

The MRC logo consists of the letters 'MRC' in a bold, dark blue, sans-serif font.

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# ELECTRICITY MARKET PROFESSIONAL PROGRAM

## LATIN AMERICAN POWER SECTOR REFORMS - ARGENTINA



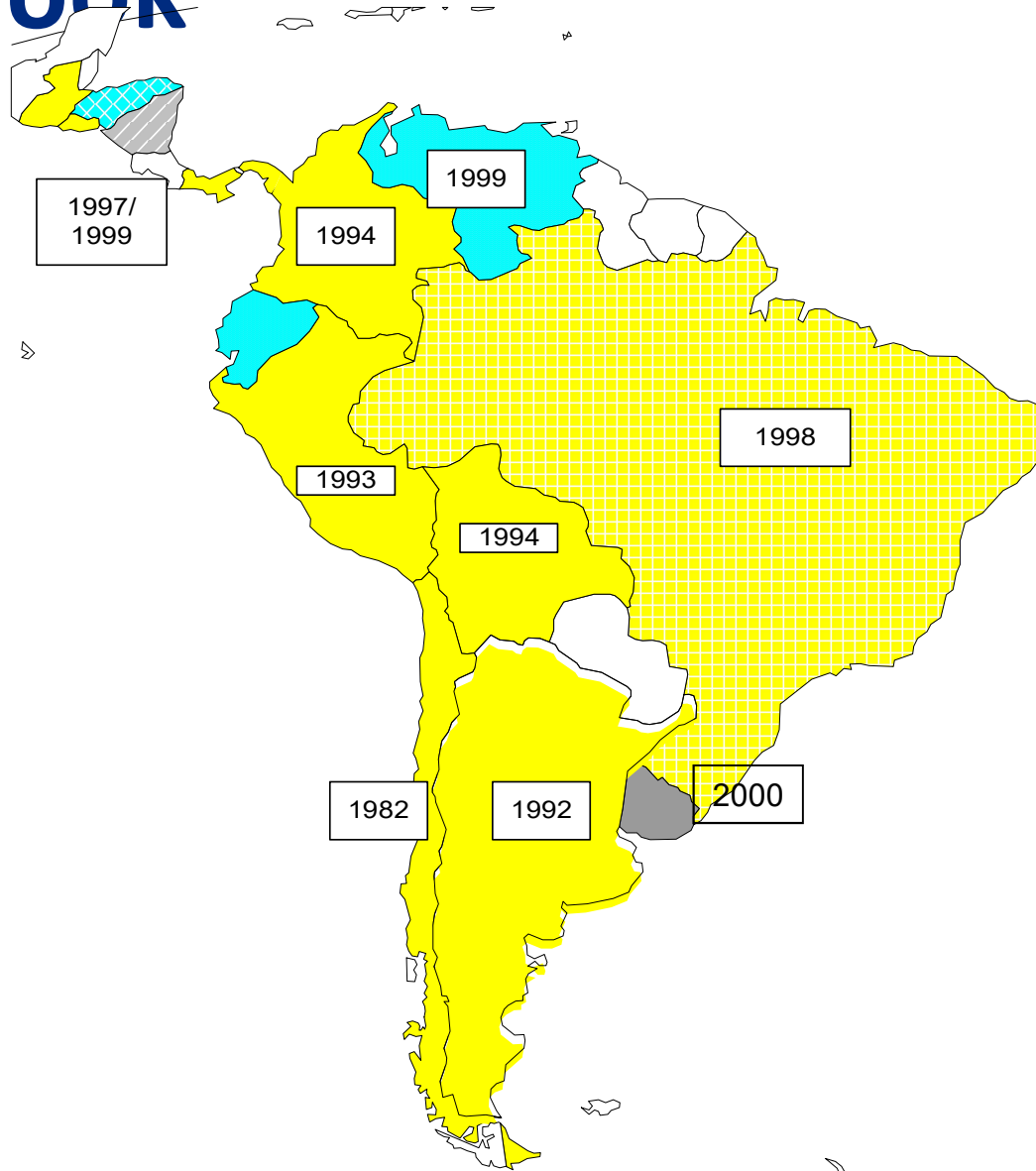
Roberto D'Addario

EMP @ LUMS  
July 17-22, 2018

# **GENERAL EXPERIENCES IN LATIN AMERICAN POWER MARKETS**

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# Outlook



# Latin America – In Common

- Developing economies
  - Need for a sustainable energy sector with competitive prices for economic growth
- Energy resources :
  - Hydroelectricity
  - South America : Natural Gas
- Need to develop infrastructure
  - Transmission
  - Gas pipelines and distribution
- Expand electrification

# Preexistent Characteristics

- Public integrated utilities
- Governments had all responsibilities
  - System Planning:
    - Energy demand projections
    - System planning: when, what and where to invest
  - Investor and Risk taker
    - Financing
    - Project administrator
  - Administration of Public Utilities
    - System operator and dispatcher
    - Supply, operation and maintenance
  - Tariff setting

# Problems

- Lack of Investment
  - Financial difficulties
  - Delay in projects
  - Problems in design and exploration
- Inefficient manager of utilities
  - High unavailability and restrictions
  - High costs and losses
  - Problems in quality of service
- Tariffs did not allow cost recovery
- Lack of environmental standards and energy efficiency

# The Chosen Solution

- Redefine the responsibilities of the Government
- Restructure the energy sector and promote competition
- Comprehensive legislation and regulatory conditions for private investors to participate taking market risks
- Deregulate and diversify where possible
- Regulate monopolies with efficient costs
- Pass through of efficient costs and of benefits competition to tariffs
  - Lower costs lead to lower tariffs

# Why It Worked

- Principal objective was not privatization but to increase efficiency and better power supply quality
- The will (and belief) that restructuring was needed
  - Existing organization created more problems than solutions
- The creation of a task force with local know how (technical experts from utilities and Ministry)
  - Consultants work for the task force
- Comprehensive negotiations with politicians and unions
  - Agree benefits and conditionalities



# Restructuring (1)

## ■ Roles of the Government

- Be the policy maker through defining organization and rules of the Sector
  - Legislation and regulatory framework
  - Market design, rules for efficiency and economy
- Promote electrification and energy efficiency
  - Explicit subsidies
  - Programs to increase knowledge
- Abandon (total or partially) role as investor and/or manager
  - Energy businesses to attract private investors and promote efficiency

# Restructuring (2)

- Create the necessary institutions
  - Independent Regulatory Entity
    - Independent Regulatory Entity
    - Licenses
    - Service and tariff regulation for monopolies
  - Independent System Operator
- Decide unbundling issues
- Clarify system planning roles
  - System operator
  - Transmission company
  - Generators and Distributors

# Unbundling and Diversification

- Specialization:
  - Specific rules adapted to each activity
- Unbundling for efficiency, considering realities
  - Distributors can own generation with limits
  - Generators and Distributors can own lines to connect to the principal grid
- Create business units of integrated utilities by activity and/or localization and/or type
- Open to private investment and new entries
  - Rules to promote efficient investment
  - Risk taker (contracts instruments to hedge risk)

# Transparency

- Independent Regulator
- Non discriminatory operation rules
  - Regulation and framework for system operation and market administration
  - Pricing and settlement system
- Open access to information.
  - Technical Data
  - Market results (commercial)
- Independent System operator
- Define environmental requirements
- Rules for pass through of costs to tariffs

# Efficiency and Competition (1)

- Prices are “set by the Market” to promote necessary investment
  - Prices show relation between offer and demand
  - Prices show scarcity.
- Market Participant’s income = results of market commercial operations.
  - Incentives to take market risks and be market efficient
- Big Consumers:
  - Freedom to choose supplier
  - Facilitates investments for special quality needs

# Efficiency and Competition (2)

- Distribution and transmission monopolies
  - Multi year tariffs
    - Maximum regulated wheeling tariffs
    - Rules, methodologies and parameters for tariffs adjustments
    - Obligations as service provider (quality standards)
    - Compensations to consumers for bad quality
- Small Consumers
  - Regulated maximum tariffs
  - Compensations to consumers for non supply

# Market Rules Characteristics

- Predictable and Transparent.
- Minimize implementation costs.
  - Keep it simple (no unnecessary complexity).
- Take in consideration realities
  - Respect legal conditions and pre existing conditionalities
  - Reflect physical infrastructure
- Open
  - New entries
  - Promote regional interconnections
- Special rules for transition and possible initial lack of competition. Gradual implementation

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# Planning the Transition

- Initial simple rules
  - Using existing operation experience and procedures
  - Program gradual increase in quality of service and, if necessary, sophistication
- Design open access and transmission pricing
- Communication systems
  - Maximize use of existing communication and data systems
- Tariffs
  - Minimize possible initial impact
  - Design, if necessary, special initial contracts



# Wholesale Electricity Markets

- Tight Pool
  - Reflects preexistent centralized dispatch and hydro optimization
  - Obligatory centralized dispatch
  - Hourly prices
- Independent System Operator is also Market Administrator
  - Based on existing Dispatch and Control Center

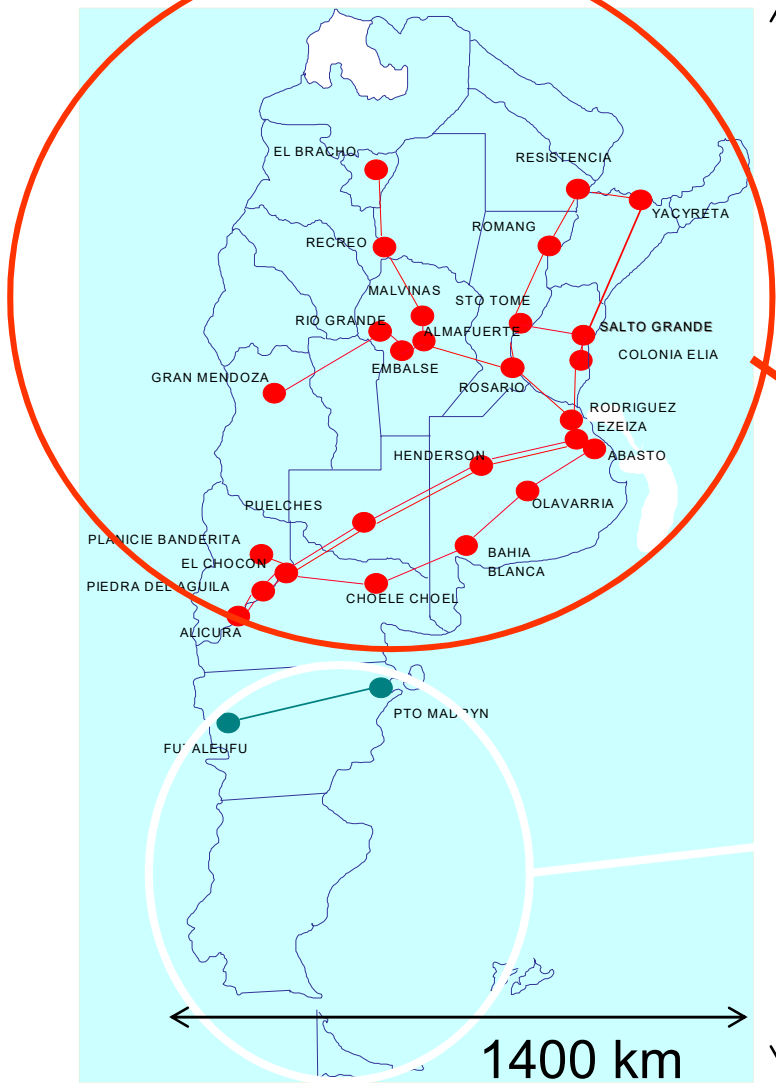
# Generation Capacity

- Capacity: a different product
  - “Secure” payment for efficient or competitive generation
  - Paid independently of energy generated, to guarantee enough installed capacity
- Related to security of supply
  - Avoid power shortages
- Pool Generation Capacity price
  - Regulated price = investment cost of typical peak unit (e.g. open cycle gas turbine)

# **THE ARGENTINEAN CASE**

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# Main Figures - 1990



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Installed Capacity	21.319 MW
Energy Consumption	70.970 GWh
500 kV	7.752 km
330 kV	1.111 km
220 kV	1.403 km
132 kV	10.055 km

## MEM

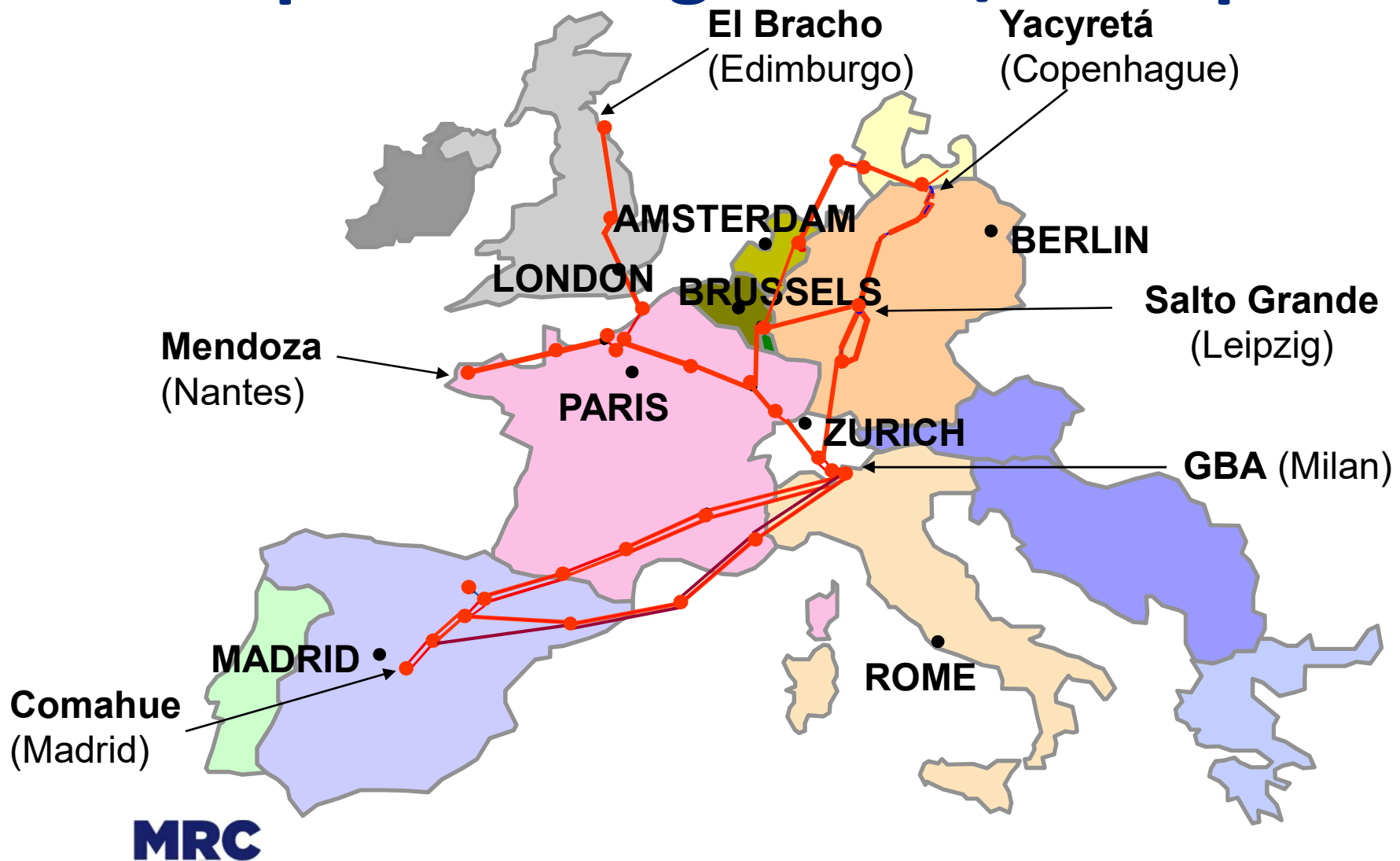
Installed Capacity	20.403 MW
Energy Consumption	66.176 GWh

## Patagonia

Installed Capacity	916 MW
Energy Consumption	4.851 GWh

# HV SYSTEM

## Comparison Argentina / Europe



# Pre-existing Conditions (1990).

- Secretary of Energy
  - Policy Maker
  - Regulator
  - Companies Shareholder
- Electricity sector crisis:
  - Load shedding up to 20% of national demand
  - High unavailability
  - Payment chain broken
    - Discos didn't pay Gencos
    - Gencos didn't pay Fuel Companies
  - High deficit in the sector
  - Very high losses (technical and non technical)

# Pre-existing Conditions (1990).

- Governance crisis:
  - Companies in hands of:
    - medium level management
    - unions
    - suppliers
- Tariffs system:
  - Cost Plus (accounting costs recognition)
    - generalized corrupted information systems
  - Highly politicized tariffs
- Inefficient investments

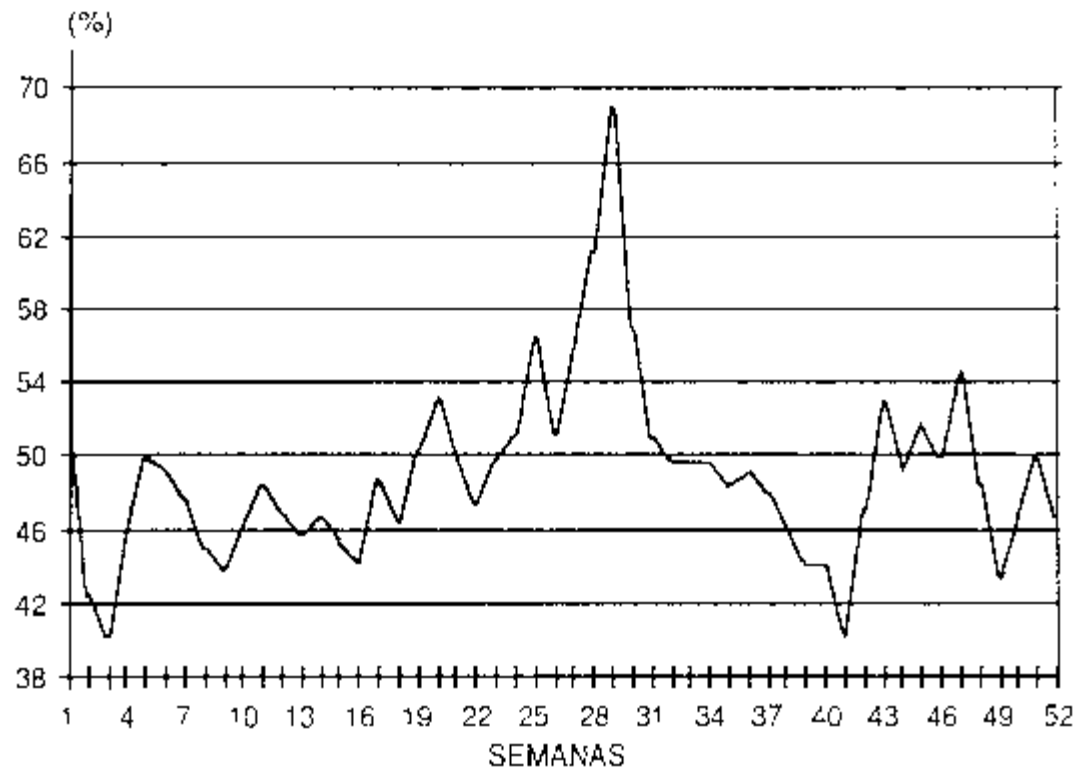
# Pre-existing Conditions (1990). Structure.

	G	T 500	T HV	Operation	Distribution
AyE	21 %	52 %	6 Regional Systems	National Dispatch 6 Regional CC	8 %
Segba	23 %	25 %	3 %	T&D Control Center	45 %
Hidronor	13 %	45 %	-	1 Control Center	-
Provincial Companies	10 %	-	Various	-	13 Comp. 37 %
Nuclear	16 %	-	-		
Generation Bi-National	17 %	-	-	-	-

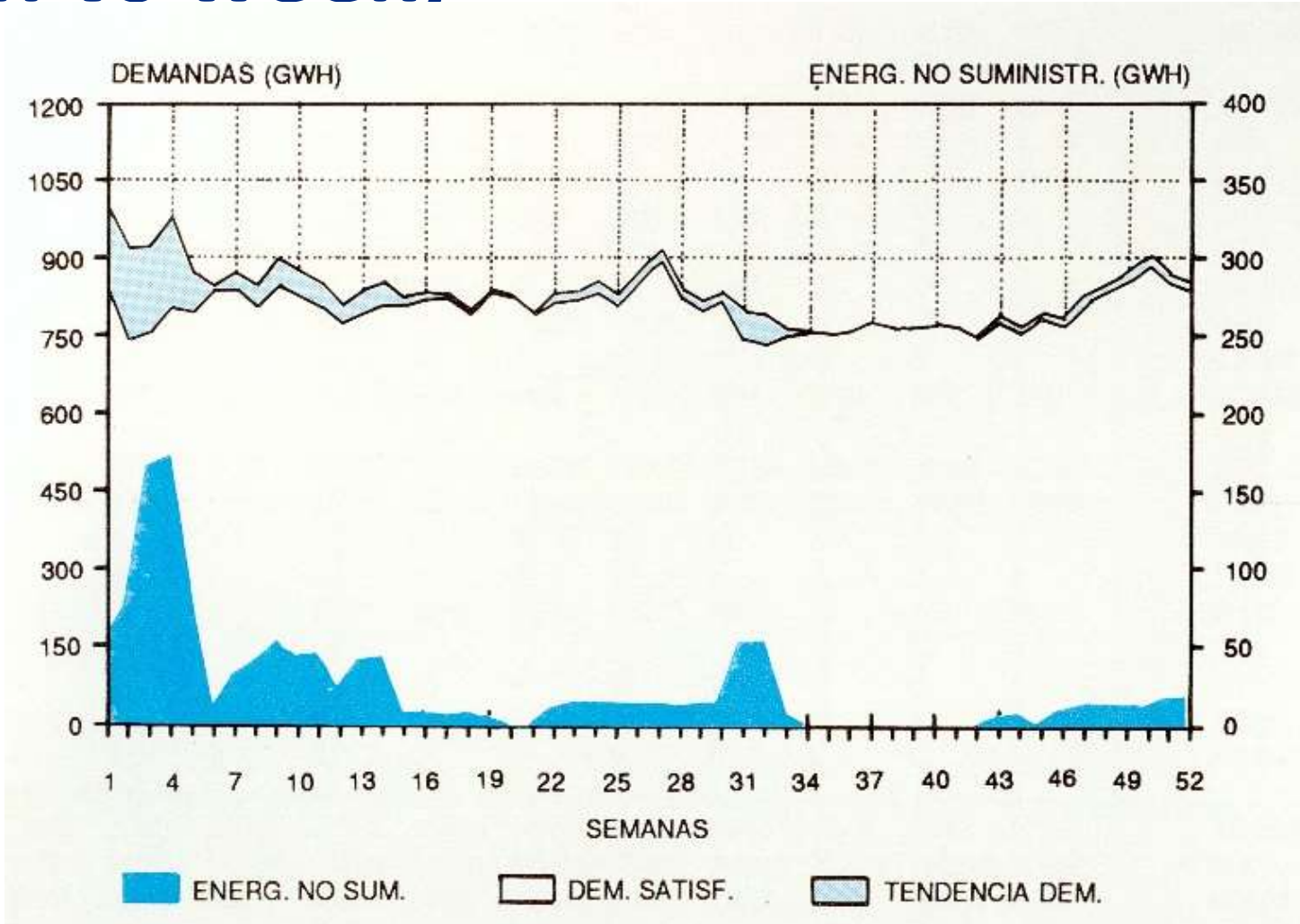


# Thermal Unavailability (1990)

INDISPONIBILIDAD TERMICA TOTAL SIN  
PROMEDIO SEMANAL



# Load Shedding 1989 (GWh vs week)



# New Legal Framework

- Began with the passage of two fundamental laws
  - Economic Emergency Law
    - prohibited central bank financing government deficits
  - Administrative Reform Law
    - rules for investment in federally-owned companies
    - gave the federal government authority to privatize federal companies
- Electricity Law
  - legal structure for restructuring and privatizing the electricity industry.
- Amendment to the Foreign Investment Law
  - removed restrictions that applied only to foreign investors

# Basic Aims of Restructuring (1)

- Transfer to the private sector commercial activities associated to the electricity services
- Release the State from the burden of the sector deficit and expansion financing (concentrate the use of scarce State resources in non transferable responsibilities)
- Take advantage of modern management skills available in private companies.
- Concentrate the State activities in regulating tariffs and guaranteeing quality of service and fair competition
- Environmental policy for the electricity sector established and controlled by the State

# Basic Aims of Restructuring (2)

- Increase competition and efficiency
- Encourage private investment in generation, transmission and distribution, to secure long-term supply at reasonable costs.
- Increase quality of service and availability
- Maximize economic use of energy resources and transmission infrastructure
- Competitive tariffs that reflect efficient economic costs
- Promote regional power trading

# Basic Aims of Restructuring (3)

- Competition for all those activities where that is possible
- Regulation where competition doesn't guarantee convergence between public interests and service providers interests
- Privatization
- Roles rearrangement and creation of new institutions:
  - Energy Policy: Energy Secretariat.
  - National Regulatory Entity (ENRE)
  - System Operator and Market Administrator (CAMMESA)
- Government withdrawal from investment and planning roles

# Energy Secretariat

- Sets Energy Policy, including:
  - Alternative energy resources and demand side management
  - Policy for supply of Rural Areas
- Power Industry Regulation
- Indicative Forecasts
- Statistics
- Second Stage Conflict Solving Forum
- Market Participant's Entry Authorization

# National Regulatory Entity (ENRE)

- In charge of controlling the compliance of the obligations set forth in the concession agreements
  - Distribution and Transmission Tariffs
  - Distribution and Transmission Quality of Service
- Apply Penalties



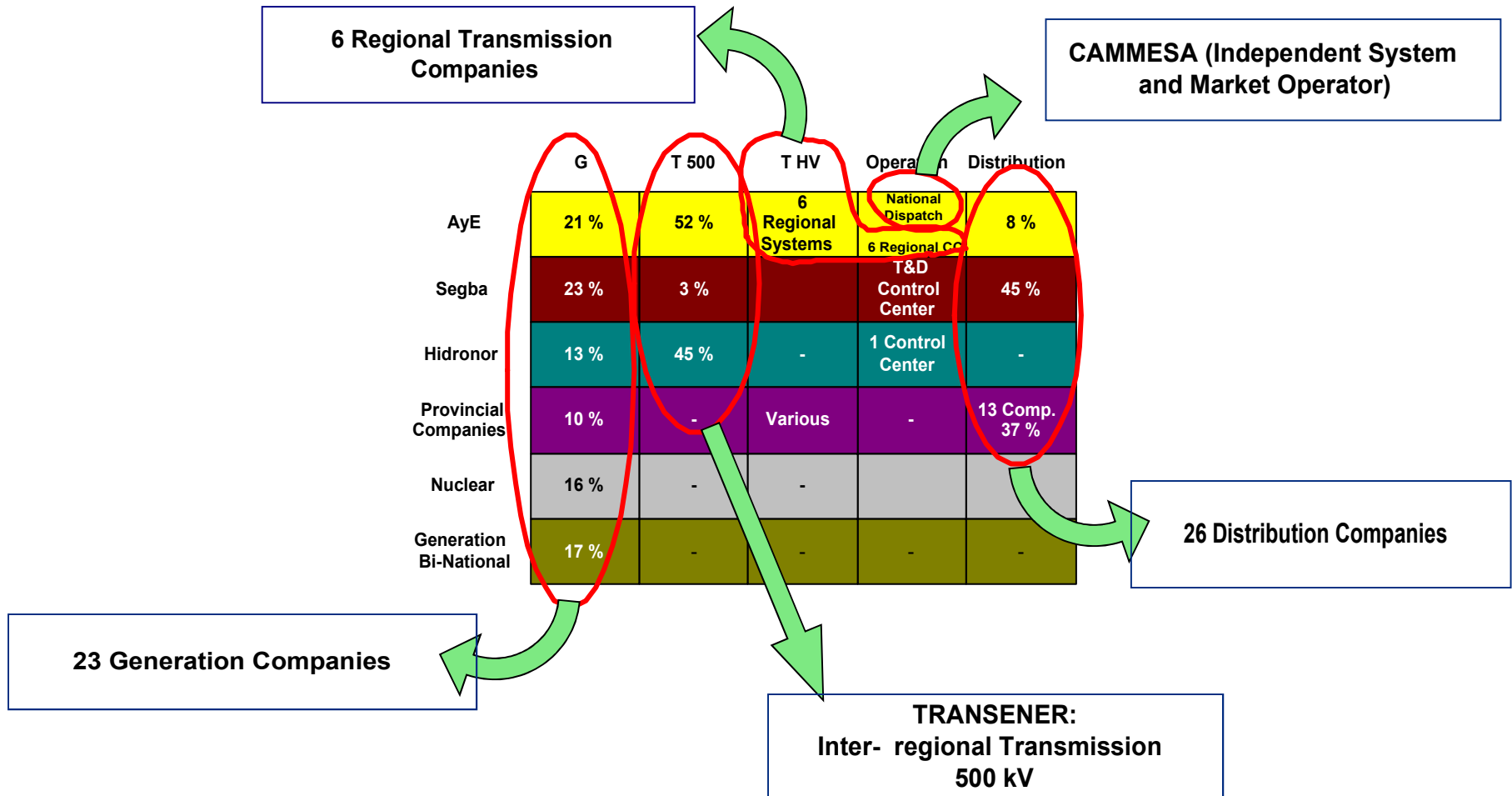
# CAMMESA

- Wholesale Operator and Administrator
- Private non profit company
- A share holding company. Shareholders:
  - 20 % Generators Association
  - 20 % Distributors Association
  - 20 % Transmitters Association
  - 20 % Large Consumers Association
  - 20 % Federal Government
- Main Functions
  - Long, medium and short term operational planning
  - Seasonal prices calculation
  - Centralized economic merit order dispatch
  - Real time operation

# CAMMESA - Organization

- Board of directors. Policies of Company
  - 2 members per shareholder group.
  - President: Representative of Government.
- Executive Committee. (Administrative) 3 members:
  - Chairman: appointed by the market (full time).
  - Large Consumers: permanent
  - 1 representative of the industry: 1 year shift each
- General manager (Technical, Commercial):
  - Isolate political direction from system operation and market administration
  - Transparency: Technical and commercial rules defined by Energy Secretariat

# Pos-restructuring Structure (1993)



# Privatization

- Stock Classes
  - Class A: 51 ~ 60% (control)
  - Class B: 30 ~ 40% (free - Stock Exchange)
  - Class C: 3 ~ 10% (reserved for workers)
- Selling of Stocks Class A and eventually part, nothing or all Stocks Class B.
- Workers were authorized to pay for Stocks Class C with dividends produced by the companies
- Typically the State kept as much Stock Class B for future selling (good business).
- Public Bonds (nominal value) were accepted as way of payment.

# Timing

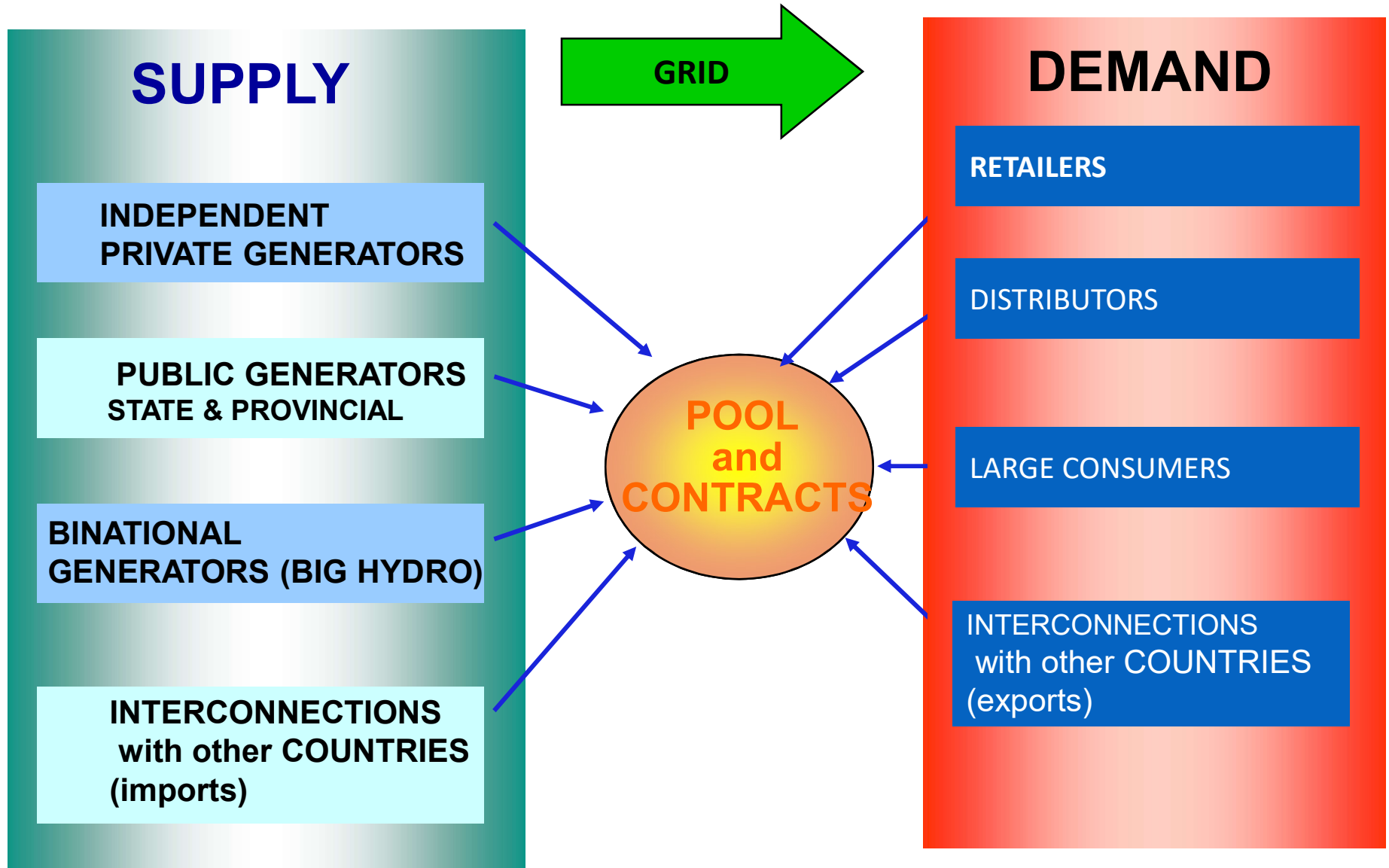
	1990	1991	1992	1993	1994	1995
<b>Legal Framework and rules</b>						
<b>Companies restructuring</b>						
<b>Privatization</b>						

	Restructuting	Privatization
<b>Federal Distribution</b>	1991-1992:	1992
<b>Thermal Generation</b>	1991-1992	1992-1994
<b>Transmission</b>	1992	1992-1994
<b>Hydro Generation</b>	1992	1993-1995
<b>Provincial Distribution</b>		1993, continues
<b>Nuclear and Bi-national Hydro</b>	Non Privatized	
<b>Creation of ENRE</b>	1993	
<b>Creation of CAMMESA</b>	1992	

# WHOLESALE ELECTRICITY MARKET

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# Market Structure



# Dispatch, Products and Trading

- Centralized Security Constrained Economic Dispatch
  - Software approved by the regulator
- Products that are bought and sold
  - energy
  - capacity
  - ancillary services.
- Ways of trading
  - Long and Medium term agreements : Through contracts
  - Short term opportunity trading : in the Spot Market



# Energy Pricing (1)

- Based on declaration of costs
  - Thermal Units:
    - Variable production cost for each fuel it can burn
    - Cap price, related to a international fuel markets or local fuel prices, fuel transportation and heat rates.
  - Hydro Power plants
    - Water values for different levels in the reservoir
    - Expected future replacement cots.
  - Imports from other Markets:
    - Bid at the interconnection

# Energy Pricing (2)

- Quality of Supply
  - Operation reserve for frequency regulation and load following
- Risk of non supply (deficit or insufficient reserve)
  - Social and economic costs for different levels of non supply
  - Cost increases as risk or deficit increases
  - Short term signal to lack of investment or lack of quality.
- Spot (Pool) Price
  - Hourly cost to supply an increase of the load (local+exports), maintaining the required reserve
  - Defined at the system load center (Market Node).

# Energy Pricing

## Marginal Cost Thermal Generators (MC)

- Generation Variable Cost
- Heat Rate

$$MP(\text{load, reserve}) = f(\text{CM, WV, CMBASE, NSE})$$

Cost to supply  
next MW with  
quality of service

## Marginal Cost Hydro Plants (WV)

- \* Reservoir Level
- \* Water Value (WV)

## Marginal Cost of risk of non supply (deficit or lack of reserve

NSE in u\$/MWh	
< 1,6%	120
< 5,0%	170
< 10,0%	240
> 10,0%	1500

NSE: non supplied energy  
CMBASE : Start up Costs (base load units)

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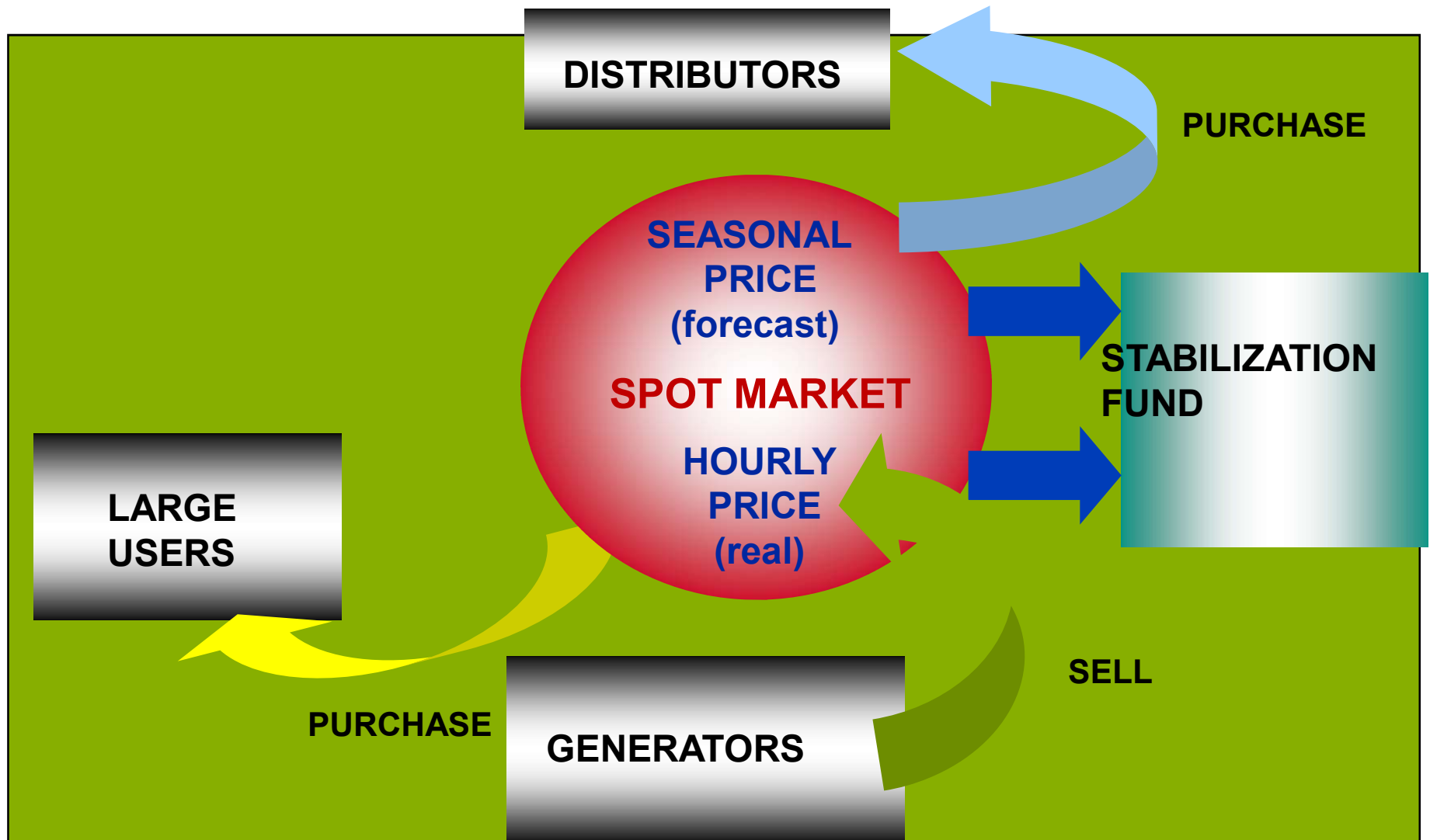
# Nodal Energy Pricing

- Nodal energy prices
  - Price at each node reflects marginal losses to connect the node to the Market node (Nodal Factors).
    - ❖ smaller than 1 at exporting nodes
    - ❖ bigger than 1 at importing nodes
- Transmission congestion = Local (zonal) pricing
  - If congested area has power surplus, prices fall and are lower than Market prices
  - If congested area has power deficit or expensive generation, prices increase and are higher than Market prices

# Stabilized Energy Pricing

- For Distribution companies and consumers tariffs:
  - Transfer (pass through) Pool prices to consumers' tariffs
  - Seasonal stabilized price (three months)
    - Average expected spot price for the next 3 months
    - Stabilization Fund absorbs differences between seasonal prices and real Pool prices of the previous stabilization period.
  - CAMMESA calculates:
    - forecasted Spot prices for next 3 months
    - Differences absorbed by Fund
  - Energy Secretariat defines seasonal price

# Stabilized Energy Price



# Generation Capacity Pricing

- Price
  - Set in the Market Node
  - Each off valley hour of working days: 10 U\$S per MW
  - All other hours, 0 U\$S
  
- Zonal generation capacity price:
  - Affected by the reliability and quality of the transmission system required to connect the area to the Market node
  - Adaptation Factor measures the extra costs because of probability of transmission outages.

# Generation Capacity Payment

- Thermal Unit
  - Paid generated capacity plus hot spinning reserve and cold back up reserve
  - Guaranteed a monthly payment of at least the average yearly generation capacity that would be dispatched on the driest hydrological recorded conditions (dry year reserve)
    - ❖ Dry year reserve for each unit calculated monthly as:
      - (Predicted capacity required for dry year)
      - (Real capacity generating or spinning or cold reserve)
- Hydro Power plants
  - Payment for generated capacity plus spinning reserve



# Restrictions and Must Run

- Priority : reliability and quality of service
  - Restrictions to system operation
- CAMMESA must schedule generation because of restrictions, independent of merit order (must run generation)
  - Not a result of competition in Market
  - Prices for must run generation are regulated (Generator has market power) only to recover generation costs
  - Load pays extra cost equal to difference between
    - ❖ Price it could have bought in the Pool (if restrictions did not exist)
    - ❖ and regulated price of must run

# Supply Contracts (1)

- Seller: Generator or Trader
  - Obligation to supply, but not to generate
    - Cannot force a specific unit
    - Centralized dispatch does not take into account contracts.
- Buyer: Distribution Company, Large Consumers, Traders
  - Obligation to pay contracted amounts, but can re-sell
- Commitment:
  - Blocks of energy to be supplied in the future at contracted prices
    - Financial bilateral contracts (price) but become physical in deficit conditions

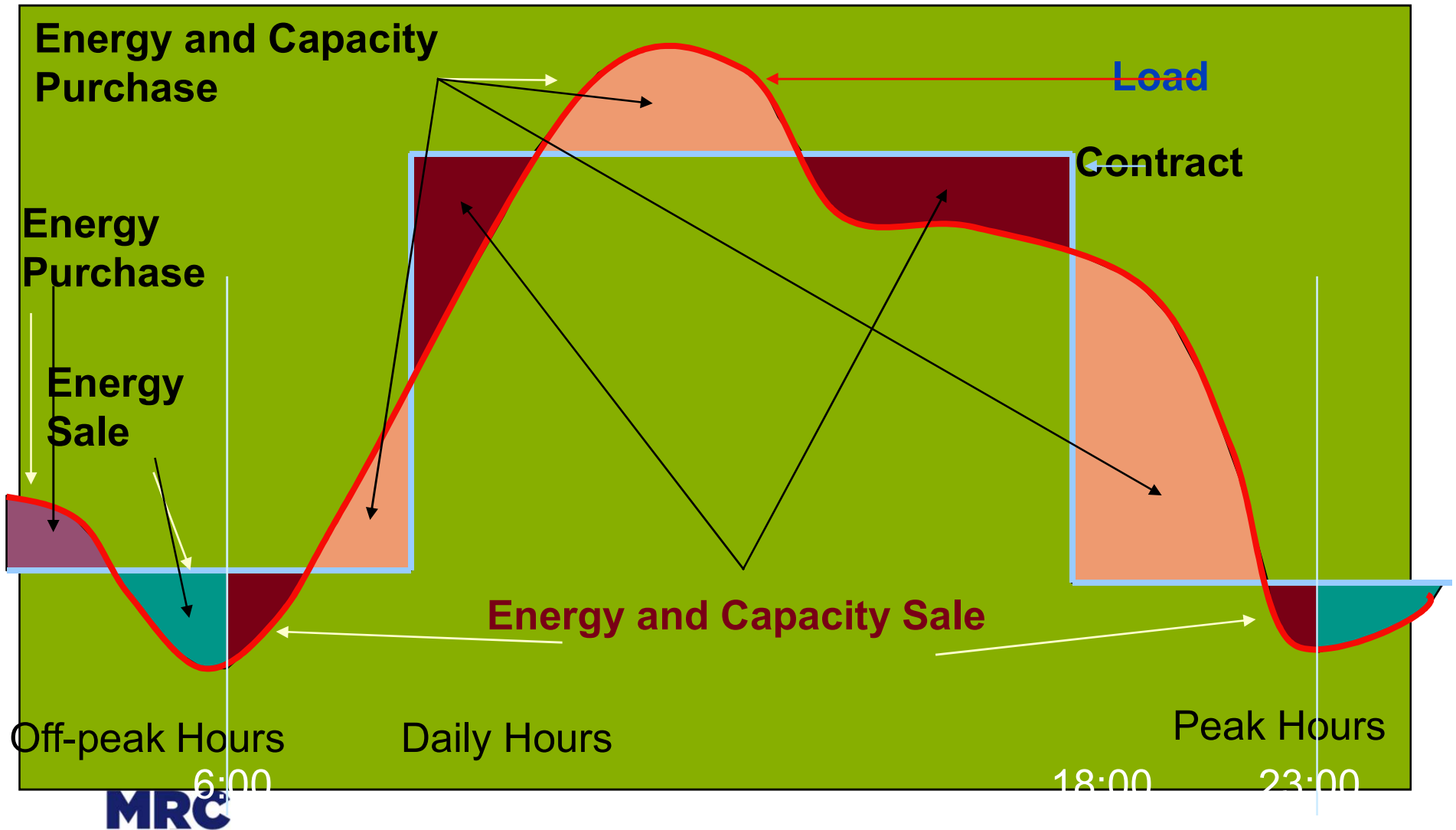
# Supply Contracts (2)

- For seller;
  - Units are dispatched according to the merit order list (contracts are not taken into account)
  - Difference between seller's generation in real time dispatch and contract commitments is cleared in the Spot Market:
    - If not dispatched up to contract commitment, buys the difference in the Pool (at energy price lower than own generation costs)
    - If unavailable, can buy from the Spot market the energy and capacity needed to supply contracts (price risk) if there is enough extra energy available (risk of not fulfilling contract)

# Contracts (3)

- For buyer (Large Consumer or Trader)
  - Difference between buyer's real time load and contract commitments is cleared in the Spot Market:
    - If load higher than contracts, can buy the difference from the Spot market (price risk) if there is enough extra energy available (risk of non supply)
    - If load less than contracts, sells to the Pool at the Spot price;

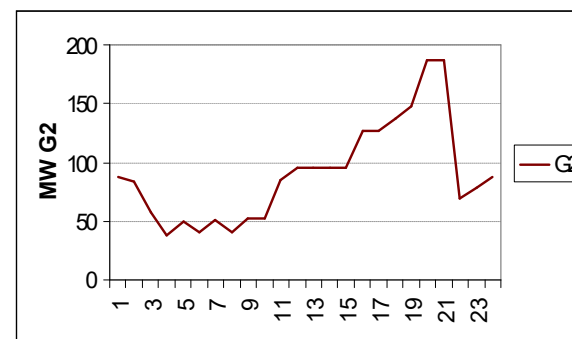
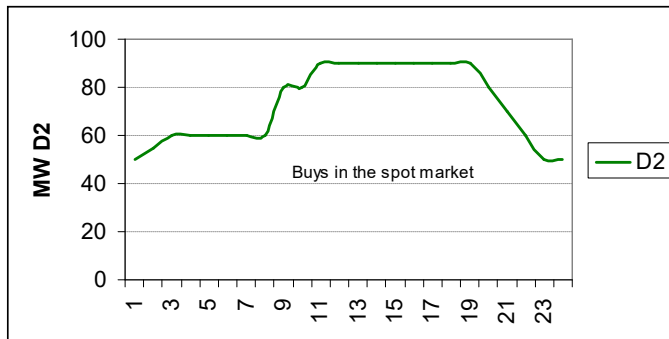
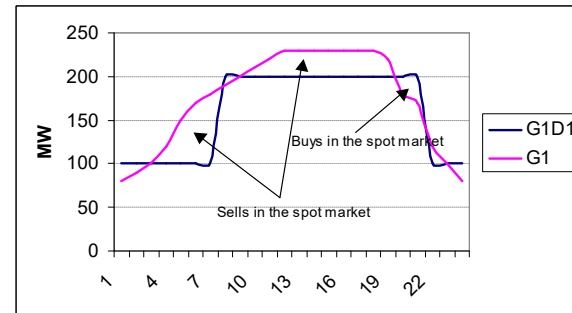
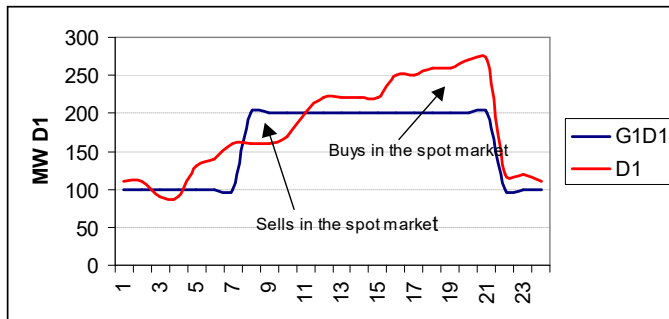
# Supply Contracts (Demand) (4)



# Pool Settlement

- Pool = hourly transactions (energy, capacity, ancillary services)
- Monthly settlement = net result for each Participant
- CAMMESA calculates monthly amount each Participant must pay or be paid
  - Totals hourly payments due, when Participant buys
  - Totals hourly remuneration, when Participant sells
  - Net result = total of payments minus total remuneration
- Participant with a negative net result must pay
  - Amount due to each Participant with a positive net result
  - Amount paid assigned proportionally to each Participant with a positive result

# Settlement



# Distribution Companies

- Quality standards defined in Concession Contract
- Obligation to supply captive customers (obligation of expansions) within quality of service standards
- Penalties if fails to supply or if bellow quality standards
- **Can import from other markets**
- Tariffs pass trough:
  - Pool prices (through seasonal stabilized prices);
  - plus a regulated distribution margin, which includes capital costs, expansion and O&M costs, regulated network losses and profits
  - plus discounts when penalties are applied.



# Generators

- ❑ Open access to new generation (no central planning)
- ❑ Specific hydro and nuclear regulation.
- ❑ Centralized economic dispatch (competition to generate).
- ❑ Can sell supply to large consumers and distribution companies through contracts
- ❑ Can buy and sell in the Spot market
- ❑ Can buy backup from other Generators through contracts
- ❑ Quality obligations related to ancillary services
- ❑ Can sell additional ancillary services
- ❑ Right to require system expansion
- ❑ Can export to other markets

# Large Consumers

- Major (GUMA): more than 1 MW load
  - Must contract at least 50% of load
  - Hourly metering (can buy/sell in Pool)
  - Can import from other markets
- Minor (GUME): load between 2 MW and 100 kW
  - No Hourly metering, shape of load curve of Distribution company assumed
  - Must contract 100% of load
- Special (GUPA): load between 100 kW and 50 kW
  - No Hourly metering, shape of load curve of Concession Contracts
  - Must contract 100% of load

# Traders

- Cannot be a Generation Company, Distribution Company or Transmission company
- Financial requirements (defined by Energy Secretariat in regulated commercial rules)
  - Deposit a guarantee for payments to the Pool
  - Capital assets requirements
- Can buy and sell through contracts and in the Spot market
- Role :
  - Load aggregator for GUMAs
  - Generation aggregation
  - Trade (import and export) with other markets
    - ❖ Absorbs differences in prices and market rules

# Transmission Companies

- Cannot buy or sale energy
- Quality of service standards defined in Concession Contract
- Responsible for O&M of existing transmission facilities
- Loss of revenues if bellow quality standards (unavailability)
- No obligation to expand.
- Right to compete in system expansion
- Regulated tariffs
  - Multiyear allowed revenue (5 years) with reductions if fails in availability standards
  - Public hearing for tariff discussion, after each 5 year term.

# Transmission Expansions

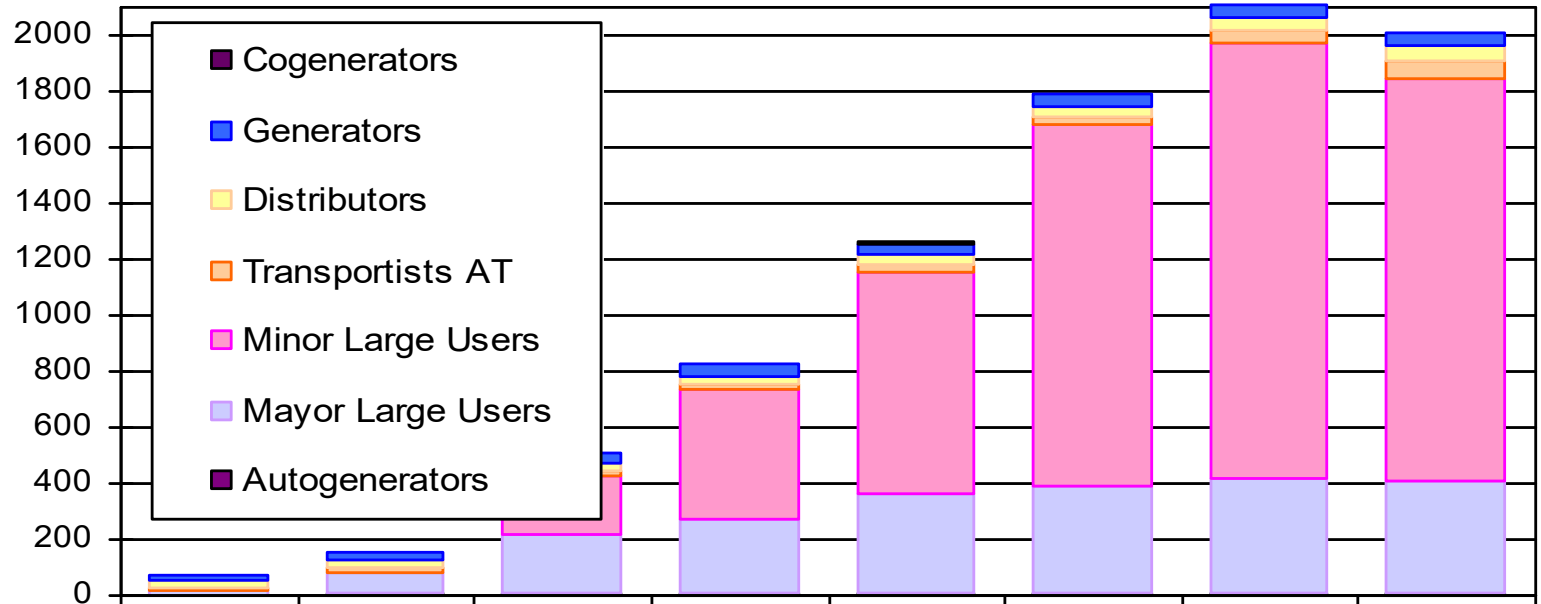
- Initiated by requirement of market Participants
  - Initiator must be “user” of the expansion
- Requires authorization of the regulator
  - Other users can present opposition (30% rule)
  - Expansion approved if expansion is for “public benefit” and there is no opposition
- Built, owned, maintained and operated by a new Independent Transmission Company
- Competitive procurement supervised by the regulator

# Miscellanea

- Real time operation data
  - SCADA owned by each regional control centers
  - CAMMESA has links with regional SCADA systems
  - Tele-control by regional control centers
- Telecommunications
  - Responsibility of each Participant
- Commercial metering
  - Participant must provide metering (regulated standards)
  - CAMMESA collect data, audit meters and habilitation

# Market Participants

## Number of Agents per Activity

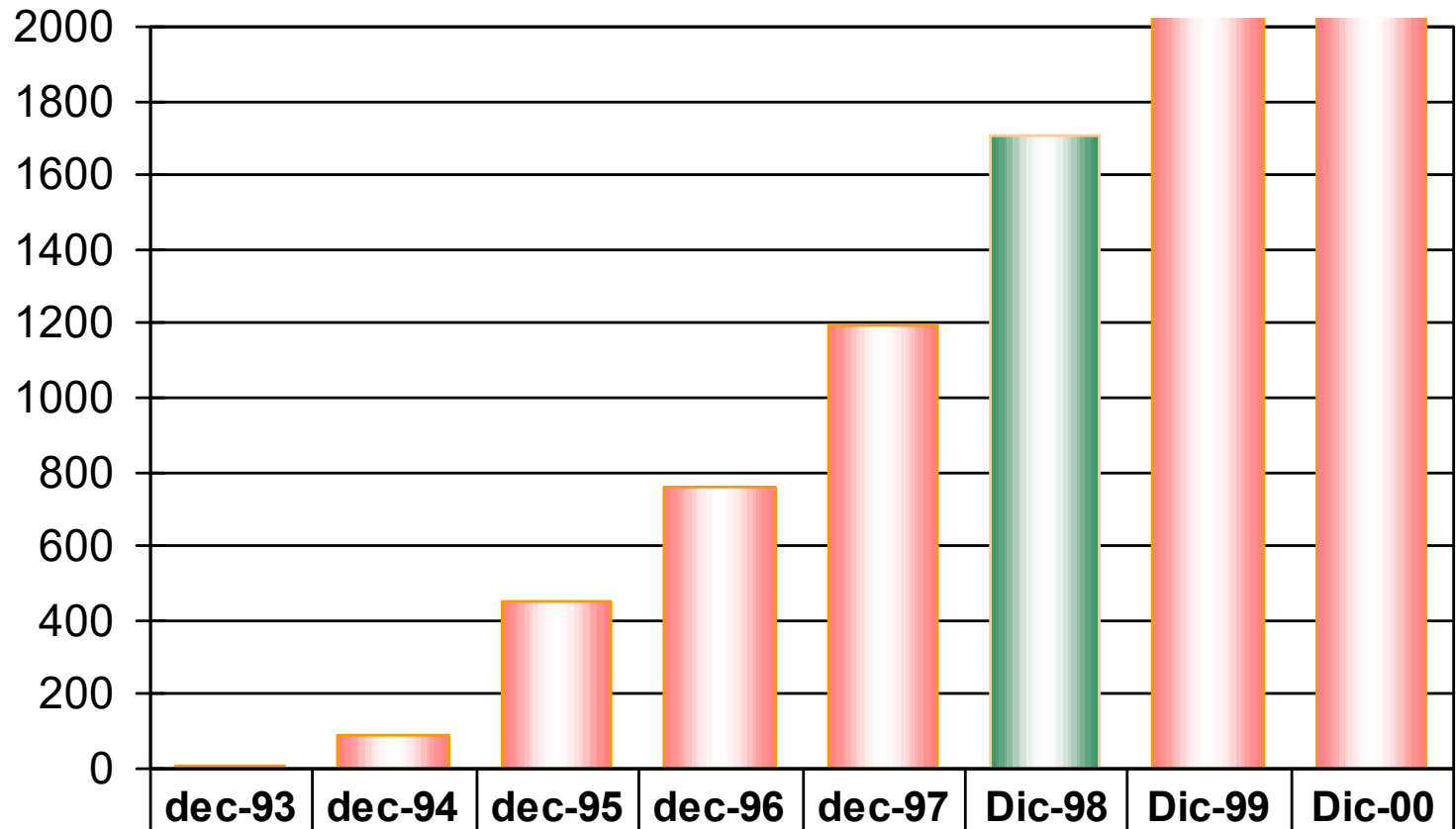


	Dic-93	Dic-94	Dic-95	Dic-96	Dic-97	Dic-98	Dic-99	Dic-00
<b>■ Cogenerators</b>					2	2	3	3
<b>■ Generators</b>	23	31	37	43	44	44	44	43
<b>■ Distributors</b>	26	25	26	28	31	32	50	57
<b>■ Transportists AT</b>	7	14	21	21	25	27	47	58
<b>■ Minor Large Users</b>	0	0	207	459	798	1291	1548	1438
<b>■ Mayor Large Users</b>	18	80	208	265	350	382	409	397
<b>■ Autogenerators</b>	2	5	9	9	11	12	12	13

# Contracts

## Number of Contracts in the Pool

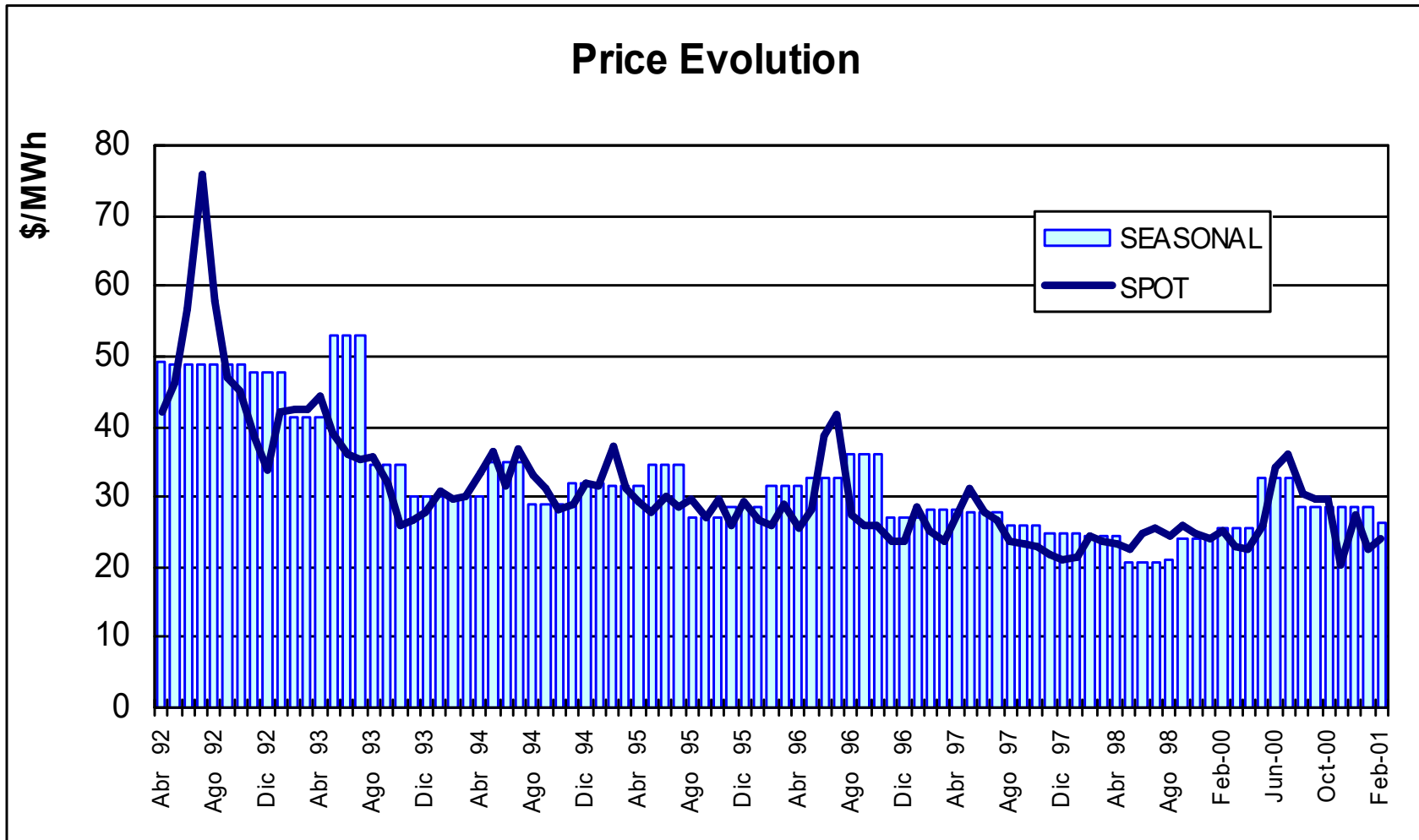
No. of Contracts



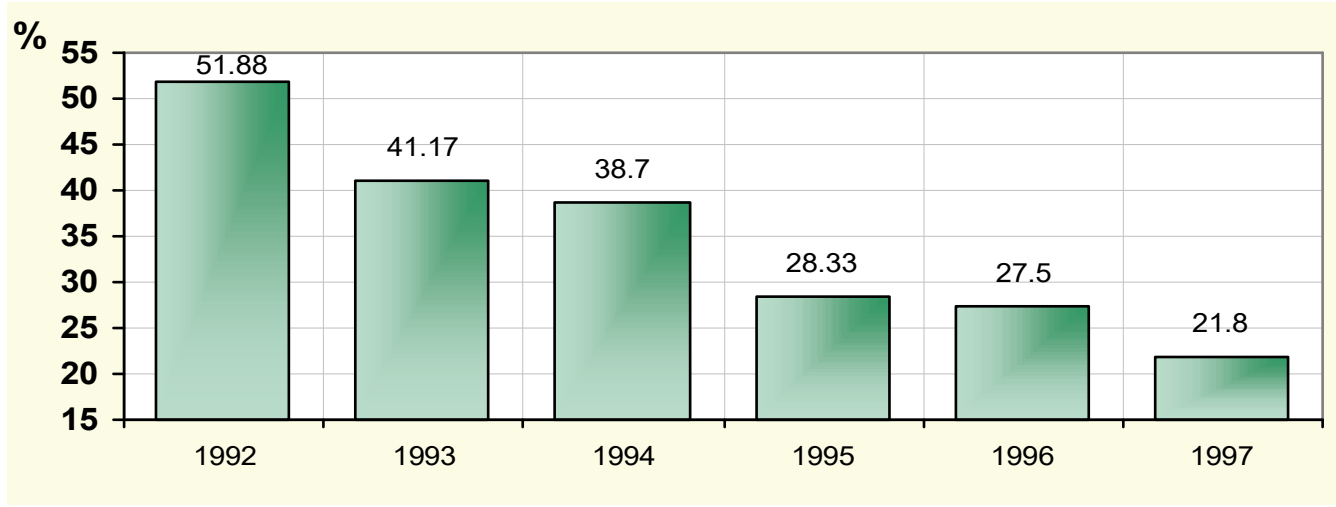
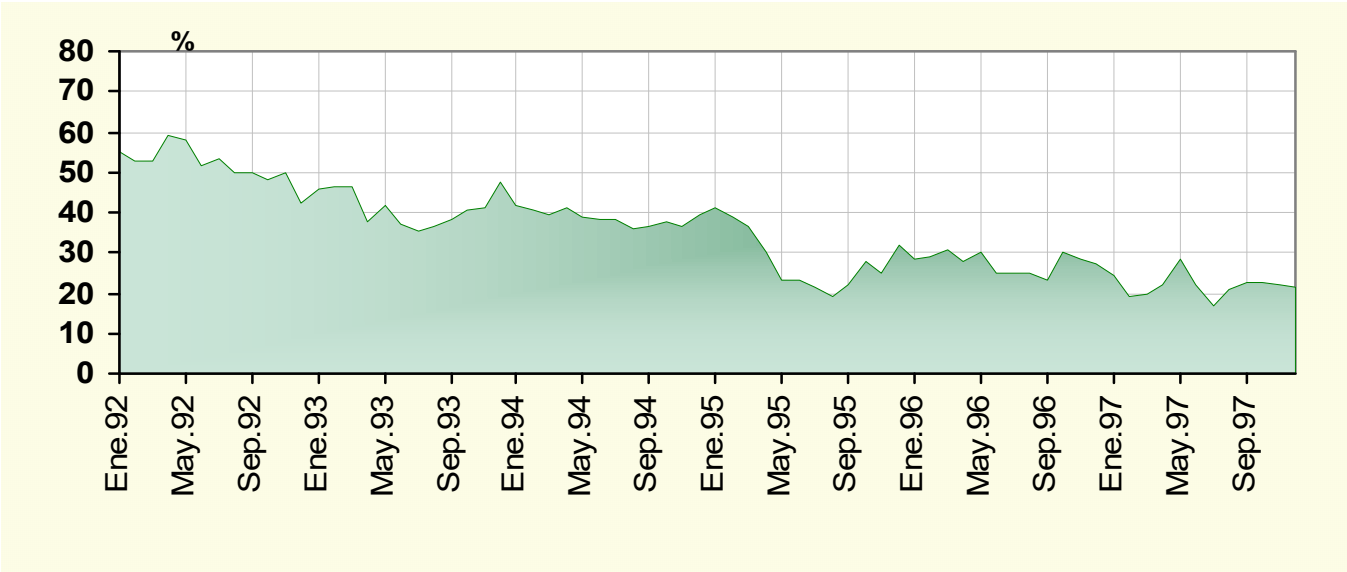
No. of Contracts	dec-93	dec-94	dec-95	dec-96	dec-97	Dic-98	Dic-99	Dic-00
	10	91	449	757	1192	1708	2101	2063



# Spot Price Evolution

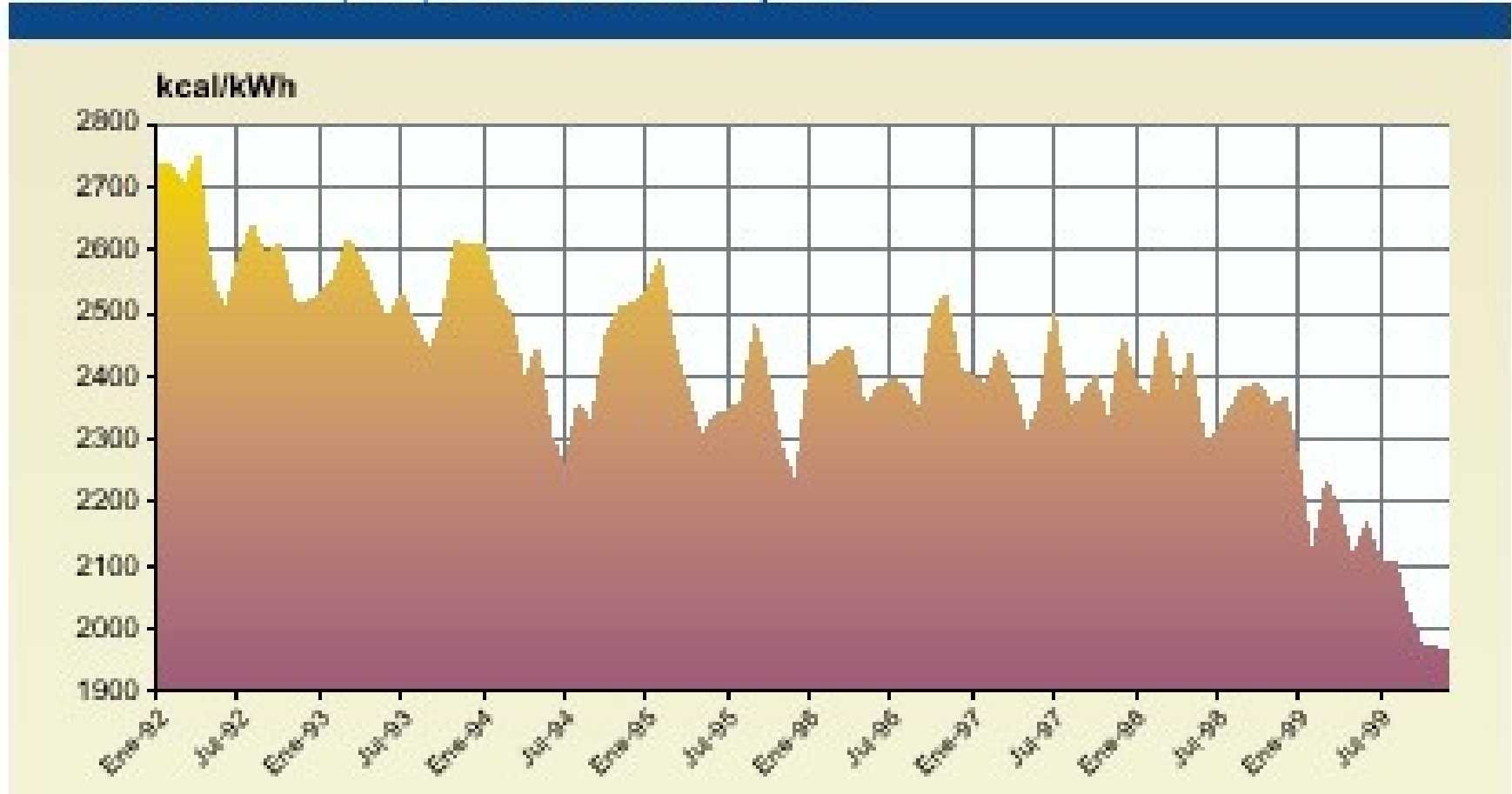


# Thermal Unavailability

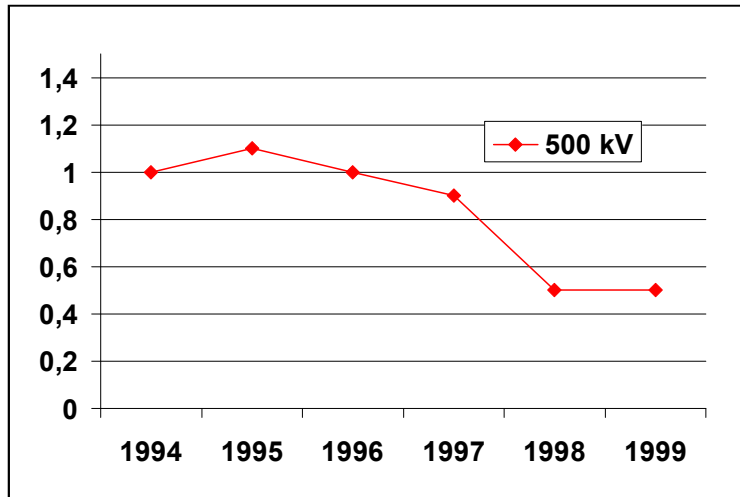


# Average Heat Rates Evolution

Historical Heat Rate Evolution / Evolução Histórica dos Consumos Específicos



# Transmission Service Quality



$\lambda$  = number of forced outages / km line

