

# **INAC 2013**

## **THE BENEFITS OF NUCLEAR TECHNOLOGY FOR SOCIAL INCLUSION**

### **The End of Hydroelectricity Resources and the Expansion of Electric Energy Production in Brazil**

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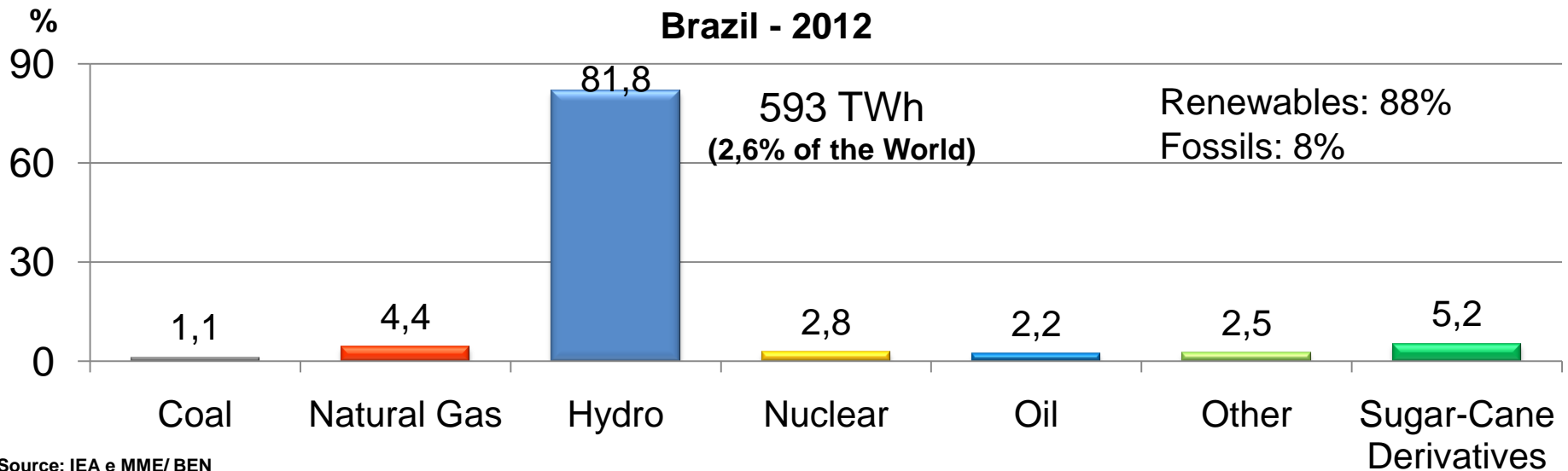
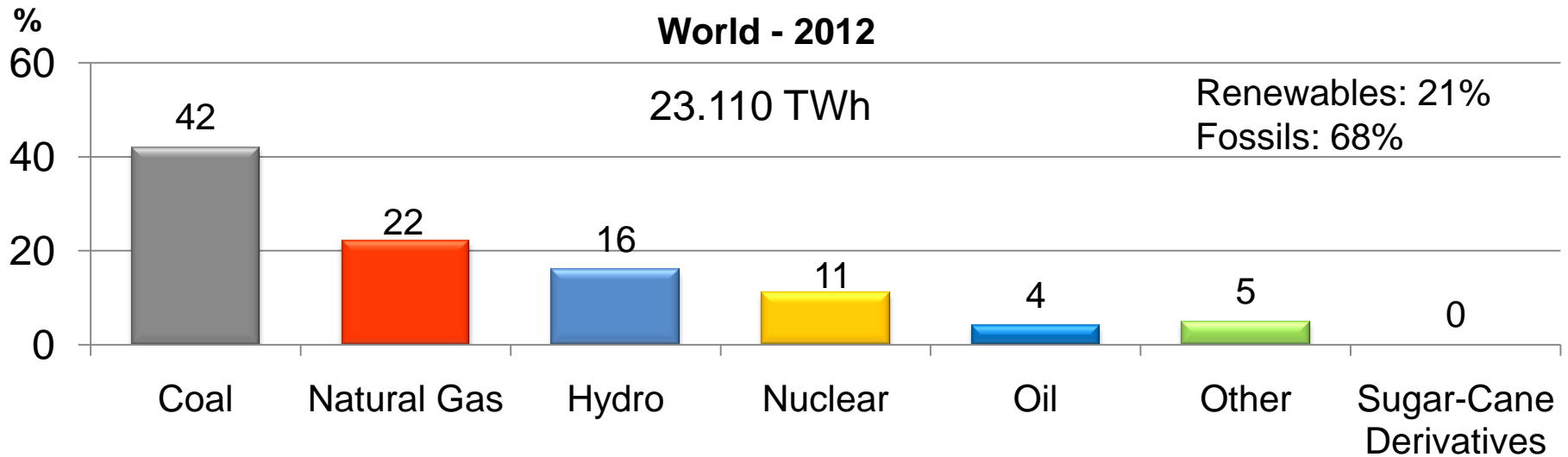
# Summary

- **Energy in Brazil / Ten-Year Plan 2022 (PDE 2022)**
- **Developing of the National Hydroelectric Potential**
- **Nuclear Option in the Brazilian Generation System, in the Long Term**



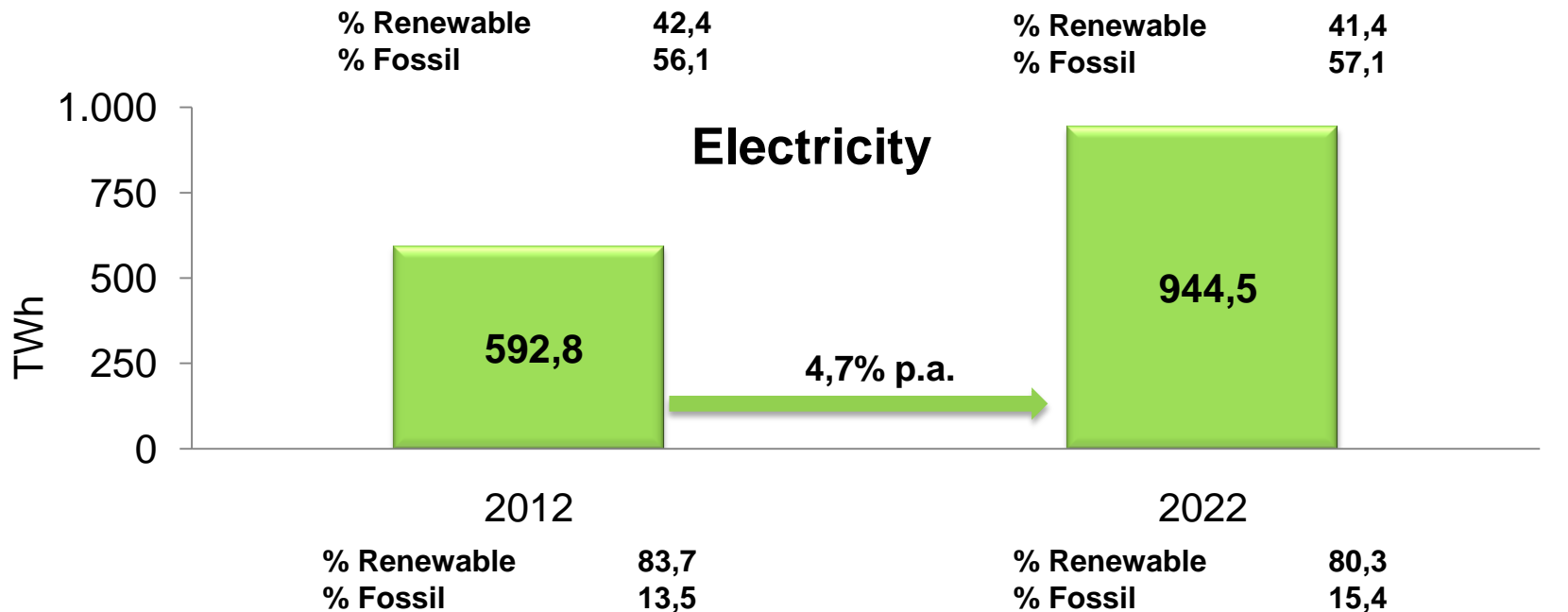
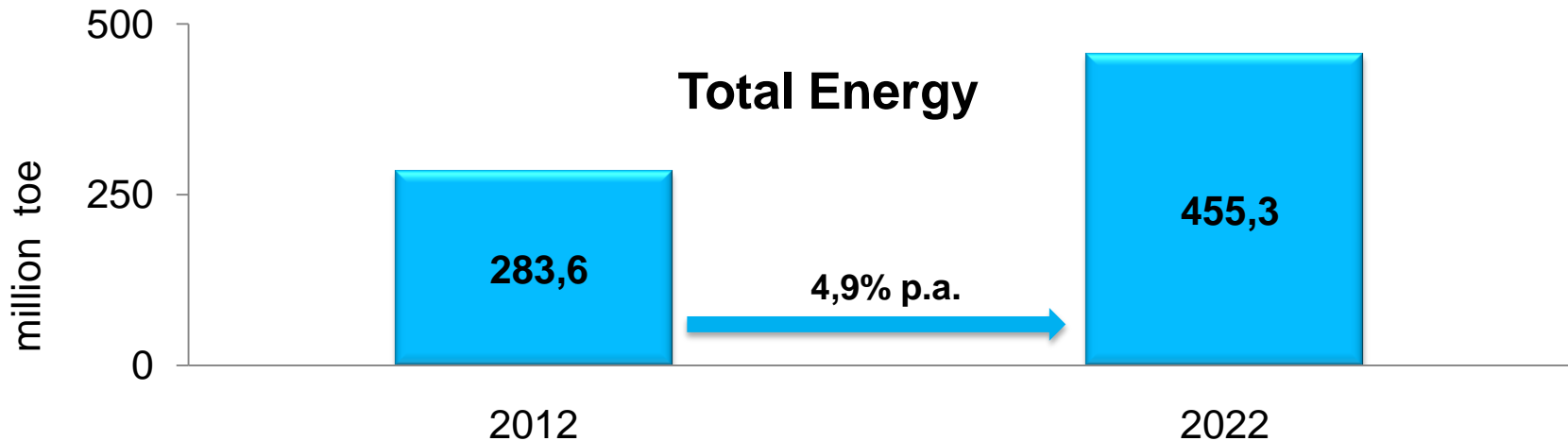
# ELECTRICITY SUPPLY MATRIX

## WORLD x BRAZIL (%)



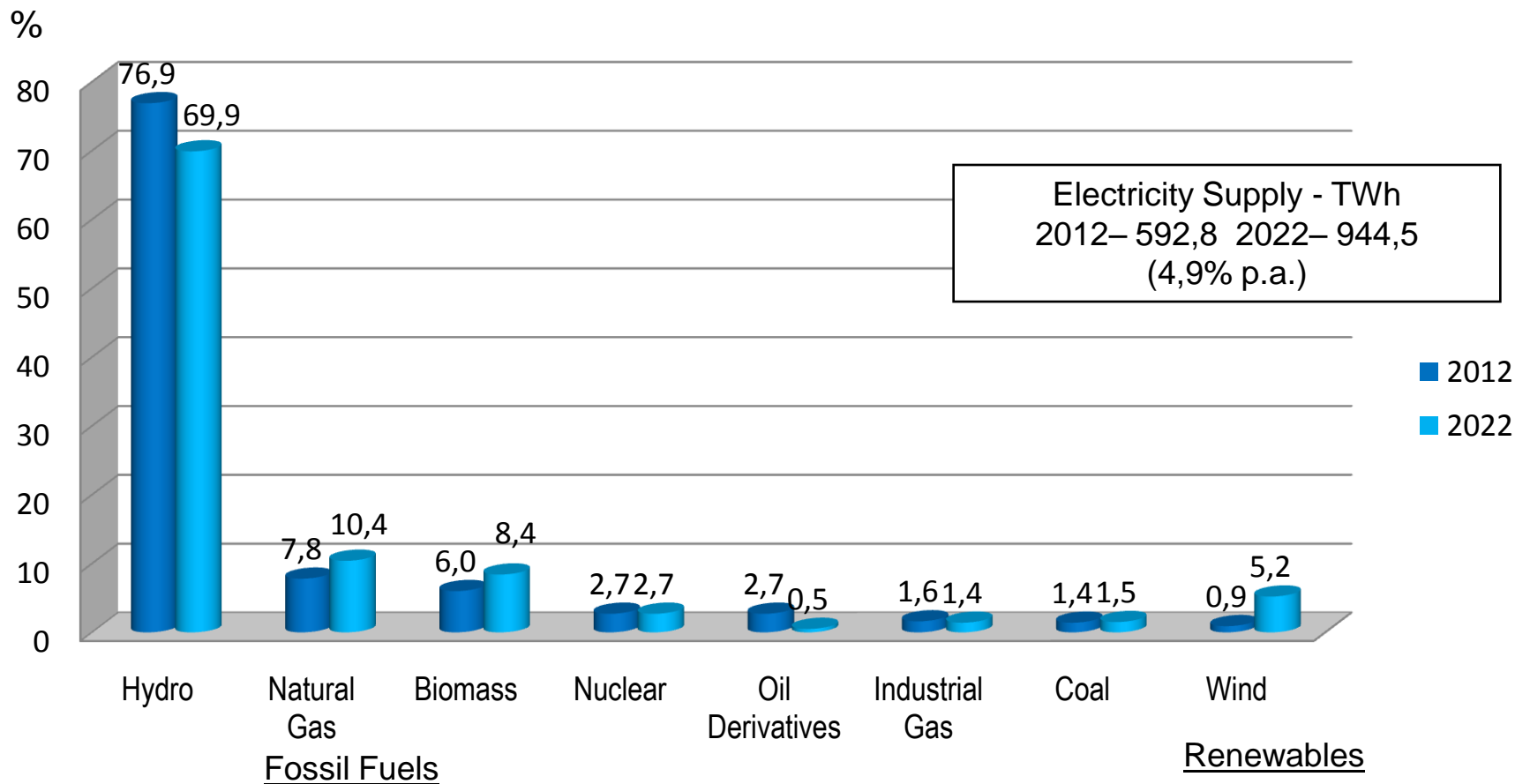


# BRAZILIAN TOTAL ENERGY SUPPLY





# BRAZILIAN ELECTRICITY SUPPLY MATRIX – 2012 / 2022



Brazil: 2012 – 13,5% 2022 – 13,8%  
World: 2010 – 68%

Brazil: 2012 – 83,8% 2022 – 83,5%  
World: 2010 – 18%



# BRAZIL – PDE 2022 INSTALLED CAPACITY

**2012:** GW 121 (84,3 hydro – 70% )

**2022:** GW 200,0 (121,3 hydro – 61%)

79 GW in Ten Years Growth – 2012/2022 (7,9 GW/year)

Source	GW	%	
Hydro	37,0	47	} 81%
Wind	15,6	20	
Biomass	10,8	14	
Natural Gas	12,1	15	
Nuclear	1,4	2	
Coal	1,1	1	
Industrial Gas	1,0	1	
<b>Total</b>	<b>79,0</b>	<b>100,0</b>	<b>(Self-producers: 15,4 GW)</b>



## BRAZIL – PDE 2022

### INSTALLED CAPACITY ELECTRICITY (\*) (GW)

Source	2012 (GW)	2022	Structure %	
			2012	2022
Hydro	84,3	121,2	69,7	61,2
Nuclear	2,0	3,4	1,7	1,7
Natural Gas	11,4	22,8	9,4	11,5
Coal	2,3	3,6	1,9	1,8
Oil	7,2	6,4	6,0	3,3
Industrial Gas	1,8	2,6	1,5	1,3
Biomass	10,0	20,7	8,3	10,3
Wind	1,9	17,5	1,5	8,9
<b>TOTAL</b>	<b>121,0</b>	<b>198,2</b>	<b>100,0</b>	<b>100,0</b>

(\*) With captive self-producer and does not include the Paraguayan part of Itaipu.



# BRAZIL – PDE 2022

## INVESTMENTS IN THE ENERGY SYSTEM

### PERIOD 2013/2022

#### Investments in Energy

	R\$ billion	%
Oil and Natural Gas	835	72,5
Electricity	260	22,6
Biofuel	56	4,9
Total (*)	1.151	100,0

Referential Exchange Rate: R\$ 1,88/US\$

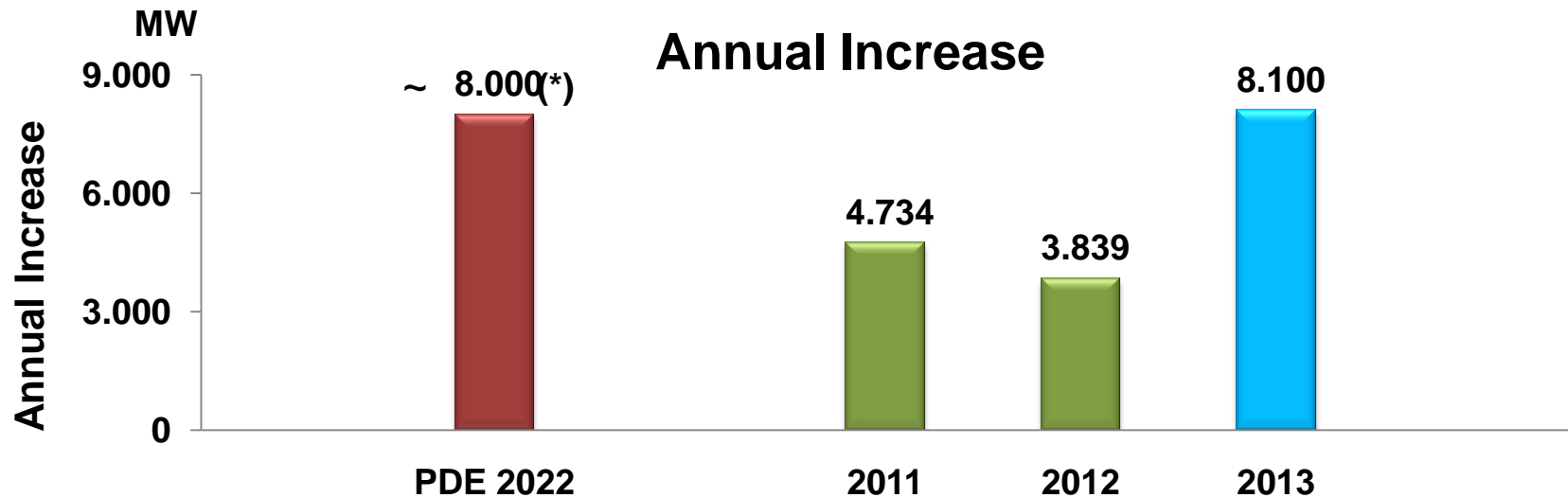
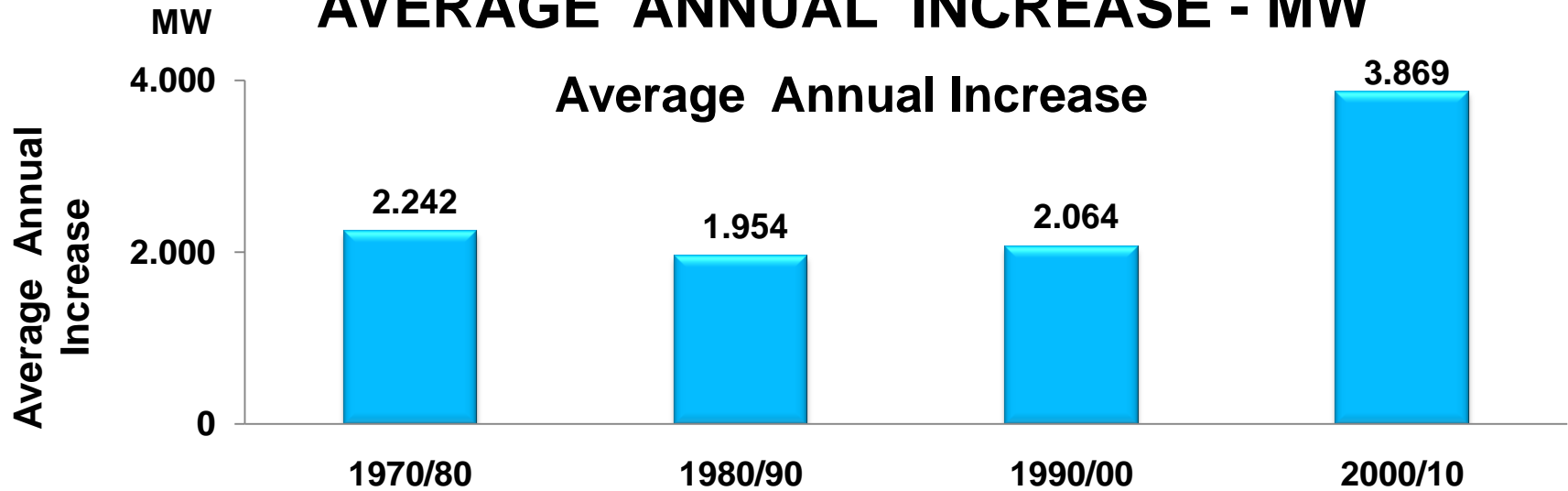
(\*) Represents about 2.3% of GDP and 10.7% of GFCF, both accumulated during the period.

R\$ of 2010





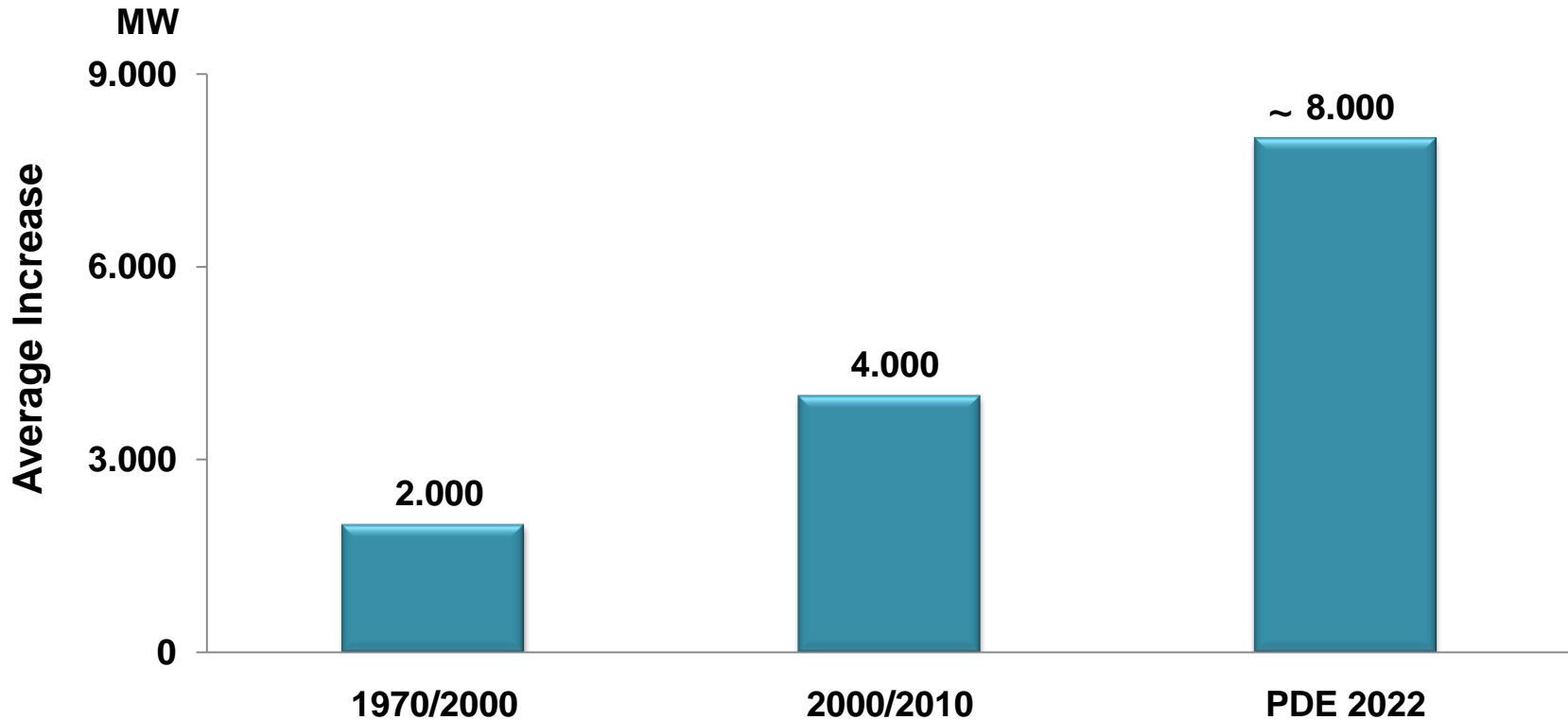
# BRASIL - INSTALLED CAPACITY AVERAGE ANNUAL INCREASE - MW



(\*) Average Annual



# BRAZIL - INSTALLED CAPACITY AVERAGE INCREASE - MW





## FEASIBLE BRAZILIAN HYDROPOWER POTENTIAL (COMPETITIVENESS AND ENVIRONMENTAL VIABILITY)

- Brazilian Hydropower Potential: 260,000 MW (3<sup>o</sup>/4<sup>o</sup> of the world)
- 2030 Plan (completed in 11/2007): 180,000 MW considered as feasible
- Currently: hardly exceed 150,000 MW, amount needed up to the five-year period 2025/2030  
(depending on the energy and environmental scenarios in the future)
- The Expansion of Installed Capacity in Brazil from this five-year period with no new hydropower plants will be mostly a combination of Nuclear, Natural Gas, and Mineral Coal.
  - Natural gas: supply / price / other uses
  - Nuclear: public acceptance, evolution of this option in the world
  - Mineral Coal: CO<sub>2</sub> emission



# NUCLEAR PROGRAM

## (Why it did not occur until 1990?)

- Nuclear Agreement with Germany in 1975: Eight nuclear power plants of 1,245 MW until 1990  
(there will not be eight nuclear power plants until 2030 - Anticipation of, at least, 40 years)
  
- **Reasons**
  - high market growth;
  - lack of knowledge of national hydroelectric potential;
  - questions about long-distance transmission;
  - political decision.



# THE NUCLEAR ALTERNATIVE FOR ELECTRICITY PRODUCTION IN BRAZIL

## History

- Angra I (70s)
- Angra II, Operation in 2000
- Conclusion of Angra III - CNPE Decision  
(operation planned for 2018)



## **NUCLEAR OPTION IN THE LONG TERM STRATEGIC PLANNING – 2030 PLAN**

- Carry on the nuclear program after Angra III taking into account the scenarios of 4,000, 6,000 and 8,000 MW by 2030.
- The reference scenario would be 4,000 MW, four new nuclear plants of 1,000 MW each, for the Northeast and Southeast regions.



# STUDIES AND ACTIONS TO ENABLE THE NEXT NUCLEAR PLANTS AFTER ANGRA III

## I) Site Study

- Area Choosing (office work)
- Micro Location Choosing (fieldwork)

## II) Technology and Costs Study

- Technology: international experience with the new generation of reactors
- Budget (costs) and Construction Schedule
- Economic Feasibility: Cost per MWh (supplied )



# STUDIES AND ACTIONS TO ENABLE THE NEXT NUCLEAR PLANTS AFTER ANGRA III

## III) Energy Sales

- Key Project: operation horizon beyond the A-5 auction
- Competitiveness with other options of primary sources production

## IV) Socio-Environmental and Nuclear Licensing





## CONCLUSIONS

- Energy sector: growth of about 4-5% per year over the next 10 or 15 years;
- Expansion of installed capacity: about 8,000 MW per year, including self-production in the next 10 or 15 years;
- Expansion of installed capacity according to Ten Year Plan 2022: 80,000 MW in the 10 years (2013/2022), as follows:

### Renewables (64 GW, 81%):

Hydro - 37 GW (47%), Wind 16 GW (16%), Biomass - 11 GW (14%);

### Non-Renewables (14.5 GW, 18%):

natural gas - 12 GW (15%), nuclear - 1.4 GW (2%) and coal - 1.1 GW (1%).



## CONCLUSIONS

- End of the feasible hydropower potential, about 150,000 MW, in the period 2025/2030;
- Future thermal generation: base load operation, with a low fuel cost, in this case: natural gas, nuclear and coal;
- Installed capacity expansion from the period 2025/2030 on: mostly with a mix of natural gas, nuclear and mineral coal;
- New nuclear plants after Angra III: technical-economic and environmental feasibility studies ;
- Strategic planning: National Energy Plan 2050, with completion expected in the first half of 2014.