

**A Personal Prospective:**  
Electrification, the Electricity  
Enterprise and  
Collective Action

Thomas R. Schneider

October 21, 2002

CMU Electricity Industry Center

# Biographical Info

## - Positions

- Chair, IEEE-USA Energy Policy Committee, 2001 - 2002
- Principal, TRSenergy (consulting on energy technology and strategy), 1998 - 2002
- Executive Scientist, EPRI. Strategic research and Development 1987 – 1998
- President, Lighting Research Institute, New York, NY, and Palo Alto, CA. 1985 – 1987
- Director, Energy Utilization and Conservation Technology, EPRI. 1981 - 1986
- Assistant Director, Energy Management and Utilization, EPRI, 1979 - 1981
- Program Manager, Energy Storage, EPRI. 1977 - 1979
- Principal Research Physicist, (PSE&G, 1972 - 1977)

# Biographical Info - Education

- University of Pennsylvania, Post-doctoral Fellow, Energy Management and Power, 1972
- University of Pennsylvania, 1971, Ph.D., Physics.
- Stevens Institute of Technology, 1967, B.S.

# **The Outstanding Technological Innovation of the 20th Century?**

## **Electric Power And Electro-technologies**

# Electricity and Electrification

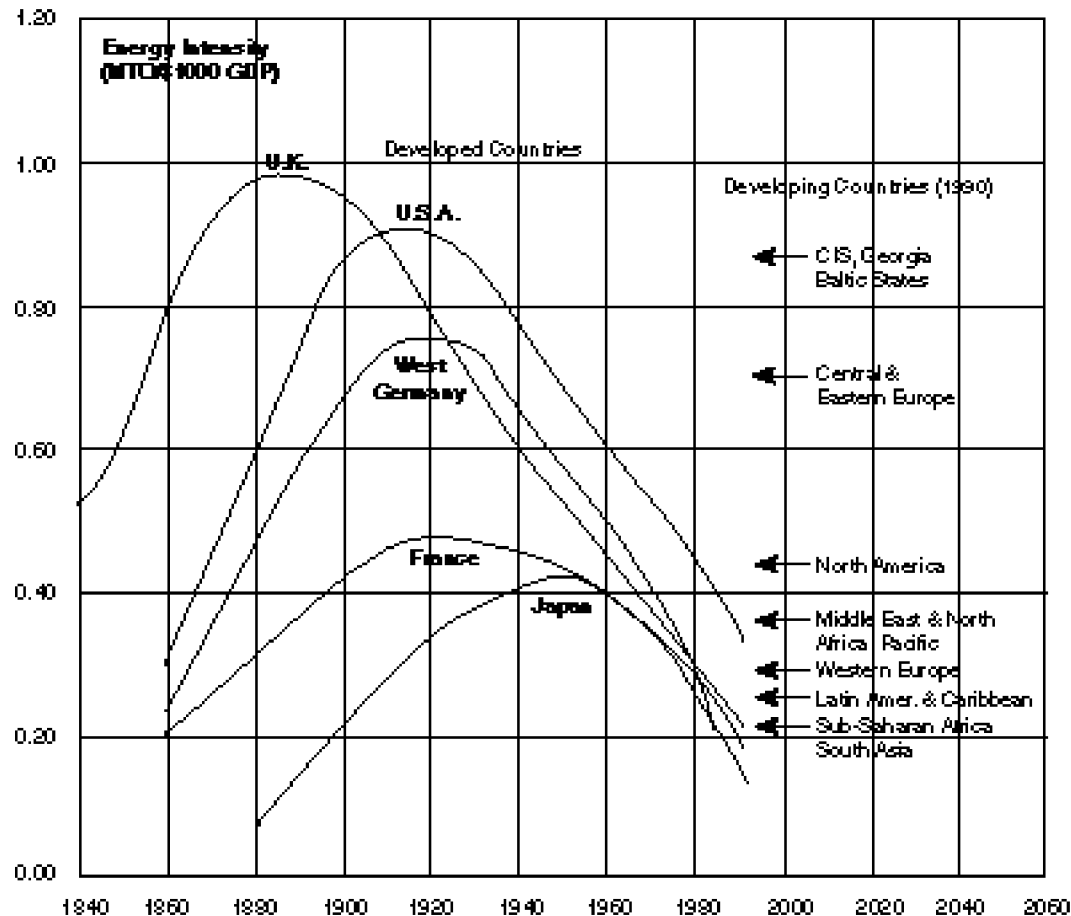
- Extended the length of the day
- Expanded the distances that could be traveled
- Reorganized the way we work
- Powers the New Electronic Economy of the 21st Century

**Electrification is an ongoing process  
and not a historical event!**

**Insert Coal Fired Tea pot**

# **Systems view of Energy**

# Energy Intensity in Developed and Developing Countries





**What was the heat rate of the Pearl Street Station**

**What is best available commercial heat rates?**

# **Major Events 1965 -1980**

- **Blackout of 1965**
- **Formation of NERC in 1968**
- **Growth of Environmentalism**
- **Formation of EPRI in 1972**
- **The October War**
- **Oil Crisis of the 70's (Carter years)**
- **PURPA and the Fuel Use Act**
- **TMI**

# Events on the 1990's

- EPAC of 1992
- Rule 888 and 889
- Early State Adopters Rush to Retail Access (Precipitously?)
- The Western Outages of 1996
- The Beginning of Price Spikes and Wholesale Market price volatility
- The Outages of 1999

# Energy Policy Act of 1992

(H.R. 776)

^(e) **EXEMPTION OF EWGS-** An exempt wholesale generator shall not be considered an electric utility company under section 2(a)(3) of this Act and, whether or not a subsidiary company, an affiliate, or an associate company of a holding company, an exempt wholesale generator shall be exempt from all provisions of this Act

# Energy Policy Act of 1992

(H.R. 776)

**^ (b) UTILITIES TO PROVIDE WHOLESALE TRANSMISSION SERVICES-** Whenever-....the Commission shall issue an order requiring each such transmitting utility (and each affiliate thereof which provides wholesale transmission service in a service area directly affected by the covered sale, merger, or consolidation, as determined by the Commission), to provide wholesale transmission services in accordance with this section and section 212. An order under this section shall include tariffs of general applicability for the transmission services to be provided and shall include such other terms and conditions as necessary pursuant to section 212.

# **Deregulation - Promises, Promises**

- **Lower Costs to Consumer and Society**
  - 1999 EIA \$ 20 Billion
- **Releasing the forces of innovation**
- **Creating Freedom of Choice and New services**

# Results of Restructuring??

- **CA Costs Of \$9 To \$30 Billion**
- **Innovative Generation Technology?**
  - **60% to 65% ICCC. 40% Simple cycle**
  - **3-D Seismic imaging and horizontal drilling for gas?**
- **Creating Freedom of Choice**
  - **Green Electrons?**
  - **Higher costs**
  - **Lower reliability**

# Results of restructuring??

- **Enron, New Power (bankrupt -- 'nuff said)**
- **PG&E (bankrupt)**
- **NRG Energy (close to bankruptcy)**
- **Allegheny Energy (shares down 50%)**
- **Aquila (shares down 85%)**
- **Williams Co. (shares at near all-time low)**
- **Dynegy (shares down 15%)**
- **Illinois Power, a Dynegy subsidiary (faces \$2 billion in debt)**



# Results of restructuring??

- **Mirant (shares all-time low; bonds rated lower than "junk")**
- **TXU Corp. (shares down 34%)**
- **Duke (shares down another 5%)**
- **Teco Energy (shares down 13%)**
- **El Paso (shares at a 52-week low)**
- **Calpine (shares at a 52-week low)**
- **American Electric Power (shares down 23%)**
- **Dominion and Northeast Utilities (shares down 13%)**

# **How to Move Forward?**

Is a Standard Market Design the  
answer?

How does one validate market  
design?

# H.R.4: Senate response to House

October 2002

15      **“SEC. 210. STANDARD MARKET DESIGN RULEMAKING.**

16      “The notice of proposed rulemaking issued by the

17      Federal Energy Regulatory Commission entitled ‘Rem-

18      edying Undue Discrimination through Open Access Trans-

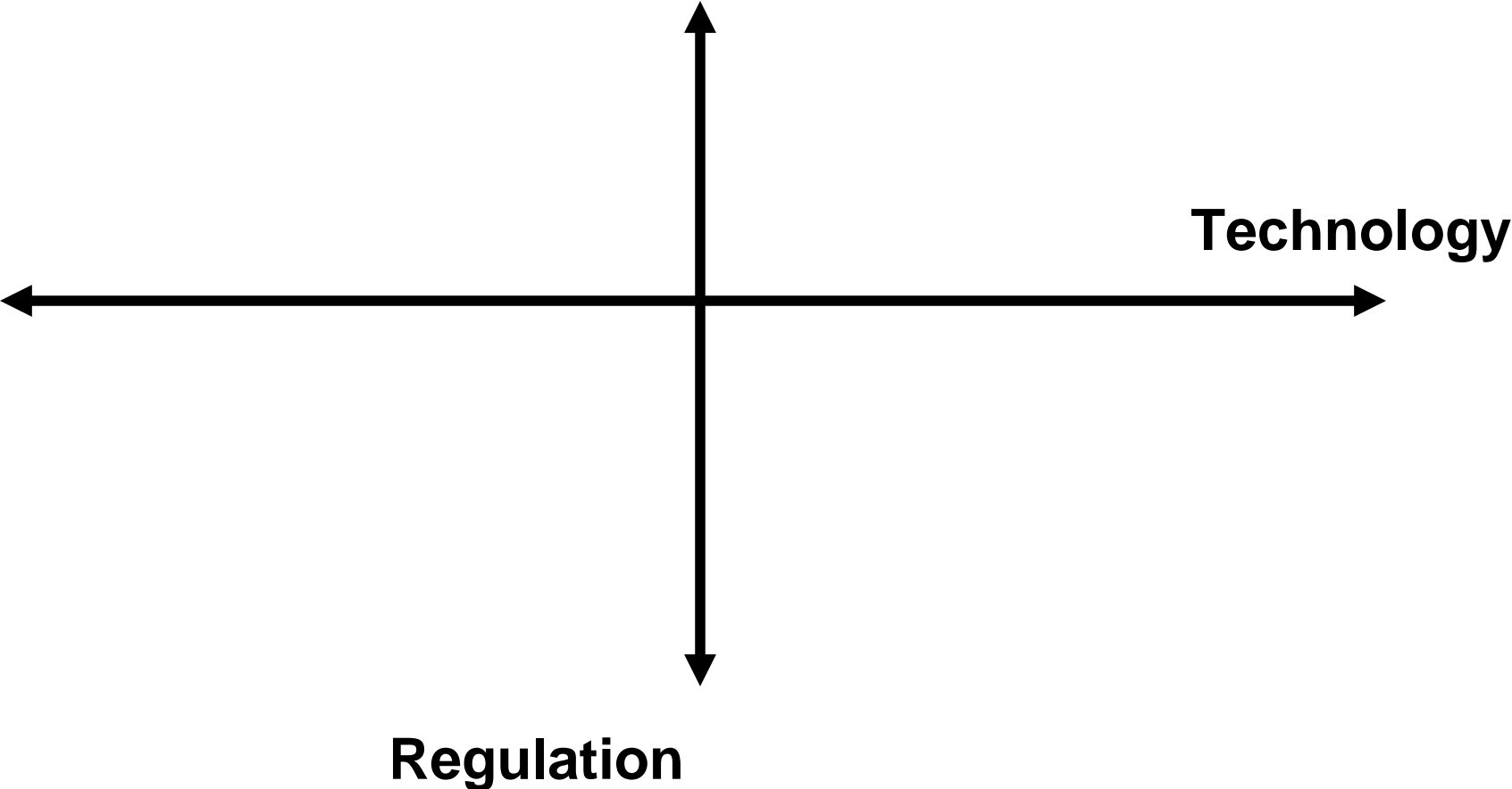
19      mission Service and **Standard Electricity Market Design’**

i20      **is vacated.**

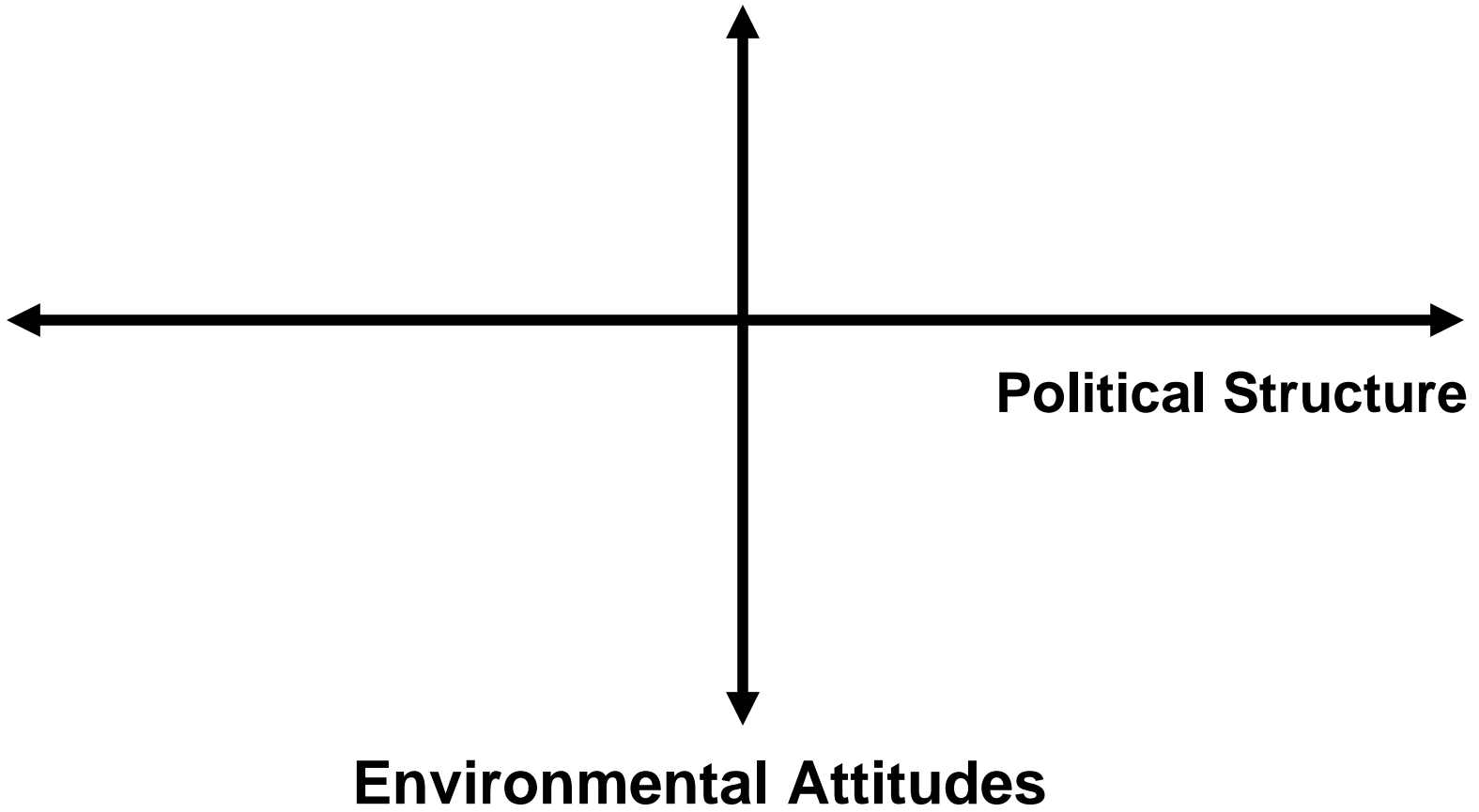
**Looking Towards the Future**

Taking the Long View

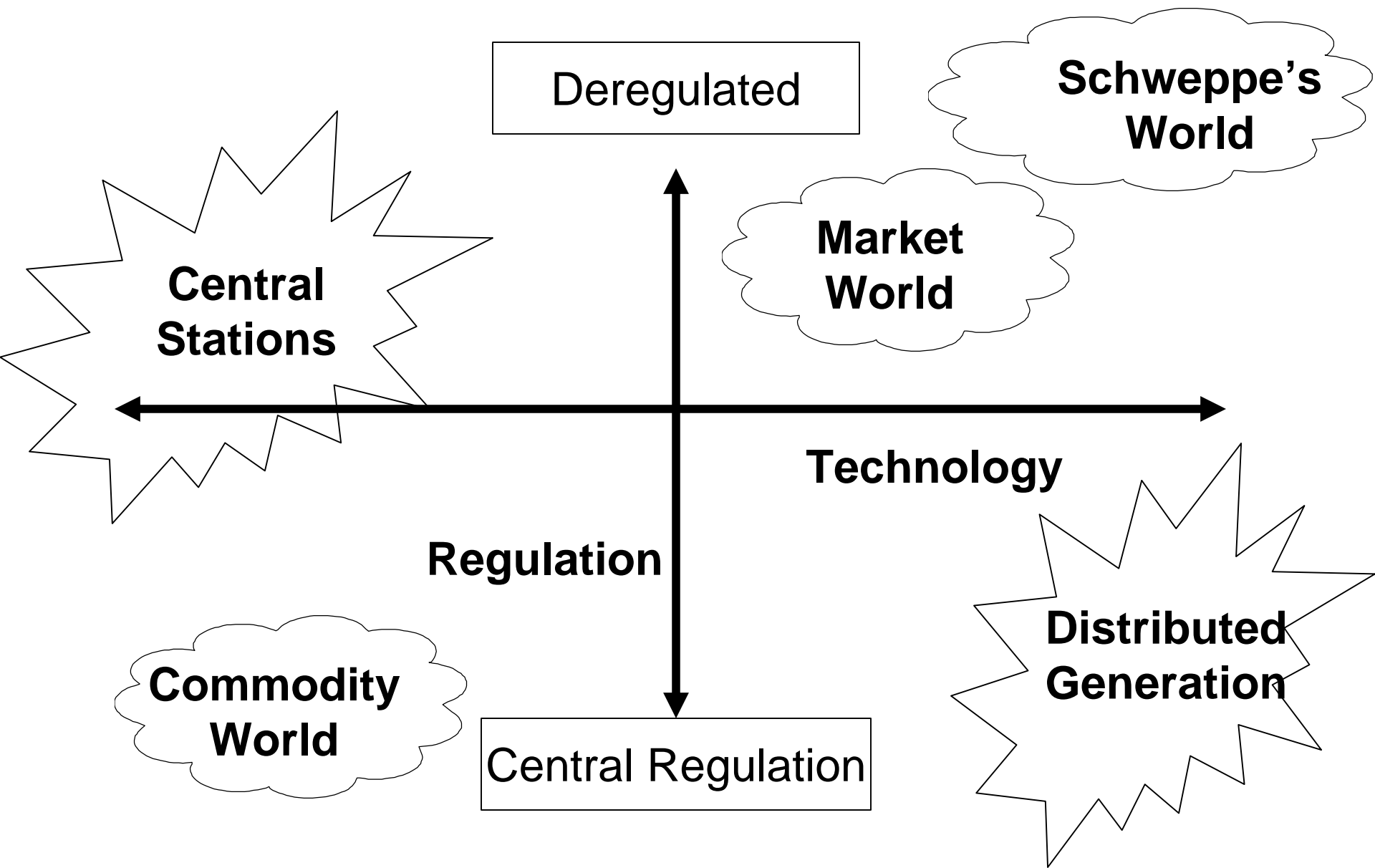
# Regulation-Technology Scenarios



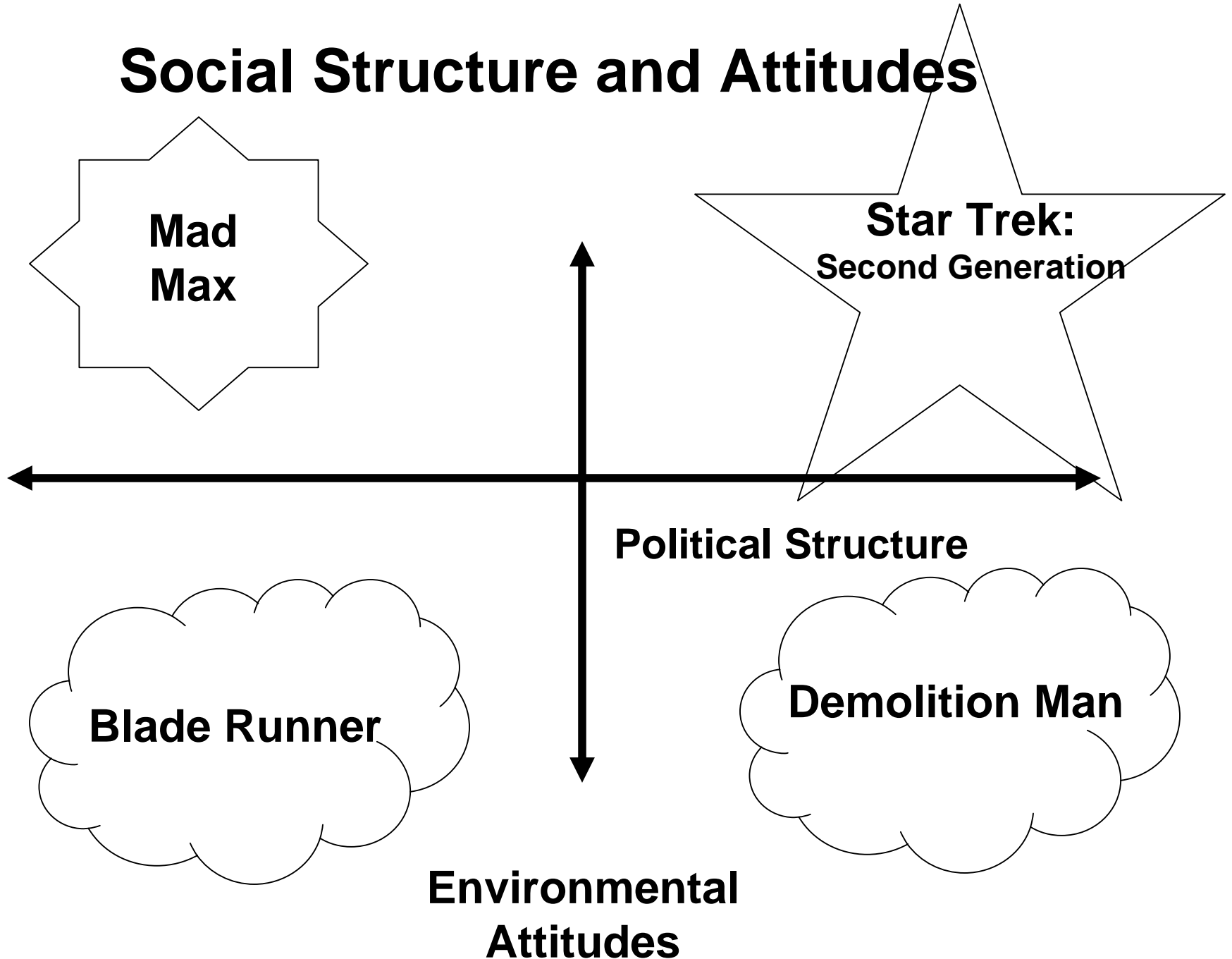
# **Social Structure and Attitudes Scenarios**



# Regulation-Technology Scenarios



# Social Structure and Attitudes





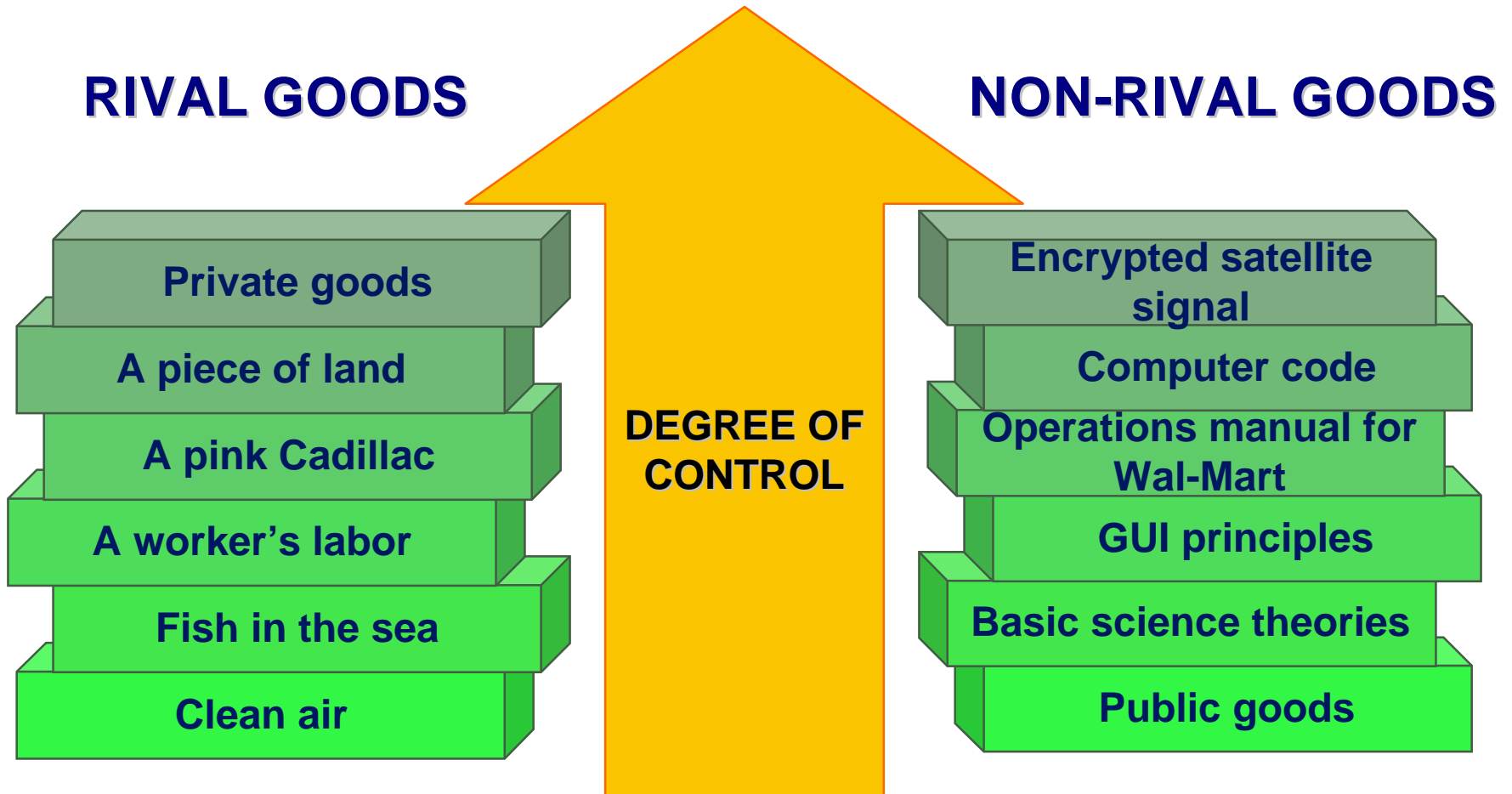
# Taxonomy of R&D



# Assumptions

- R&D creates knowledge and innovation
- Knowledge and innovation drives GDP in excess of other inputs
- Government has role in increasing health, welfare and prosperity of citizens
- Government has role in addressing market failures

# Economic Attributes of Goods



# Dimensions of Value of R&D

- Breadth and monetary value of R&D
  - Individual firm - tens of \$Millions
  - Industry as a whole - tens of \$Billions
  - Society - \$Trillions
- Compounding of value over time
  - Spread of results to other industries
  - Compounding of results
- Unexpected consequences
  - Unexpected and unanticipated
  - Scope of impacts that are unexpected

# Market Failures

## Under-Investment in R&D

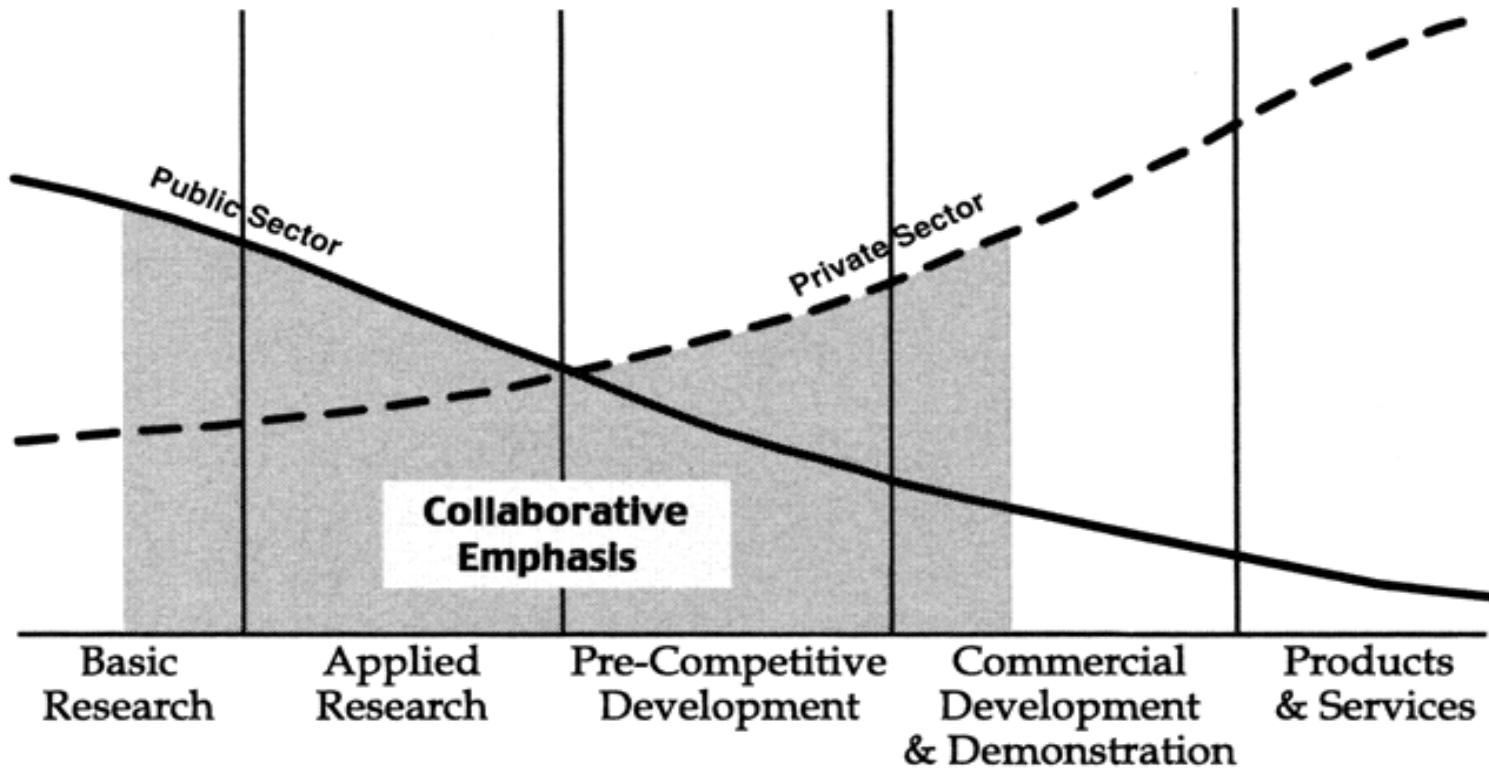
- General
  - non-capturability, benefits accrue to society rather than individual firm
  - Cost of capital, return too distant to benefit
- Industry Specific
  - External discontinuities
  - Regulatory changes
  - Market timing

# Under-Investment in R&D (Cont.)

- Company Specific
  - Functionality of innovation
  - Scope of Market
  - Infrastructure technology
- R&D Specific
  - Intrinsic technical risk
  - Development time
  - Excessive investment cost

# Filling the Gap

R&D Investment



# Collective R&D Response Industry Specific

**MARKET FAILURE**

**PRIVATE SECTOR  
RESPONSE**

**GOVERNMENT  
RESPONSE**

<b>External discontinuities</b>	<b>Horizontal consortia</b>	<b>Government funding</b>
<b>Regulatory changes</b>	<b>Horizontal consortia</b>	
<b>Scope of market</b>	<b>Concentric consortia</b>	
<b>Market timing</b>	<b>Horizontal consortia</b>	<b>Government funding</b>



# Collective R&D Response

## Topic Specific

**MARKET FAILURE**

**PRIVATE SECTOR  
RESPONSE**

**GOVERNMENT  
RESPONSE**

<b>Non-capturability</b> <b>Disciplinary basic science</b> <b>Generic research</b>	<b>Horizontal consortia</b>	<b>Direct government funding</b>  <b>R&amp;D tax credits</b>
<b>Infrastructure technology</b>	<b>Horizontal consortia</b>	<b>R&amp;D tax credits</b>

# Why collective action ?

- Reduce costs of resolving social dilemmas
- Eliminate duplication of efforts
- Develop common pool resources greater than single firm can afford
- Influence actions of outside parties
- Address common problems
- Reduce risks

# Theoretical Background

- Game theory and small group social dilemmas - Huberman
- Study and Theory of Common Pool Resources – Ostrom
- Economic properties of goods - Romer

# References

- **Paul M. Romer, Implementing a National Technology Strategy with Self-Organizing Industry Investment Boards,** Brookings Papers: Microeconomics 2, Brookings Institute, Washington, DC (1993).
- **Elinor Ostrom, Governing the Commons: The Evolution of Institutions for Collective Action,** Cambridge University Press, Cambridge, UK (1990).
- **P.A. Roussel, K.N. Saad, and T.J. Erickson, A.D. Little, Inc., Third Generation R&D: Managing the Link to Corporate Strategy,** Harvard Business School Press, Boston, MA (1991).
- **N.S. Glance and B.A. Huberman,** Scientific American, p. 76 (March, 1994).

# Theory of Social Dilemmas

- Small group and each participant knows the others action and its impact
- Continuing connection with the group's future
- Ability to periodically reassess group's actions and understand that their own actions are being judged

# Common Pool Resource Design

- Right to organize
- Clearly defined boundary and withdrawal rights
- Consistency between rules and local conditions
- Mechanisms for true collective choice
- Accountability to participants
- Graduated sanctions
- Low costs conflict resolution
- Governance in nested layers

# Principles for Collective R&D

- Right to organize and cooperate
  - University research centers, U/iCRC
  - Government private partnerships
  - Non-profit collective R&D institutions
  - R&D Partnerships, National Cooperative Research Act of 1983
- Sharing the costs and equitable benefits

# Principles for Collective R&D

- Right to organize and cooperate
- Sharing the costs and equitable benefits
  - Clearly defined boundaries of resource and withdrawal rights
  - Consistency between rules and local conditions
  - Monitoring accountable to participants
  - Gradual systems of sanctions



# Collective R&D Institutions

- Non-profit public-benefit corp. 501(c)3
- Horizontal R&D consortia or partnerships
- Private sector self-taxing collective R&D
- University/Industry collective R&D
- University/Industry collaborative R&D
- Industry/Government partnerships
- Direct government funding
- Private Foundation Funding

# **Collective R&D Institutions**

**The CMU  
Electricity Industry Center is a  
Common Pool Resource and  
NGO for Collective Action!**

# **Sloan Industry Research Centers: - one form of Collective R&D**

- Minimal right to organize and cooperate
  - Sloan sponsorship provides credibility with industry
  - University host provides safe harbor

# CMU Electricity Industry Center

- Privately funded academic research center
- First year of operation - an impressive start
- Established strong cadre of students
- Established initial research directions
- Created strong advisory board
- Current results?
  - Students
  - research

# Searching for Future Direction

- Vision of Success
- Art of the Long View
- Third Generation Portfolio Analysis
- Differentiation and Collaboration
- Strategic Alliances and “Cooperation”
- Broaden Funding Base

# **CMU Electricity Industry Center ?Future Directions?**

- Expand Concept beyond Academic Research center?
- Provide National Leadership in the Electricity Enterprise?
- Become an NGO for Collective Action
- A Common Pool Resource?
- Exercise Convening Power

# Many Open Questions for EIC

- What R&D topics are most appropriate?
- Where should students go after graduation?
- What is the appropriate scale of EIC?
- What are appropriate funding levels?
- What is the scope of non - R&D activities?
- What is the longevity of Sloan funding?
- Can a stable source of industry or government funding be developed?

**Open Discussion**

**Thank You!**