Dollars and "Sense" of Electricity Market and Pricing

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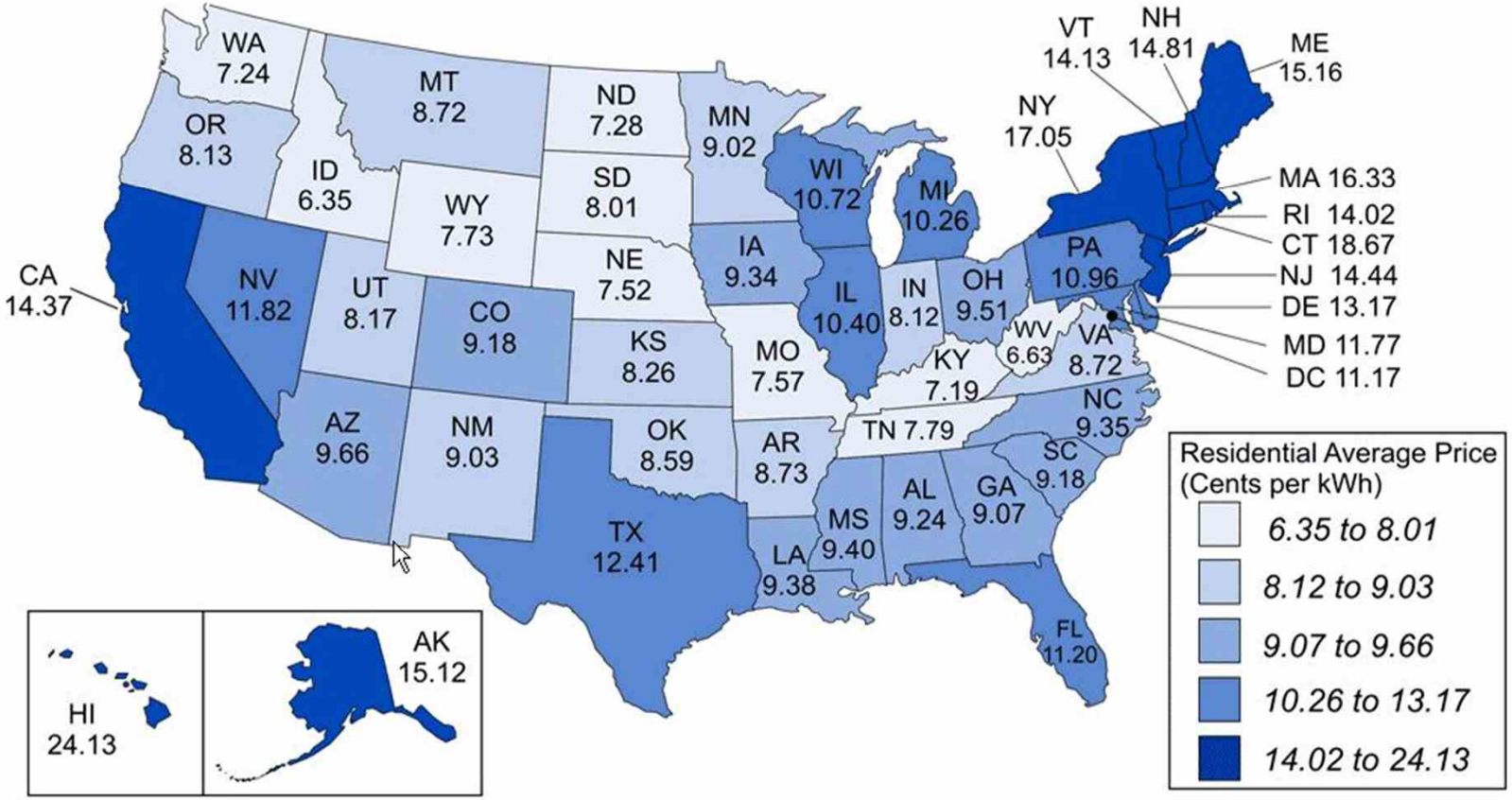
EGEN 598: Renewable Energy & Power Transmission

February 14, 2011

The U.S. average residential retail price of electricity was 10.64 cents per kilowatthour in 2007.



Source: Energy Information Administration, Form EIA-826, "Monthly Electric Sales and Revenue with State Distributions Report."

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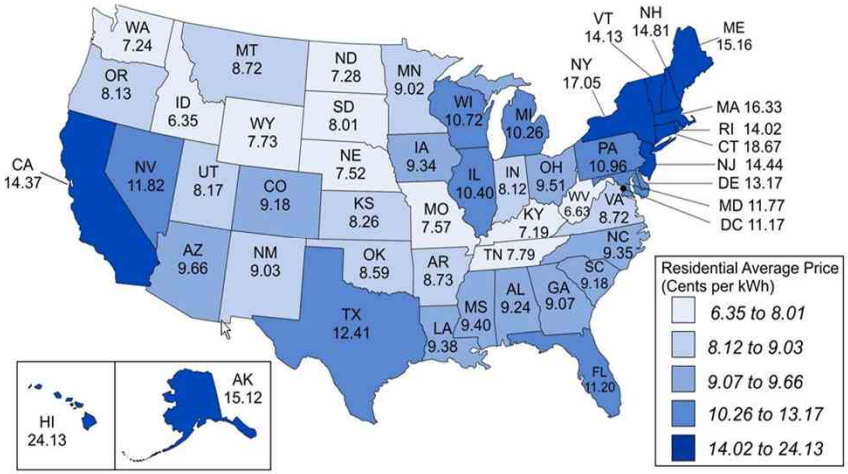


Source: Energy Information Administration, Form EIA-826, "Monthly Electric Sales and Revenue with State Distributions Report."

Electricity Prices Vary by Locality

Prices vary over time and by locality due to the availability of power plants and fuels, local fuel costs, and pricing regulation and structures.

The three States with the highest average price of electricity in 2007 were:

- Hawaii (21.29¢ per kWh)
- Connecticut (16.45¢ per kWh)
- New York (15.22¢ per kWh)

Those with the lowest average prices in 2007 were:

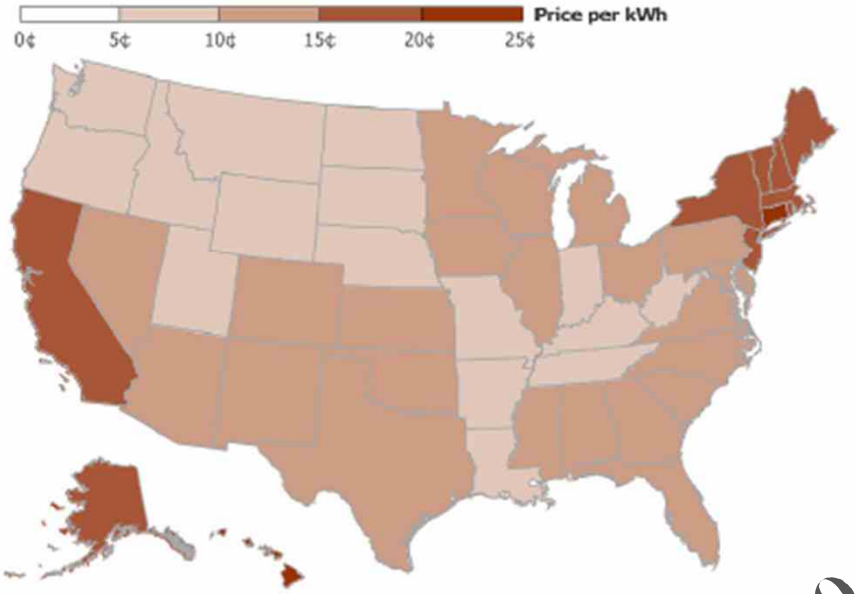
- Idaho (5.07¢ per kWh)
- Wyoming (5.29¢ per kWh)
- West Virginia (5.34¢ per kWh)

On average, electricity prices are highest in Hawaii, mainly because most of the electricity there is generated with fuel oil. Idaho usually has the lowest prices mainly because of the availability of low-cost hydroelectric power from Federal dams.

February 13, 2011

U.S. Residential Electricity Prices Rise 1.8 Percent in May

Average Residential Electricity Prices, By State



SOURCE: U.S. ENERGY INFORMATION ADMINISTRATION
GRAPHIC CREDIT: SOLAR HOME & BUSINESS JOURNAL

Published Aug. 14, 2010

The average U.S. residential retail price of electricity increased in May to 11.96 cents per kilowatt-hour from 11.75 cents per kwh in April, according to the monthly electricity report compiled by the U.S. Energy Information Administration.

Colorado:

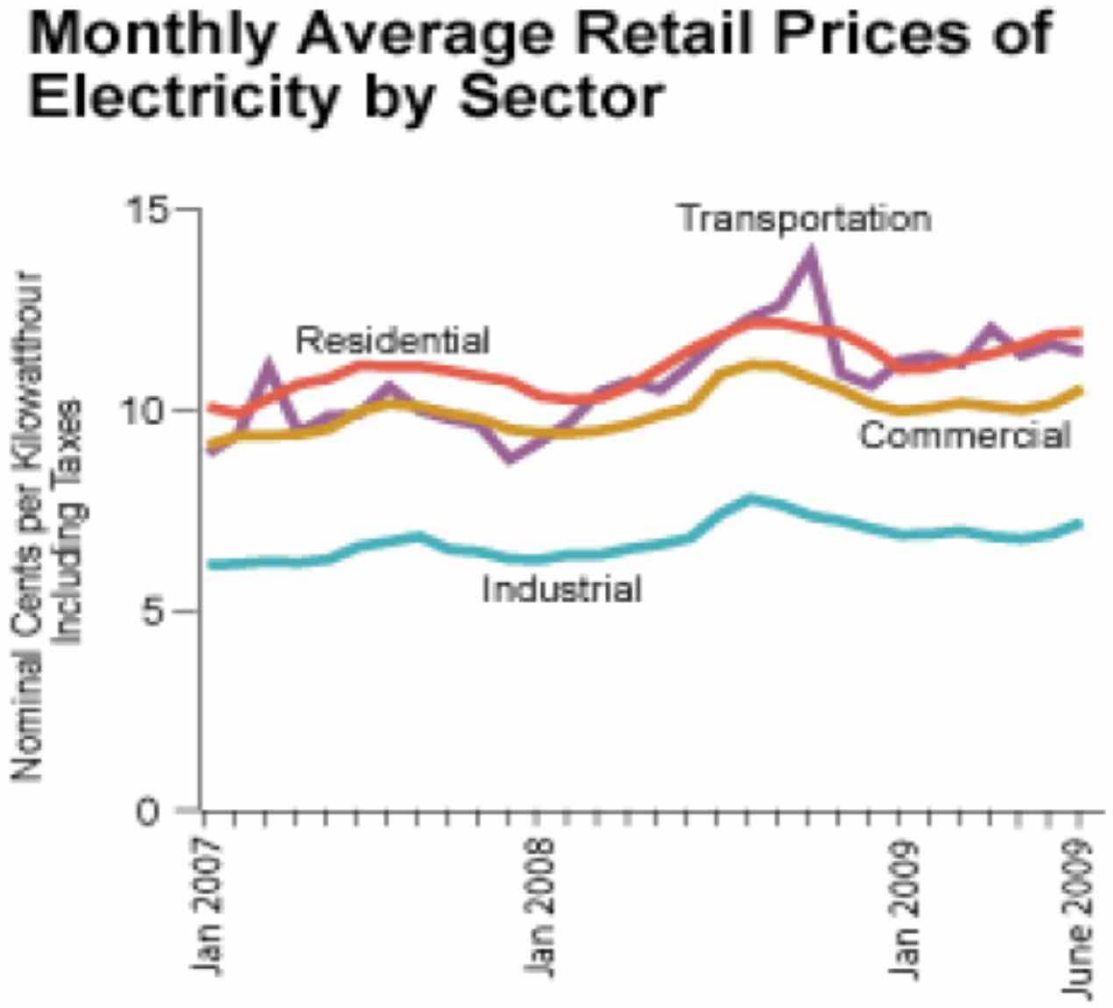
9.18 ¢/kWh [2007]
11.52 ¢/kWh [2010]

25% Increase

10.64 Cents in 2007 In USA

http://solarhbj.com/news/us-residential-electricity-prices-rise-18-percent-in-may-0834

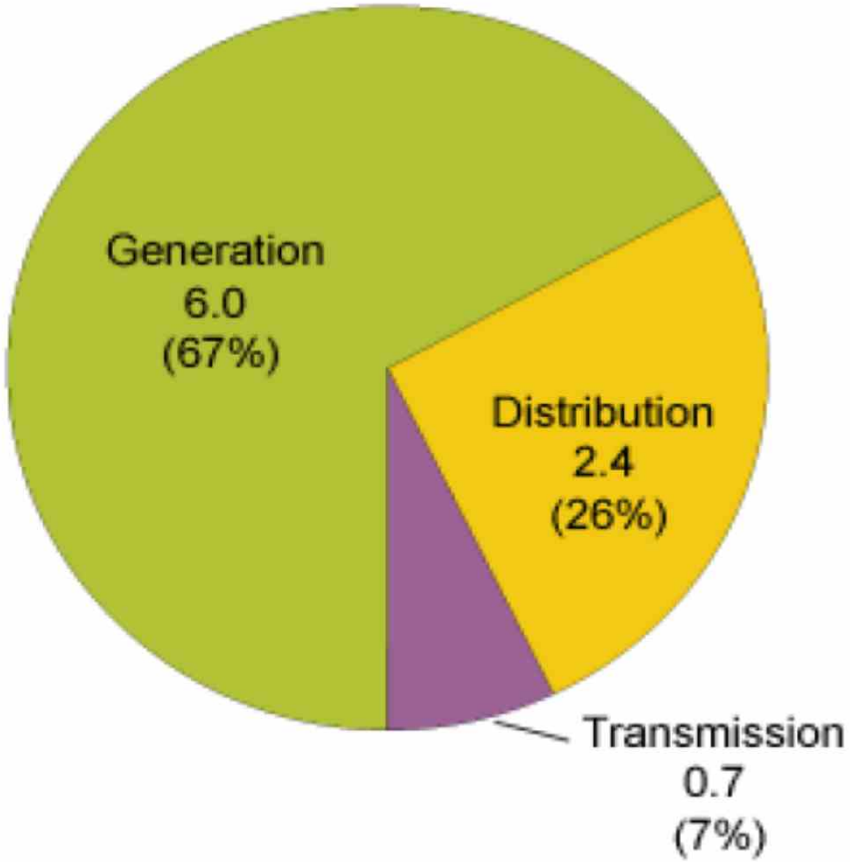
Electricity prices tend to rise in the summer and fall in the winter.



Source: Energy Information Administration, *Monthly Energy Review*, Table 9.9: Average Retail Prices of Electricity (September 24, 2009).

The cost of generating electricity is the largest component of the price of electricity.

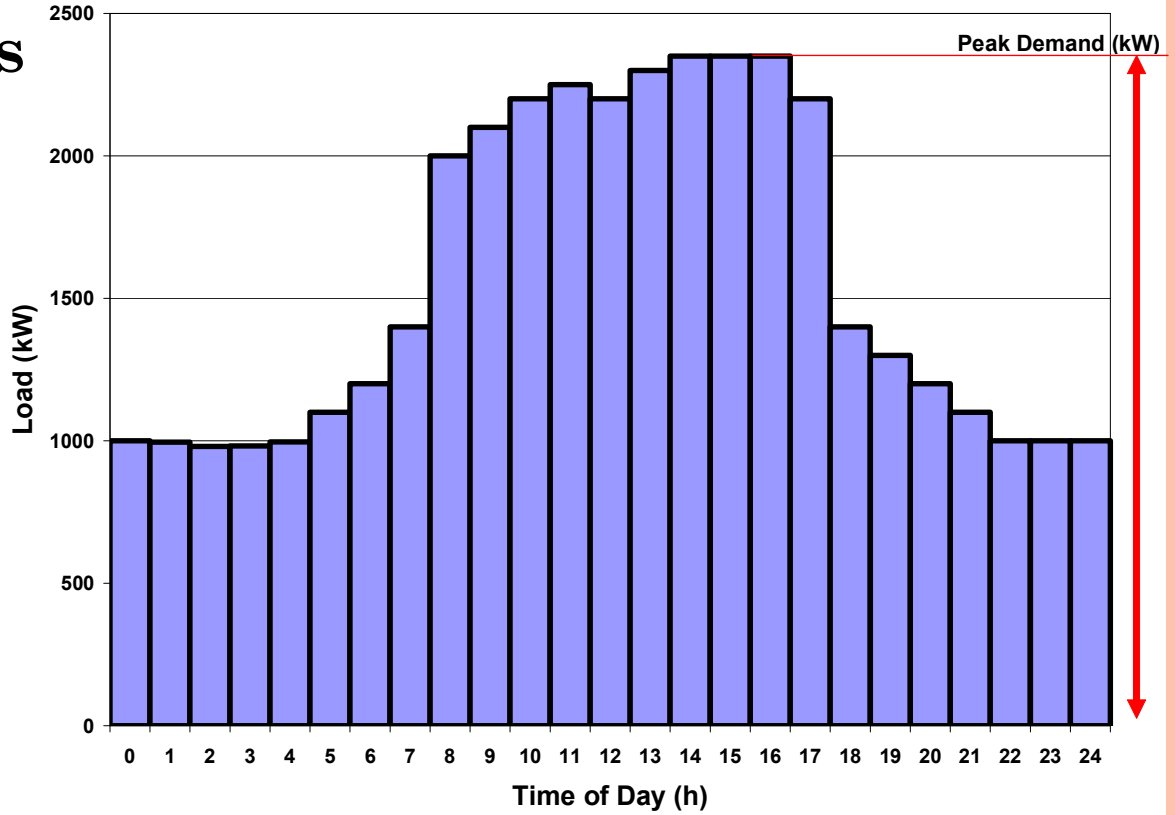
Major Components of U.S. Average Electricity Price, 2007
(Cents per KWh and Share of Total)



Source: Energy Information Administration, *Annual Energy Outlook 2009*, Updated Reference Case, Table A8: Electrical Supply, Disposition, Prices, and Emissions, Prices by Service Category (2009).

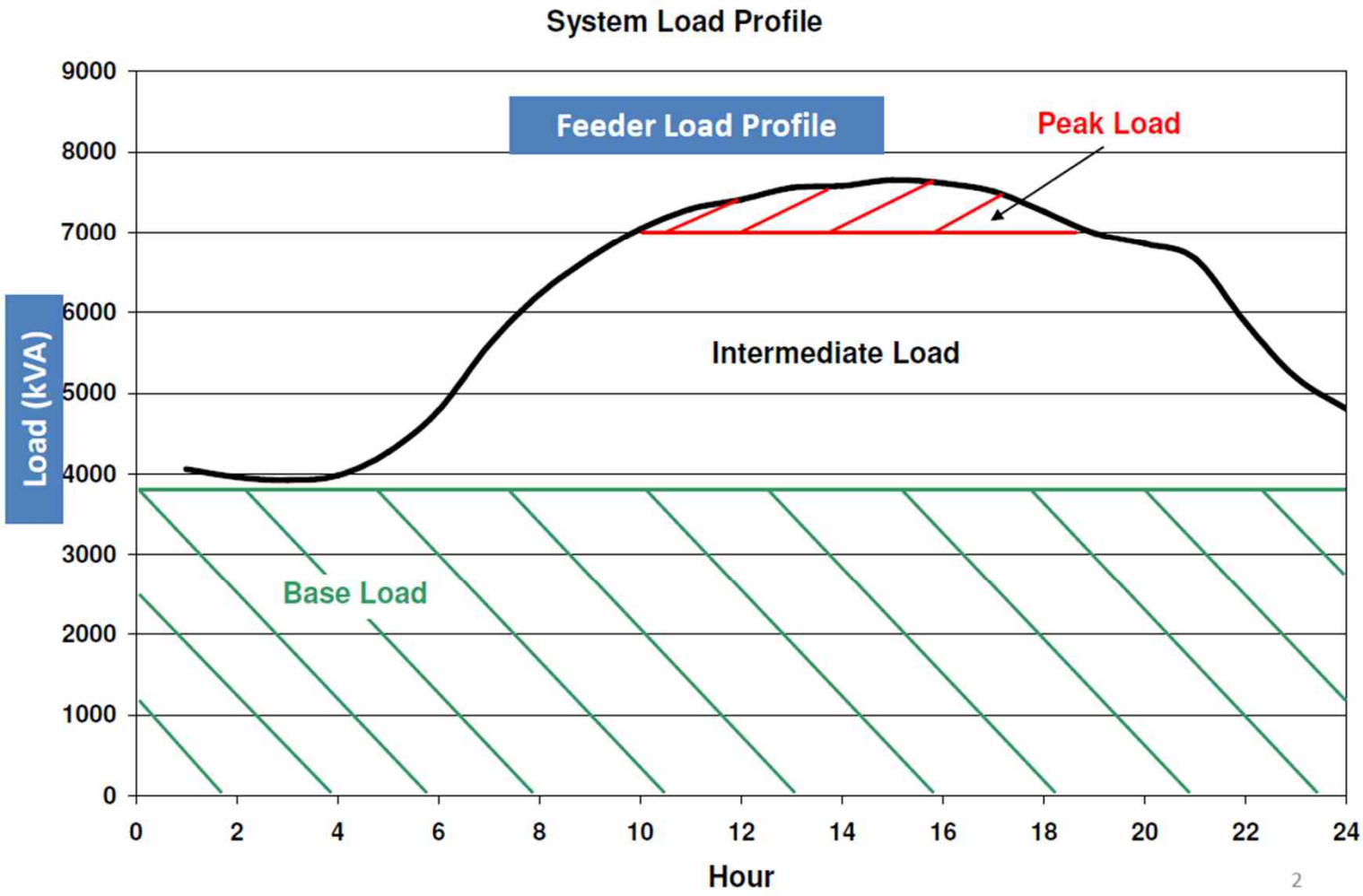
Electricity Pricing

- **Residential Rates**
  - Energy Charge (kWh)
- **Commercial Electricity Rates** [Several Components]:
  - Energy Charge (kWh)
  - Demand Charge (kW)
  - Power Factor Clause
  - Ratchet Clause

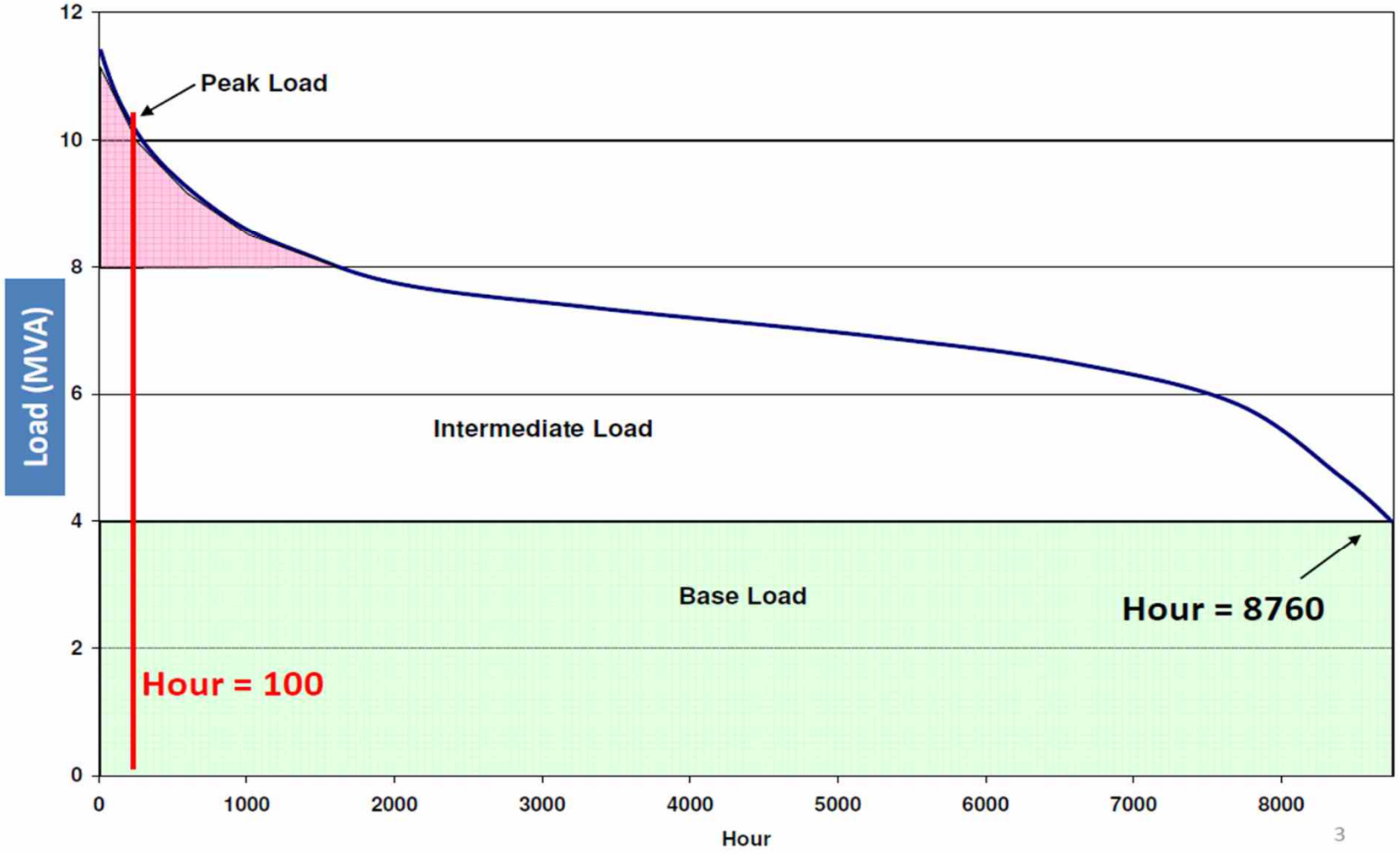


Need to Understand Differences Between Commercial and Residential Rate Structures

Daily Load Profile



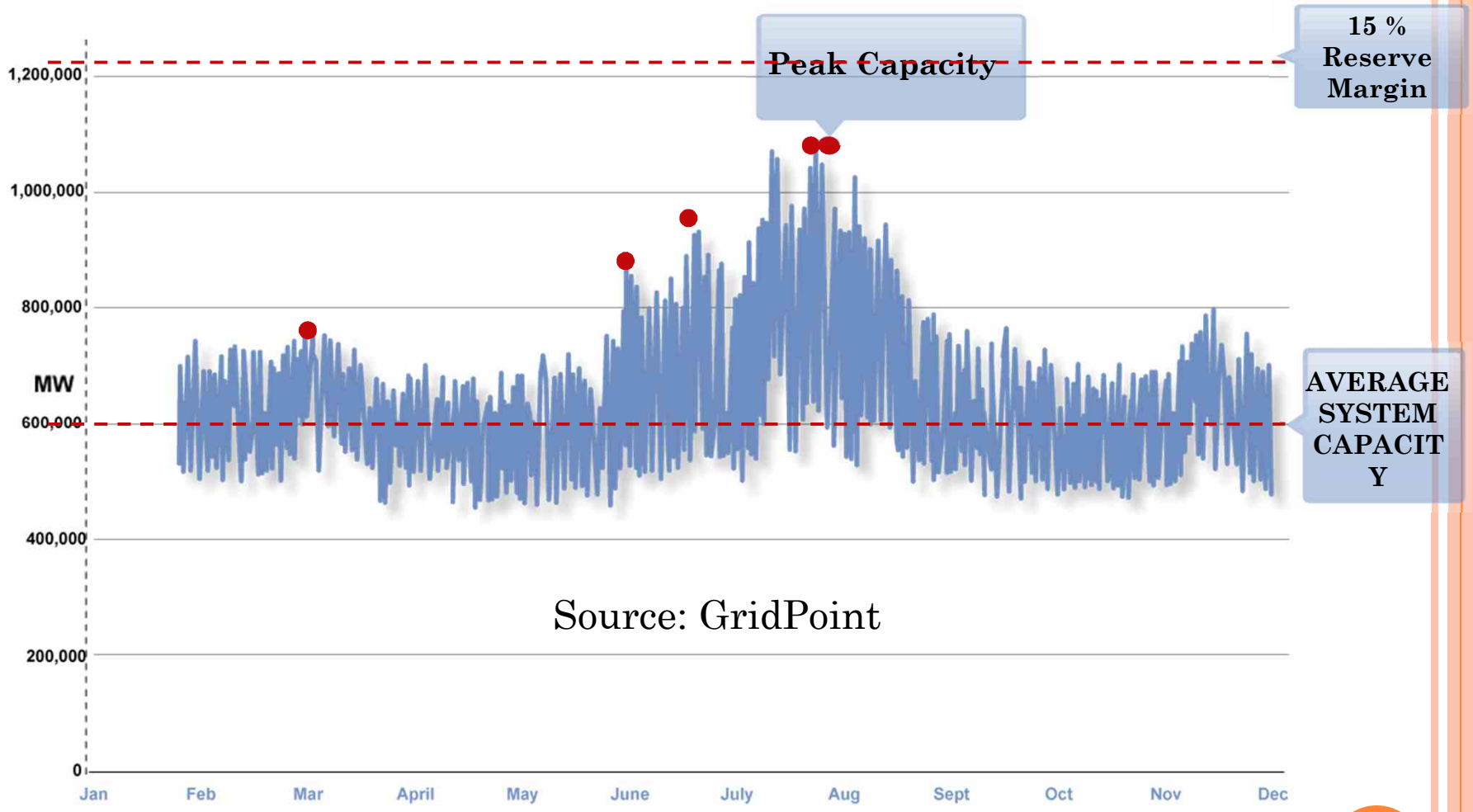
Feeder Load Duration Curve (LDC)



Typical Load Cycle:

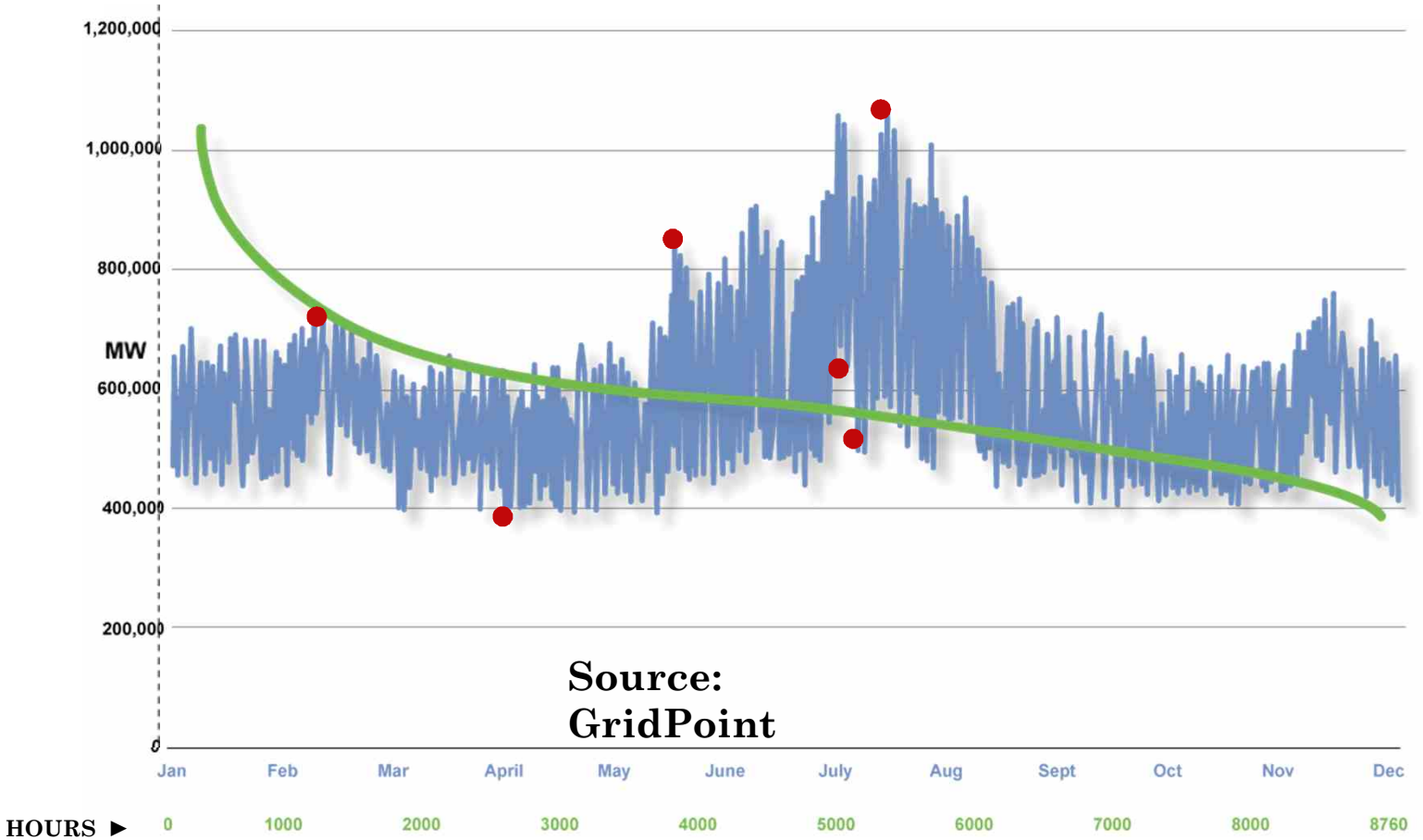
- Base Load
- Intermediate Load (typically runs between 2,000-5,000 hrs./year)
- Peak Load (typically runs between 100-2,000 hrs./year)

YEARLY LOAD PROFILE (USA)

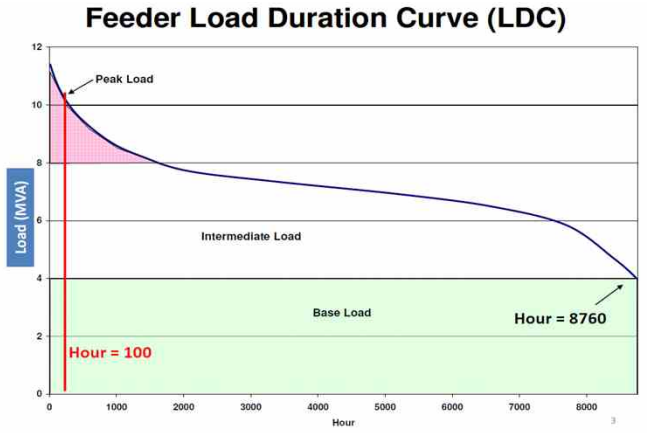


Source: GridPoint

LOAD DURATION CURVE (LDC)



Electricity Pricing:

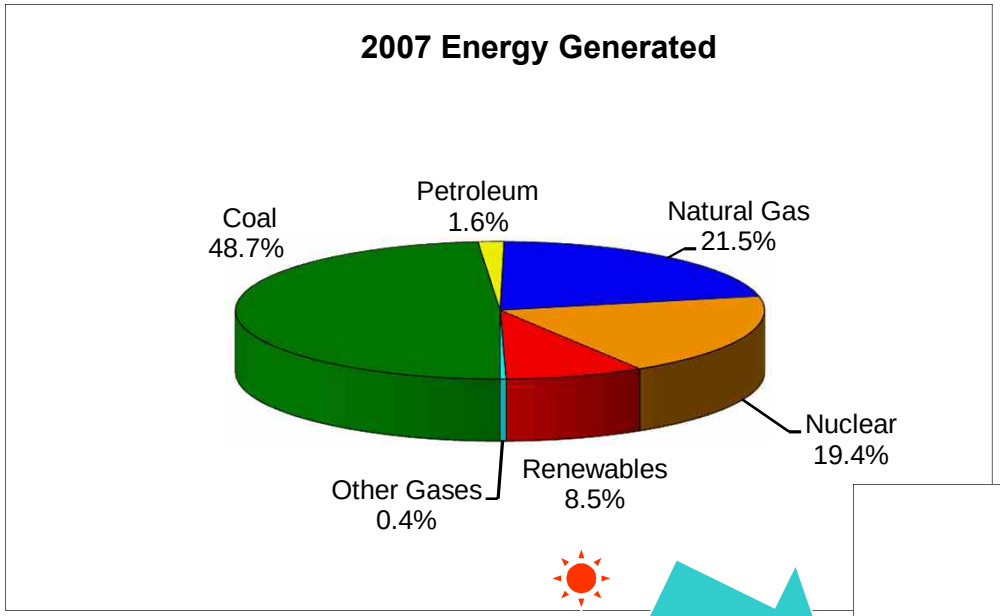


- **Fixed Costs (Capital Cost + "Fixed" Operations & Maintenance (O&M), etc.)**
- **Variable Cost (Fuel Cost + "Variable" Operation & Maintenance (O&M), etc.)**

- **Fixed Cost ($/yr-kW) = Capital Cost ($/kW) x Fixed Charge Rate (FCR) /yr**
- **Variable Cost ($/yr-kW) = [Fuel ($/Btu) x Heat Rate (Btu/kWh) + O&M ($/kWh)] x [hr/yr]**

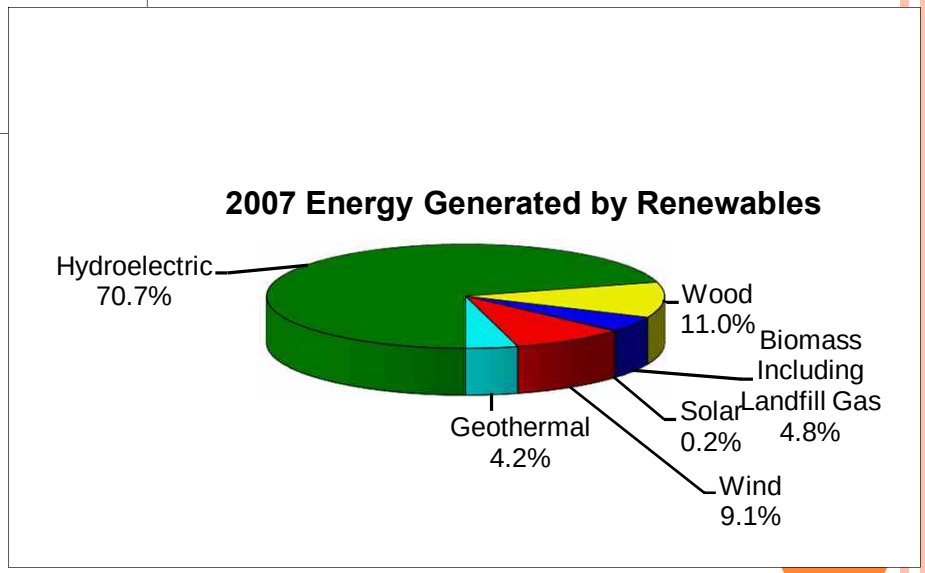
Ref: DOE/EIA-0384(2007), June 2008

4,167Million MWh ≈ 4,200TWh



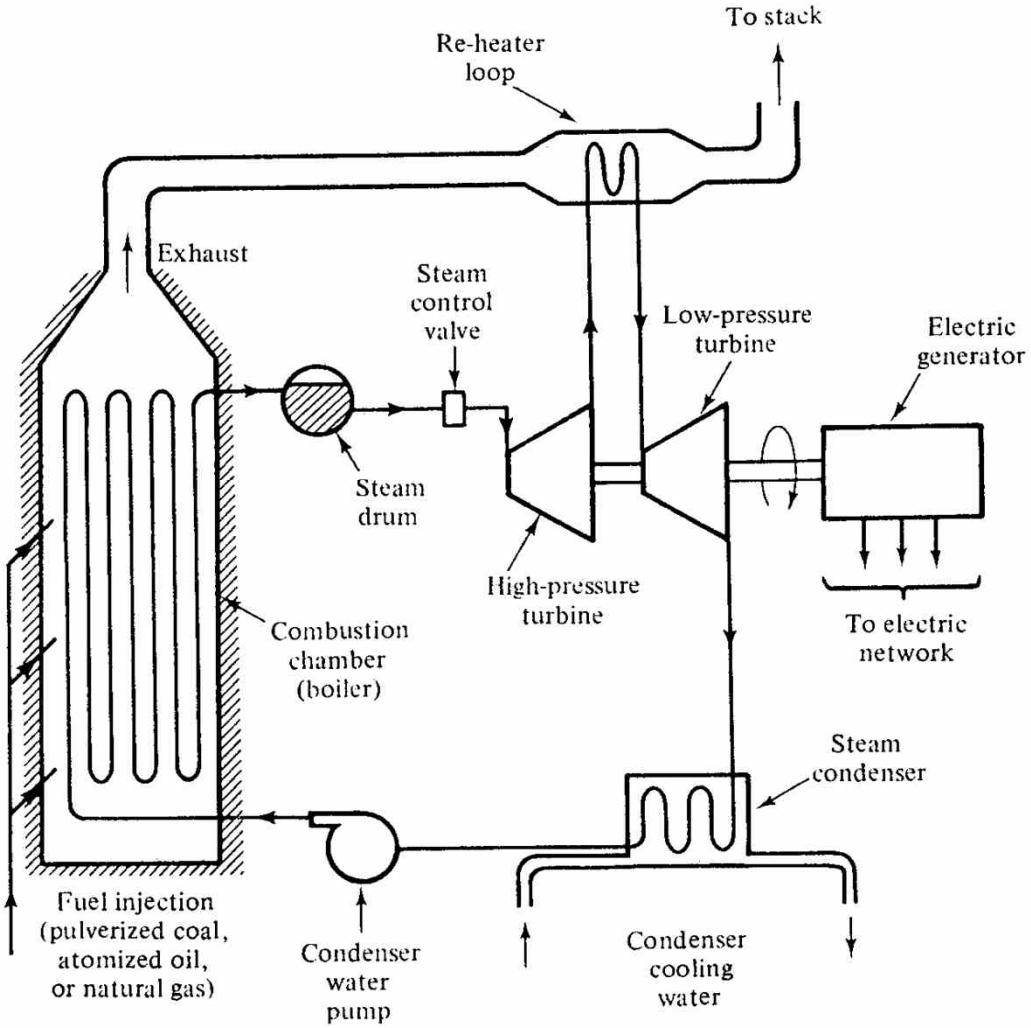
2007

Energy Production



COAL-FIRED POWER PLANT

Air Pollution



Characteristics:

- Low Thermal Efficiency ≈ 35%
- Thermal Pollution (Condenser)
- Air Pollution (Stack)
- **Base-Load** (Long Time to Start and Stop)
- Larger Units (300 - 800 MW) Economical
- ?? Years to Build
- Environmental Impact Study?
- ≈ 50% of Total Energy in US

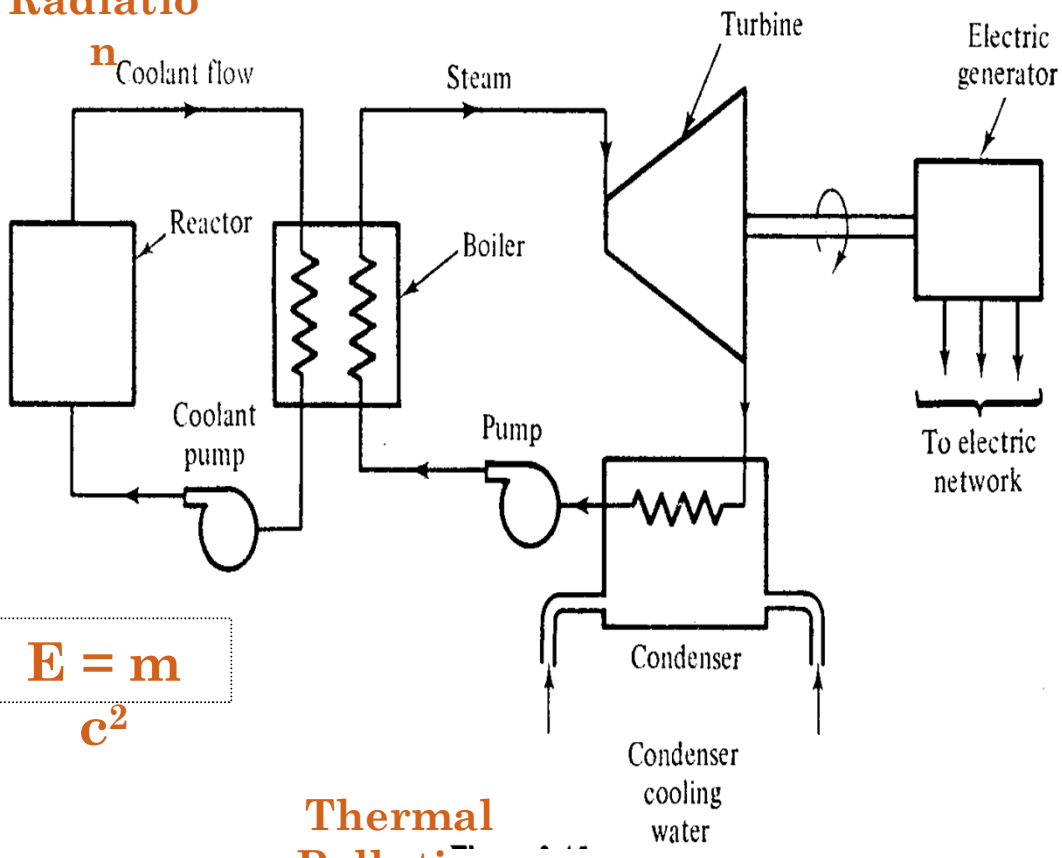
Coal / Fuel

(Chemical Reaction)

Thermal Pollution

Nuclear Power Plant

Radiation



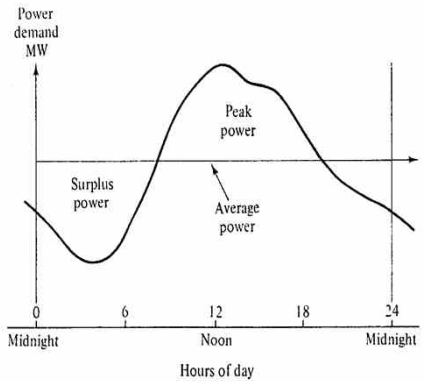
$E = mc^2$

Thermal Pollution

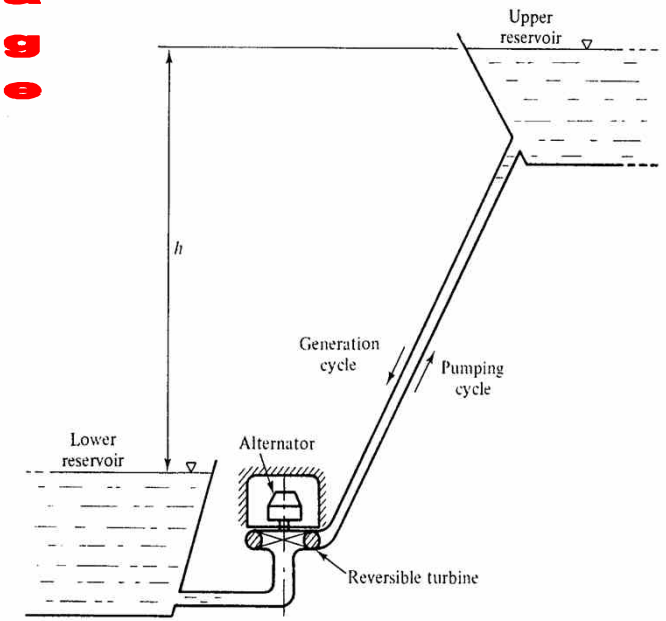
Characteristics:

- Low Thermal Efficiency ≈ 35%
- Thermal Pollution (Condenser)
- Radiation Leaks
- **Base-Load** (Long Time to Start and Stop)
- Larger Units (1,000 -1,200 MW) Economical!!!
- ?? Years to Build
- Environmental Impact Study?
- ≈ 20% of Total Energy in US

Hydroelectric Power Plant



Pump Storage



Characteristics:

- Efficiency ≈ 85-90%
- Simple, High Initial Cost,
- **No Fuel Cost**,
- Base-Load, Intermittent & Peaking Units
- Controllability
- Pumped Storage
- Unit Sizes (50 - 600 MW)
- Mostly Built
- Environmental Impact ?
- ≈ 6% of Total Energy in US

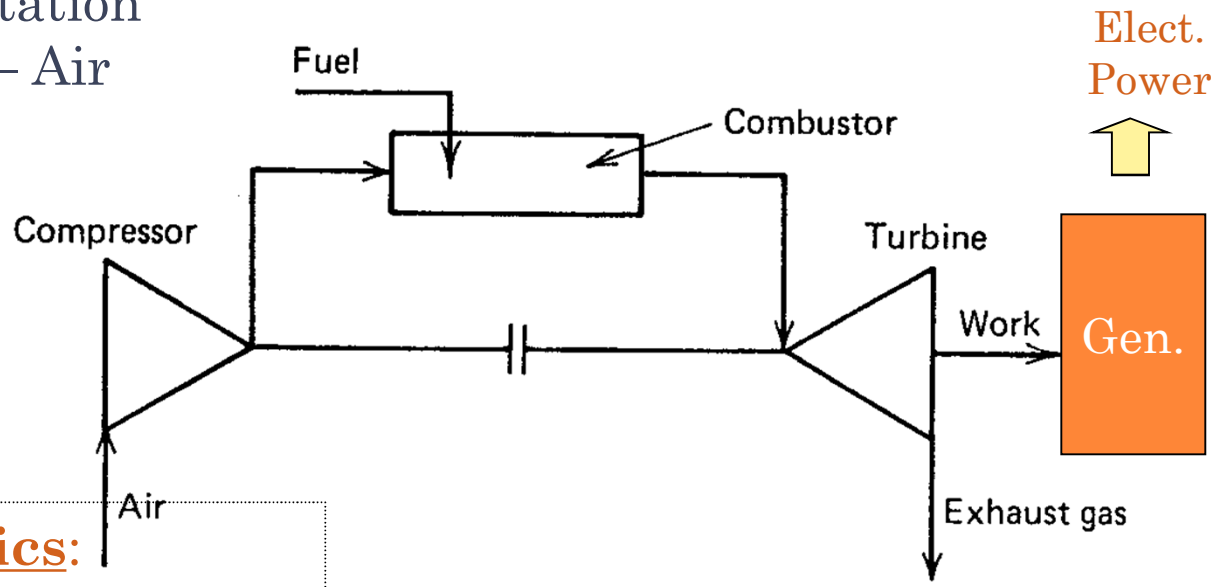
Potential Energy = mgh

Mostly Developed

Gas Turbine System

Heat Transportation Medium – Air

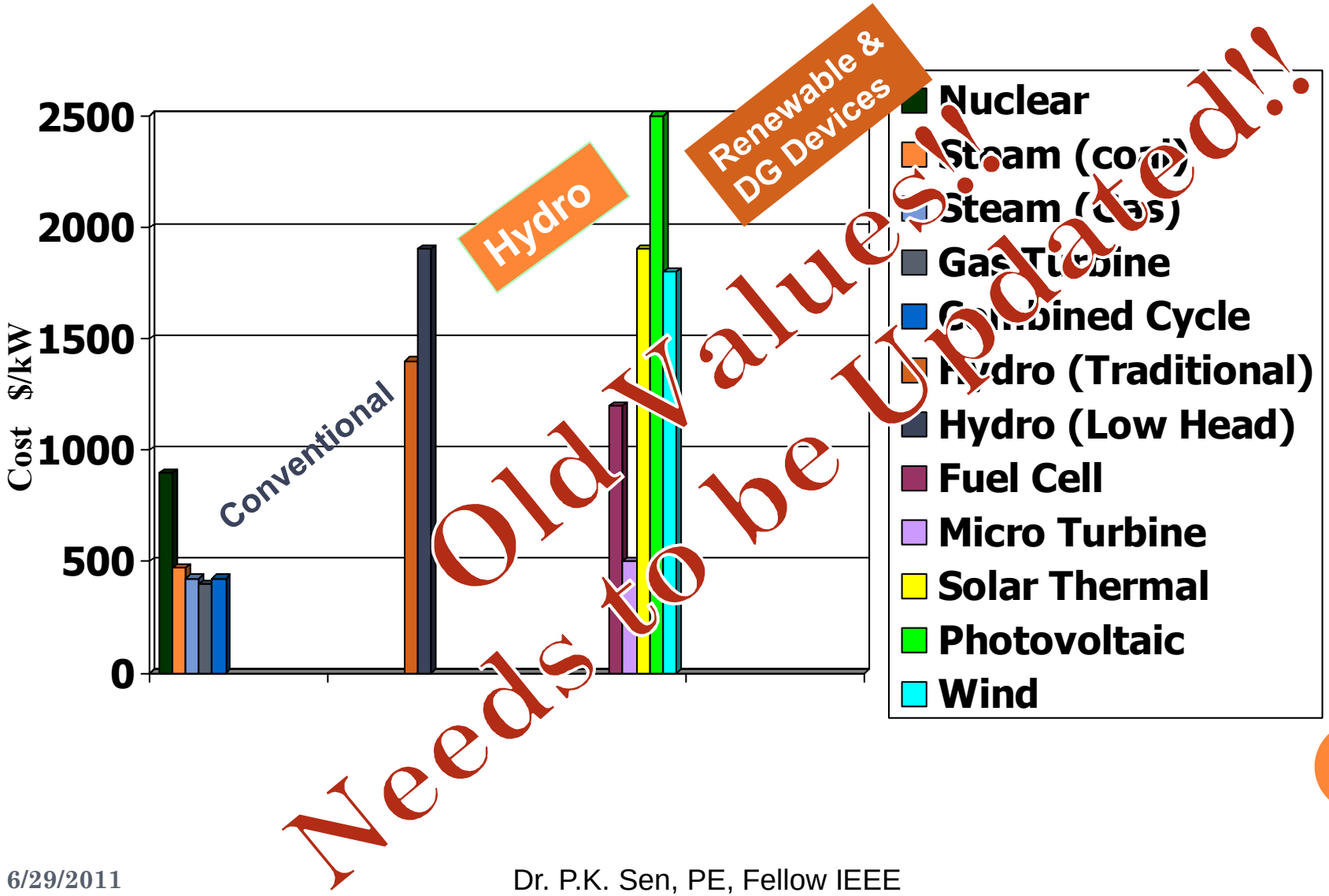
Major Components



Characteristics:

- Thermal Efficiency ≈ 35%
- **Peaking-Unit** (Quick Start and Stop)
- Unit Sizes (10 - 300MW)
- 6-12 months to Build
- Environmental Impact Study?
- ≈ 20% of Total Energy in US

CAPITAL COST COMPARISON



FACTS
POWER PLANTS

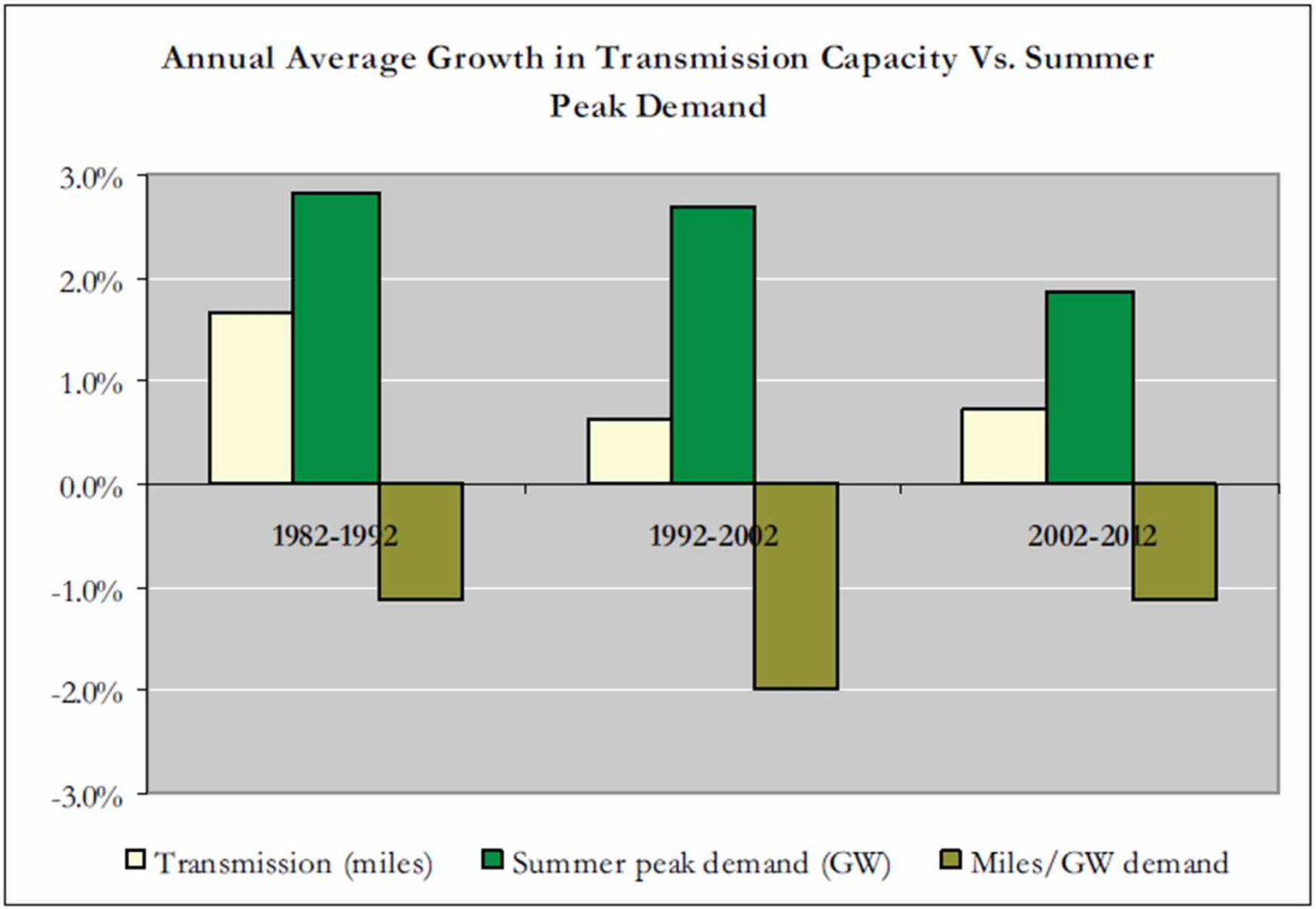
Cost Breakdown

- **Generation (Power Plants)**
  - **40-50%**
- **Transmission (Bulk Power 115 kV and Above)**
  - **15-20%**
- **Distribution (69 kV and Below)**
  - **30-35%**
- **Miscellaneous**
  - **3-5%**

- **Capital Investment Cost**
  - **$ 500 - $ 3,000 / kW**
- **Construction Period**
  - **6 months - 10+ years**
- **Environmental Impact Study**
  - **2 - 5+ years**

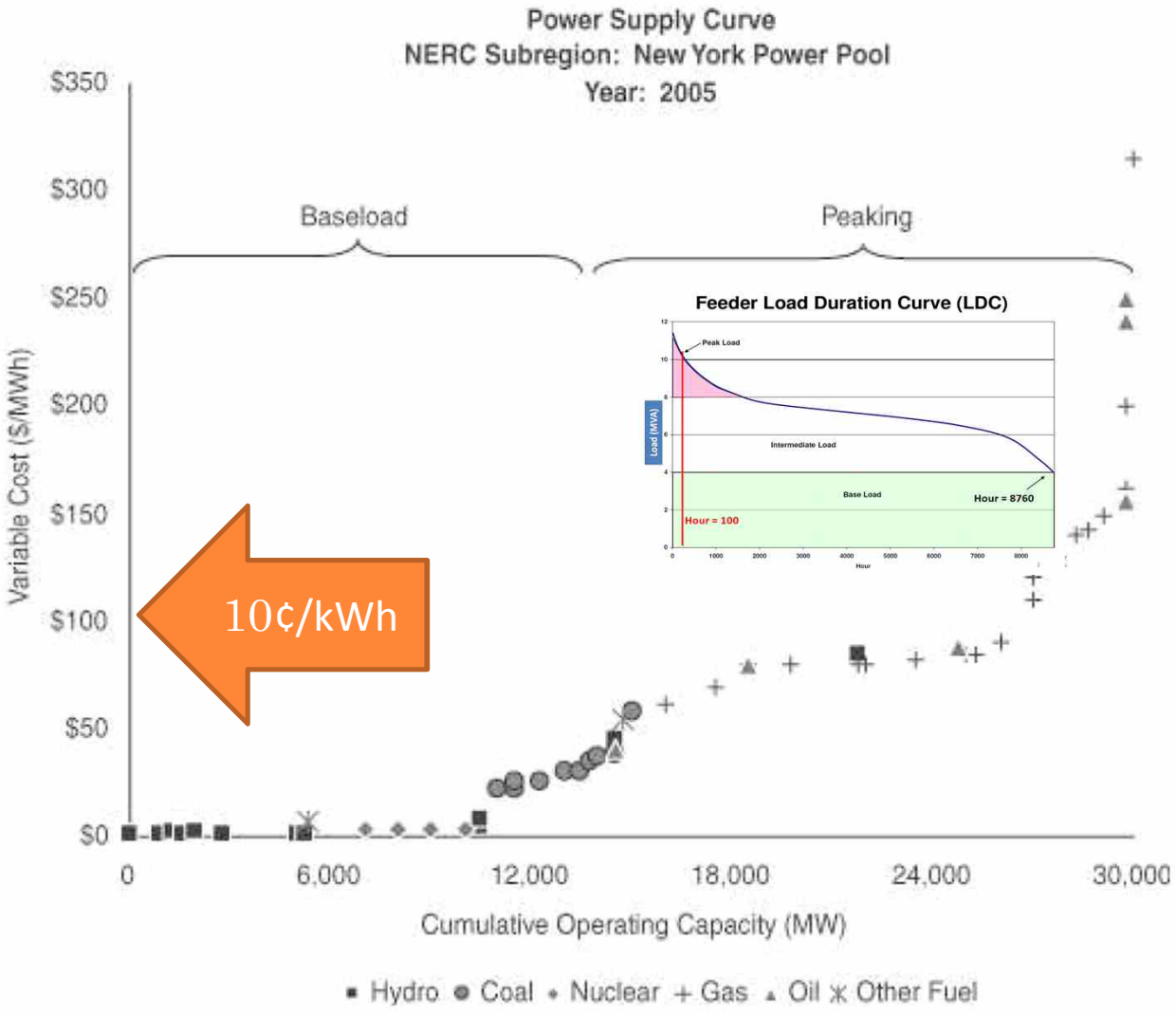
The Regulatory Side of Electric Power:

- PUHCHA [1935]
- PURPA [1978]
- EPAct [1992]
- FERC Order 888 and 2000
- EPAct [2005]
- Energy Independence and Security Act [2007]



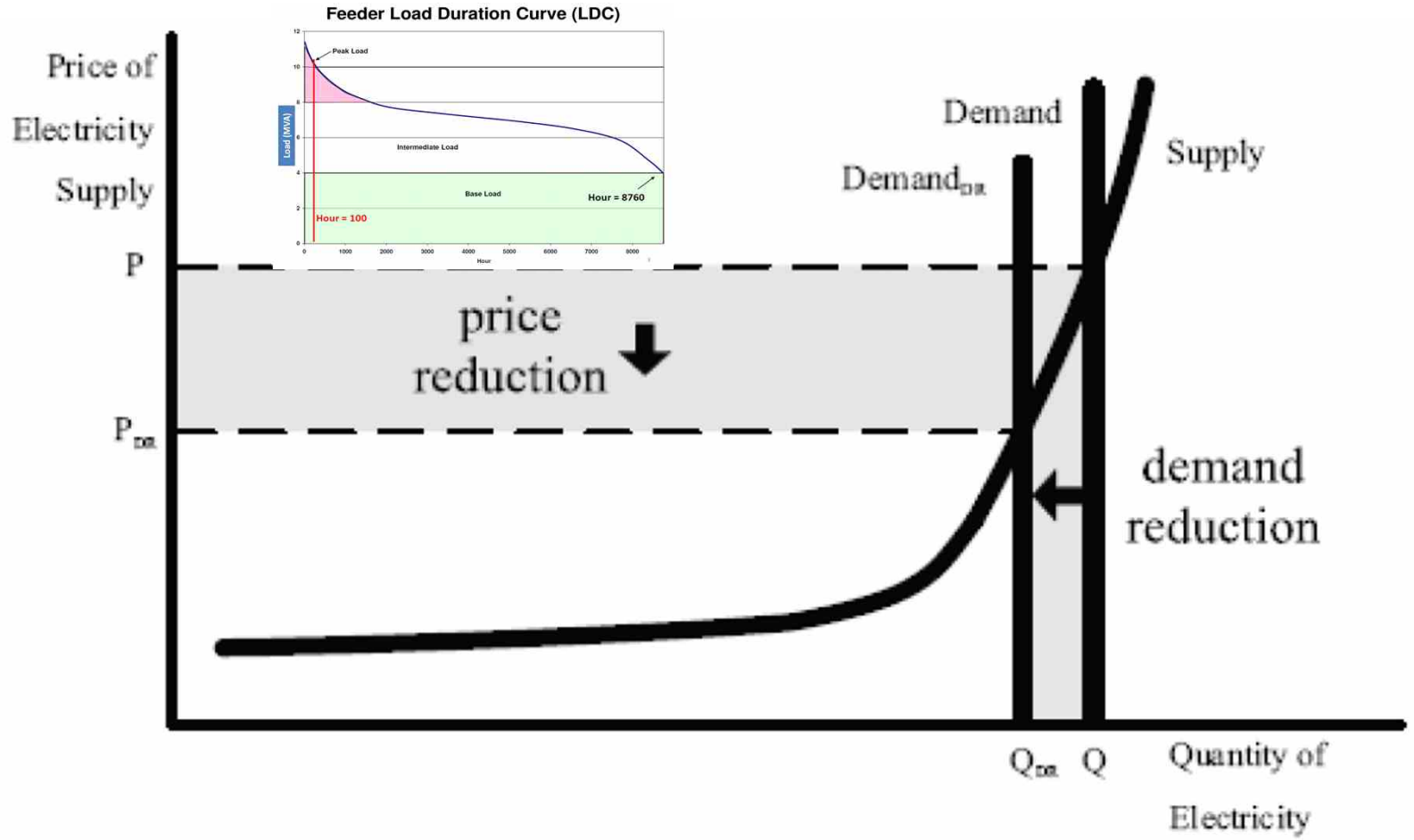
Source: U.S. Department of Energy

2005 Cost Structure for the New York Power Pool



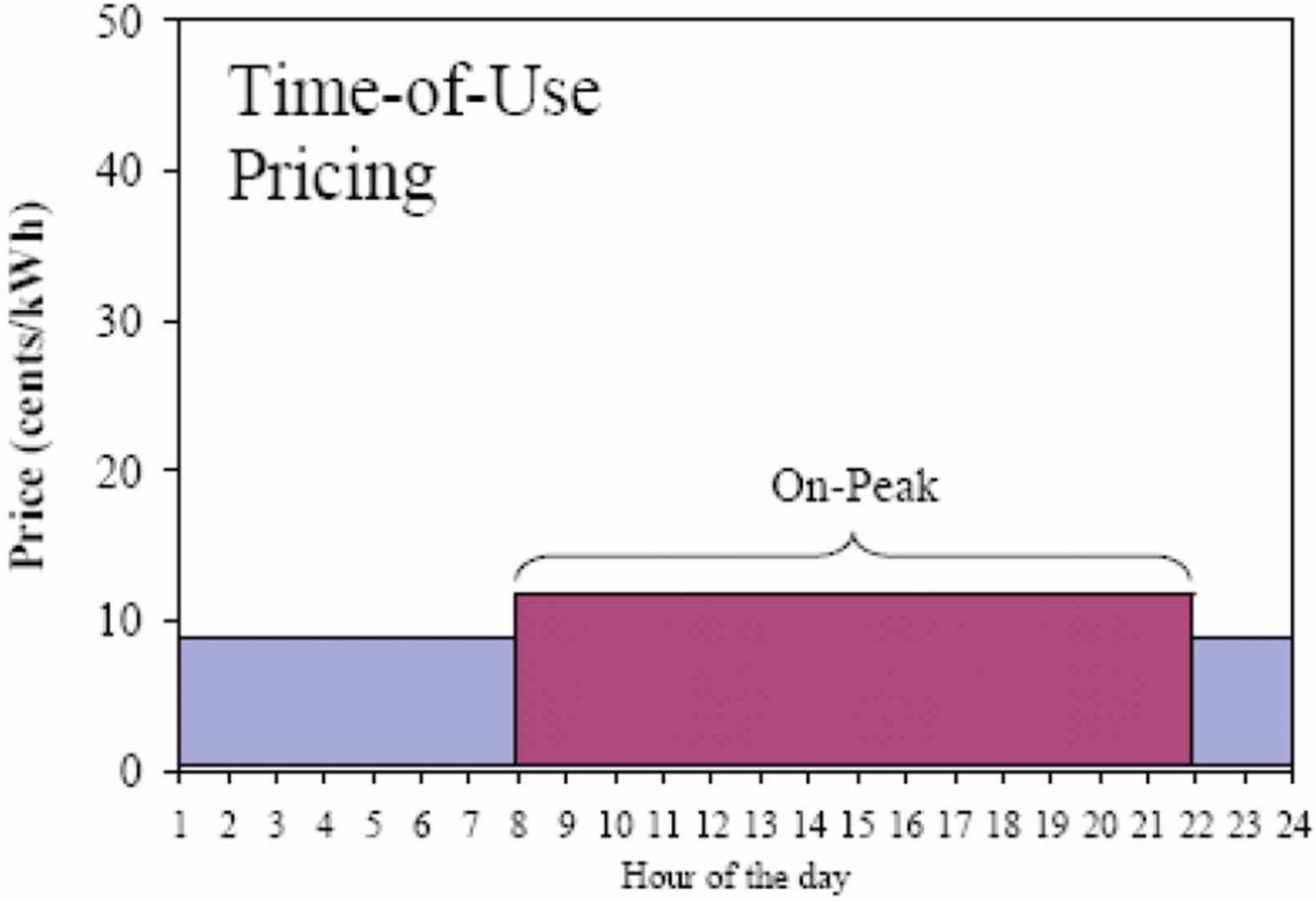
Source: Comverge 424B filed April 13, 2007

Demand Response Moves the Demand Curve Downward, Pushing Electricity Prices Down



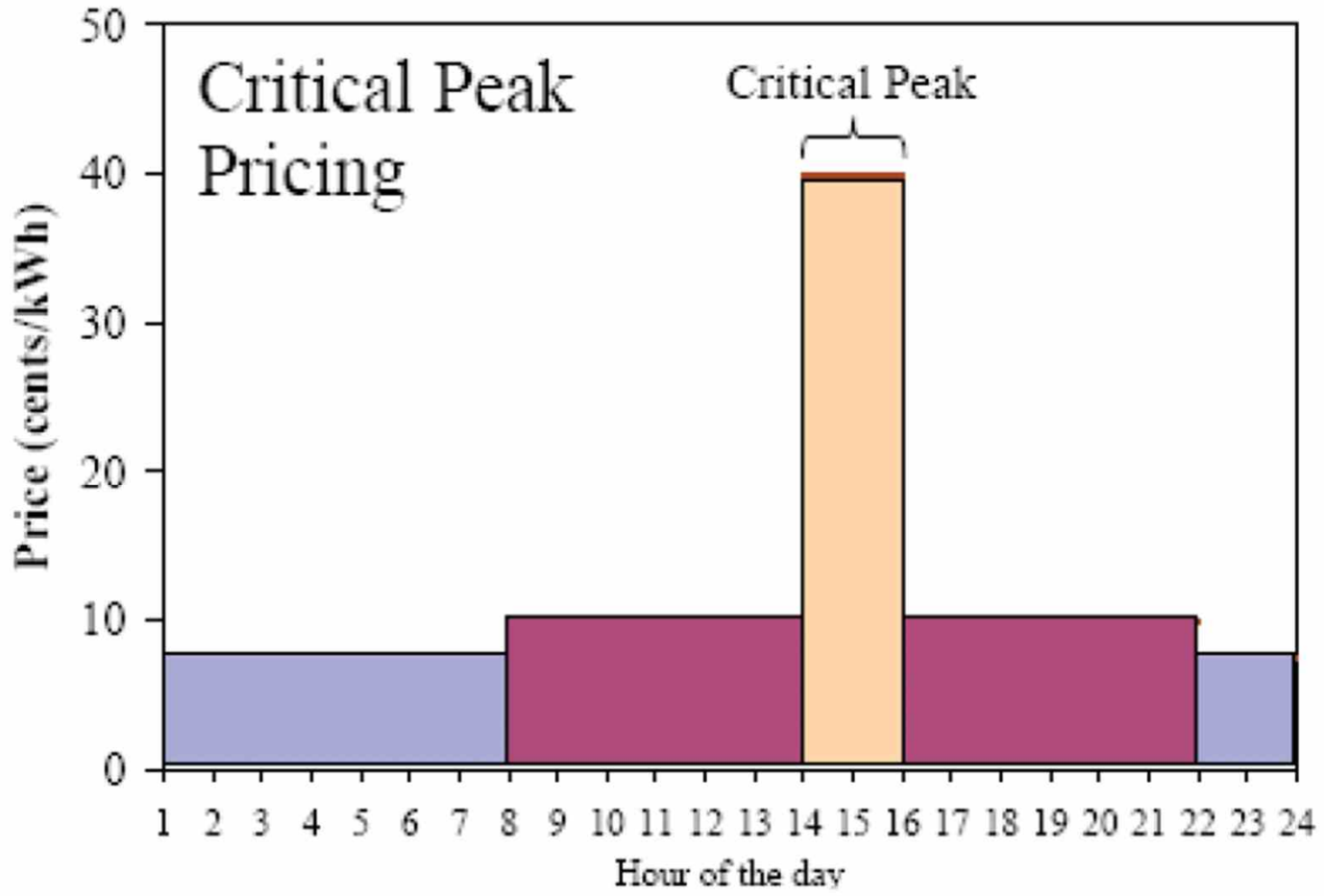
Source: U.S. Department of Energy

Time-of-Use Rates: Pricing Hourly Variations



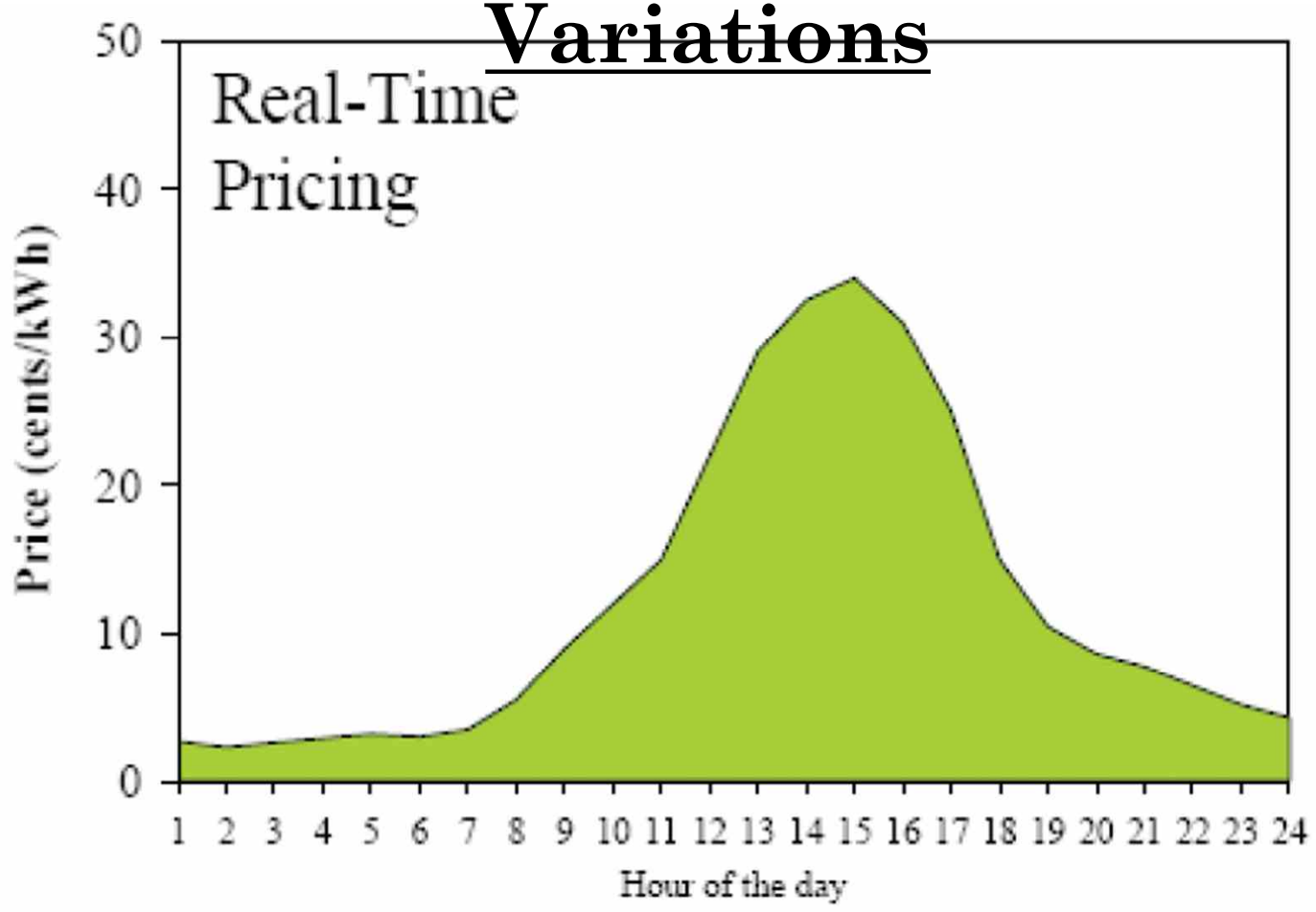
Source: FERC

Critical Peak Pricing Rates: Pricing Hourly Variations



Source: FERC

Real-Time Pricing Rates: Pricing Hourly Variations



Source: FERC

Demand Response

- **Price Based**
  - Time-of-Use
  - Real Time Pricing
  - Critical Peak Pricing

- **Incentive Based: Direct Load Control**
  - Direct Load Control
  - Interruptible Service
  - Demand Bidding / Buyback Program
  - Emergency Demand Response Program
  - Capacity Market Program
  - Ancillary Services Market Program

Summary and Conclusion:

- $300 Billion of Sales in 2005
- 3% US GDP
- Investment Projection ► $10 Trillion [2005-2030]

Make your "Smart Grid" Smarter!!