CEPEL 35 anos

Sistema Eletrobrás

Sixth DIALOGUE ON WATER at Deutsches Institut für Entwicklungspolitik

DISCUSSION FROM BRAZIL

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DIRECTOR GENERAL

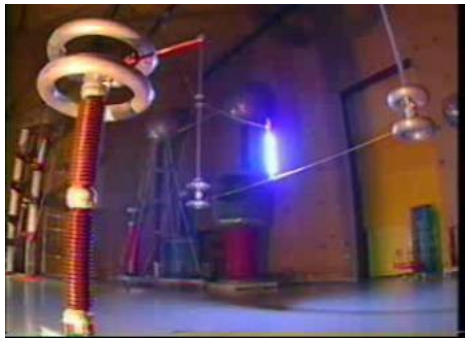
Bonn, Germany

15-16 October, 2009

CEPEL – The Brazilian Electric Energy Research Center

- Eletrobrás´ R&D Center
- Founded in 1974
- Largest Brazilian Electric Energy R&D Center
- Largest High Voltage and High Power Labs in Latin America
- More than 500 employees
- Technical Support for
  - Eletrobrás Group
  - Government (Mines and Energy Ministry, Science and Tech. Ministry)
  - Electrical Sector Entities (National System Operator -ONS, Wholesale Energy Market -CCEE, Expansion Planning Company -EPE) and Regulatory Agency -ANEEL)
  - Utilities and Industry

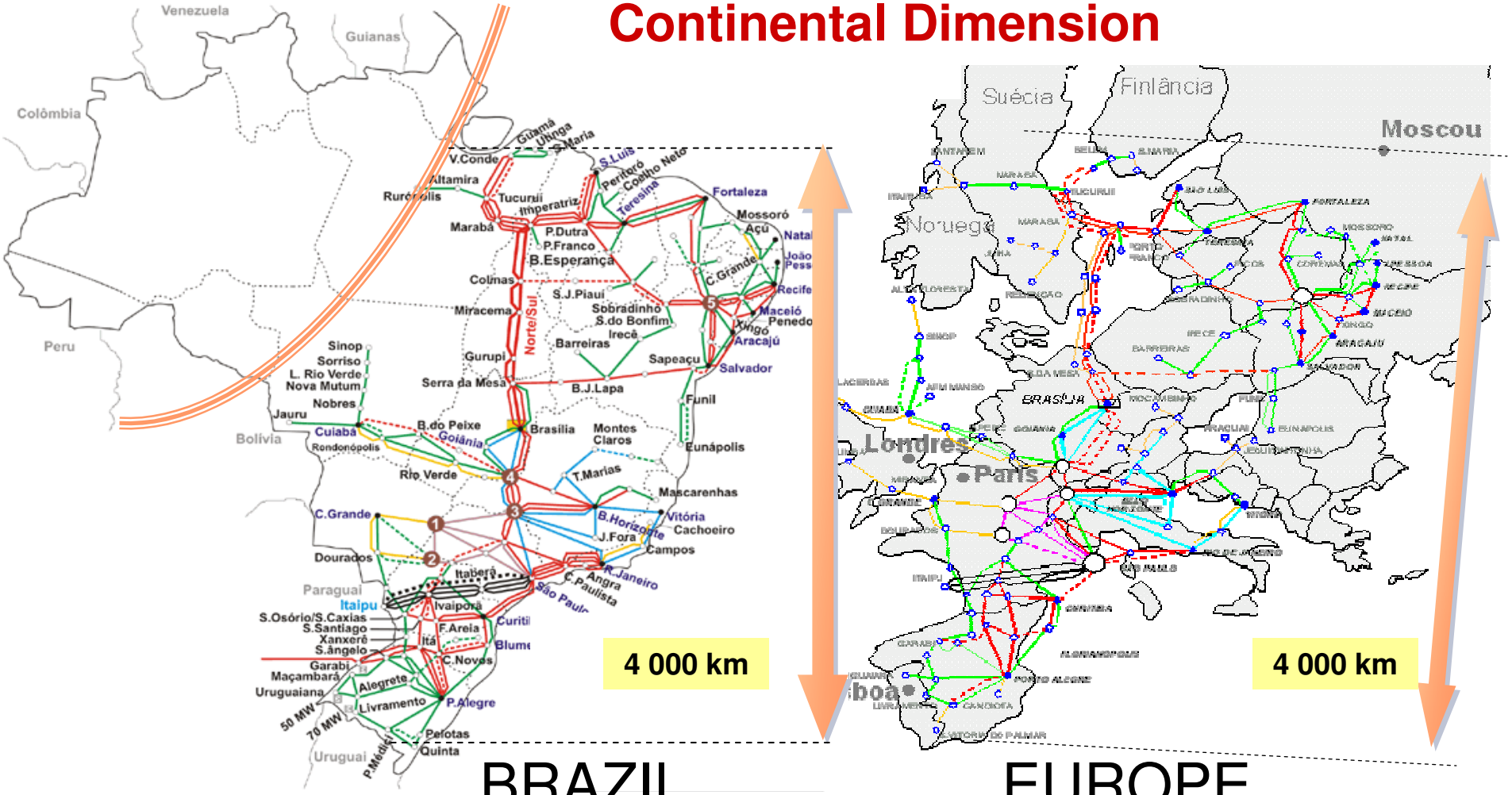
Fundão Island Site



Adrianópolis Site

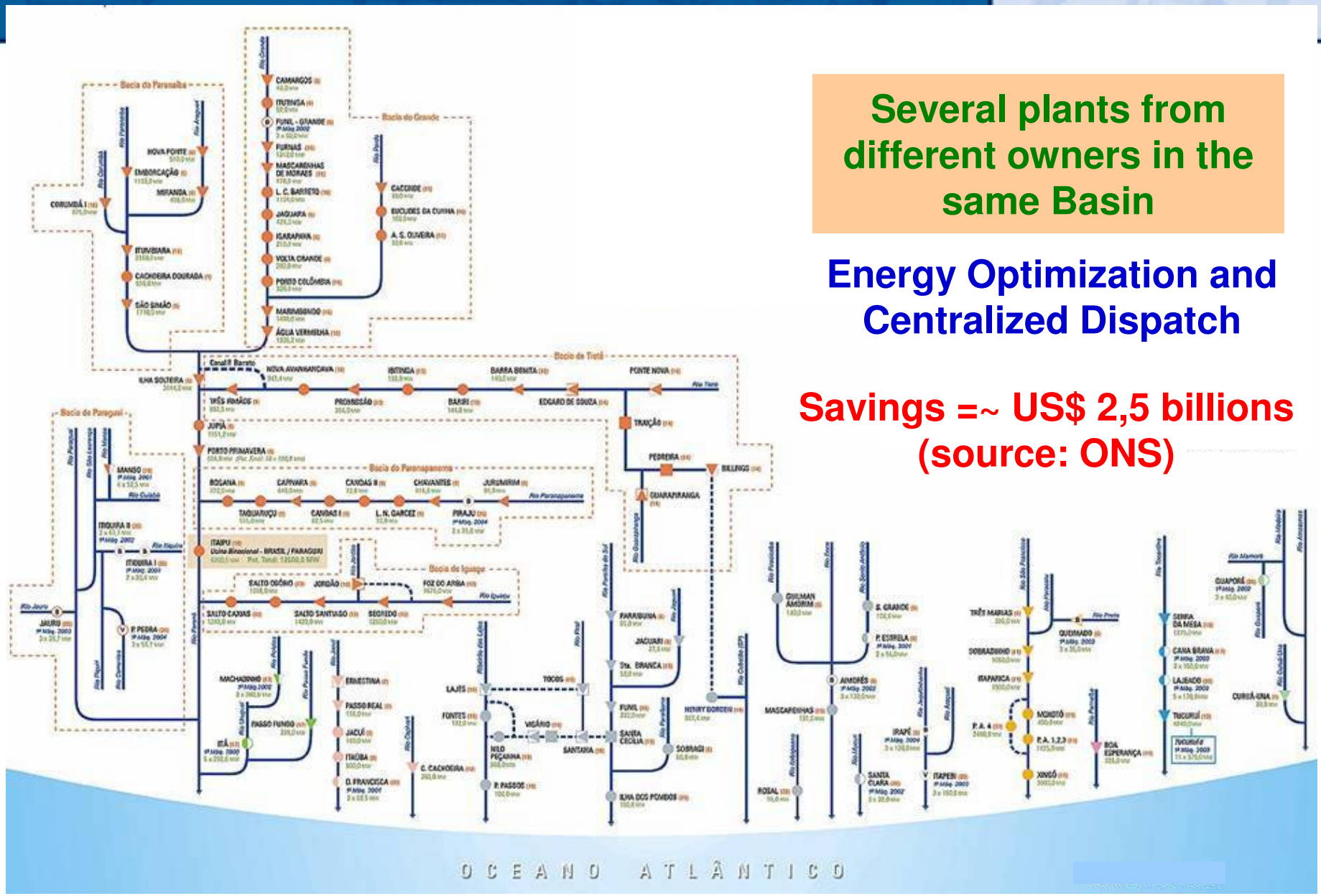
Brazilian Transmission System

Continental Dimension



BRAZIL EUROPE

Hydroelectric Interdependence

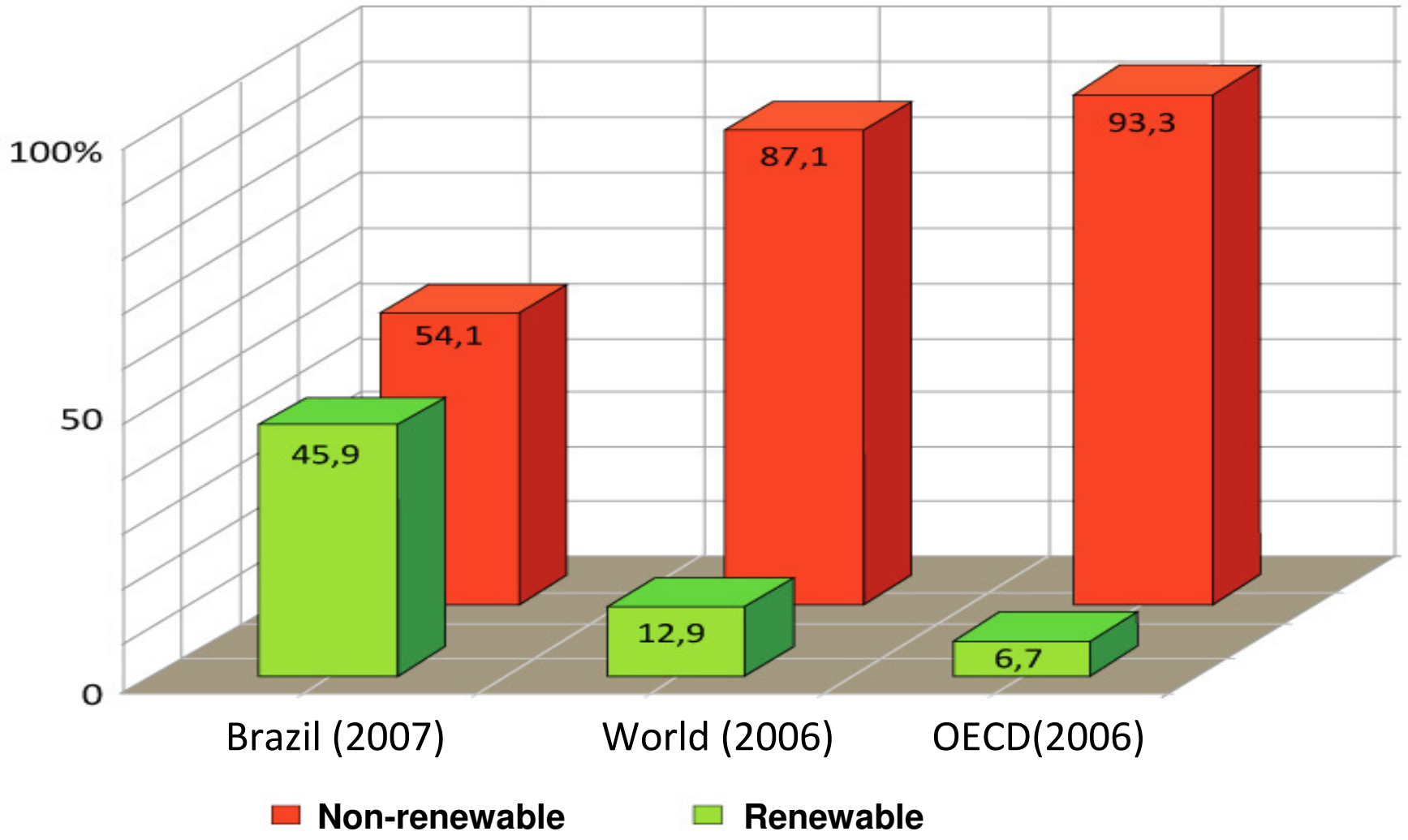


Several plants from different owners in the same Basin

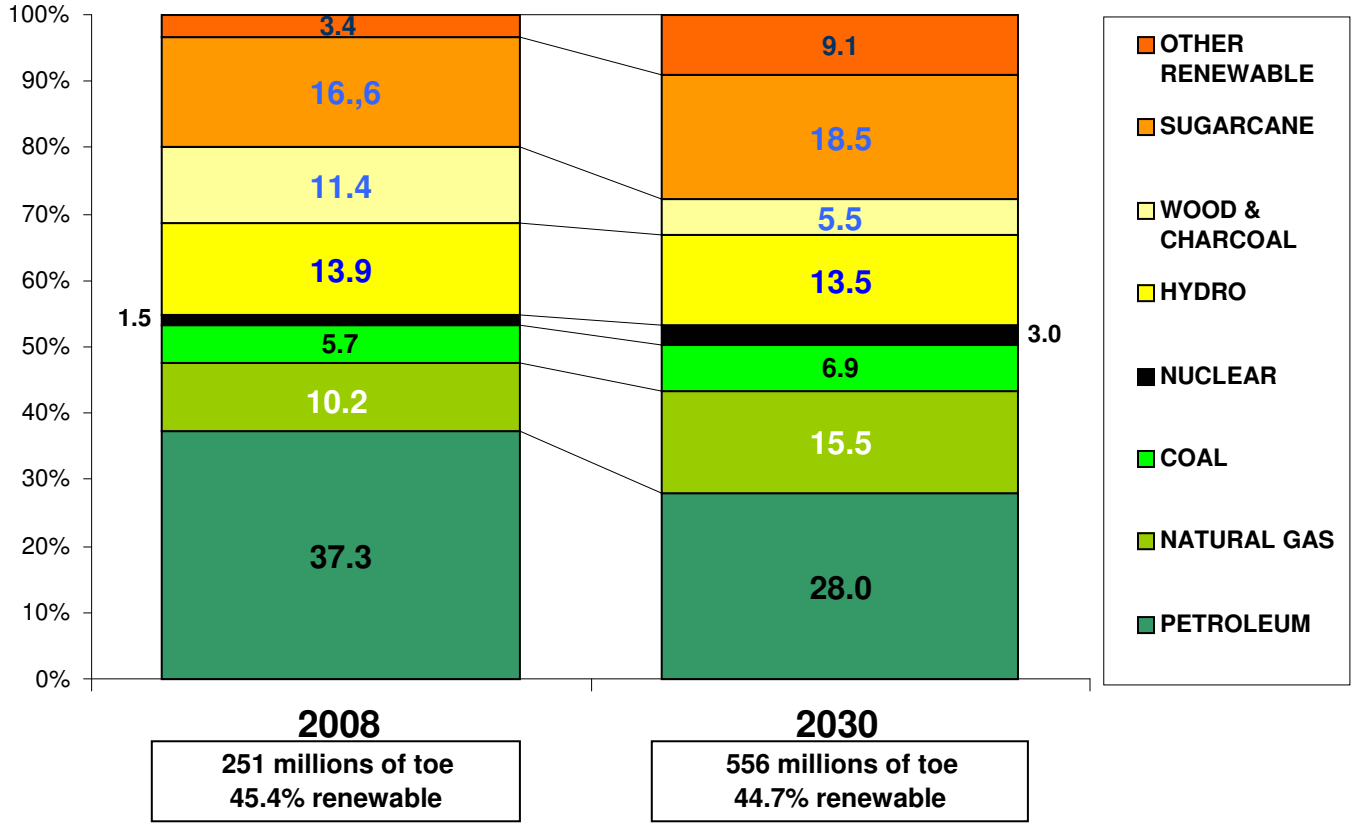
Energy Optimization and Centralized Dispatch

Savings =~ US$ 2,5 billions (source: ONS)

Overview: World Energy Matrix - 2007



ENERGY SUPPLY MATRIX

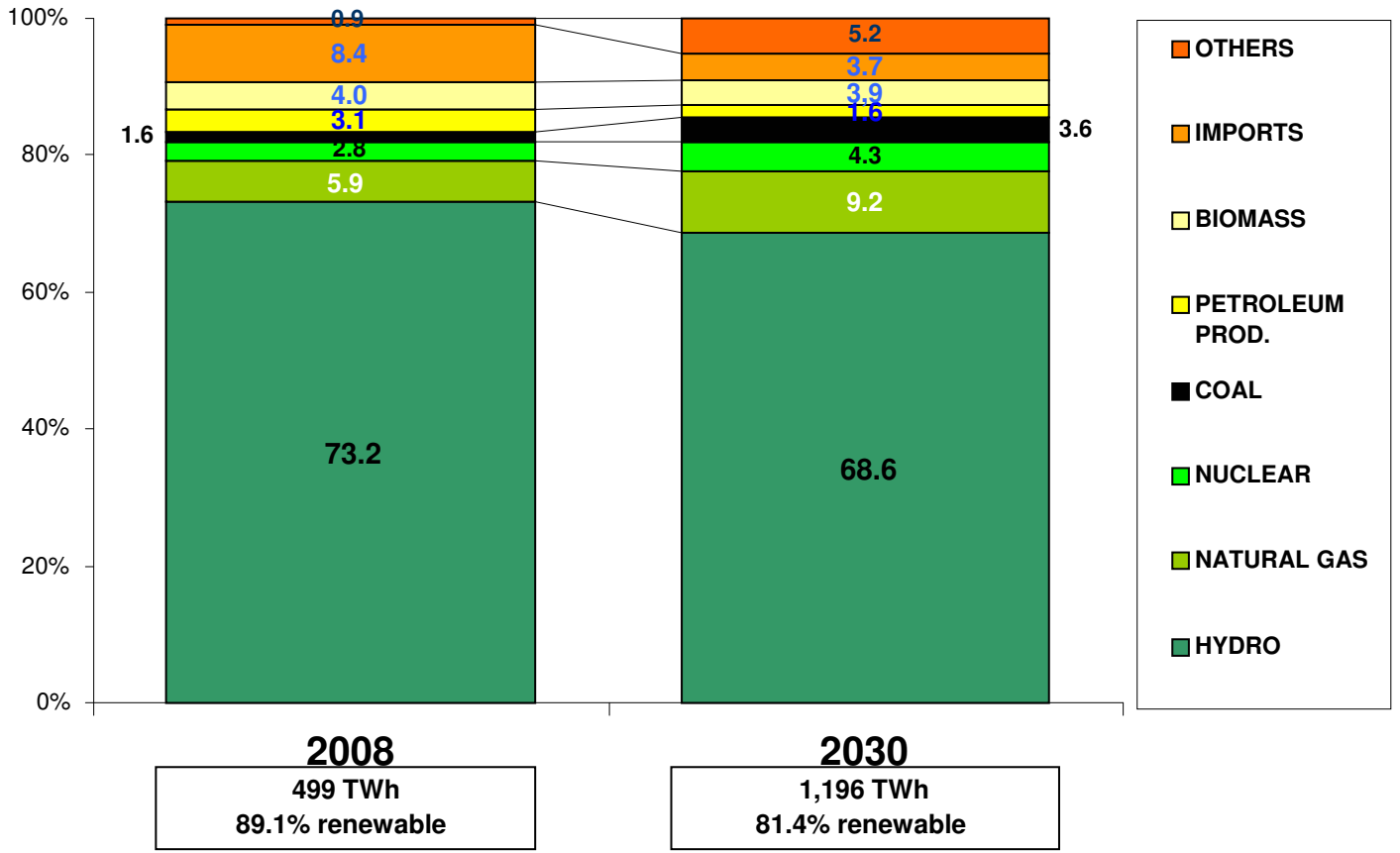


Renewable:

Brazil:	**45.4 % (2008)**
World:	**14.0 % (2006)**
OECD:	**6.0 % (2006)**

Source: PNE 2030

ELECTRICAL ENERGY MATRIX

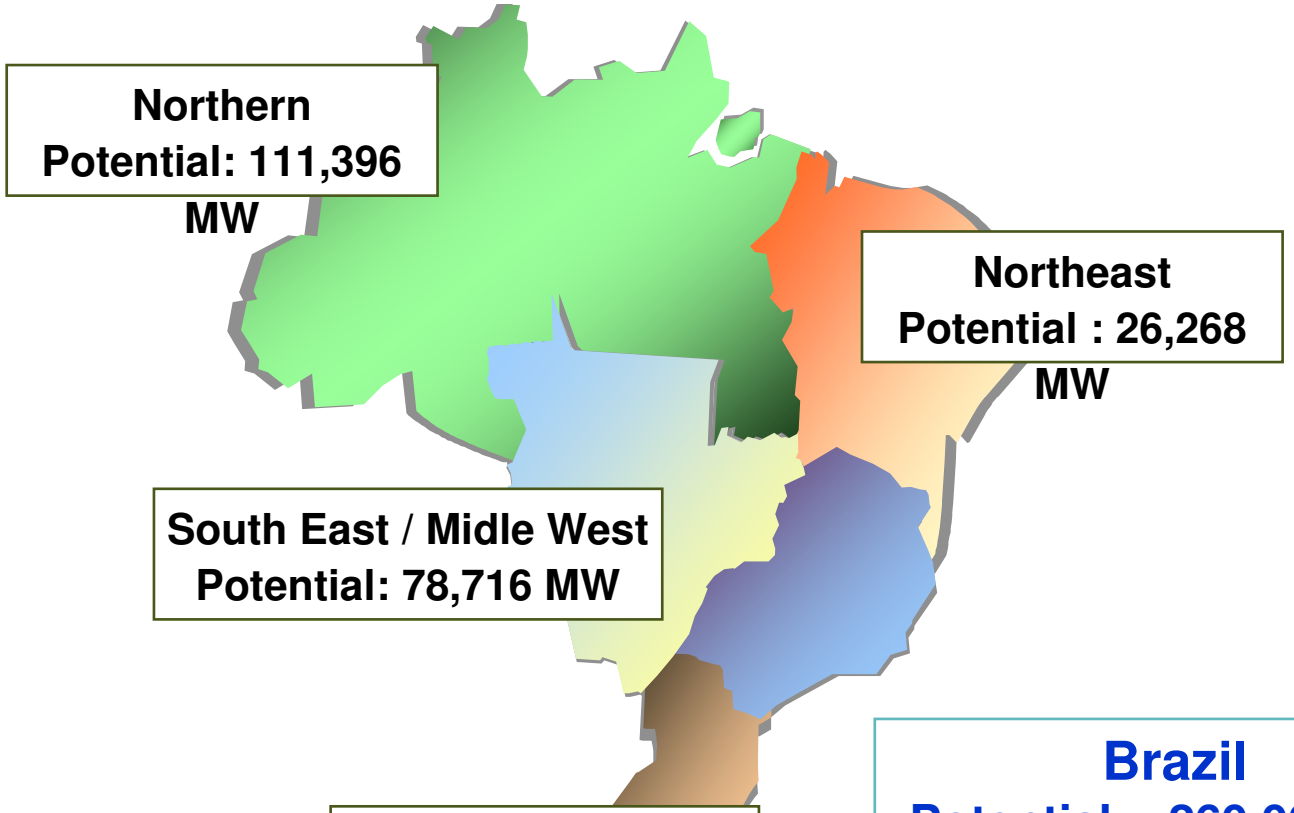


Renewable:

Brazil:	**89 % (2008)**
World:	**17 % (2006)**
OECD:	**20 % (2006)**

Source: PNE 2030

HYDROPOWER POTENTIAL



Brazil
Potential : 260 000 MW

Already Developed: 30%

Challenges for Hydropower Development in Brazil

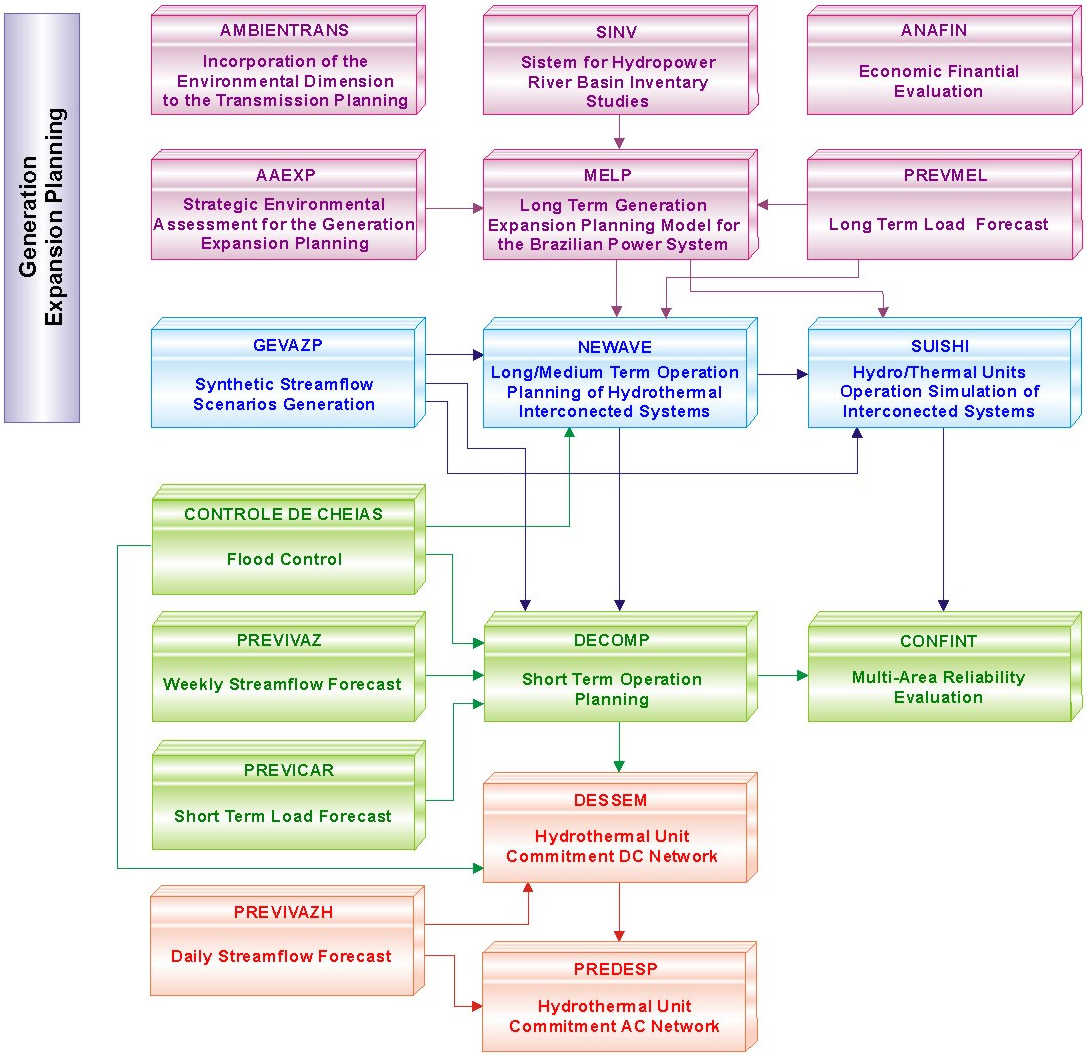
- **Hydropower has a dominant role in our power system**
  - **almost 80% of our installed capacity (106 GW)**
  - **around 90% of electrical energy production**
- **This role should remain over the next decades**
  - **huge undeveloped potential (170 out of 260 GW)**
  - **National Energy Outlook 2030:**
    - **addition of 90 GW in the next 20 years**
    - **share in the electricity matrix: 2007 - 78%; 2030 – 72%**
    - **90 GW to be developed: includes large projects in the Amazon Region,e.g., Santo Antônio/Jirau (6,5 GW), Belo Monte (11 GW), Tapajós (10 GW)**

- **Challenge: Brazil intends to develop its hydropower potential (90 GW in the next 20 years), including those in the Amazon region, in a sustainable manner**

Solutions for Hydropower Development in Brazil

- **Environmental, social and economic impacts and benefits must be carefully addressed**
  - **Social-Environmental aspects are**
    - **considered since the very first phase of the Expansion Planning**
    - **continuously imonitored throughout projects cicle of life**
- **Examples**
  - **Chain of optimization models and methodologies for power system planning and operation**
  - **Hydroelectric Inventory and Dimensioning Studies**
    - **2007 Edition of the Hydroelectric Inventory Manual, sponsored by the World Bank and the Brazilian Government**
  - **Environmental assessment**
    - **project, set of projects, whole expansion plan**
  - **Changes on project design**
    - **Belo Monte project : 1225 km^2, 11,000 MW to 440 km^2, 11,231 MW**
  - **Public hearing in the licensing process**
    - **More than 5,000 people in 6 public hearings (Belo Monte project)**
  - **Social-Environmental initiatives enforced by Law**
  - **Brazilian companies seeking for sustainability indices**
  - **Adequate institutional framework**

CEPEL´s Chain of Optimization Models for the Generation Expansion and Operational Planning of the Brazilian System

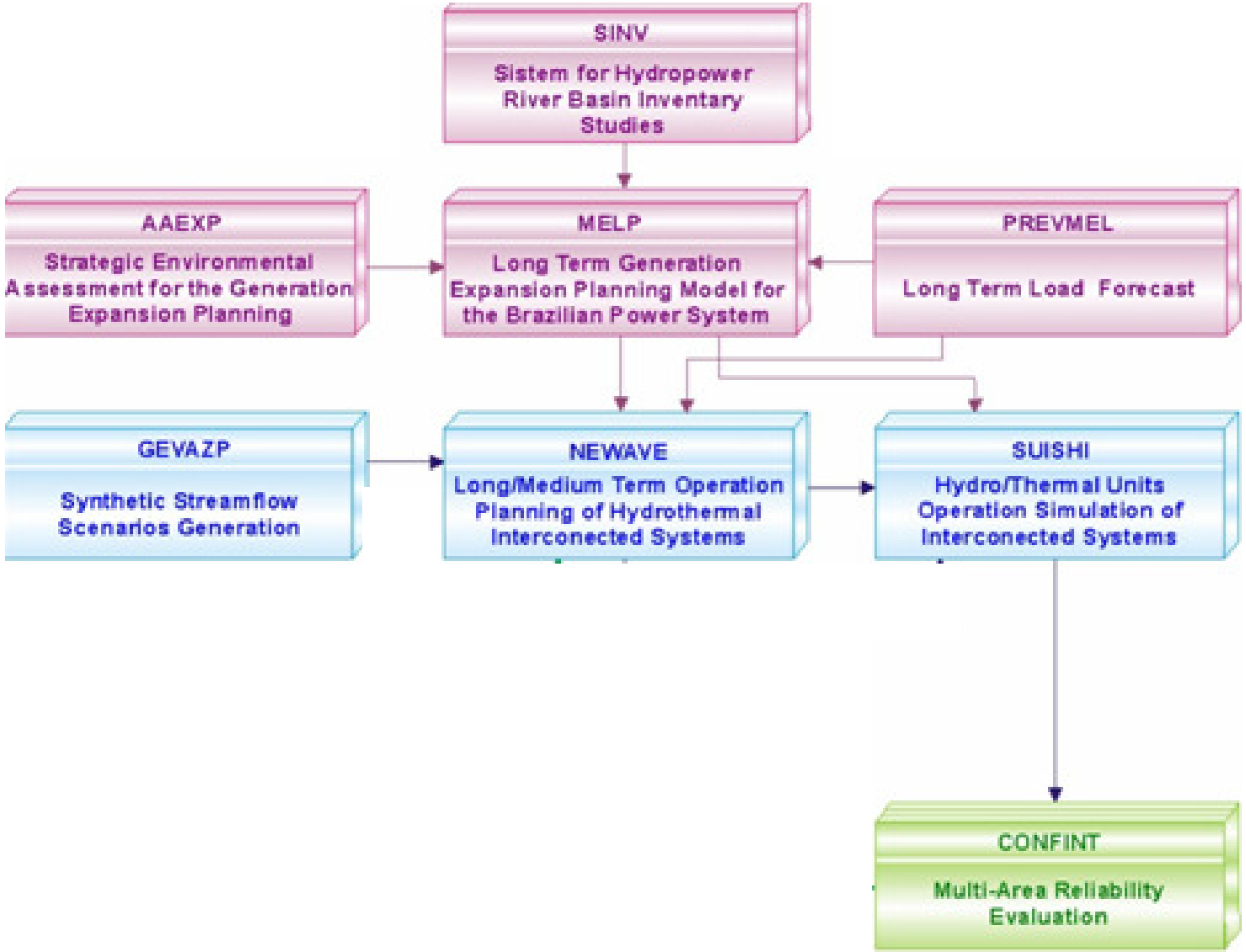


Horizons and Time Steps

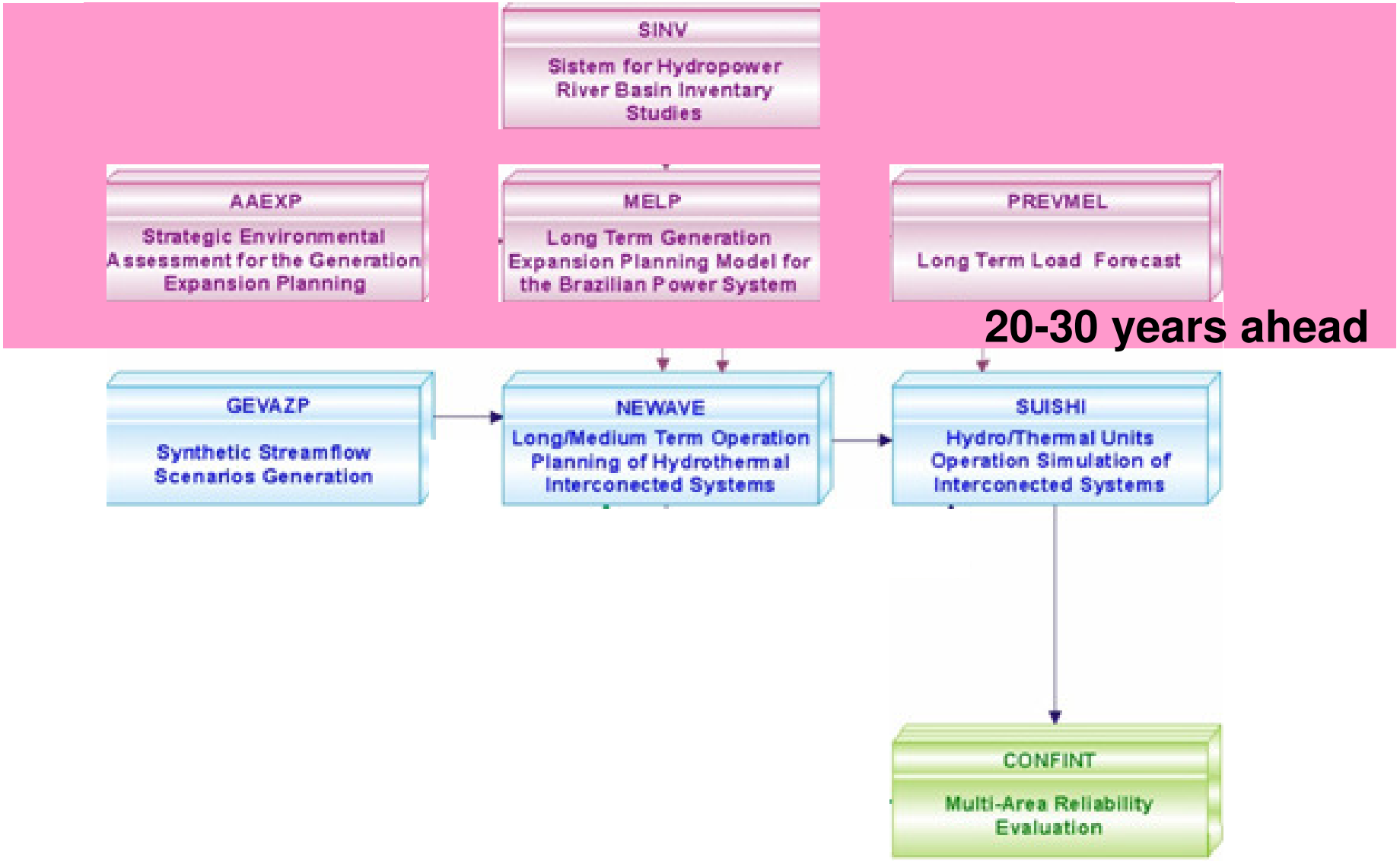
20-30 Years, annual steps to 1 Week, hourly steps

Official Programs

Chain of Models for Generation Expansion Planning

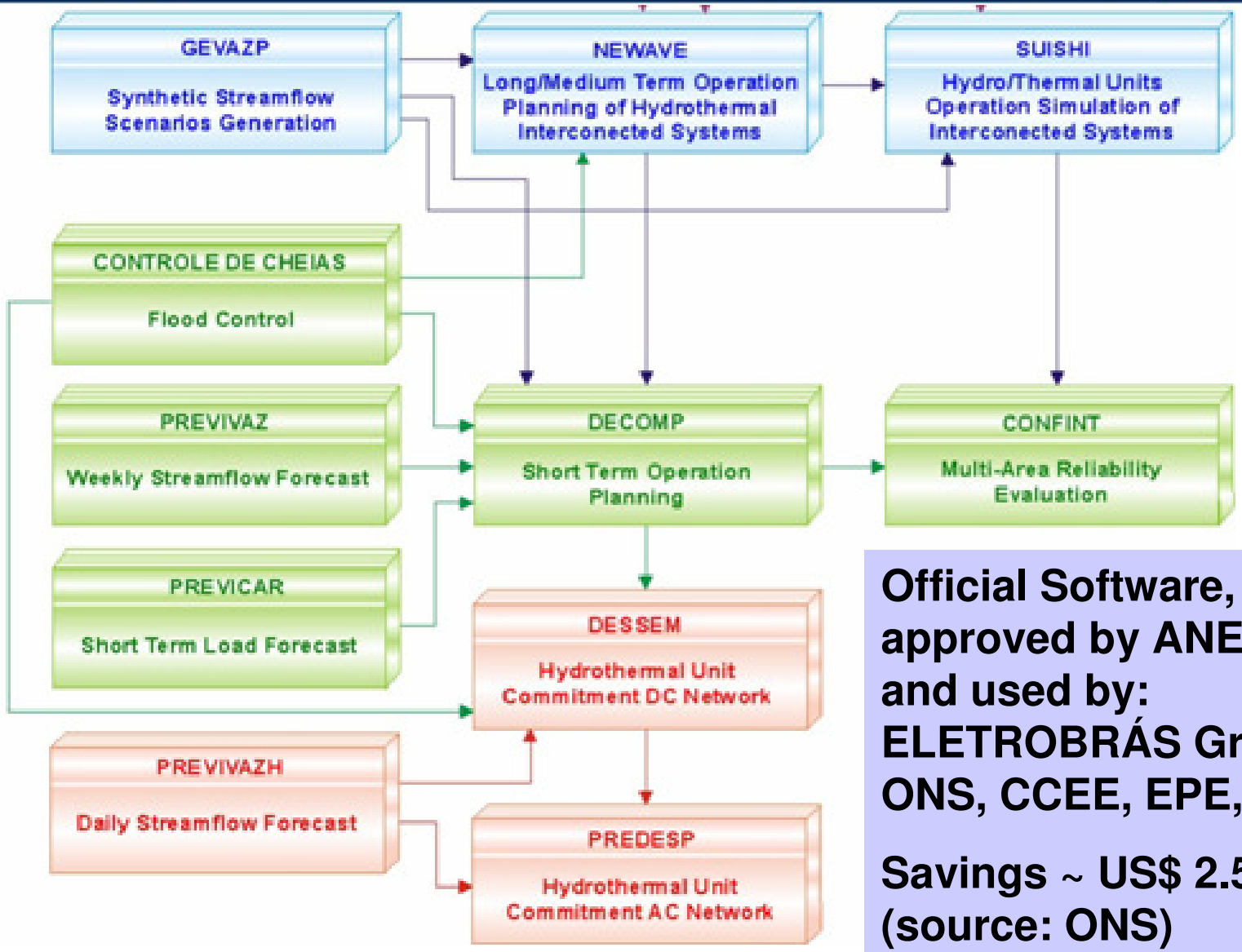


Chain of Models for Generation Expansion Planning



Chain of Models for Generation Expansion Planning

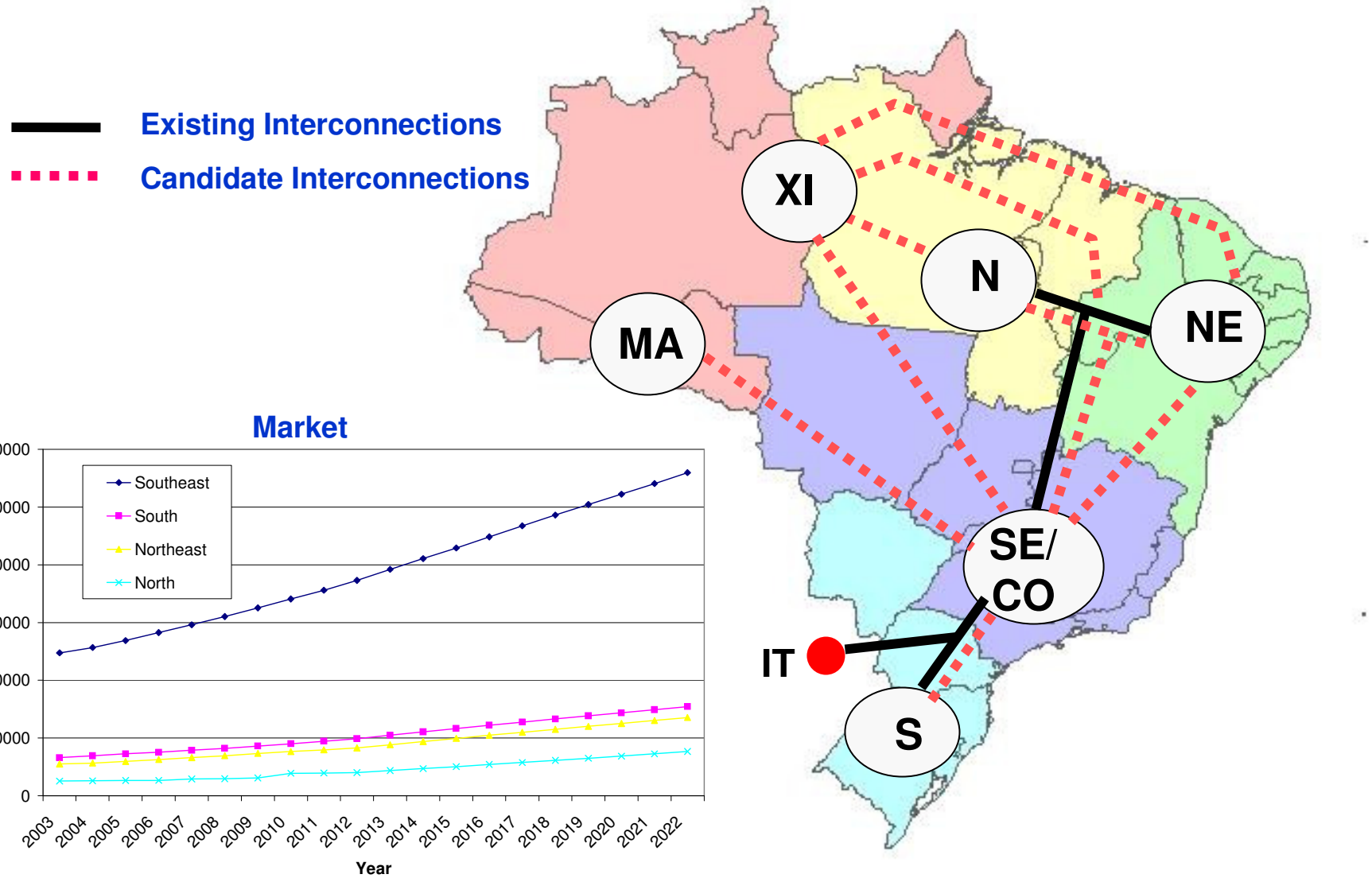
Chain of Models for Generation Operational Planning



Official Software, approved by ANEEL and used by: ELETROBRÁS Group, MME, ONS, CCEE, EPE, Agents

Savings ~ US$ 2.5 billions (source: ONS)

MELP Application Example – National Energy Overlook - 2030

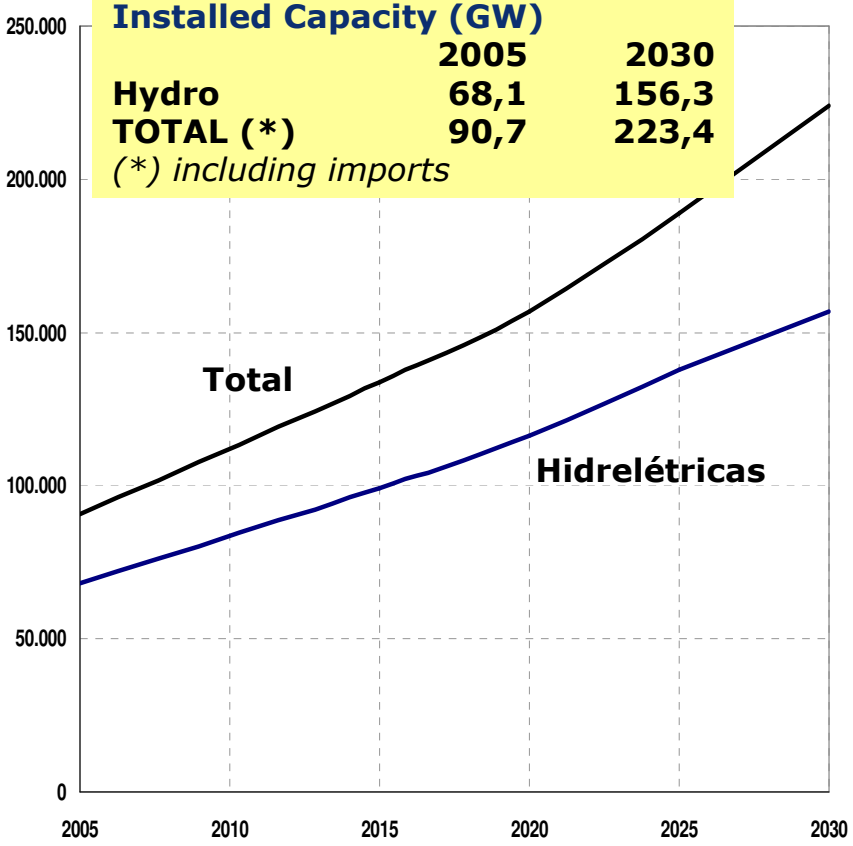


MELP Application Example – PNE-2030
Generation Expansion – Scenario 1
(Market B1 with additional conservation)

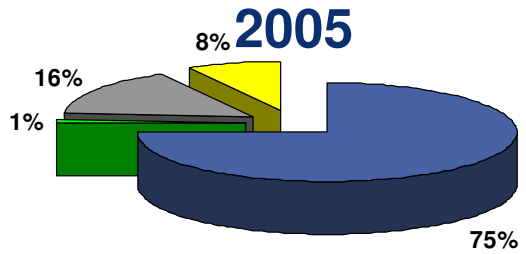
Installed Capacity (GW)

	2005	2030
Hydro	**68,1**	**156,3**
TOTAL (*)	**90,7**	**223,4**

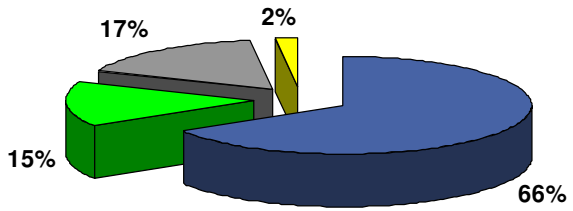
(*) including imports



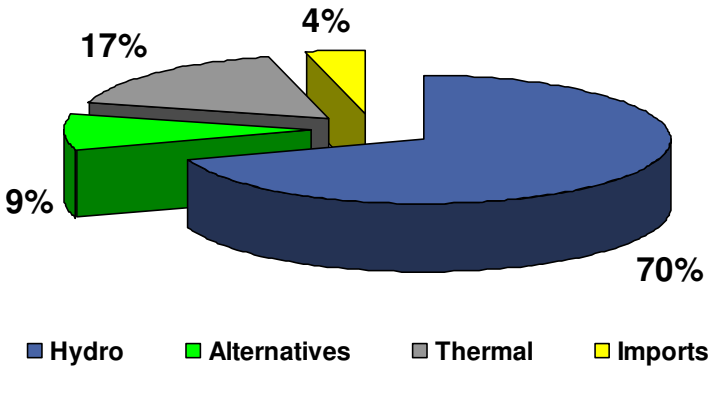
Alternatives
Small Hydro
Wind
Sugarcane biomass (cogeneration)
Urban residues



Expansion 2015-2030

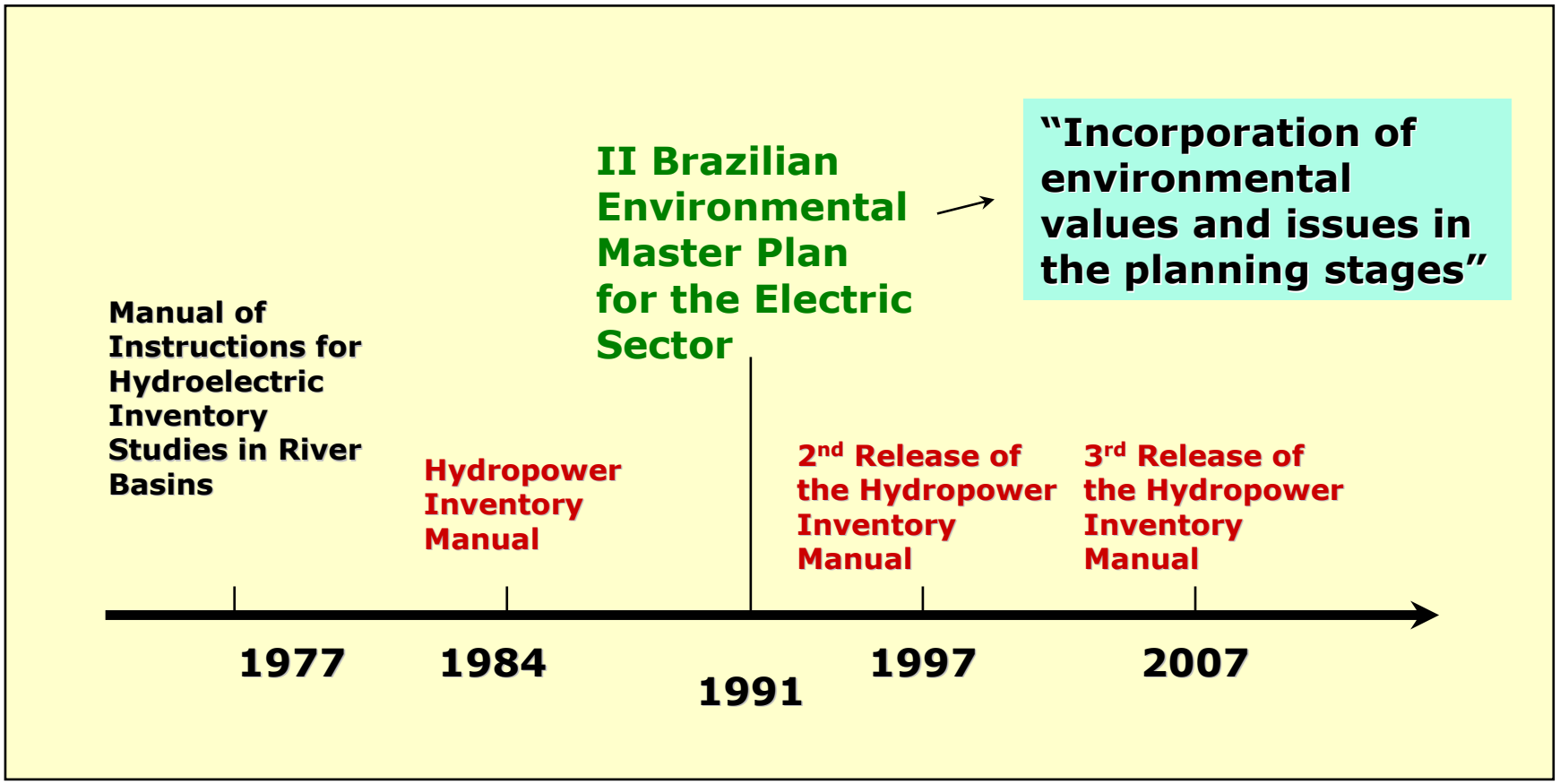


2030



Source: EPE/MME

Evolution of the Brazilian Hydropower Inventory Manual



1997 – National Water Resources Policy
2000 – Water National Regulatory Agency
2006 – National Water resources Plan

Hydroelectric Inventory Manual - 2007 Edition

- Social-Environmental aspects are considered since the first phase of Expansion Planning
- Objective of the Hydroelectric Inventory Studies: balancing economical energy production, social-environmental impacts (negative and positive) and multiple uses of water.

INVENTORY	
	MW
Total	30,991.50
Total PAC*	28,992.00

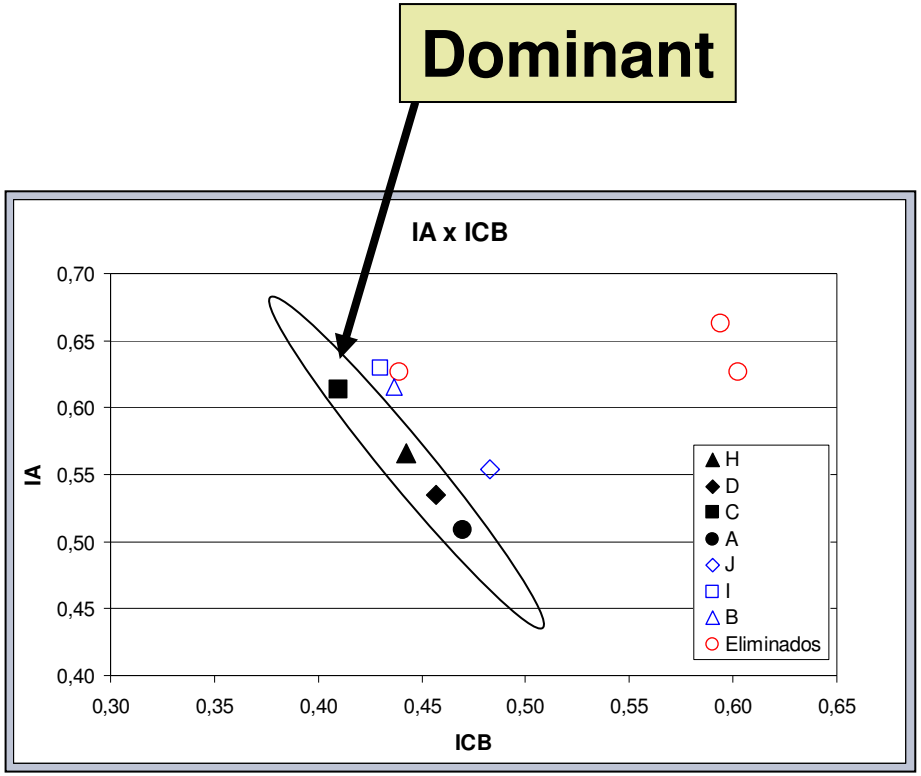
VIABILITY	
	MW
Total	20,034.00
Total PAC*	12,287.00

* PAC: Programa de Aceleração do Crescimento – national program to foster public and private investment

Application of the Software SINV - Preliminary Studies

Socio-environmental negative impact index (IA) and Cost-Benefit Energetic index (ICB/CUR)

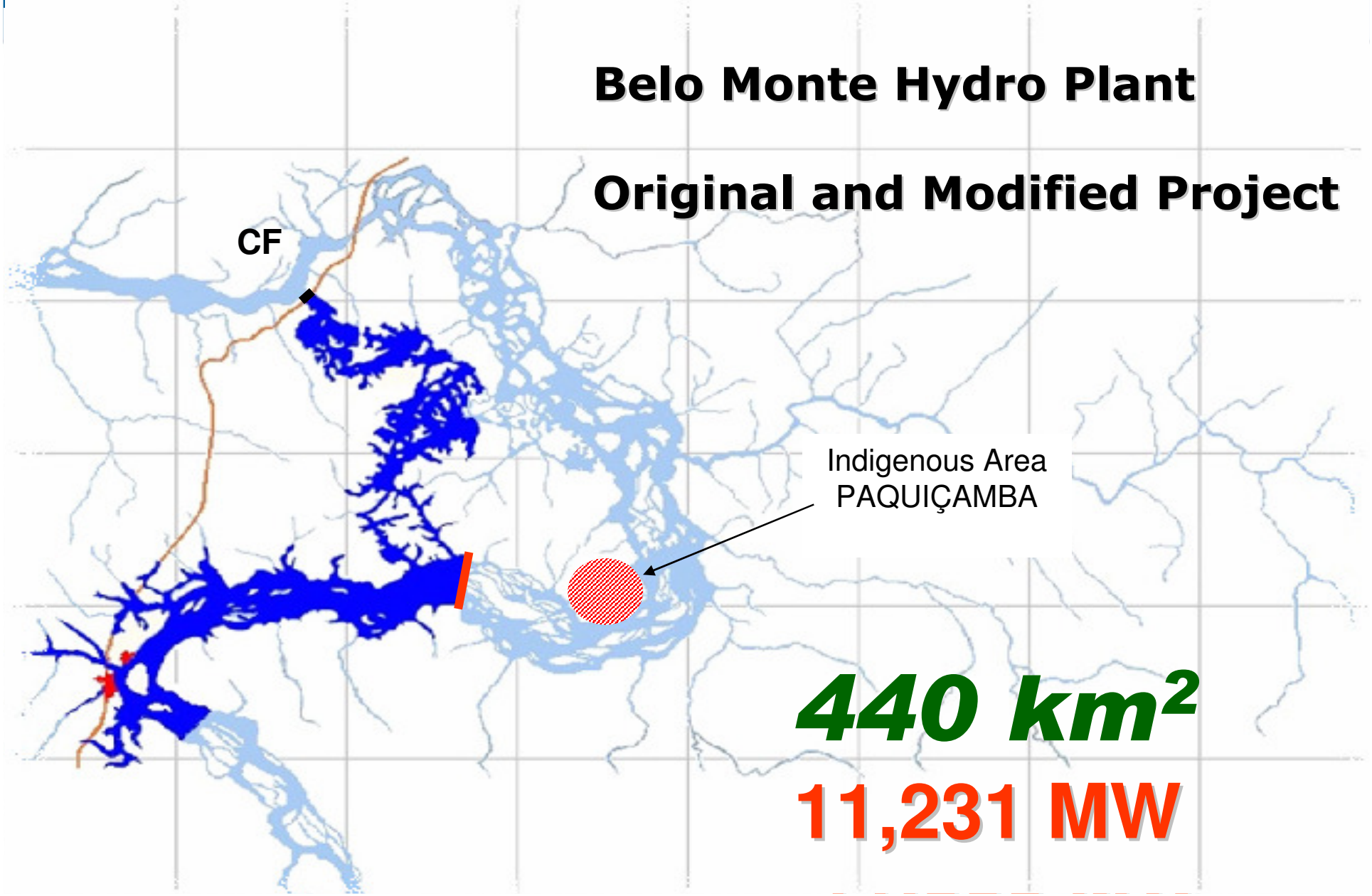
Alternative	IA	ICB/CUR
A	0,509	0,470
B	0,615	0,436
C	0,613	0,410
D	0,535	0,457
E	0,627	0,602
F	0,663	0,594
G	0,627	0,439
H	0,566	0,443
I	0,630	0,430
J	0,554	0,483



Example of Environmental Commitment

Belo Monte Hydro Plant

Original and Modified Project

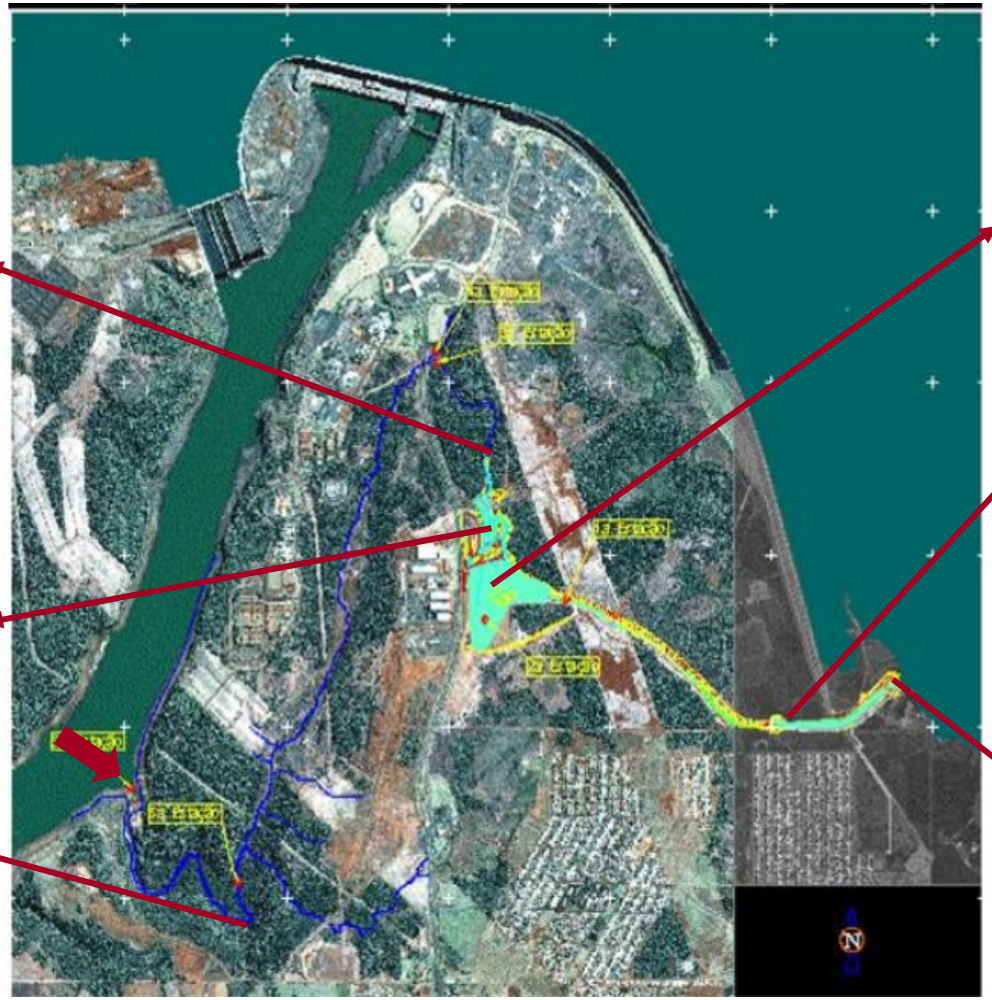


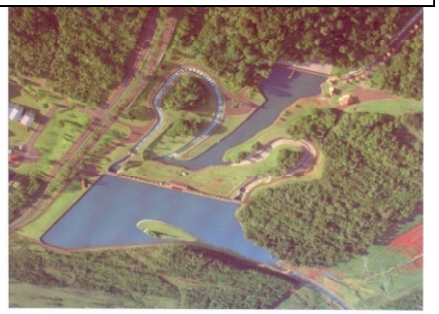
440 km²

11,231 MW

Itaipu Fishes Water Ways

Built 20 years after Initial Operation of the Plant
A large water head Hydropower Plant (120m)
A large extension channel (10 km) including channels and fish stairs





ITAIPU Hydro Power Plant
14,000 MW (20 x 700 MW)

CEPEL 35 anos
Sistema Eletrobrás

ENERGY PRODUCTION IN 2007:

90,620,003 MWh

526,027 barrels of oil/day

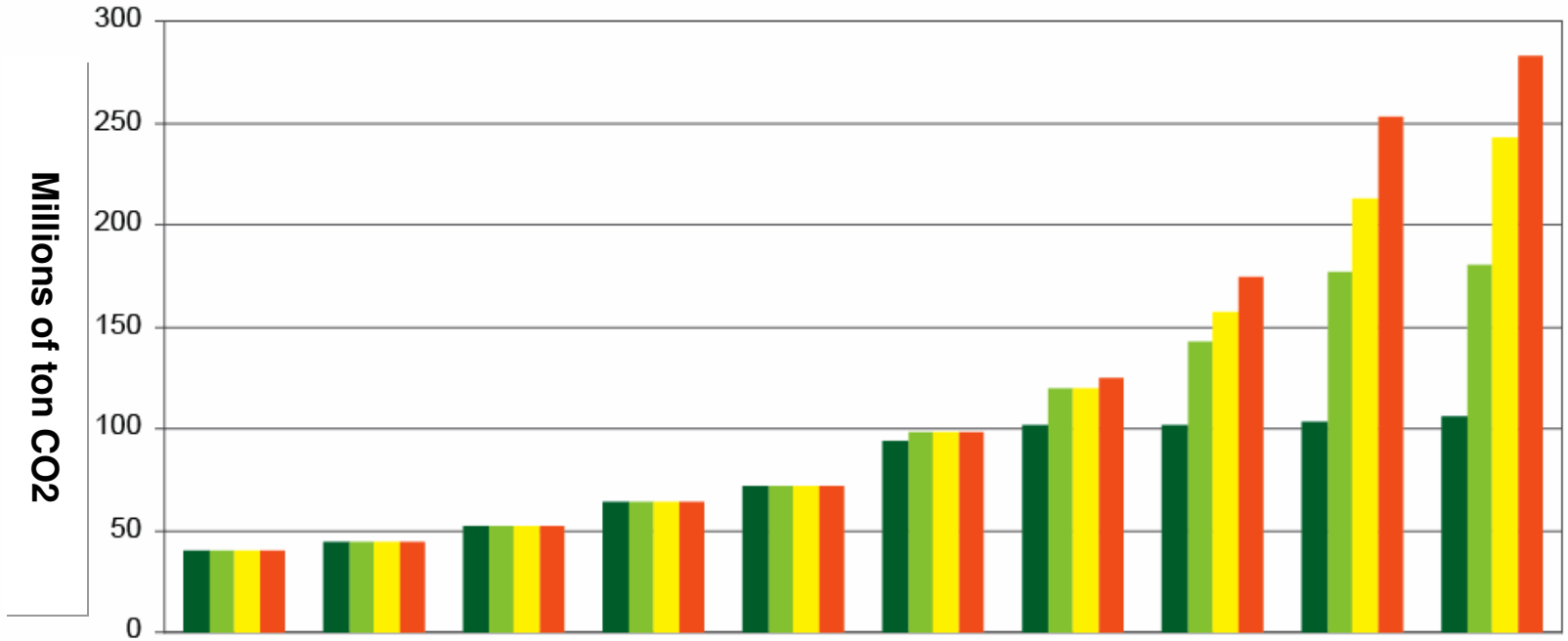
or

46 Millions of m^3 of gas/day

Avoided CO_2 Emissions:

- 83 Mton (by Coal)
- 37 Mton (by Gas)

Estimated Potential CO_2 Emissions by Replacing Planned Hydros



	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
I: Base	40,0	44,6	52,4	64,2	71	94	102	102	103	106
II: I - Madeira	40,0	44,6	52,4	64,2	71	98	120	143	177	180
III: II - Belo Monte	40,0	44,6	52,4	64,2	71	98	120	157	212	243
IV: III - UHEs do Norte	40,0	44,6	52,4	64,2	71	98	125	174	253	283

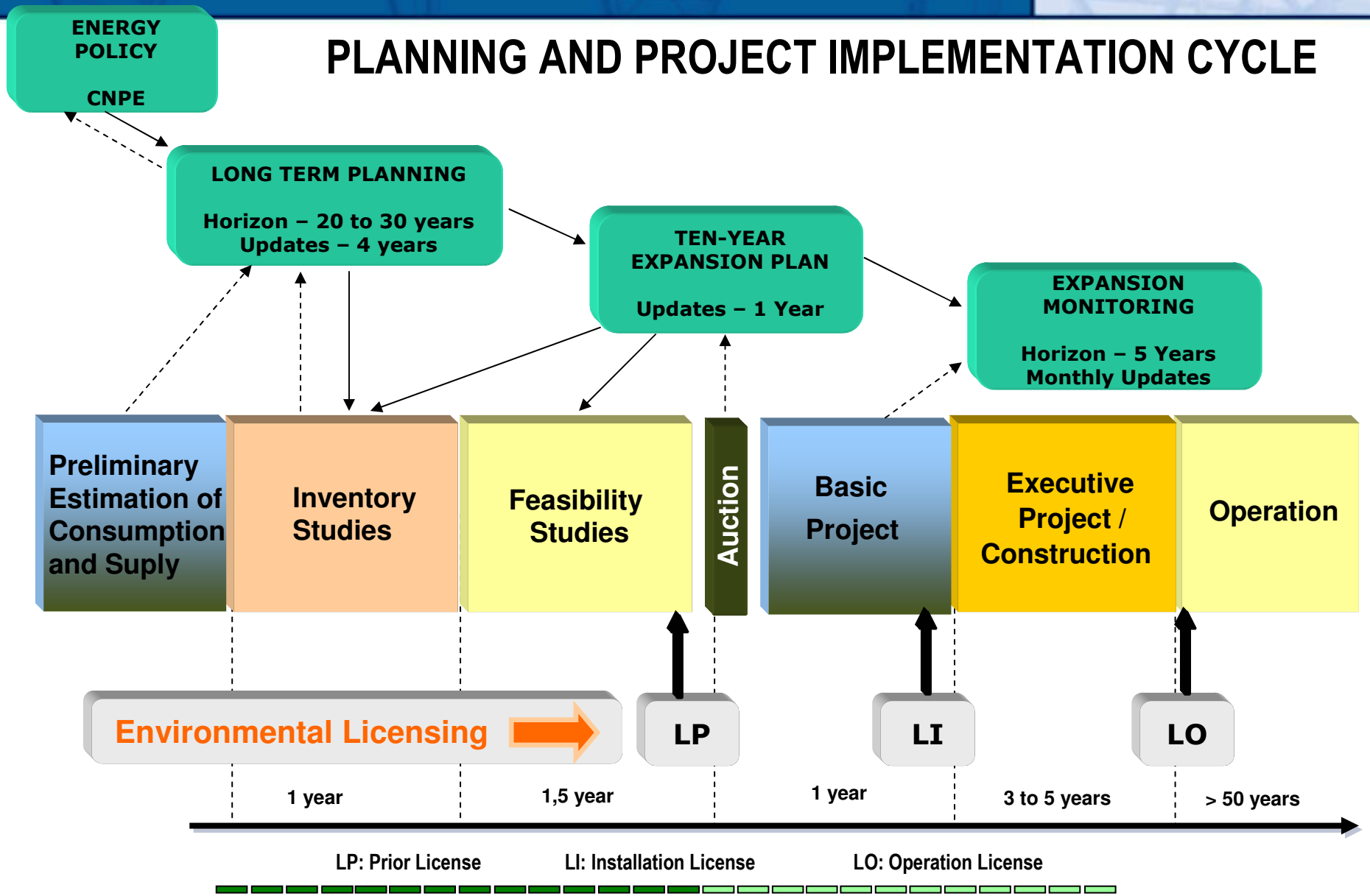
Social-Environmental Initiatives Enforced by Law

The Brazilian Environmental Law Framework is one of the most restricted in the world

- **Environmental Feasibility as the first step for auctioning and public concession (Decree 5.163/2004, Art. 20 c)**
- **Social-Enviromental Integrated Planning required by Law (IEA-Integrated Environmental Assessment);**
- **Public Hearing as a requirement during the project development (IEA and EIA/RIMA);**
- **Permanent Monitoring of Social and Environmental issues by the Ministry of Mines and Energy**
- **"Water Law"- Creates the National Water Resources Policy and National Water Resources Managemant System (Law 9.433/1997)**
- **In 2006, the National Water Resource Plan (PNRH) was concluded**
- **In 2007 a new Hydroelectric Inventory Manual was published**

Adequate institutional framework

PLANNING AND PROJECT IMPLEMENTATION CYCLE



Solutions for Hydropower Development in Brazil

- **Adequate Institutional Framework - I**
  - National Energy Policy Council – policies and guidelines for energy sector
  - Long-Term Expansion Plan – 20 to 30 years ahead
  - Ten-Year expansion plan – projects ranking
  - Expansion and Operationon Monitoring – 5-year horizon
- **Adequate Institutional Framework - II**
  - Energy Buying based on Auctions
  - Winner receives a long-term contract (30 years) with all distribution companies
  - Need of Prior Environmental License for each project to go to auction process
    - Includes social aspects and water rights
  - 100% of captive load should be long-term contracted
- **Introduction of new concepts**
  - "Off-shore platform" concept
  - Methodologies and tools for designing long distance transmission lines
- **Improvement of communication capability with society**

Promoting Sustainability in the Electrical Matrix

Hydroelectricity

- ✓Hydroelectric power is one of Brazil's principal energy assets
- ✓ Total Potential to be exploited estimation is in the range of 260 GW, and just 30% is in operation

Nuclear Energy

- ✓The 6th reserve of uranium in the world. (309.000 t existents and 800.000 t likely, in this case it would be 1th or 2th in the world)
- ✓Nuclear Energy is promising a strong expansion after 2030 (55 GW up to 2050)
- ✓ Low emission and providing energy security

Bioenergy

- ✓The largest bioenergy program in the world.
- ✓Biomass potential in the range of 500 MW / year meaning more than 6.000 MW up to 2016

Wind Energy

- ✓Capacity Factor in the range of 23%
- ✓ Indicative Potential: 143,5 GW

Efficiency

- ✓A huge potential for saving energy: 10%
- ✓PROCEL

The Major Research Question and the Three Hypotheses

"What are the <u>main determinants</u> influencing national decision-makers to internalize and implement international standards for sustainable dam development?

- **H1: A government's embeddedness in international institutions / regimes and its reference to fundamental international norms (e.g. human rights) increases the likelihood that international norms for sustainable dam development are internalized and implemented**
  - **Participation in international forums helps the exchange of views, experiences and best practices**
  - **Marginal influence**
- **H2: Social mobilization within the society enhances activities of domestic decision-makers to internalize and implement international standards**
  - **The growing of environmental consciousness and social mobilization was a key factor to internalize international standards and best practices**

The Major Research Question and the Three Hypotheses

"What are the <u>main determinants</u> influencing national decision-makers to internalize and implement international standards for sustainable dam development?

- **H3: The reliance of domestic dam developers – public and private – on foreign financial services and expertise which demand the application of international standards, induces activities of domestic decision-makers to implement international standards**
  - **It was determinant until nineties**
  - **Recentely the BNDES (Brazilian National Bank for Economic and Social Development) took the role as the major financer of hydropower plants in Brazil**
  - **Banks acting as equity investors have not been facing problems because the environmental requirements in Brazil are relatively mature and reasonably comply with international standards**
  - **Nowdays they help but are not determinant**