O Futuro do TNP

Seminário Internacional

Não Proliferação Nuclear e Desarmamento

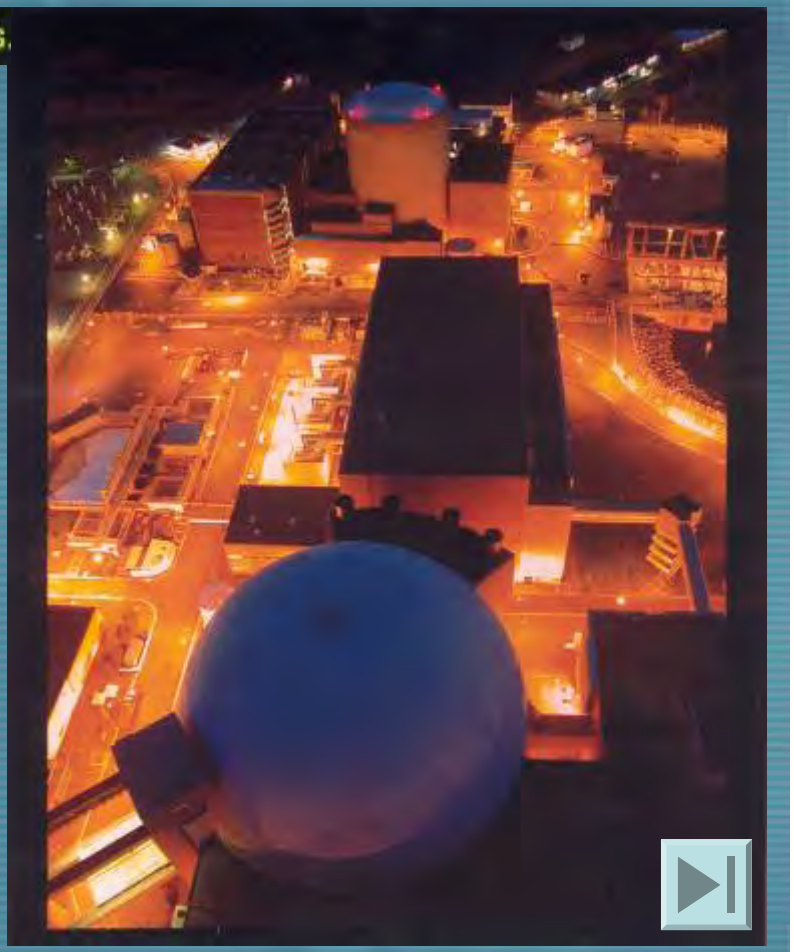
Rio de Janeiro
29 e 30 de outubro de 2009

Painel 4: Impactos de Iniciativas de Não-Proliferação envolvendo Materiais Físseis.

Assurances of Supply

ELETRONUCLEAR

Brazilian utility perspective



Rio de Janeiro, October 30th 2009

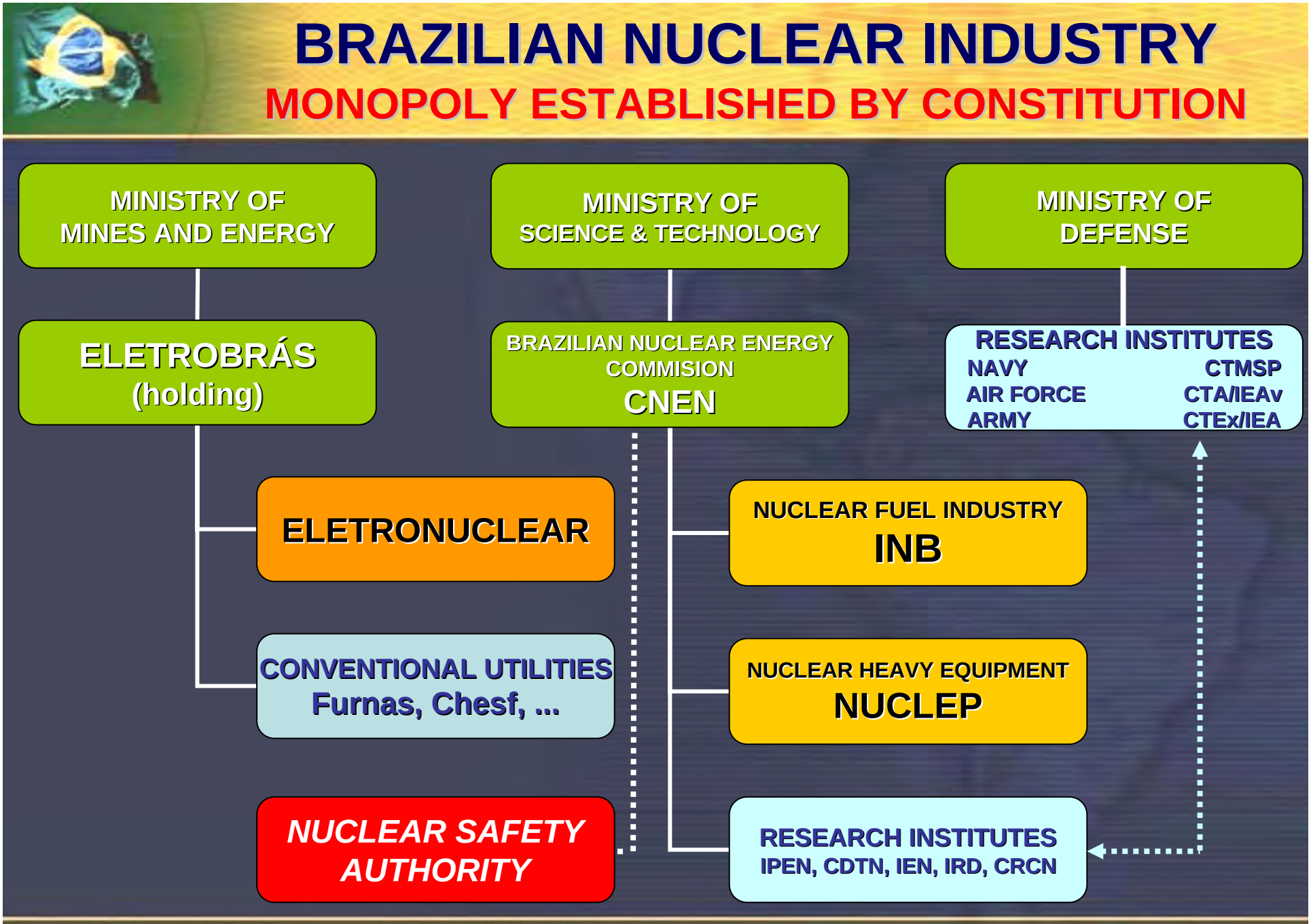
Leonam dos Santos Guimarães

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

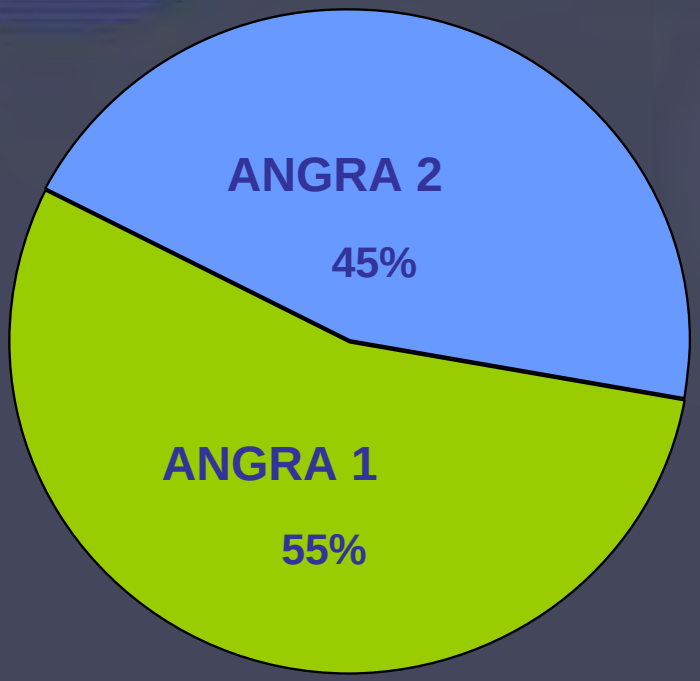
1. *TODAY : Operation & Maintenance*
   - *Angra 1 :1985 (Westinghouse PWR 657 MW)*
   - *Angra 2: 2001 (Siemens-KWU PWR 1350 MW)*

2. *TOMORROW: Engineering, Procurement, Construction & Commissioning*
   - *Angra 3: 2015 (AREVA NP PWR 1405 MW)*

3. *FUTURE: Research & Development*
   - *4 to 8 New NPP: 2015-2030 (national configuration PWR concept)*

100 MILLION MWH GENERATED

MILESTONE REACHED ON FEBRUARY 2006



1997-2008

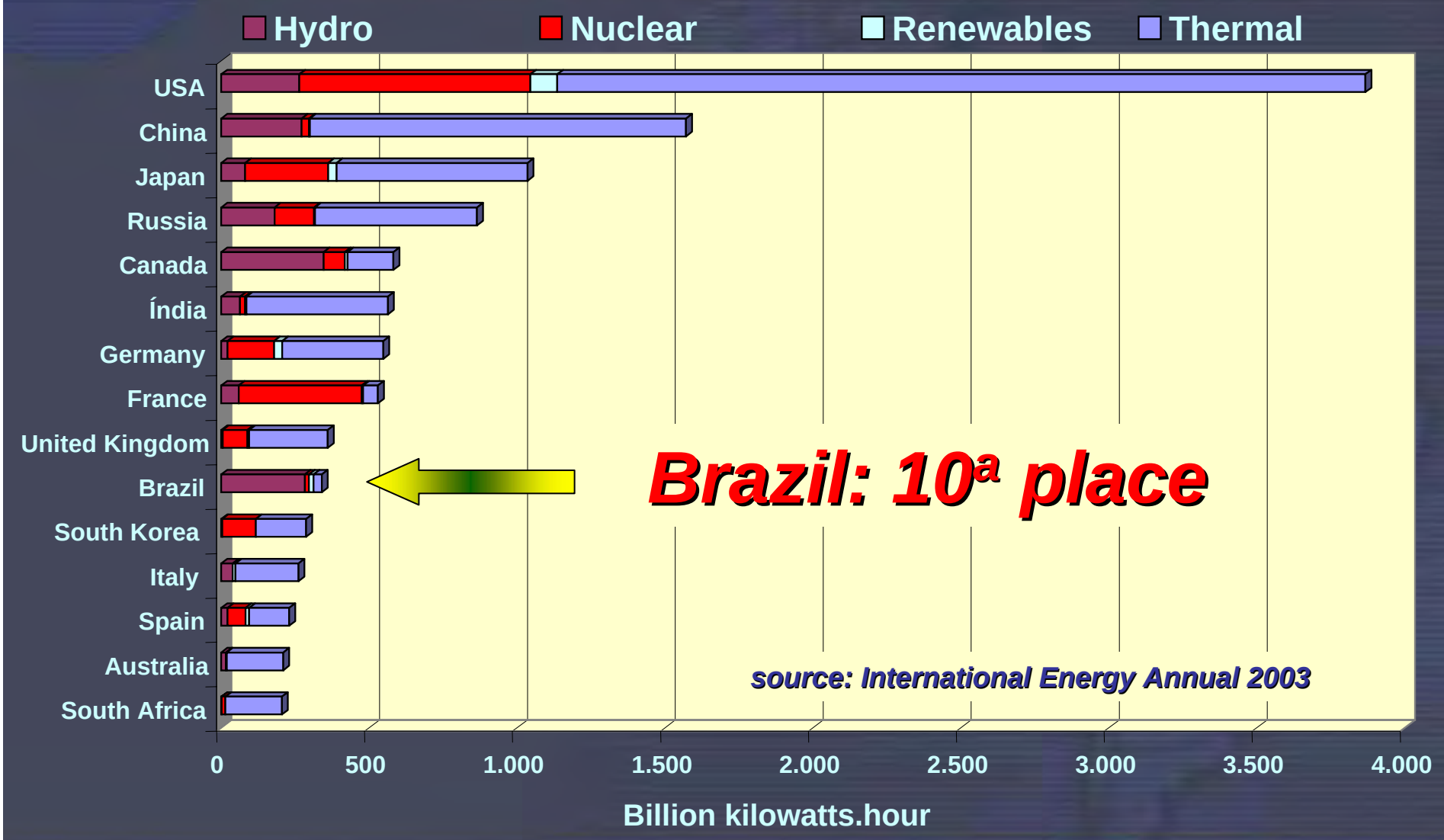
Availability factors:

Angra 1: 82,44%

Angra 2: 82,97%

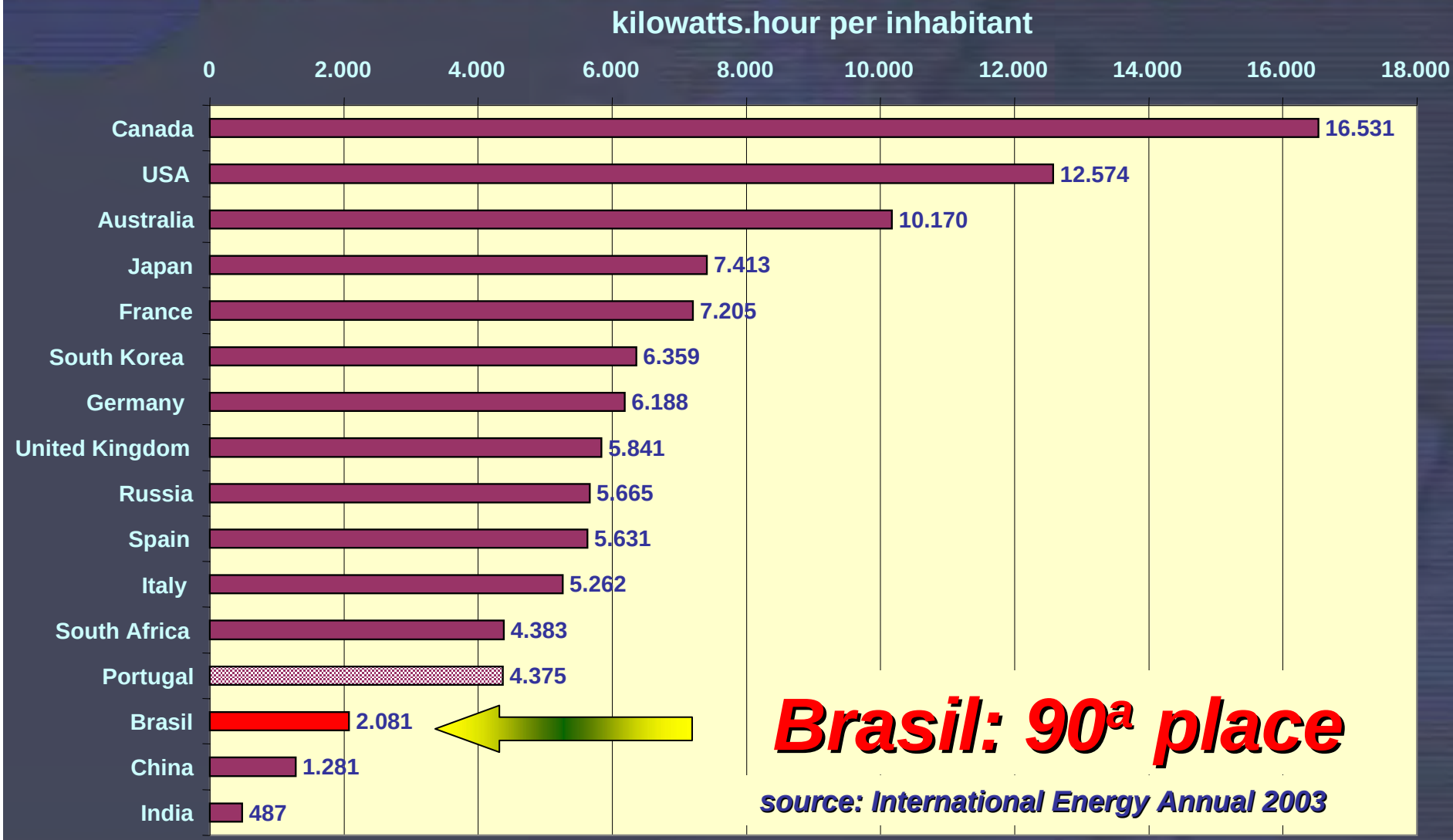
TOP 15 WORLD ELECTRIC GENERATORS

BRAZIL IS ONE OF THE MAIN WORLD ELECTRICITY PRODUCERS



TOP 15 WORLD ELECTRIC GENERATORS

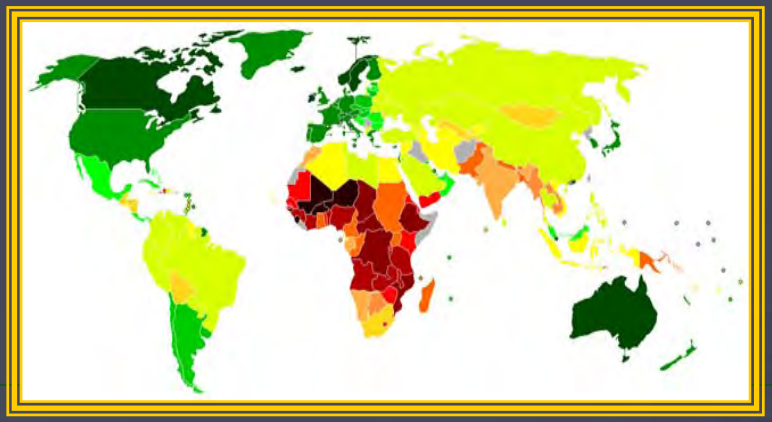
but its consumption per inhabitant is very low

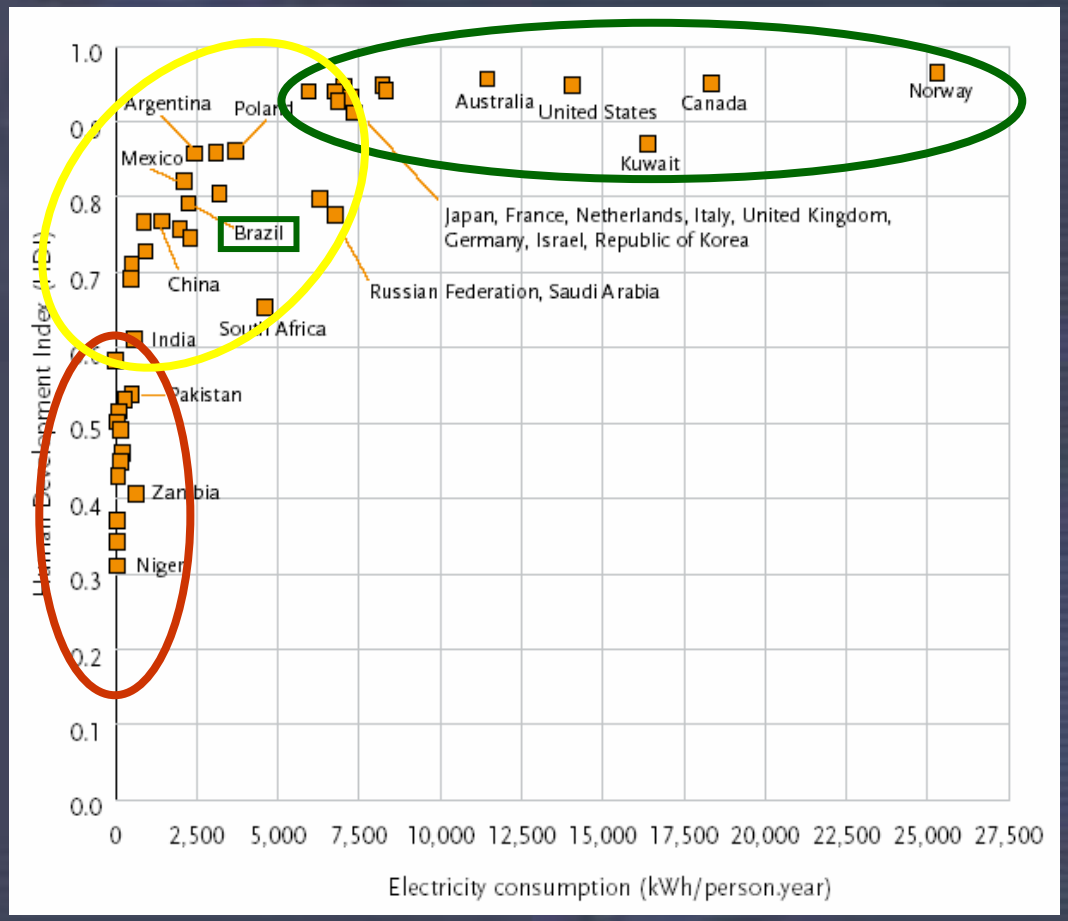


HDI X ELECTRICITY CONSUMPTION

BRAZIL: 90th place

BRAZIL: 69th place

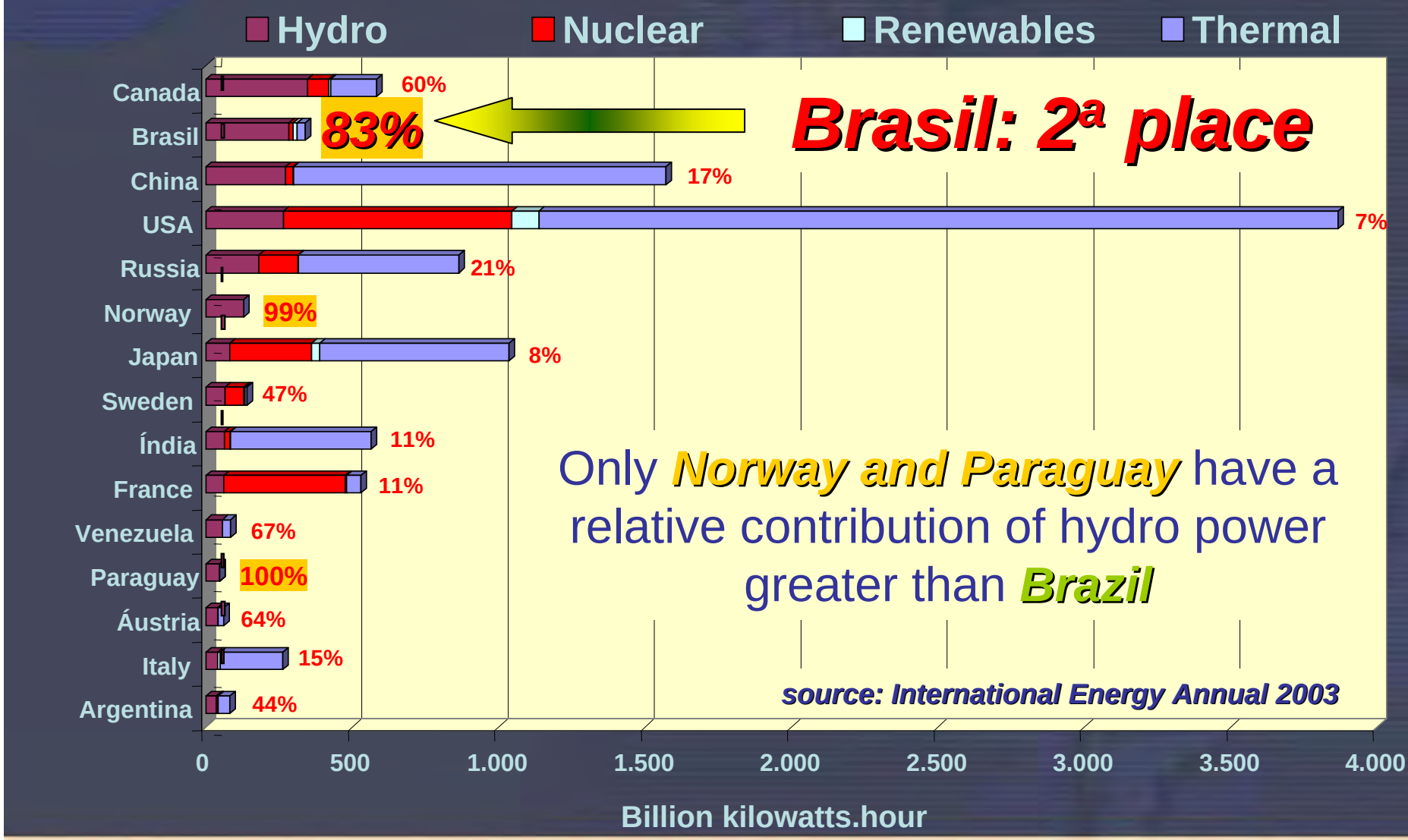




Fonte: Lighting the way, InterAcademy Council, 2007

TOP 15 WORLD HYDRO GENERATORS

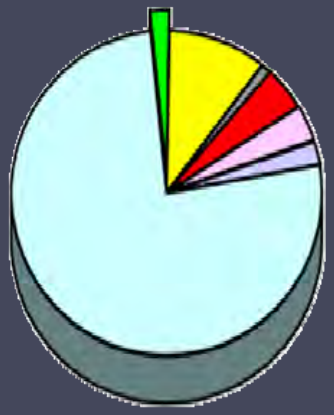
GREATEST CONTRIBUTION OF HYDRO POWER



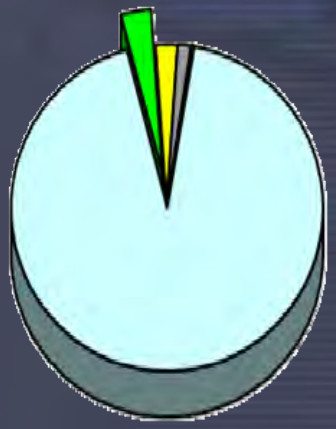
ELECTRICITY GENERATION IN BRAZIL

an unique renewable matrix

Installed capacity



Total Generation



Thermal Generation

Hydro
Nuclear
Gas
Coal
Fuel Oil
Biomass
Wind
Import

CO2 emissions avoided in Brazil

2000 – 2006

HYDRO POWER:
1.677 million tons

BIO ETHANOL:
165 million tons

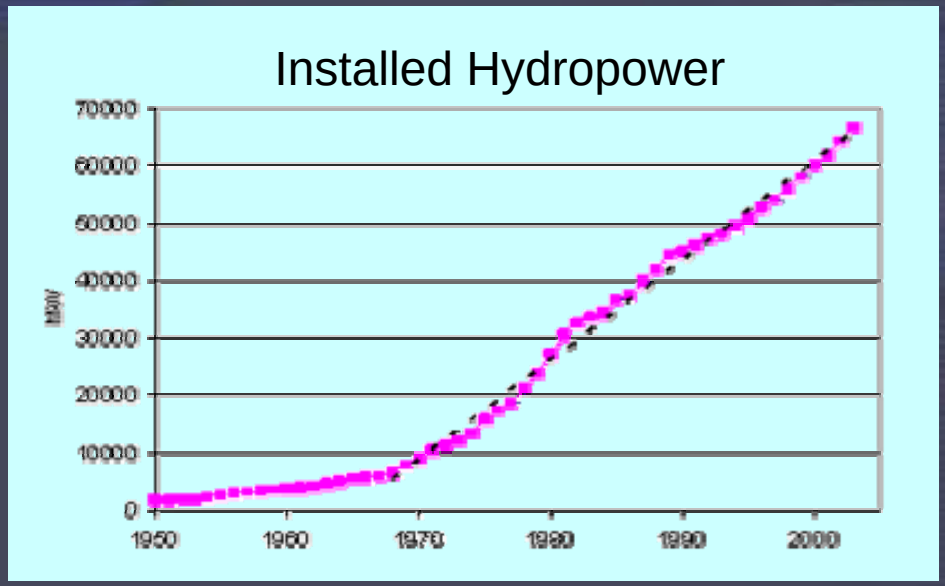
NUCLEAR POWER:
63 million tons

38%

HYDROPOWER REQUIRES SYSTEM INTEGRATION

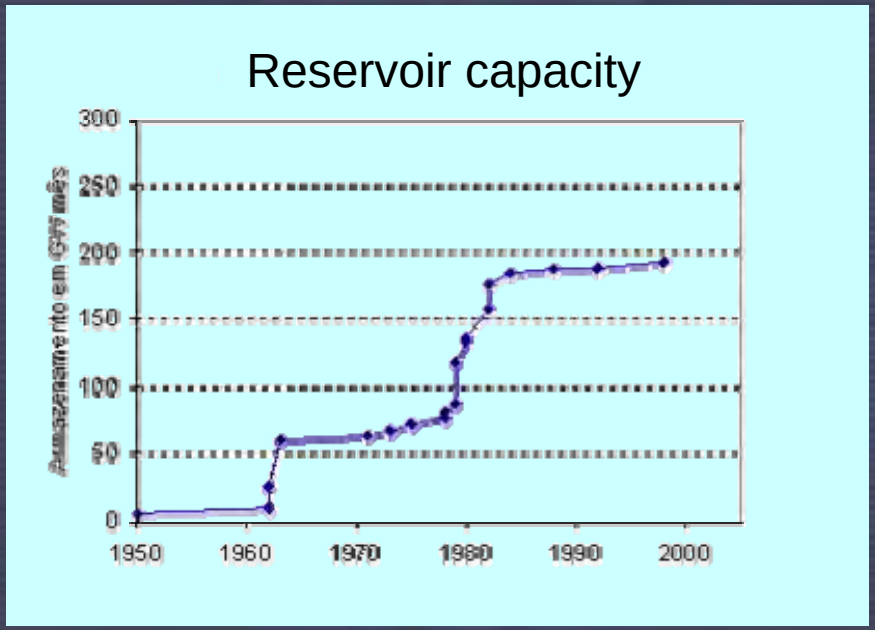
HAVING CONTINENTAL DIMENSIONS EQUIVALENT TO EUROPE

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
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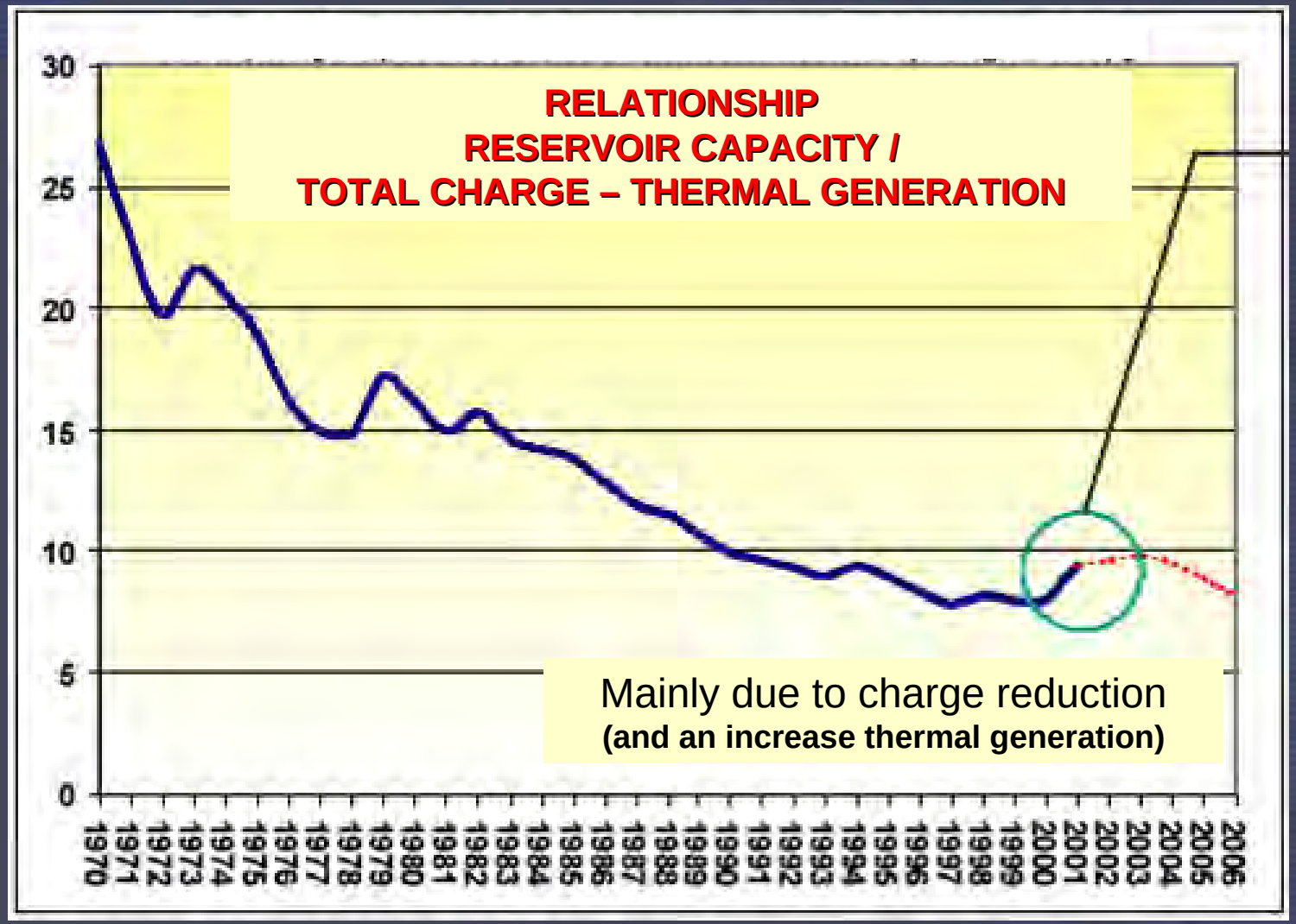
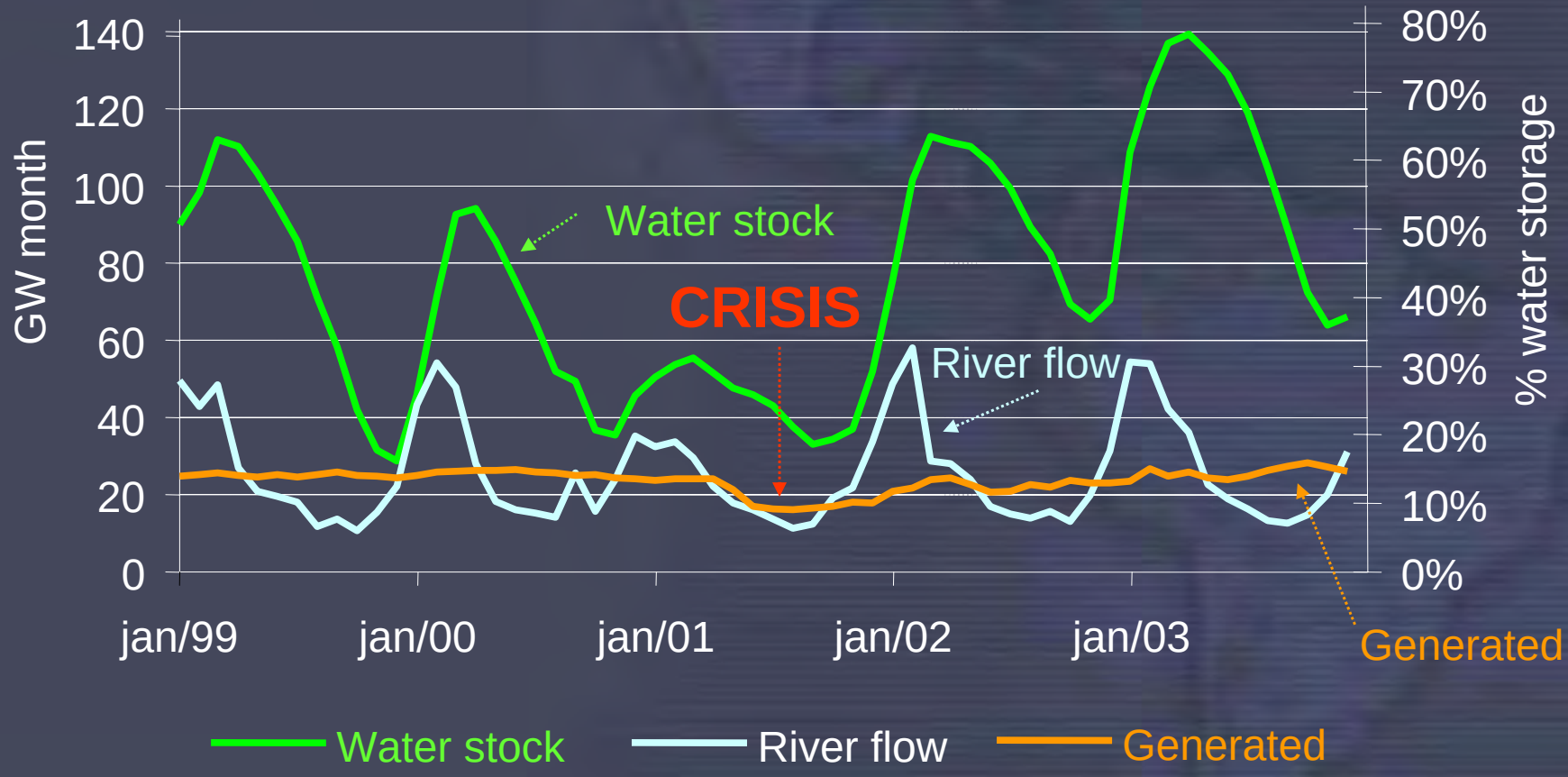


2001

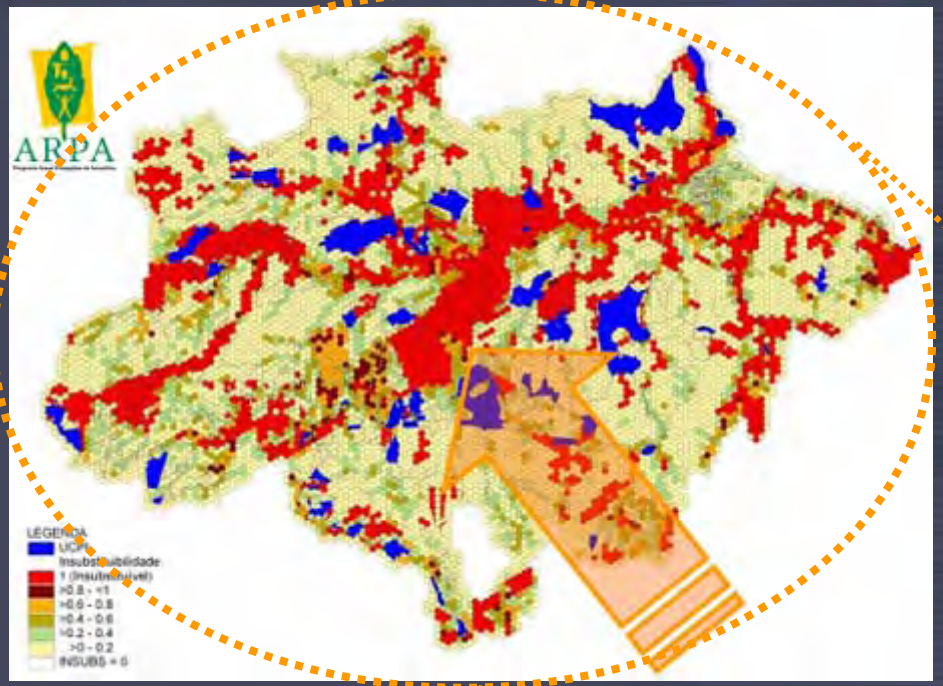
SUPPLY CRISE

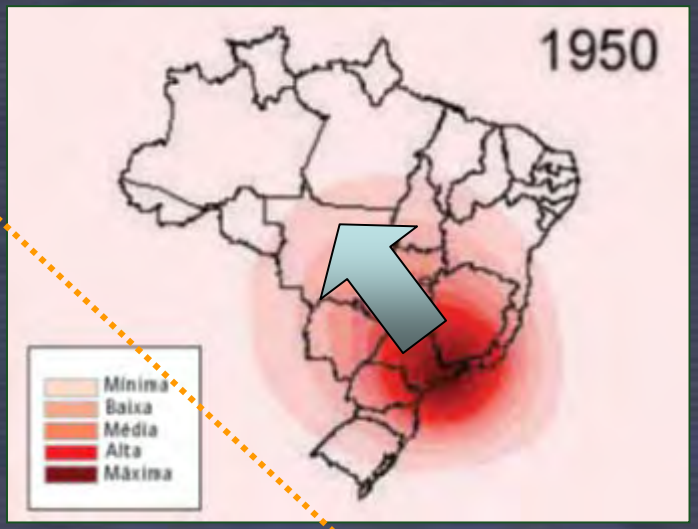
ELECTRIC SYSTEM EVOLUTION
NEED FOR THERMAL REGULATION

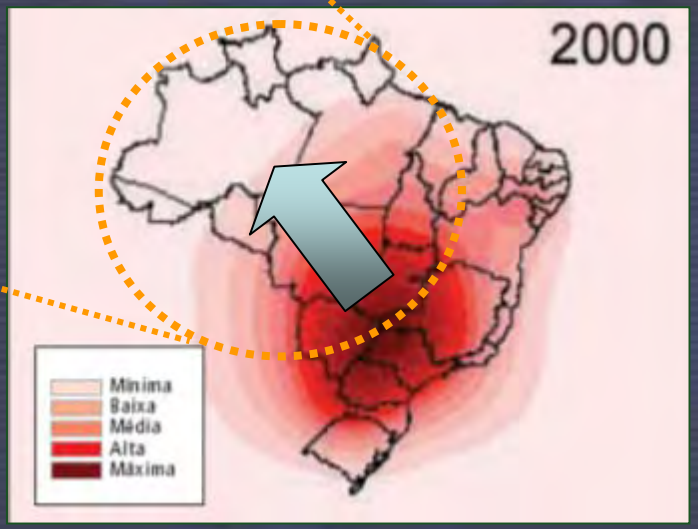
root cause of 2001 supply crisis



ELECTRIC SYSTEM EVOLUTION IN THE 90´s
"DAM CULTURE" CHANGE







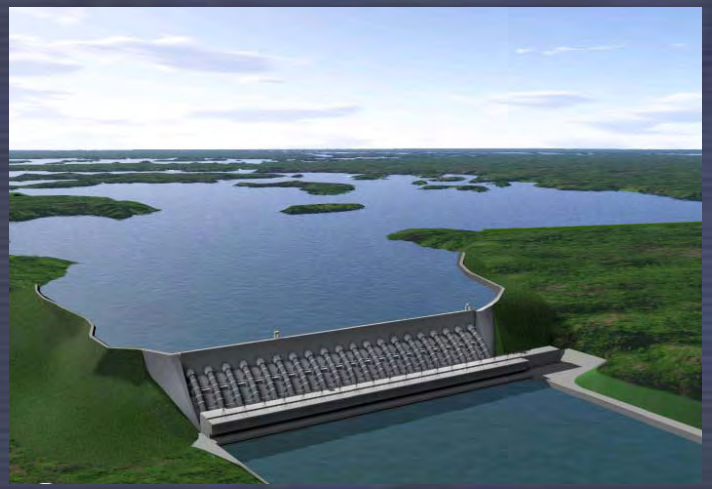
small reservoirs to avoid flooding large surfaces

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

This tendency will be amplificated by new projects in Amazon Bassin

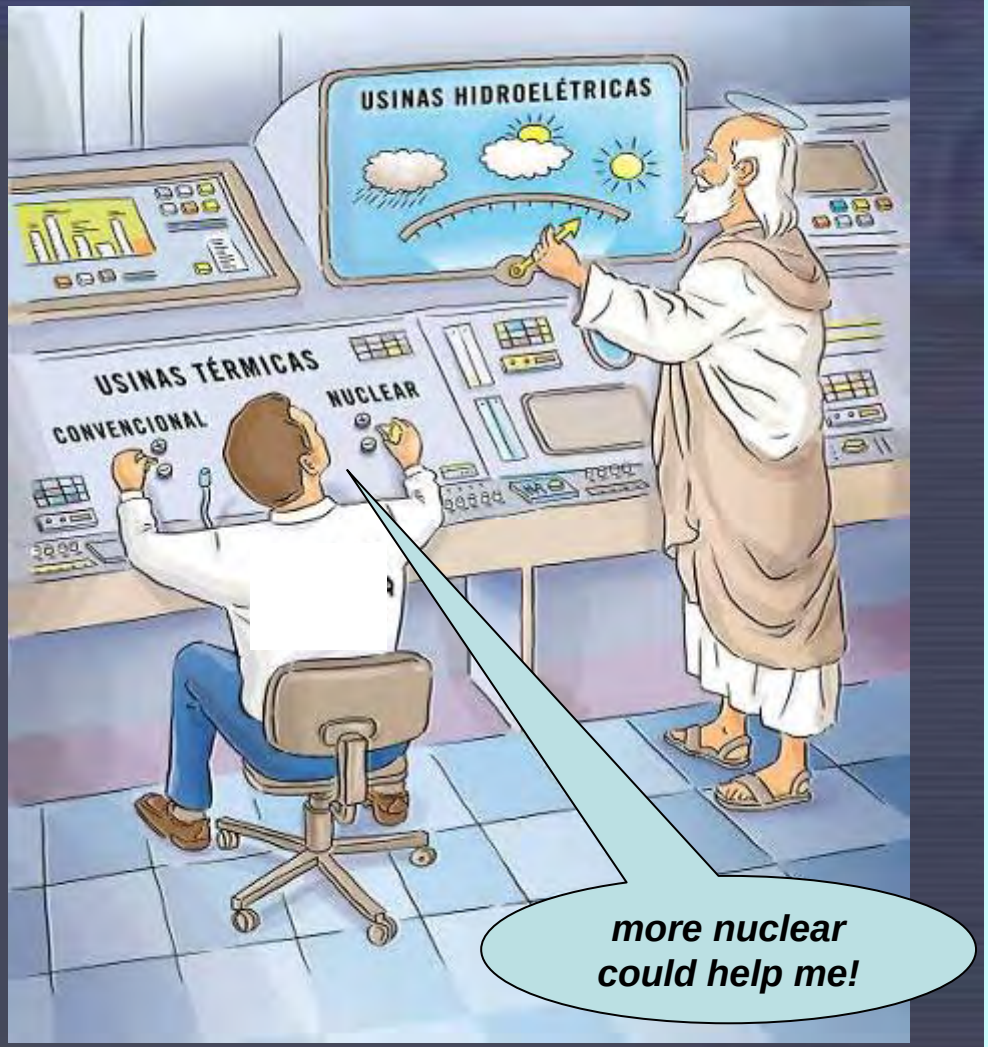
- **Current average hydro capacity factor: 55%**
- **Future average Amazon hydro capacity factor: 20-25%**

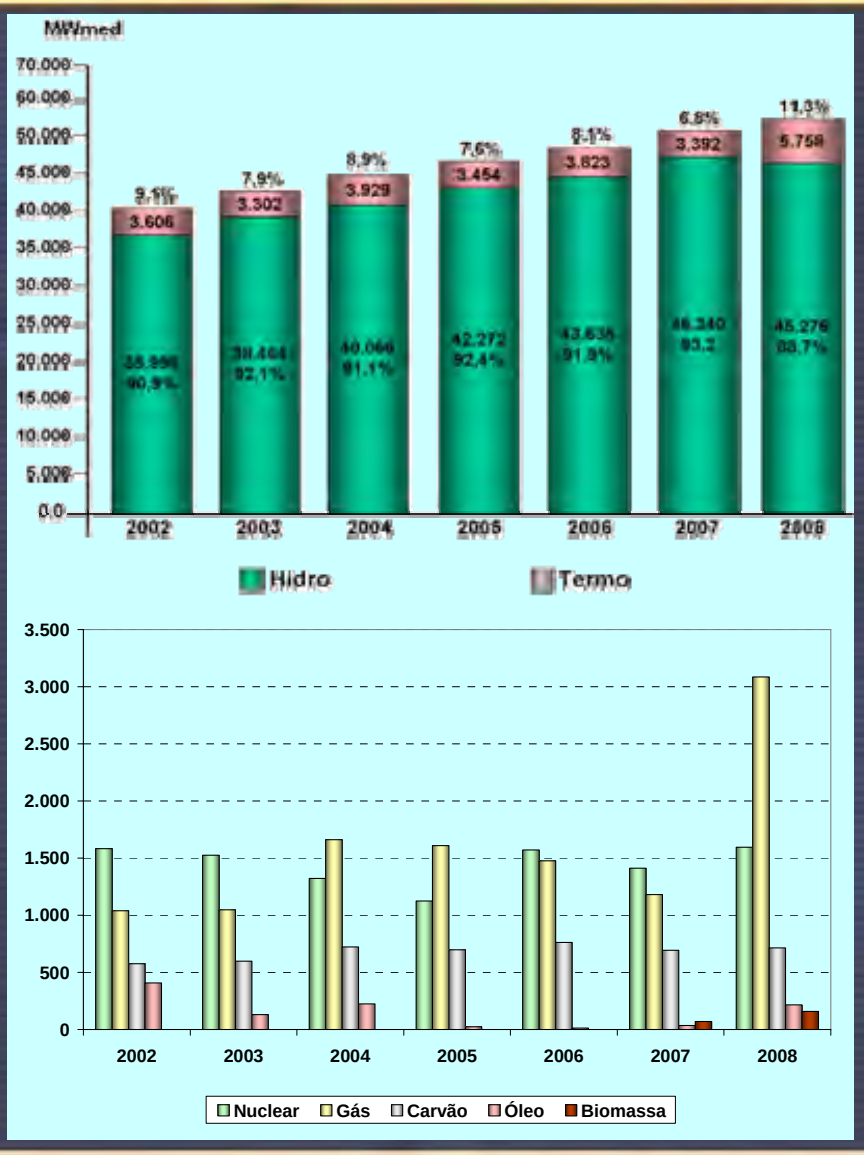
Project AHE MADEIRA 6.500 MW



Project AHE BELO MONTE 11.000 MW

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



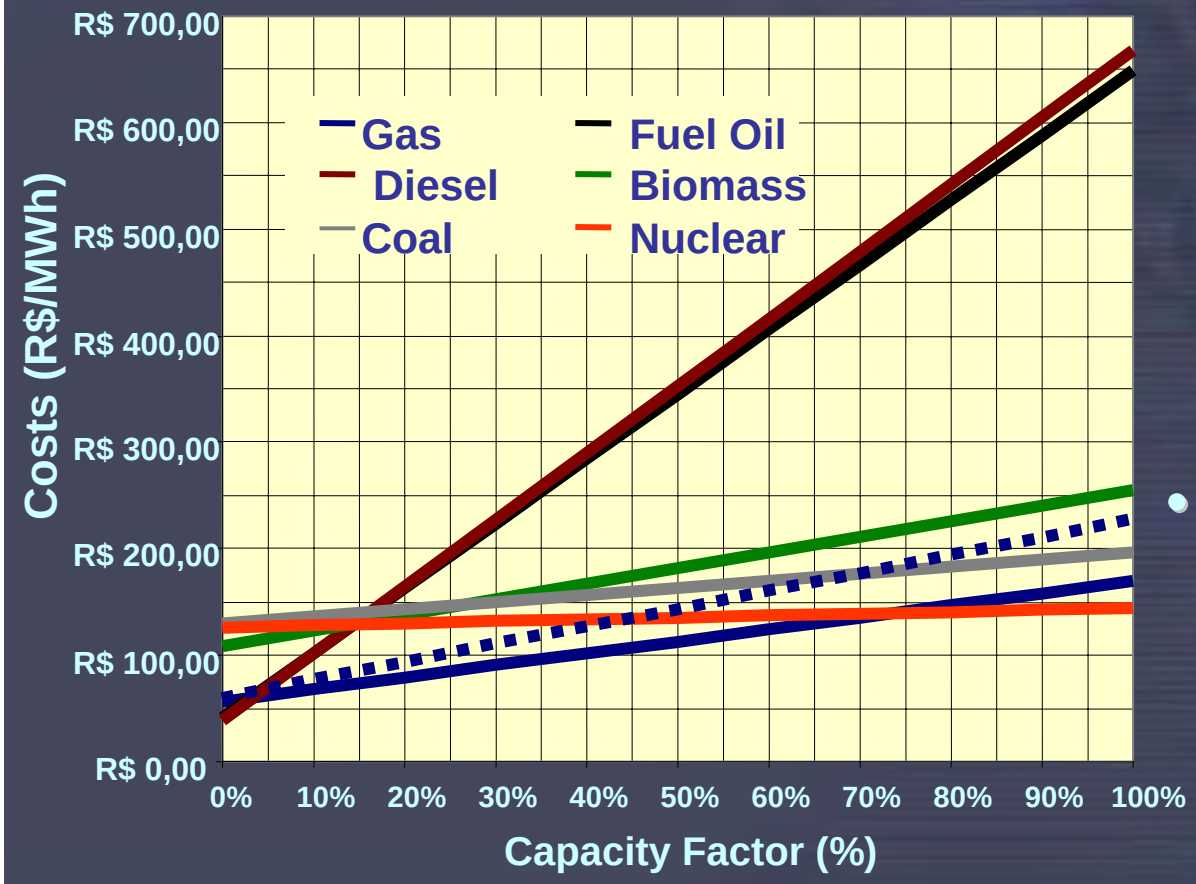


BRAZILIAN THERMAL OPTIONS

The main thermal fuels avaliable 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

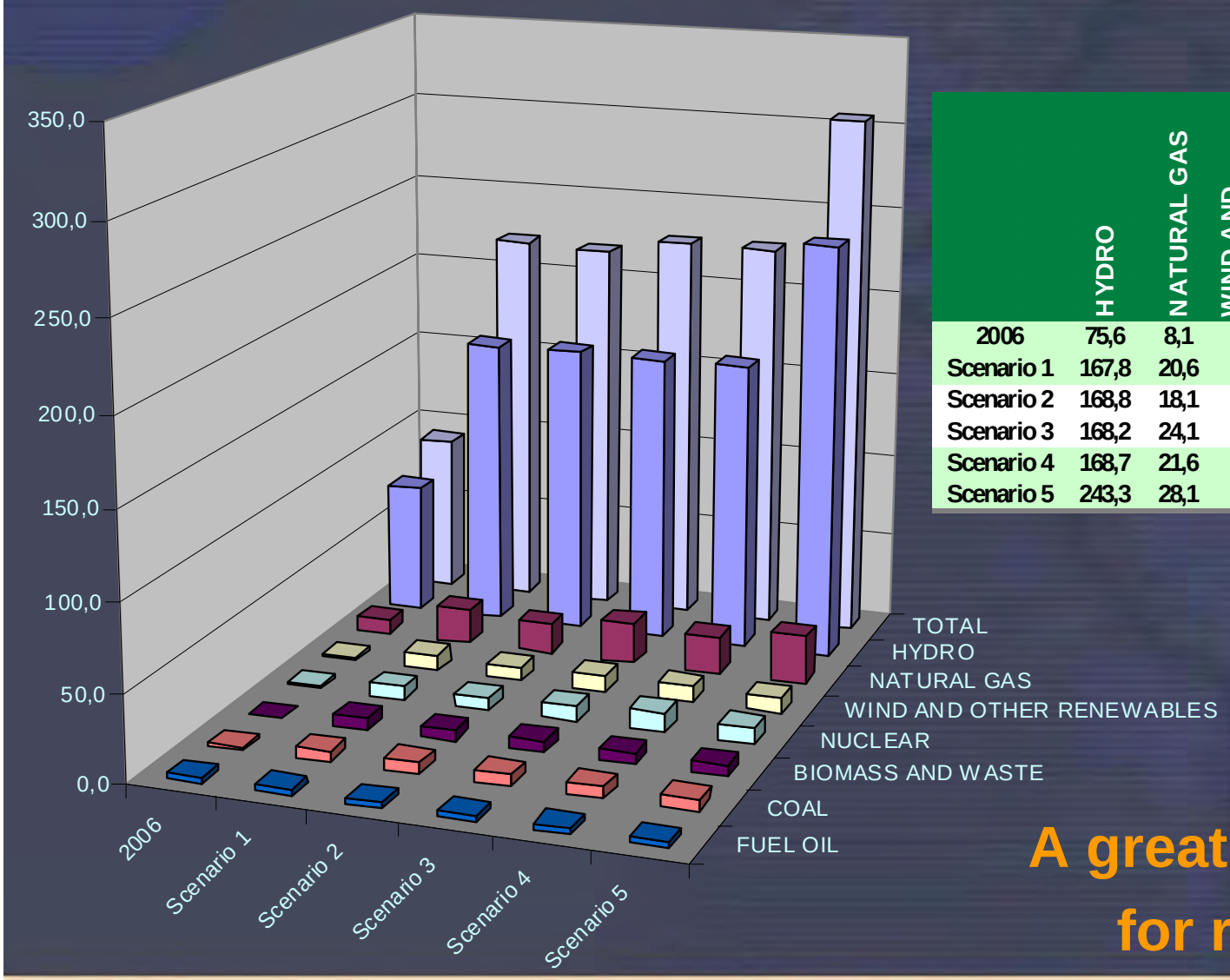


- There will be a place for all thermal options
  - Minimum cost according capacity factor range
- But costs are not the only decision factor:
  - ❑ *Price volatility*
  - ❑ *Assurance of supply*

must be considered too

NUCLEAR RENAISSANCE IN BRASIL

PROJECTIONS FROM NATIONAL ENERGY PLAN 2030



	HYDRO	NATURAL GAS	WIND AND OTHER RENEWABLES	NUCLEAR	BIOMASS AND WASTE	COAL	FUEL OIL	TOTAL
2006	75,6	8,1	1,6	2,0	0,1	1,4	2,9	91,6
Scenario 1	167,8	20,6	9,1	7,3	6,5	5,9	3,3	220,5
Scenario 2	168,8	18,1	8,0	7,3	6,5	6,5	3,3	218,5
Scenario 3	168,2	24,1	9,1	9,3	6,5	6,5	3,3	227,0
Scenario 4	168,7	21,6	9,1	11,3	6,5	6,5	3,3	227,0
Scenario 5	243,3	28,1	9,1	9,3	6,5	6,5	3,3	306,1

A greater growth rate for renewables

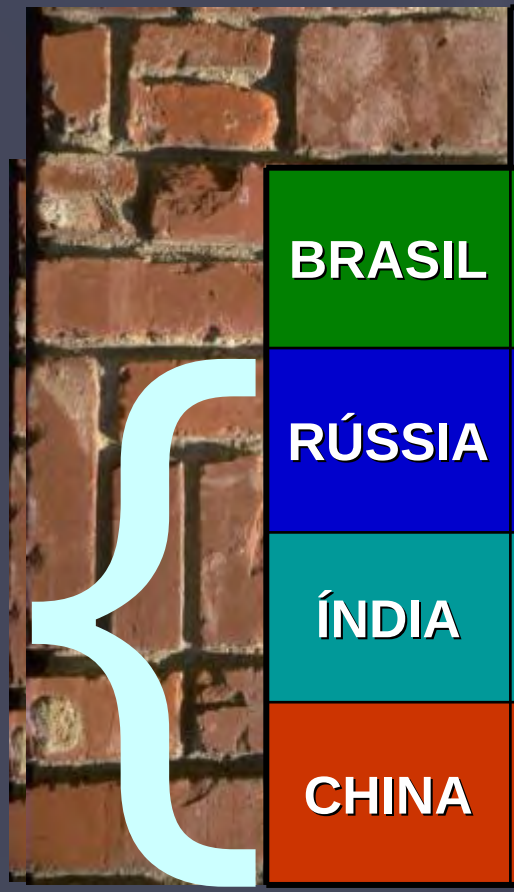
NUCLEAR RENAISSANCE IN BRASIL

PROJECTIONS FROM NATIONAL ENERGY PLAN 2030

	2007-2015	*2016-2020*	*2021-2025*	*2026-2030*	*2016-2030*
REFERENCE	1.405 MW Angra 3	1.000 MW NE 1	1.000 MW NE 2	2.000 MW SE 1+SE 2	4.000 MW
MEDIUM	1.405 MW Angra 3	1.000 MW NE 1	2.000 MW NE 1+NE 2	3.000 MW SE 1+SE 2+NE 3	6.000 MW
HIGH	1.405 MW Angra 3	2.000 MW NE 1+NE 2	3.000 MW SE 1+SE 2+NE 3	3.000 MW SE 3+SE 4+NE 4	8.000 MW

ELECTRIC SYSTEM EVOLUTION
NUCLEAR CAPACITY INSTALLED - 2030

Thermal based Electric systems



	High Scenario Adicional MW	Low Scenario Adicional MW
BRASIL	9.360	5.360
RÚSSIA	33.760	26.760
ÍNDIA	32.160	16.260
CHINA	43.830	24.830

NUCLEAR EXPANSION IN BRAZIL

ANGRA 3 + 6 x 1.000 MW NUCLEAR STATIONS

ANGRA 3
CONNECTED
IN 2015

NUCLEAR EXPANSION IN BRAZIL

ANGRA 3 + 6 x 1.000 MW NUCLEAR STATIONS

ANGRA 3

WORKS ON SITE

NUCLEAR EXPANSION IN BRAZIL

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ANGRA 3

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NUCLEAR RENAISSANCE IN BRASIL

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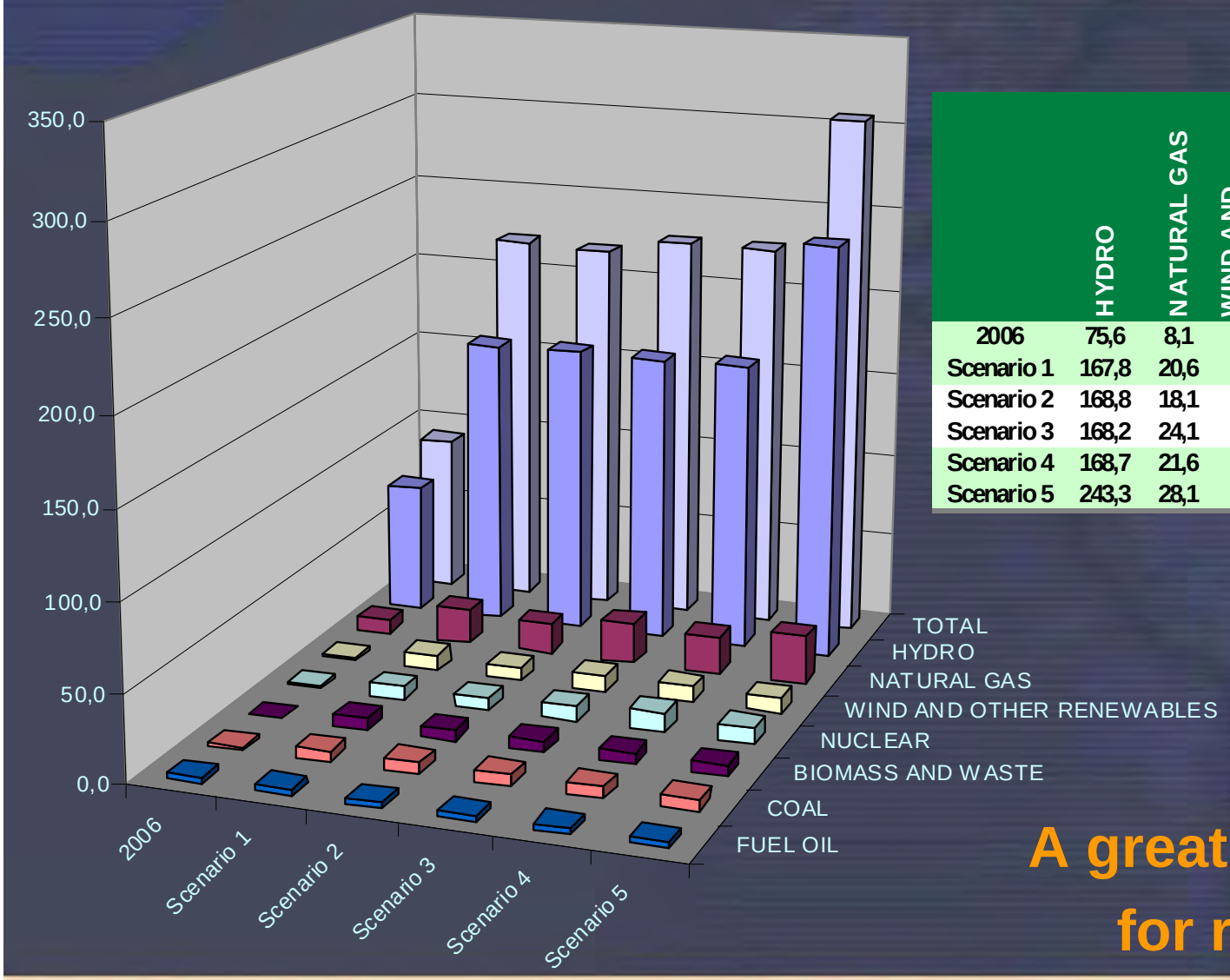

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A greater growth rate for renewables

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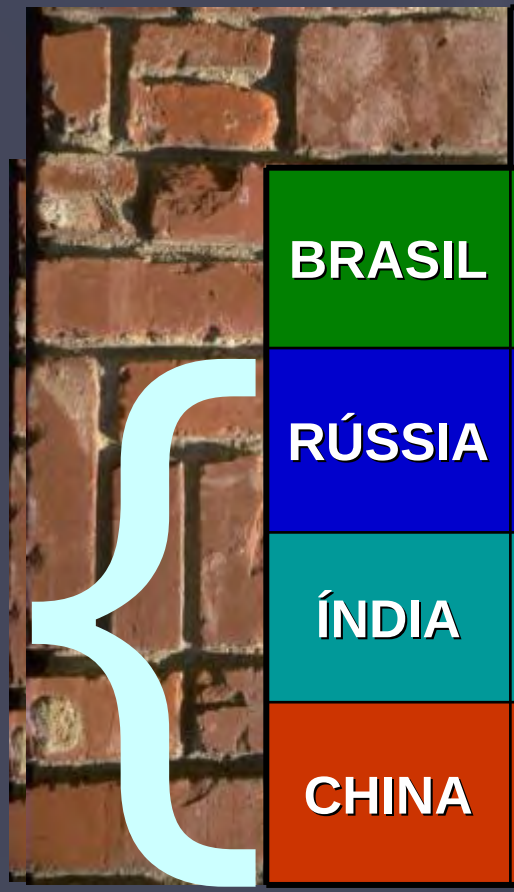
ELECTRIC SYSTEM EVOLUTION
NUCLEAR CAPACITY INSTALLED - 2030

Thermal based Electric systems



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CONNECTED
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NUCLEAR EXPANSION IN BRAZIL

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ANGRA 3

WORKS ON SITE

NUCLEAR EXPANSION IN BRAZIL

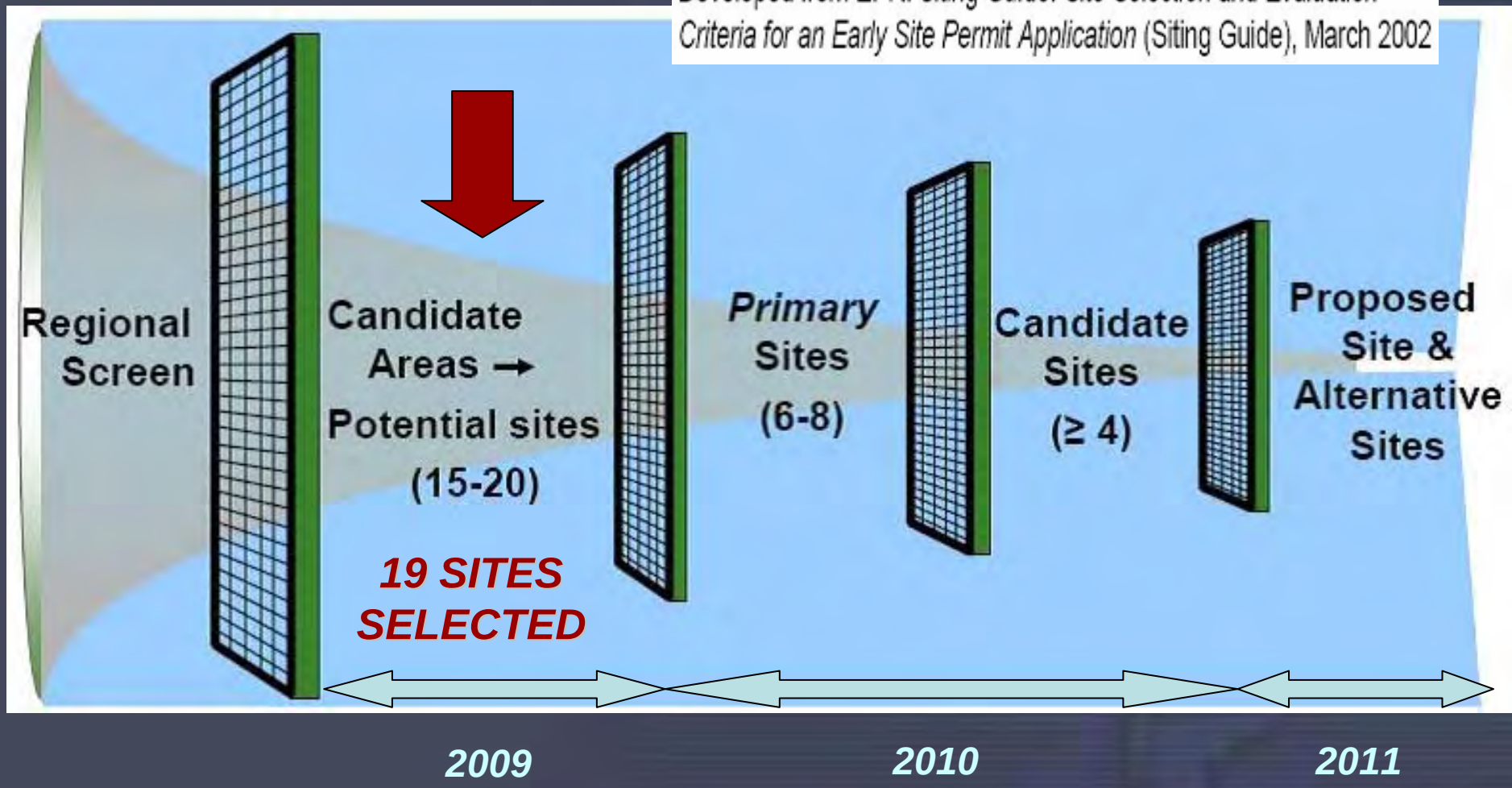
ANGRA 3 + 6 x 1.000 MW NUCLEAR STATIONS

ANGRA 3

WORKS ON SITE

NUCLEAR EXPANSION IN BRAZIL

SITE SELECTION



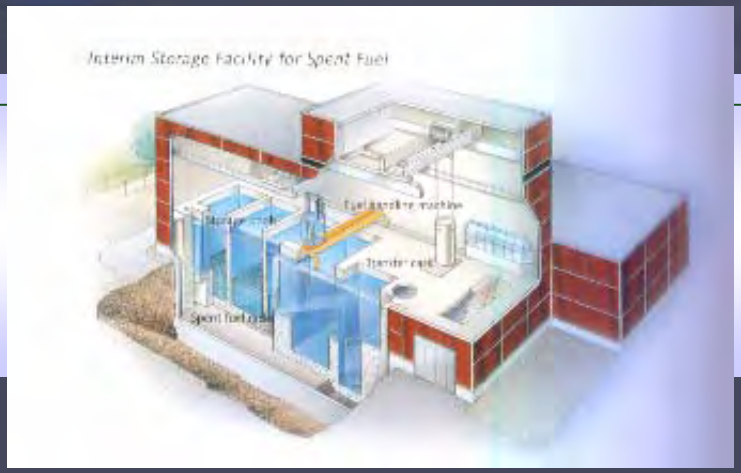
NUCLEAR EXPANSION IN BRAZIL

SITE SELECTION

SPENT FUEL LONG TERM STORAGE

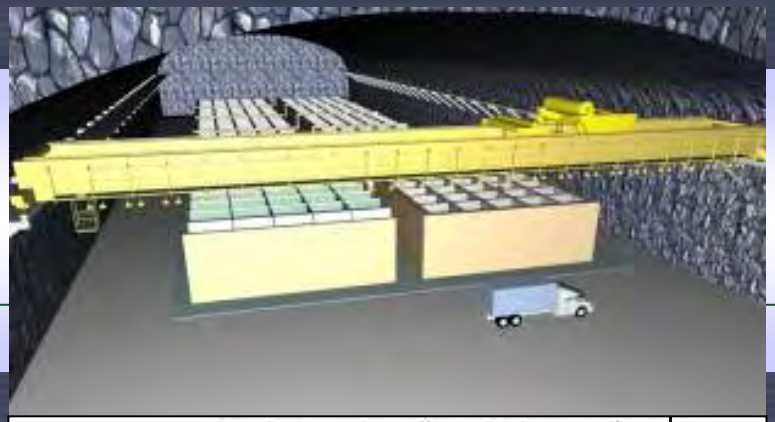
BRAZILIAN SOLUTION

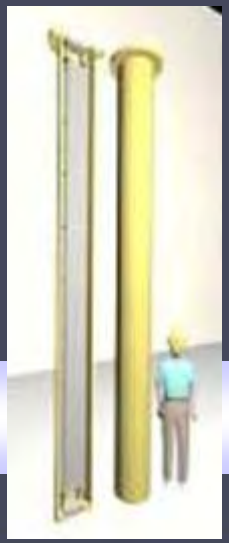
External pool (2020)

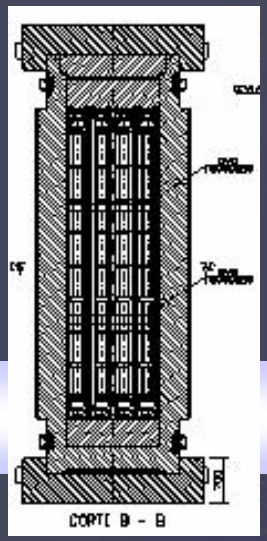


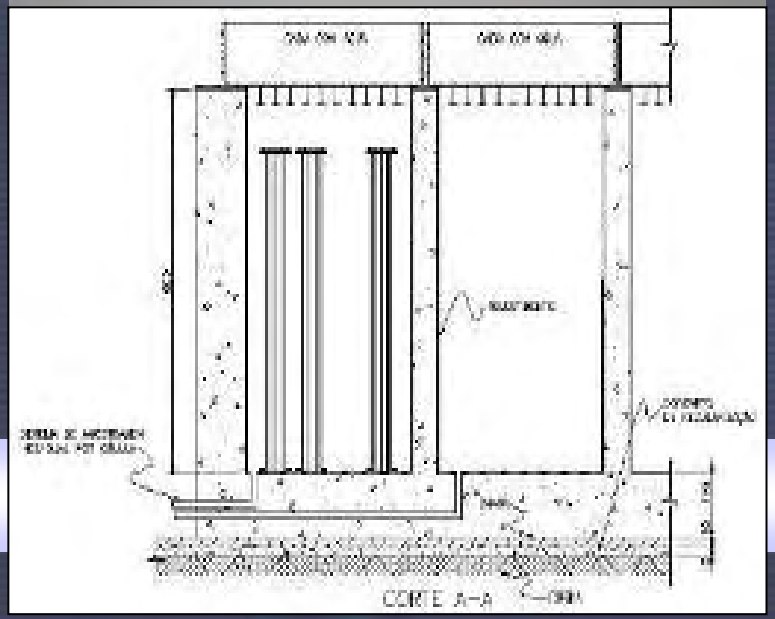
Designed for 500 years

Long Term Interim Storage (2050)



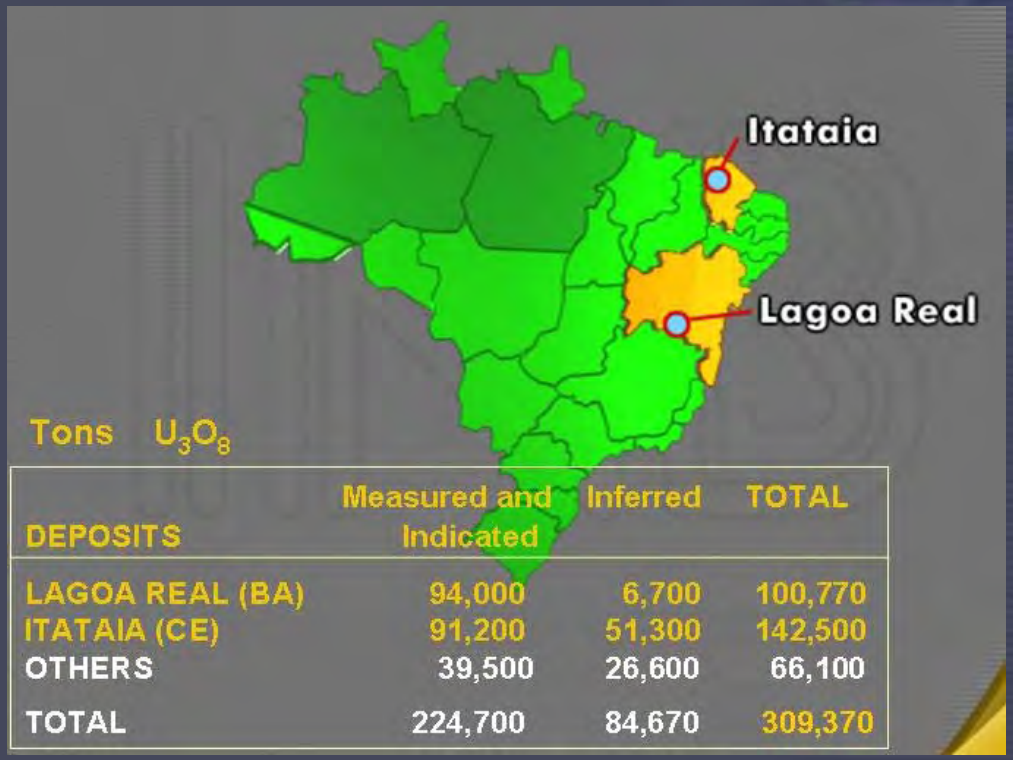






BRAZILIAN URANIUM RESOURCES

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

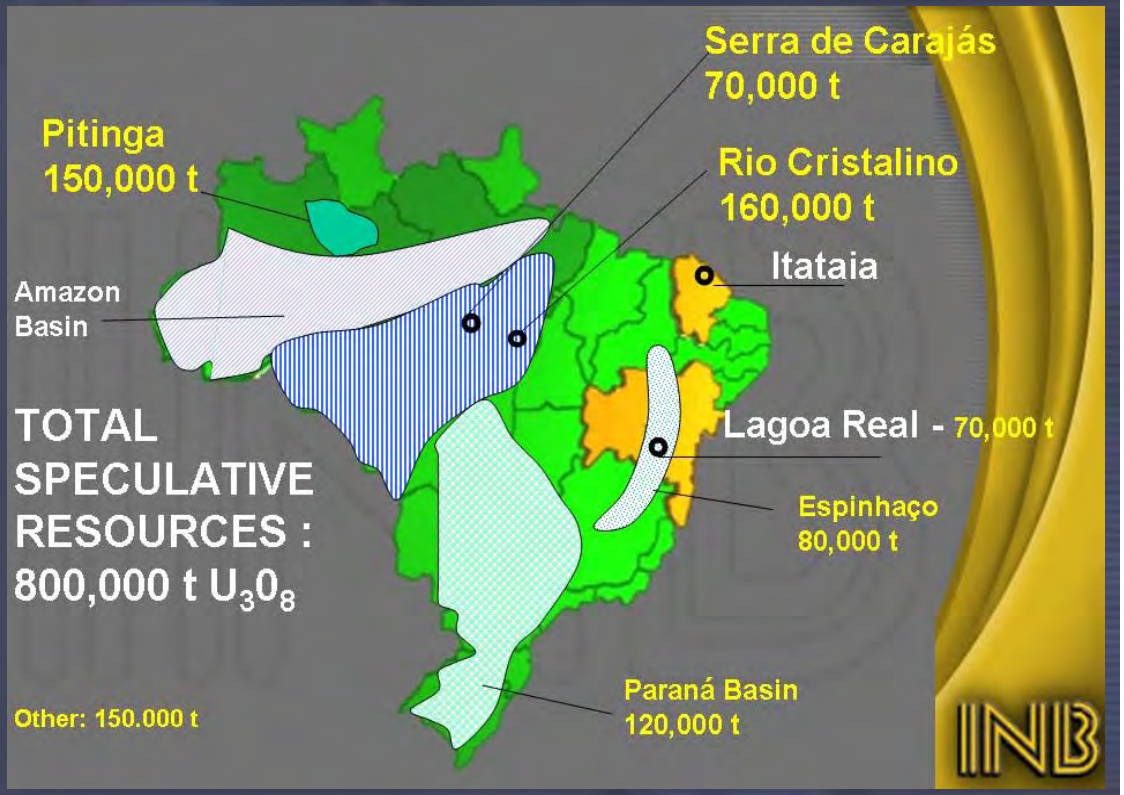
Prospected area:

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

6th. WORLD RESERVE

BRAZILIAN URANIUM RESOURCES
ONE OF THE MAIN RESERVES IN THE WORLD

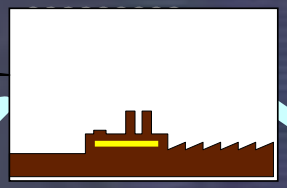
After prospected all the national territory, probably *Brazil should be among the 3 MAJOR WORLD RESERVES*



NUCLEAR FUEL INDUSTRY IN BRAZIL
URANIUM + TECHNOLOGICAL CAPABILITIES

USEXA - NAVY
(CONSTRUCTION)

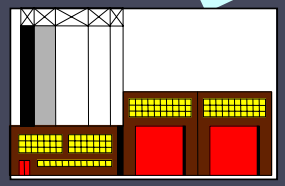
INB



CONVERSION
(PROJECT)

LEI and USIDE - NAVY
(OPERATION)

INB



URANIUM MINNING
AND MILLING

LAGOA REAL
(OPERATION)

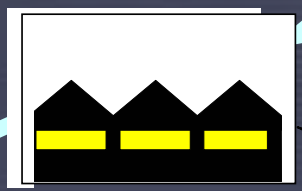
One of the few countries having both:

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

INB

ENRICHMENT
RESENDE
(CONSTRUCTION)

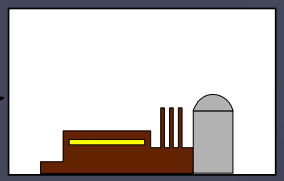
INB



FUEL FABRICATION
RESENDE

(OPERATION)

ELETRONUCLEAR



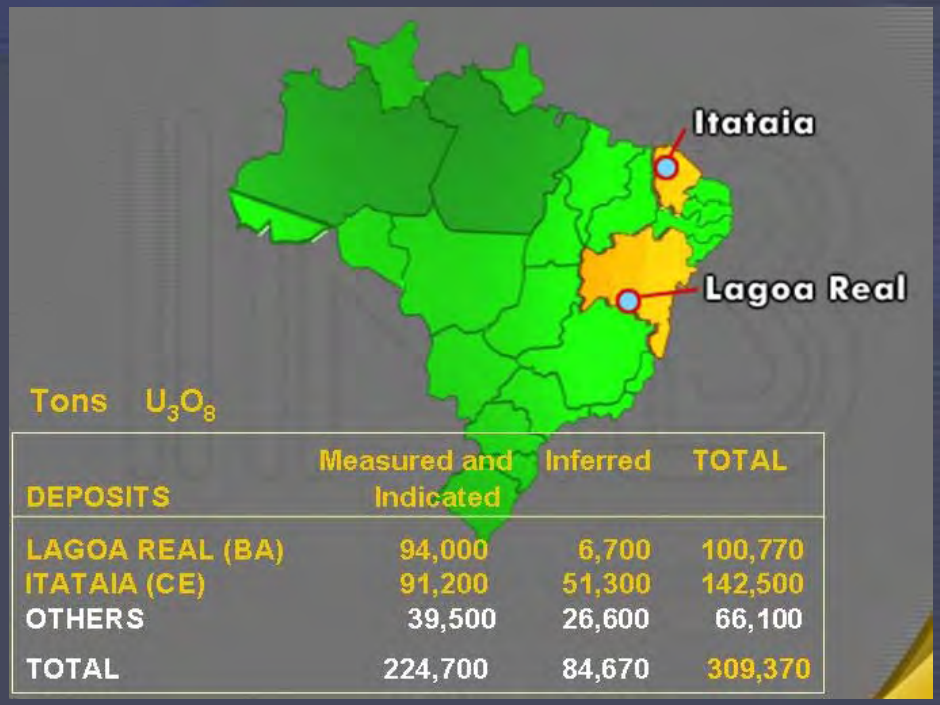
ANGRA 1/2/3
PWR

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 NPPs planned for 2030**
- ***Itataia*** **mine *(phosphate and uranium production)* could 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

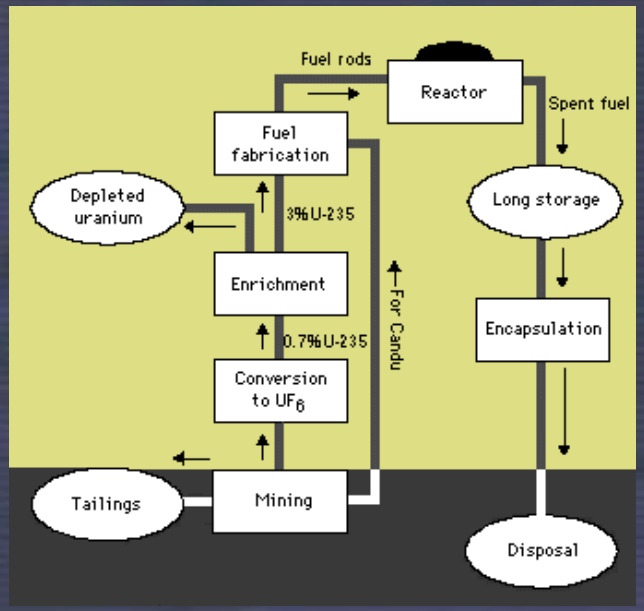
RESENDE Enrichment facility

NUCLEAR FUEL INDUSTRY IN BRAZIL

LONG TERM VISION

Continental integration

1. Mercosur
2. South America
3. Latin America

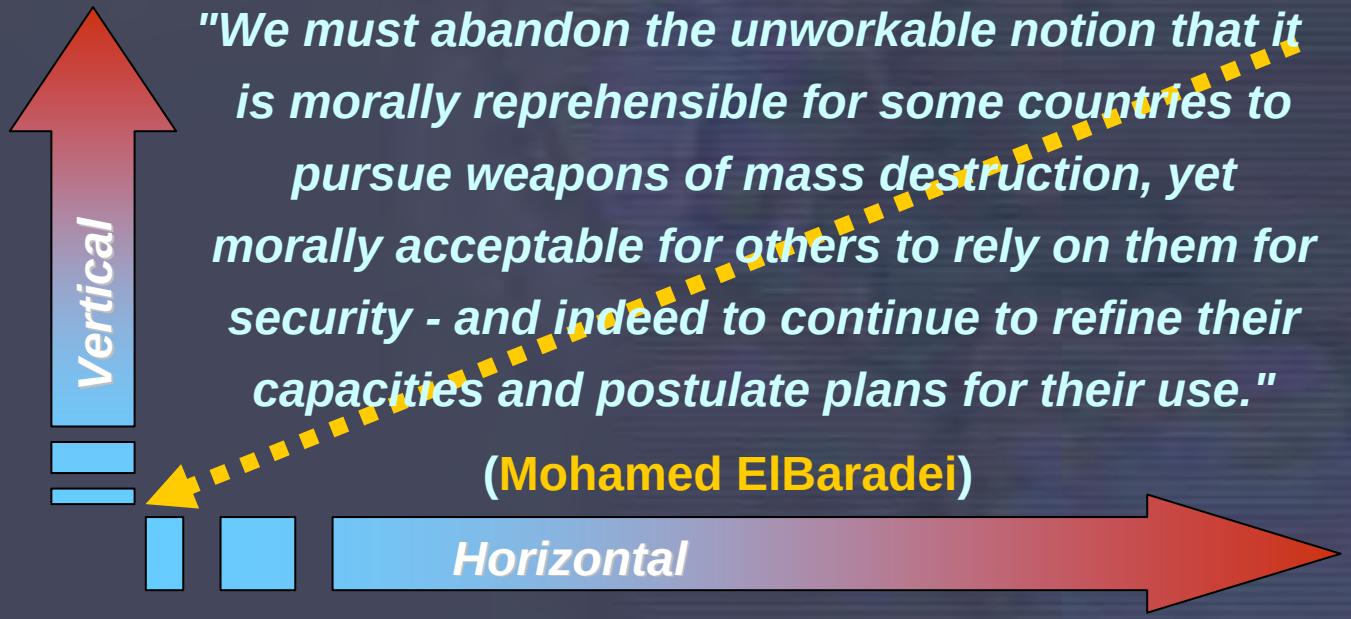


Assuring regional supply

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


LEI

- ✓ 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


USIDE


RESENDE Enrichment facility

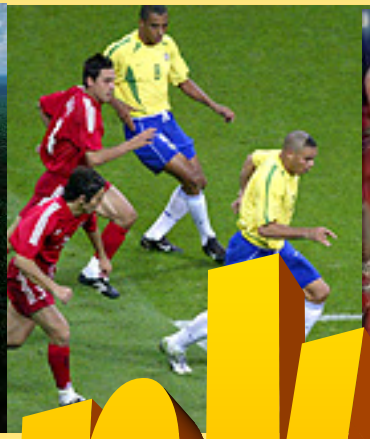
CONCLUDING REMARKS
"PEPPERING" THE DISCUSSION

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

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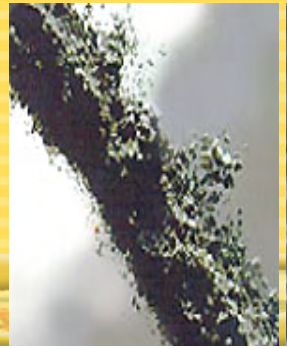
Mini chment UO2 powder Pellets Fuel Elements Generation




Thank you!