

# **Regulation and Deregulation of Electric Power Markets**

John R. Birge

Dean, R.R. McCormick School of Engineering  
and Applied Science  
Northwestern University

# Outline

1. Basic Mechanisms
2. Market Problems
3. California Specifics
4. Ongoing Problems
5. Potential Resolutions

# Regulated versus Deregulated Markets

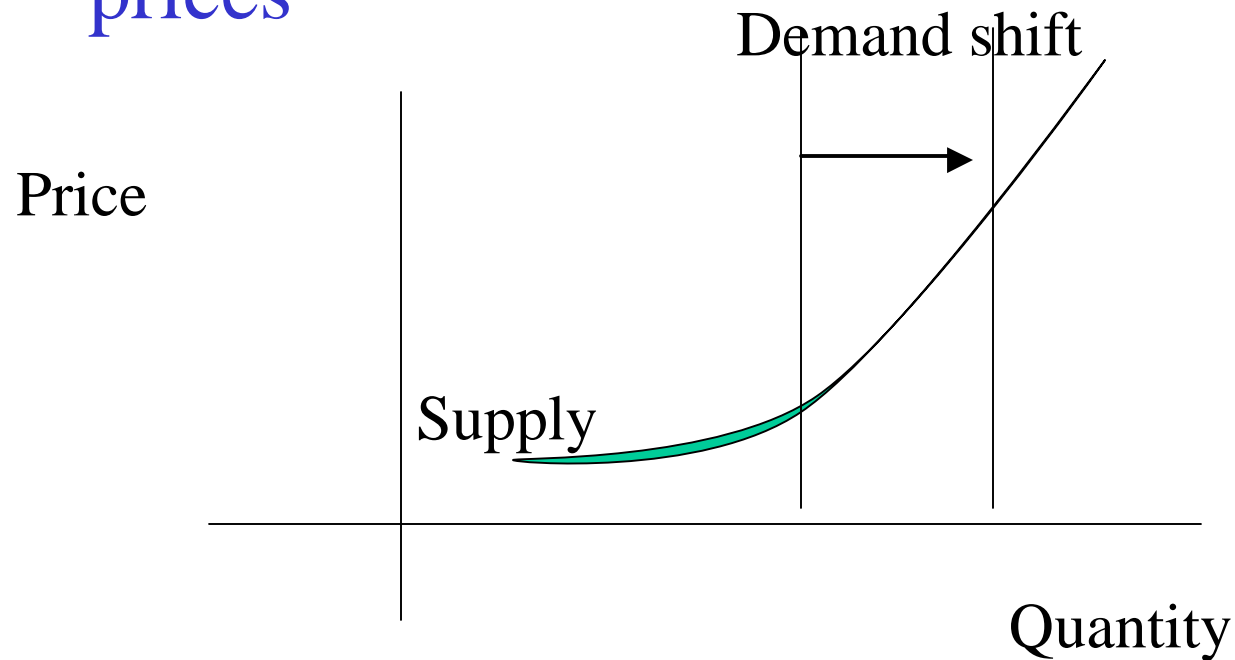
- Regulated
  - Single or few producers
  - Prices controlled by commission
  - Costs passed to consumers (eventually)
  - Little incentive for efficiency
- Deregulated
  - Multiple producers
  - Prices governed by market mechanism
  - Potential for **market power** (vary supply to manipulate price)
  - Questions about security (sufficient capacity)

# Problems of Electricity Markets

- Inelastic demand
- Variable demand
- Limited transmission capacity
- Limited (unavailable) storage capacity

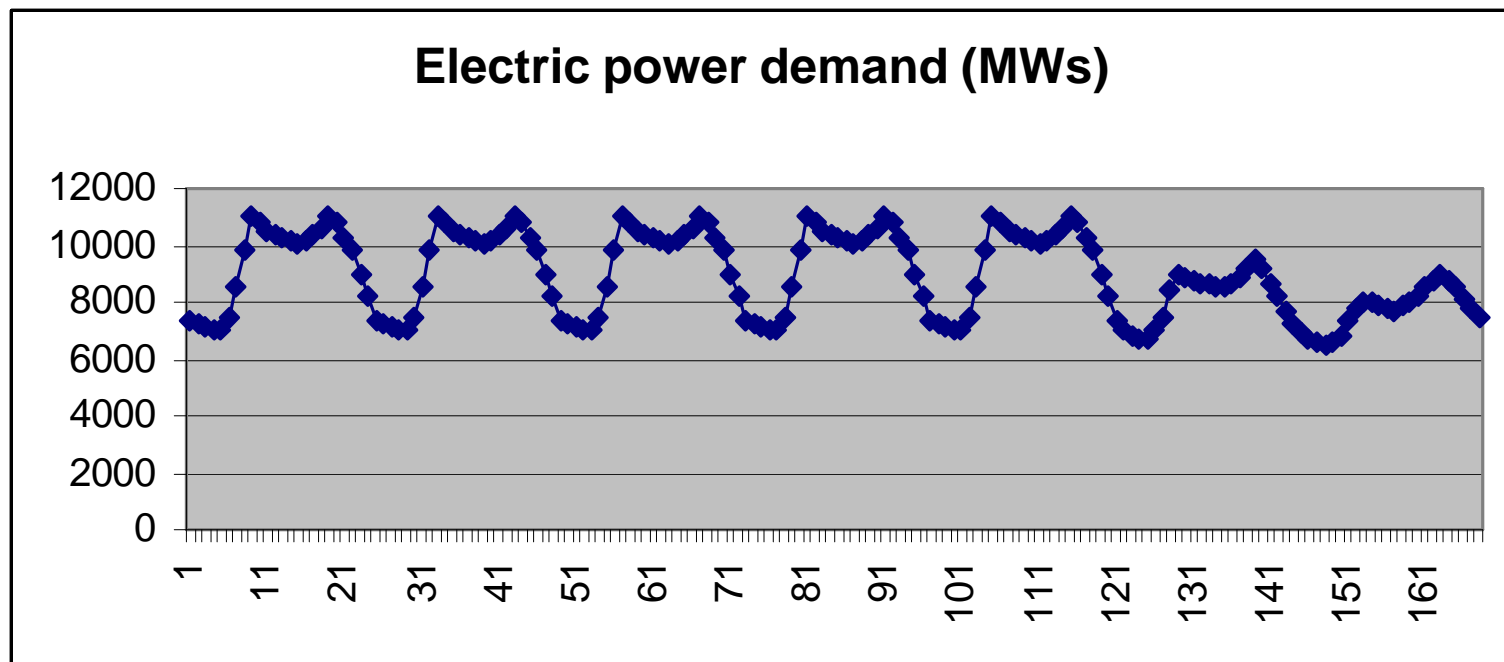
# Inelastic Demand

- Demand increases can sharply increase prices

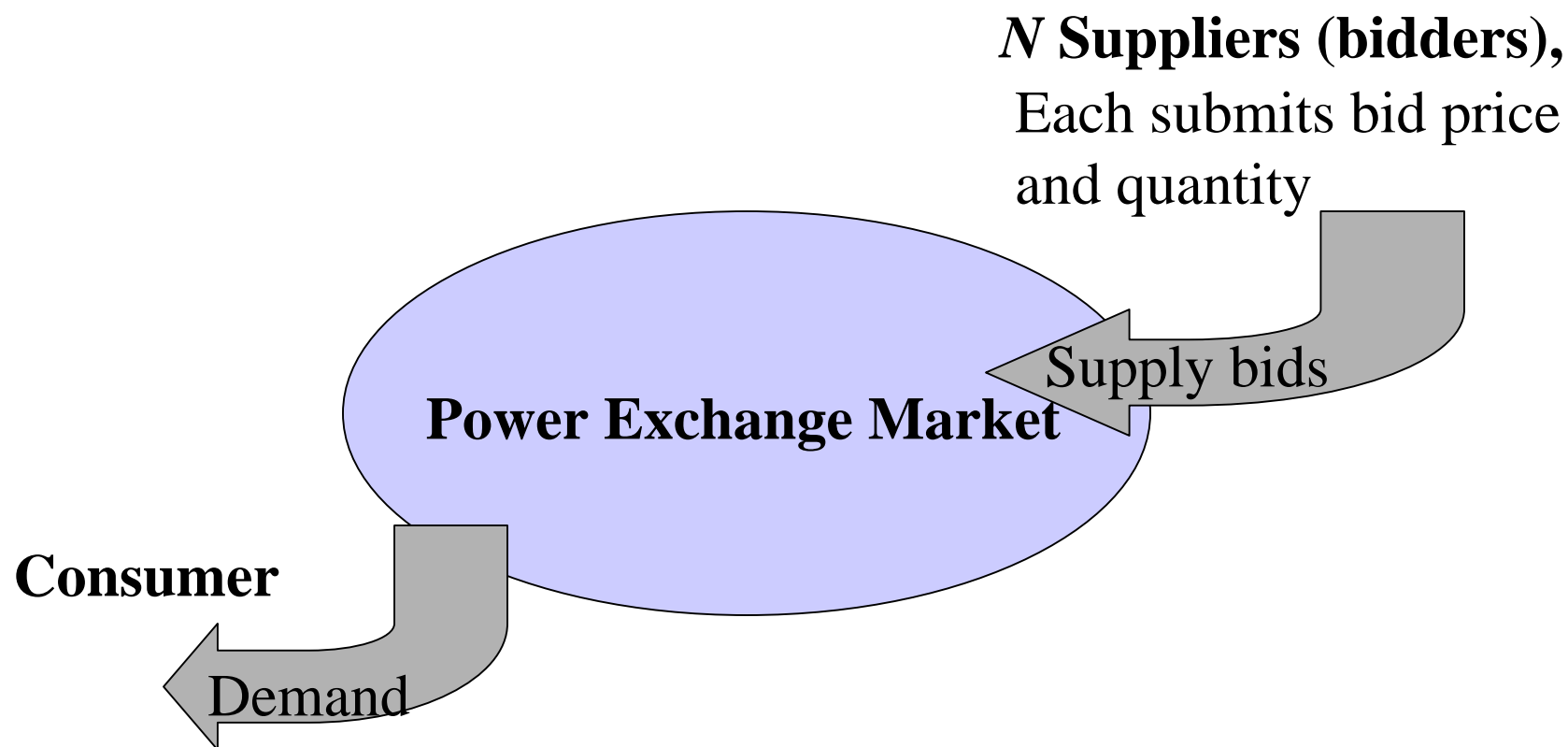


# Variable Demand

- Demand often doubles (or more) during peak hours



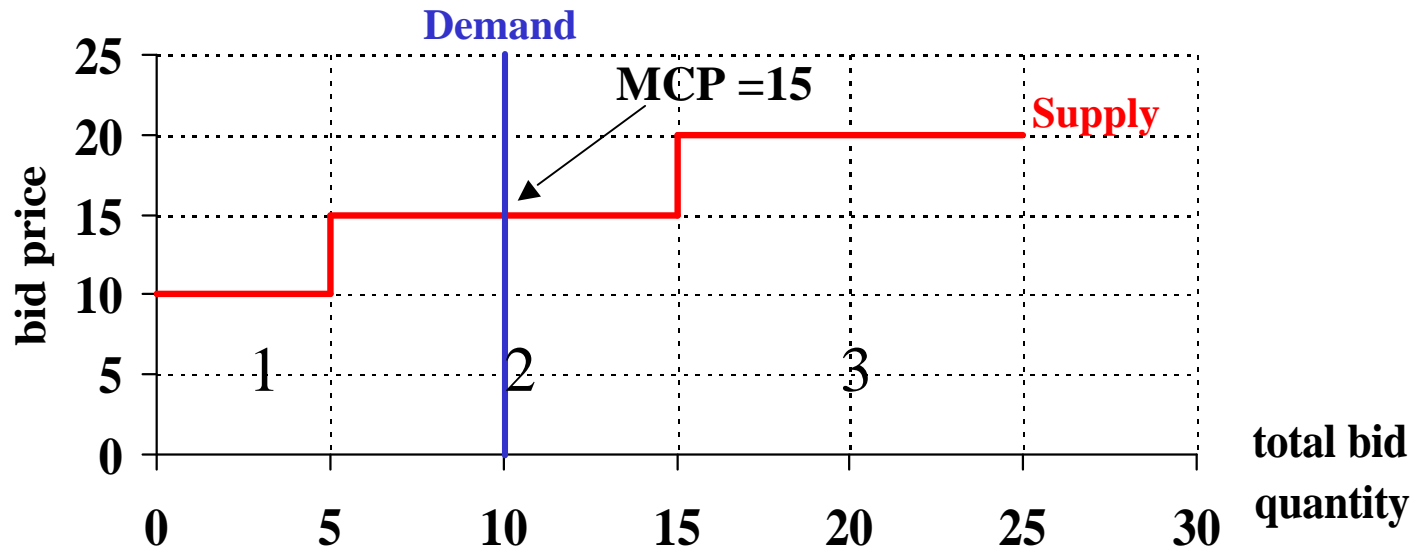
# Competitive Markets



# Market Clearing Process

Supplier 1 : 5MWh @ \$10  
Supplier 2 : 10MWh @ \$15  
Supplier 3 : 10MWh @ \$20

Demand is 10



**Problem:** finding optimal bidding strategies and the resulting MCP



# Power Exchange Overview

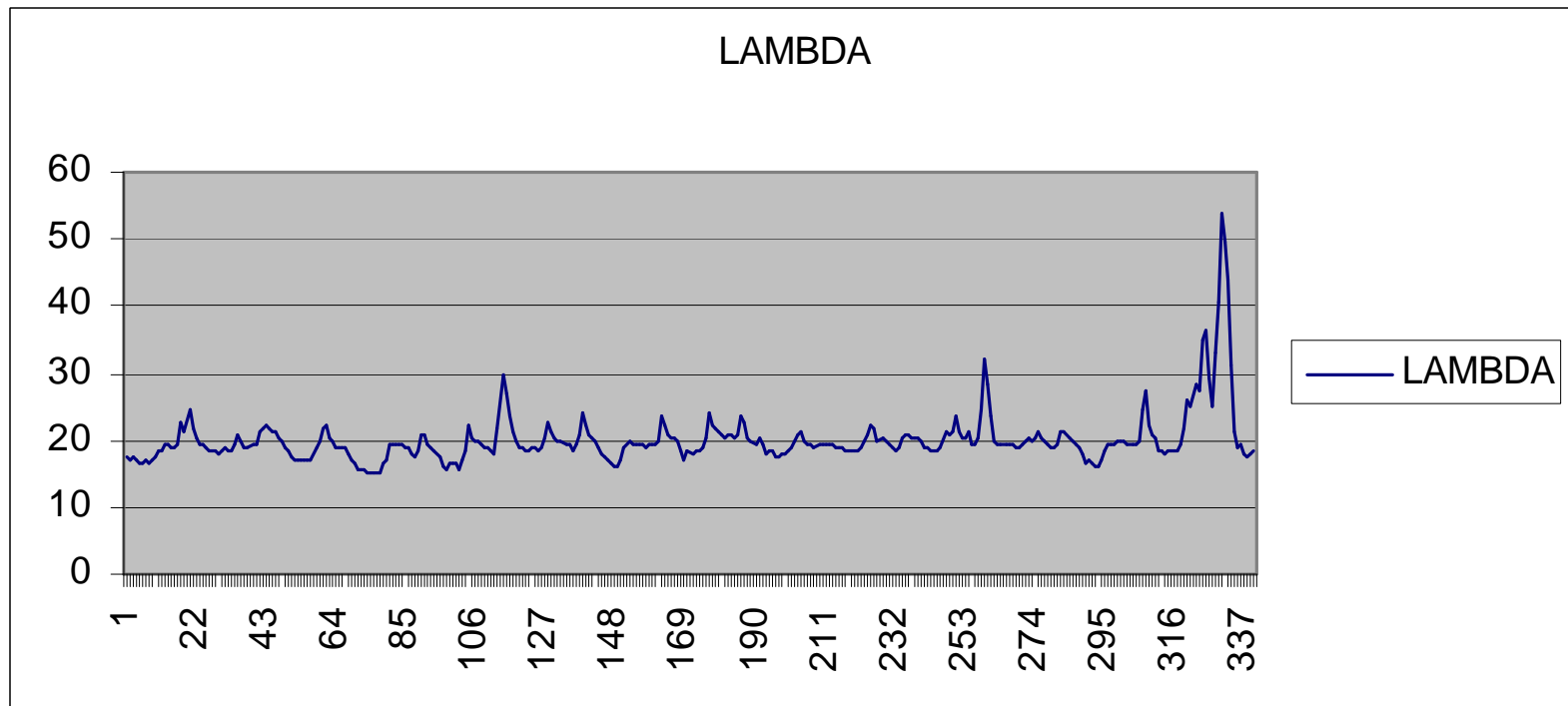
- **Non-sealed bid, Multi-round**
  - Bidders can see each other's bids and can adjust their prices as many times as they want
  - Market is closed when no bidder wants to adjust his/her bid price
- **Selling at spot:**
  - All dispatched units are traded at the same price

# California Power Exchange (PX)

- Two markets
  - Day ahead
  - One hour-ahead
- Independent System Operator (ISO)
  - Coordinates supply and transmission
  - Operates energy imbalance market (spot market)

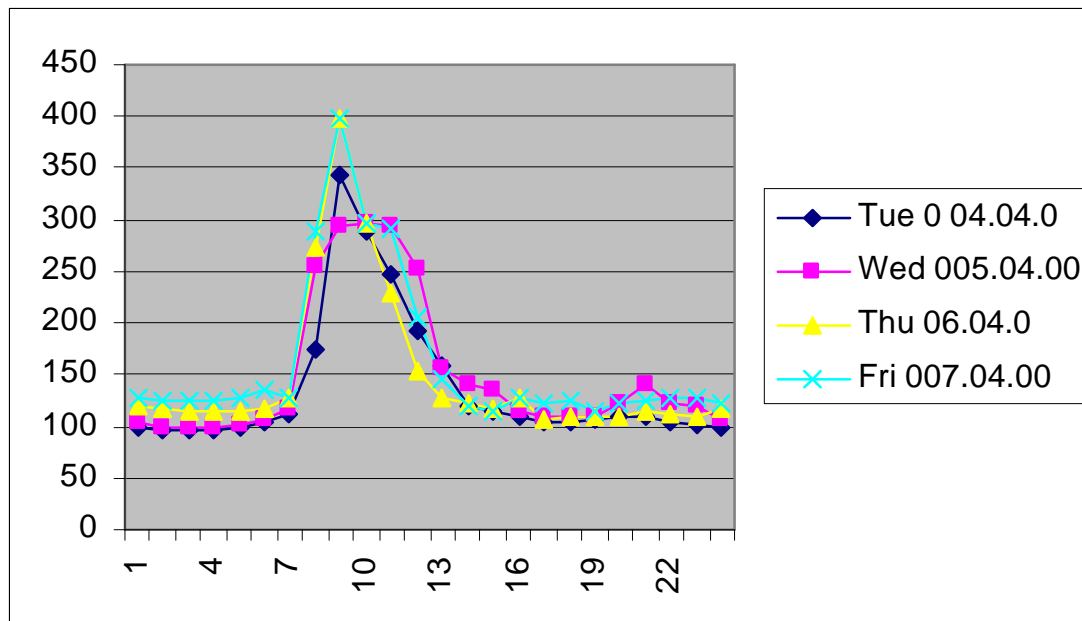
# Electricity Price Example

- California Power Exchange



# Electricity Price Example: Norway

- NOK Prices



# Simple Market Power

- Generators: Capacity, Cost

- Coal, 10, \$5
- Oil, 10, \$50
- Hydro, 10, 0

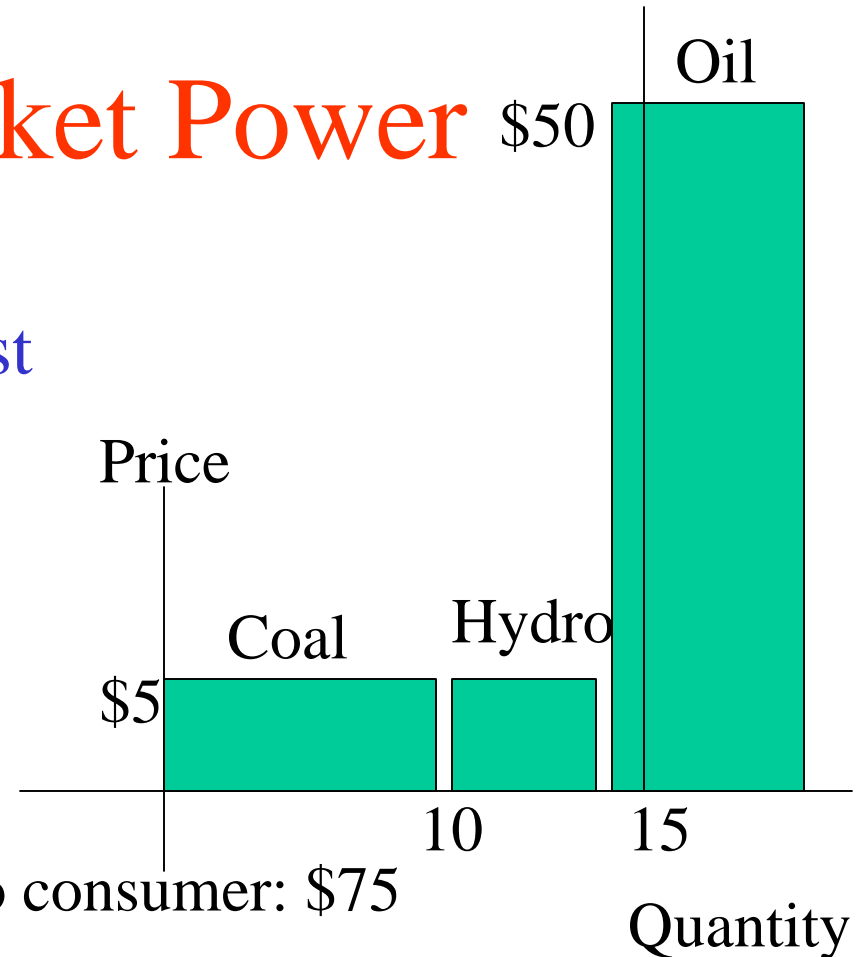
- Demand: 15

- Cheapest dispatch

- Hydro, 10; Coal, 5; Cost to consumer: \$75

- Market power of hydro

- Bid only 4 into market, now oil also used
- Coal, 10; Hydro, 4; Oil, 1; Cost to consumer: \$750



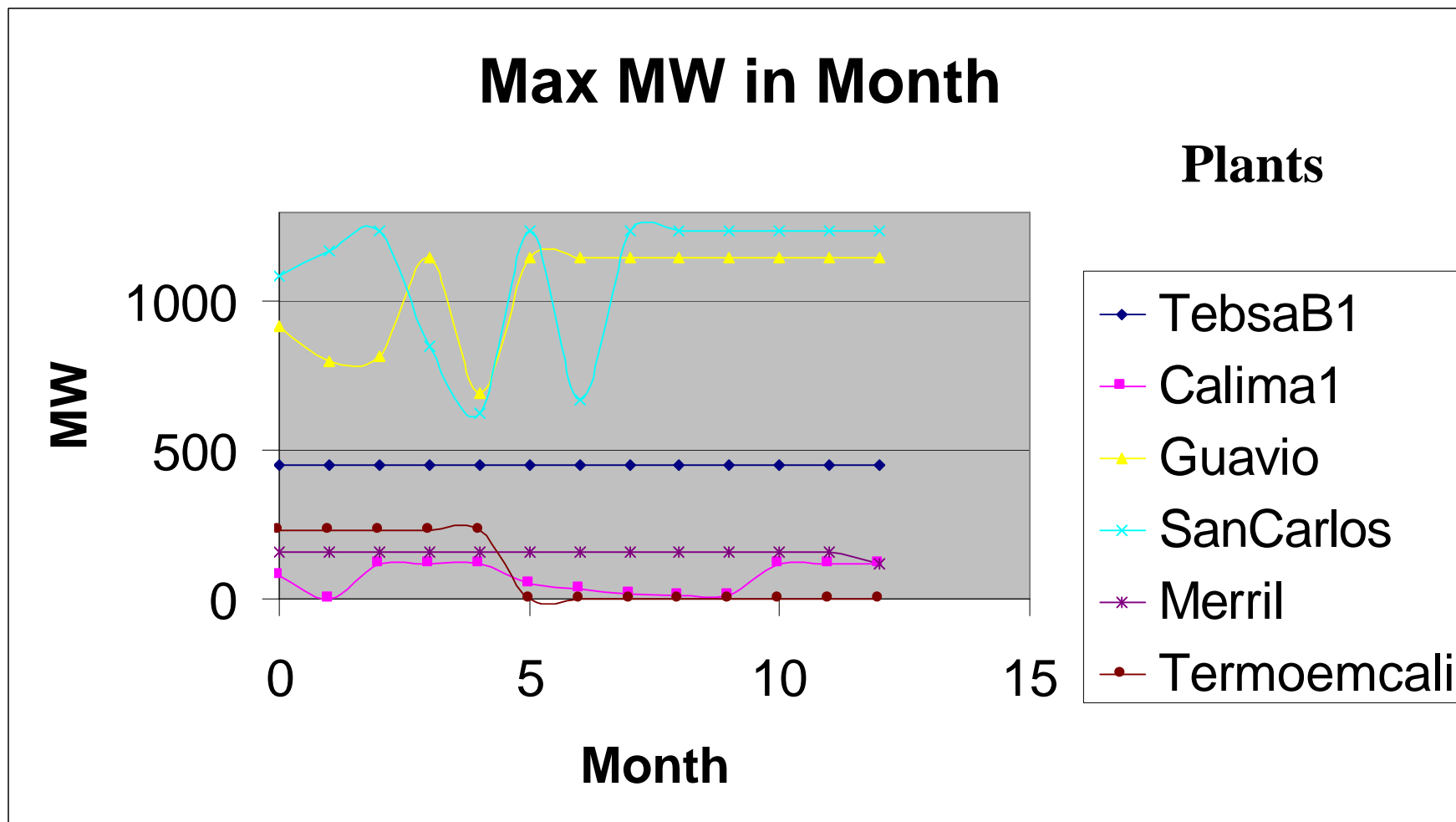
# Comparisons to Other Markets

- High Volatility
  - 10 to 100 times that of common stock
  - Prices from 0 to \$10,000 per MWhr
- Difficulty in storage
  - Electricity close to un-storable
    - Difficulty substitution (liquidity)

# Additional Problems

- Capacity investment
  - How to ensure enough capacity?
- Start-up and shutdown costs
  - How to obtain efficiency for long-run operations?
- Colombia case
  - Compare to “optimal”
  - Problems: multiple “optimal” choices
  - Optimal depends on future – must consider what will be available (not just what is available now)

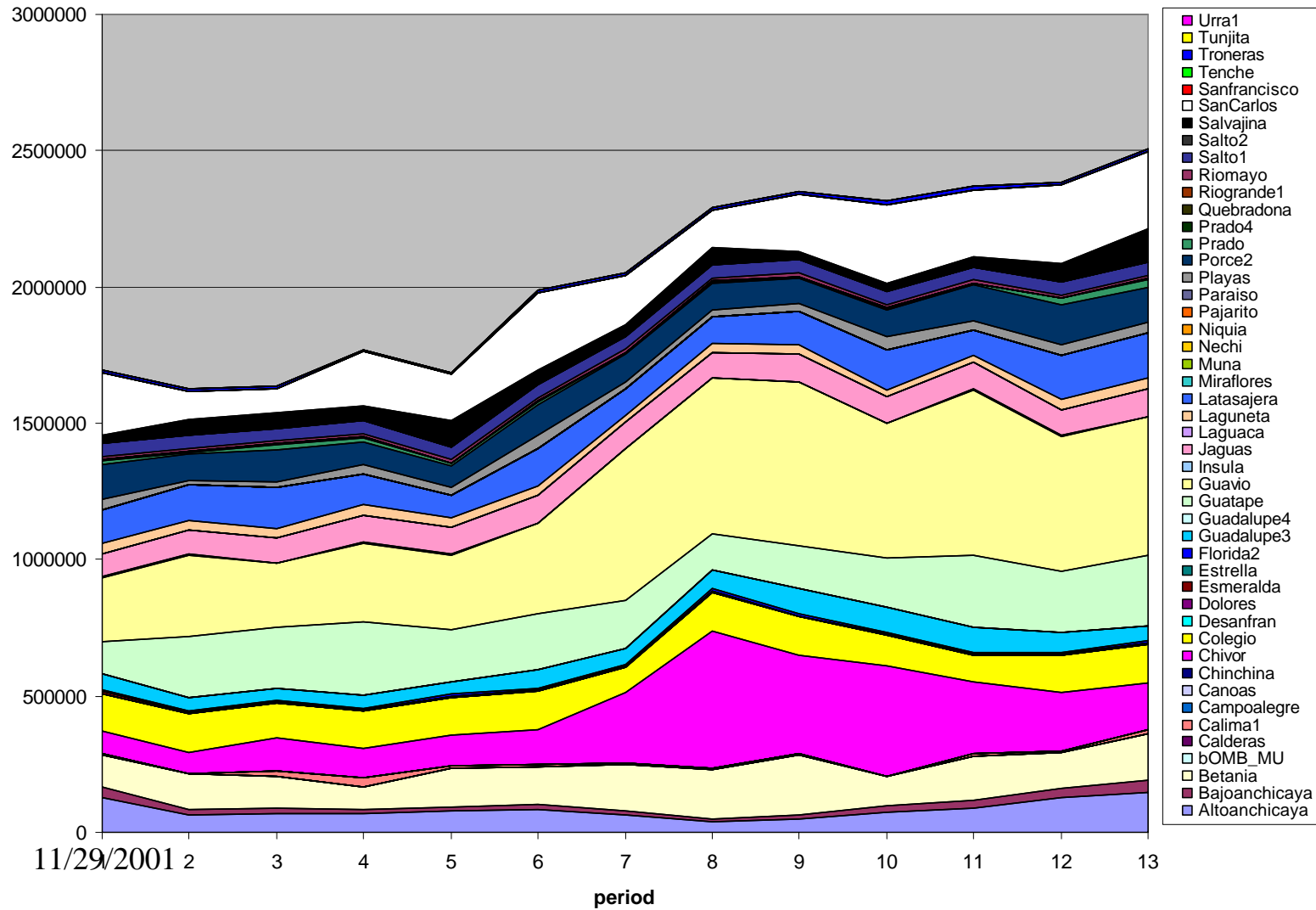
# Production Changes in Colombia (multiple possible ranges)





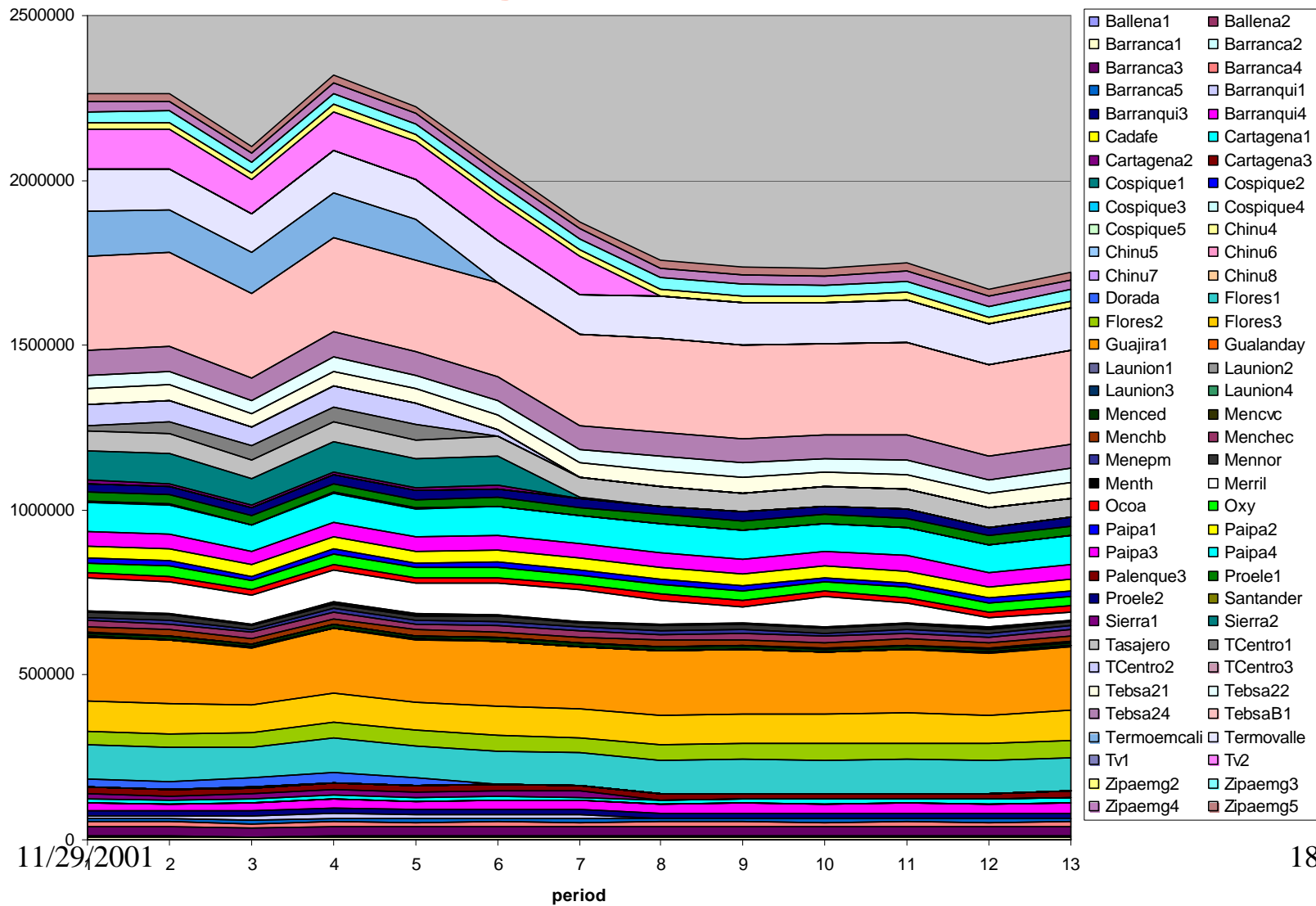
# Colombia “Optimal” Hydro Generation

hydro generation



# Colombia “Optimal” Thermal

## Thermal generation Generation



# California Problems

- Demand timing
  - More rapid expansion than forecast
- Capacity timing
  - Long lead times
  - Large utilities sold generation
- Transmission capacity
  - Limited ability to take advantage of surpluses elsewhere
- Current Situation
  - Weather advantage

11/29/2001 Voluntary conservation

# Long-run Resolution

- Additional capacity and transmission
  - Need to know the market environment
  - Need to have instruments to hedge risks
- Useful innovations
  - Additional long-term contracts
  - Demand price responses
    - allow spot prices to pass through
    - can reduce monthly fluctuation with long-term contracts

# Conclusions

- Market structure
  - Problems for electricity because of storage, inelastic demand
- Market power
  - Created by limited capacity, few producers
- Resolutions
  - Demand responsiveness and more ability to hedge risks