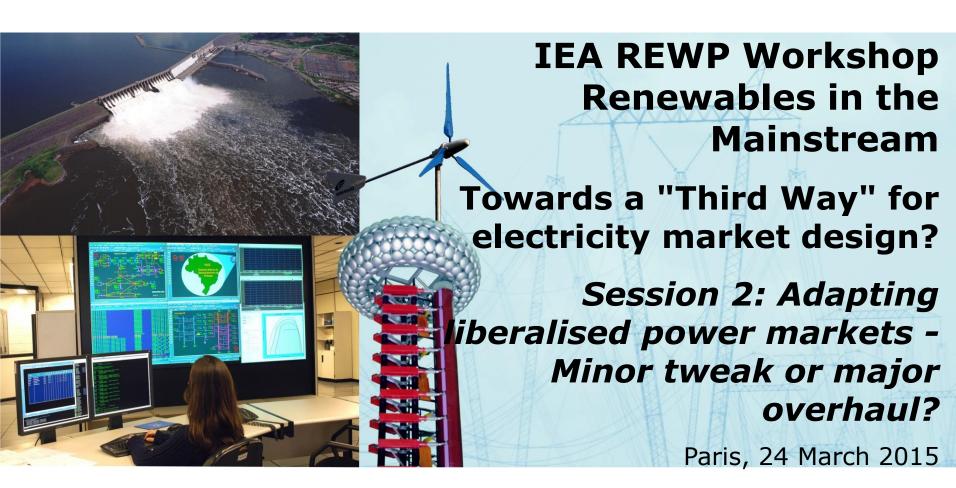
#### **Electric Energy Research Center**



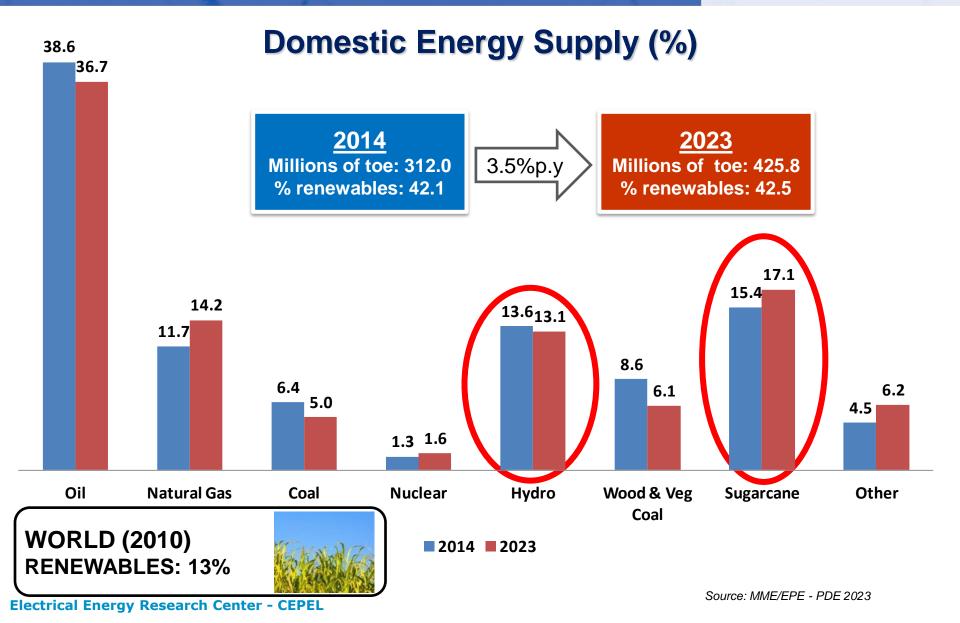


Albert C. G. Melo

DIRECTOR-GENERAL, CEPEL ASSOCIATED POFESSOR, IME/UERJ

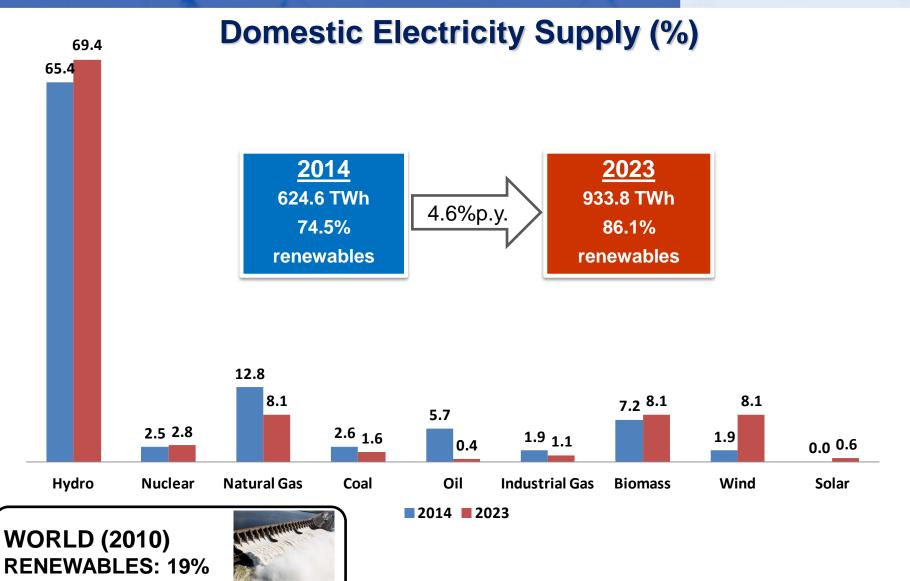
### **Brazilian Energy Matrix**





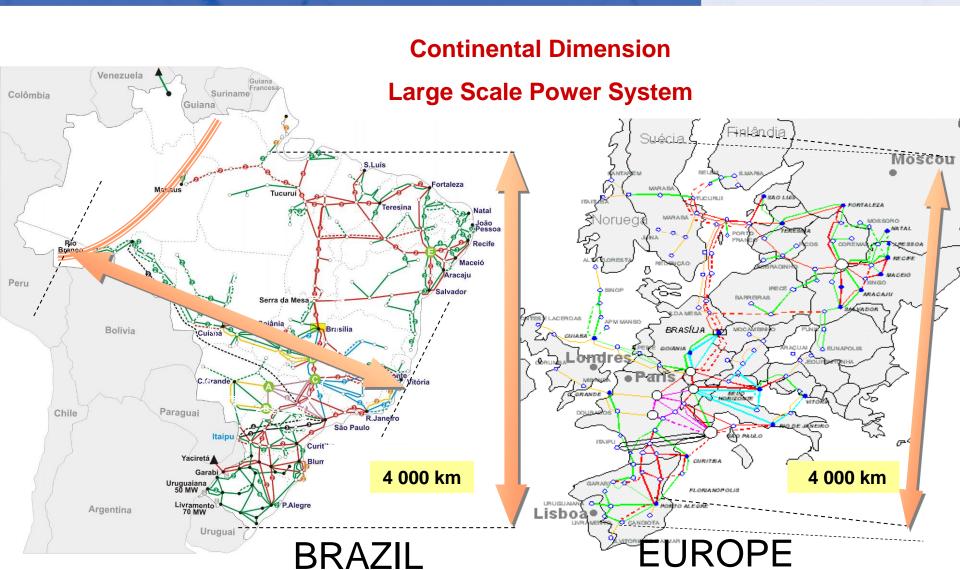
## **Brazilian Electricity Mix**





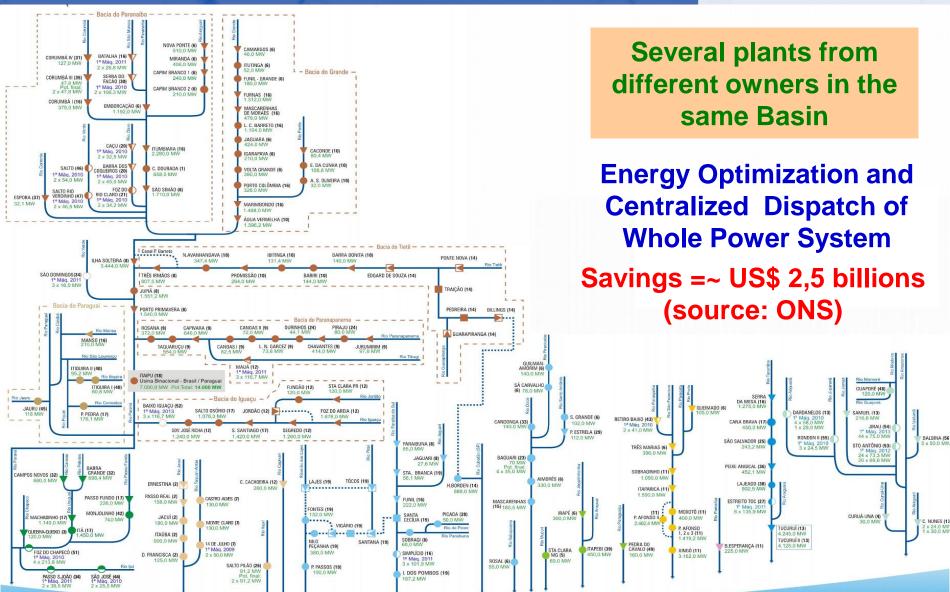
### **Brazilian Transmission System**





### **Hydroelectric Interdependence**





# **Policy Framework** and Market Design



Should consider country circumstances
□ Brazil main features □ Territorial Extension 8,514,876 km²; Population (2014): 200.2 million
☐ GDP 2013 US\$ 2.3 trillion
☐ Installed capacity (Sep 2014) 134 GW
☐ Hydro: 67 % (Capacity); 75-90% (Power production)
☐ Thermal: 30 %
☐ Wind: 3 %
will double in the next 15 years
□ Transmission lines 126,000 km
□ Consumption (2014 est.) 530 TWh
☐ Load growth rate: 4% to 5% per year
→ Continental country
Large renewables potential
→ Hydro-dominated
→ Rapidly expanding
☐ Importance of tools for
☐ Expansion Planning
Hydrothermal centralized dispatch, considering
hydrological diversity



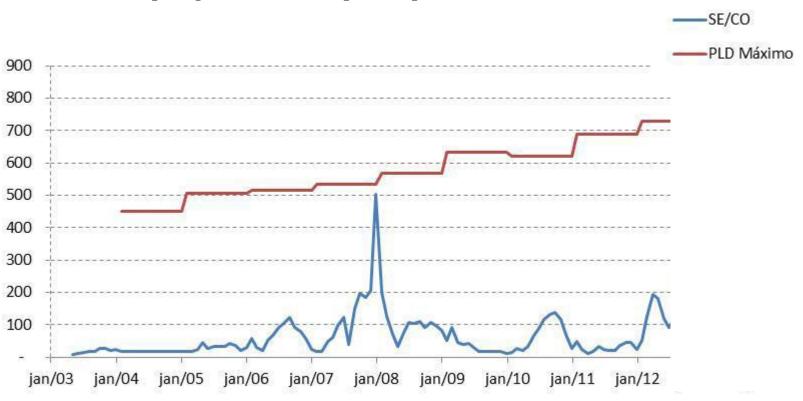
- □ The development of a hydropower project was granted to that one that offered to the Government the largest monetary value for this
  - ☐ He assumed the obligation to seek " loads ", ie, distributors and free consumers
  - ☐ to establish a long-term contract for the purchase of energy (PPA)



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 □ However, in a system with predominantly hydroelectric production
 □ most of the time, the operation marginal costs are low



#### **Monthly Spot Price (PLD)**





The development of a hydropower project was granted to that one that offered to the Government the largest monetary value for this
He assumed the obligation to seek "loads", ie, distributors and free consumers
☐ to establish a long-term contract for the purchase of energy (PPA)
However, in a system with predominantly hydroelectric production
<ul> <li>most of the time, the operation marginal costs are low</li> <li>if the loads had established PPAs with generators, they would have to pay higher long-term prices</li> </ul>
The loads decided to act as "free-riders"
and to not establish PPAs with generators
once there was no real obligation to be long-term contracted
With no PPAs
generators unable to get financing for plants implementation
the expansion of generation capacity required to meet the demand growth did not materialize
also transmission expansion was not adequate
This structural imbalance was a key issue that led to the electricity rationing in 2001/2002



- ☐ Introduction of competition for the *Long-Term* market
- Loads have now to be 100 % contracted
  - Regulated (captive) consumers, supplied by Discos
  - ☐ Free consumers

□ need to present *Fuel Supply Purchase Agreement* 



□ Introduction of competition for the Long-Term market
 □ Loads have now to be 100 % contracted
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 □ All contracts, which are financial instruments, must be covered by real power production capacity
 □ defined by a "plate number" called Assured Energy Certificate – AEC (or "Physical Guarantee")



	Introduction of competition for the <i>Long-Term</i> market Loads have now to be 100 % contracted
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	All contracts, which are financial instruments, must be covered by real power production capacity
	□ defined by a "plate number" called <i>Assured Energy Certificate – AEC</i> (or "Physical Guarantee")
	□ need to present <i>Fuel Supply Purchase Agreement</i>
	Public auctions were introduced as a procurement mechanism for
	purchasing energy for captive consumers
	☐ the winner in auctions is the one that offers the lowest price per kWh
	in exchange, all distributors have an obligation to enter into Long-
	Term PPAs with each auction winner
	this future cash flow can be used to obtain loans from banks
	hydros need the Preliminary Environment License to go to Auctions
	□ role of the Brazilian National Development Bank (BNDES)
	□ dedicated auctions for <i>Structuring Projects</i> or <i>Specific Technologies</i>

□ as long as they remain 100% contracted

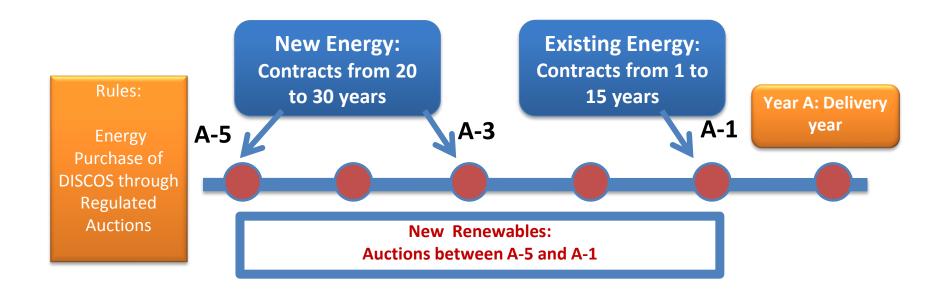


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□ dedicated auctions for <i>Structuring Projects</i> or <i>Specific Technologies</i>
Free consumers can procure their energy needs as they please

### **Public Auctions**



■ Auction prices are then passed on to electricity tariffs



#### **Buyers: Distribution Companies**

- Auction works centralized with DISCOS declaring their needs to cover the load.
- Obligation to cover 100% of the load

## Sellers: Generators technically qualified by EPE or ANEEL

- Hydro: Contracts of 30 years
- Thermal, Wind, PV and Biomass:
   Contracts of 20 or 25 years

### **The Brazilian Spot Market**

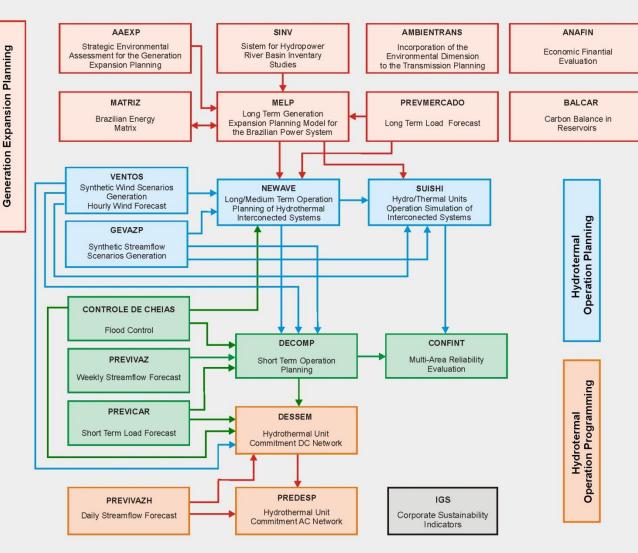


- □ Auctions act as the main driver to promote efficient purchases by distribution companies when acting on behalf of captive consumers
- ☐ Since 100% of the load needs to be contracted, the *spot market* serves to settle (positive or negative) differences between
  - □ a plant's actual production, scheduled by the National System Operator, and its contracted energy /Assured Energy Certificate
  - □ a load actual consumption and its contracted energy
- The clearing price in the Spot Market is the short run operation marginal cost
  - □ it is called *Preço de Liquidação das Diferenças Differences ′ Clearing Price*
  - which is obtained as by-product from the hydrothermal scheduling stochastic optimization tools, developed by CEPEL

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



#### Chain of Optimization Models for the Generation Expansion and Operational Planning



Energy
Optimization
and
Centralized
Dispatch of
the Whole
Interconnected
Hydrothermal
System:

20% More Energy Production

Need of capturing synergies in planning and operation stages

### **Consolidated Results**



Auction Type	Qt	Added Capacity (MW)	Energy (TWh)	Current Financial Allocation	
				(R\$ Billion)	(US\$ Billion)
Existing Energy	30	-	1,550	189	95
New Energy	20	56,319	4,234	711	355
Renewable Sources	2	2,235	160	29	14
Structuring Projects	3	17,684	1,523	160	80
Reserve Energy	6	9,609	563	84	41
TOTAL	61	85,846	8,030	1,172	585

Source: Brazilian Ministry of Mines and Energy; Brazilian Chamber for Commercialization of Electrical Energy

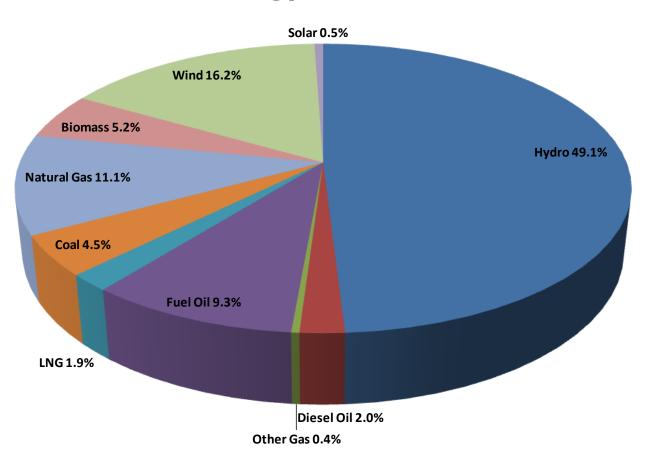
Reference date for current values: october/2014 (IPCA)

Exchange rate: 2 R\$/US\$

#### **Consolidated Results**



#### **Total Energy Traded – 6,614 TWh**



71% of the
Energy Traded
and Added to
the System
comes from
Renewables

Source: Brazilian Chamber for Commercialization of Electrical Energy

Includes New Energy Auctions, Renewable Sources Auctions, Structuring Projects Auctions and Reserve Energy Auctions





# Merci Beaucoup!

albert@cepel.br



Ministério de Minas e Energia

