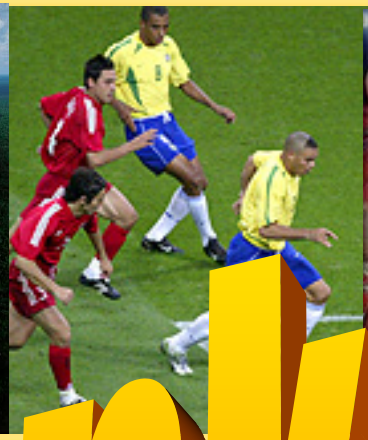

# CONCLUDING REMARKS
## "PEPPERING" THE DISCUSSION

1. Any solution envisaging to limit access of some countries to technology will mean assuming the "bankruptcy" of international non-proliferation regime
   - Unfortunately: in technical grounds, it can work very well
     - Brazilian example shows it clearly

# CONCLUDING REMARKS
## TRYING TO ANSWER THE "DISCUSSION PAPER"

2. **Having large uranium reserves, technology and fully safeguarded industrial facilities for all open fuel cycle steps**
   - **Brazil could play an important role in future IAEA assurance of supply mechanisms**
   - ***as a regional production center***

Amazon forest Football Carnival Coffee

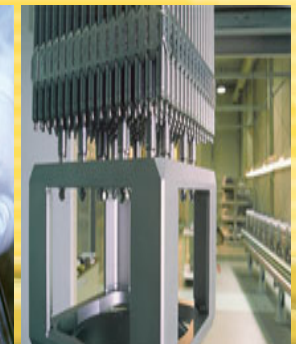



Inno te pet t y



Mini chment UO2 powder Pellets Fuel Elements Generation






# Thank you!