



THE 48th JAIF ANNUAL CONFERENCE

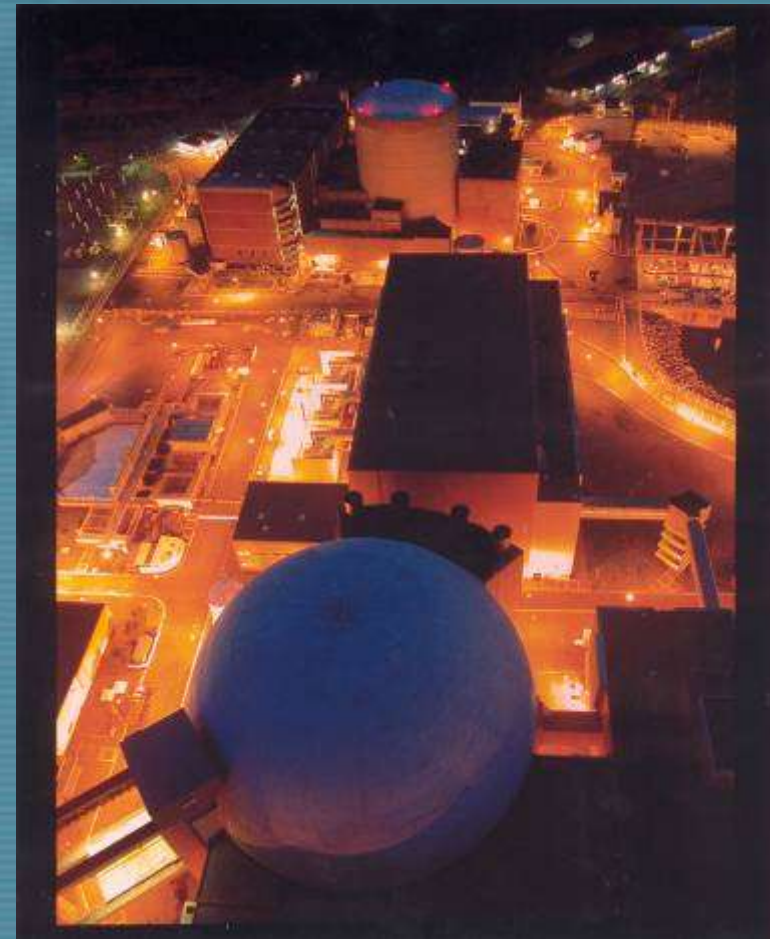
April 13 - 14, 2015
TOKYO, JAPAN

"Why Nuclear?"



Eletrobras
Eletronuclear

Hydrothermal Transition: Why nuclear in Brazil?



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

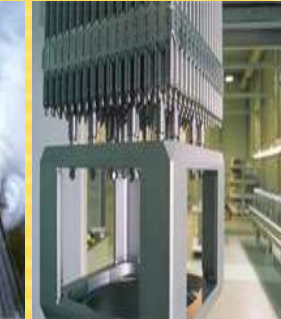
Enrichment

UO₂ powder

Pellets

Fuel
Elements

Power
Generation



A synergic mix of:

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



BRAZIL

GENERAL DATA

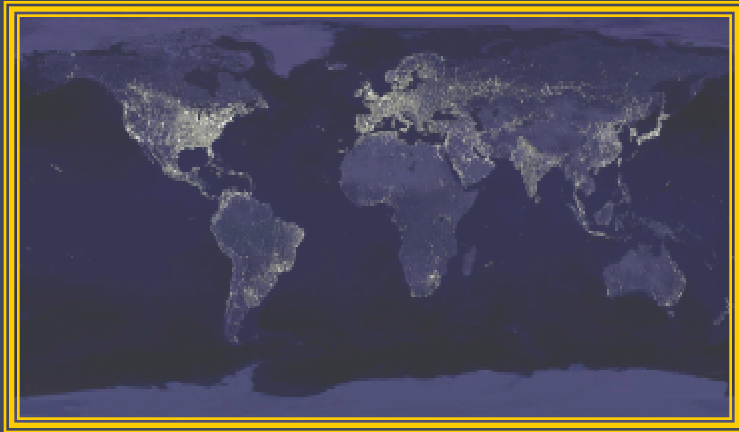
National Interconnected System



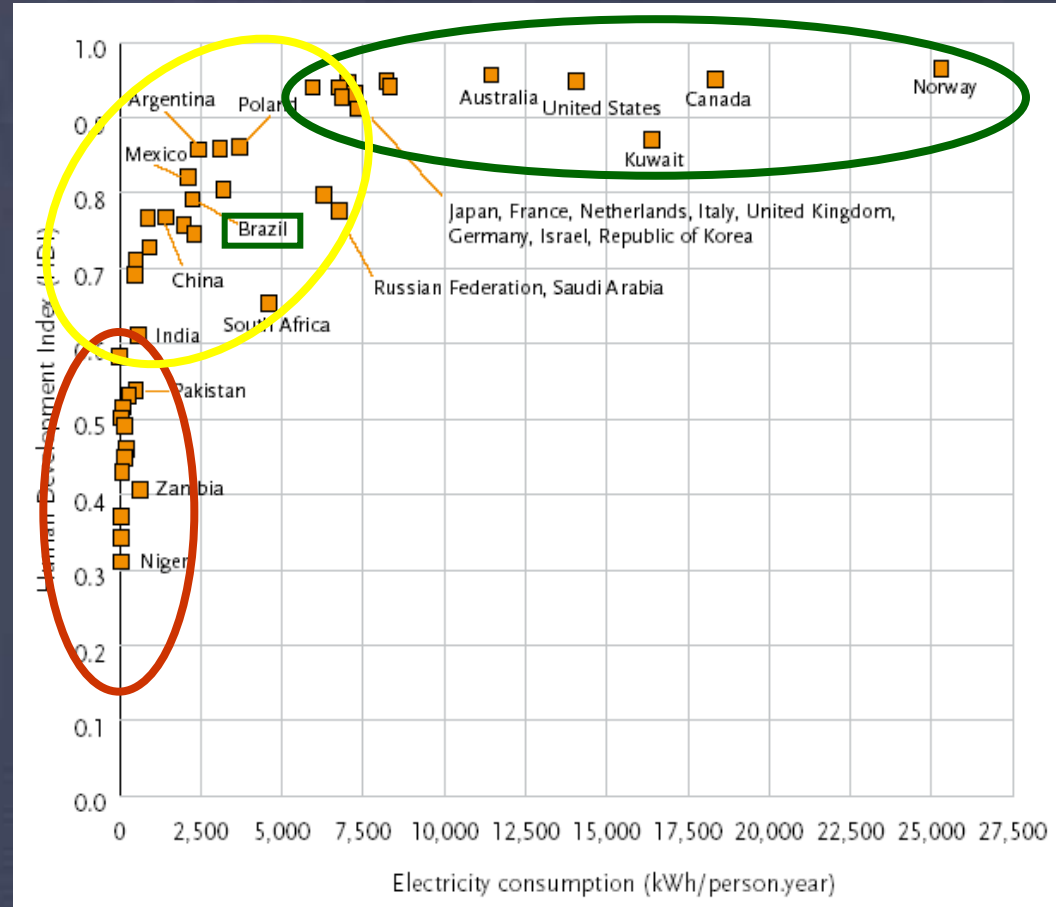
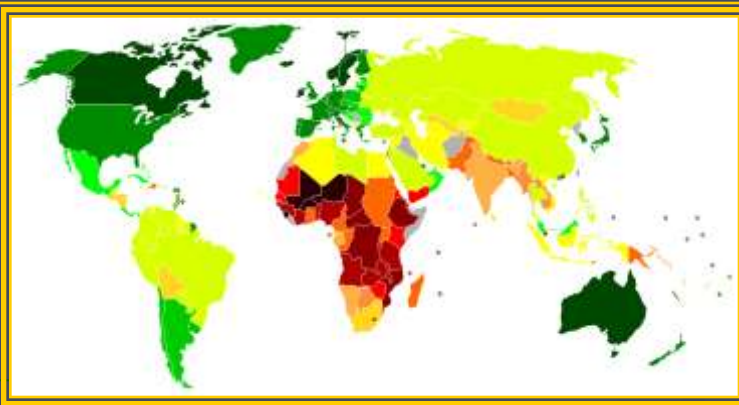
Population	192 million	5th
Surface	8.5 million km ²	5th
GDP	US\$ 1.98 trillion	8th
GDP/capita	US\$ 10,300/inh	77th
HDI	0.807	70th
Electric installed capacity	102.6 GW	9th
electricity production/year	450 TWh	10th
electricity consumption/capita	2,400 kWh/inh	90th

HDI X ELECTRICITY CONSUMPTION

BRAZIL: 90th place

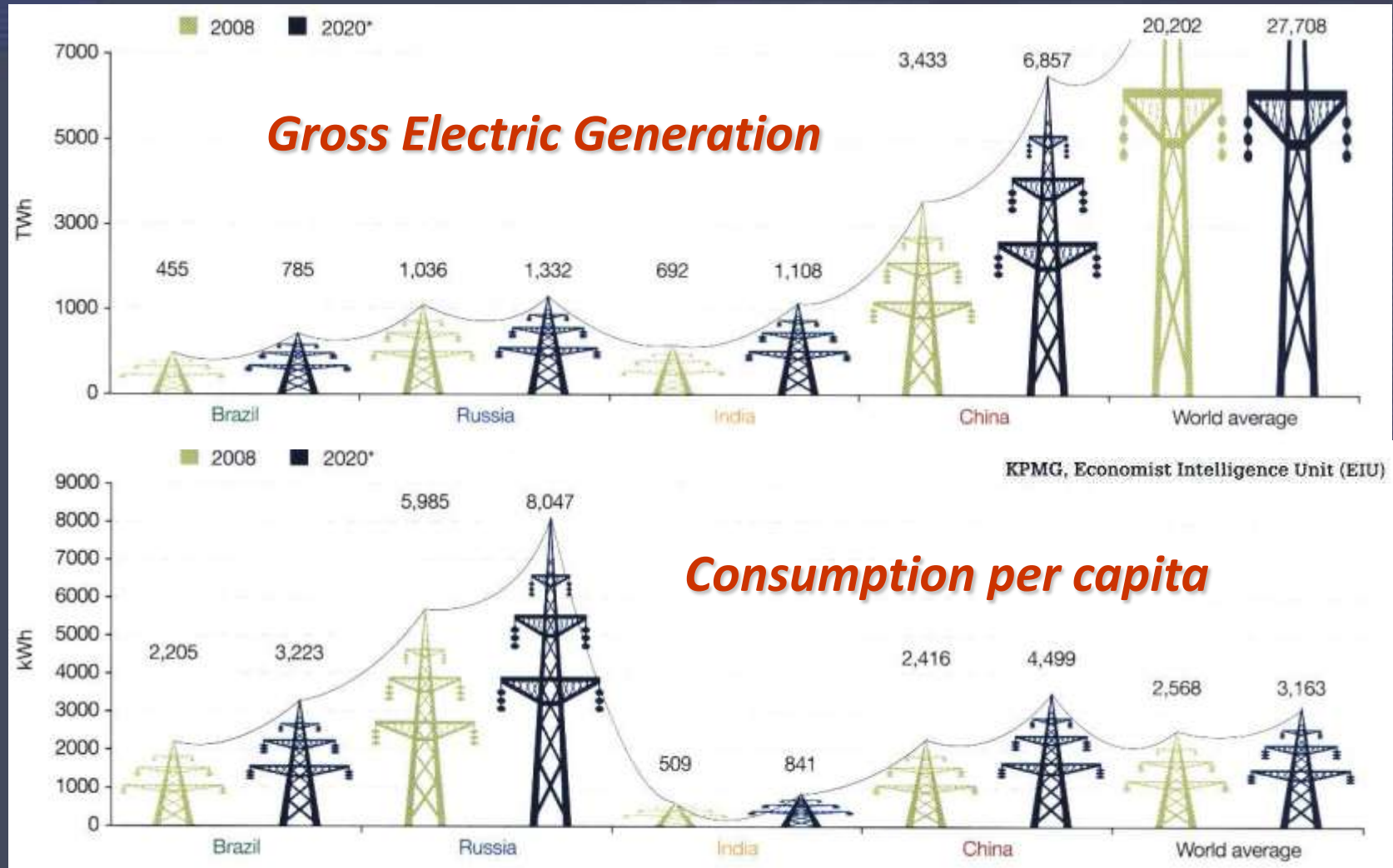


BRAZIL: 69th place



Fonte: Lighting the way, InterAcademy Council, 2007

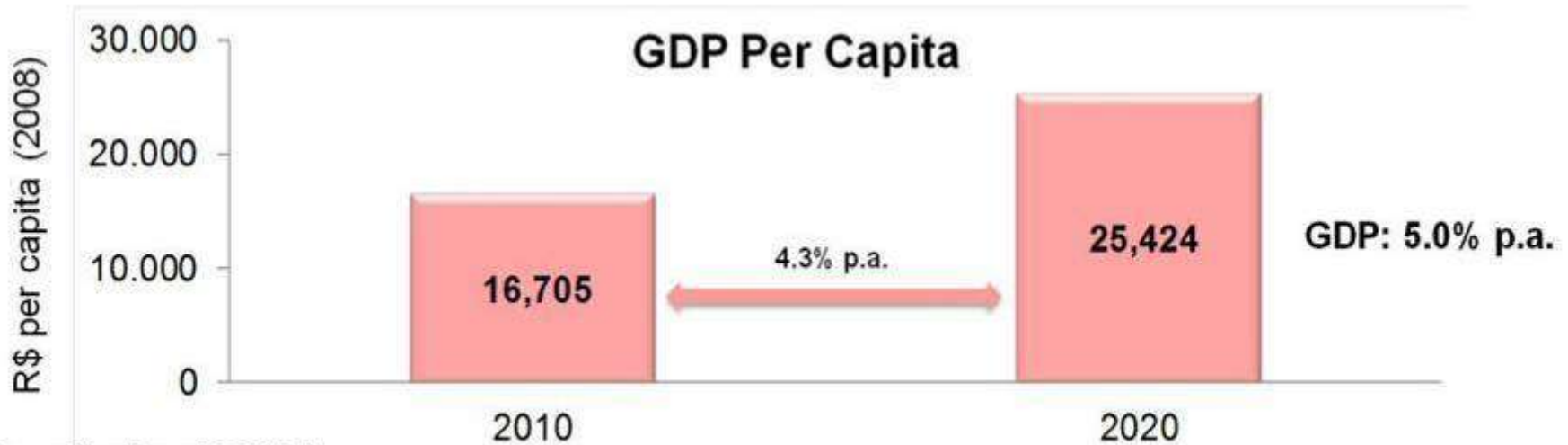
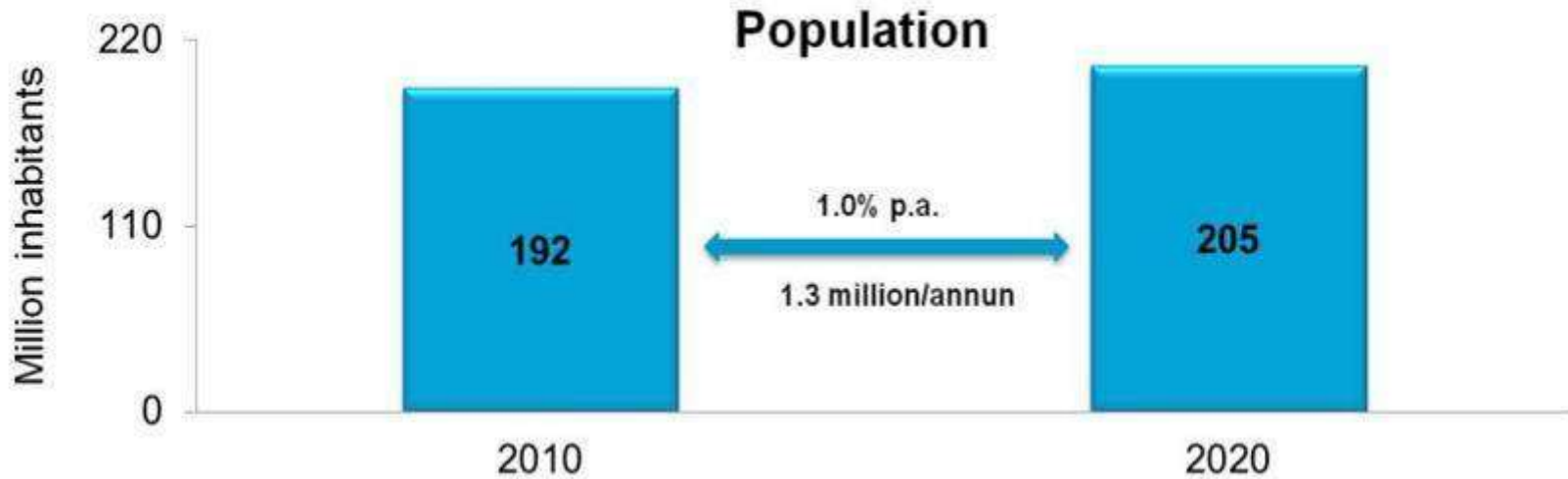
HDI X ELECTRICITY CONSUMPTION





FORECASTS 2020

Population and GDP per capita

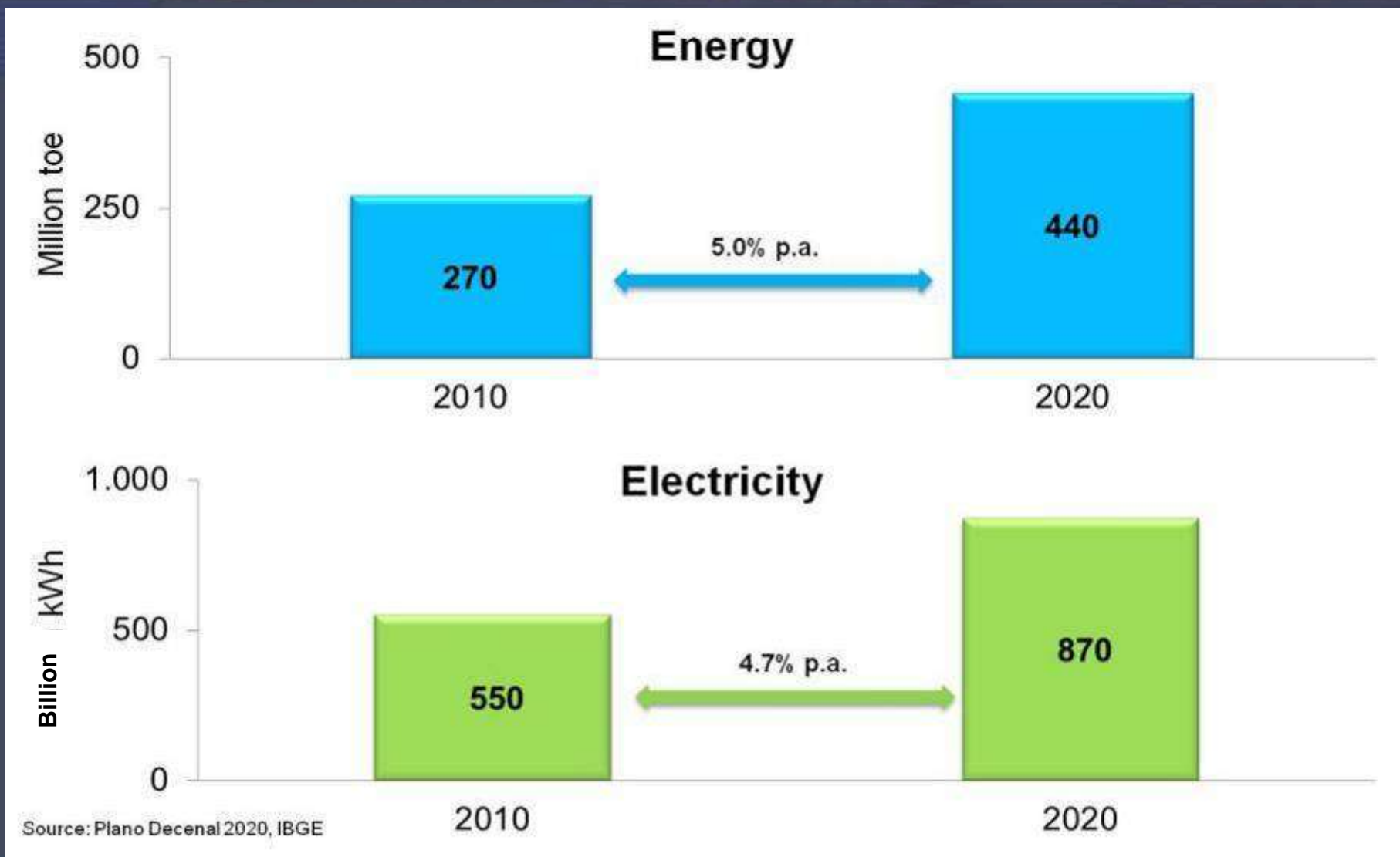


Source: Plano Decenal 2020, IBGE



FORECASTS 2020

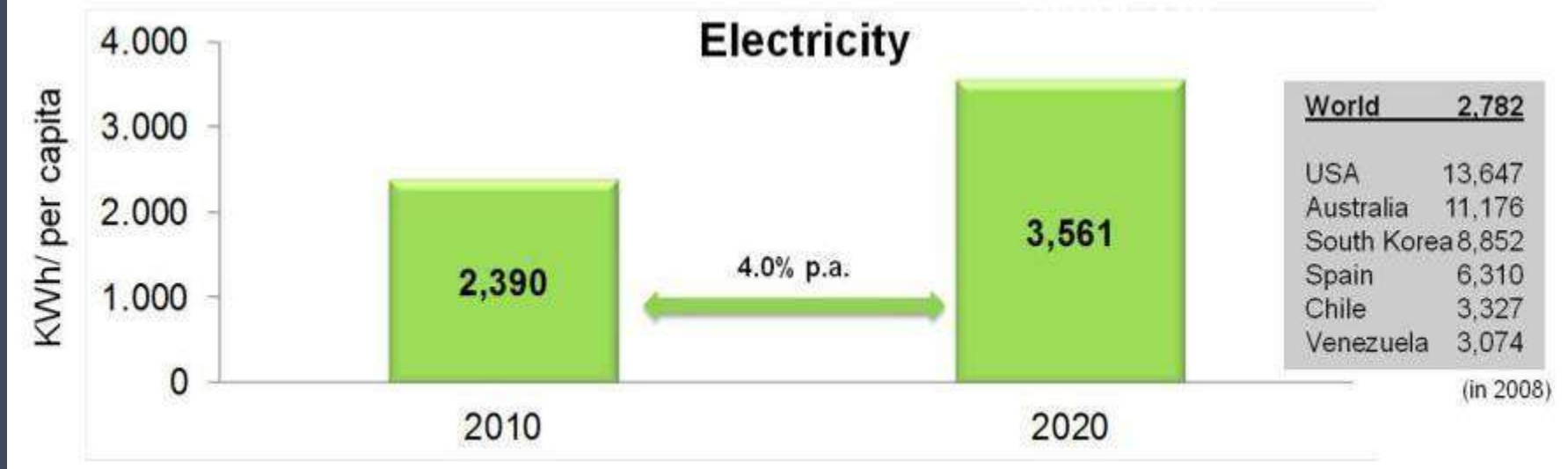
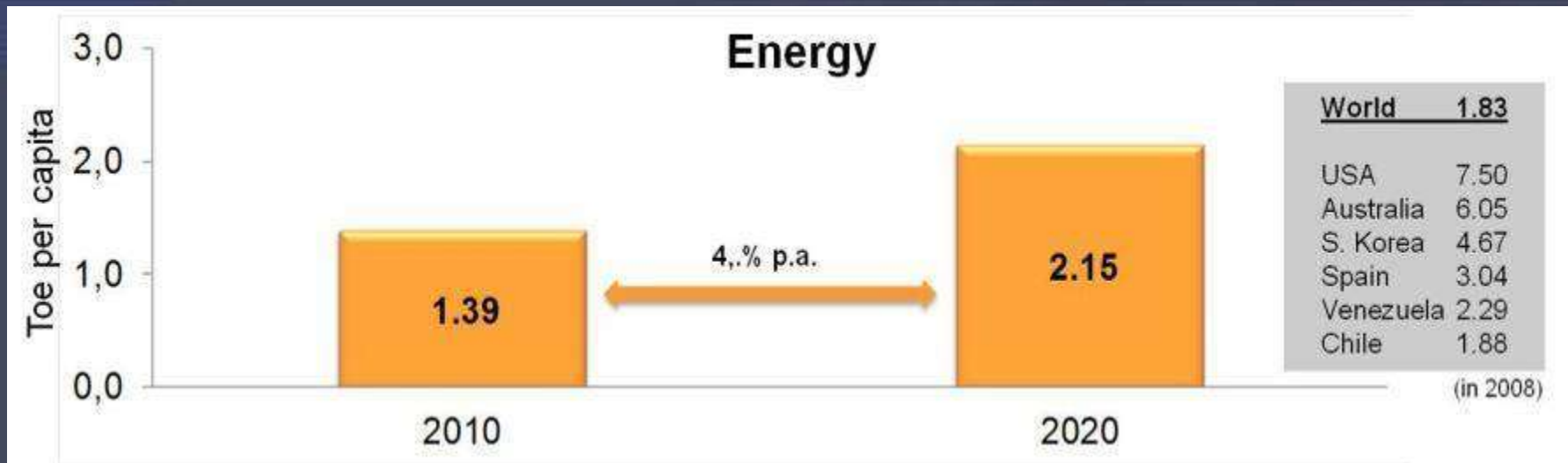
Energy and electricity consumption





FORECASTS 2020

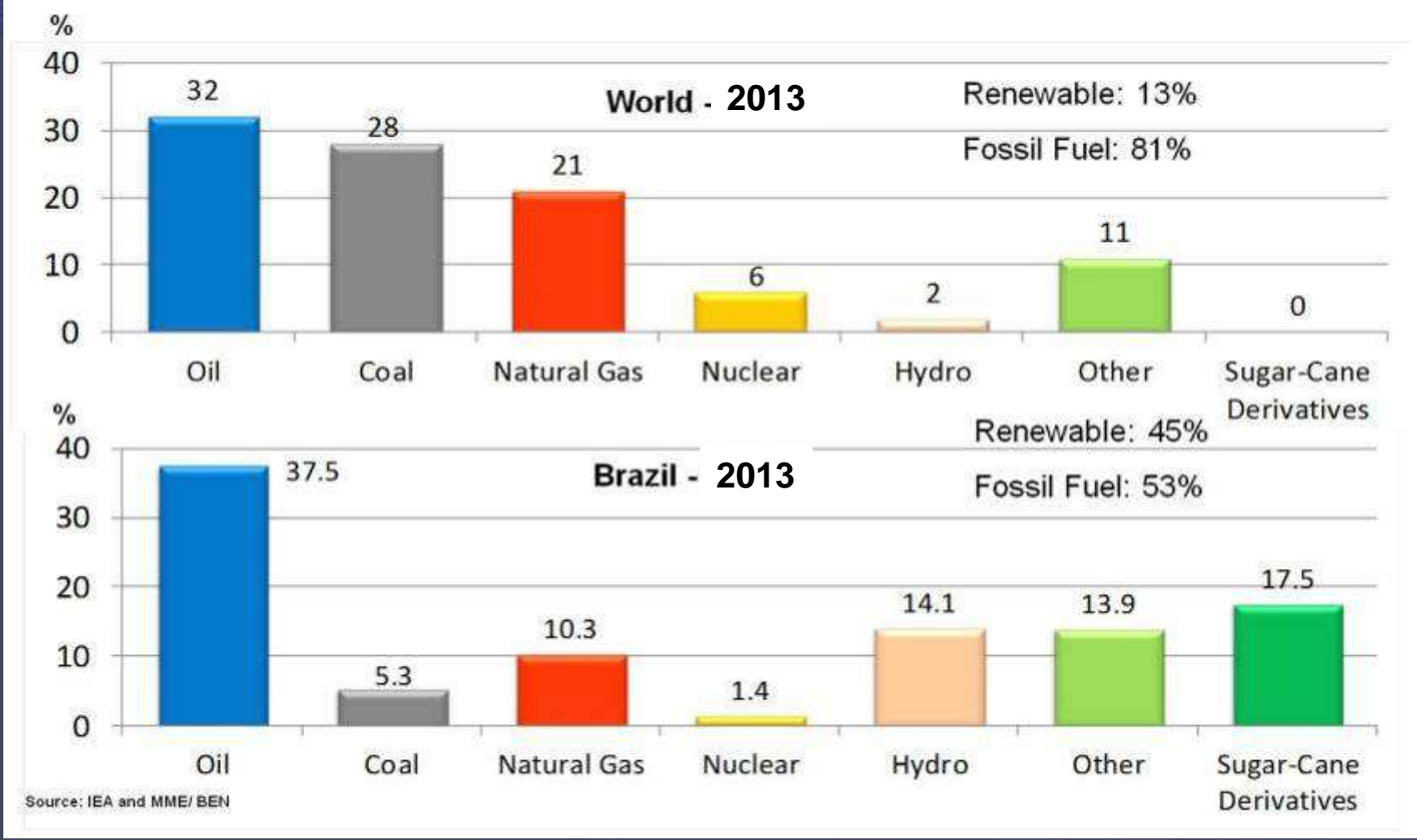
Energy and electricity consumption





ENERGY SUPPLY MATRIX

WORLD x BRAZIL (%)

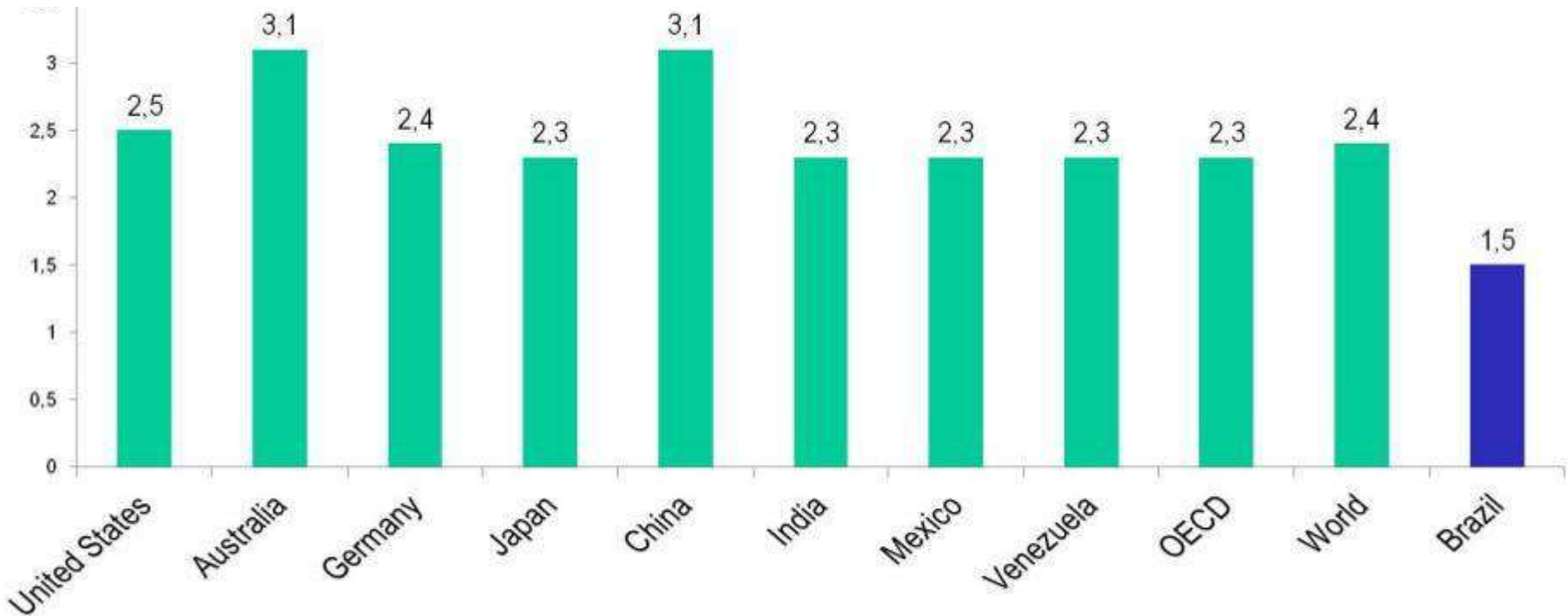




ENERGY SUPPLY MATRIX

WORLD x BRAZIL (%)

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



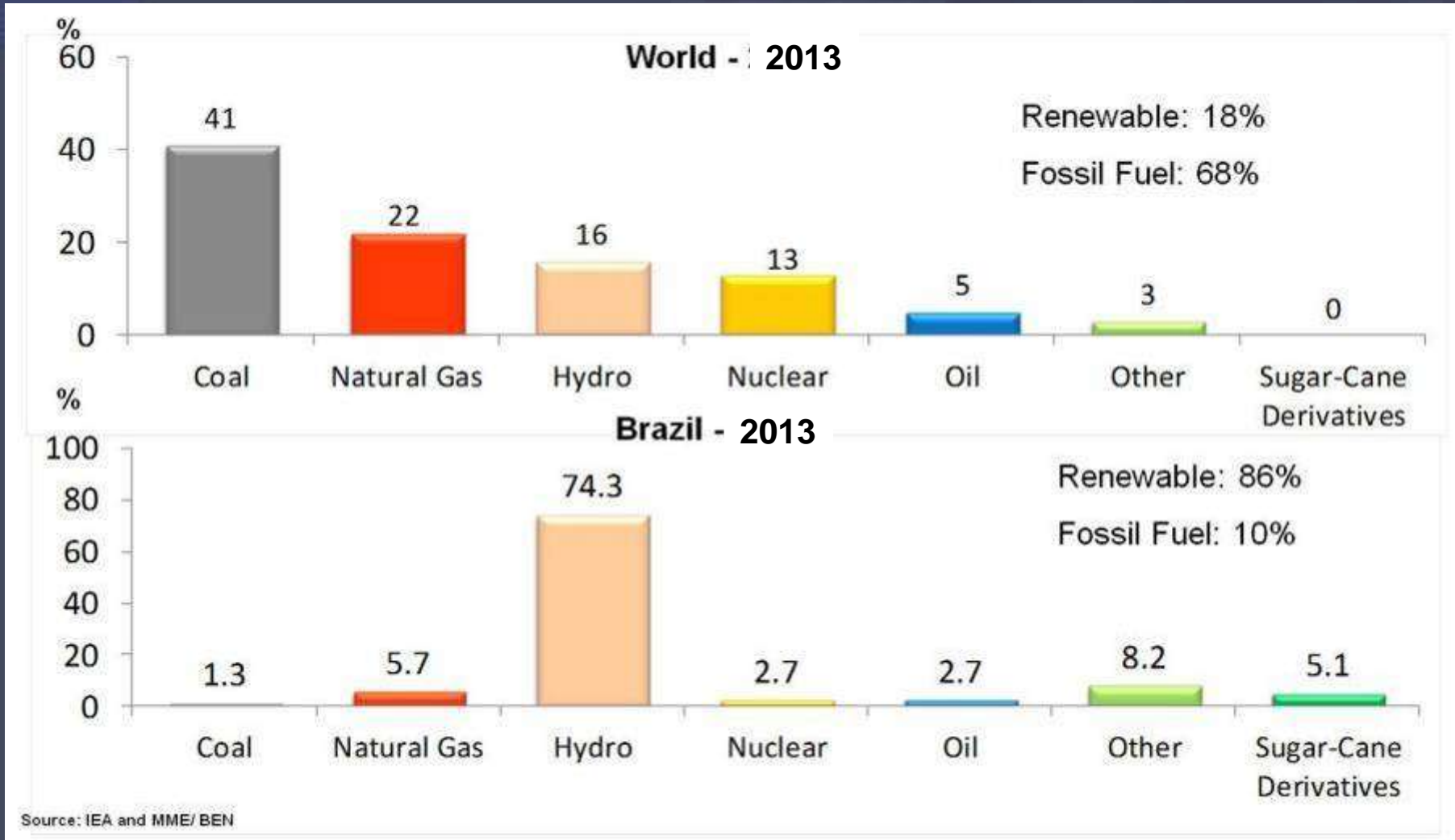
Source: International Energy Agency

(*) Evaluated Based on the Domestic Energy Supply



ELECTRICITY SUPPLY MATRIX

WORLD x BRAZIL (%)



HYDROPOWER REQUIRES SYSTEM INTEGRATION

HAVING CONTINENTAL DIMENSIONS EQUIVALENT TO EUROPE



4.000 km

Fortaleza

Manaus

Recife

Salvador

Brasília

Belo Horizonte

Rio de Janeiro

Itaipu

São Paulo

Porto Alegre

Angra
NPPs

Stockholm

Helsinki

Moscow

London

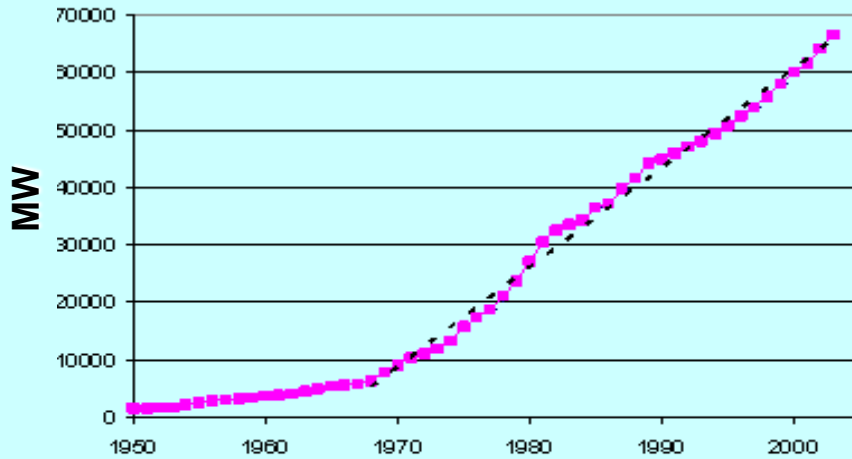
Paris

Lisbon

ELECTRIC SYSTEM EVOLUTION IN THE 90's

NEED FOR THERMAL REGULATION

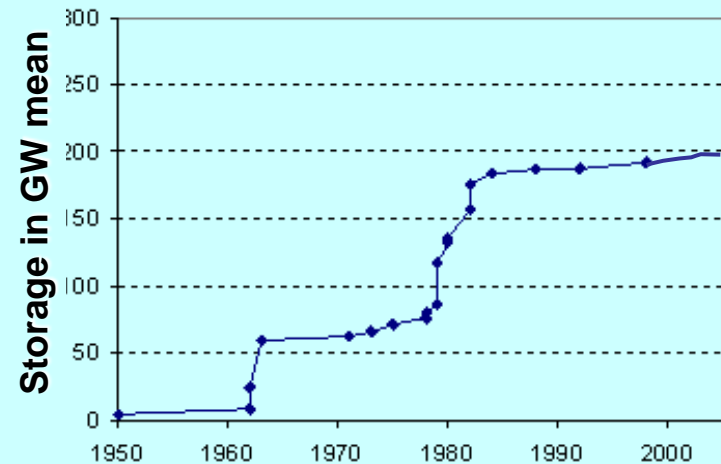
Installed Hydropower



installed hydro capacity increasing ...

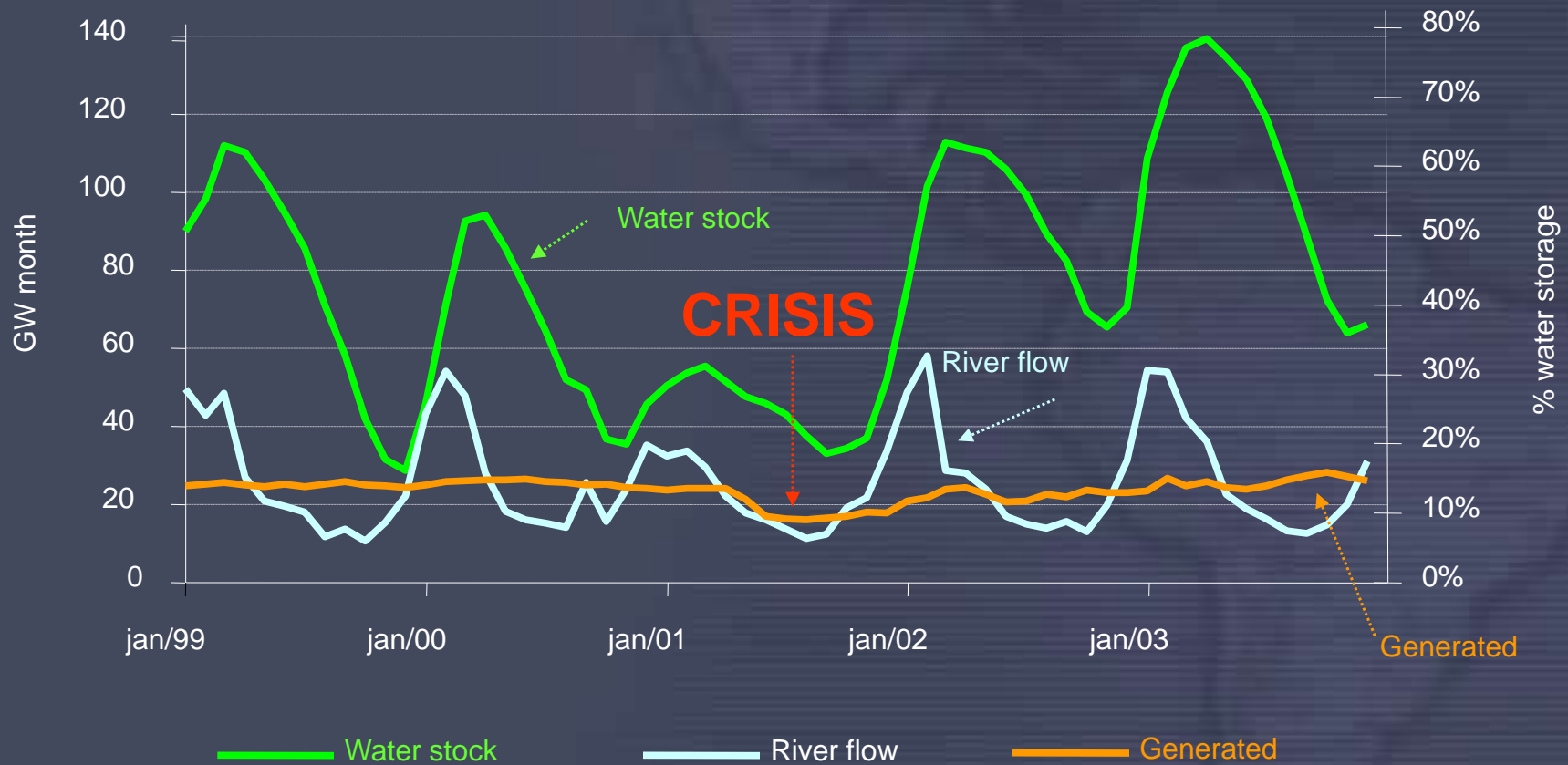
... but without a proportional increase in the water stock

Reservoir capacity



ELECTRIC SYSTEM EVOLUTION NEED FOR THERMAL REGULATION

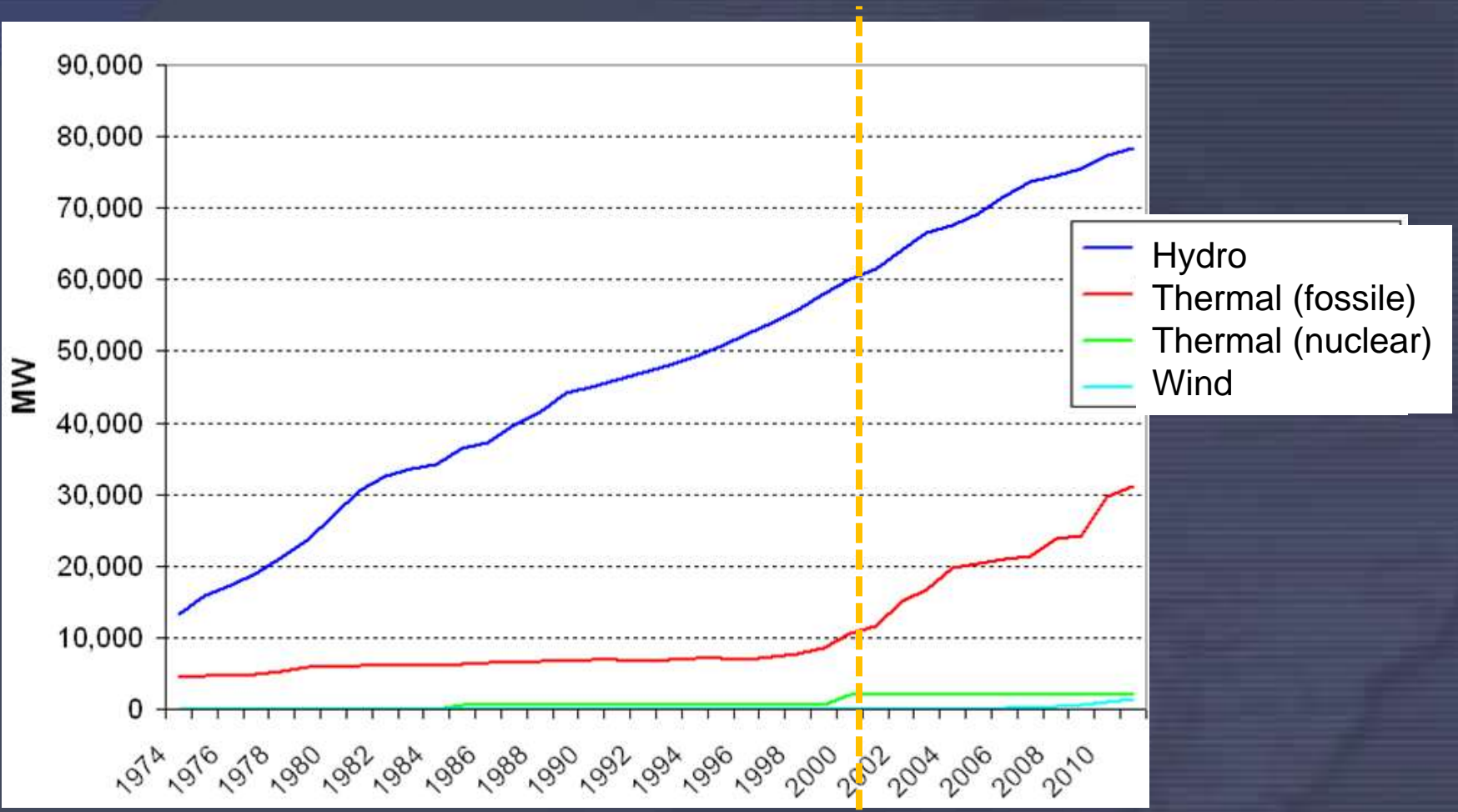
root cause of 2001 supply crisis





ELECTRIC SYSTEM EVOLUTION

HYDRO-THERMAL TRANSITION



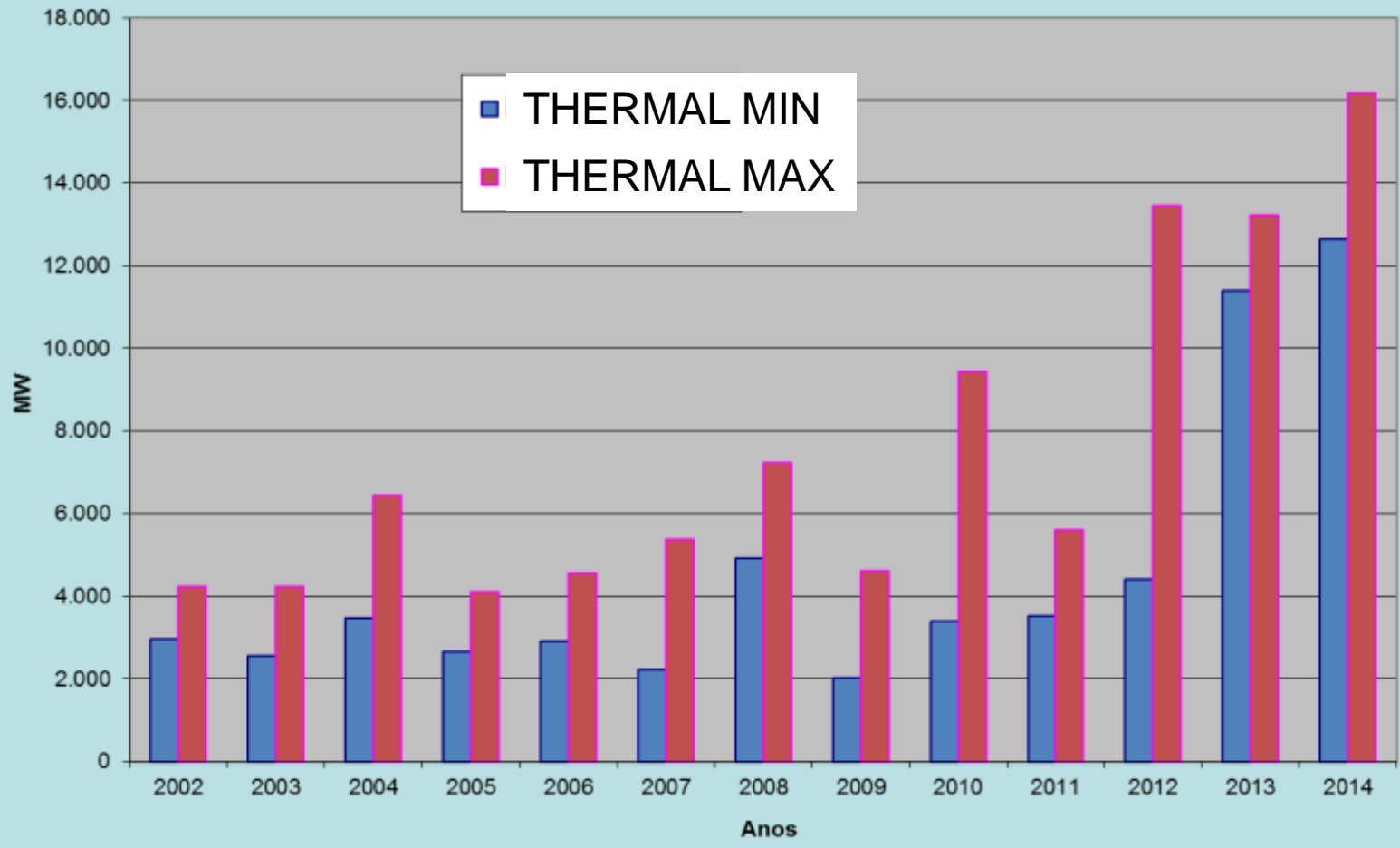
HYDRO-THERMAL TRANSITION



ELECTRIC SYSTEM EVOLUTION

HYDRO-THERMAL TRANSITION

MONTHLY MAXIMUM AND MINIMUM THERMAL POWER GENERATION





ELECTRIC SYSTEM EVOLUTION

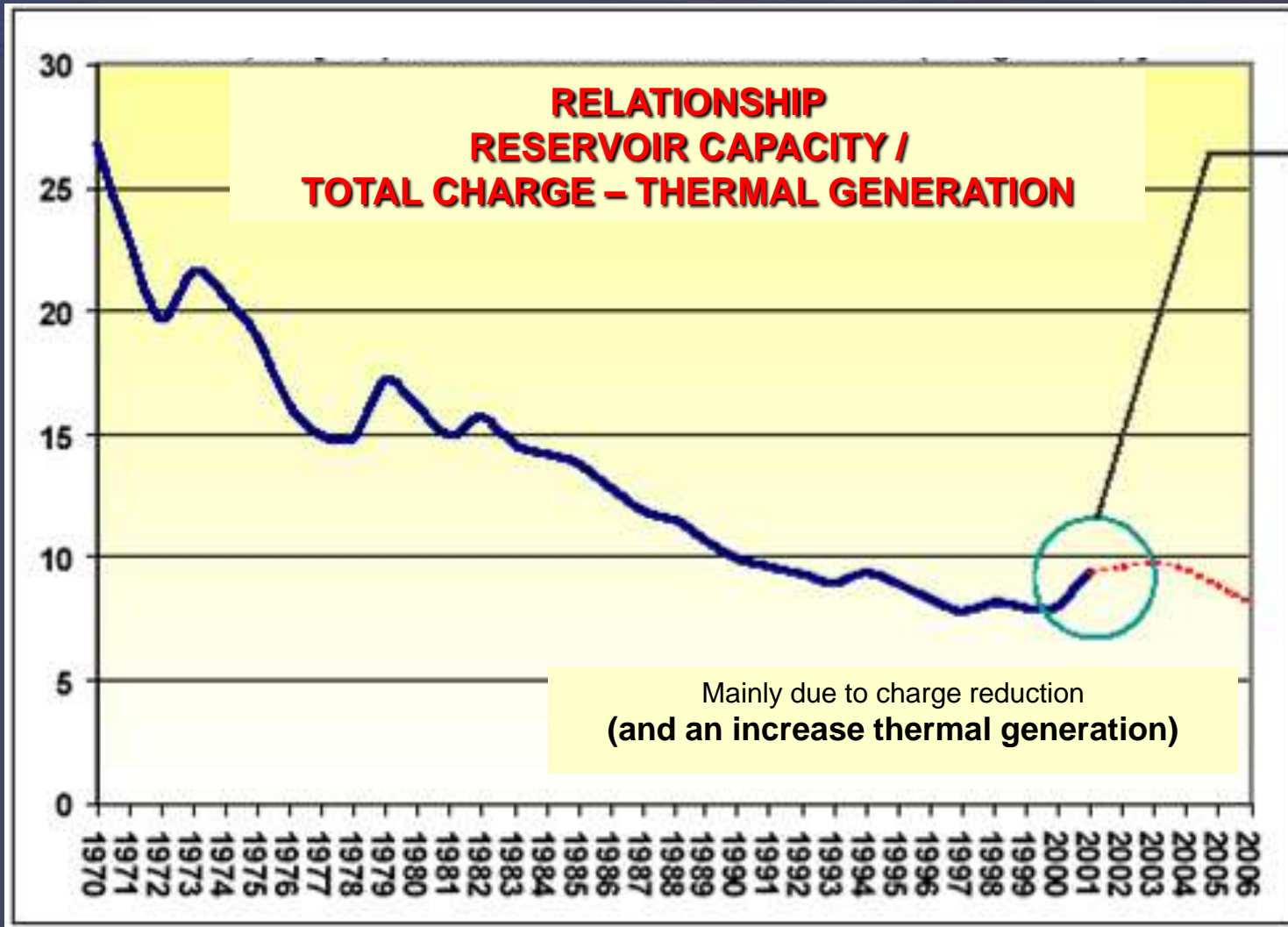
HYDRO-THERMAL TRANSITION

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

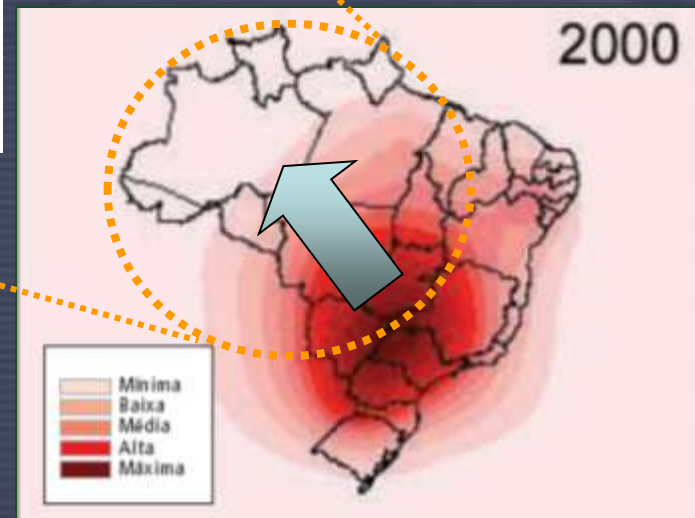
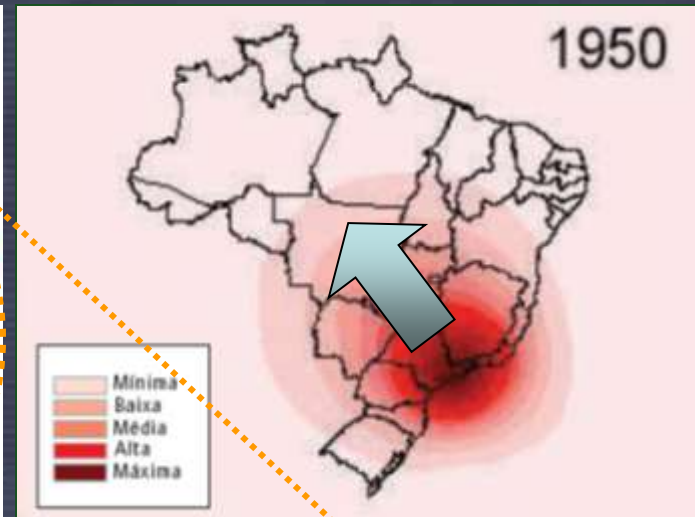
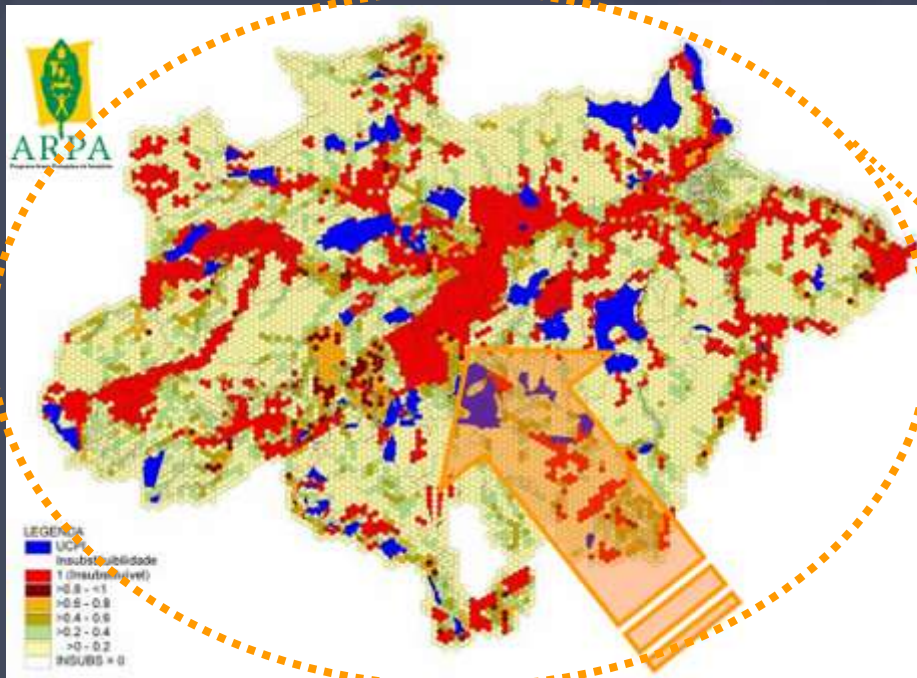
NEED FOR THERMAL REGULATION



2001
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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%**



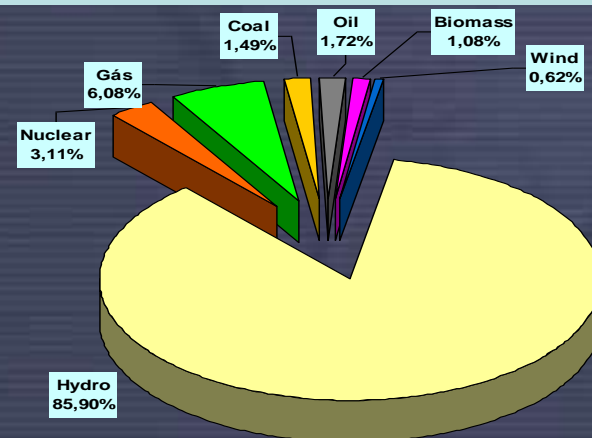
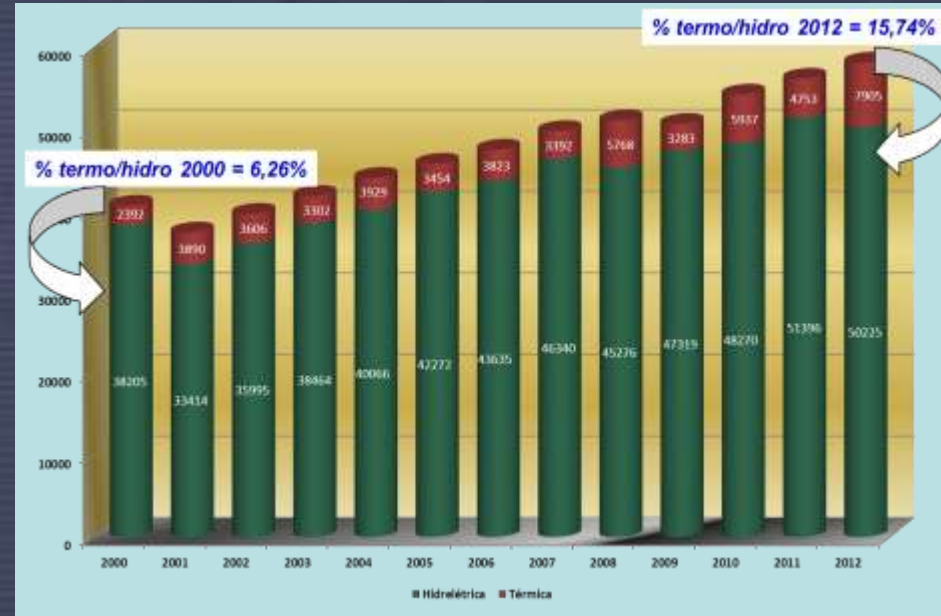
Project AHE MADEIRA 6.500 MW



Project AHE BELO MONTE 11.000 MW

ELECTRIC SYSTEM EVOLUTION IN THE 90's

NEED FOR THERMAL REGULATION

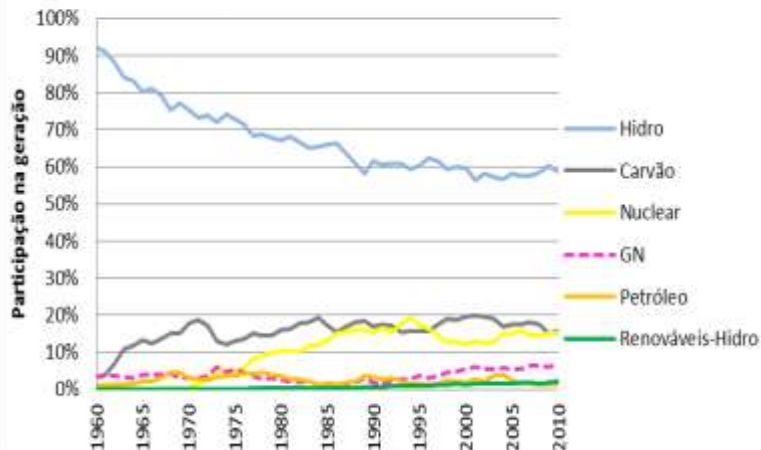




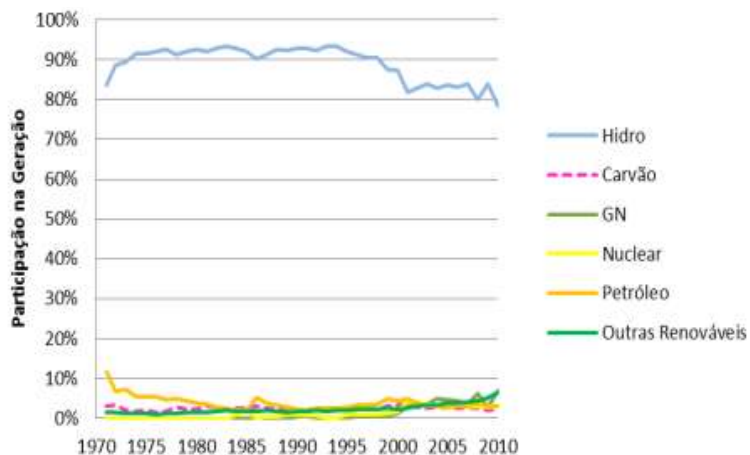
ELECTRIC SYSTEM EVOLUTION

HYDRO-THERMAL TRANSITION IS NOT NEW

ELECTRICITY GENERATION IN CANADA



ELECTRICITY GENERATION IN BRAZIL

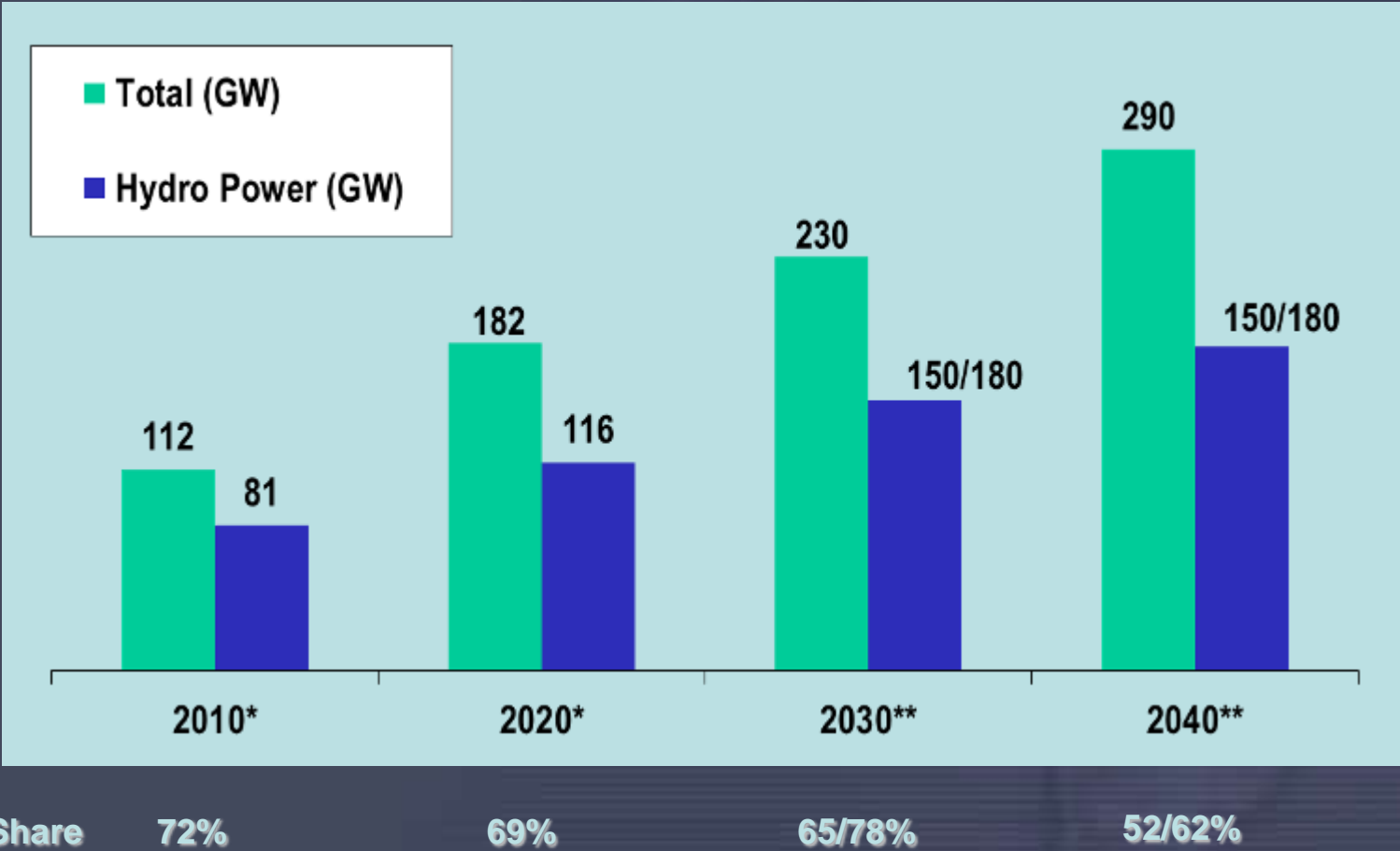


The evolution of the Canadian electrical system in 50 years holds many similarities with the situation of the Brazilian electrical system in last 15 years.



ELECTRIC SYSTEM EVOLUTION

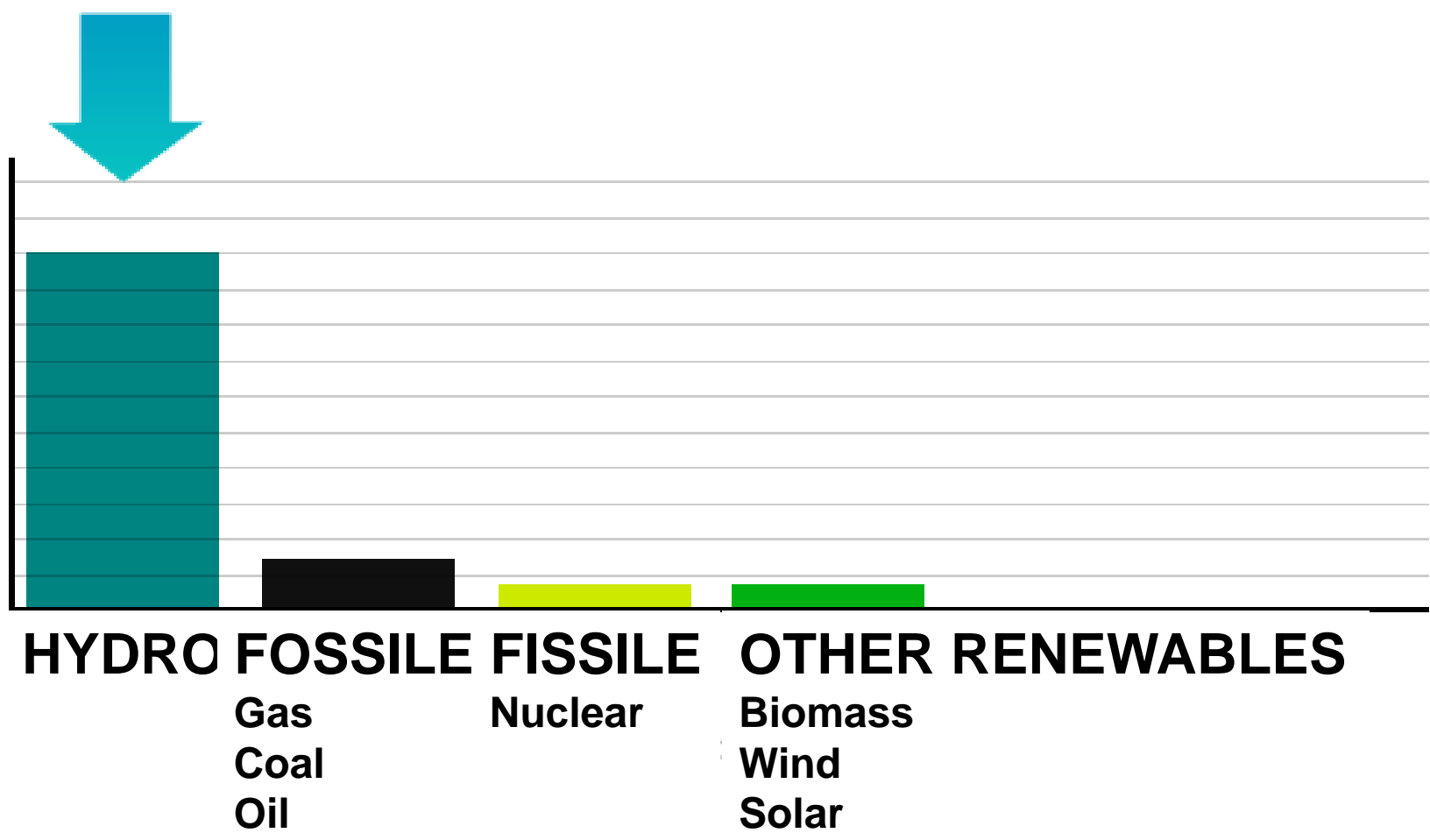
BRAZILIAN TRANSITION IS NEW





ELECTRIC SYSTEM EVOLUTION

BRAZILIAN TRANSITION IS NEW

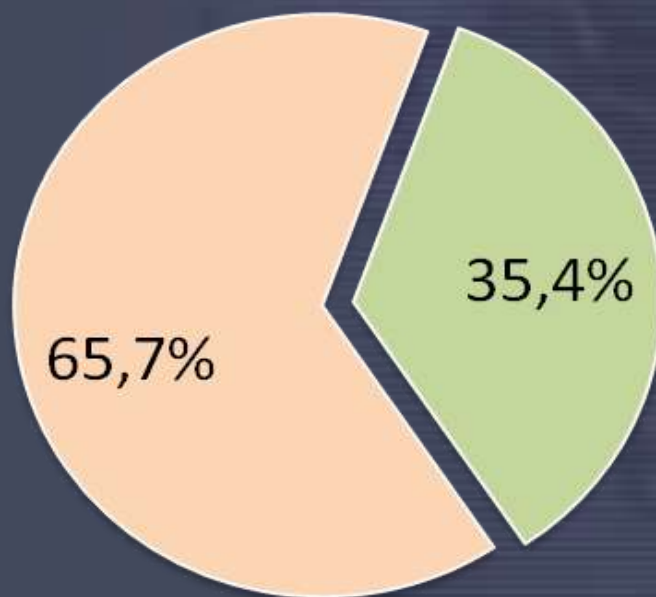




PUBLIC ACCEPTANCE

NUCLEAR IN BRAZIL

**NEGATIVE
OPPINION**

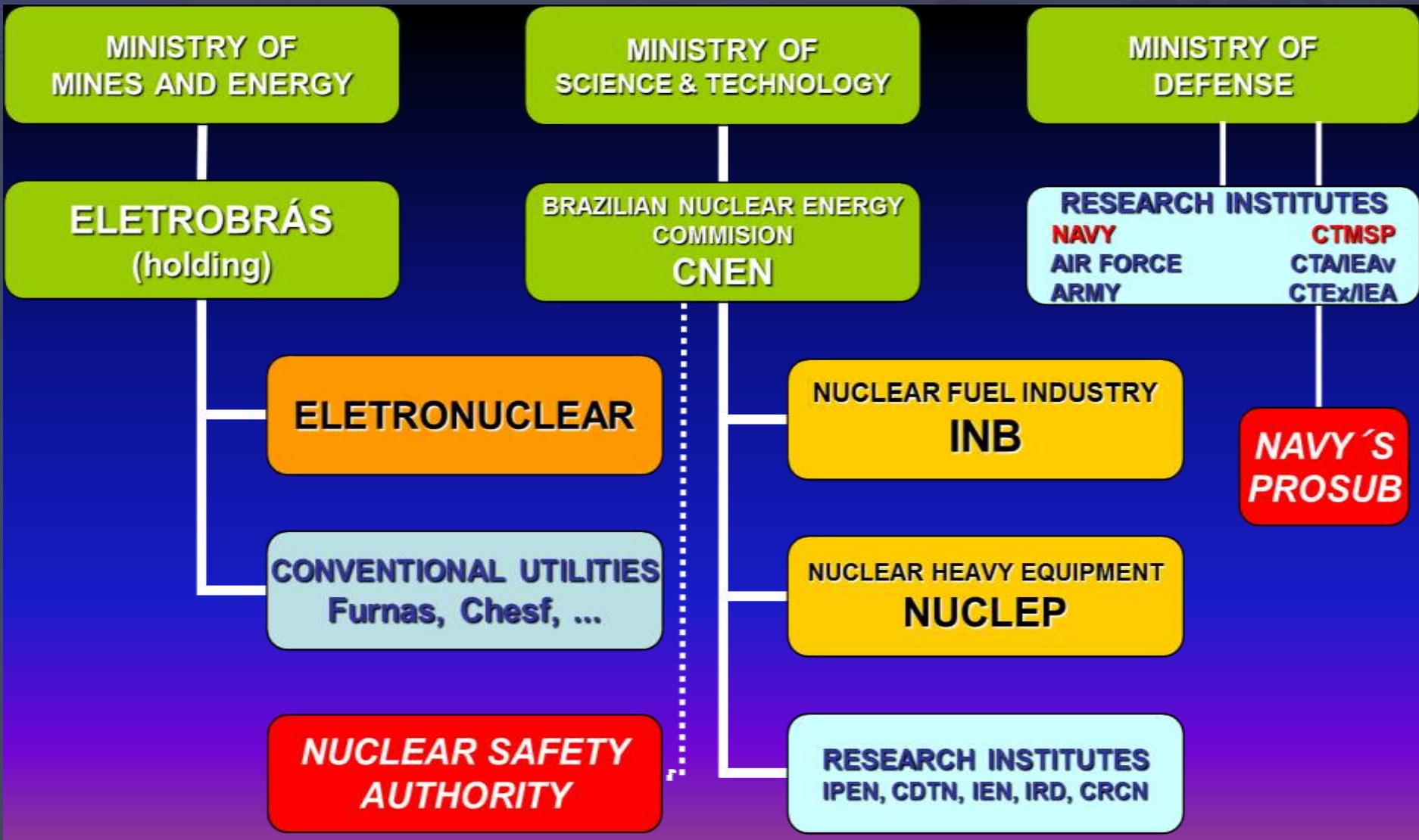


**POSITIVE
OPPINION**

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

BRAZILIAN NUCLEAR INDUSTRY

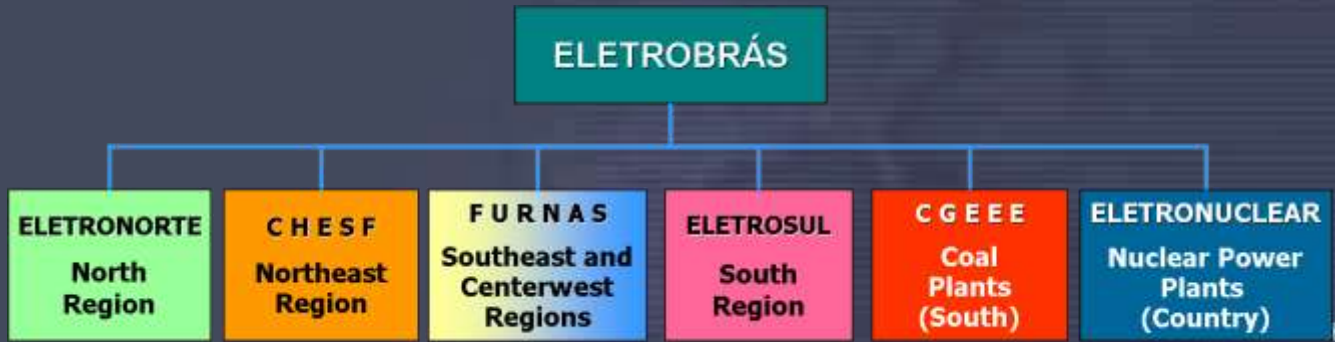
MONOPOLY ESTABLISHED BY CONSTITUTION





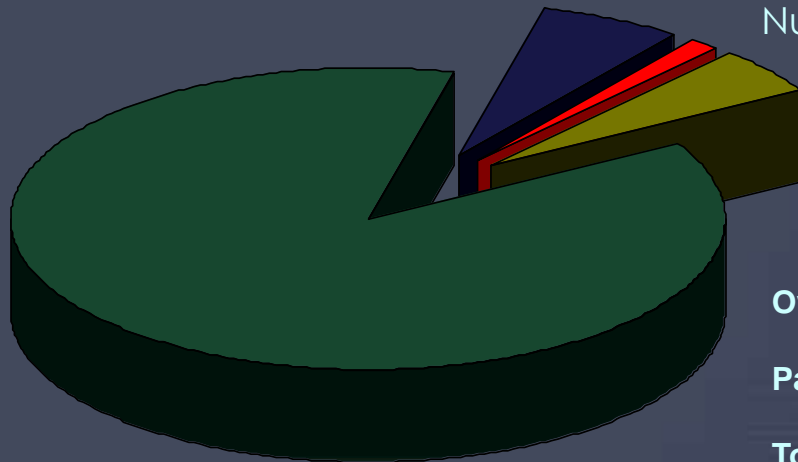
ELETRONORTE

10th. WORLD UTILITY



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

Oil and Gas = 7%
Coal = 1%
Nuclear = 5%



							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*

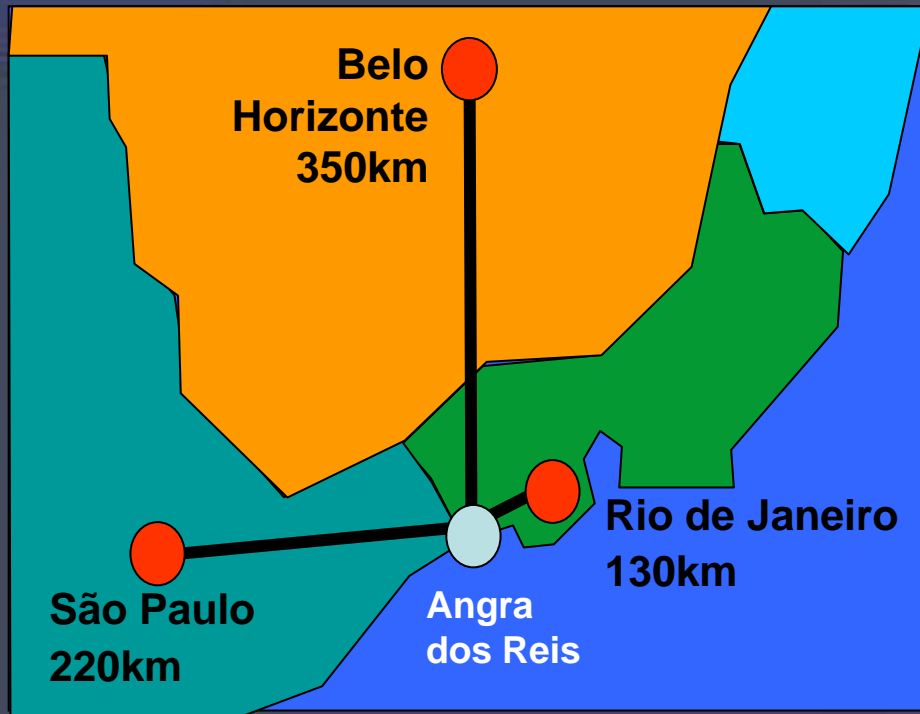
- *Angra 3: 2015 (AREVA NP PWR 1405 MW)*



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 2 PWR

Power: 1.350 MW

Technology: Siemens/KWU

Operation start: Janeiro/2001

ANGRA 1 PWR

Power: 657 MW

Technology: Westinghouse

Operation start: Janeiro/1985





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

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	76.2
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	88.0	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	87.6	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	83.6	2	80.0	2	82.6	2	85.2
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	88.5	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	88.2	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	83.4	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	460	77.8

The following information is included in the totals:

TAIWAN, CHINA	6	91.4	6	92.4	6	87.7	6	90.5
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ANGRA 3 CONSTRUCTION



ANGRA 3: 1.405 MW AREVA PWR



FIRST CONCRETE POURED JUNE 2010



Ministério de Minas e Energia
Secretaria de Planejamento e Desenvolvimento Energético

PLANO DECENAL DE EXPANSÃO DE ENERGIA 2022



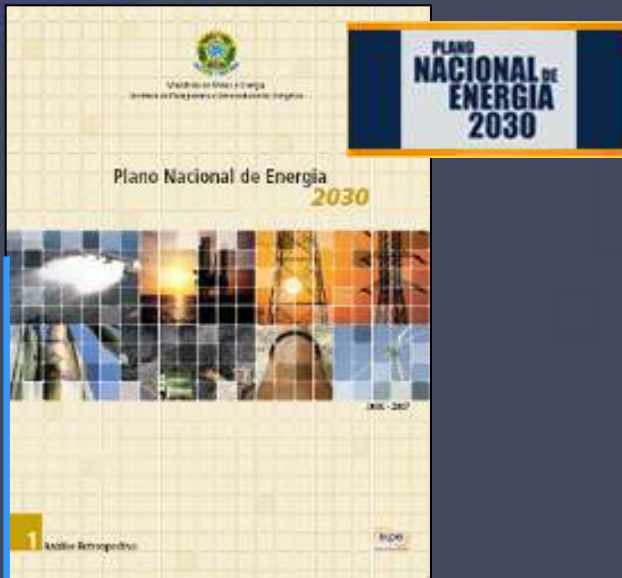
ANGRA 3
1.405 MW
2018



ANGRA 3 CONSTRUCTION



NATIONAL ENERGY PLAN 2030

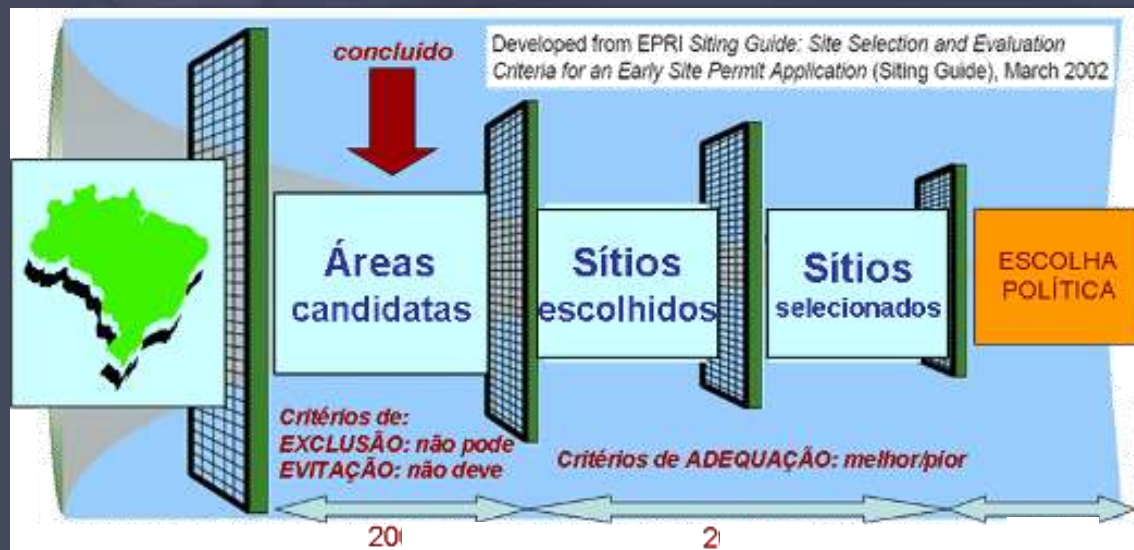


**1) Northeast
2.000 MW**

**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



Northeast



Southeast



South



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**



NUCLEAR EXPANSION IN BRAZIL

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

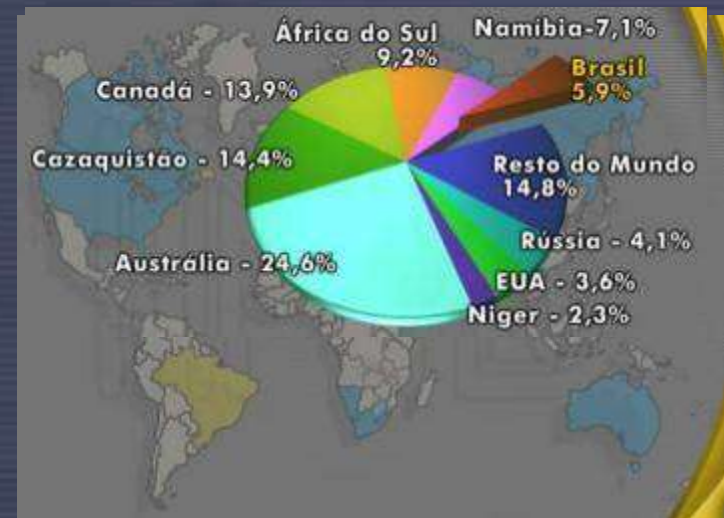
- In operation x construction x design
- FOAK x NOAK
- Passive x Active Safety

BRAZILIAN URANIUM RESOURCES

ONE OF THE MAIN RESERVES IN THE WORLD



Prospected area:
only 30% of national territory
up to 100 meters deep
6th. WORLD RESERVE

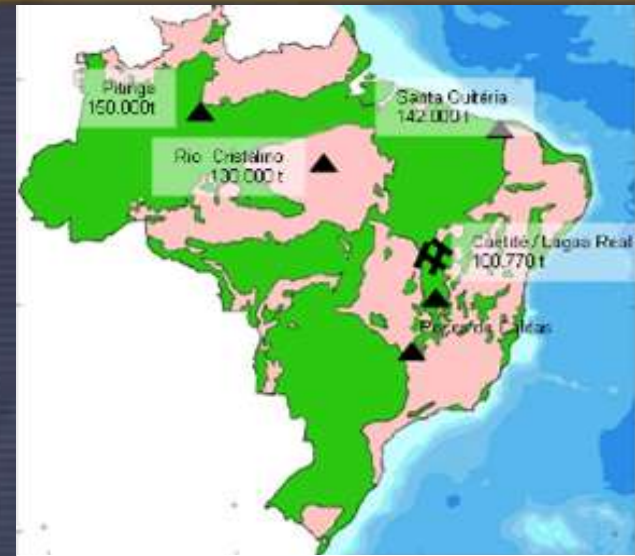




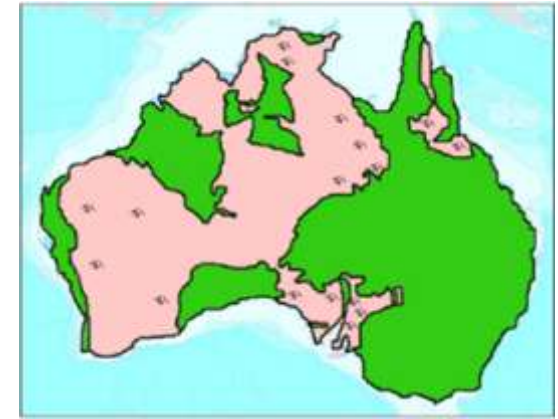
BRAZILIAN URANIUM RESOURCES

ONE OF THE MAIN RESERVES IN THE WORLD

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

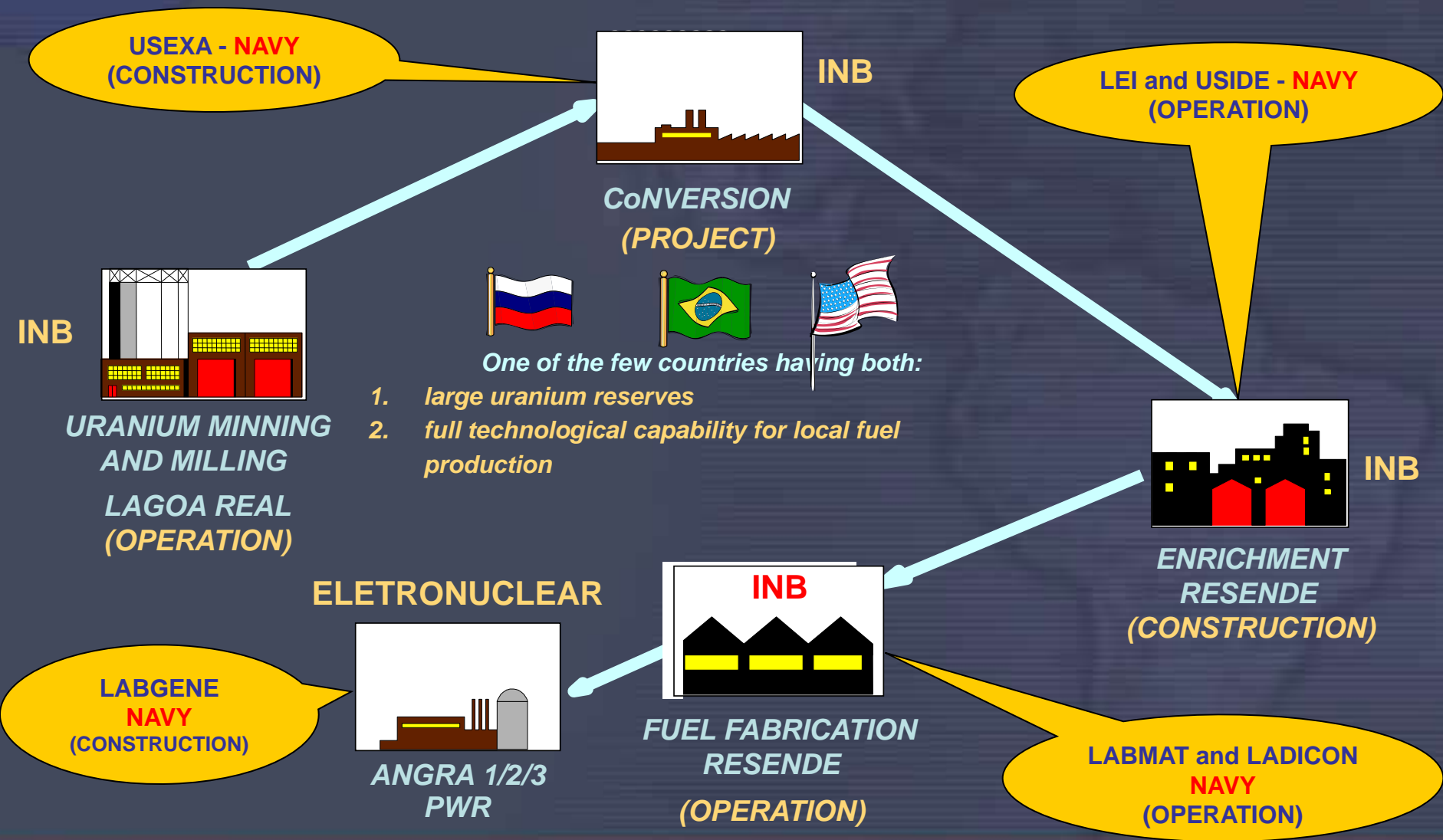


Pré-cambrian soils
Brasil 3.400.000 km²
Austrália 3.800.000 km²



NUCLEAR FUEL INDUSTRY IN BRAZIL

URANIUM + TECHNOLOGICAL CAPABILITIES





NUCLEAR FUEL INDUSTRY IN BRAZIL

URANIUM + TECHNOLOGICAL CAPABILITIES



RESENDE:
POWDER & PELLETS
ENRICHMENT
FUEL FABRICATION



RESEARCH REACTORS IN BRAZIL



*IEA-R1m
CNEN/IPEN
São Paulo*



*IPEN/MB-01
São Paulo*



*TRIGA
CNEN/CDTN
Belo Horizonte*

*Argonauta
CNEN/LEN
Rio de Janeiro*





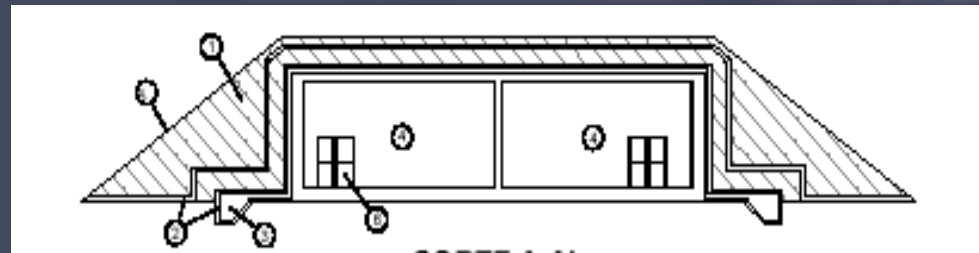
RESEARCH REACTORS IN BRAZIL



LOW AND MEDIUM LEVEL WASTE FINAL DISPOSAL



CNEN



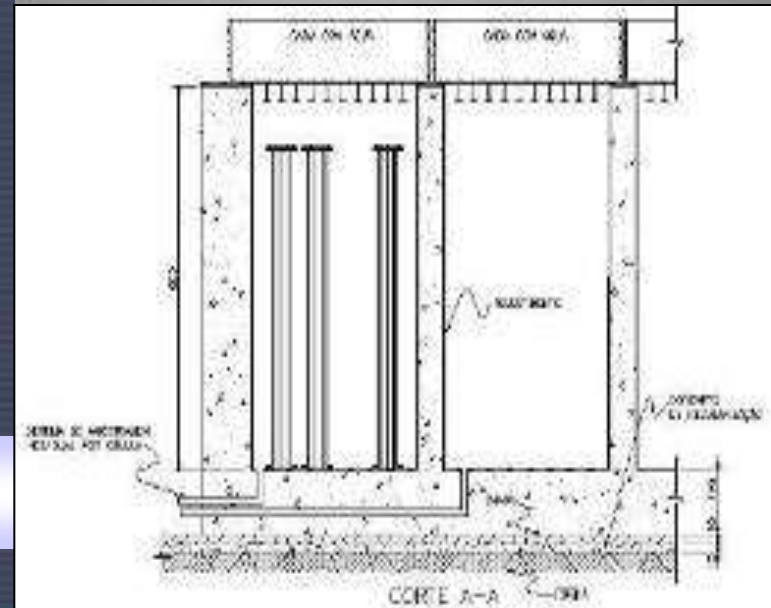
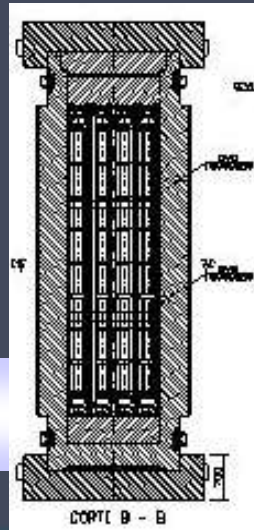
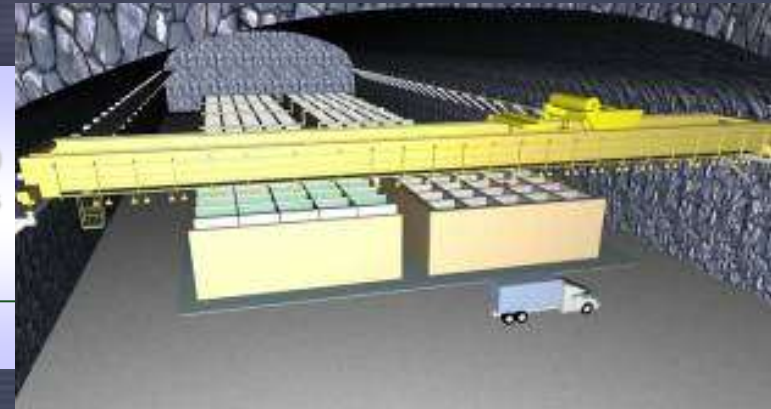
SPENT FUEL LONG TERM STORAGE BRAZILIAN SOLUTION

External pool (2020)



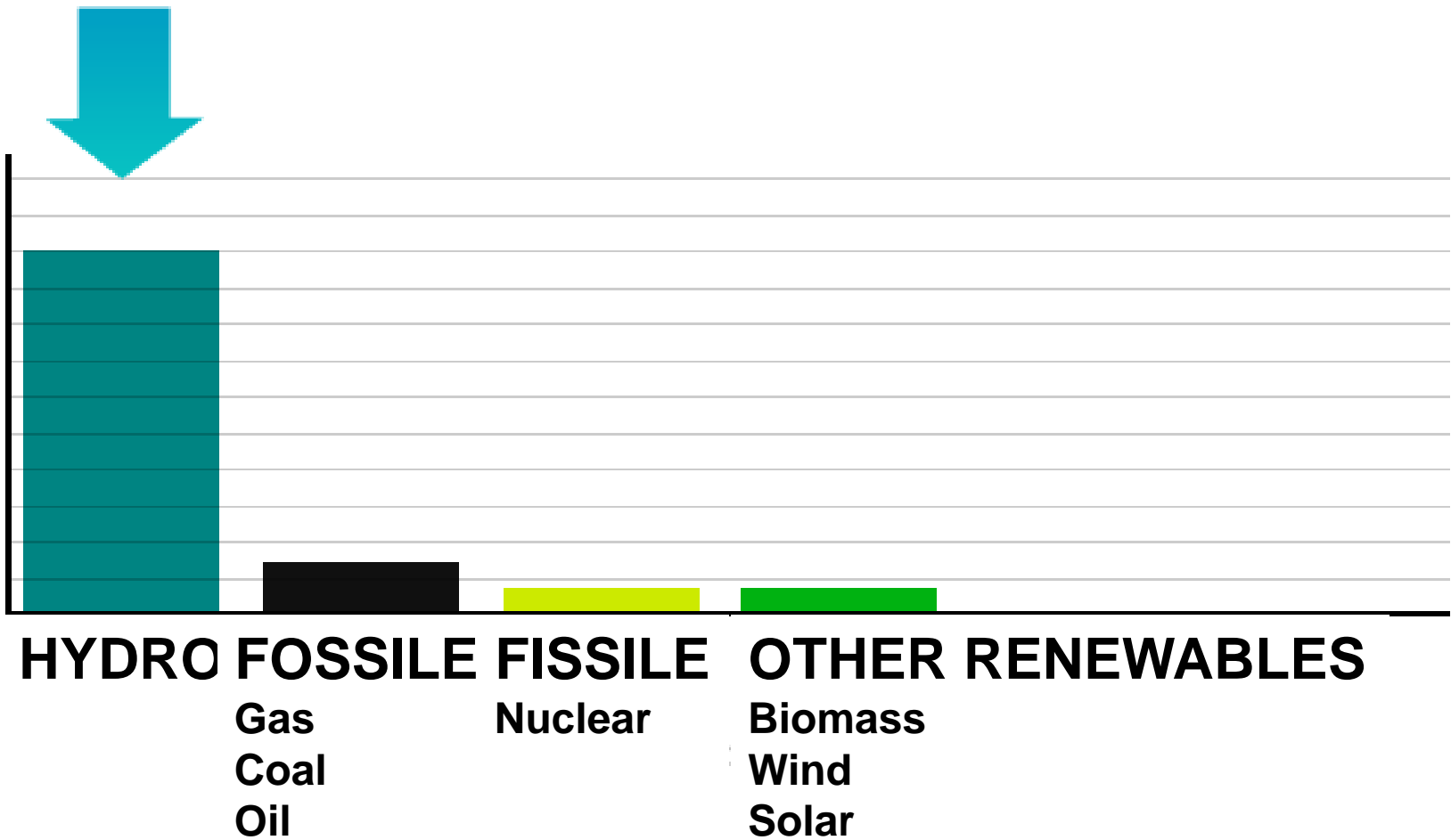
Designed for 500 years

Long Term Interim Storage (2035)





WHY NUCLEAR IN BRAZIL? HYDRO-THERMAL TRANSITION

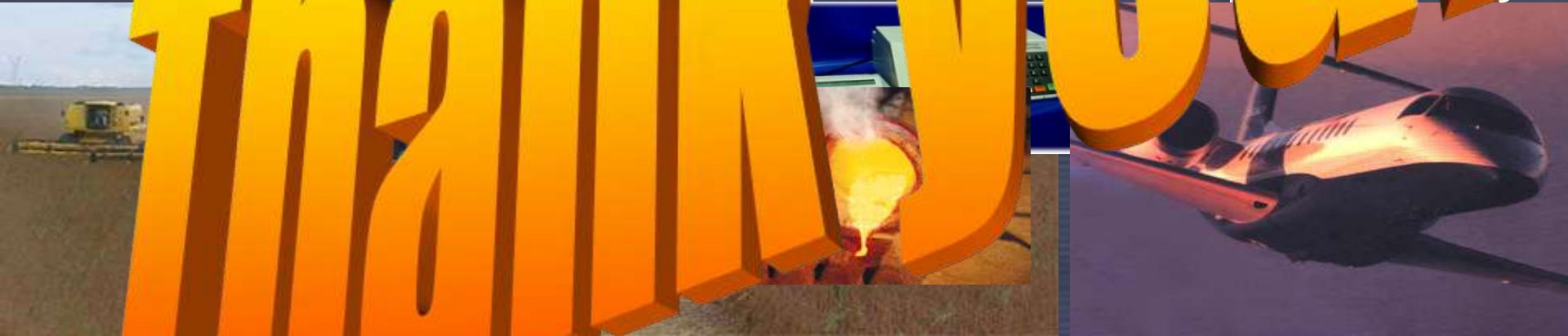


Amazon forest Football Carnival Coffee



Innovation Technology Competition Global Innovation

Thank You!



Mineral Enrichment UO2 powder Pellets Fuel Elements Generation

