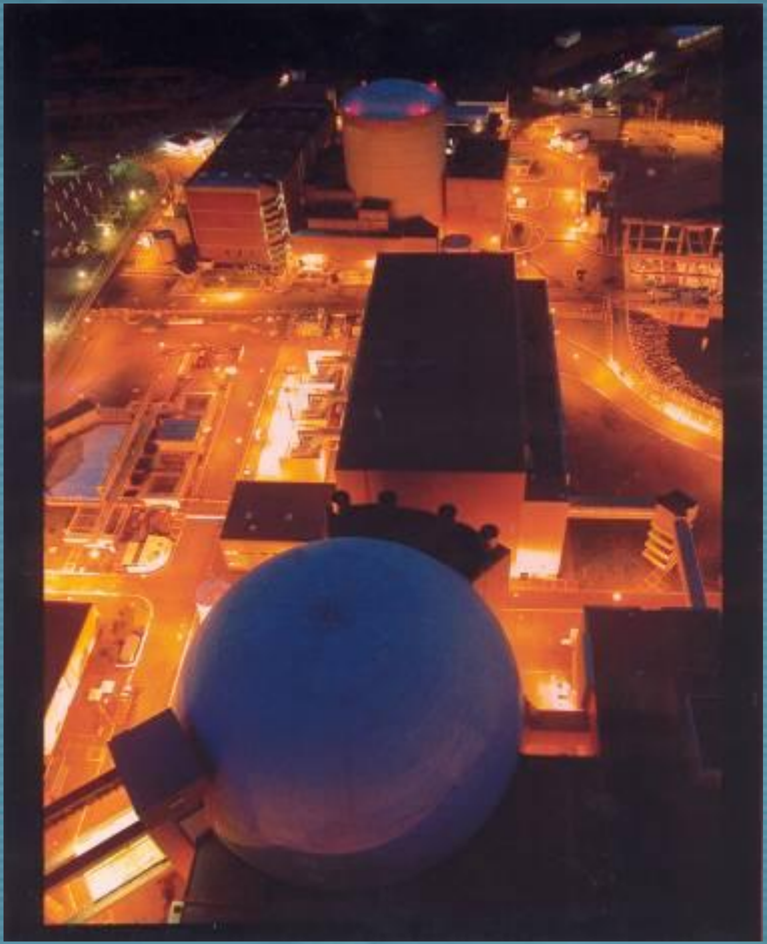
THE 48th JAIF ANNUAL CONFERENCE

April 13 - 14, 2015
TOKYO, JAPAN

"Why Nuclear?"

Eletrobras
Eletronuclear



Hydrothermal Transition:
Why nuclear in Brazil?

Tokio, April 13th 2015

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 | Power Generation

A synergic mix of:

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

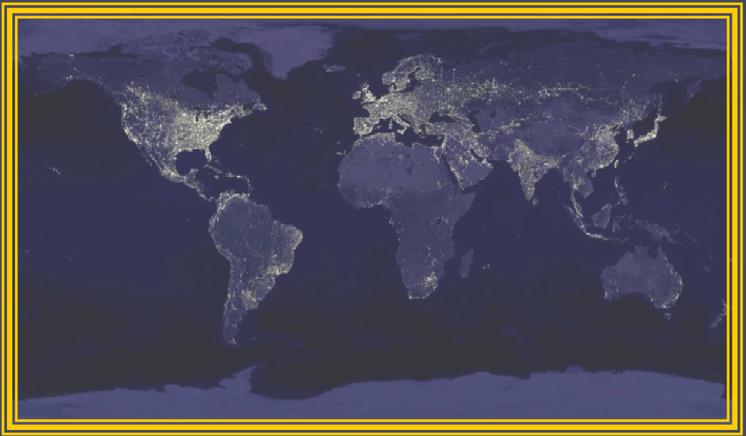
BRAZIL
GENERAL DATA

National Interconnected System

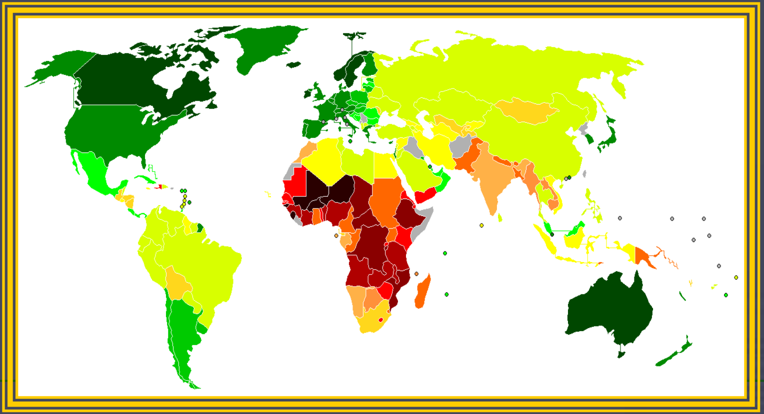
Population	192 million	5th
Surface	8.5 million km2	5th
GDP	US$ 1.98 trillion	8th
GDP/capta	US$ 10,300/inh	77th
HDI	0.807	70th
Electric installed capacity	102.6 GW	9th
electricity production/year	450 TWh	10th
electricity consumption/capta	2,400 kWh/inh	90th

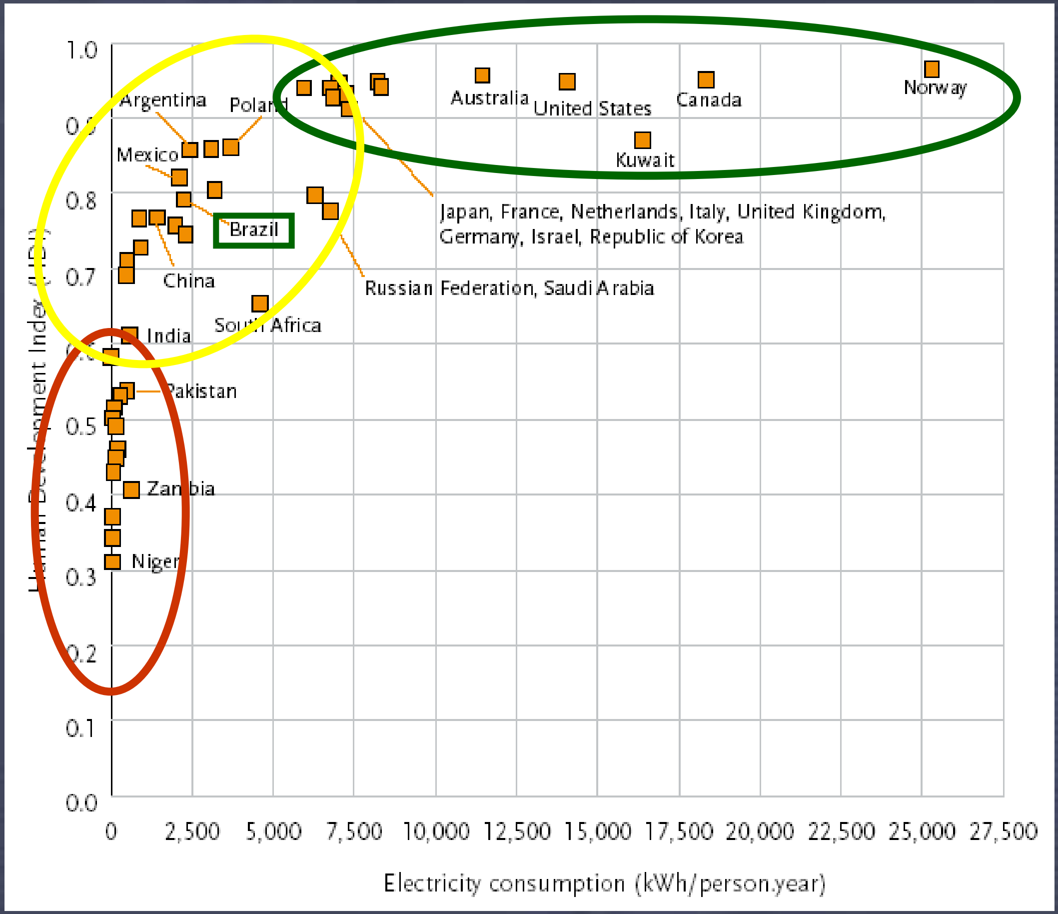
HDI X ELECTRICITY CONSUMPTION

BRAZIL: 90th place



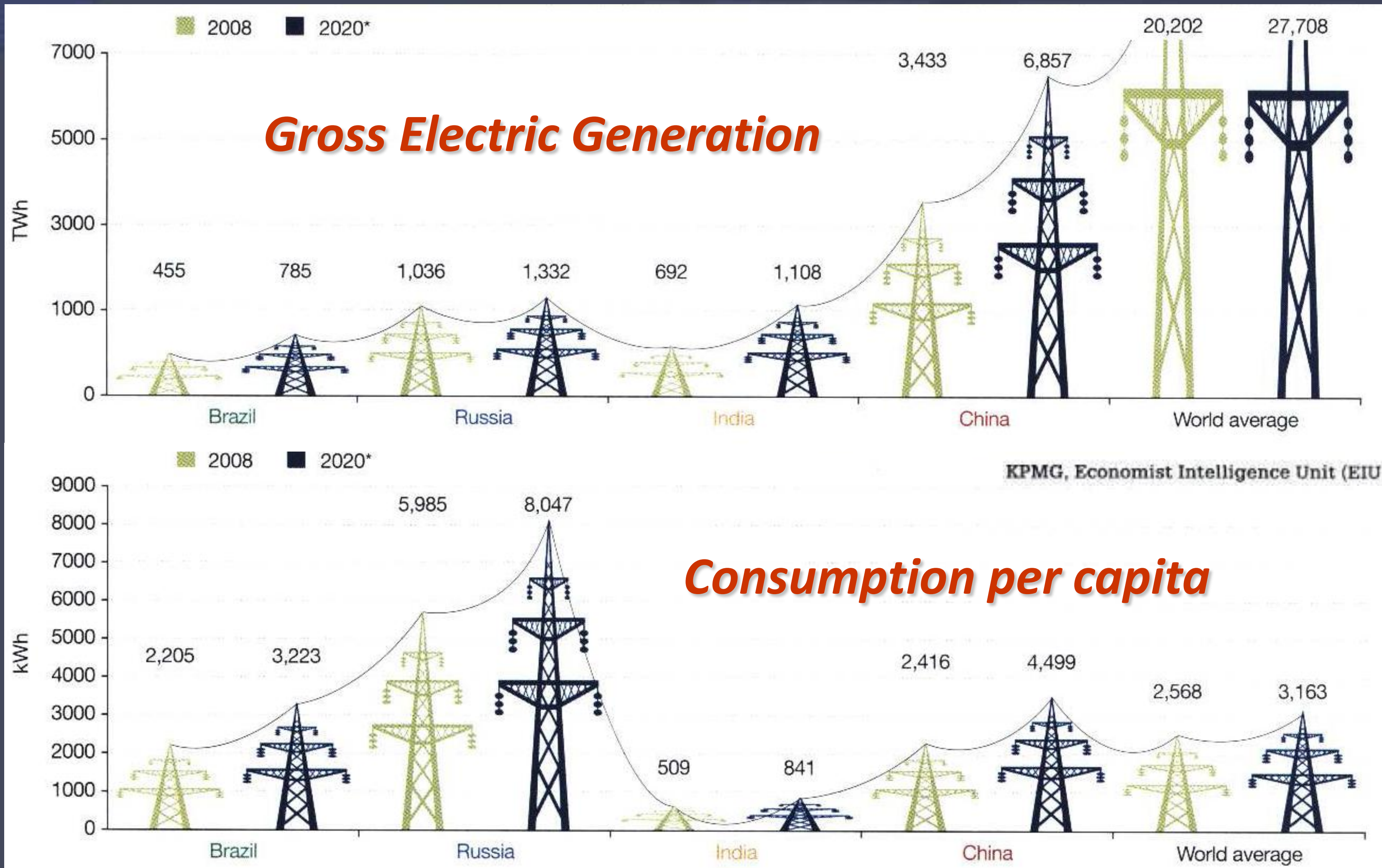
BRAZIL: 69th place



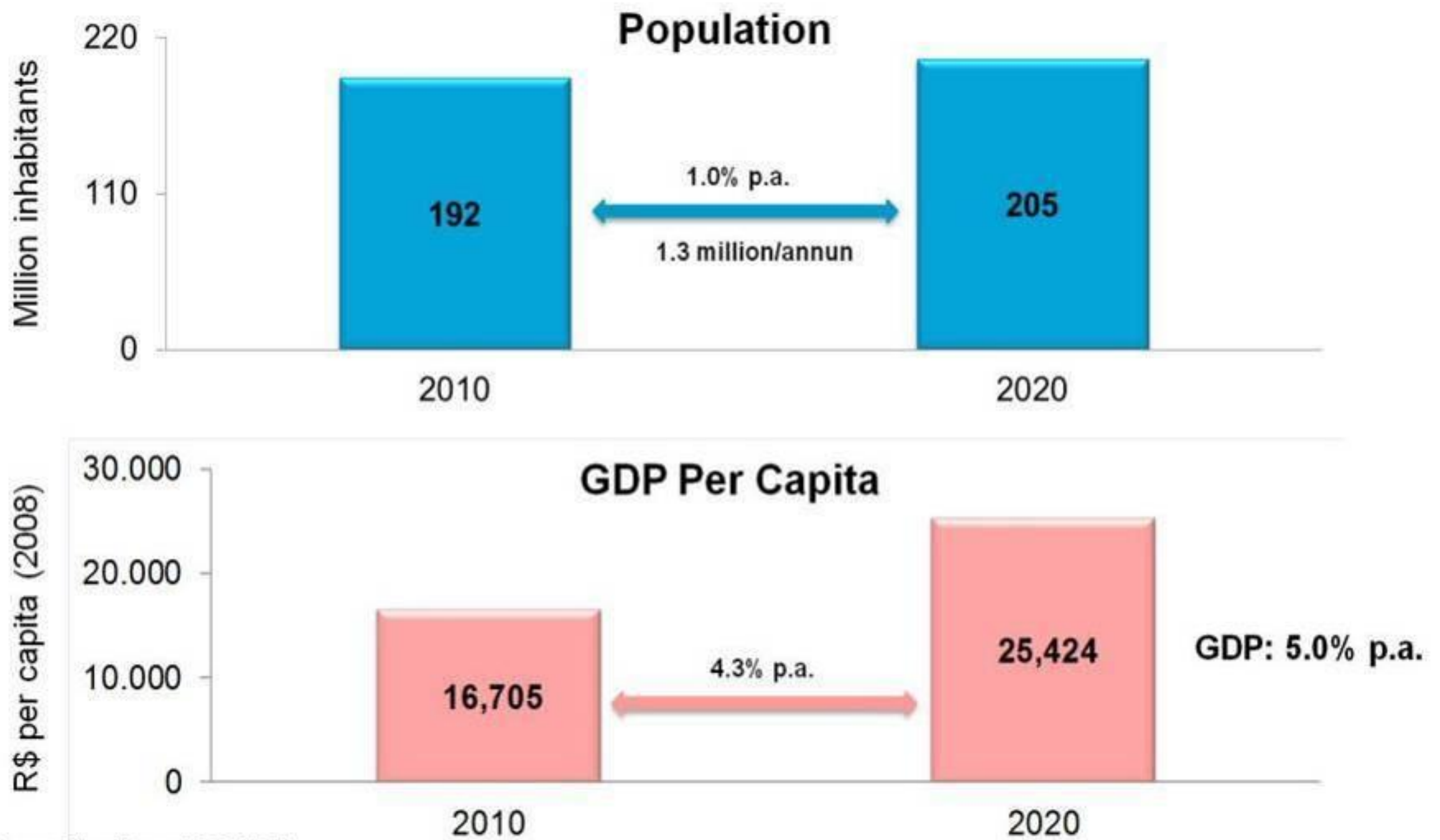


Fonte: Lighting the way, InterAcademy Council, 2007

HDI X ELECTRICITY CONSUMPTION

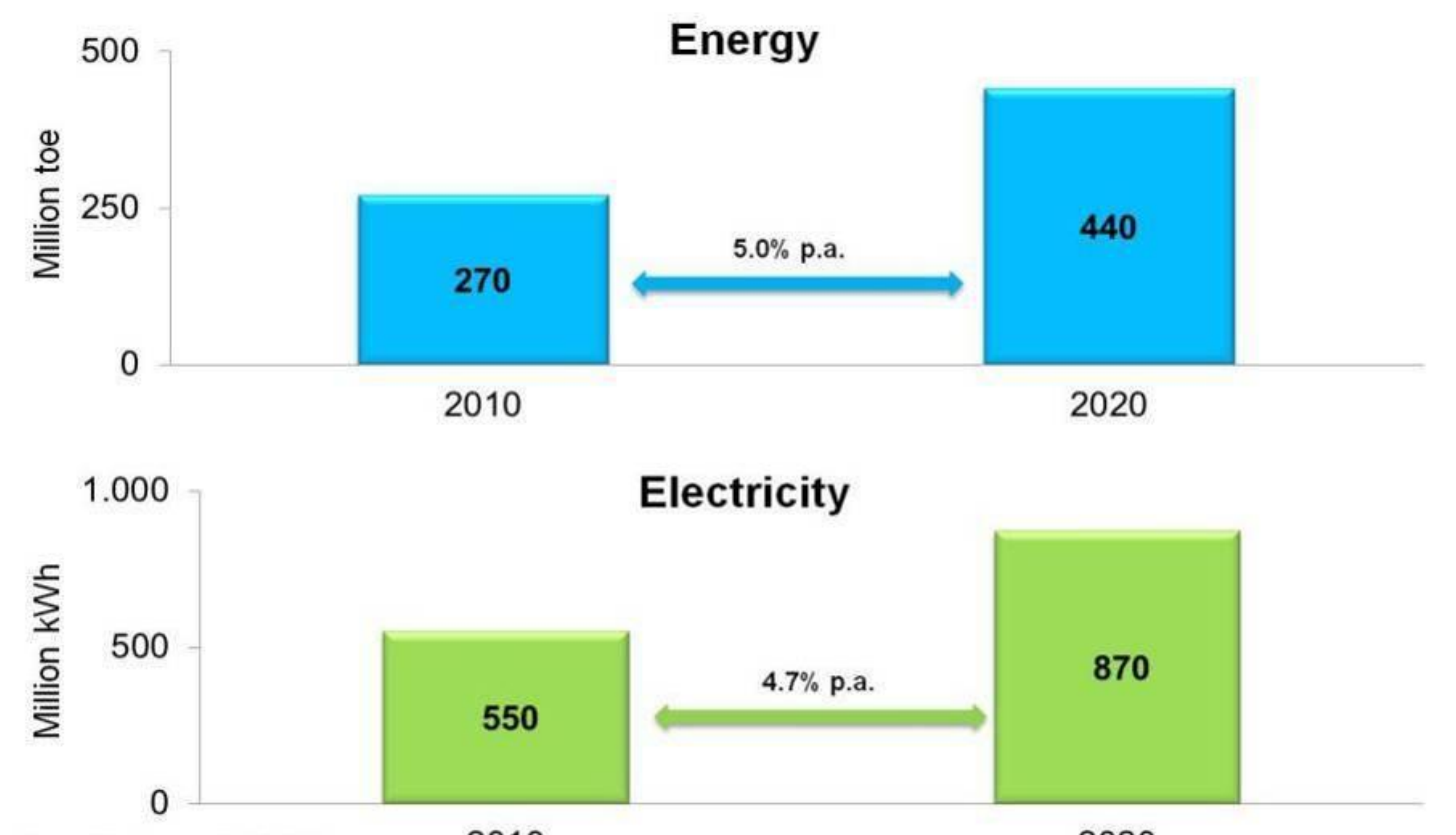


FORECASTS 2020
Population and GDP per capita



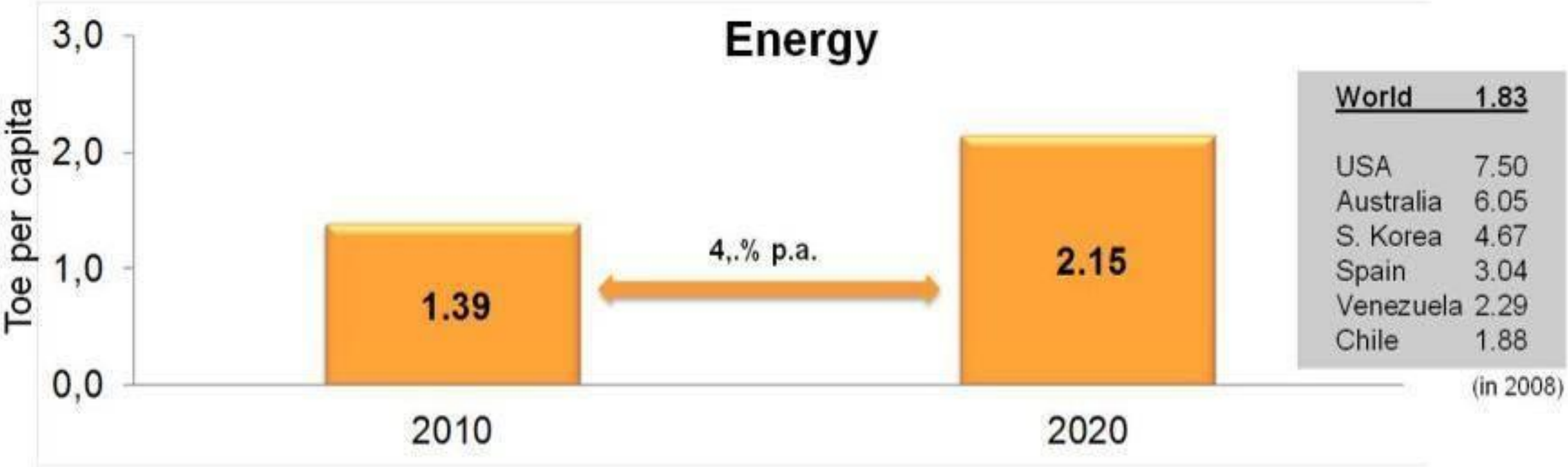
Source: Plano Decenal 2020, IBGE

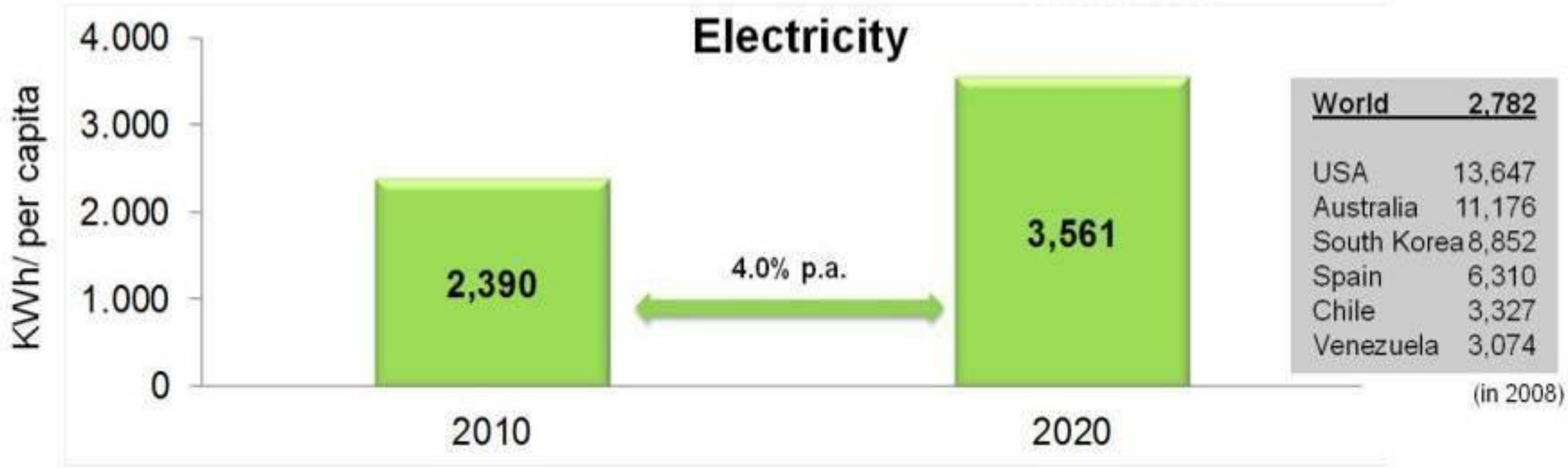
FORECASTS 2020
Energy and electricity consumption



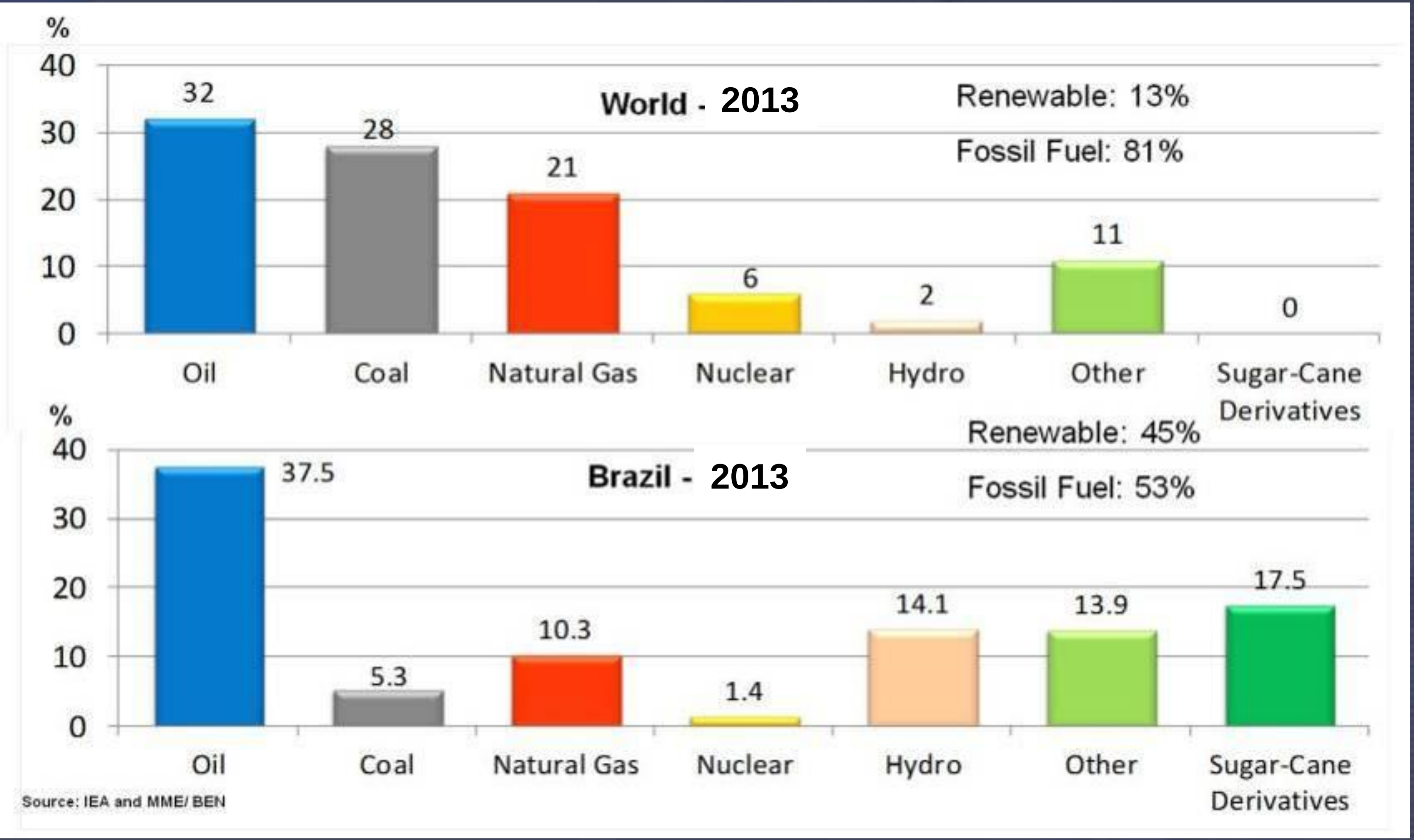
Source: Plano Decenal 2020, IBGE

FORECASTS 2020
Energy and electricity consumption



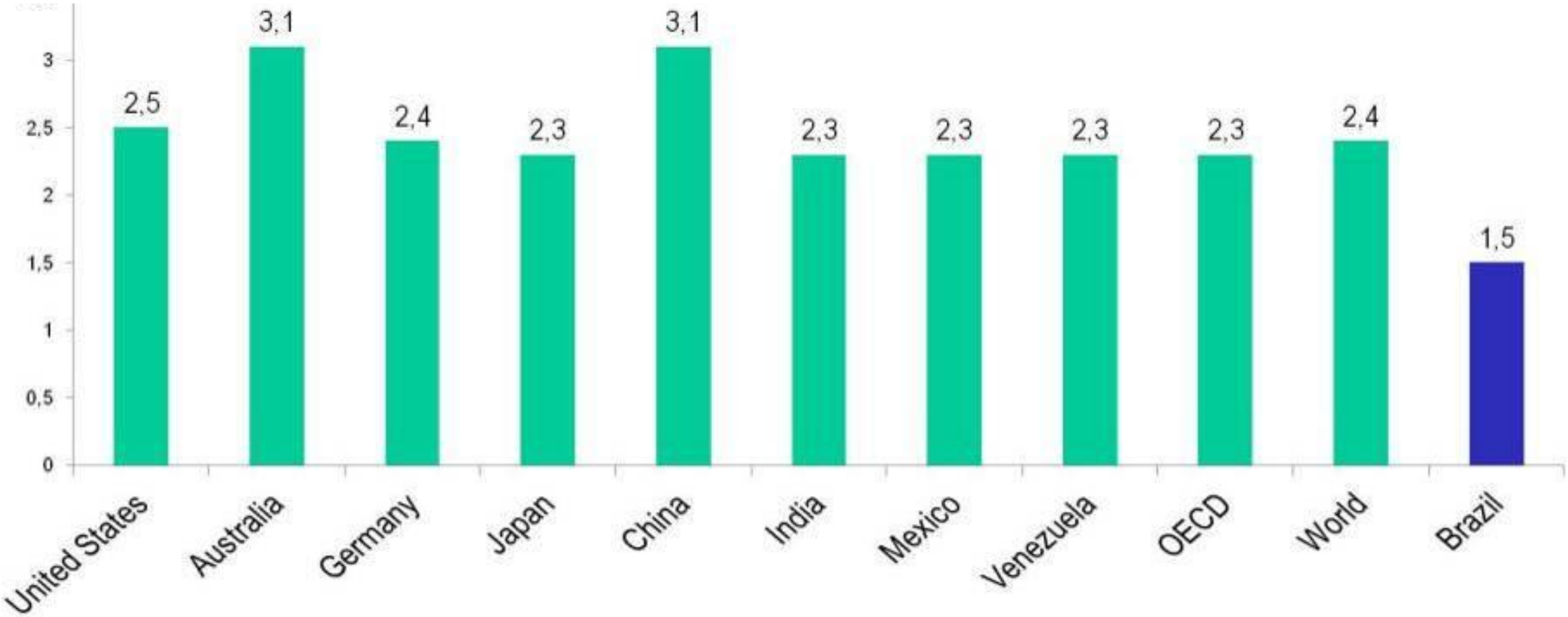


ENERGY SUPPLY MATRIX
WORLD x BRAZIL (%)



ENERGY SUPPLY MATRIX
WORLD x BRAZIL (%)

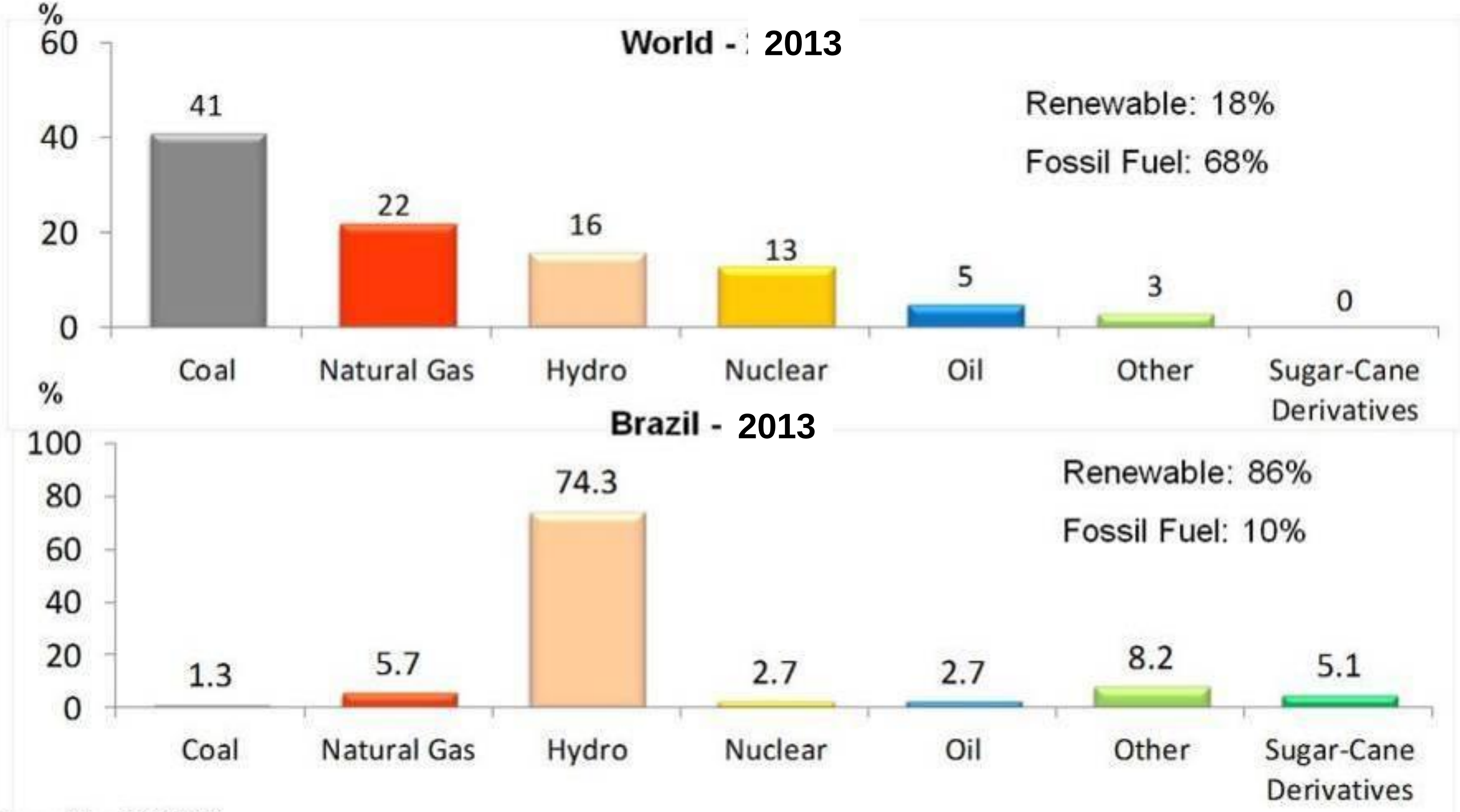
ENERGY SECTOR CARBON EMISSIONS (*)
SOME COUNTRIES AND REGIONS (tCO2/toe)



Source: International Energy Agency

(*) Evaluated Based on the Domestic Energy Supply

ELECTRICITY SUPPLY MATRIX
WORLD x BRAZIL (%)

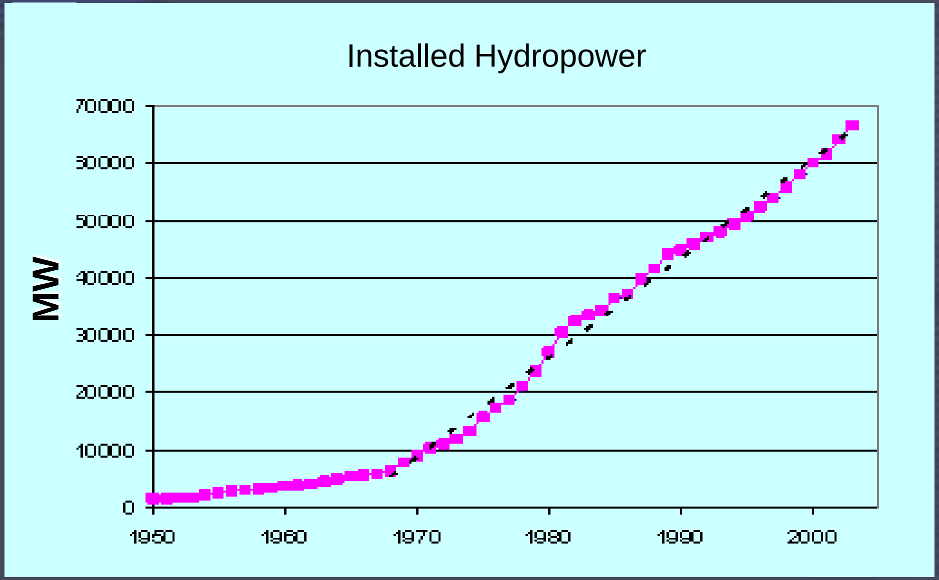


Source: IEA and MME/ BEN

HYDROPOWER REQUIRES SYSTEM INTEGRATION

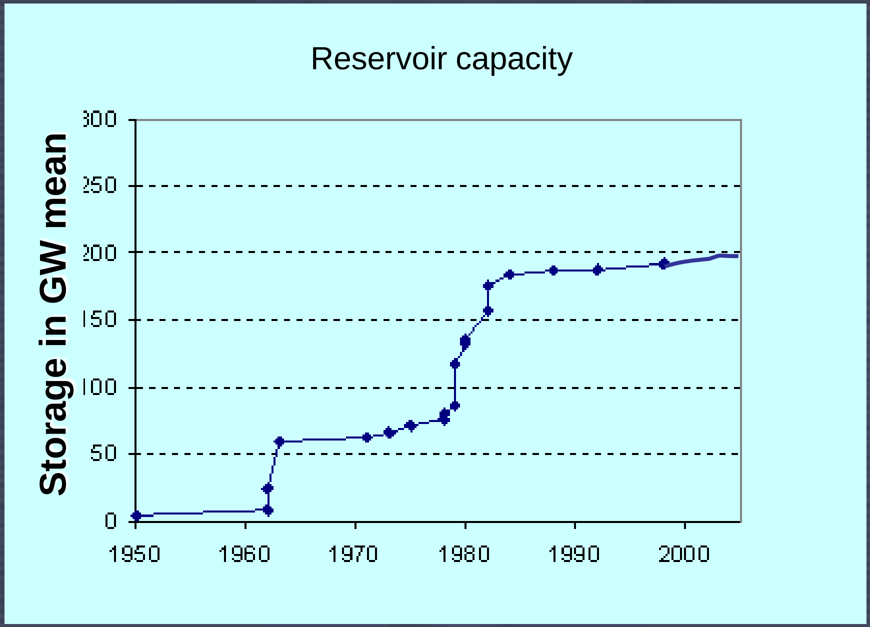
HAVING CONTINENTAL DIMENSIONS EQUIVALENT TO EUROPE

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



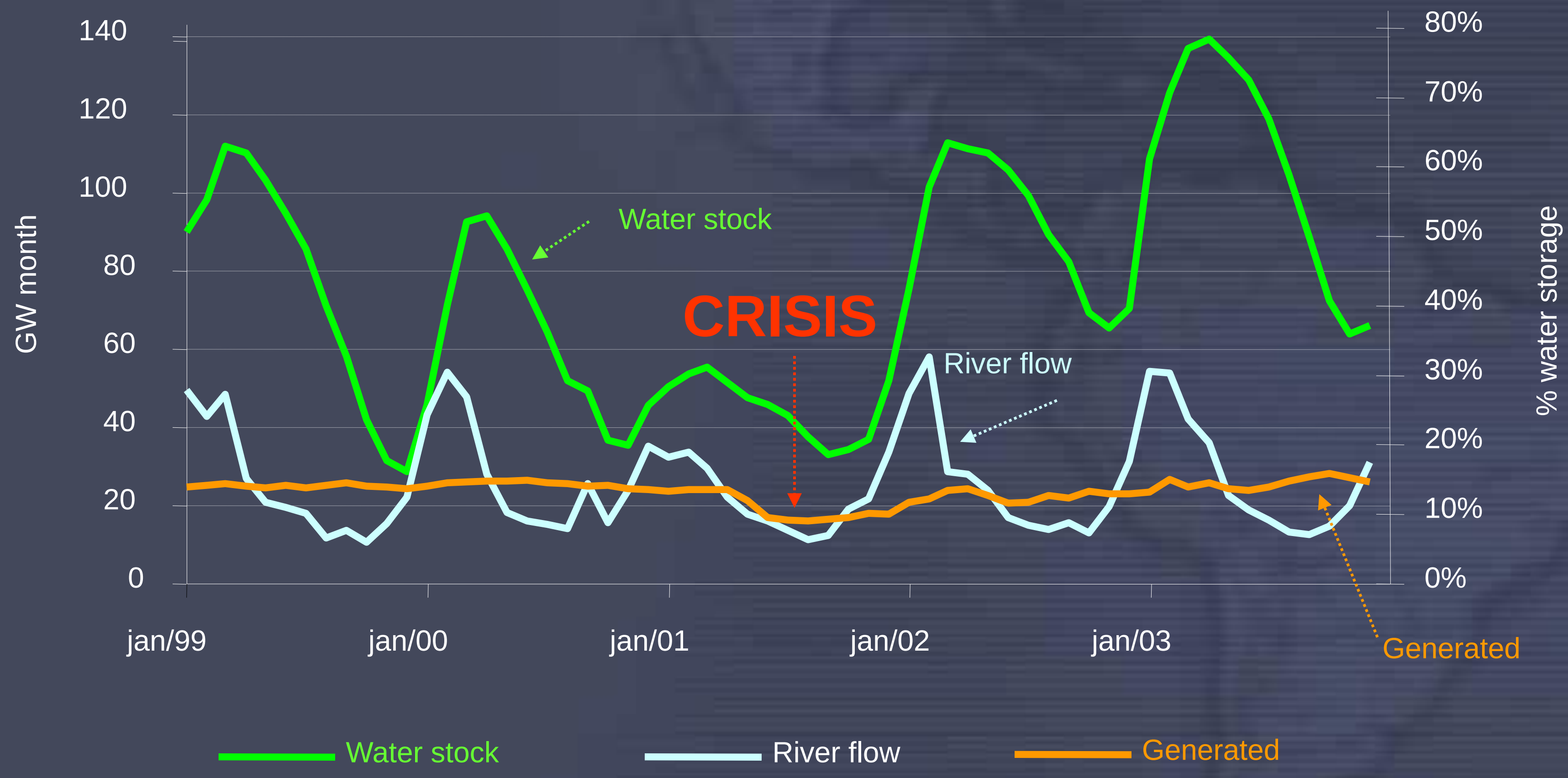
installed hydro capacity increasing …

… but without a proportional increase in the water stock

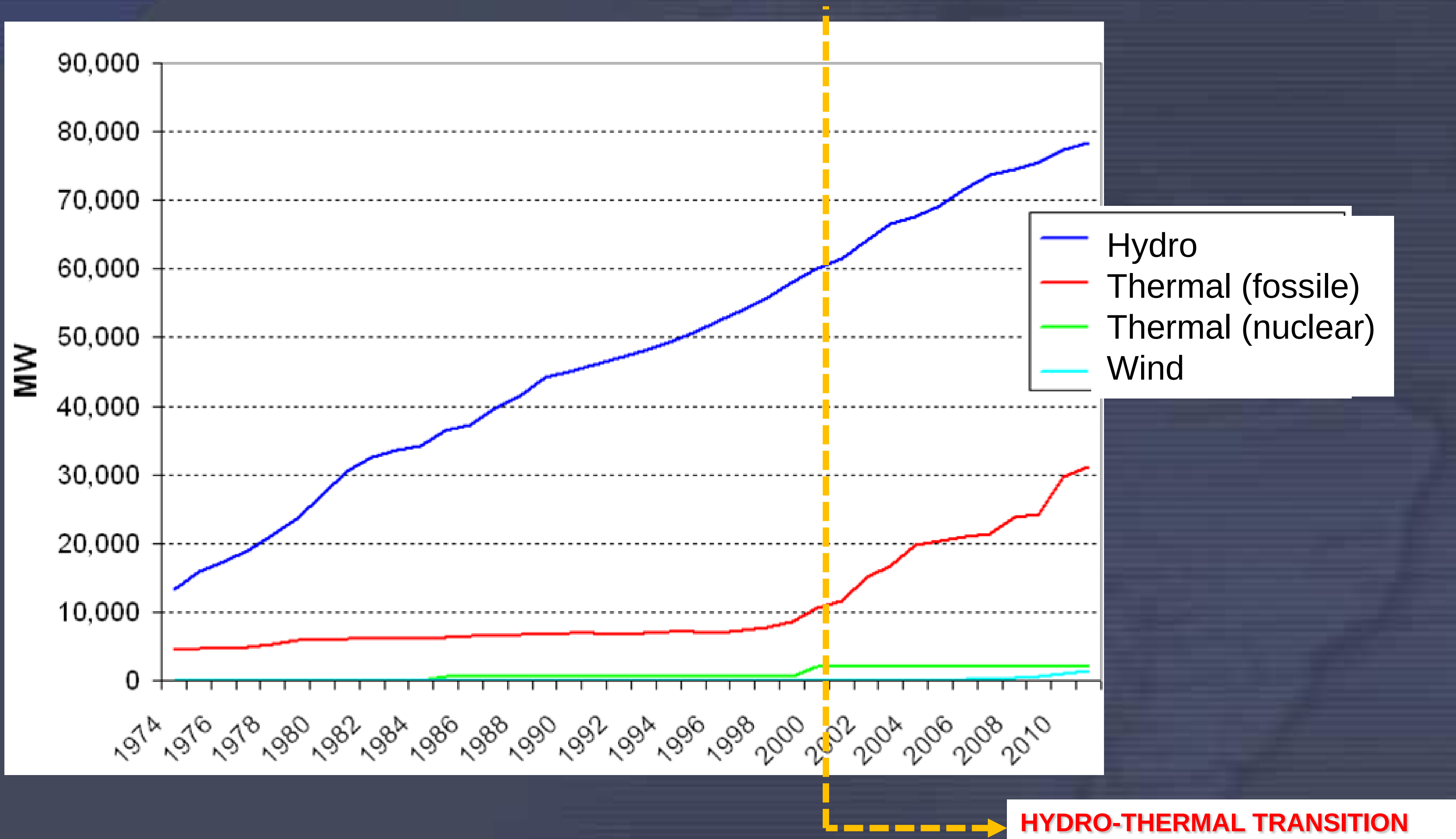


NEED FOR THERMAL REGULATION

root cause of 2001 supply crisis



ELECTRIC SYSTEM EVOLUTION
HYDRO-THERMAL TRANSITION



ELECTRIC SYSTEM EVOLUTION
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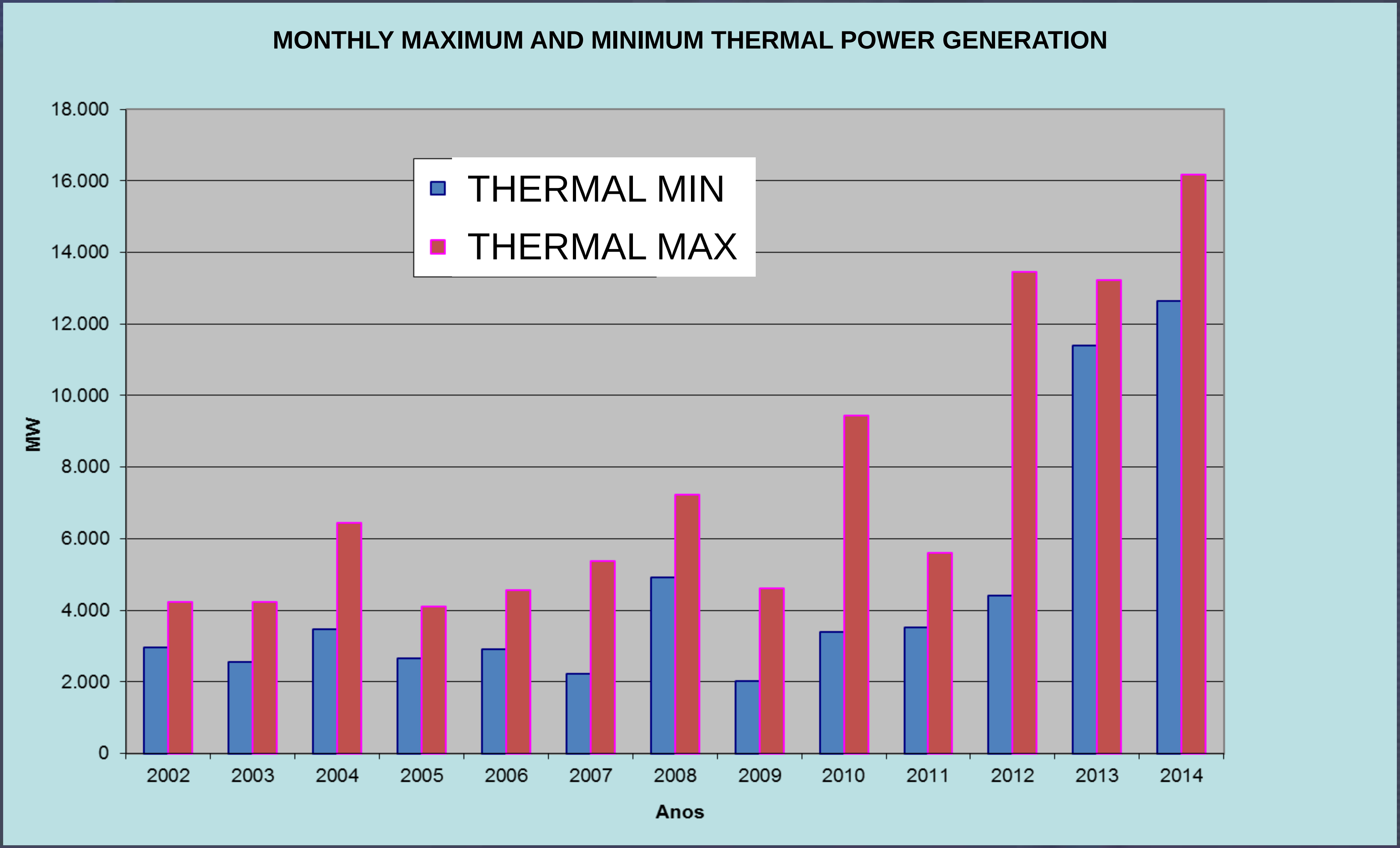
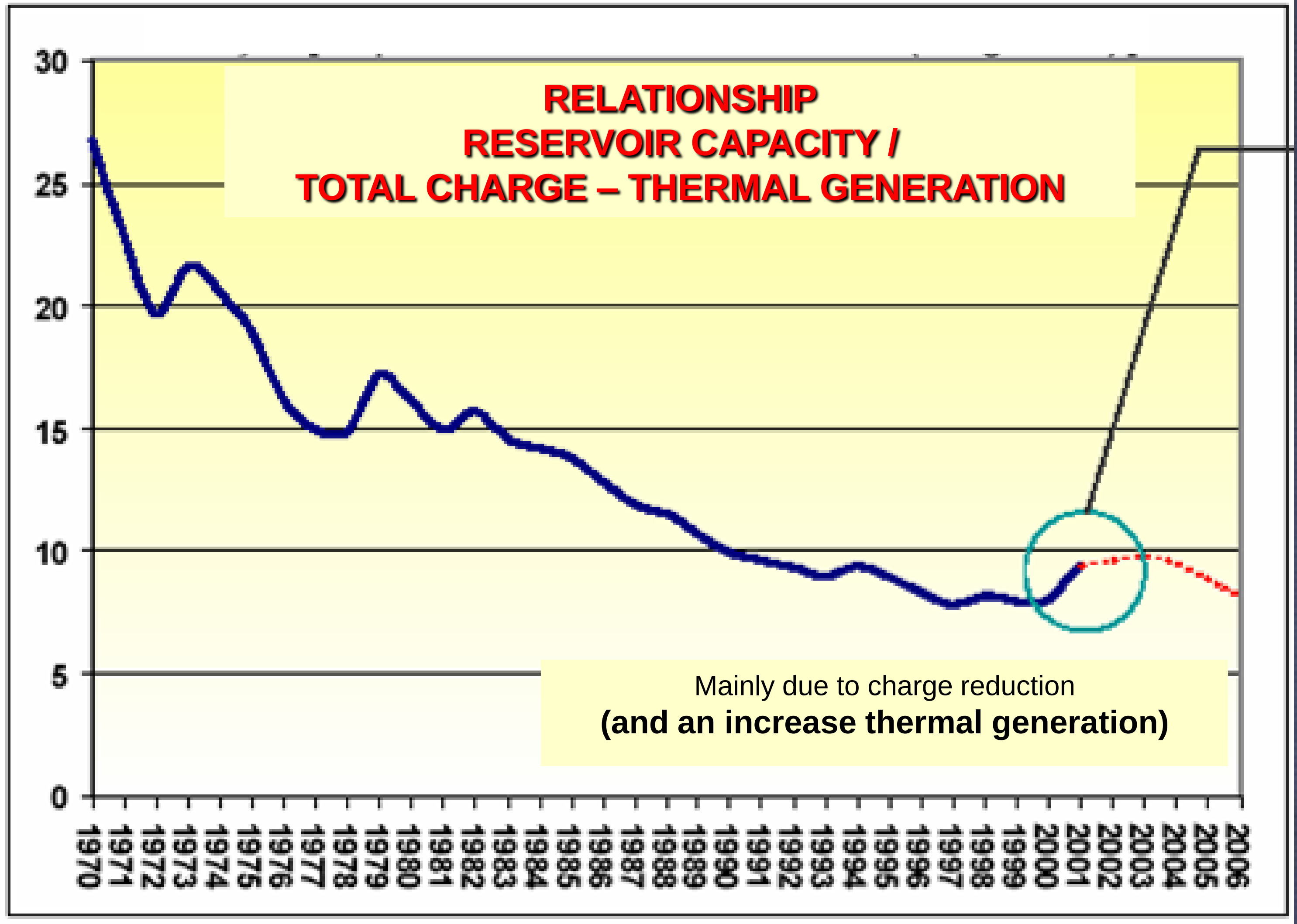


ELECTRIC SYSTEM EVOLUTION
HYDRO-THERMAL TRANSITION

the expansion of a large interconnected power system, with significant predominance of hydro renewable primary source now requires an increasing thermal contribution,

•by gradual exhaustion of the economic and environmentally feasible hydro potential and / or
•loss of autoregulation capacity due to lower water storage capacity in reservoirs in relation to the system load growth.

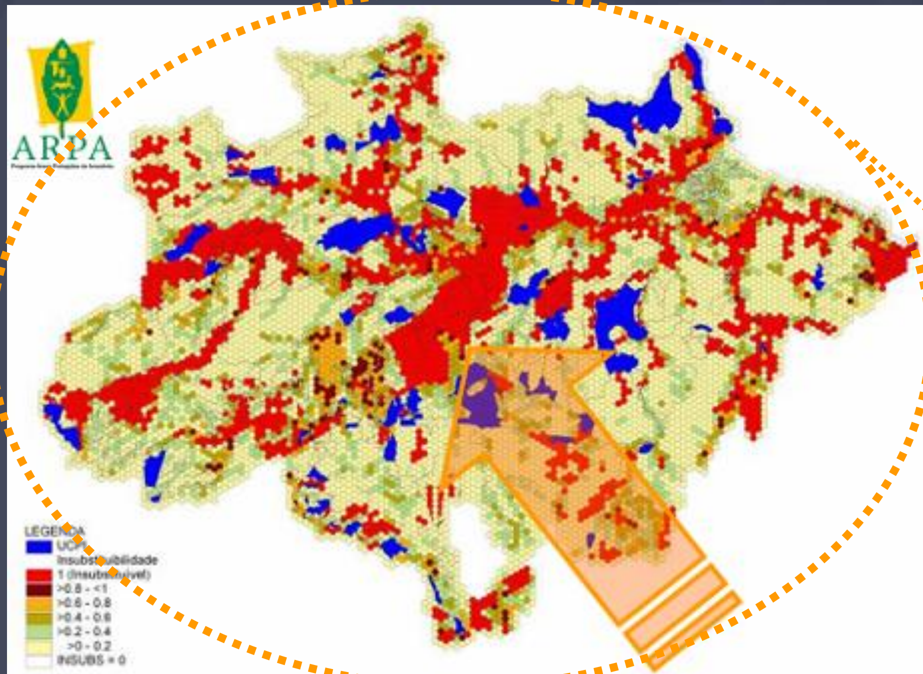
ELECTRIC SYSTEM EVOLUTION
NEED FOR THERMAL REGULATION

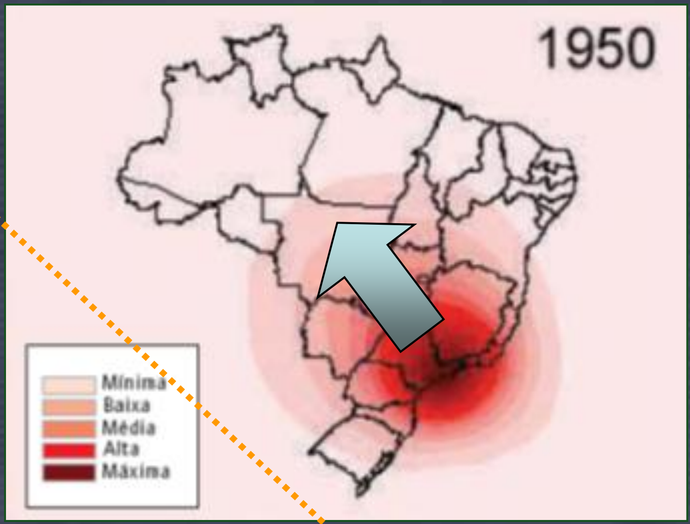


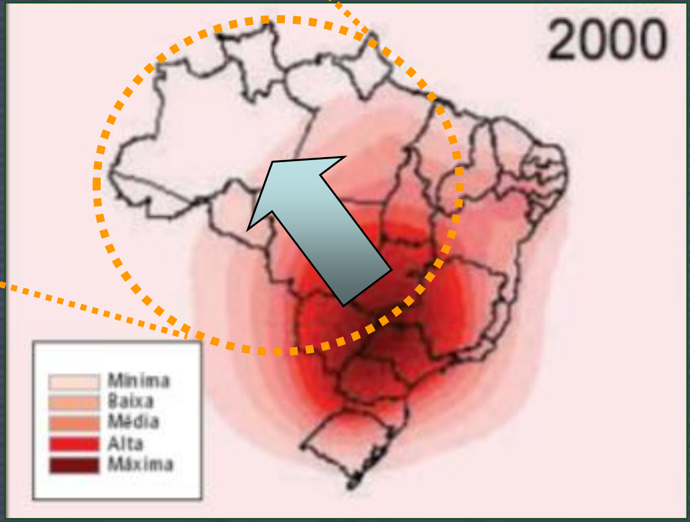
2001

S U P P L Y C R I S E

ELECTRIC SYSTEM EVOLUTION
"DAM CULTURE" CHANGE







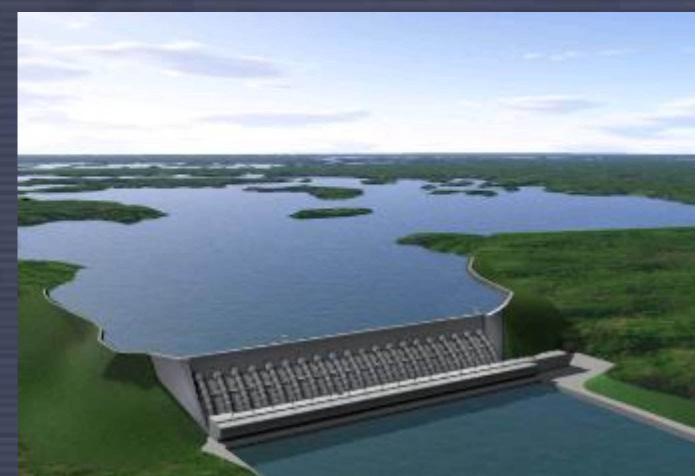
small reservoirs
to avoid flooding
large surfaces

ELECTRIC SYSTEM EVOLUTION
“DAM CULTURE” CHANGE

This tendency will be amplificated by new projects in Amazon Bassin

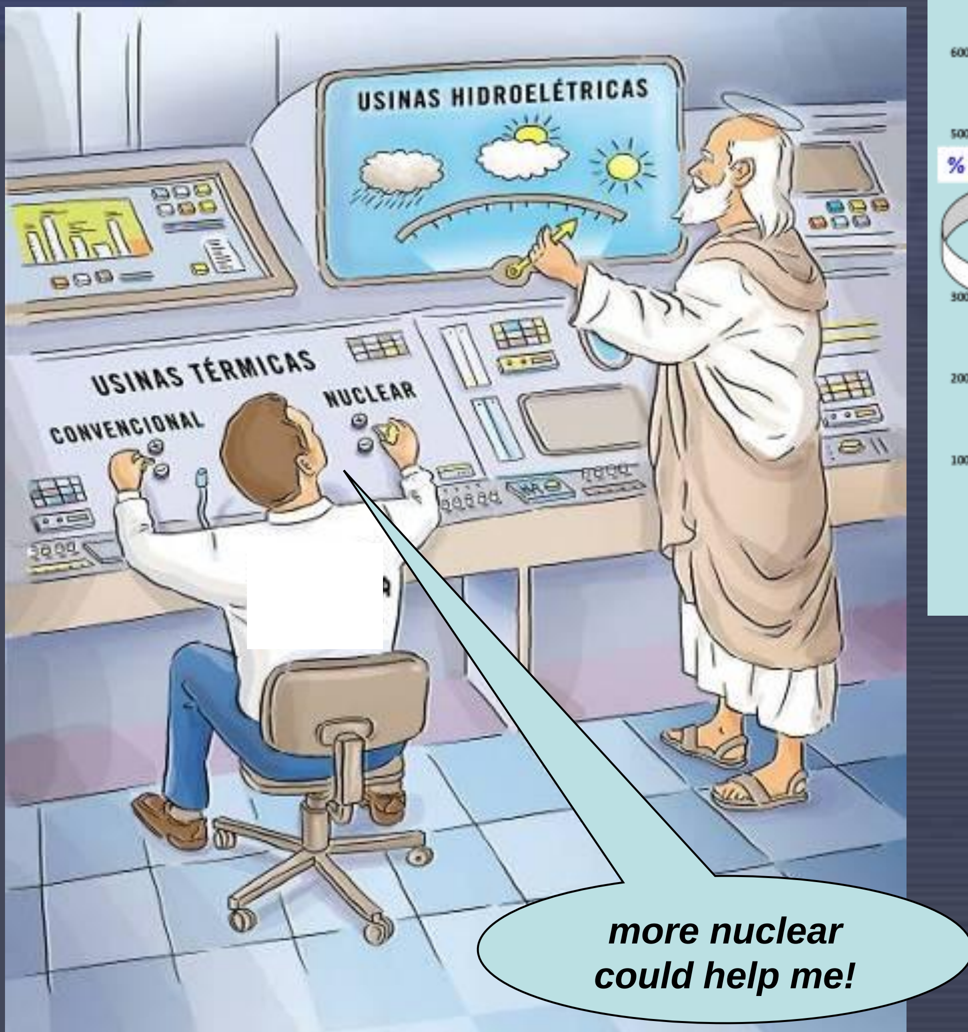
- **Current average hydro capacity factor: 55%**
- **Future average Amazon hydro capacity factor: 20-25%**

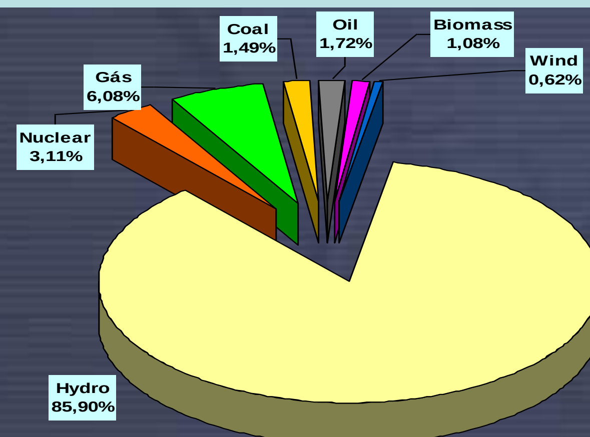
Project AHE MADEIRA 6.500 MW



Project AHE BELO MONTE 11.000 MW

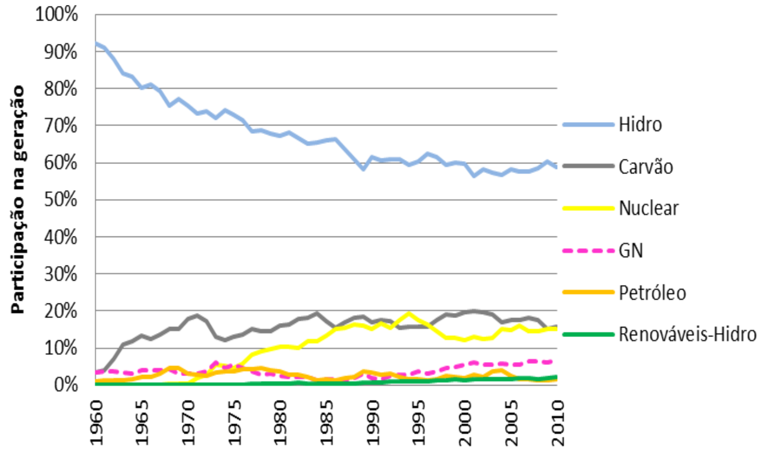
ELECTRIC SYSTEM EVOLUTION IN THE 90´s
NEED FOR THERMAL REGULATION



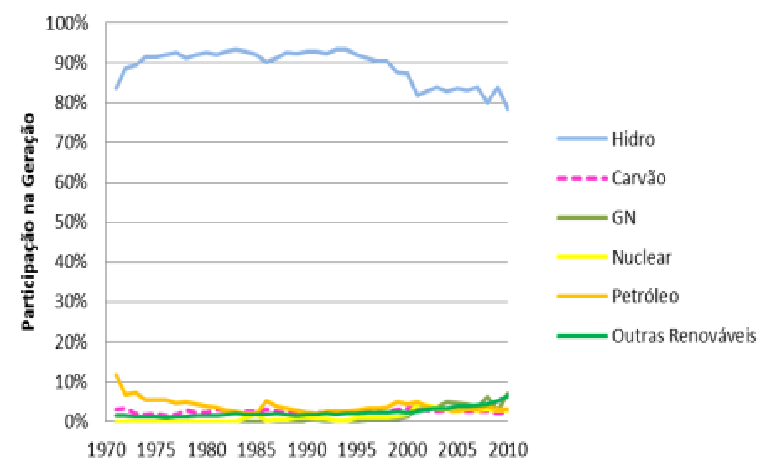


ELECTRIC SYSTEM EVOLUTION
HYDRO-THERMAL TRANSITION IS NOT NEW

ELECTRICITY GENERATION IN CANADA

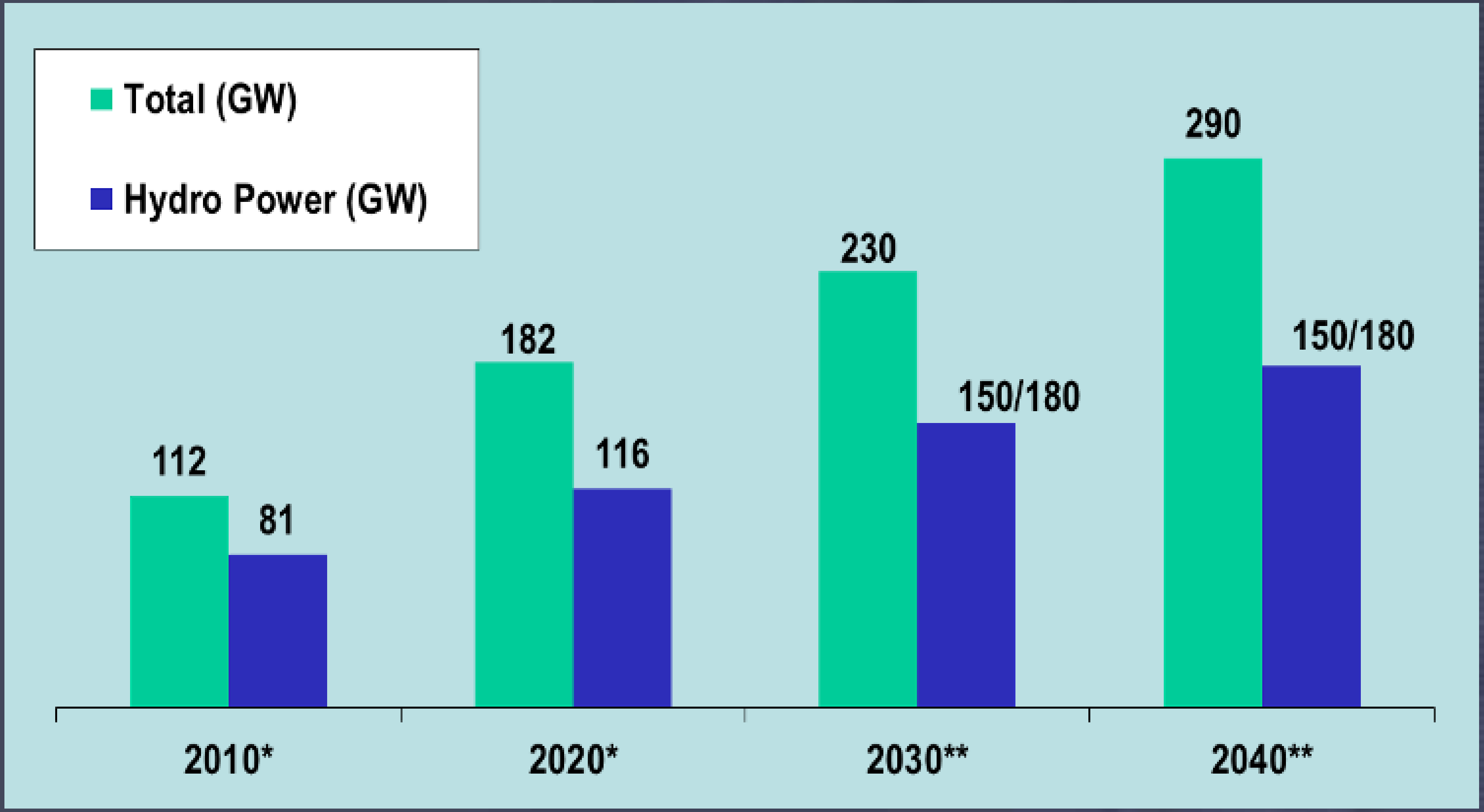


ELECTRICITY GENERATION IN BRAZIL



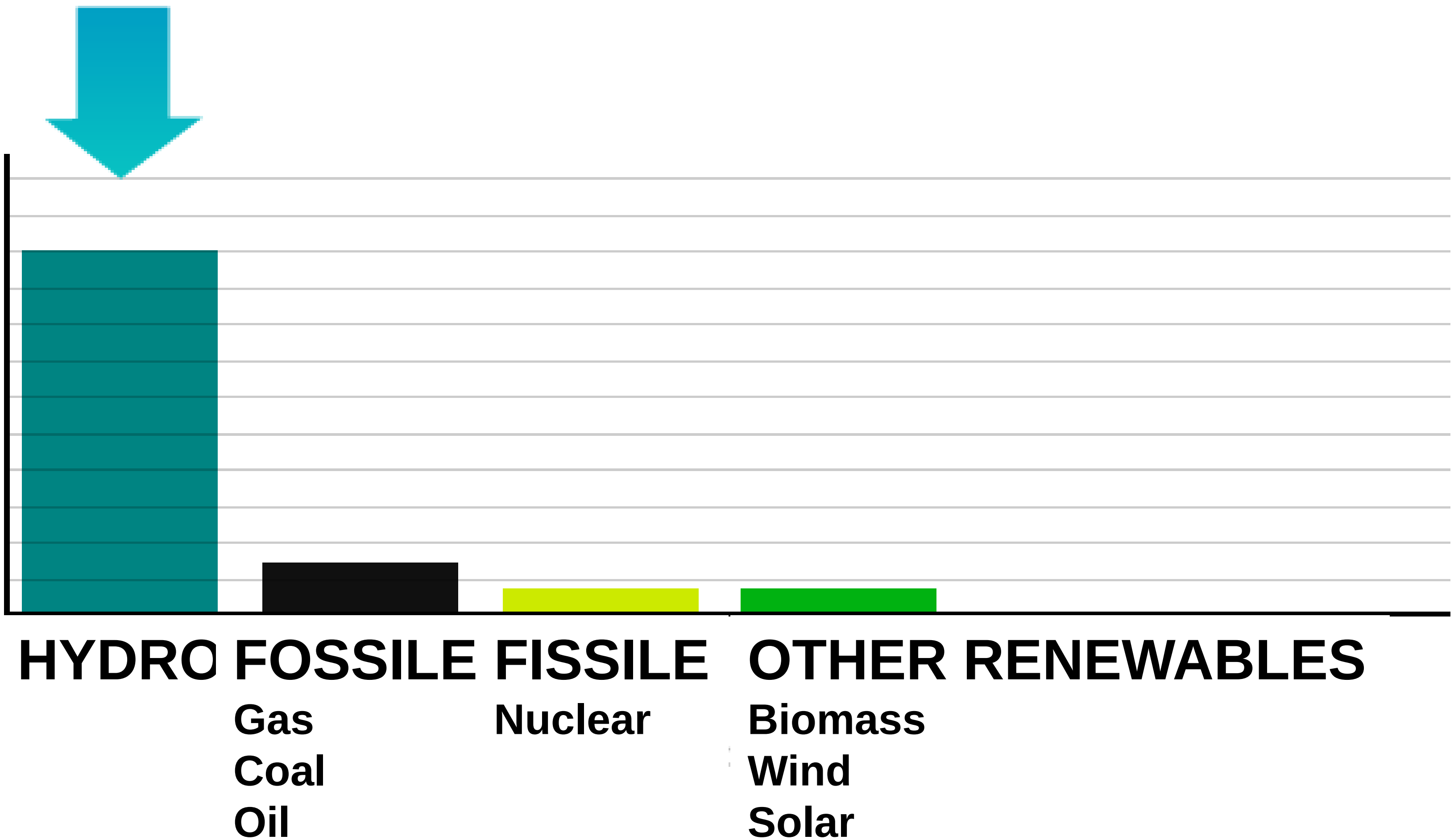
The evolution of the Canadian electrical system in 50 years holds many similarities with the situation of the Brazilian electrical system in last 15 years.

ELECTRIC SYSTEM EVOLUTION
BRAZILIAN TRANSITION IS NEW



Hydro Share	72%	69%	65/78%	52/62%

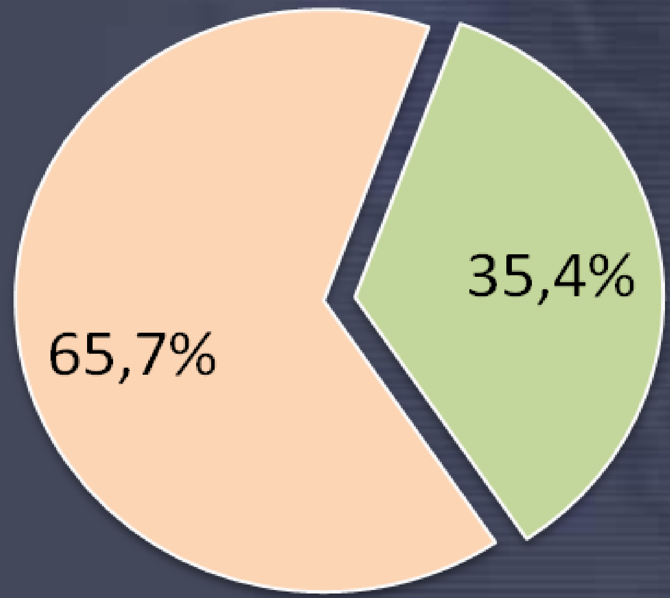
ELECTRIC SYSTEM EVOLUTION
BRAZILIAN TRANSITION IS NEW



PUBLIC ACCEPTANCE

NUCLEAR IN BRAZIL

NEGATIVE OPPINION

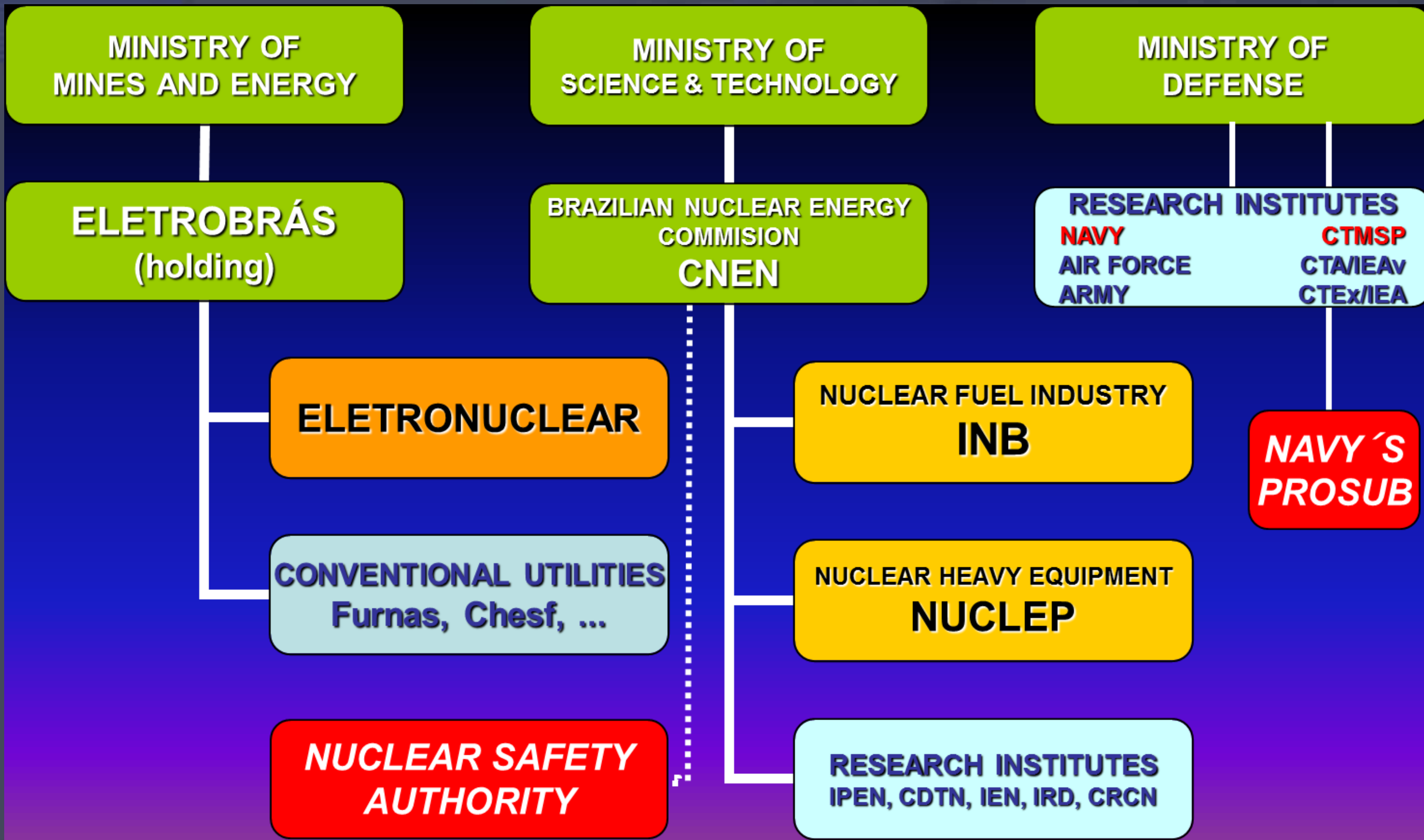


POSITIVE OPPINION

	Costa Verde	Rio de Janeiro	Other state capitals
POSITIVE OPPINION	55,6%	46,3%	32,4%
NEGATIVE OPPINION	45,4%	53,7%	67,6%

BRAZILIAN NUCLEAR INDUSTRY

MONOPOLY ESTABLISHED BY CONSTITUTION

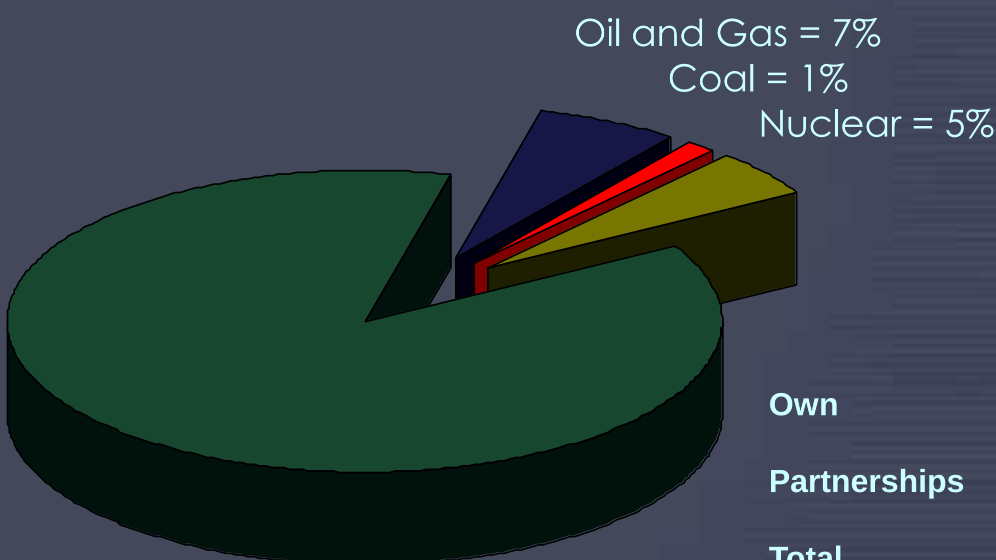


ELETROBRAS

10th. WORLD UTILITY

ELETROBRÁS

- ELETRONORTE – North Region
- CHESF – Northeast Region
- FURNAS – Southeast and Centerwest Regions
- ELETROSUL – South Region
- CGEEE – Coal Plants (South)
- ELETRONUCLEAR – Nuclear Power Plants (Country)



- ✓39,434 MW in operation
- ✓37% of Brazil Installed Capacity
- ✓59.000 km of transmission lines
- ✓56% of Brazil total transmission

	FURNAS	Chesf	Eletronorte	ITAIPU BINACIONAL	ELETRONUCLEAR	CGTEE	Total
Own	8,137	10,618	10,203	7,000	2,007	490	38,455
Partnerships	968	-	11	-	-	-	979
Total	9,105	10,618	10,214	7,000	2,007	490	39,434

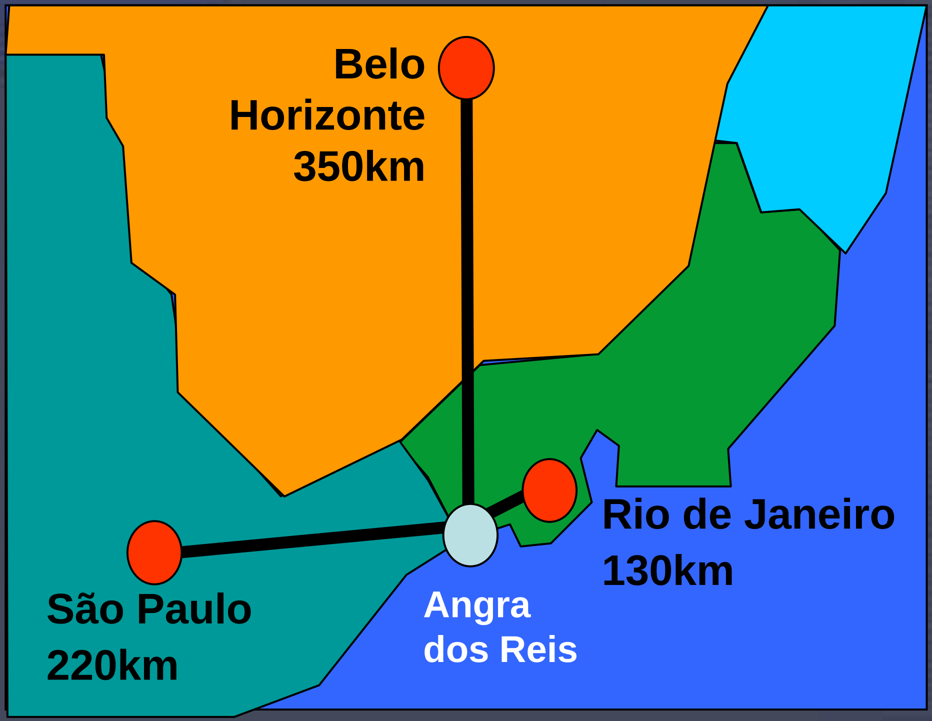
MISSION
WORKING ON 3 TIME FRAMES

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)

ADMIRAL ÁLVARO ALBERTO
NUCLEAR POWER STATION



LOCATED NEAR FROM THE 3 BRAZILIAN MAIN METROPOLITAN REGIONS

ADMIRAL ÁLVARO ALBERTO
NUCLEAR POWER STATION

ANGRA 1 AND ANGRA 2 OPERATION

GENERATION TILL 2012: 198.490.932 MWh

GENERATION RECORD 2012: 16,1 TWh*

*** Itaipu record: 94 TWh***

ANGRA 1 AND ANGRA 2 OPERATION

EAF 2010-2013
Angra 1&2: 4th

EAF 2012
Angra 1&2: 2nd

EAF 2011
Angra 1&2: 2nd

EAF 2010
Angra 1&2: 15th

IAEA | PRIS Power Reactor Information System

World Statistics | Country Statistics | Publications | Glossary | About PRIS

REACTOR STATUS REPORTS
- Operational & LTS
- Under Construction
- Permanent Shutdown

LAST THREE YEAR FACTORS
- Energy Availability
- Unit Capability
- Unplanned Capability Loss

LIFETIME FACTORS
- Energy Availability
- Unit Capability
- Unplanned Capability Loss

TREND REPORTS
- Nuclear Power Capacity
- Energy Availability
- Unit Capability
- Unplanned Capability Loss
- Load Factor
- Electricity Supplied

MISCELLANEOUS Reports
- Nuclear Share
- Reactors by Age

Energy Availability Factor

Includes all reactors that were in commercial operation within 2010 and 2012

Country	2010		2011		2012		2010 - 2012	
	Number of Reactors	EAF [%]	Number of Reactors	EAF [%]	Number of Reactors	EAF [%]	Number of Reactors	EAF [%]
ARGENTINA	2	81.9	2	72.0	2	71.7	2	75.2
ARMENIA	1	69.7	1	73.7	1	66.4	1	69.9
BELGIUM	7	87.5	7	88.7	7	74.1	7	83.4
BRAZIL	2	83.8	2	95.7	2	92.0	2	90.5
BULGARIA	2	84.3	2	90.0	2	88.5	2	87.6
CANADA	18	77.6	18	80.4	20	79.1	20	79.0
CHINA	13	88.8	14	87.7	15	89.2	15	88.6
CZECH REPUBLIC	6	81.6	6	81.7	6	86.0	6	83.1
FINLAND	4	91.9	4	92.8	4	91.0	4	91.9
FRANCE	59	76.4	58	79.3	58	76.0	59	77.2
GERMANY	17	76.7	17	82.0	9	90.5	17	81.9
HUNGARY	4	88.6	4	88.9	4	89.0	4	88.8
INDIA	19	57.6	20	76.2	20	77.3	20	70.6
JAPAN	54	66.9	54	41.8	50	9.8	54	40.0
KOREA, REPUBLIC OF	20	90.6	21	90.0	23	81.6	23	87.2
MEXICO	2	53.6	2	80.0	2	62.6	2	65.2
NETHERLANDS	1	88.9	1	92.1	1	86.9	1	89.3
PAKISTAN	2	69.7	3	70.3	3	84.3	3	75.9
ROMANIA	2	93.5	2	94.6	2	92.6	2	93.6
RUSSIA	32	81.4	32	80.3	32	80.6	32	80.8
SLOVAKIA	4	87.0	4	90.6	4	90.4	4	89.3
SLOVENIA	1	89.3	1	98.6	1	86.5	1	91.5
SOUTH AFRICA	2	82.9	2	81.3	2	77.4	2	80.5
SPAIN	8	90.1	8	83.2	8	88.7	8	87.4
SWEDEN	10	68.2	10	71.3	10	74.5	10	71.3
SWITZERLAND	5	88.6	5	89.5	5	84.8	5	87.6
UKRAINE	15	76.0	15	75.6	15	75.2	15	75.6
UNITED KINGDOM	19	63.4	19	71.2	18	77.1	19	70.4
UNITED STATES OF AMERICA	104	91.5	104	89.0	104	86.5	104	89.0
Total	**441**	**81.0**	**444**	**78.7**	**438**	**73.6**	**450**	**77.8**

The following information is included in the totals:

TAIWAN, CHINA	6	91.4	6	92.4	6	87.7	6	90.5

ANGRA 3 CONSTRUCTION

ANGRA 3
1.405 MW
2018

ANGRA 3 CONSTRUCTION

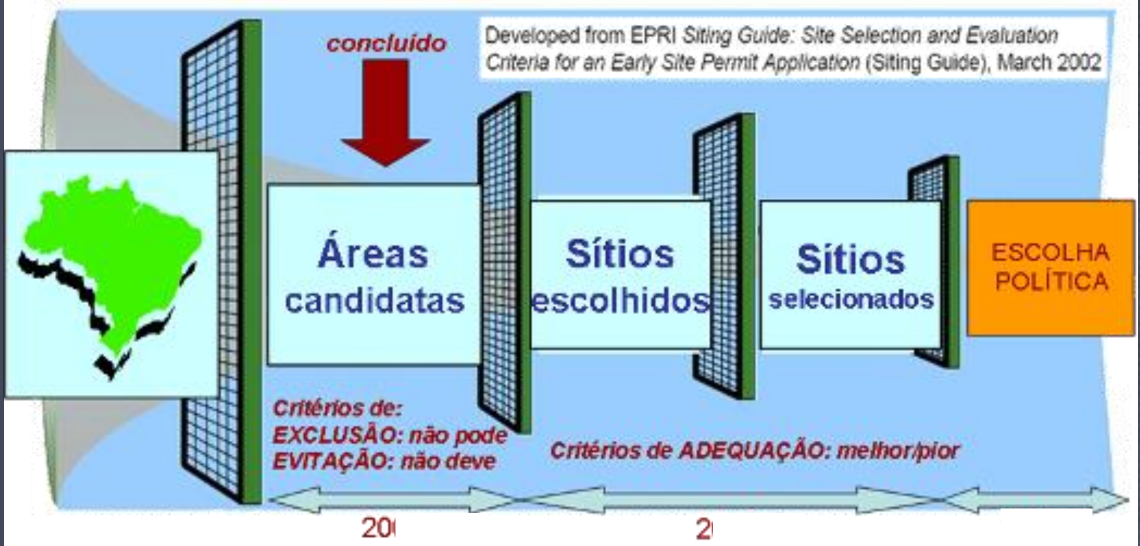
NATIONAL ENERGY PLAN 2030

1) Northeast
2.000 MW

2) Southeast
2.000 MW

STARTING OPERATION:
2025 - 2030

EPRI SITTING CRITERIA GEOPROCESSING TOOLS



NUCLEAR POTENCIAL ATLAS OF BRASIL

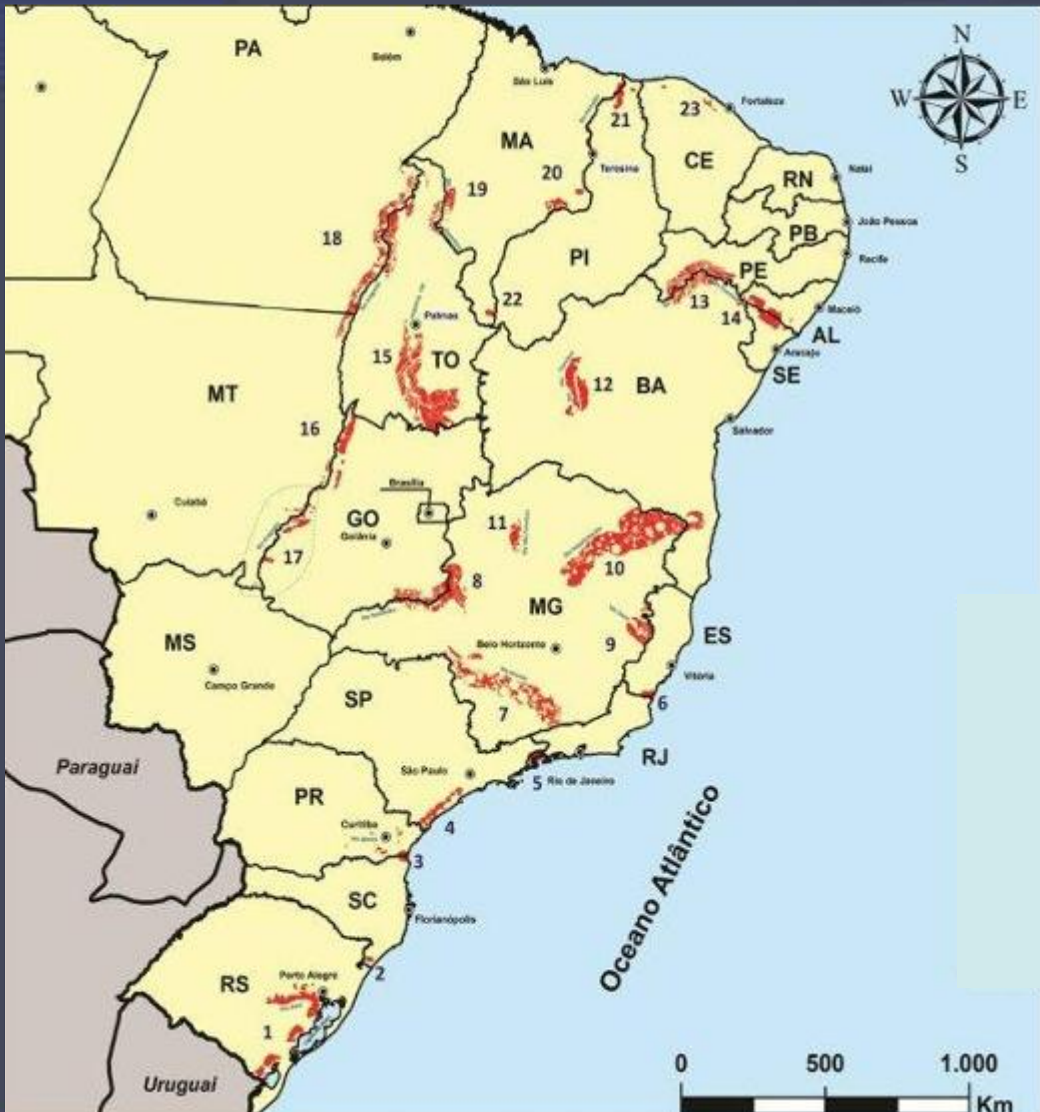
ELECTRIC SYSTEM EVOLUTION

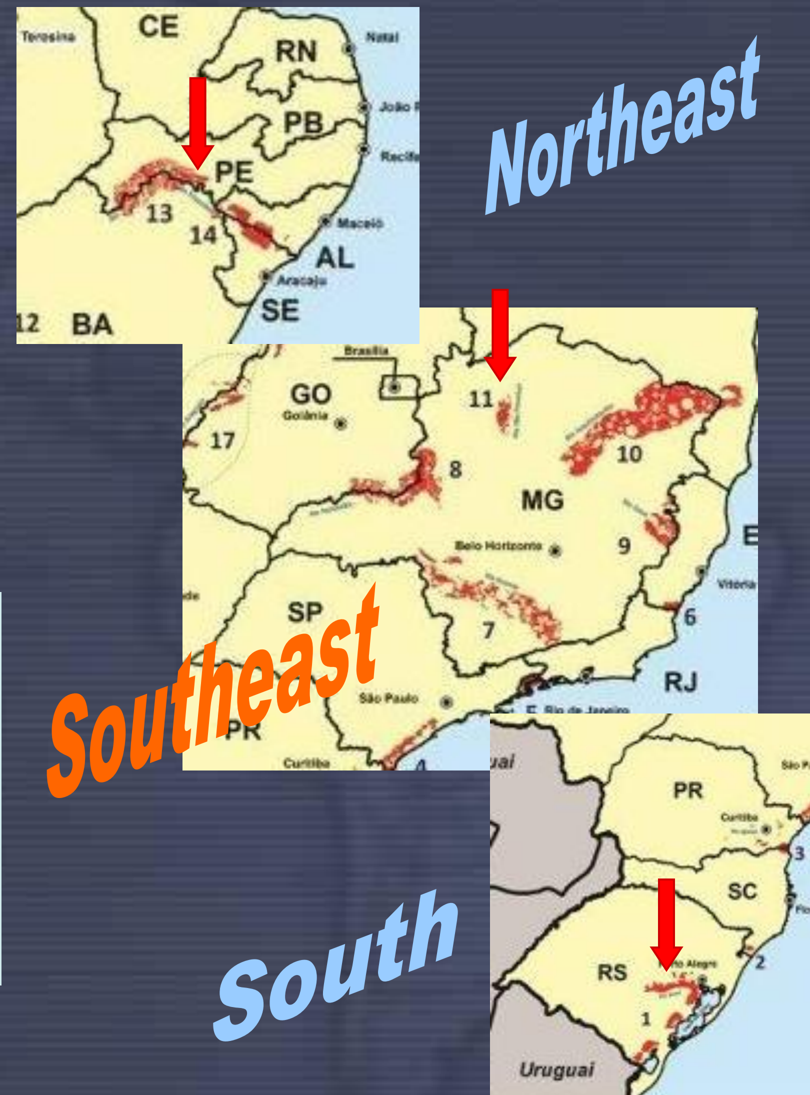
NUCLEAR CAPACITY INSTALLED - 2030

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

BRAZILIAN NUCLEAR POTENCIAL ATLAS





NUCLEAR EXPANSION IN BRAZIL

SÃO FRANCISCO RIVER NUCLEAR POWER STATION

Current Activities

- **Plant Parameter Envelope**
  - RFIs to suppliers
  - Early Site Permit Report
- **Brazilian Utility Requirements**
  - URD/EUR model
- **Business Model**
  - Private participation
- **Economic and Financial Feasibility studies**
- **Social and Economic Impact studies**

SÃO FRANCISCO RIVER NUCLEAR POWER STATION

INSPIRED ON TVA ROADMAP

A ROUTE TO DEVELOPMENT

BUILDING NEW NUCLEAR
THE CHALLENGES AHEAD

Plans for new build in Brazil

Consequence of failing to deliver new build

Will the new nuclear programme be delivered?

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

BRAZILIAN URANIUM RESOURCES

ONE OF THE MAIN RESERVES IN THE WORLD

Tons U_3O_8

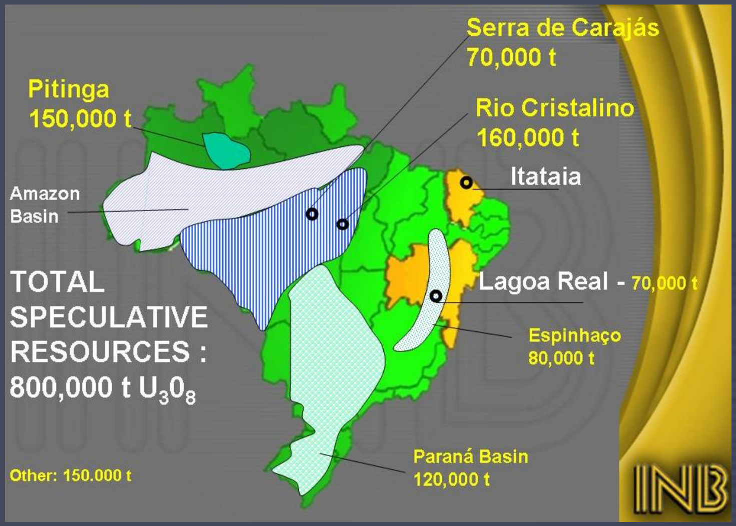
DEPOSITS	Measured and Indicated	Inferred	TOTAL
LAGOA REAL (BA)	94,000	6,700	100,770
ITATAIA (CE)	91,200	51,300	142,500
OTHERS	39,500	26,600	66,100
TOTAL	224,700	84,670	309,370

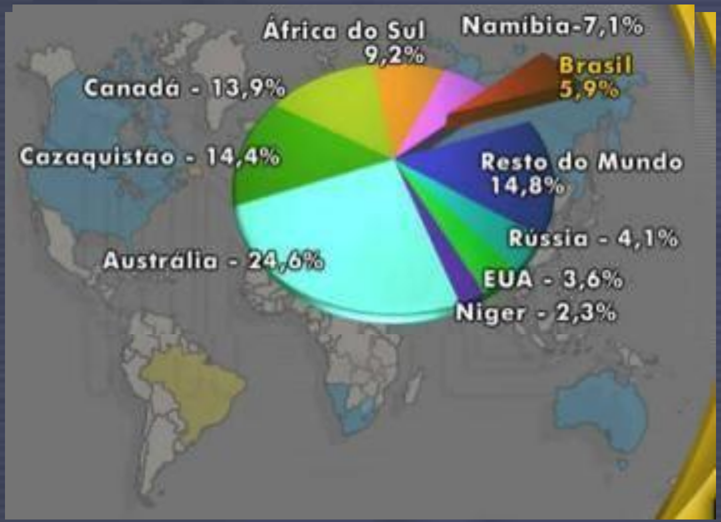
Prospected area:

only 30% of national territory

up to 100 meters deep

6th. WORLD RESERVE

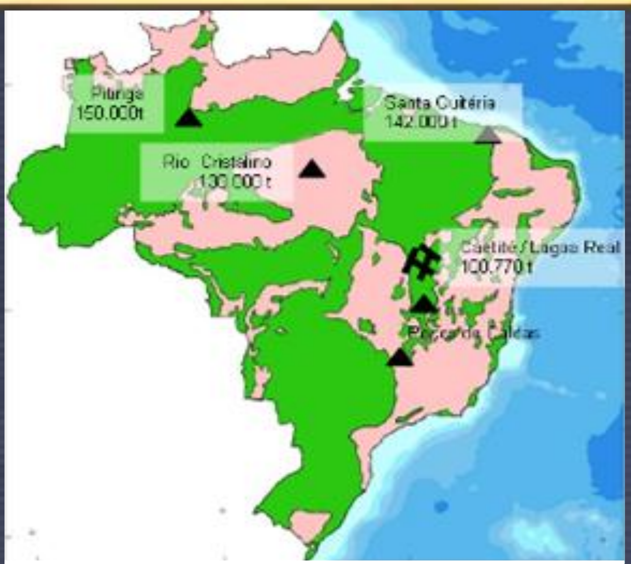




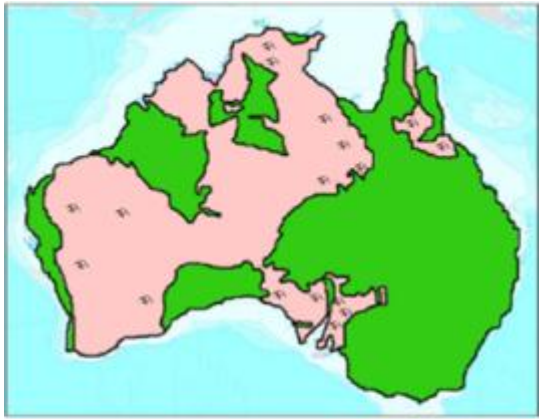
BRAZILIAN URANIUM RESOURCES

ONE OF THE MAIN RESERVES IN THE WORLD

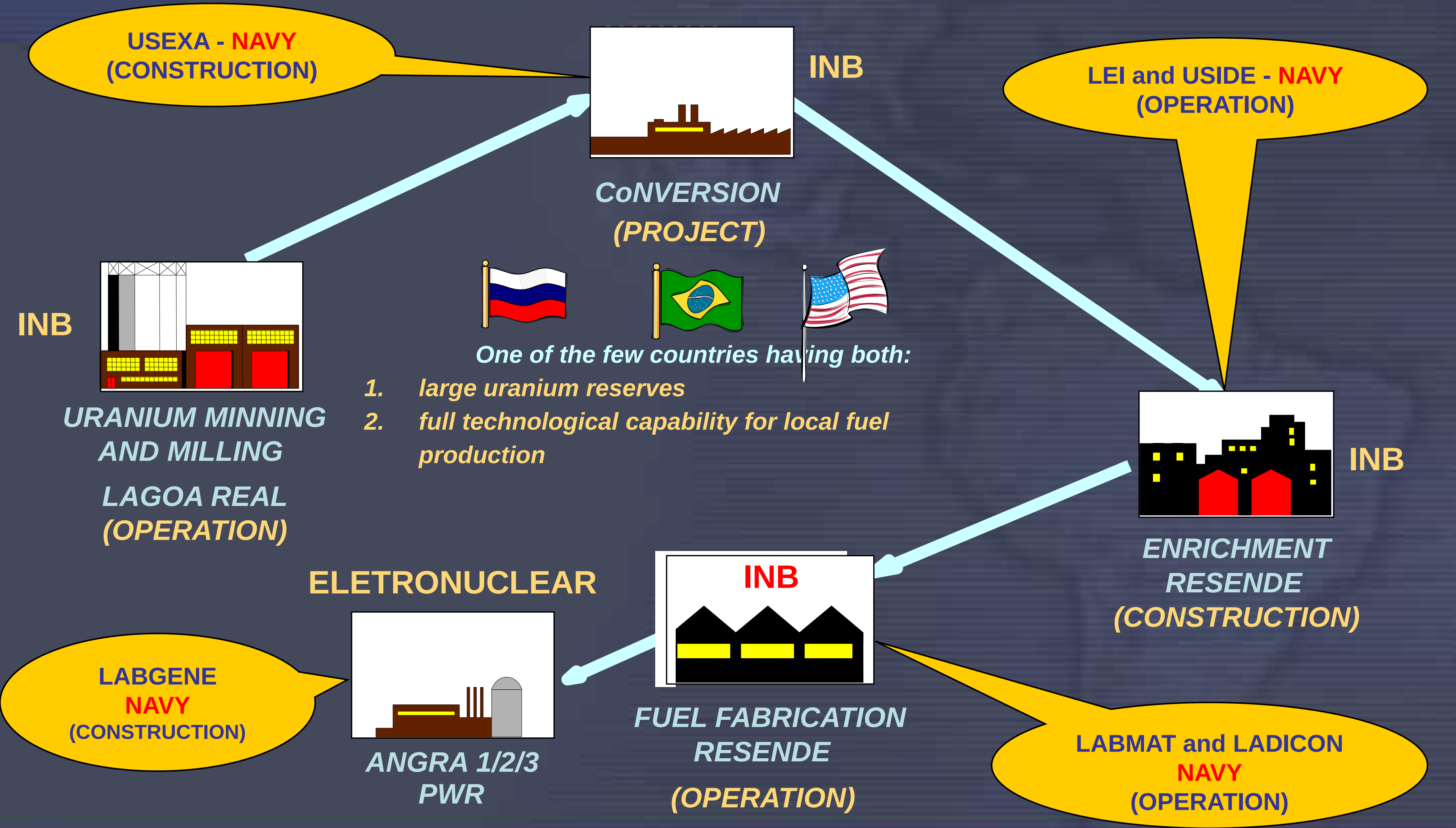
After prospected all the national territory, probably *Brazil should be among the 2 MAJOR WORLD RESERVES*



Pré-cambrian soils
Brasil 3.400.000 km2
Austrália 3.800.000 km2



NUCLEAR FUEL INDUSTRY IN BRAZIL
URANIUM + TECHNOLOGICAL CAPABILITIES



NUCLEAR FUEL INDUSTRY IN BRAZIL
URANIUM + TECHNOLOGICAL CAPABILITIES

INB

RESENDE:

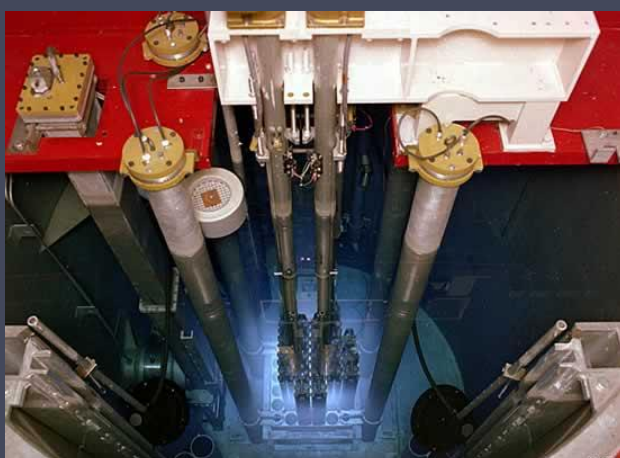
POWDER & PELLETS
ENRICHMENT
FUEL FABRICATION

RESEARCH REACTORS IN BRAZIL

IEA-R1m
CNEN/IPEN
São Paulo

IPEN/MB-01
São Paulo

CNEN

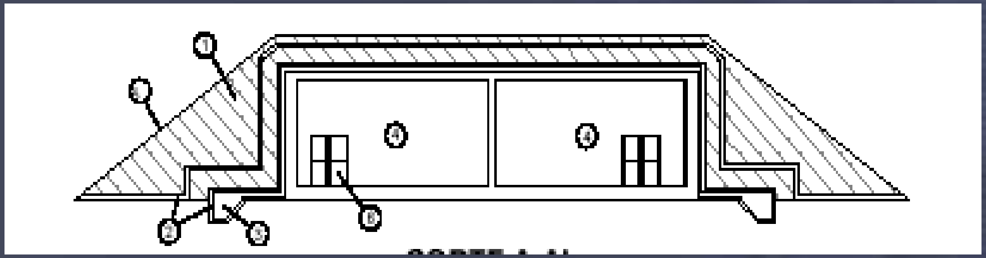


TRIGA
CNEN/CDTN
Belo Horizonte

Argonauta
CNEN/IEN
Rio de Janeiro

RESEARCH REACTORS IN BRAZIL

LOW AND MEDIUM LEVEL WASTE
FINAL DISPOSAL

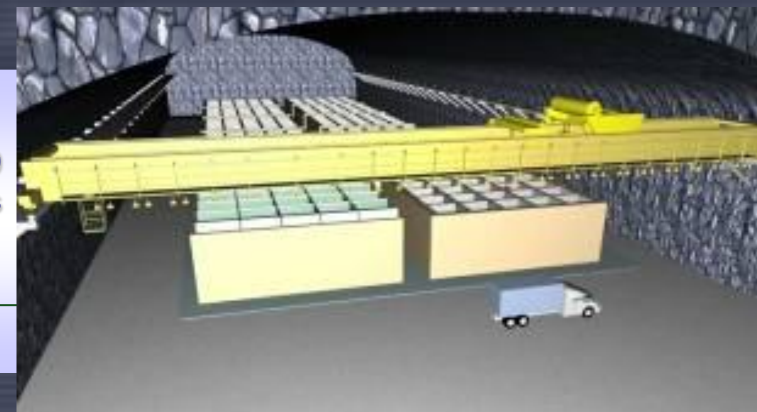


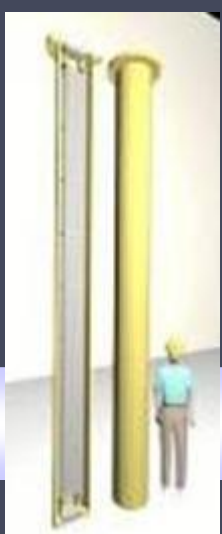
SPENT FUEL LONG TERM STORAGE
BRAZILIAN SOLUTION

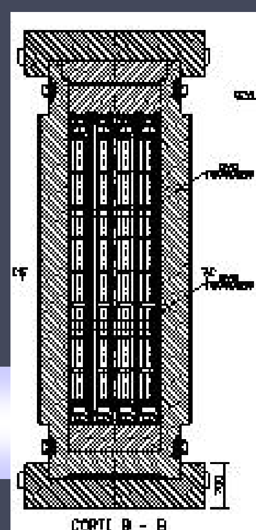
External pool (2020)

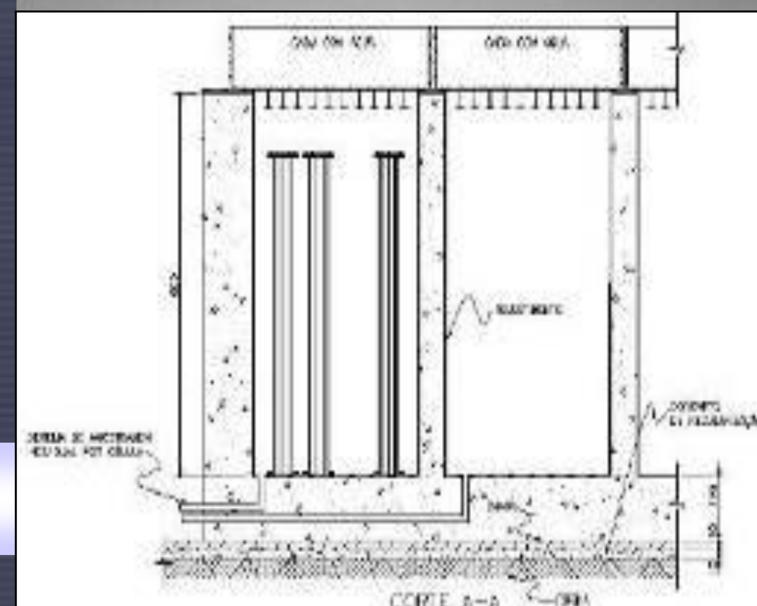
Long Term Interim Storage (2035)

Designed for 500 years



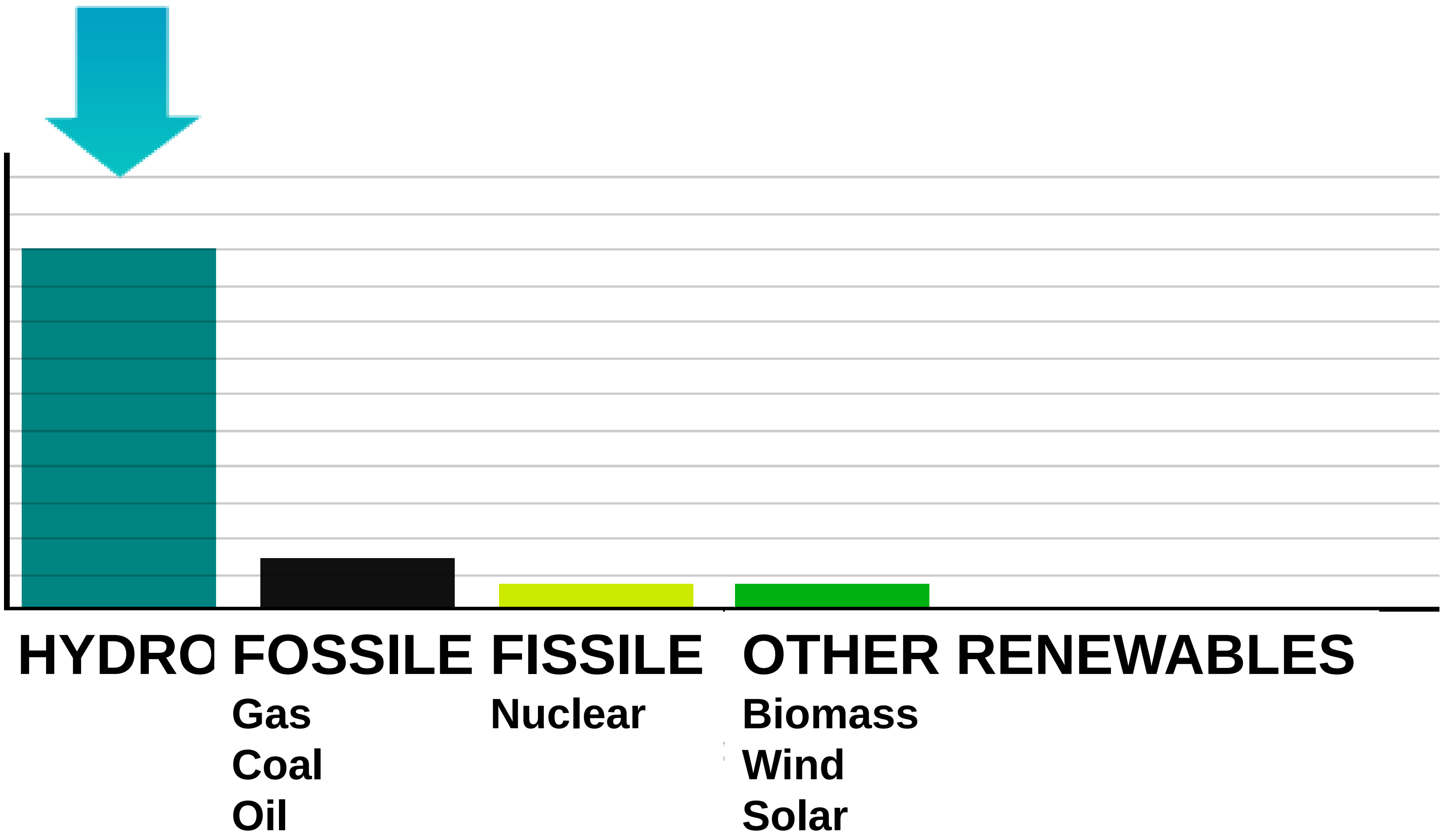






WHY NUCLEAR IN BRAZIL?

HYDRO-THERMAL TRANSITION




Amazon forest
Football
Carnival
Coffee
Thank you!
UO2 powder
Pellets
Fuel Elements
Generation