

# Political Economy and the Hydrogen Revolution ver 1.0

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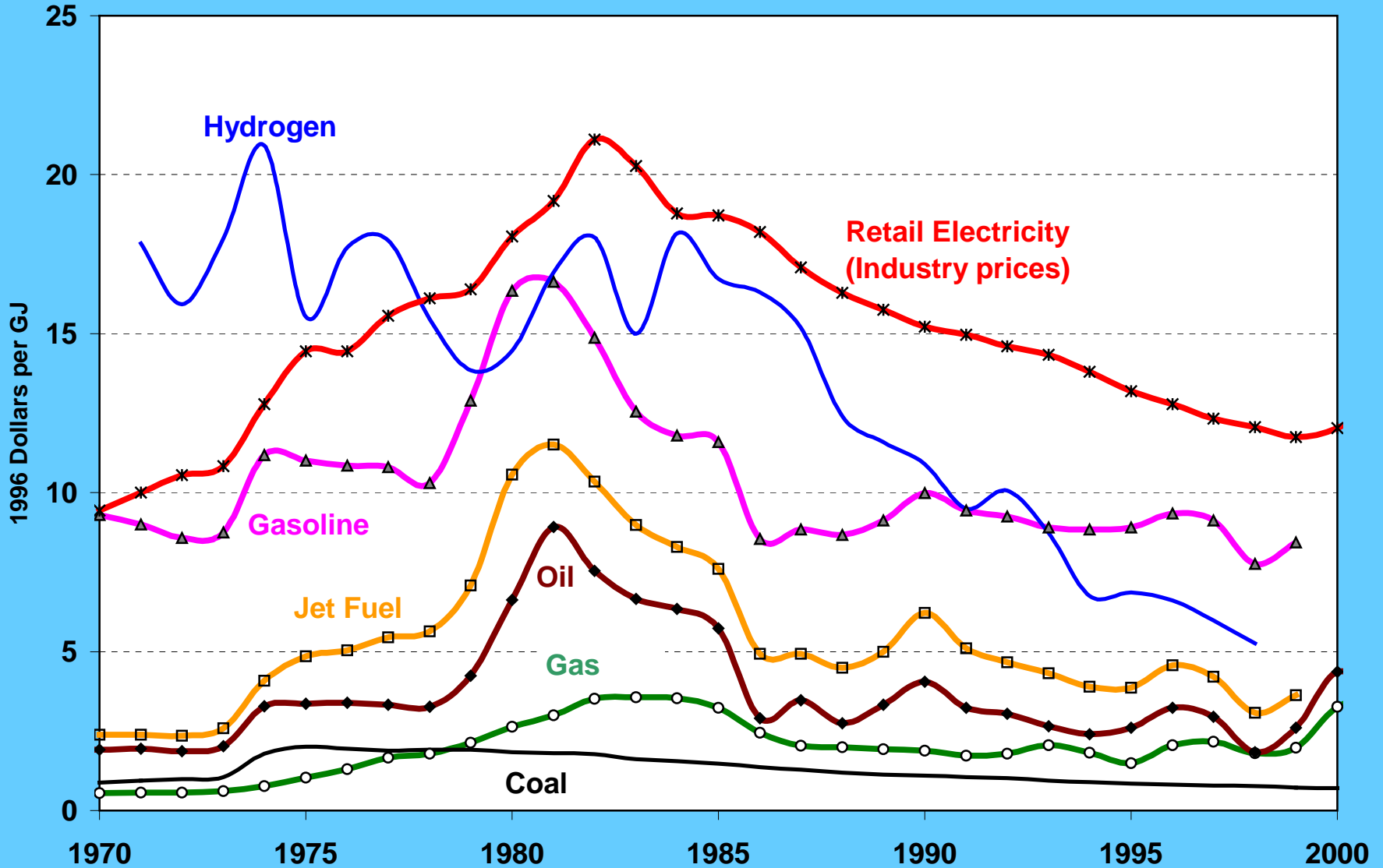
Program on Energy & Sustainable Development  
<http://cesp.stanford.edu/pesd>

# Three Topics

1. Rates of Change
2. Incumbents Fight back
3. Niche Markets

# Hydrogen and Its Competitors

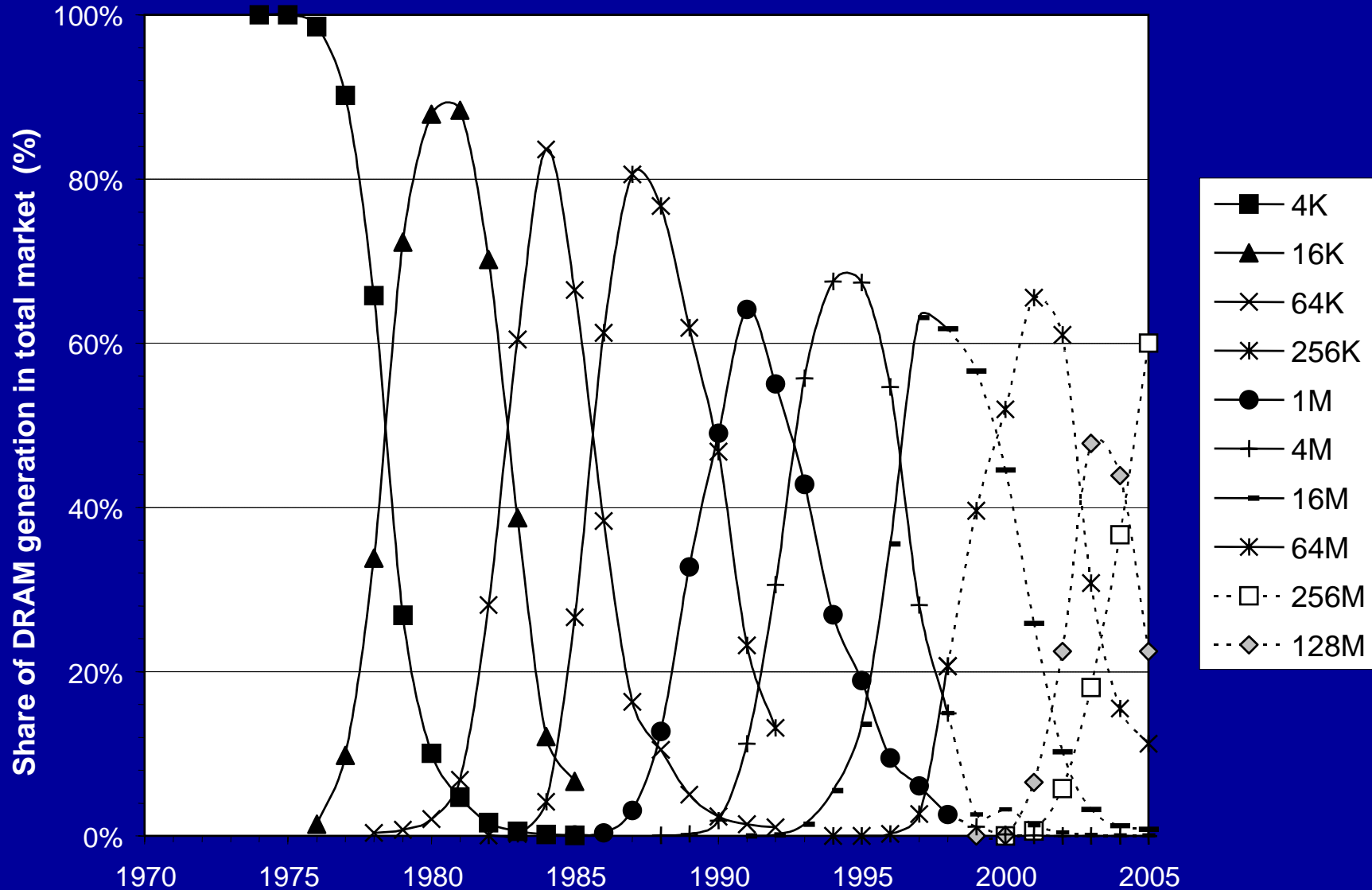
USA: Prices for Major Fuels and Energy Carriers, 1970-1999



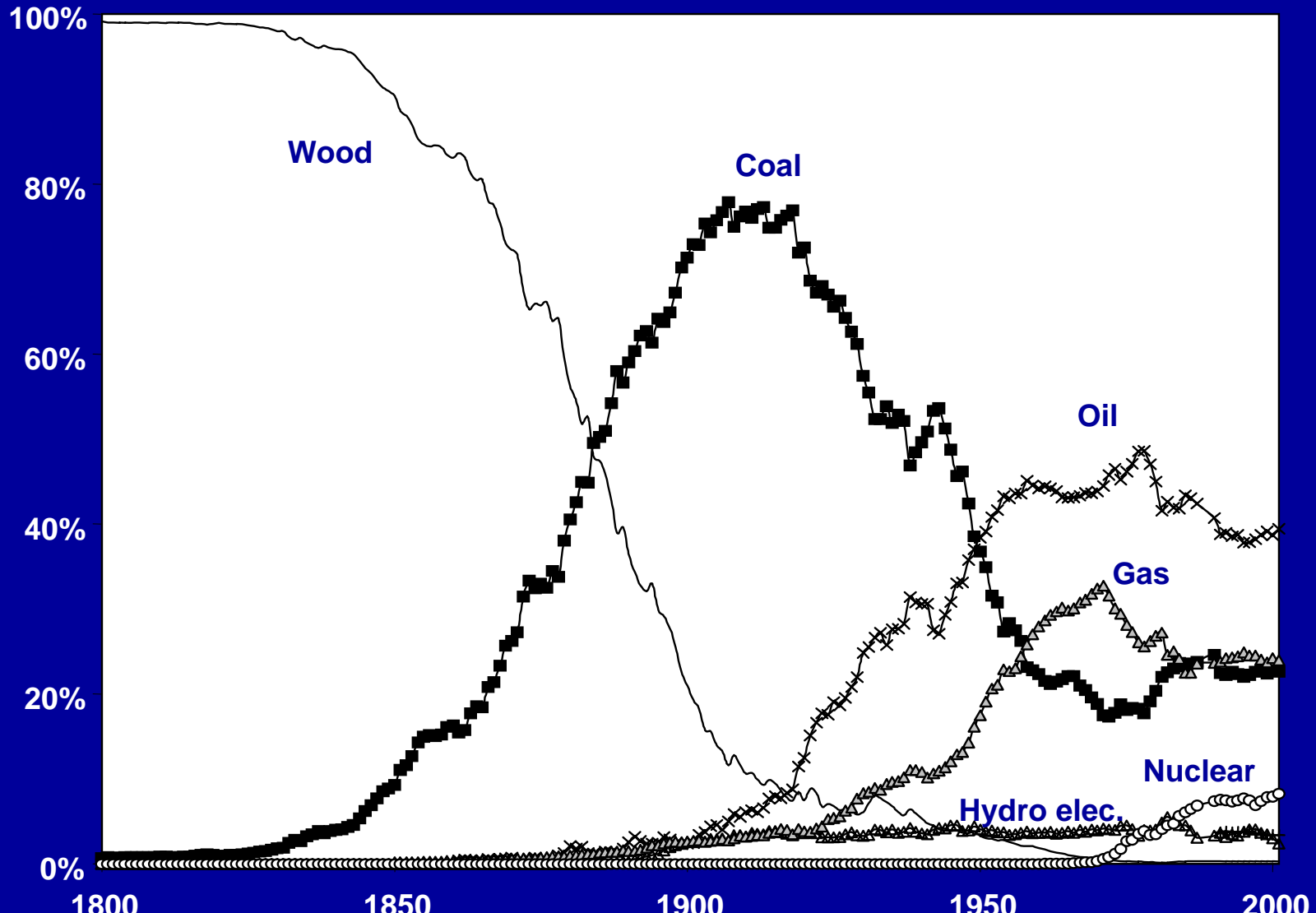
# 1. Rates of Change

# Rapid Evolution: DRAMs

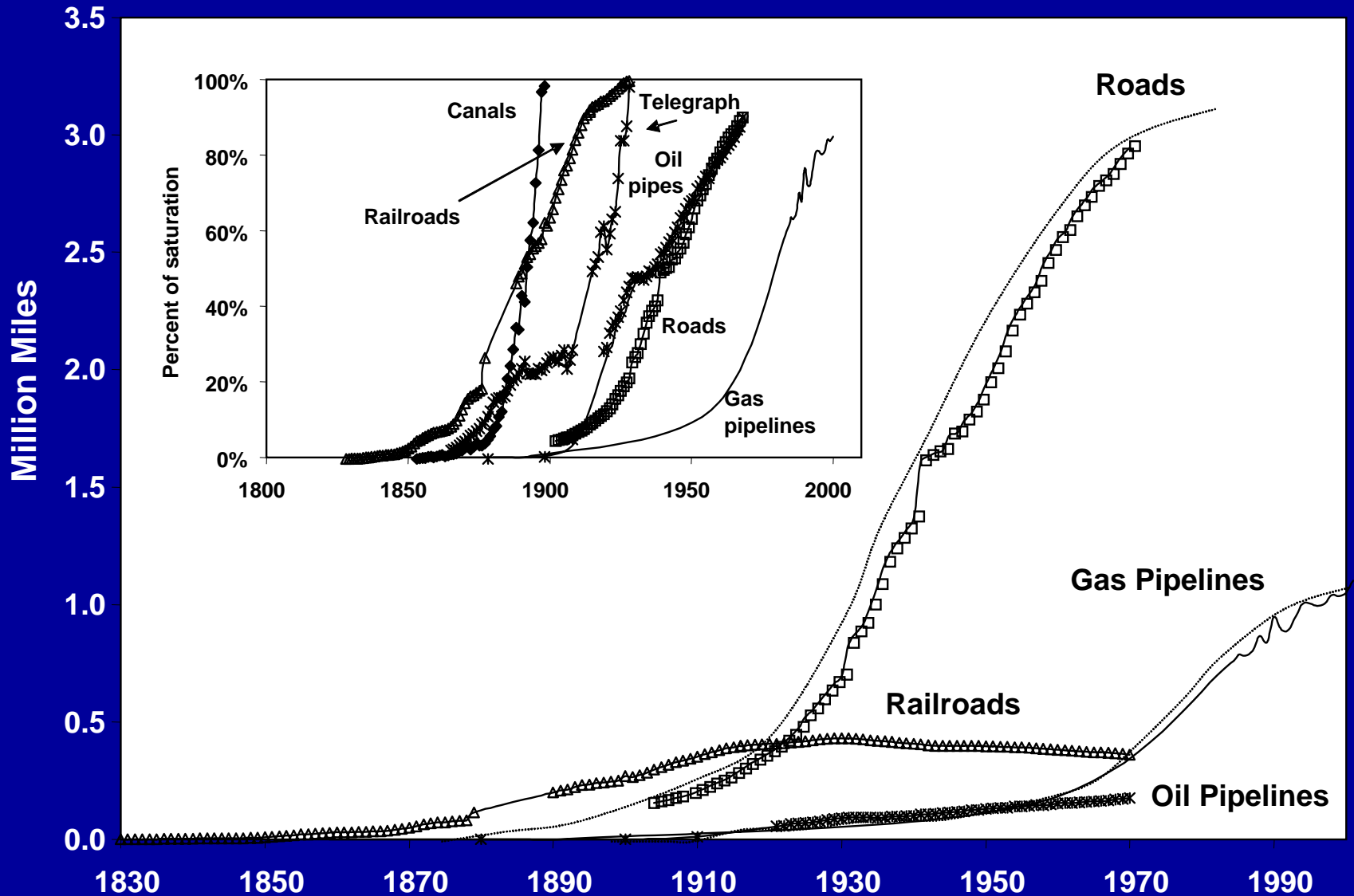
N. Victor & Ausubel (2002)



# Slow Evolution: Primary Energy Systems



# Evolution of Infrastructures



# Causes of Slow Diffusion

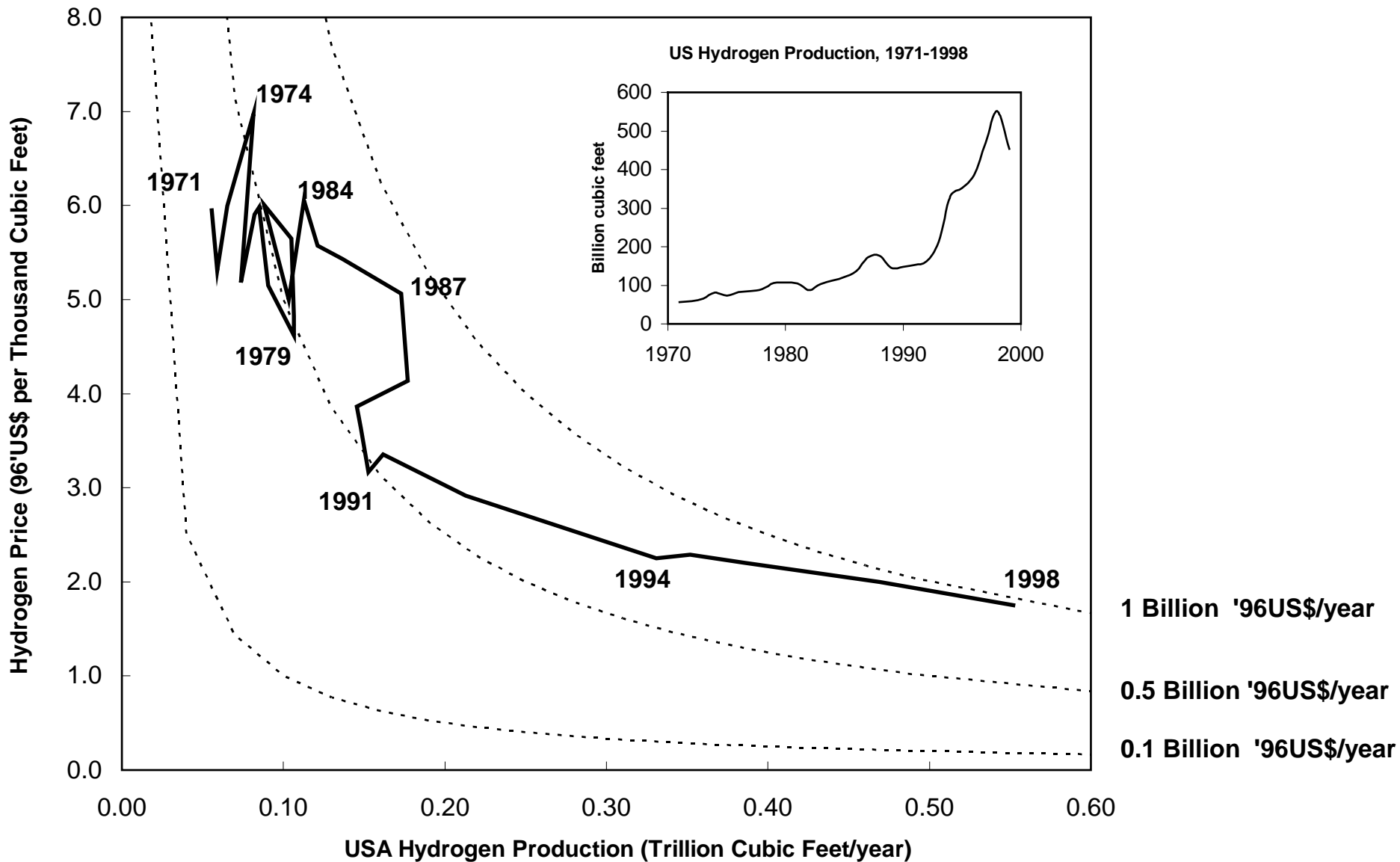
- Network effects lock out early stages
  - co-location and co-evolution of infrastructures can speed diffusion
  - Niche markets are essential
- Numerous complementary innovations required
  - Infrastructure and end user
  - Organizational (e.g., methods of production)
  - Social (e.g., finance)
  - Professional (e.g., training)
- Political coalitions difficult to form
  - Trial and error; not perfect information
- Regulatory frameworks
  - Vital; yet often poisonous

## 2. The Empire Strikes Back

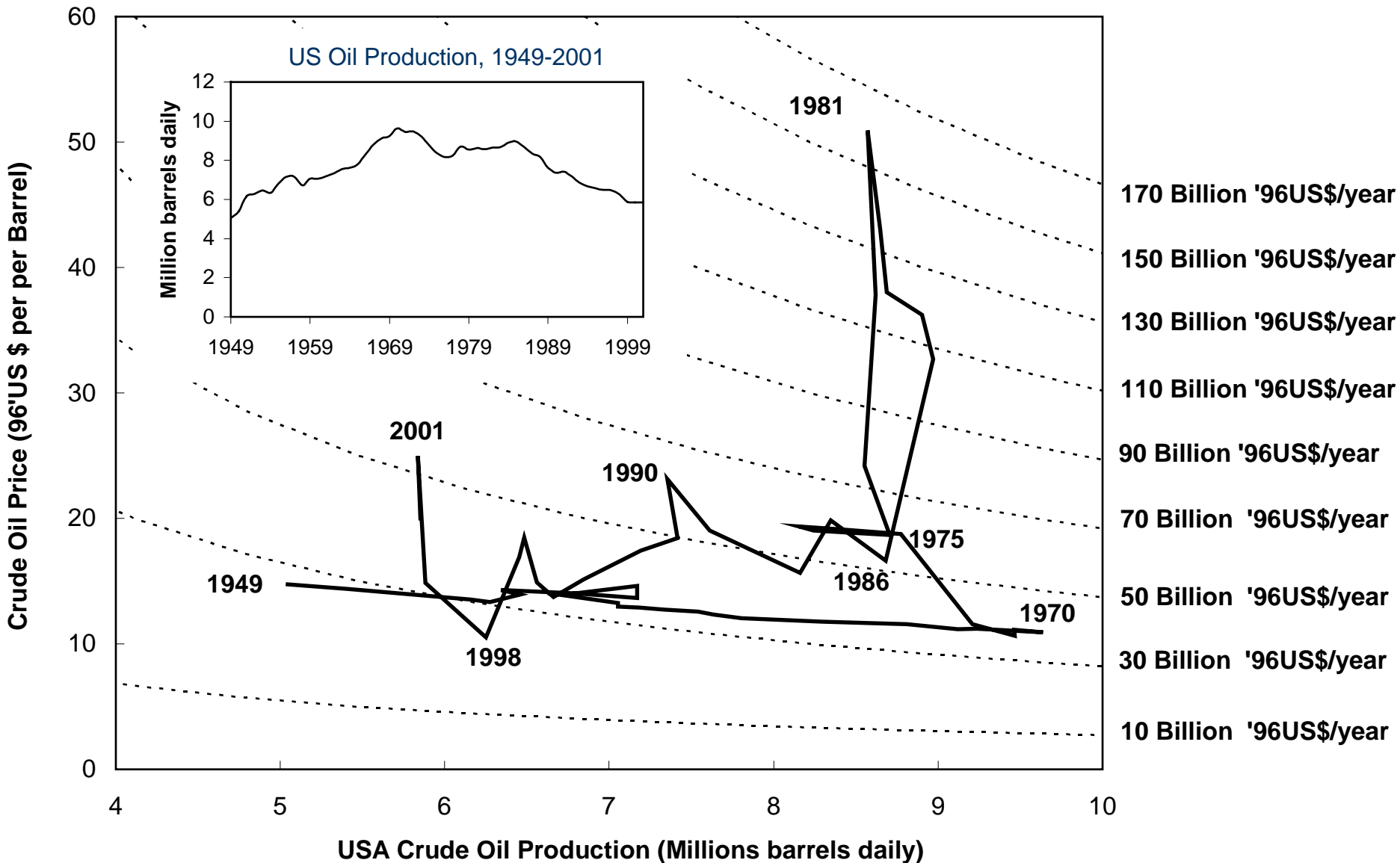
# Sources of Political Power

- Determinants of Political Power
  - Value-added (jobs, dollars)
  - Concentration of Interests
  - Organization of Interests
- Concentrated, well-organized incumbents versus diffuse, hypothetical and unknown new entrants

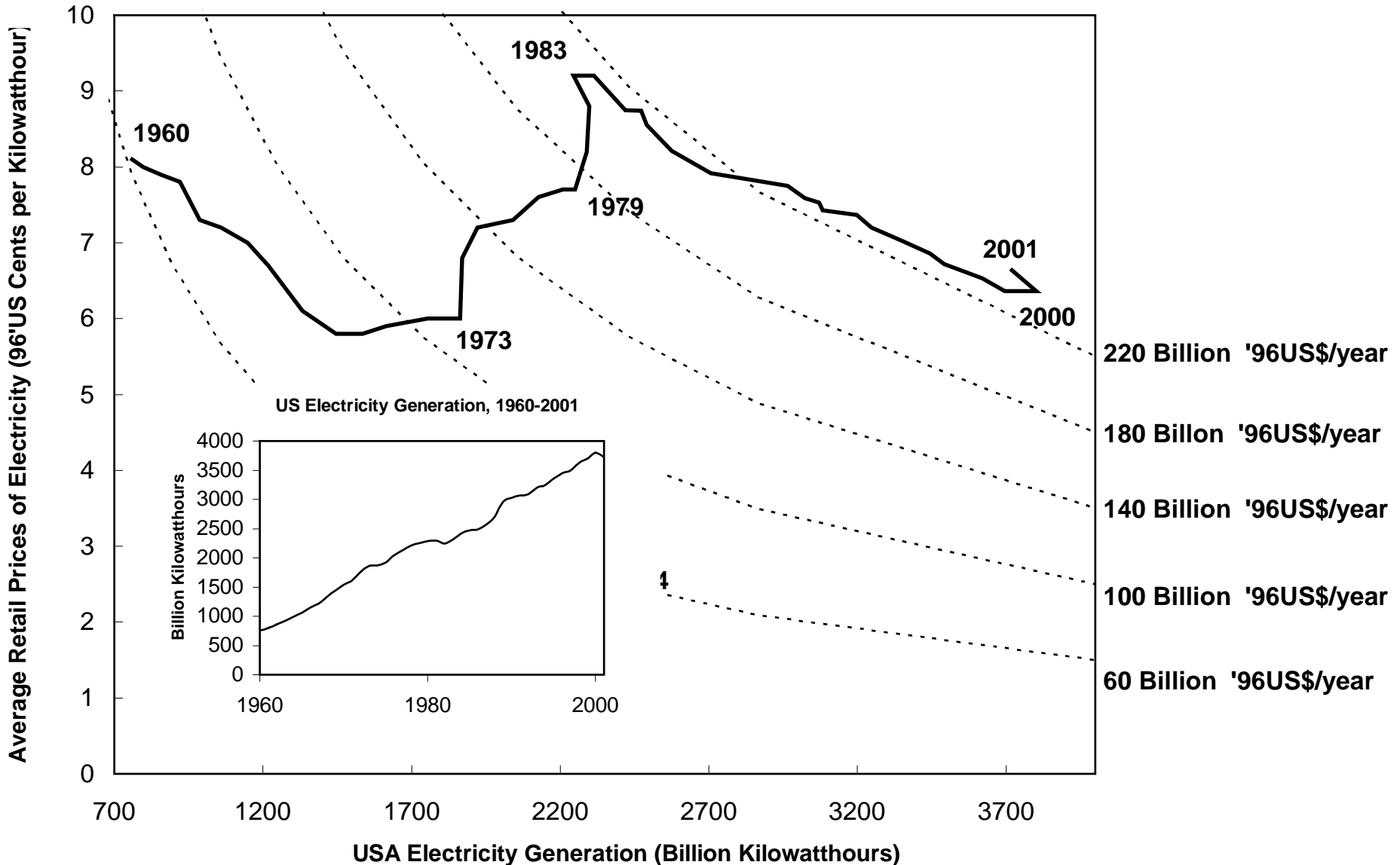
# Output of the U.S. Hydrogen Industry



# Output of the U.S. Oil Industry



# Output of U.S. Electricity Suppliers



# Uses of Political Power

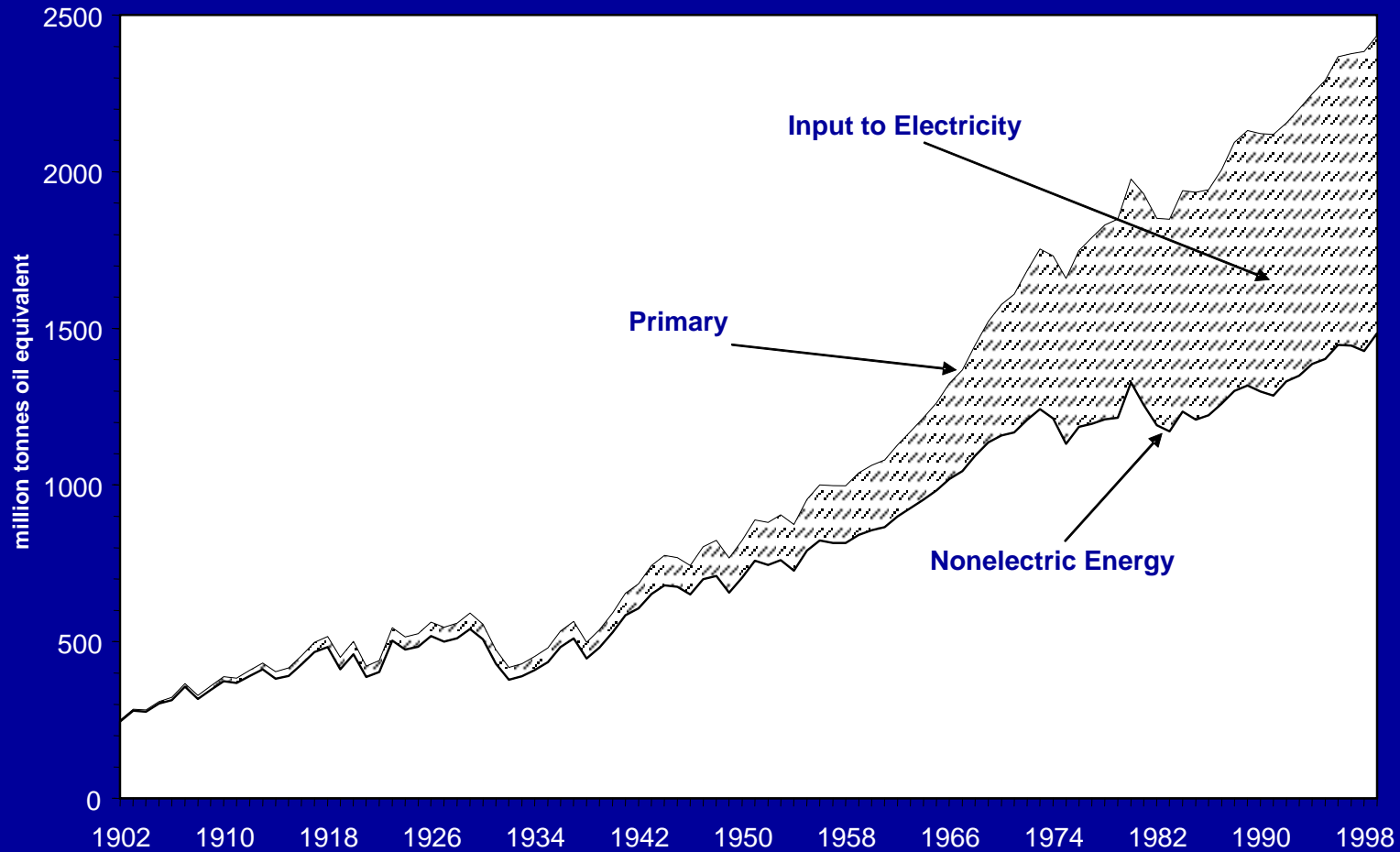
- Legislative and Regulatory Retaliation
  - “Red Flag Act” (1865)
    - Repealed for small vehicles (1895)
      - Automobiles (< 3 tonnes)
      - Locomotives
    - Automobile Club formed (1897)
    - Road signs (1904)
- Stigmatization
  - Edison against gas light
  - Edison against AC

# Three Responses to the “Hydrogen Threat”: 1

- Electrification
  - Carbon rules likely to hit electricity hard
    - Response: carbon sequestration and possibly nuclear power
  - Eliminates carbon from electricity; allows steep reductions in industry and households through electrification
  - Transport emissions reduced, in parallel, through energy efficiency (hybrids, etc.)
  - Nothing left for hydrogen

# Electrification of Industrial and Post-Industrial Societies

U.S. Primary Energy



# Three Responses to the “Hydrogen Threat”: 2

- Pipeline Safety
  - Will hydrogen pipelines and storage be easier to site than gas pipelines?
  - Rights-of-way available for hydrogen
    - Perhaps 1/3 of gas pipelines usable for H<sub>2</sub>
  - BUT, will neighbors allow it?
  - Analogy: LNG sites

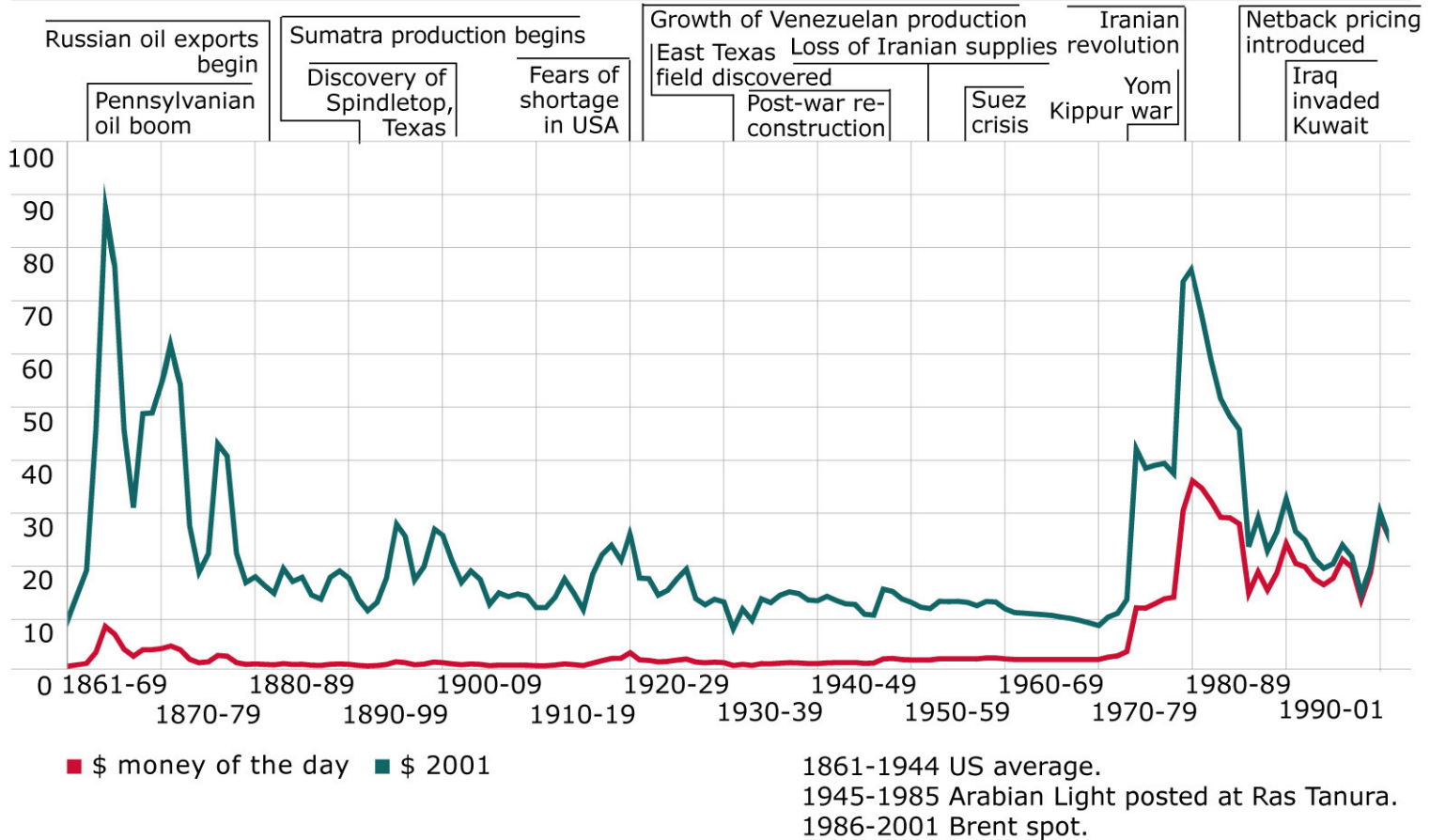
# Three Responses to the “Hydrogen Threat”: 3

- Incumbents Get Efficient
  - Analogy: Clipper Ships vs. Steam Ships
  - OPEC’s response?

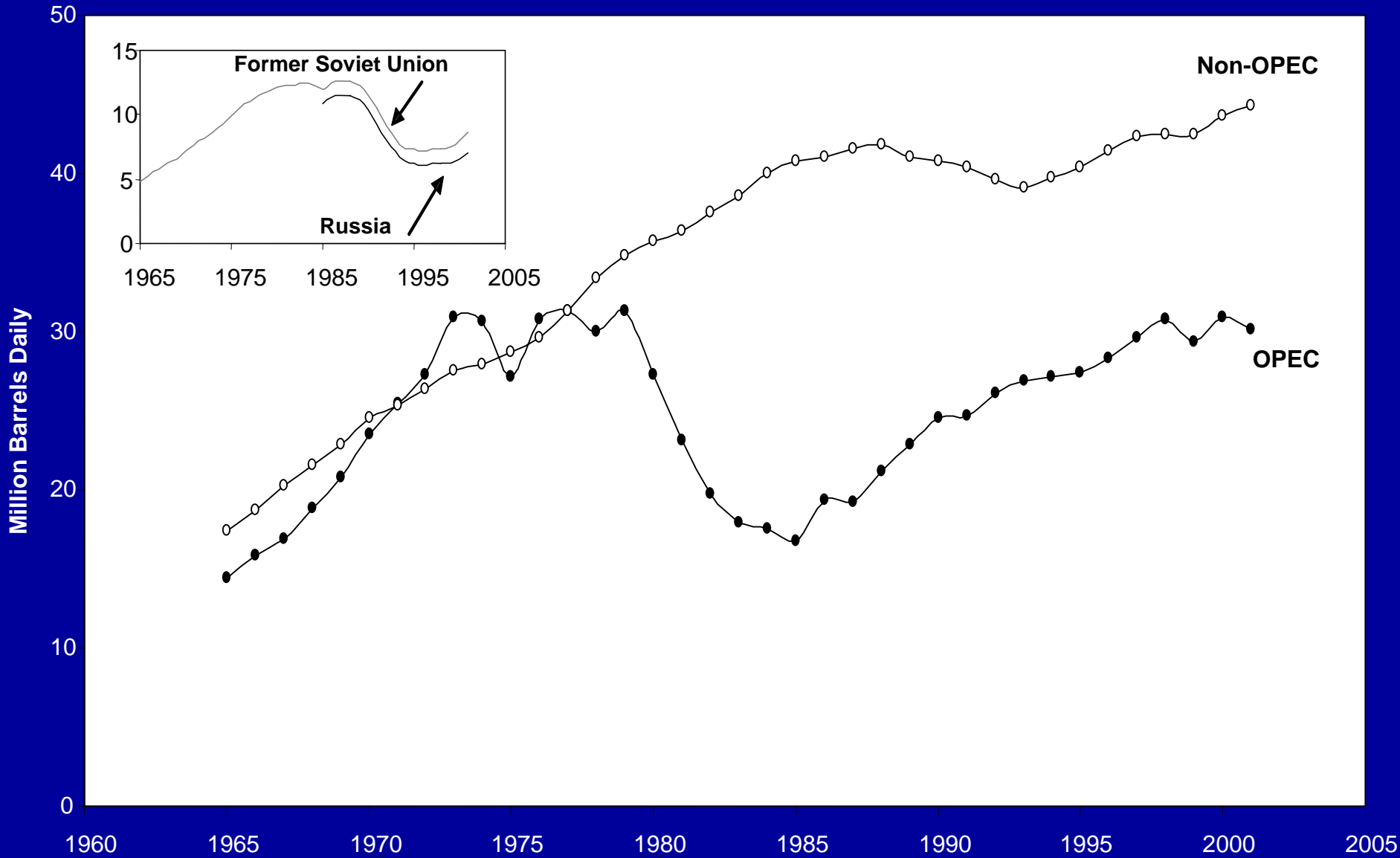
# chart of crude oil prices since 1861

US dollars per barrel

## World events



# World Oil Production: 1965-2001

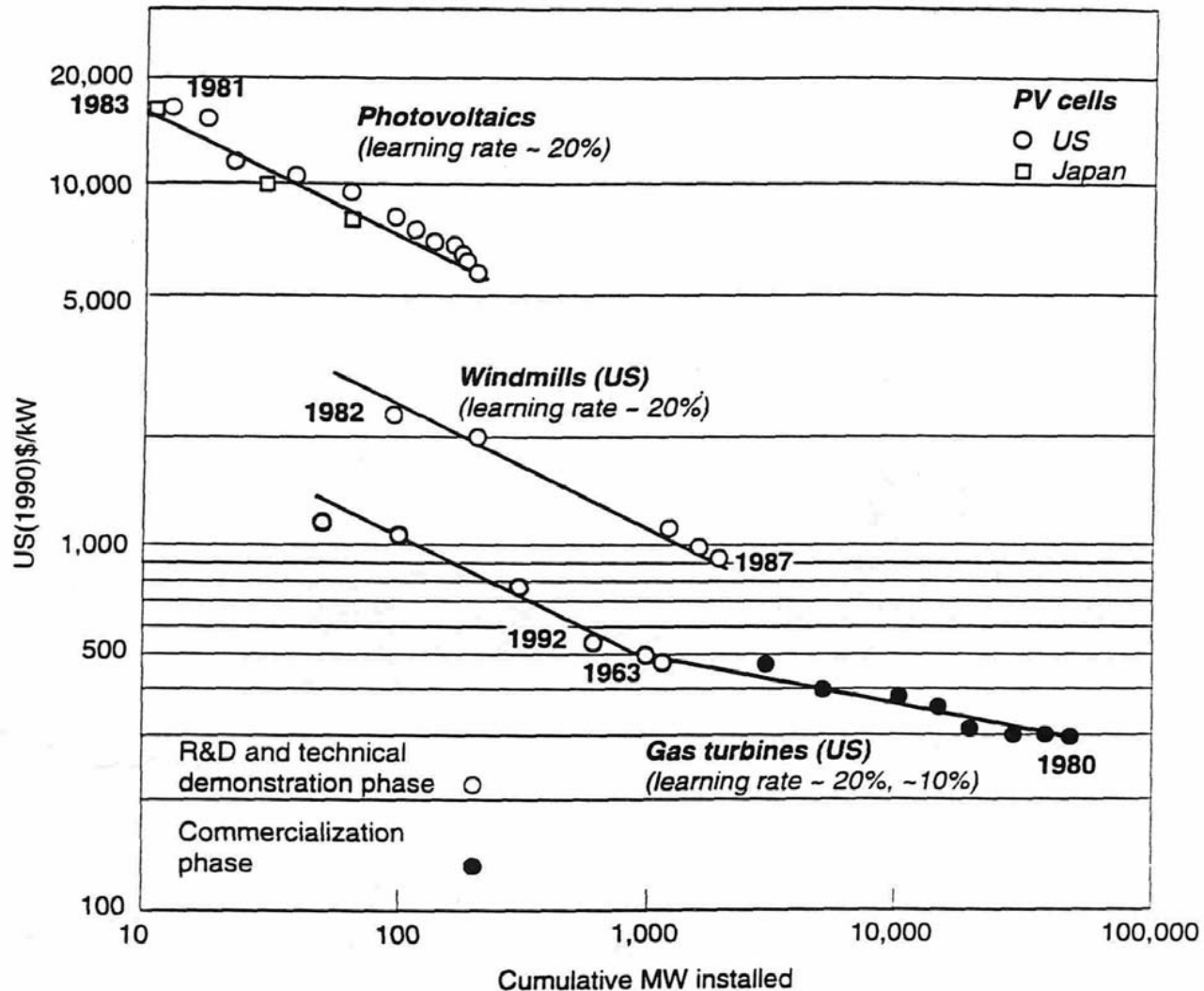


# Members of the H<sub>2</sub> Coalition?

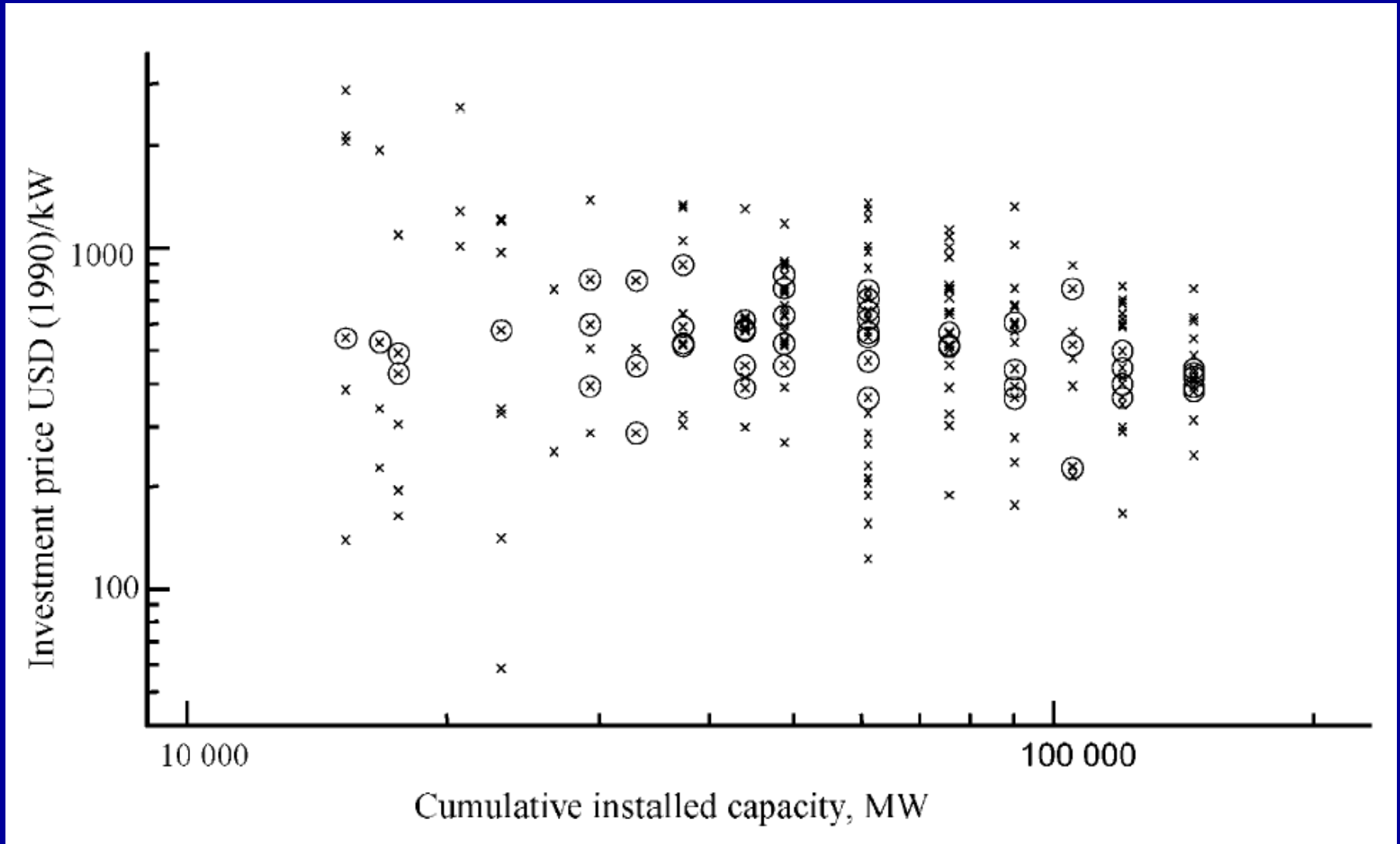
- Environmentalists?
- Gas companies?
- Coal companies?
- Automobile producers?
- Electric power generators?

# 3. Niche Markets Abuses and Uses

# Why We Care About Niches



# Abuses: Blind Assertions of “Learning”



# Hydrogen Niches: Transportation

- Mass Market Automobiles
  - Unlikely due to “lock out”
- Fleet Vehicles
  - Cutting-edge Firms
    - CNG Experience
  - Noise-sensitive communities
    - More important than air pollution?
- Ships (Farrell et al.)
  - Professional crews; located near H<sub>2</sub> source; regular routes
- Aircraft
  - LH<sub>2</sub> properties; supersonic and hypersonic

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