

# *Brazil 2002: Sensible Rationing to Alleviate Prolonged Electricity Shortfalls*

## **SAVING ELECTRICITY IN A HURRY**



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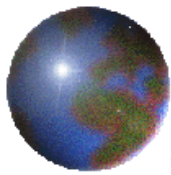
# *Agenda*

- ✚ Causes of the Brazilian 2001-2002 Power Crisis
- ✚ How Brazil approached the crisis in the short term
  - ✚ Rolling black-outs or
  - ✚ Quotas?
- ✚ Speed of customer response
- ✚ Results achieved
- ✚ Can this experience be replicated elsewhere?
- ✚ And the day (s) after?
- ✚ Where to learn more?



## *Causes and extent of the 2001 Brazilian crisis*

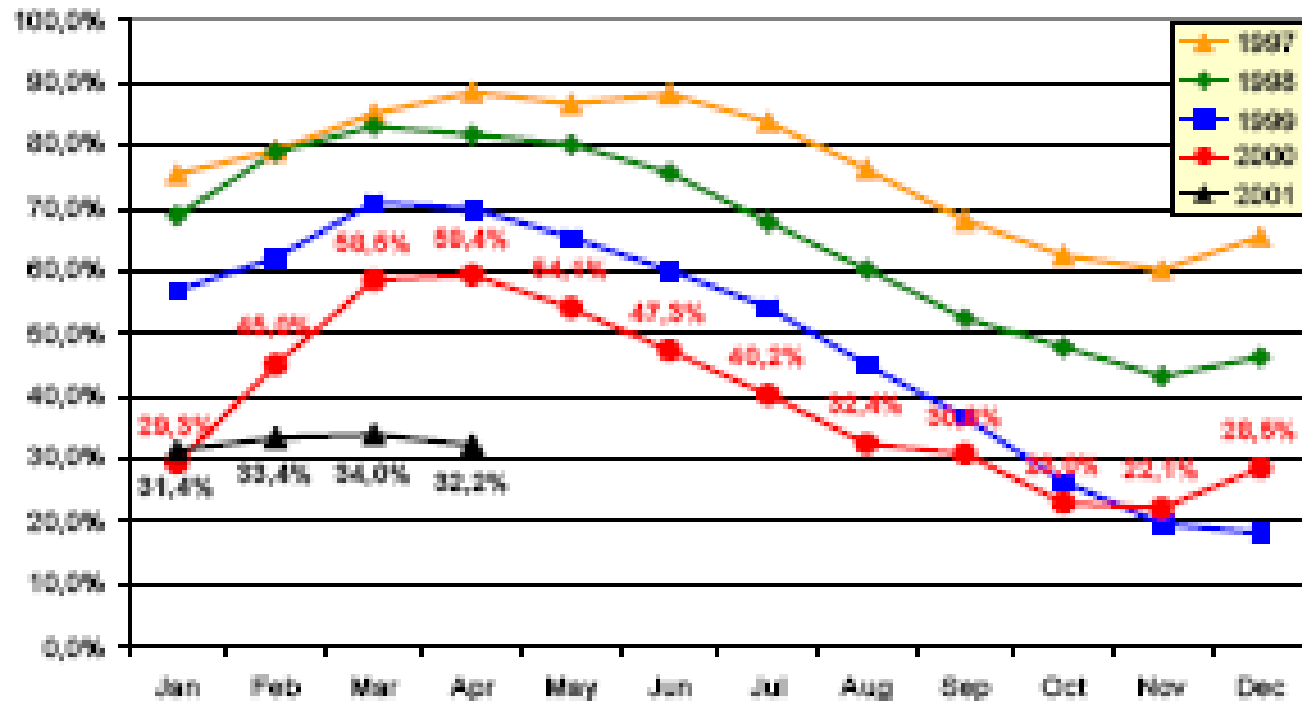
- ✚ The most serious energy crisis in recent history
- ✚ Affecting 80% of the network, including the heavily industrialized and populated Southeast region
- ✚ Hydro dependent system (>90%) has been strained - beyond capacity after several years of below average rainfall
- ✚ Capacity expansion had not kept up with market growth
- ✚ Some experience in the past in dealing with similar situations – but not to this extent and magnitude

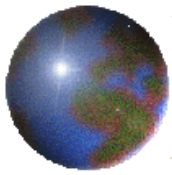


# *The crisis was not a surprise - 2001 only a wake up call*

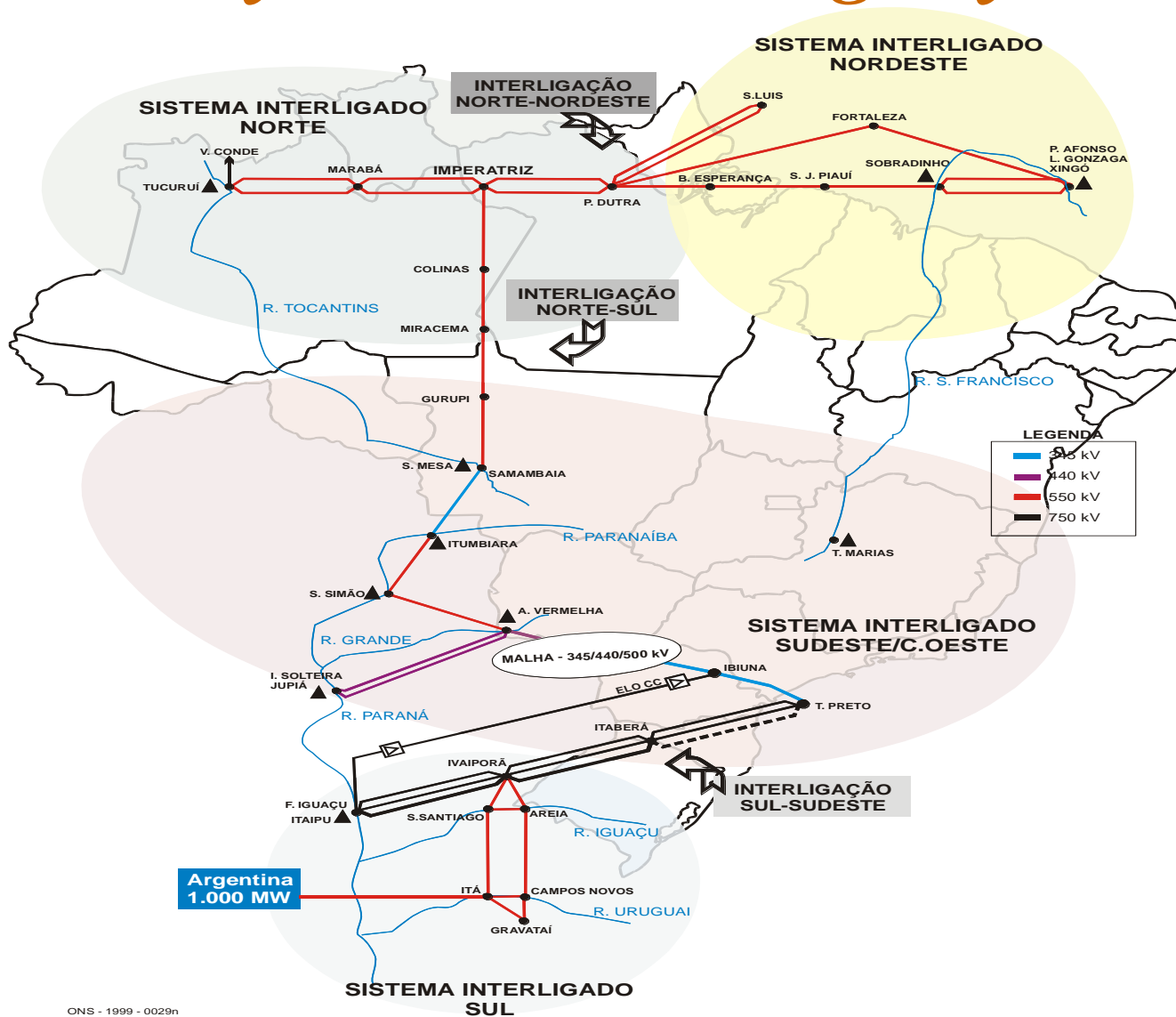
Graph 4.2: Multi-Year Reservoir Depletion— Southeast

Southeast and Center-West Regions  
Storage Levels (% of storage capacity)





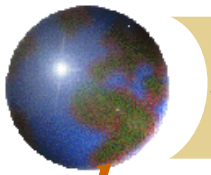
# Hydro is hydro – even large systems fail





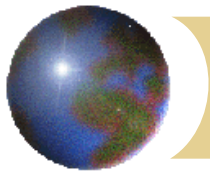
## *How Brazil approached the crisis*

- ✿ A “self-rationing,” market-based demand driven scheme
- ✿ Quotas were assigned to individual customers (20-25% reduction target) – similar to the TECC concept
- ✿ Honest perception of crisis – and massive educational campaign
- ✿ Penalties and incentives – mostly of pecuniary nature and linked to SRMC at wholesale market (about US\$ 300/MWh)
- ✿ No single black-out or brown-out -- +20% reduction, over 8 months, almost country-wide
- ✿ At least 1-1.5% of GDP saved (vis-à-vis rolling black-outs)
- ✿ An efficient safety net fostering engagement from the poor
- ✿ Not everything rosy – but a successful case, with many lessons learned



## *Implementation of “rolling black-outs” is more complex than normally alleged – and much less effective for MWh constrained systems*

- ⊗ Networks are inter-meshed - “essential” loads = 40% of feeders
- ⊗ “Intra-day” load shift weakens the effectiveness of the scheme for
- ⊗ Those two factors would entail a disproportionate burden on some customers (10 to 16 hours/day !!)
- ⊗ Manual nature of disconnection operations, difficult to follow a precise timetable
- ⊗ Dire consequences
  - ⊠ Hurts manufacturing activities with continuous processes
  - ⊠ “Melancholic urban chaos”
  - ⊠ Timetables may increase crime rates



# *Quotas (TECCs) were differentiated by customer segment*

	2000 Consumption	Reduction Target	Financial Charges (Penalties)	Bonuses?	Individual Cuts?
Residencial	Till 100 kWh/mo	Optional	No	2 to 1 saved	No
Residencial	From 101 till 200 kWh/mo	20%	No	1 to 1 saved beyond target	Yes
Residencial	From 201 till 500 kWh/mo	20%	50% of tariff, if above target	1 to 1 saved beyond target	Yes
Residencial	Above 500 kWh/mo	20%	200% of tariff, if above target (1)	1 to 1 saved beyond target	Yes
Industrial/Commercial (High Voltage)	Above 500 kWh/mo	15% to 35%	MAE price for consumption above target	No (2)	Yes (3)
Industrial/Commercial (Low Voltage)	Above 500 kWh/mo	20%	MAE price for consumption above target	No	Yes (3)
Rural	No limit	10%	No	No	Yes
Public Services	No limit	15% to 35%	No	No	Yes

(1) Corresponds approximately to MAE price

(2) May trade quotas. In the wholesale market, if load > 2.5 MW

(3) Cuts by number of days to achieve target, unless company "buys" quotas in the market





# *Trading prerogatives varied among customers*

**High Voltage  
> 2,5 MW**



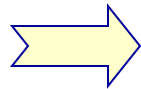
**May participate in the secondary market for "quotas" (marginal transfer)**

**High Voltage  
< 2,5 MW**

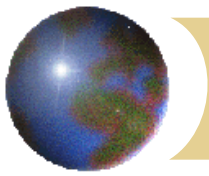


**May trade "quotas" on a bilateral basis (same holding company)**

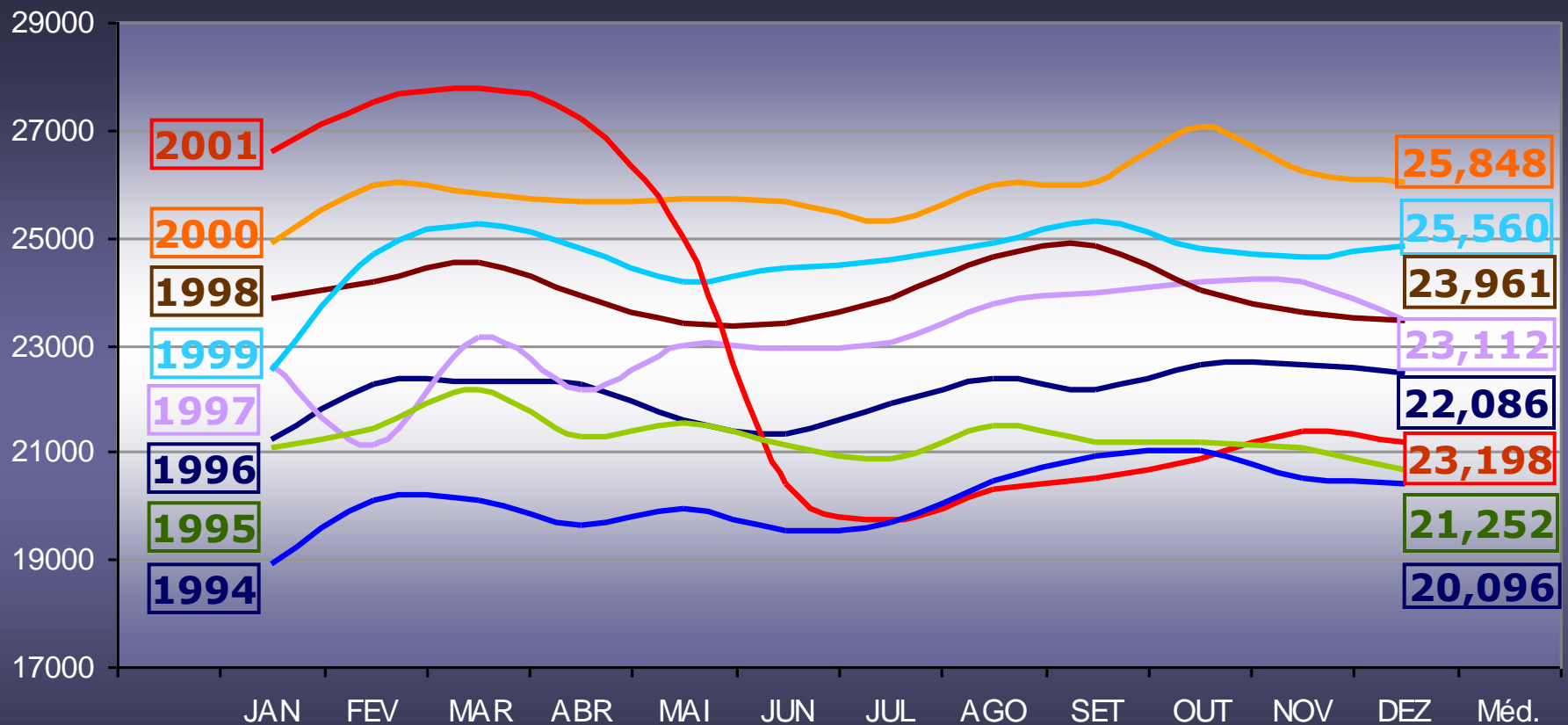
**Low  
Voltage**



**No trading allowed, but surpluses and shortfalls priced close to SRMC, traded with host utility and settled via electricity bill**

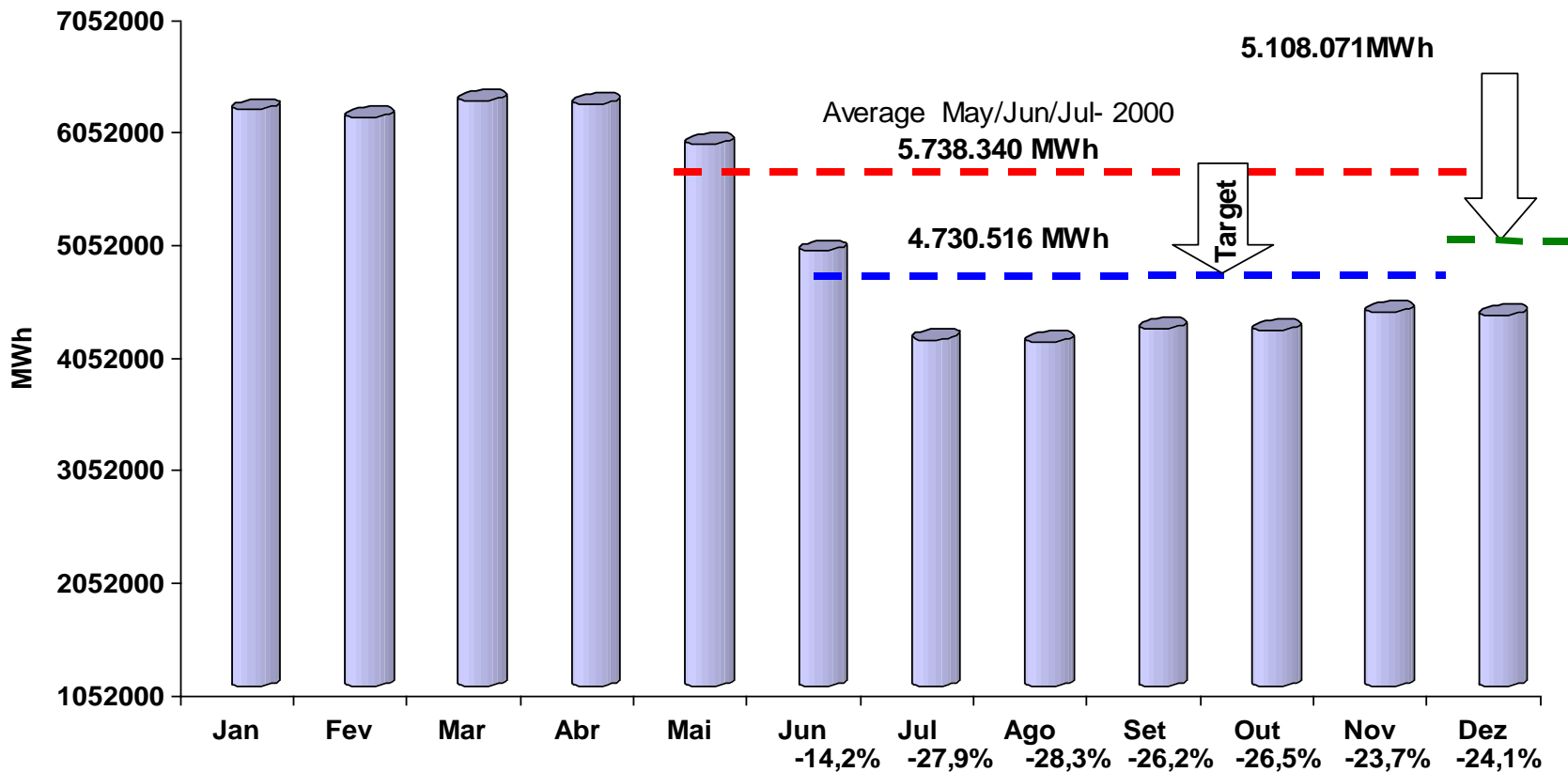


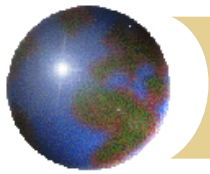
*Load response was fast and effective  
– without black-outs or brown-outs*





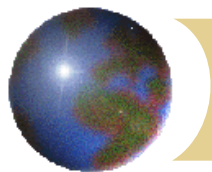
# *Residential – energy savings beyond Government targets*





# *Self-rationing - the customer decides how to save energy*

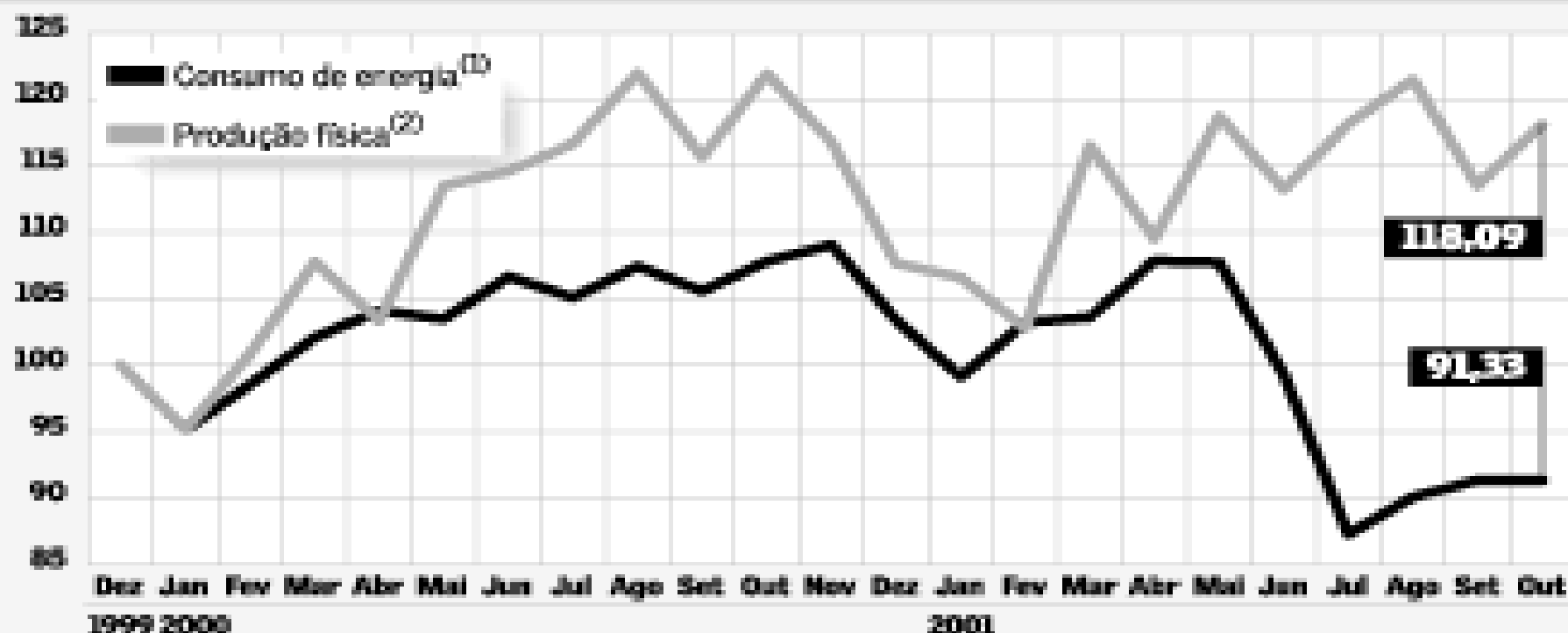
ACTIONS TAKEN BY CONSUMERS	TOTAL	SOUTH EAST	CENTER WEST	NORTH EAST
Switched off lamps	45	36	46	60
Changed lamps (mini-fluorescent)	39	36	35	45
Reduce time watching TV	31	28	31	36
Ironing - less time, on fewer clothing	23	19	22	31
Switched off freezer	23	27	26	15
Reduce time in the shower	22	30	24	8
Reduce use of laundry machine	14	17	11	9
Switched off electric oven & microwave	14	19	10	8
Reduced use of refrigerator	12	11	13	13
Switched off refrigerator	12	12	9	11
Shower with cold water	12	11	18	12
Reduced electric oven & microwave	9	14	8	3
Switched off stereo equipment	8	8	7	9
Reduced use of stereo equipment	7	6	7	8
Switched of TV	7	7	7	6
Switched off laundry machine	7	8	6	5
Did not use air conditioning	6	4	9	10
Reduced use of freezer	6	7	7	6
Reduced use of computer	6	6	6	6
Switched off VCR	6	8	4	4

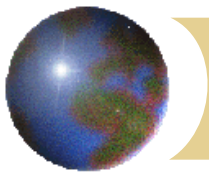


# *Industrial production grew in the period*

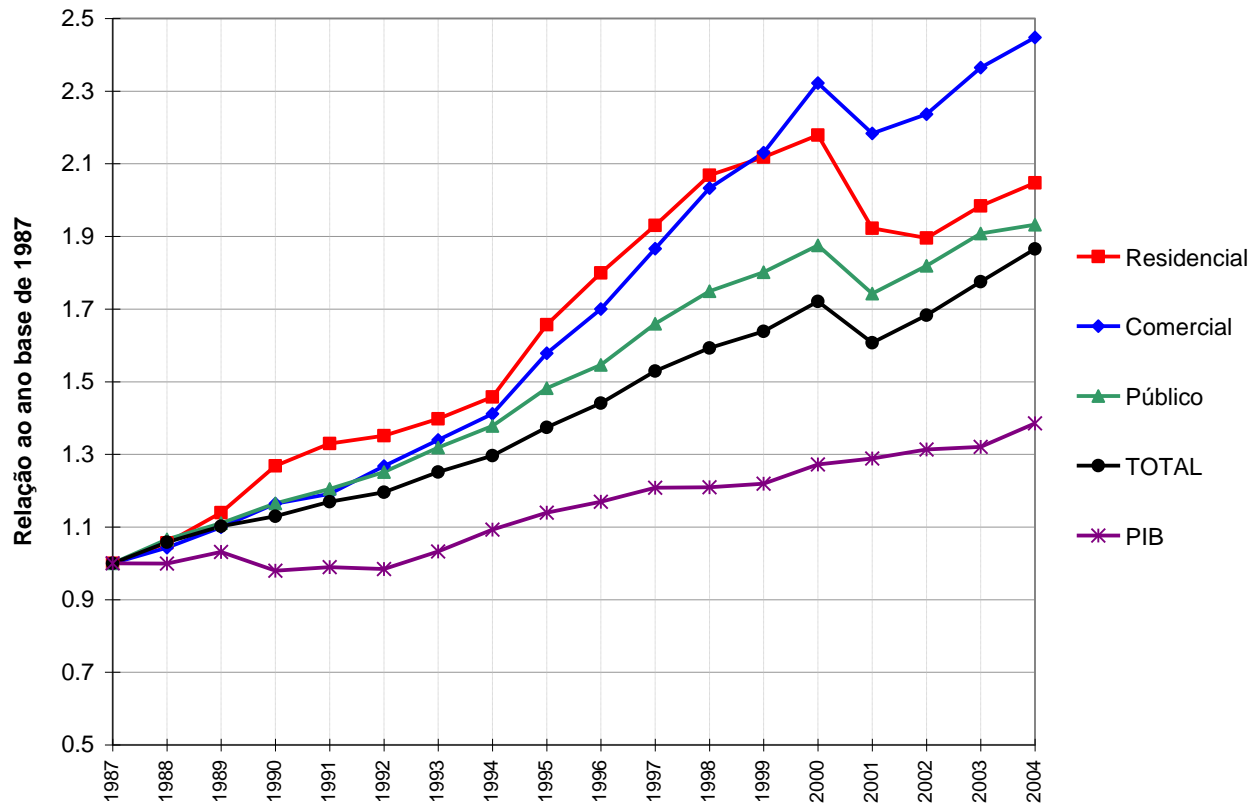
## **Consumo de energia elétrica X produção física**

Índices = 100 em dez/99





# *GDP was not materially impacted*





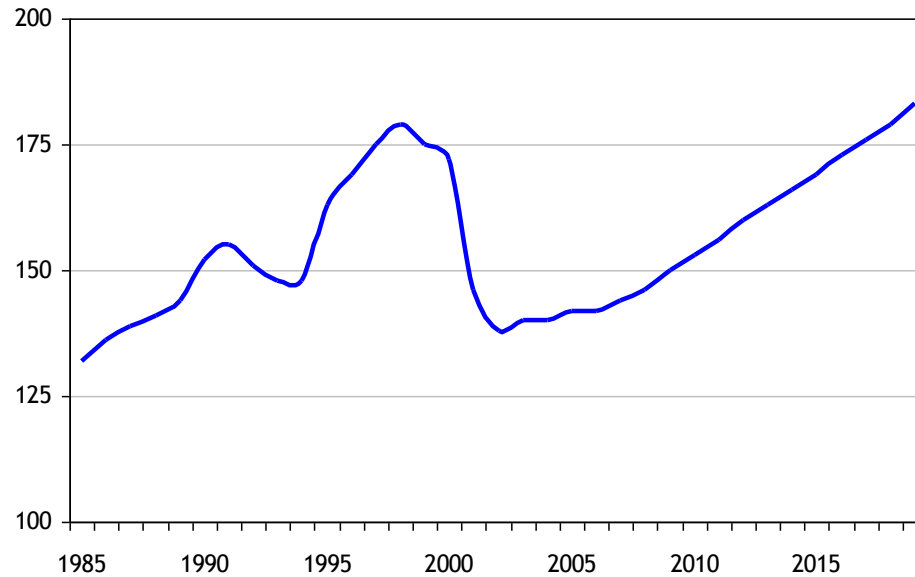
## *Change in behavior and residual impact*

- ⊗ Average individual consumption = 1994 levels
- ⊗ Average consumption pre and post rationing
  - ⊗ SE – from 199 kWh/mo to 145 kWh/mo
  - ⊗ NE – from 113 kWh/mo to 85 kWh/mo
- ⊗ 91% of households changed consumption habits during rationing – from those 65% still maintain savings
- ⊗ Energy efficiency became part of the decision making process to buy appliances
  - ⊗ 8% before crisis
  - ⊗ 58 % after crisis



# *Changes in Customer Behavior had a lingering effect*

**Household Consumption in Brazil (kWh per month)**







# *A quick comparison Ca. vs. Br.*

	California (1)	Brazil (2)
<b>Shocks</b>	Supply and Demand	Supply
<b>Shortage</b>	Capacity (Energy)	Energy only
<b>Action</b>	20/20	Cap (and Trade)
<b>Mandate</b>	Voluntary	Compulsory
<b>Load Shedding?</b>	Some	No
<b>Duration</b>	11/00 - 05/01	6/01 - 02/02
<b>Government Action</b>	Slow	Fast
<b>Cost of Demand Response</b>	US\$276/kW-yr	US\$7/MWh
<b>Second Best</b>	US\$55/KW-yr (peaking) or shedding	US\$150/MWh or shedding (US\$300/MWh)
<b>Metering Deployment</b>	No	No

(1) Sweeney, J. *The California Electricity Crisis*. Stanford - CA. The Hoover Institution Press, 2002.

(2) Maurer, Pereira, Roseblatt. *Implementing Power Shortages in a Sensible Way: Lessons Learned and International Best Practices*. Washington DC. ESMAP. Report 305/05. 2005.



## *Can this experience be replicated in other places?*

- ✚ There is not a one case fits all
- ✚ The mechanism in Brazil had some “bells and whistles” – but even a very simple scheme may produce significant results
  - ✚ Initial quota assignment (TECC-like)
  - ✚ Deviations priced at SRMC (e.g. cost of emergency generation)
- ✚ Brazil was an energy constrained case – capacity constrained systems require different approaches
  - ✚ Price signals should be conveyed on a time basis
  - ✚ But technology is seldom in place – advanced metering, two-way communication, load control
  - ✚ Pricing schemes more sophisticated than TOU – e.g. CPP, RTP
- ✚ Fuel switching or GHG emissions were not an issue
- ✚ If those are also issues to consider, then a combination of other approaches
  - ✚ Green certificates (possibly tradable)
  - ✚ Standard Offers (ala South Africa)
  - ✚ Energy Efficiency Auctions



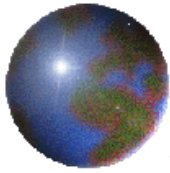
## *The Day (s) after (I)...*

- ✚ The crisis impacted the entire sector and resulted in significant financial losses for discos and gencos
- ✚ Success had a financial price – bonuses exceeded penalties, resulting in financial imbalance
- ✚ A kind of sector “bail-out” was put in place, partially funded by BNDES and partly by future tariff increases
- ✚ Political “fall-out” – in the 2002 election the opposing party used the crisis as the major element in the political debate
- ✚ Pres. Lula’s administration put strong emphasis on fixing the power sector – Mrs. Rousseff, an energy expert, was appointed Minister of Mines and Energy
- ✚ The new administration started in a comfortable position, with about 8,000 firm MW of excess capacity (half due to demand response)

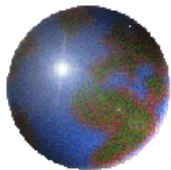


## *The Day (s) after (II)*

- ✚ 2003 – a new power sector model was constructed
  - ✚ Making important changes
  - ✚ Building upon good things of its predecessor (1998)
- ✚ An interesting mix between central planning and market forces
  - ✚ Centralized planning was strengthened
  - ✚ BNDES has played a major role in funding the system
  - ✚ Three large hydro projects in the Amazon (and T links) being built
  - ✚ Electricity auctions were introduced to foster competition both “in” and “for” the market
  - ✚ Auctions spurred investments in renewables – now wind is “in-the-money”
  - ✚ Tariff increases and more retail competition (almost 40% of demand)
- ✚ No more energy crisis – but two short duration black-outs
- ✚ Government is now revisiting demand mechanisms to make the system more affordable and reliable
  - ✚ First National Energy Efficiency Plan approved
  - ✚ Demand side bidding and energy savings auctions being considered
  - ✚ Smart grids and smart metering (possibly with load control)



*Where to learn more?*



## Implementing Power Rationing in a Sensible Way: *Lessons Learned and International Best Practices*

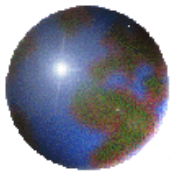


Energy  
Sector  
Management  
Assistance  
Program

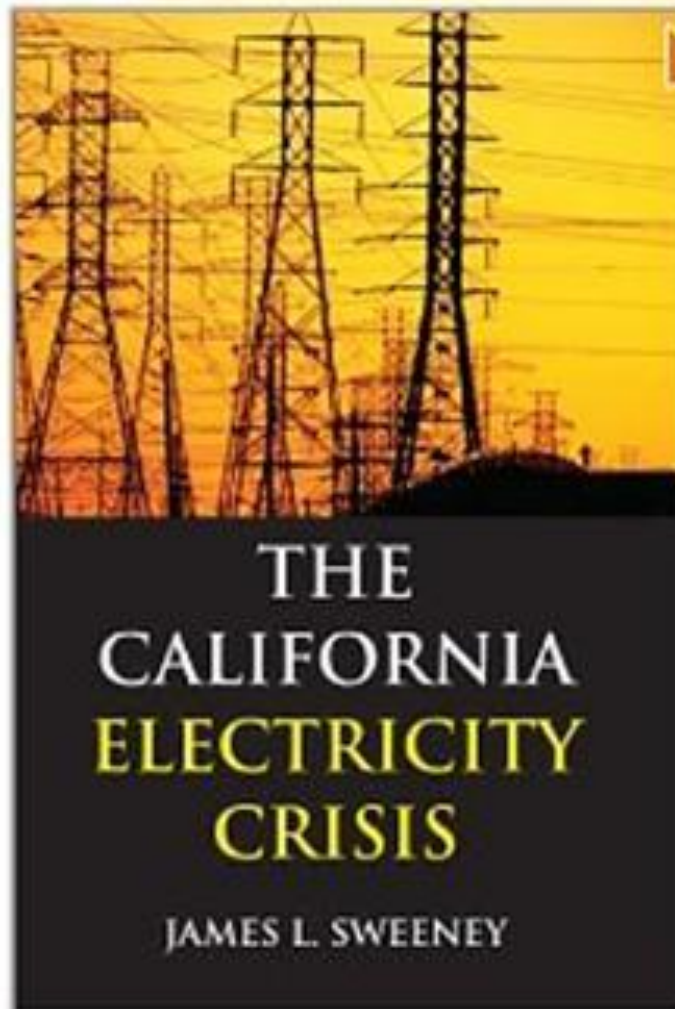


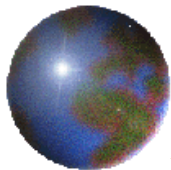
Report 305/05

August 2005



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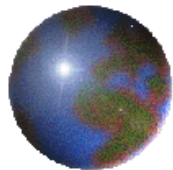
## South Africa's Market-Based Power Rationing Program

LOW CARBON GROWTH COUNTRY STUDIES PROGRAM

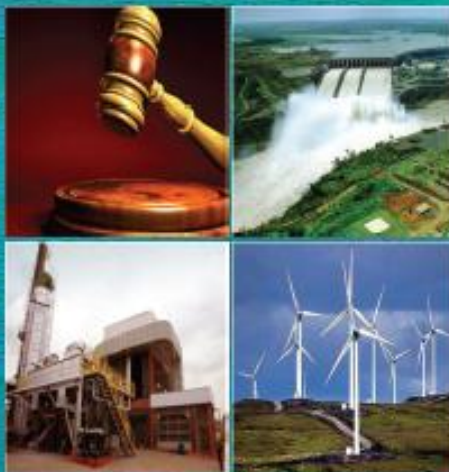
MITIGATING CLIMATE CHANGE THROUGH DEVELOPMENT







A WORLD BANK STUDY



# Electricity Auctions

AN OVERVIEW OF EFFICIENT PRACTICES



THE WORLD BANK

Luiz T. A. Maurer  
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