Responding to the Blackout of 2003
Assuring
Safe and Reliable Electricity

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Vermont Public Service Board

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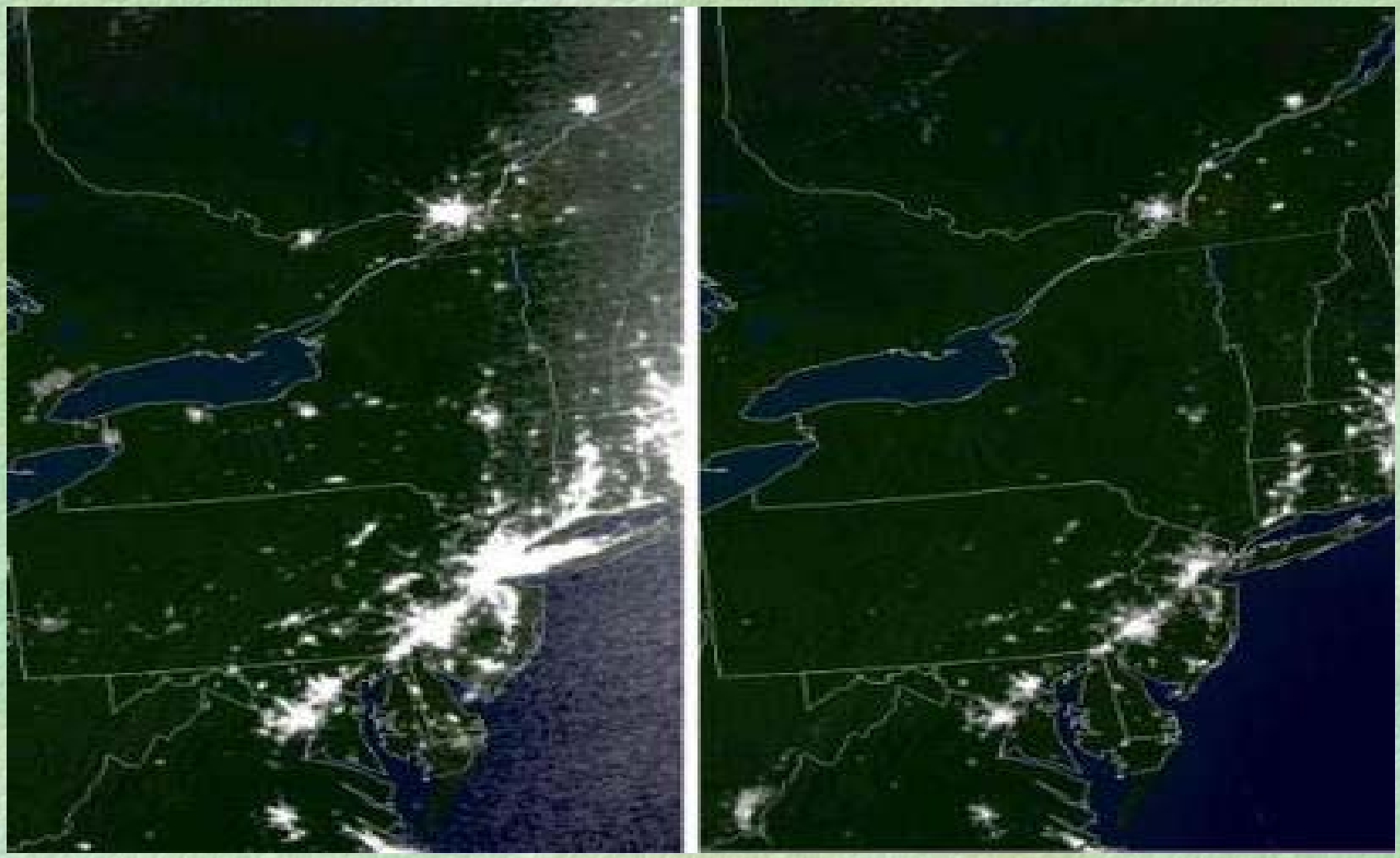
For The Council of State Governments
Eastern Regional Conference

Within minutes, 50 million North Americans lost electric power: the largest, the most recent, in a series of increasing frequency and magnitude.

What Stayed On ?



Multi-Million Person Blackouts Are A *Recurring* Reality:
1965, 1977, 1982, 1996, 1998, 1999, 2003

The system-architecture of central station power and bulk transmission can*not* reduce their probability to zero.

The August 2003 Events: The "Interim Report"

Steps to Making Such Things Less Likely & Less Serious:

- Near Term: One Mind at the Wheel
- Mid Term: Efficiency and Smart Dispatch
- Long Term: Distributed Generation and "Islands"

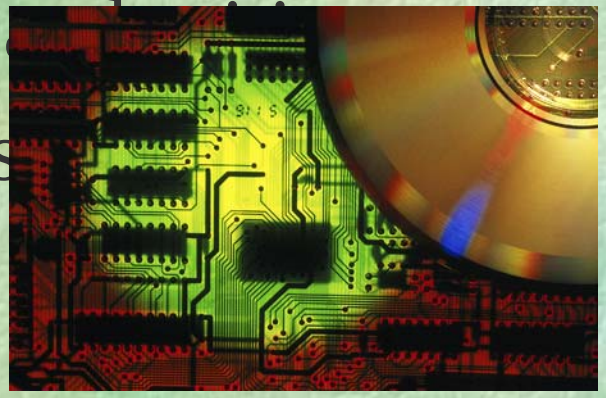
Making It Happen: Markets, Finance ***and*** Regulation

What Happened: Interim Report

- What caused the blackout
  - Inadequate situational awareness by FirstEnergy
  - Inadequate tree-trimming by FirstEnergy
  - Inadequate diagnostic support by reliability coordinators serving the Midwest
- Nuclear plants performed well
- No malicious cyber attack caused blackout

Interim Report Conclusions: Garry Brown

- Failure to follow reliability standards and procedures
- Equipment problems
- Computer and communications problems
- Unclear responsibilities and
- Failure to maintain transmiss
  ways (e.g. tree trimming)



Going Forward: Garry Brown

- Mandatory reliability rules with enforcement penalties
  - Cannot operate critical electricity system with voluntary compliance to reliability rules
  - Must be meaningful penalties for noncompliance
  - Requires federal legislation (part Bill)

Going Forward; Garry Brown

- Strengthening the electricity infrastructure
  - Need to improve regional planning and eliminate seams between systems
  - Properly functioning markets can attract investment dollars
  - Dynamic between regulatory intervention and the functioning of the free market must be harmonized
  - Uncertainty limits investment in new infrastructure – Congress and FERC must act through legislation and regulation where required

One Set of Hands on the Wheel

Operational Authority

There must be a single entity with clear operational responsibilities and authority for the bulk power system in a region.

- The system operator must be an independent transmission manager.
- Clearly defined operational responsibilities between the RTO and transmission entities reduce operational risk, particularly under emergency conditions.
- Key operational responsibilities should not be delegated.

Going Forwards: Amory Lovins' List

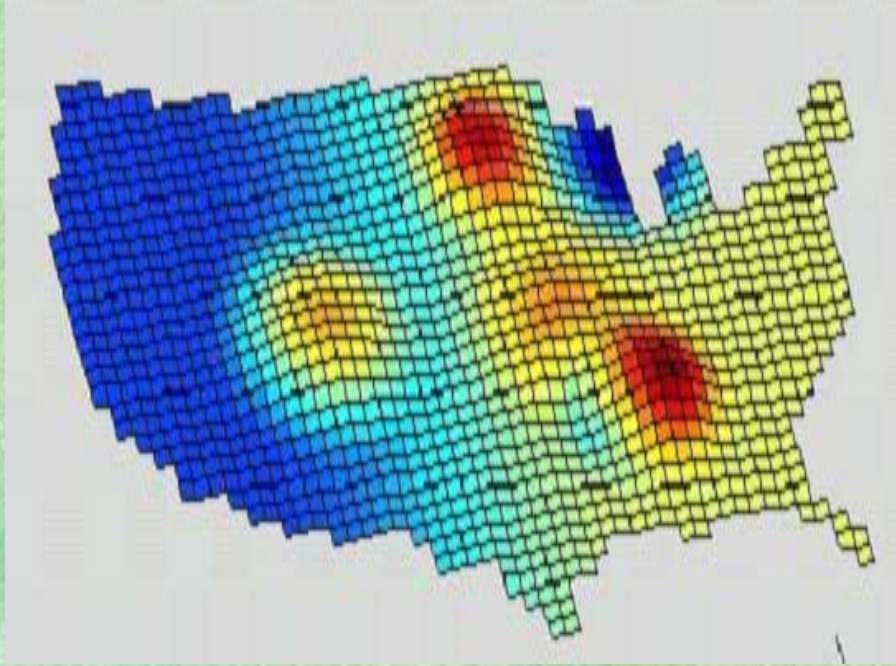
- Modest tx modernization (switches, management) is needed
- But more & bigger tx lines mean more & bigger blackouts
- Basic problem: grid architecture, overconcentration
- Three solutions are faster, cheaper, resilient, and ample
  1. End-use efficiency (also saves gas, cuts gas price & emissions)
  2. Demand response (does so dramatically; also saves cap., stabilizes kWh & gas prices, and insures against price-gouging)
  3. Distributed generation designed for islanding (IEEE 1547) — the "islands of light" amidst the darkness; also nucleate restart

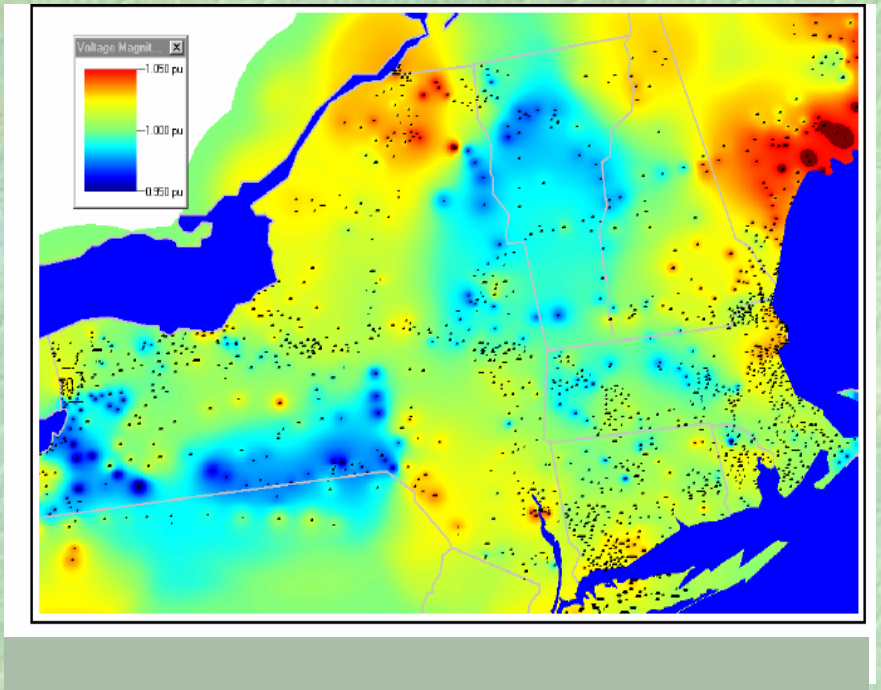
Big generating units far from load are *not* equivalent to small ones nearby

Digitally Smart Dispatch:

Whatever level of load the electric system must ultimately meet, it will do so more effectively with an improved, digitally-enhanced, command, control, and communication infrastructure (C^3I). The Electric Power Research Institute, the Electricity Innovation Institute and others have begun to identify this need – and its potential benefits. A digitally-enhanced grid will allow smarter monitoring of grid status, smarter dispatch of transmission and generation, and a far more reliable, stable, and robust electric system

Fast Simulation and Modeling Software System (FSM)





- Electricity transmission and distribution system
- Faster-than-real time for multiple timescales
- Key to automated grid control and recovery

Four Steps to A Digitally Smart Electric Grid

Michael Dworkin EPRI Talking Piece: August 2003 (*Conceptual*: Numbers Merely Order of Magnitude)

Concept	Smart **Load**	Smart **Monitoring**	Smart **Dispatch**	Smart Grid **System**
Timing	1-5 years	2-6 years	5-8 years	10-30 year (CEIDS)
Funding?	95% private $	50% private $	90% private $	80% private $
Cost Guesstimate	$ 3-5 billion	$ 5-8 billion	$ 10-20 billion	$ 50-100 billion ?
Scope of Task	1-500 large end users reading wholesale prices in each wholesale market, then telling System Operators how they will respond.	1-5,000 switches and 1-5,000 substations monitored in each system, then integrated for reporting to DHS	5-10,000 generators & 1-5,000 switches, & 1-5,000 substation controlled by each System Operators; FACTS, etc, at scalable level to control power flows	10 million - 100 million appliances, plus 5,000 transmission points, plus 10,000 generators within Control Regions

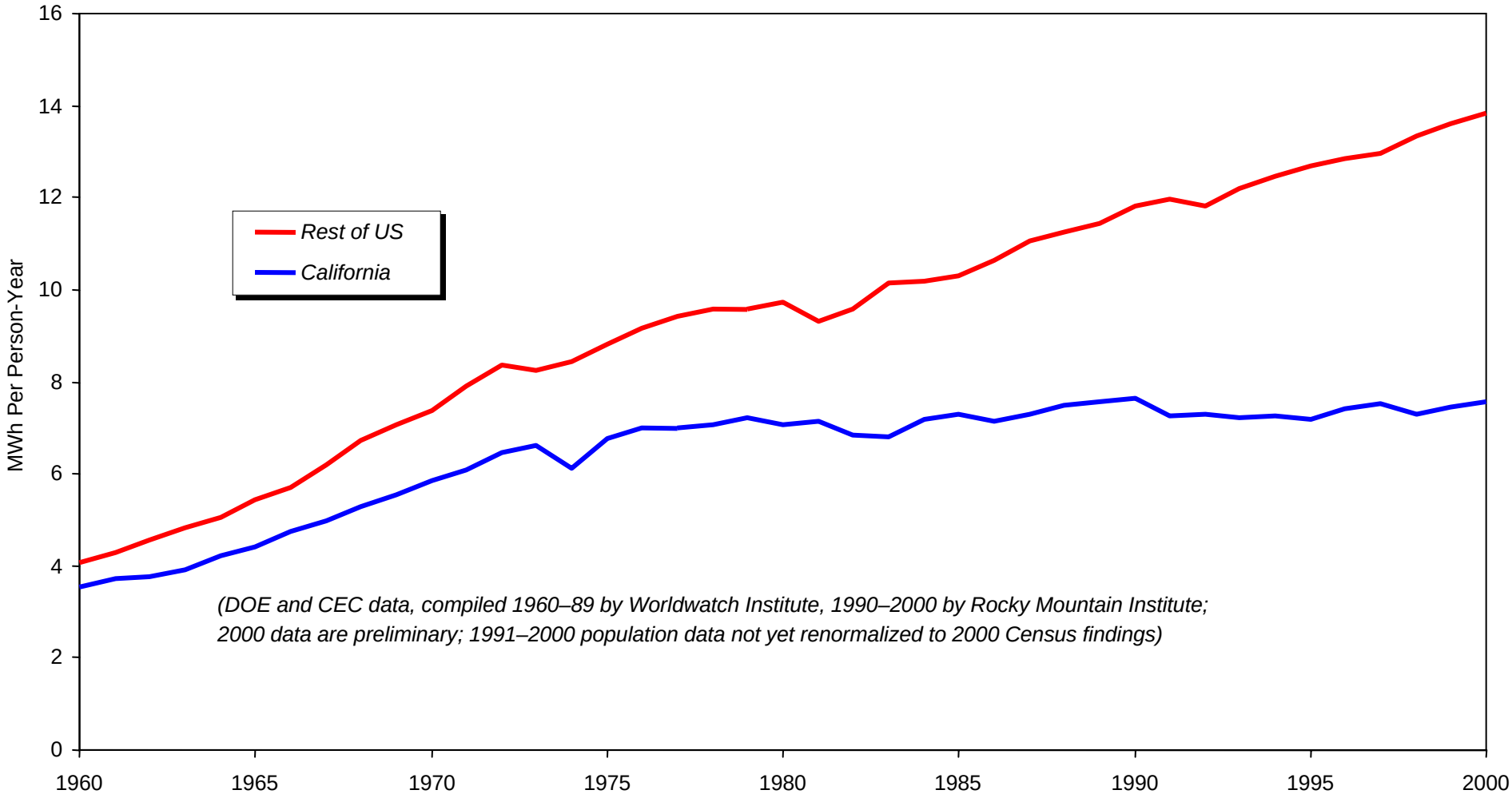
Efficiency

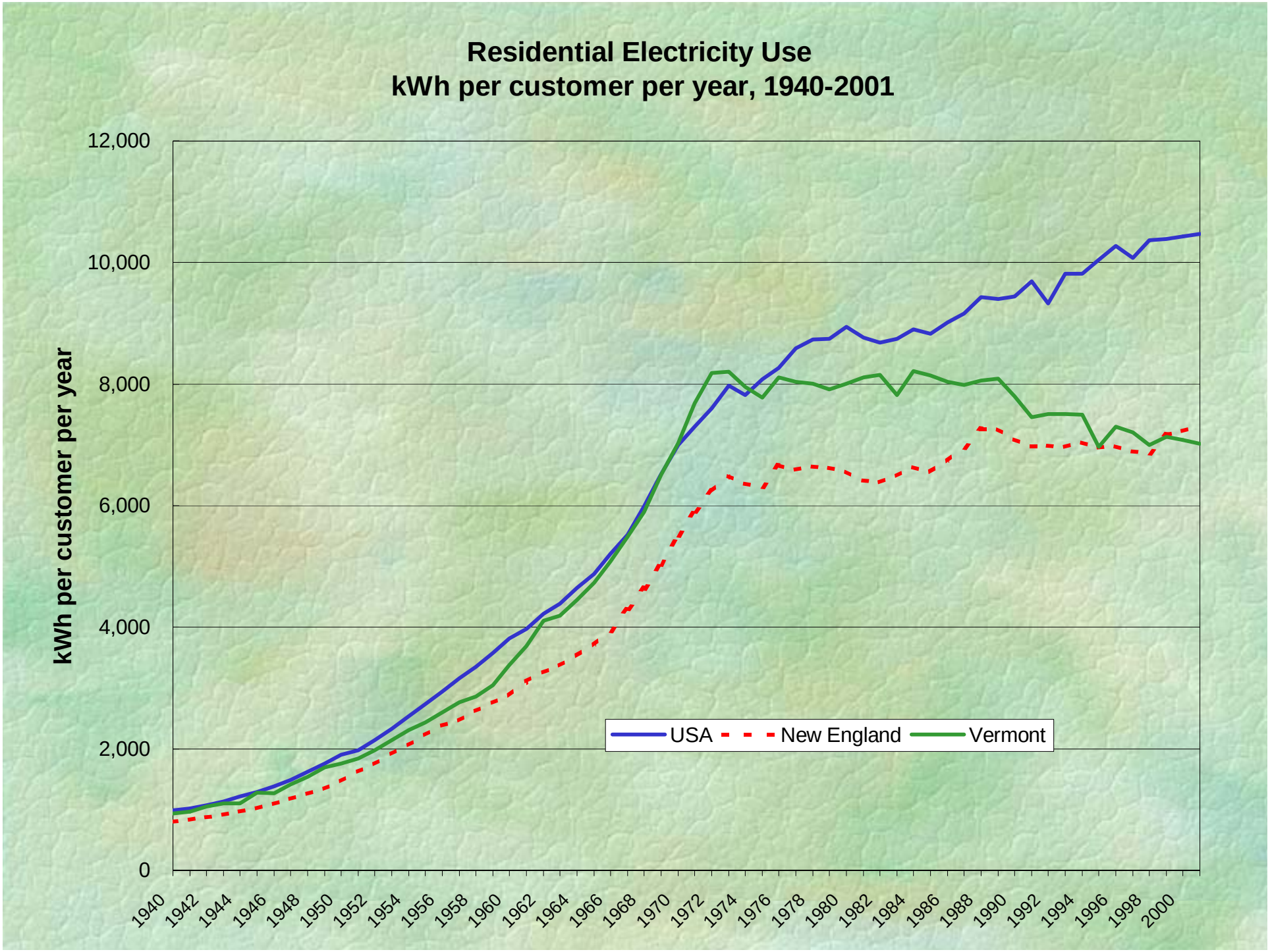
stress on the electric grid will be materially eased to the extent that we, as a society, move toward more efficient end-use of energy and greater customer response to grid conditions. Energy efficiency and demand response measures produce results by reducing load overall and at critical peak times. A commitment to these resources, particularly long-term energy efficiency programs, is critical to both the reliability and cost-effectiveness of our electric system. Because low-cost energy efficiency improvements avoid more expensive generation, fuel, and delivery costs, they can improve the reliability of America's grids while actually lowering customers' electricity bills.

Here is an analogy: American inventiveness and ingenuity beat the Russians to the moon, not by building bigger rockets (generation and transmission systems) than the Russians did, but by deploying lighter weight capsules and lunar modules (more energy efficient end-use). Our rockets were less strained because they had to lift less weight; similarly, our grid will need fewer resources as load is eased through the deployment of more energy efficiency.

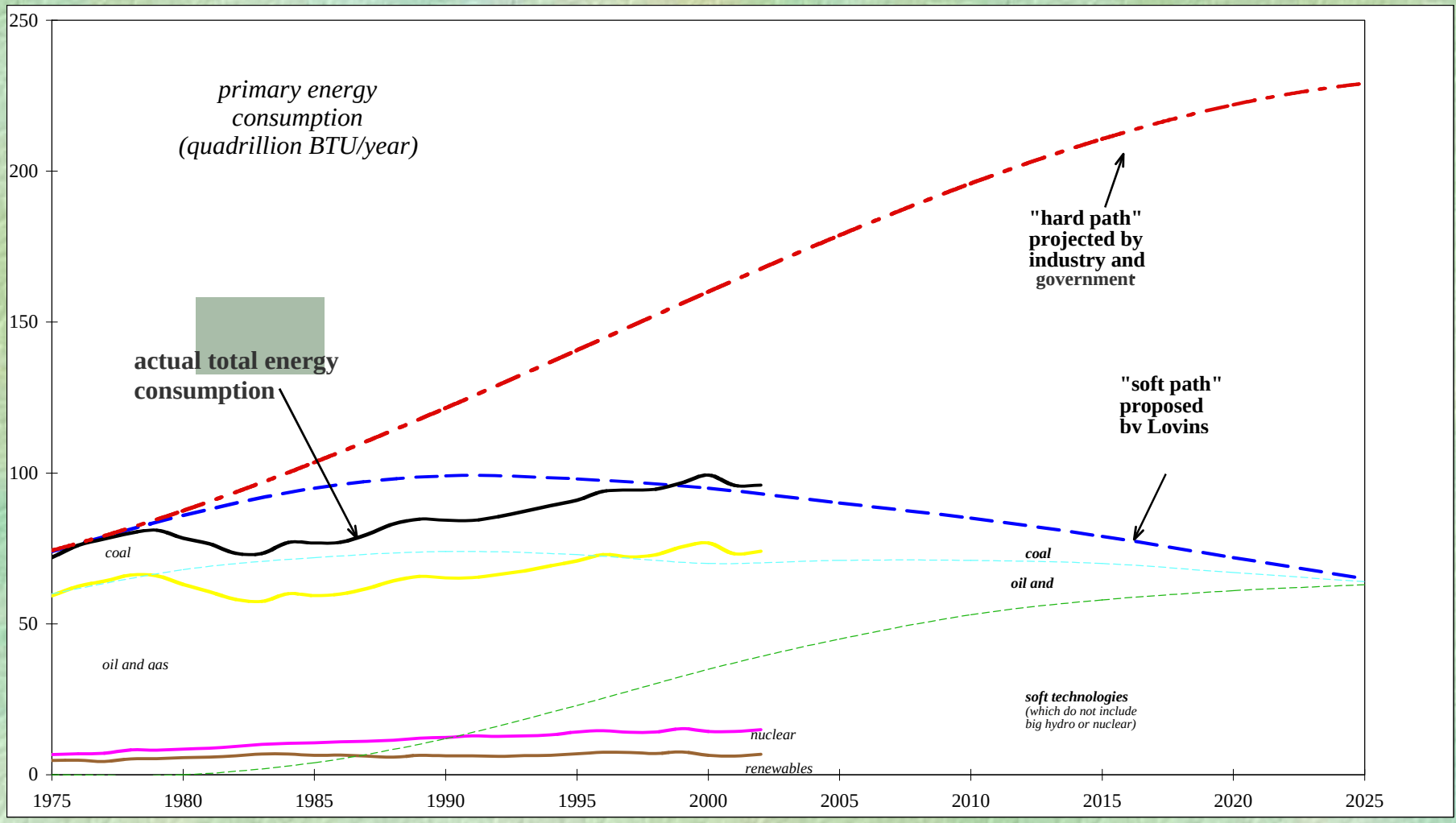
California: policy works

Per-Capita Electricity Consumption, 1960–2000




Residential Electricity Use
kWh per customer per year, 1940-2001
kWh per customer per year
12,000
10,000
8,000
6,000
4,000
2,000
0
1940
1942
1944
1946
1948
1950
1952
1954
1956
1958
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
USA
New England
Vermont

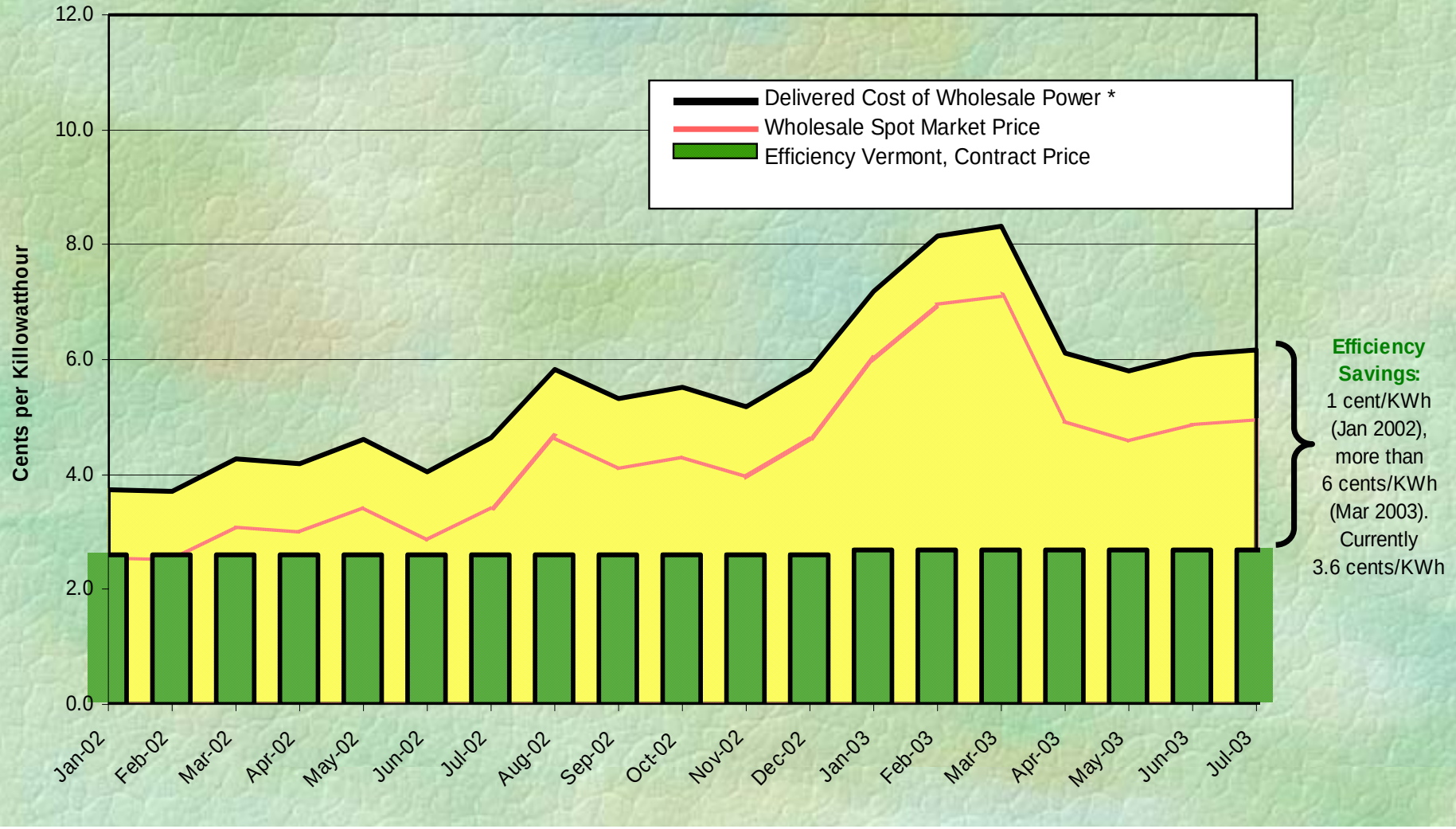
Lovins: US energy/GDP already cut to 1973 **“soft path”**



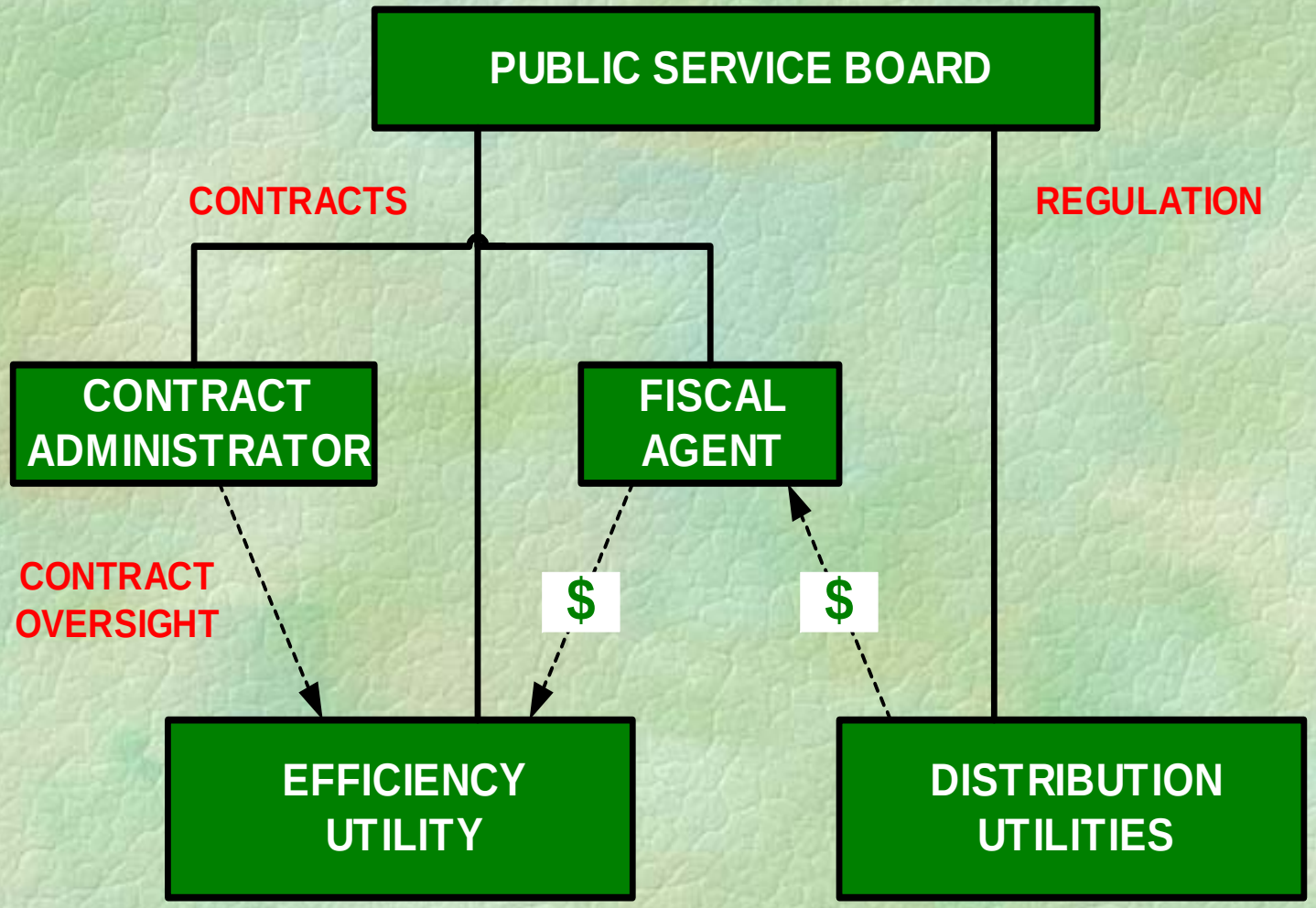
but that just scratches the surface, esp. for oil & electricity…

Power Costs vs. Efficiency Vermont Costs for 2002 & 2003

NE-ISO Average Monthly Price



EEU STRUCTURE



What is Needed to get the System We Need Built ?

- What do investors want?
  - Theory #1 –
    - High probability of moderate returns
    - Barriers to competition; Holding Company Act
    - Strict enforcement of uniform system of accounts
  - Theory #2
    - Moderate probability of high returns
    - Easy entry; Easy Consolidation/Affiliation
    - SEC and FERC tolerance of self-accounting
- Which cluster is more likely to encourage capital investment in vital infrastructure?
- “Lets run the numbers…”

Yesterday & Tomorrow

- EarlyTwentieth Century
  - Just and Reasonable Rates
    - PUCs retail: 90-98% of total
    - FERC wholesale: 2-10% of total
- Mid- Twentieth Century
  - *SEC - rules, transparency, enforcement*
    - *2 dozen utilities broken into 200 companies*
  - One of History's Greatest Flows of Capital
  - "The fastest, cheapest, wiring of any continent"
- 1995 ----> ???
  - Market-Based Rates replace Just and Reasonable Rates
    - FERC wholesale: 25-50% of total: how much more?

Electric Realities – Key Constraints

- Immediacy of load balancing (low storage)
- Significance (magnitude AND criticality)
- Inter-relatedness / Commonality
  - deficiency (including physical or economic withholding) of one supplier harms its customers AND others
- High Entry Barriers: Access to Capital Vital
- Huge External Environmental Implications
- Terrible Demand Response
  - Real-Time Feedback Pricing Doesn't Work Now – Can It Ever ?
    - A Market without demand curve is not a Market

Investor Fear → Capital Flight

(I should add "back to 1995" data to show the 95 to 98 squeeze-out of excess/stranded investment in **those** years)

- Utility Stock Market Capitalization:
  - **1998 - $460Billion**
  - Reactions to prospect of competition,
  - This is *before* general market loss
  - **2000 - $395 Billion**
  - Reactions to early years of competition
  - *and* general market loss
  - **2002 - $290 Billion**
  - Trifurcated Results:
  - Risk from Competition? → Capital Stalls
  - Accounting/Affiliate Issues ? → Capital Flees !
  - Cost of Service/Monopoly → Capital Arrives !

  - Source: Wilshire 7000 – U.S. Stock Capitalization

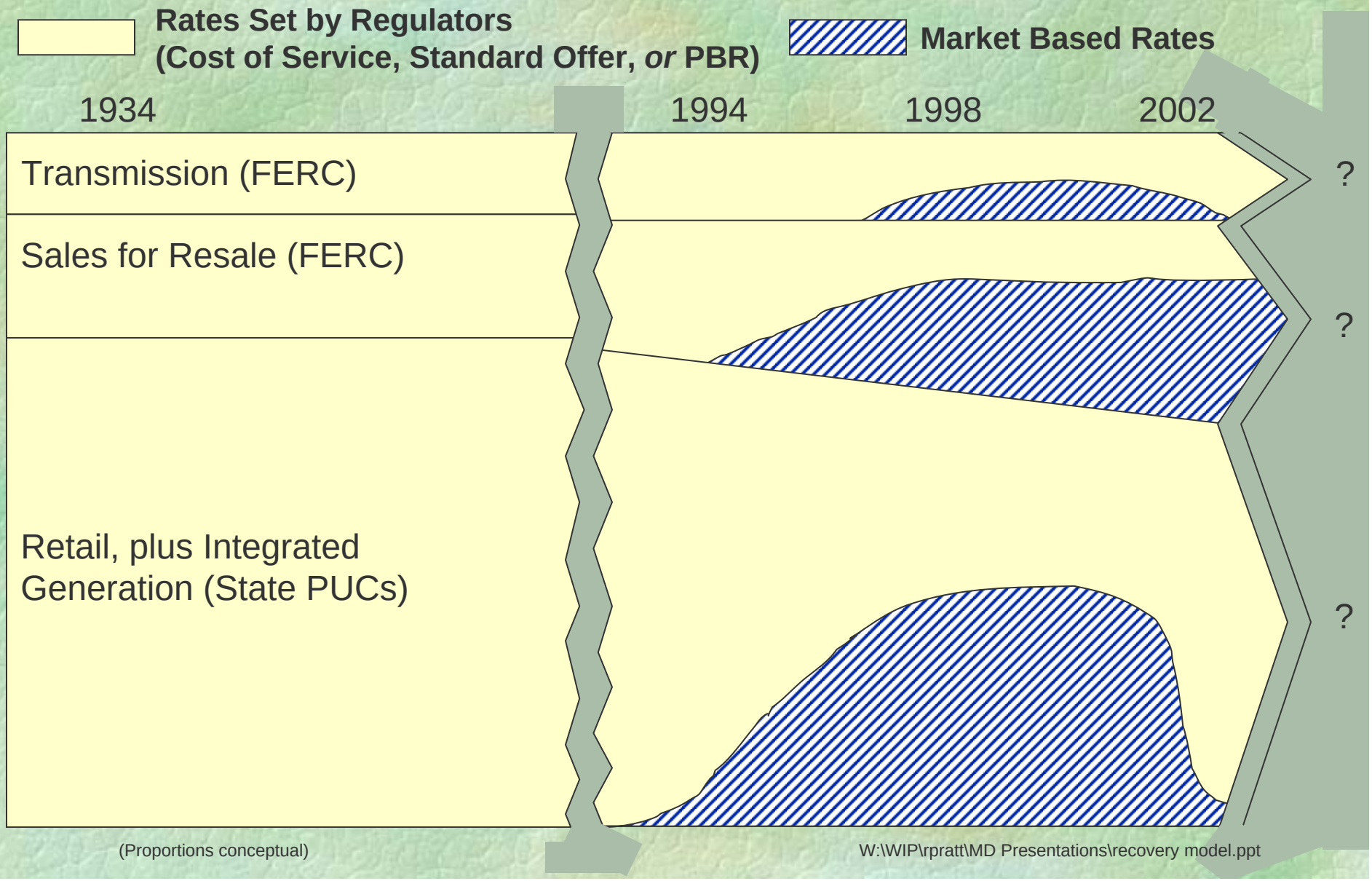
Is the Game Worth the Candle?

- Efficiency Gain from Market *Might* Equal

2-4 % of Delivered Cost of Power (FERC/ICF)

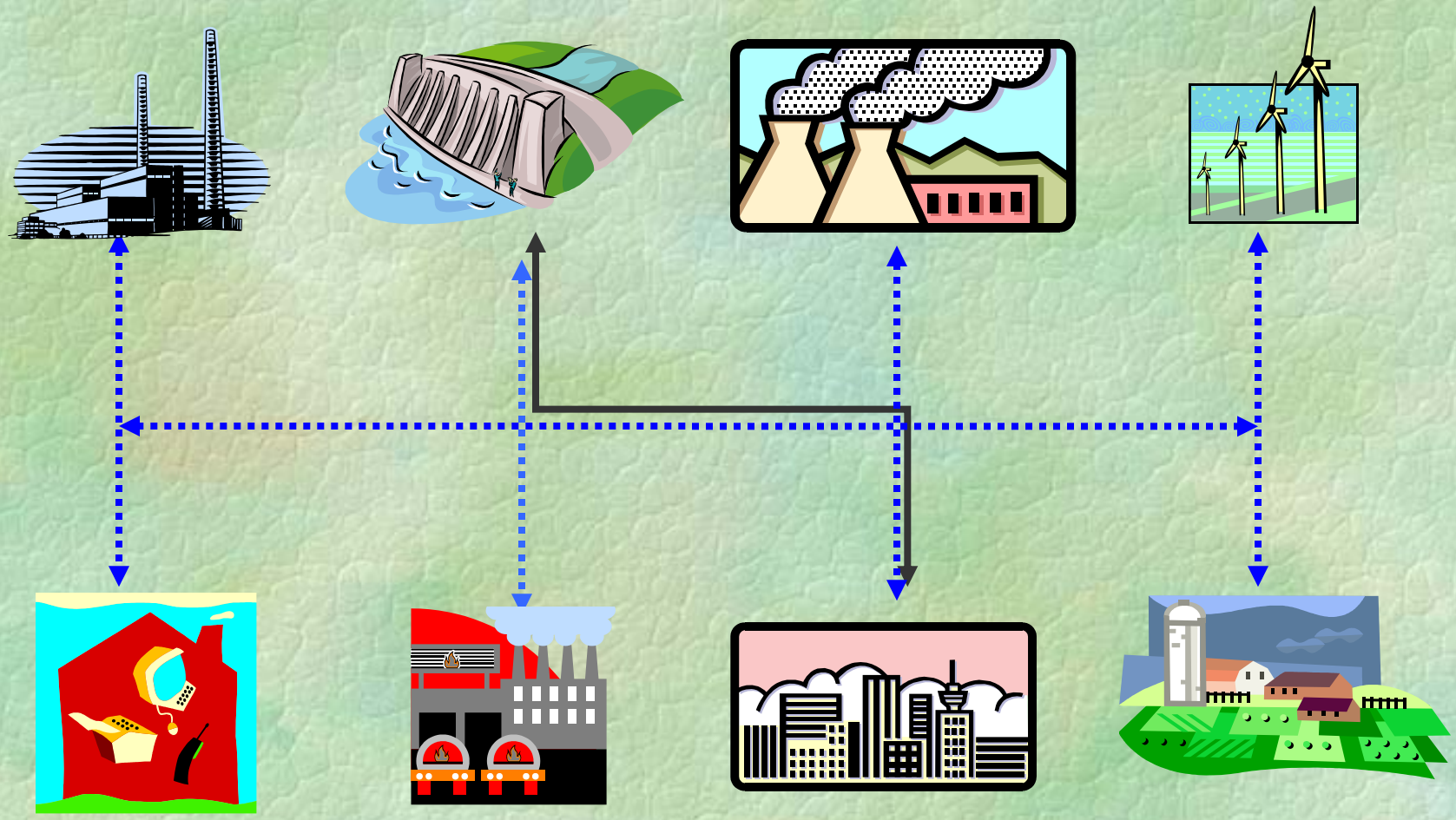
- Premium for Market Risk May Outweigh the Efficiency Gains from Market Discipline:
  "Investors LIKE Monopolies"
- Cost of Increased *Supply Margins* May Outweigh Gains From Market Discipline: Pivotal Firm Analysis Dictates Major Increase In Supply Margins
  - » -Blumsack,Perekhodtsev & Lave: Electricity Jnl. 11/02
- Customers Reject Volatility/Outage Risks
  - The 'obligation to serve' remains alive and vital in the public mind.' (Yeager 2003)

Recovery Of Electricity Investments: Changing Expectations 1934 - 2002



(Proportions conceptual)

Contract Path vs Electron Path



*Transmission is, functionally, a **single** economic unit*

States DO Have A Role

- **SMD # 1: INTRODUCE A DEMAND CURVE**
  - Only PUCs can set retail rates
- **SMD #2: REAL LOCATIONAL MARGINAL PRICING**
  - Requires FERC/PUC collaboration
- **SMD #3: INDEPENDENT TRANSMISSION CONTROL**
  - Asset transfers require PUC approvals
- **SMD #4: EFFICIENT INTRODUCTION OF RESOURCES**
  - Siting requires PUC approval or support

The RTO as an Ersatz PUC

- RTO performs two intertwined functions:
  - Operational management of transmission grid and supply dispatch
  - Management of wholesale market, as substitute for ‘just and reasonable’ rates
- Market Management is a regulatory role,
- a replacement for State or FERC *duty*;
- thus, fiduciary duty MUST be to the public good

Fiduciary Duty of an RTO

- General Public Good (not duty to ‘market participants’)

1. Responsibility to the long-term good not just short-term
2. System reliability and operational efficiency
3. Balance bargaining power of buyers and sellers, not just low transaction costs

Does this look like a State PUC’s job?