



ELECTRICITY CONSUMPTION ANALYSIS & ENERGY EFFICIENCY

# Second ELECON Workshop

## Consumer control in Smart Grids

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UNIVERSIDADE ESTADUAL PAULISTA  
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OTTO VON GUERICKE  
UNIVERSITÄT  
MAGDEBURG



FAKULTÄT FÜR  
ELEKTROTECHNIK UND  
INFORMATIONSTECHNIK



ELECTRICITY CONSUMPTION ANALYSIS & ENERGY EFFICIENCY

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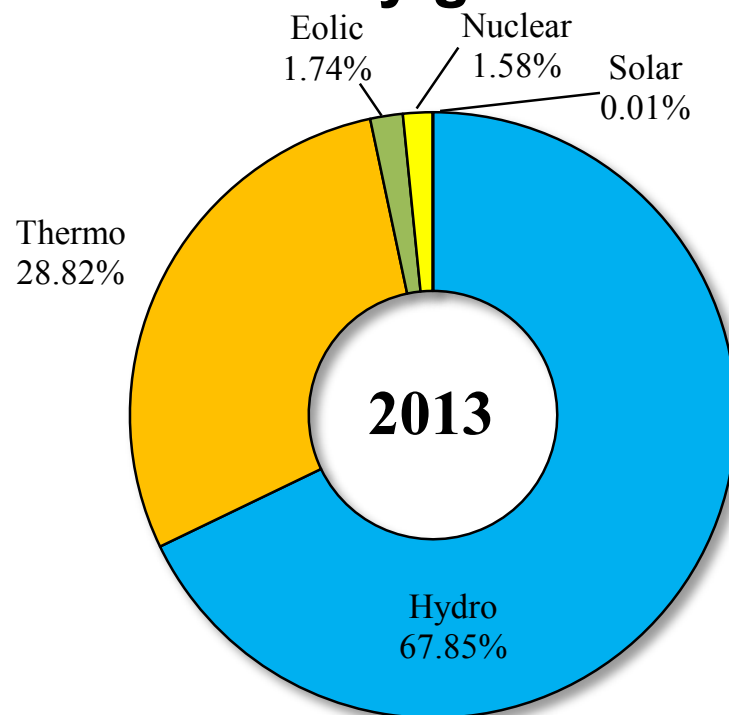
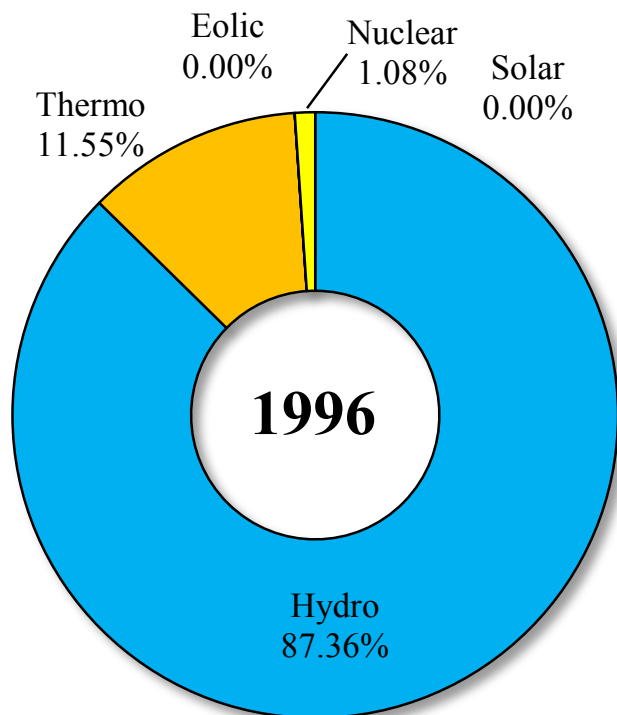
# **Electricity Consumption Characterization of the Different End-use Sectors of Brazil**

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- **Characteristics of the Brazilian Electrical Sector**
- **Electricity: Current Demand and Future Projections**
- **Load Profile for Commercial, Industrial and Residential Consumers in Brazil**
- **Summary**

# THE BRAZILIAN ELECTRICAL SECTOR

## Evolution of the installed capacity for electricity generation



### Installed capacity in 2014:

131,238 MW (3,372 plants in operation)

+

8,170 MW (imports)

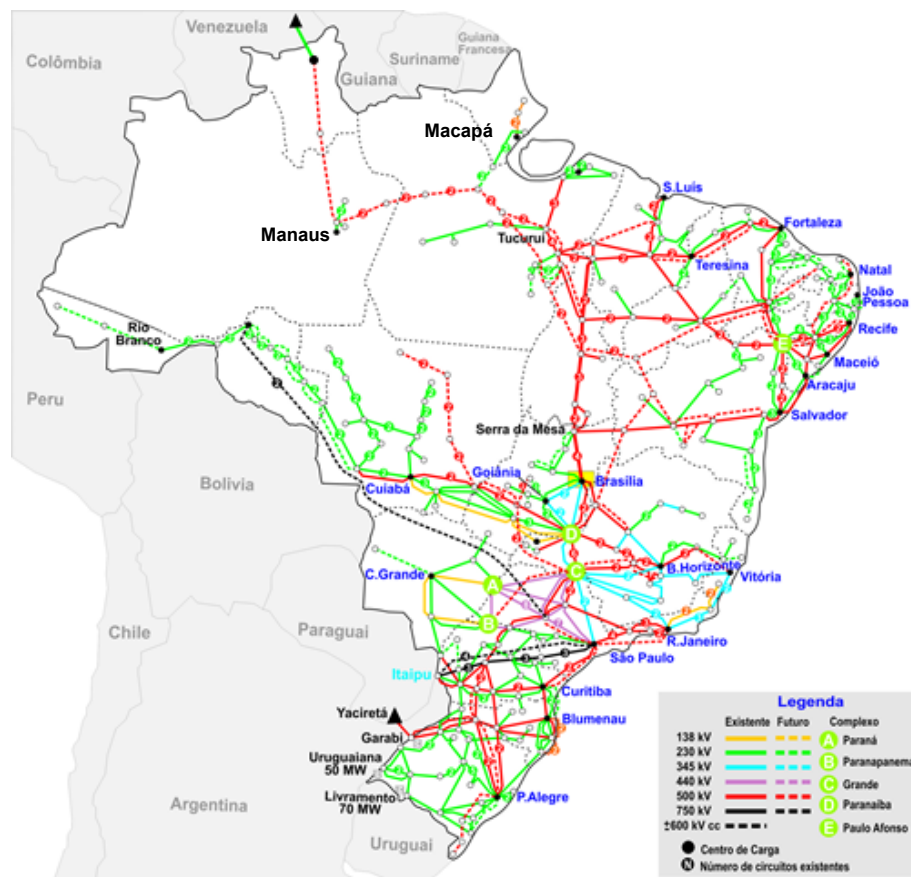
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**139,408 MW**

# Characteristics of the Brazilian Electrical Sector

## The transmission sector

### National Interconnected System



**96.6%** of the total electricity production

### Isolated Systems

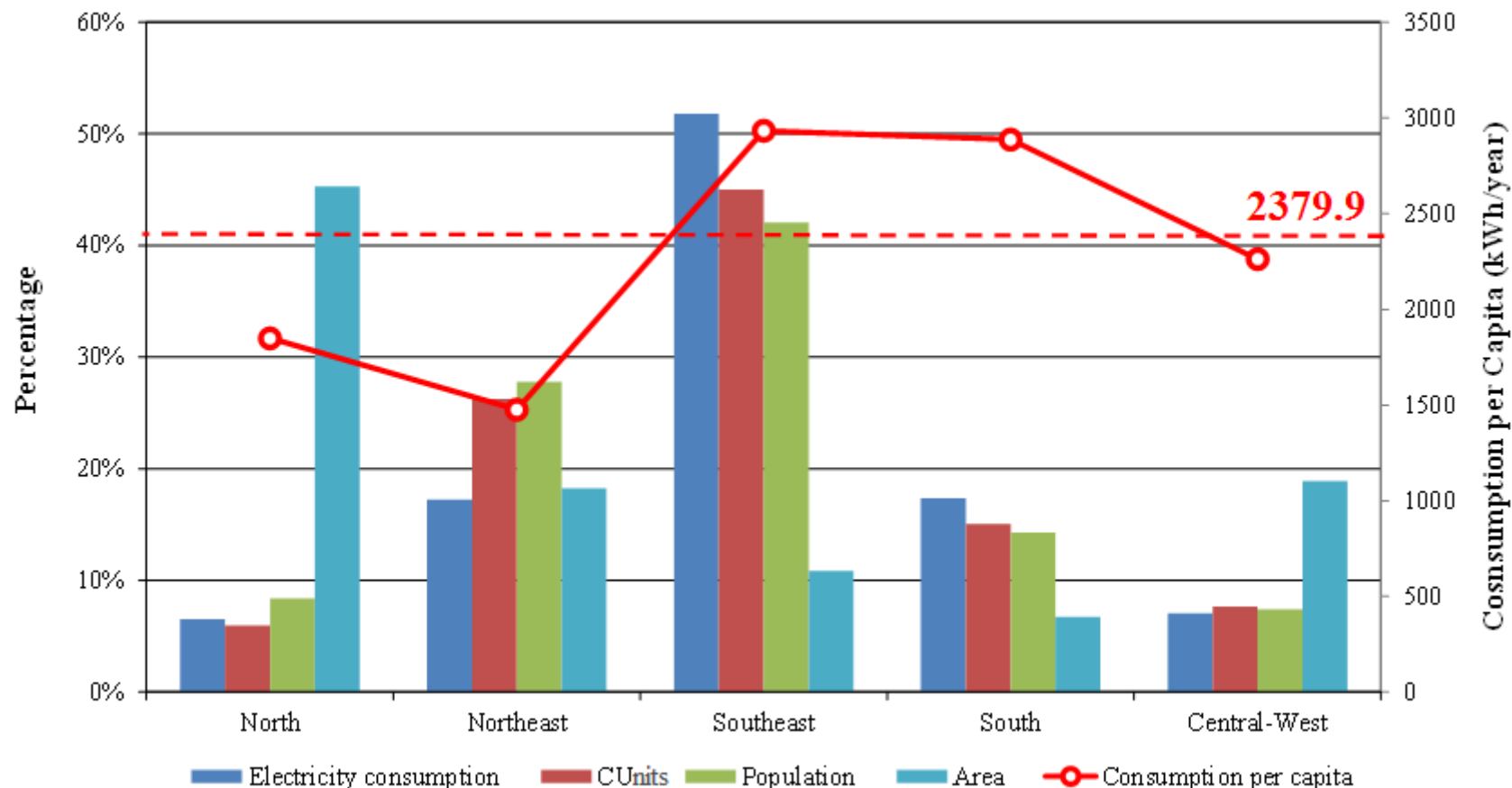


**3.4%** of the total electricity production  
(future < 1%)

# THE ELECTRICITY DEMAND

# Electricity: Current Demand and Future Projections

## Electricity consumption - 2013



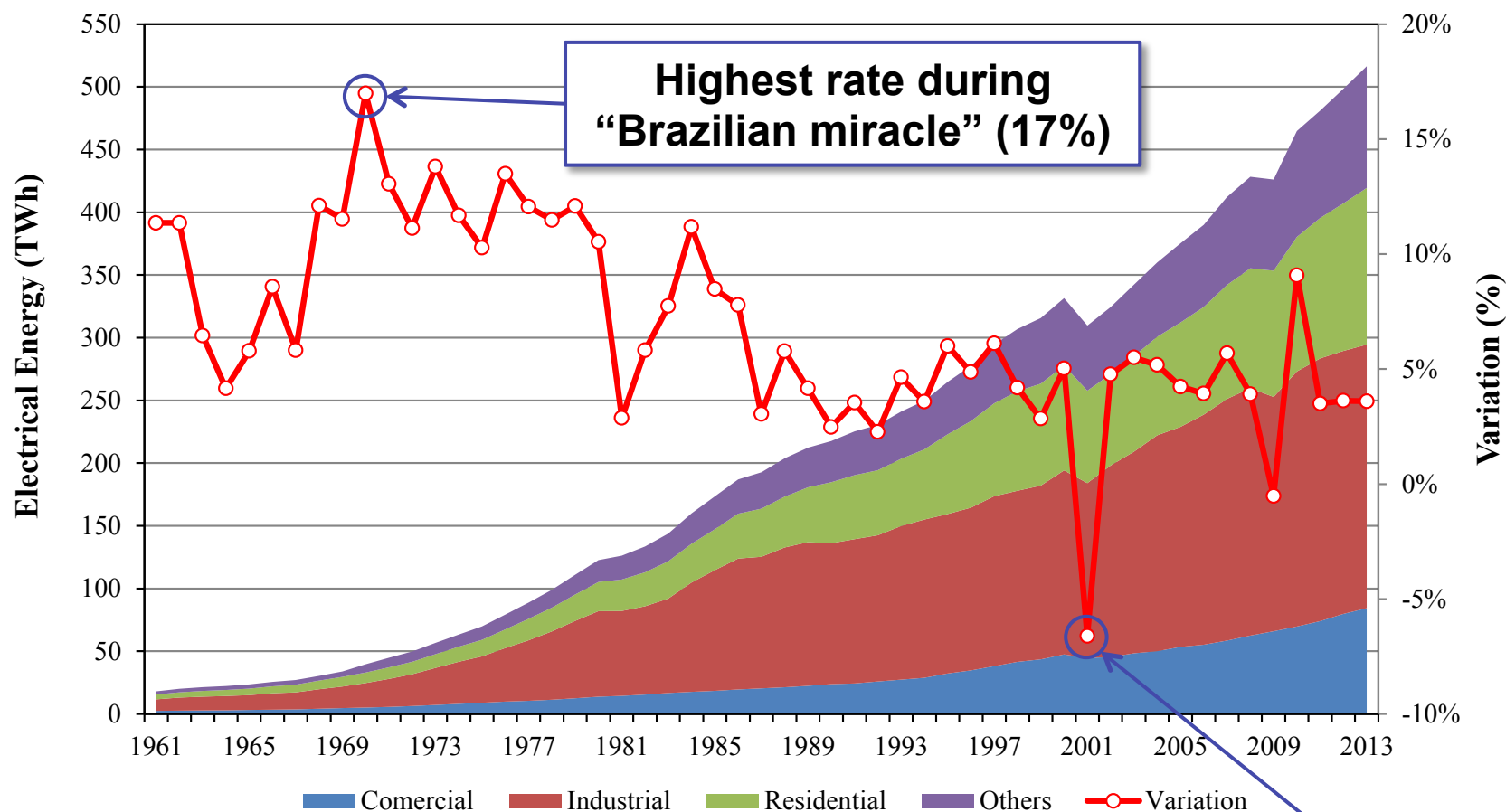
Total consumption → **516.4 TWh**

Per capita consumption → **2379.9 kWh/year**



# Electricity: Current Demand and Future Projections

## Evolution of the electrical energy consumption 1961-2013

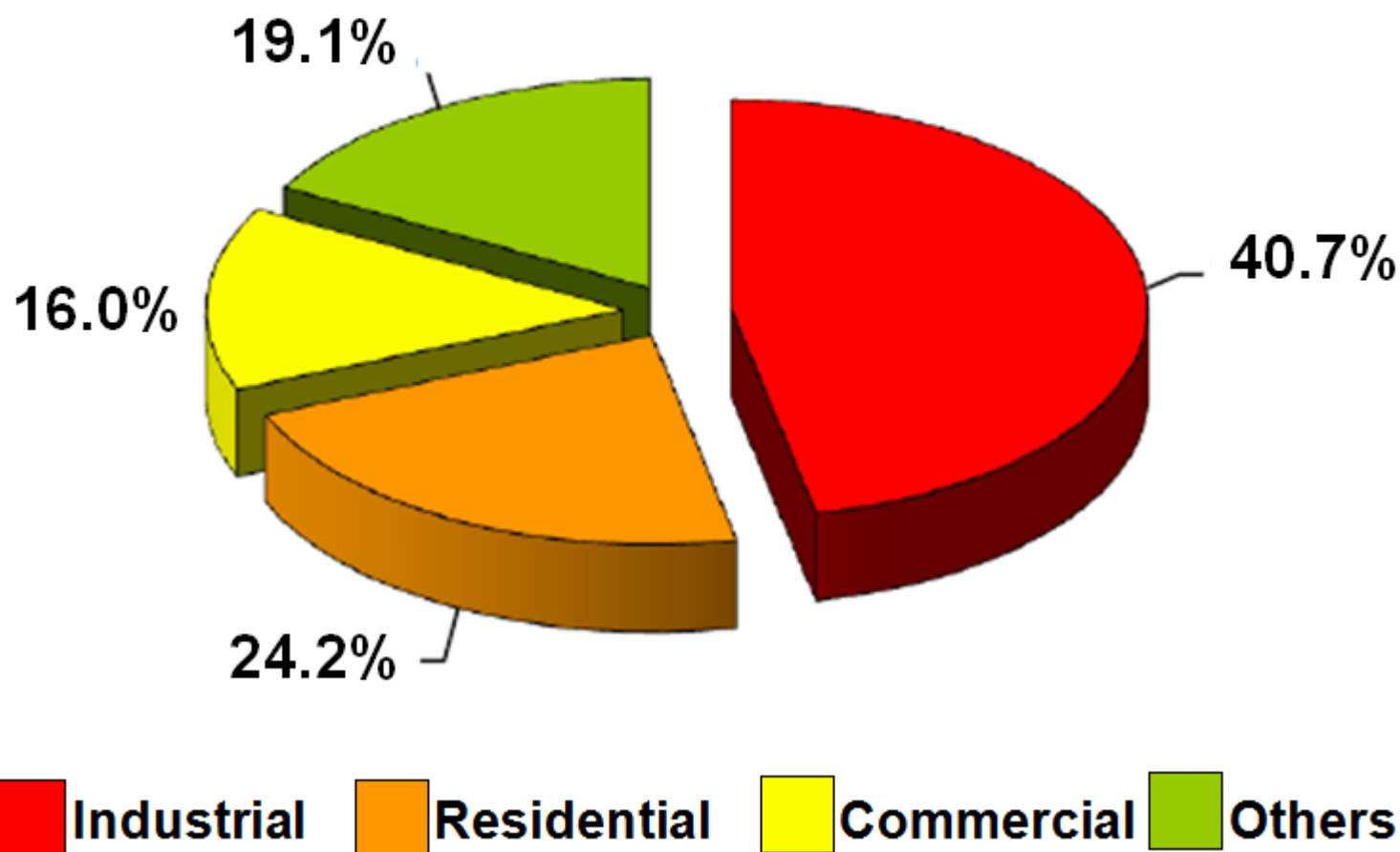


In 51 year → **increase 31 times**  
Average annual growth rate → **6.8 % year-to-year**

**Lowest rate during  
“crisis” (-6.6%)**

# Electricity: Current Demand and Future Projections

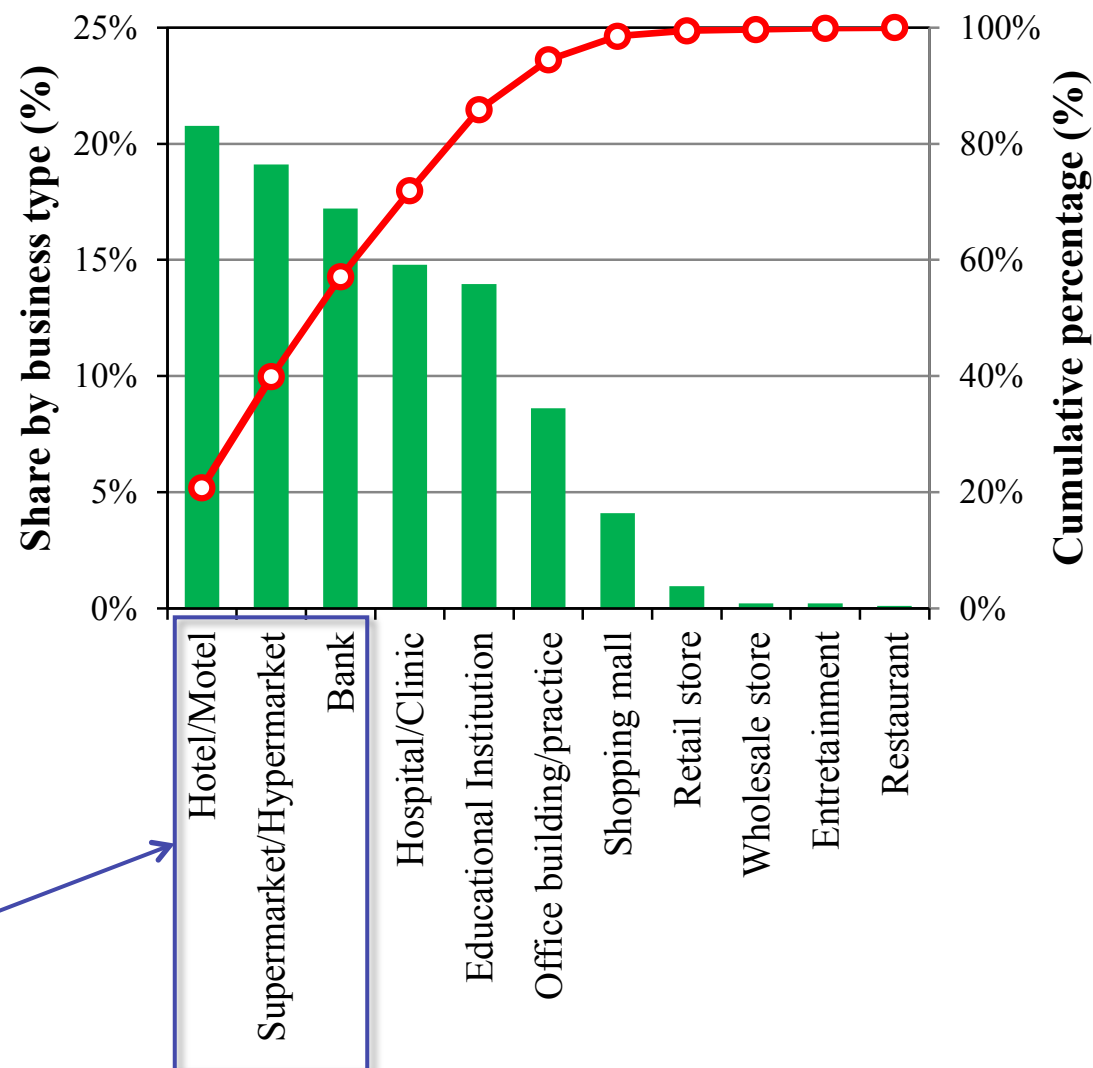
## Brazilian Electricity Consumption by Sector, 2013



# THE LOAD PROFILES

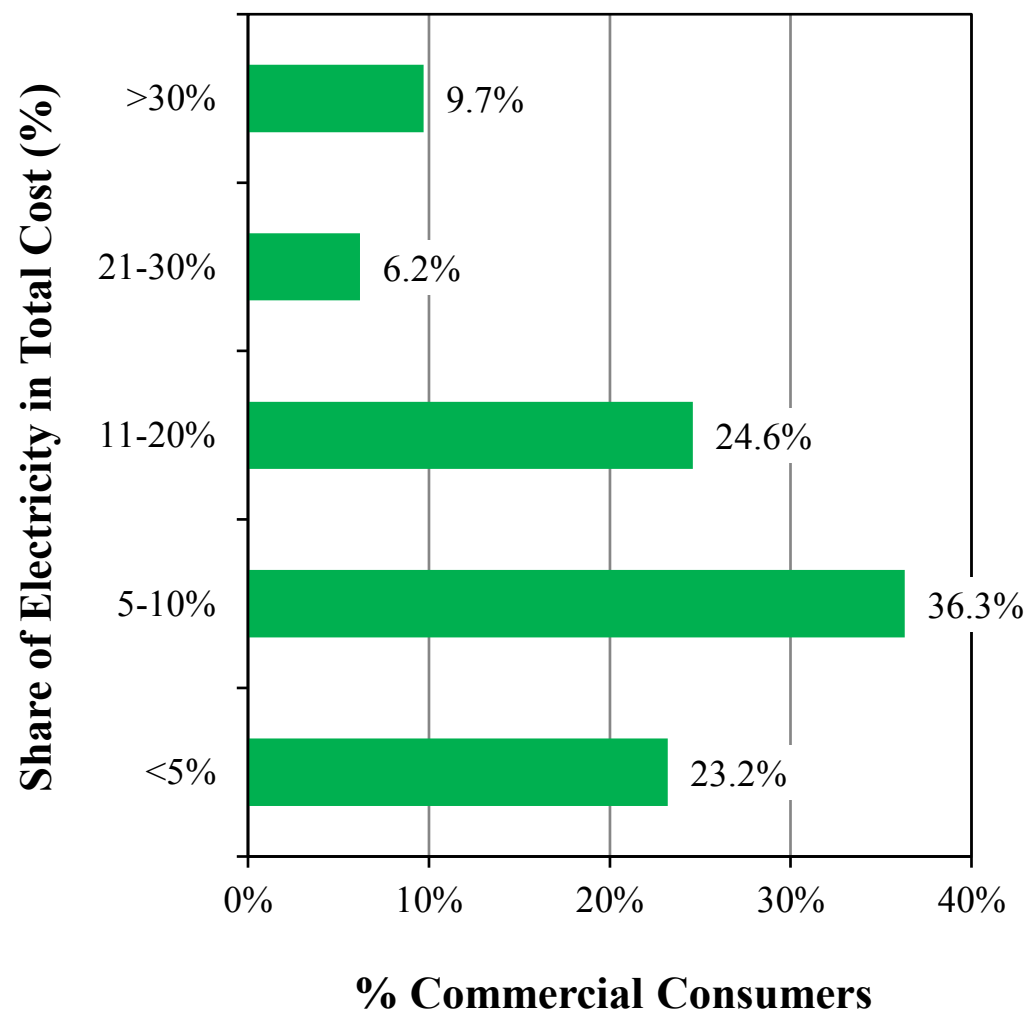
# Load Profile: Commercial Sector

Represents approximately **16%** of total electricity consumption in Brazil



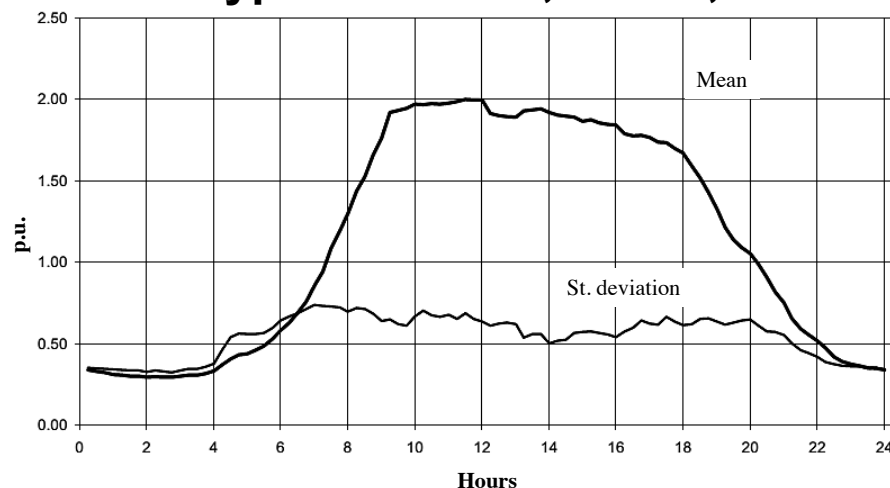
3 business → **57%** of share

## Relative weight of electricity in the total cost

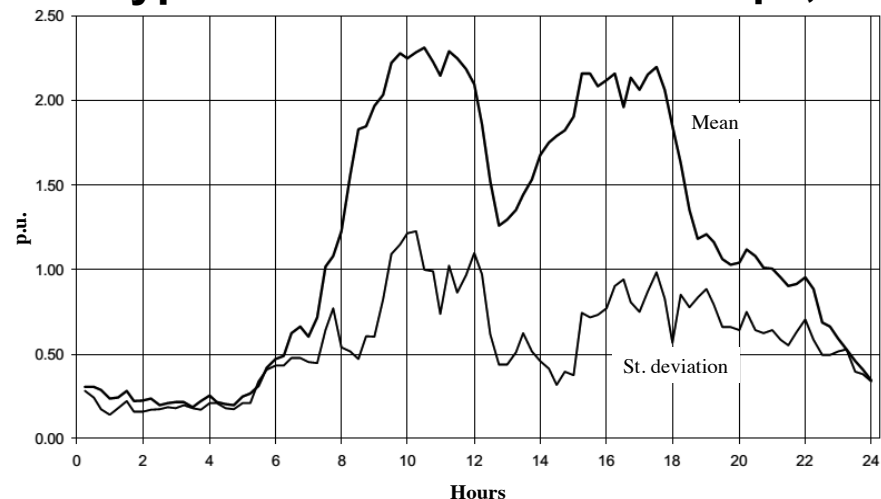


# Load Profile: Commercial Sector

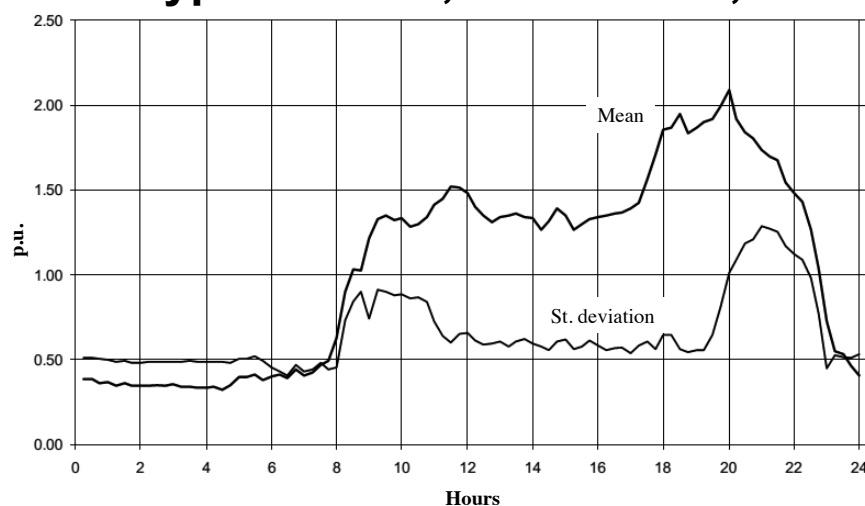
**Type 1 – hotels, banks,...**



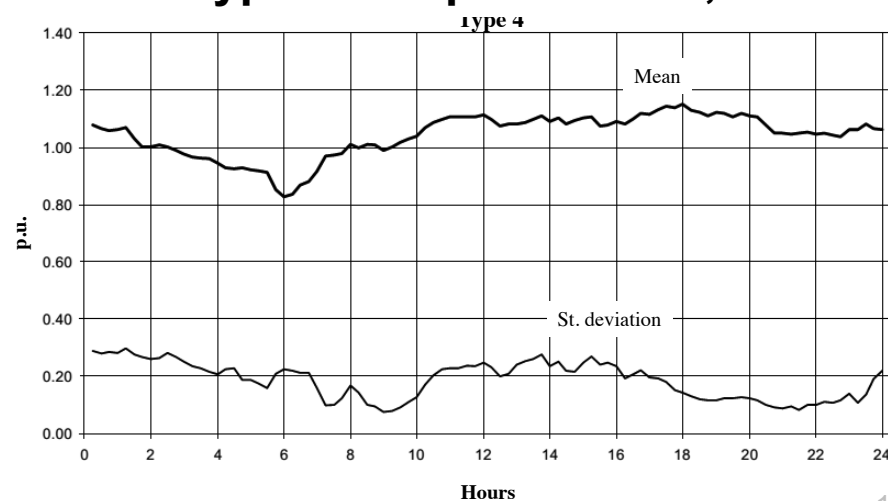
**Type 2 – mechanical workshops,...**



**Type 3 – bars, restaurants,...**



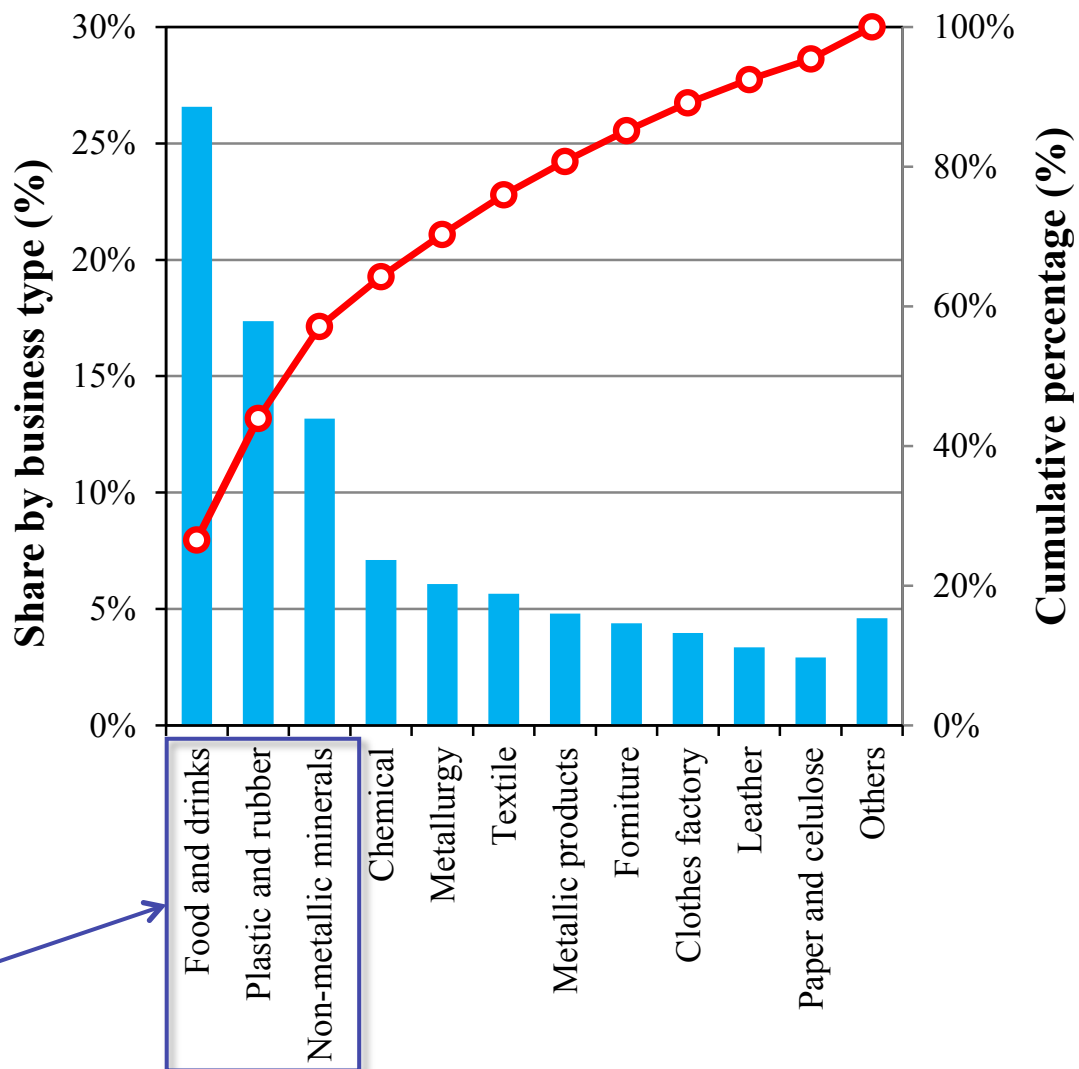
**Type 4 – supermarkets,...**



# THE INDUSTRIAL SECTOR

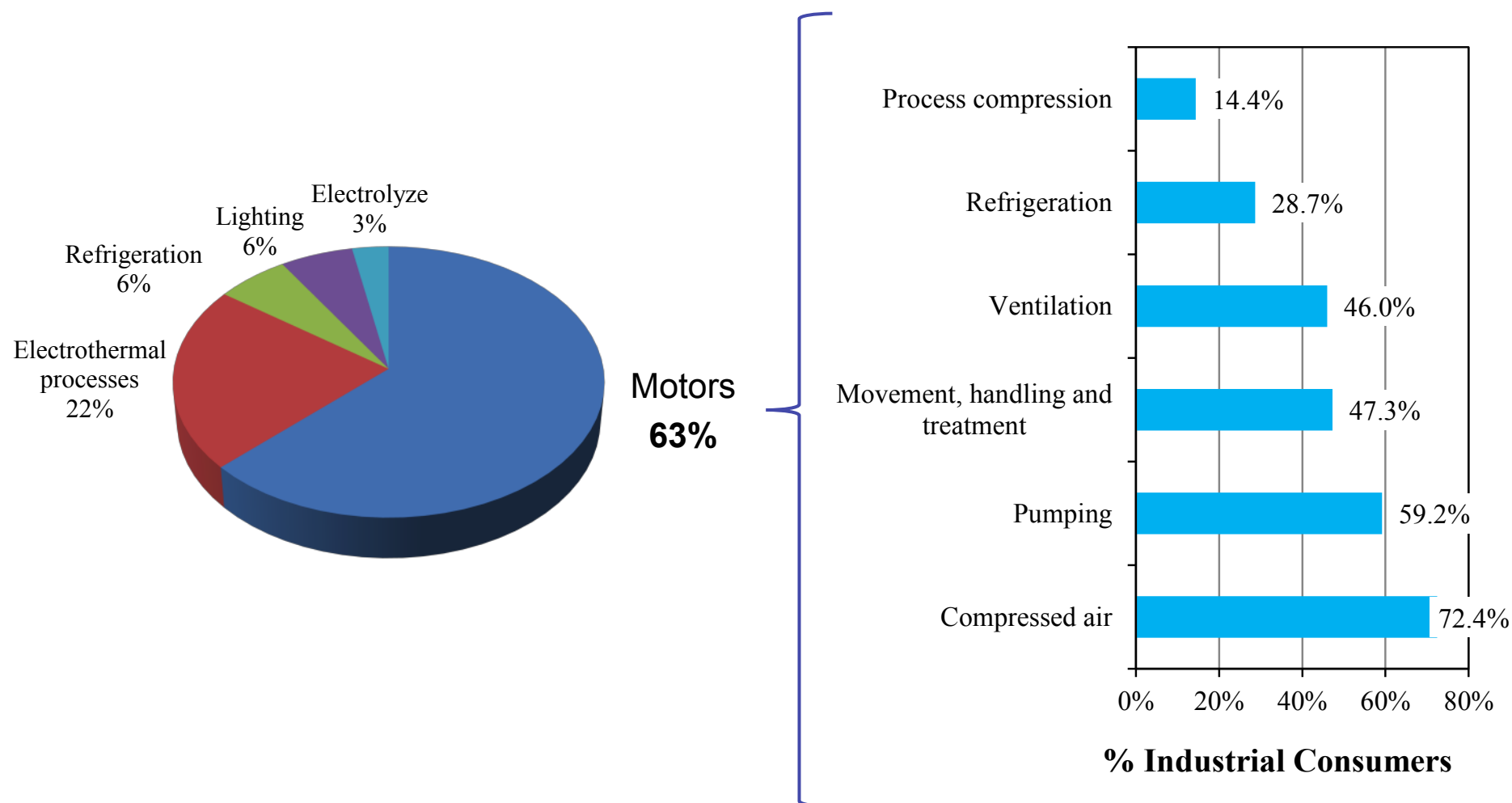
# Load Profile: Industrial Sector

Represents approximately **40.7%** of total electricity consumption in Brazil





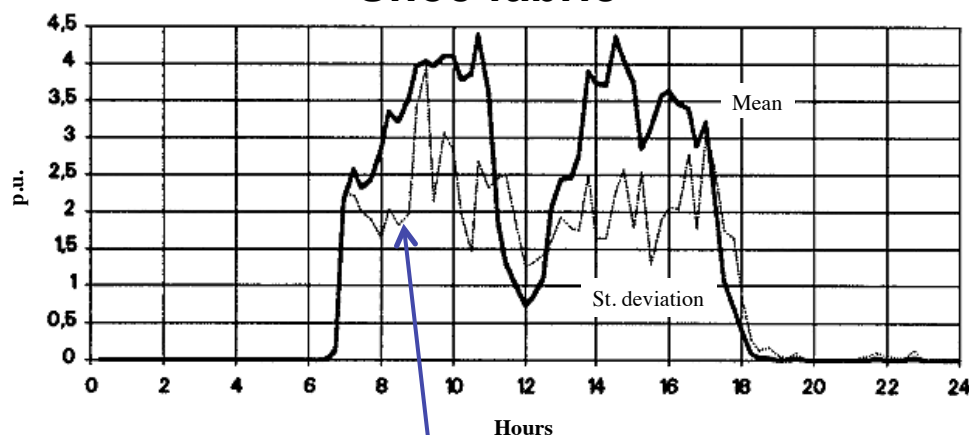
## End-use of electricity in industrial sector



## Industrial Load Curves

Due to the complexity and diversity in the load profiles that makes difficult to find a common pattern for grouping them

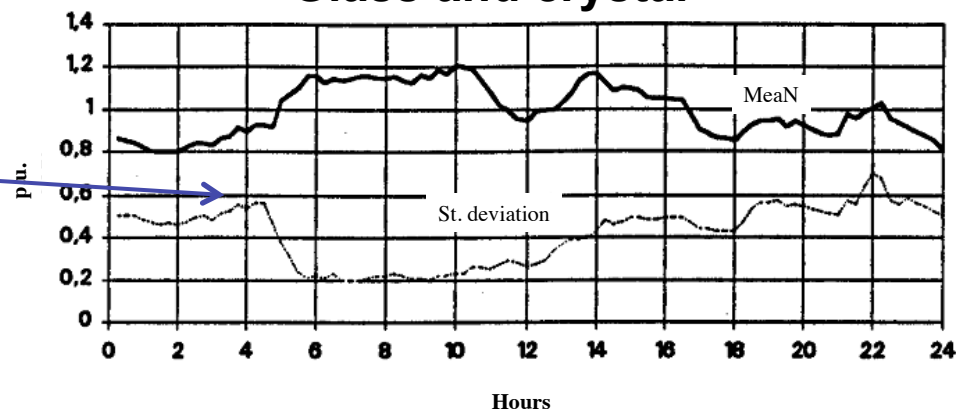
**Shoe fabric**



### High standard deviation

Presence of small size motors with an intermittent mode of operation during the day

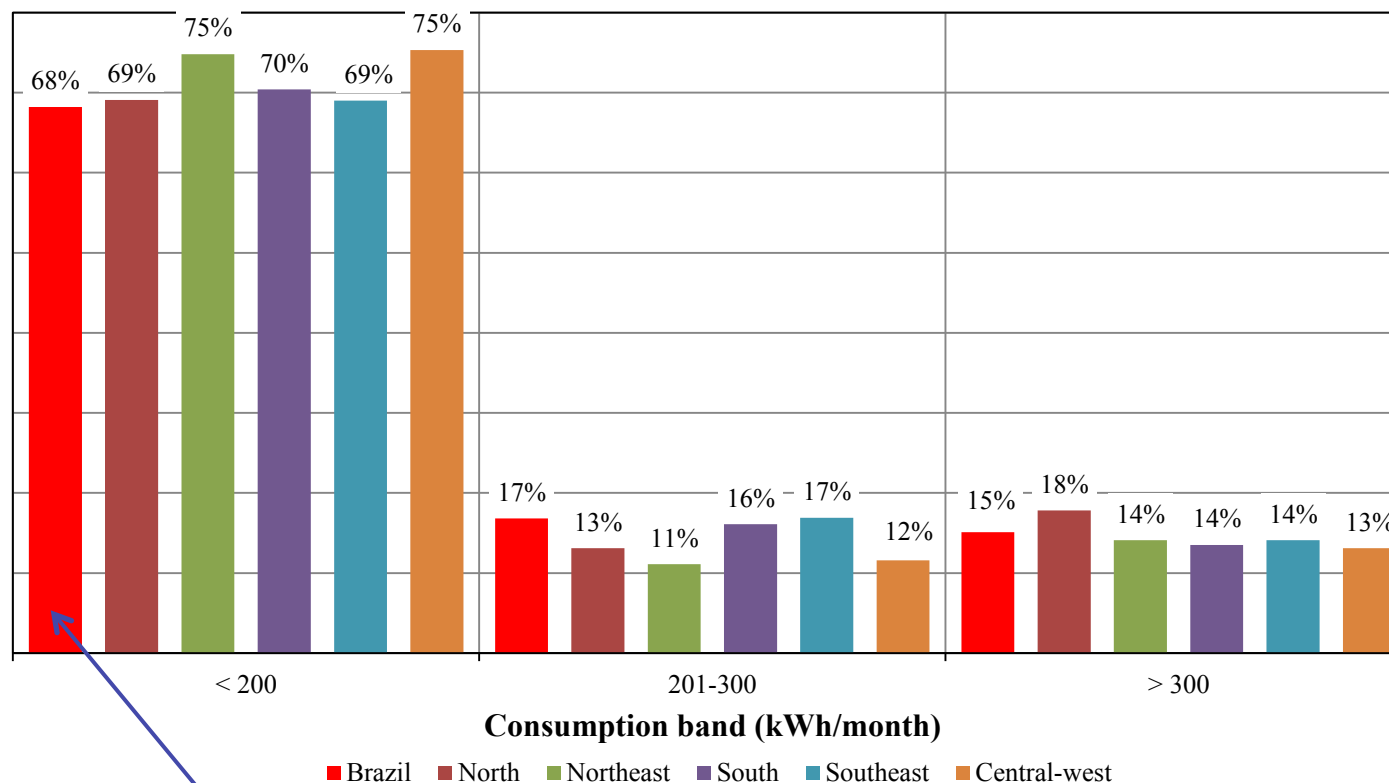
**Glass and crystal**



# THE RESIDENTIAL SECTOR

Represents **24.2%** of total electricity consumption in Brazil

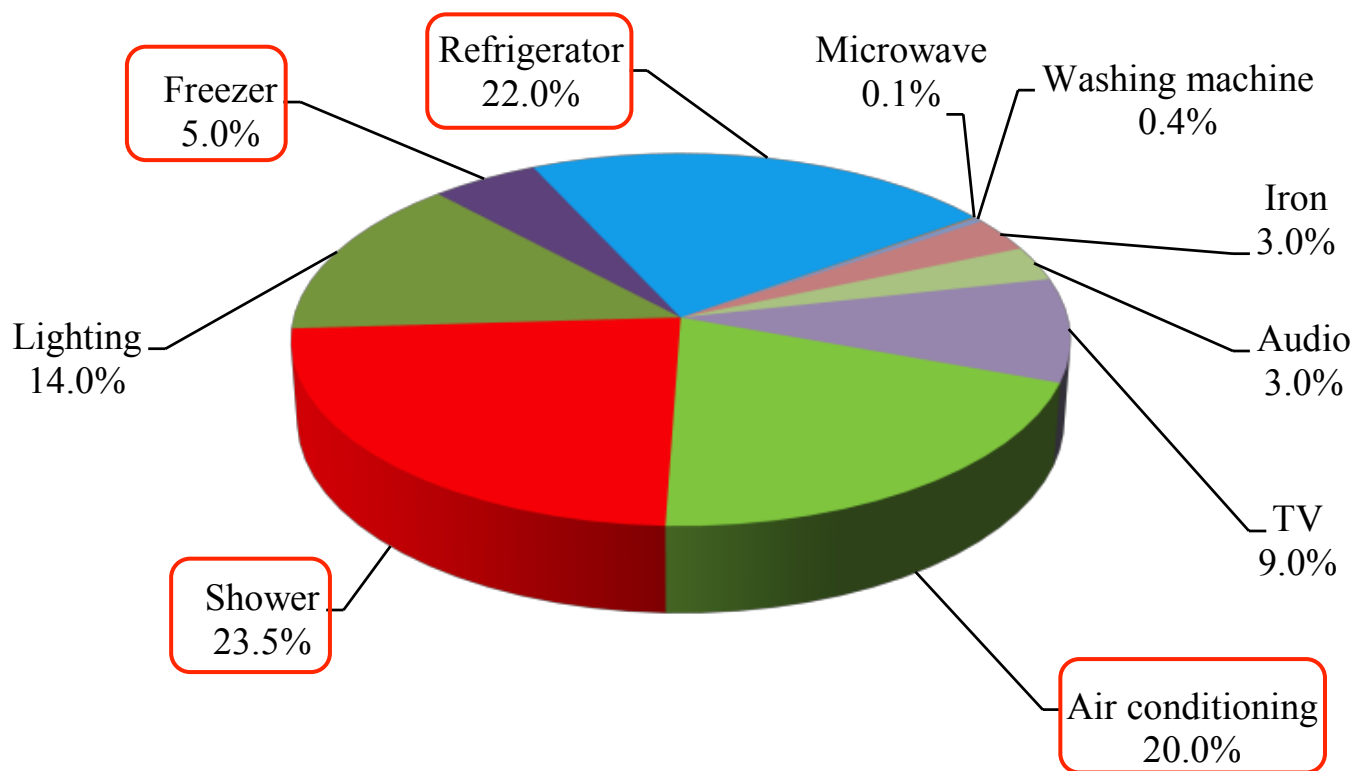
## Residential consumers per consumption band



**68%** of households consume less than **200 kWh/month**

USA → 975 kWh/month  
Germany → 300 kWh/month

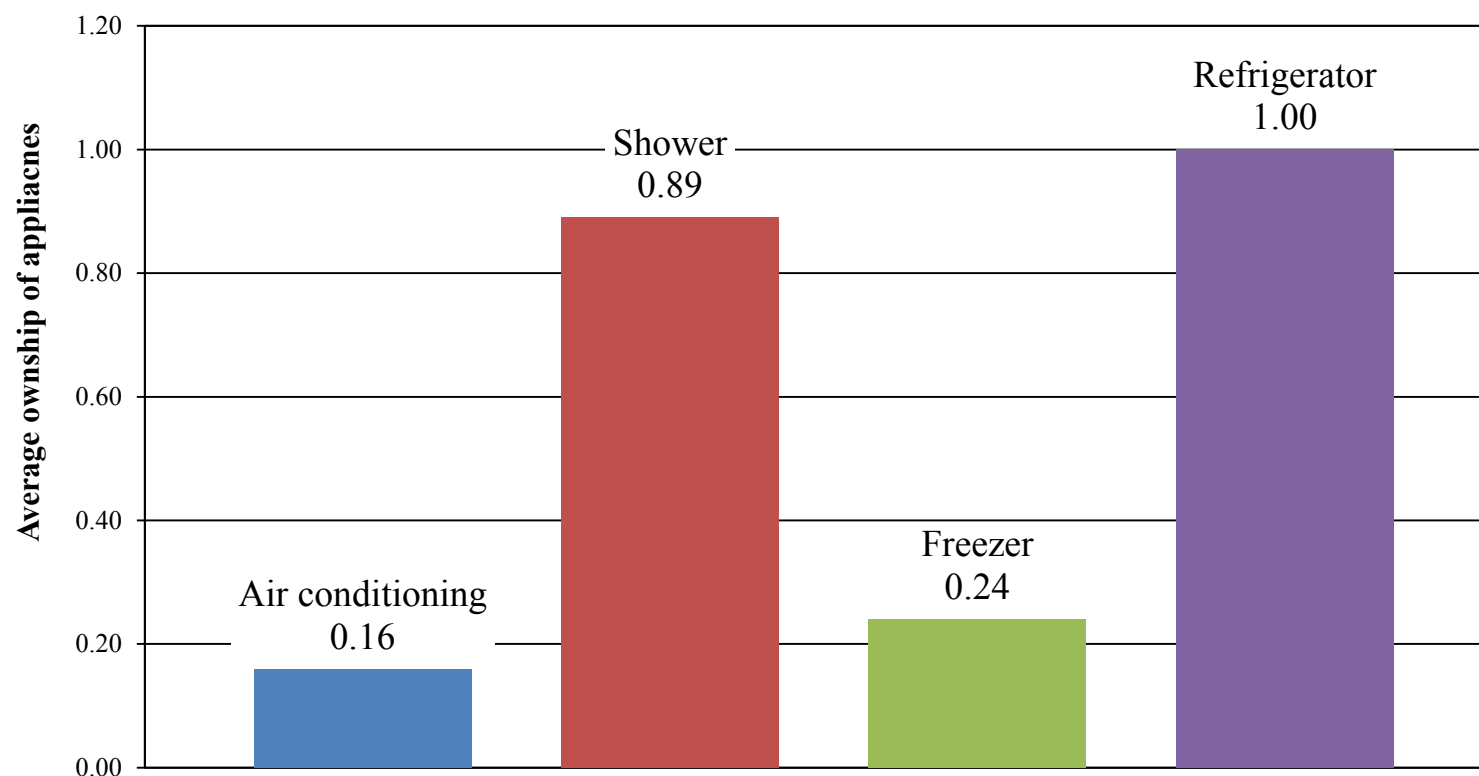
## Participation of main household appliances



Refrigerator and freezer  
Electric shower  
Air-conditioning

**70.5% in Brazil**

## Average electric appliance ownership in Brazil



Refrigerator → **saturation level**

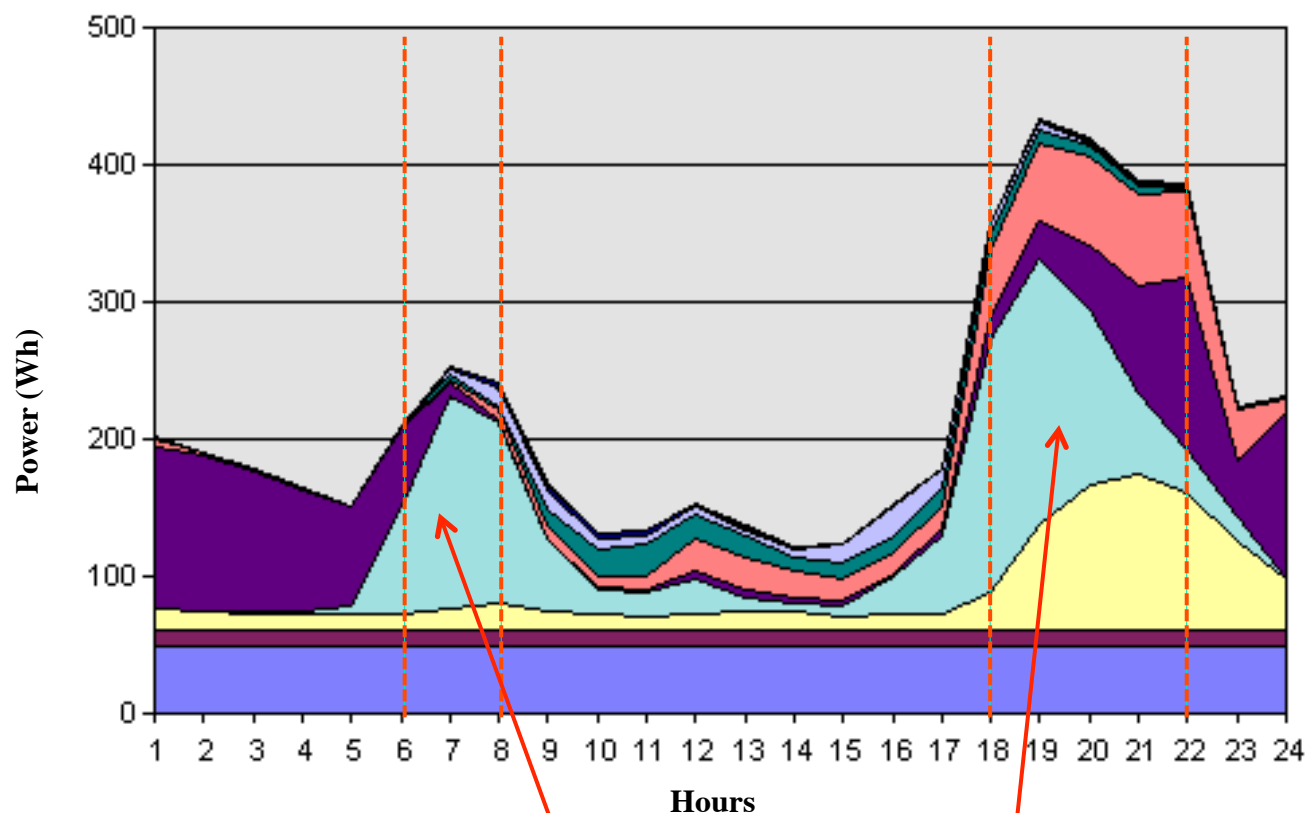
Shower → **mainly used in South, South-east and Central-west regions**

Air-conditioning and freezers → **expectation of future growth**

## Average daily load curve for Brazil

Two characteristic periods of peak consumption

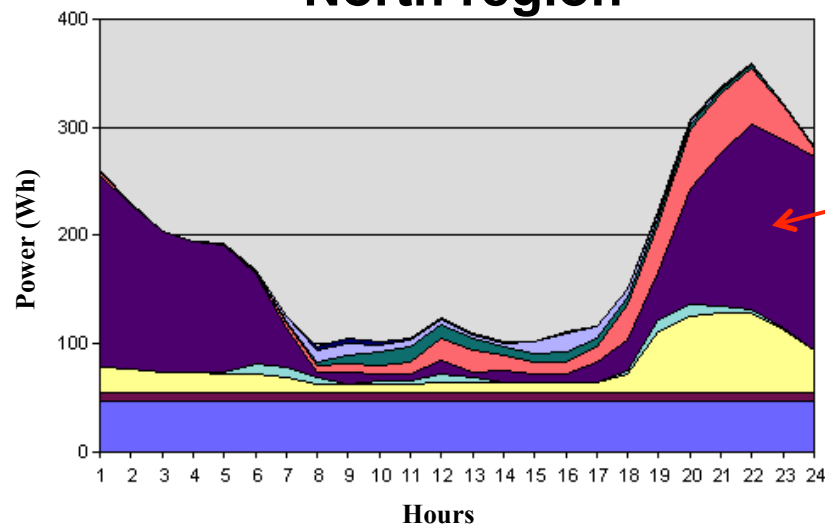
- Microwave
- TV
- Washing machine
- Air conditioning
- Freezer
- Iron
- Electric shower
- Refrigerator
- Audio
- Lamps



Electric shower represents ~50% of demand

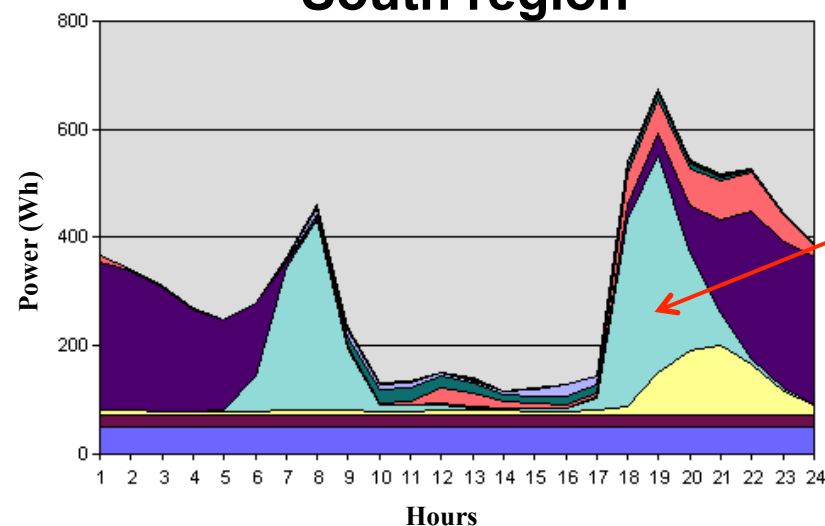
# Load Profile: Residential Sector

## North region



**Air conditioning system**  
contributes more  
extensively

## South region



**Electric shower**  
contributes more  
extensively



# SUMMARY

- Brazil relies mostly on Large Hydro Power Plants far from the consumers centers. (Hydro electricity  $\approx$  70%)
- Long transmission lines (100,000 km); High Losses (14%)
  - National Interconnected System (97%)
  - Isolated Systems (3%)
- Brazil is divided into five geopolitical regions
  - The largest region (North) has the lowest consumption (6.5%)
  - The Southeast region has the highest consumption (50%)

- The **industrial sector** accounts for 41% of total electricity consumption in Brazil (mainly motors).
  - 26 typical profile daily load curves (according to the segment)
- The **residential sector** accounts for 24% of total electricity consumption in Brazil (mainly electric showers and air conditioners).
  - Electric shower contributes with roughly 10% of the global evening peak load.
  - Replacement of electric shower for more efficient water heating systems represents a huge potential for electricity savings.
- The **commercial sector** accounts for about 16% of the total Brazilian electricity consumption.
  - Four typical profile daily load curves.

# Thank you

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