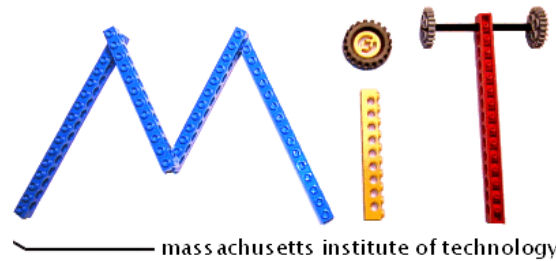


# COMPETITIVE ELECTRICITY MARKETS CHALLENGES FOR T&D

Paul L. Joskow

<http://web.mit.edu/pjoskow/www/>



December 15, 2004

# TRANSMISSION

## THE SUPPORTING PLATFORM

- A transmission network (SO+TO) with good performance attributes is essential to support efficient and reliable supplies of electricity in either a regulated or a “liberalized” system
- Electricity sector liberalization has not changed the physical constraints or physical laws that govern reliable system operation
  - The network must still satisfy physical parameters (frequency, voltage, stability, coordination with interconnected networks) and provide for operating reserves to respond to uncertain demand and unplanned outages of generating and transmission facilities

# TRANSMISSION

## THE SUPPORTING PLATFORM

- With competitive wholesale and retail markets the transmission network (TO+SO) plays a key supporting role:
  - Allows decentralized generators, marketers and consumers to trade power in competitive markets
  - Expands geographic expanse of competition among suppliers to reduce costs and prices for energy and reserves
  - Expands geographic expanse of competition to reduce market power and thus prices
  - Facilitates entry of new suppliers to match demand and supply efficiently at different network locations to achieve economic and reliability goals
  - Facilitates provision of good price signals and demand response options for wholesale and retail market participants

# TRANSMISSION

## THE SUPPORTING PLATFORM

- New organizational and regulatory mechanisms are necessary to govern transmission network operations and investment to support competitive markets, to deal with the challenges created by horizontal and vertical restructuring, and to use market price signals and mechanisms more effectively

# GET THE INCENTIVES RIGHT!

- “nobody in the history of the world has ever washed a rented car” (attributed to Larry Summers, President Harvard University, former U.S. Secretary of the Treasury, distinguished economist, MIT graduate)
- Market, network infrastructure and regulatory institutions must be designed to get the incentives right
  - In the markets
  - In the regulatory arena
- Creating these institutions right is a major challenge

# GENERATION AND TRANSMISSION ARE INTERDEPENDENT

- Physical and economic coordination between generation and transmission is essential to achieve public interest goals in an efficient manner
- This is why electric power systems evolved with vertical integration between generation, transmission, and system operations

# GENERATION AND TRANSMISSION ARE INTERDEPENDENT

- But well functioning competitive markets require organizational and regulatory changes that alter vertical relationships
  - Unbundling of prices for regulated and competitively supplied services
  - Functional separation and/or ownership changes to assure independence of the SO/TO from market participants
  - Structural changes and/or regulatory mechanisms (e.g. contracts) to mitigate supplier market power
  - Expanded geographic expanse of network operations and transmission ownership to facilitate competition
  - New transmission planning and investment protocols that are compatible with competitive markets for power

# MARKET INSTITUTIONS MUST SUPPORT “RE-INTEGRATION” OF GENERATION AND TRANSMISSION

- Well designed wholesale markets yield good price signals for the value of both energy and transmission capacity at different locations
  - Facilitates allocation of scarce (congested) transmission capacity to highest valued (lowest cost) users
  - Allows consumers to express their willingness to pay for “reliability” and express their risk preferences regarding price volatility
  - Allows generators to factor locational and time series differences in power prices into operation and investment decisions
  - Allows transmission maintenance and investment framework efficiently to incorporate the costs of congestion, the value of reliability and other factors



# WHOLESALE POWER MARKET DESIGN

- The wholesale market designs adopted by the Northeastern ISO/RTOs work reasonably well
  - Need to look at the whole package not just your favorite components
- Other market designs may also work well, but many have been proposed and/or tried that work poorly
- There remain imperfections that need more attention
  - Energy-only markets do not provide adequate price signals to support new investment
  - Capacity obligations/markets continue to be refined
  - PJM's "deep" generator interconnection rules and participant pays principles have superior properties and provide important locational incentives but have not been adopted elsewhere
  - Transmission planning and investment protocols are still evolving
  - Reliability criteria need to be better integrated with economic criteria, market signals, and market mechanisms
  - "Seams" issues need more attention
  - Unsettled state of retail competition is a problem

# TRANSMISSION INVESTMENT

- Well functioning competitive power markets require increased transmission investment
  - Reduce congestion costs and expand geographic markets
  - Facilitate entry of new generators at the most efficient locations
  - Enhance reliability without interfering with the market by giving system operators more degrees of freedom
  - The total societal costs of too little transmission capacity are greater than the costs of an equal amount of “excess” transmission capacity
- The development and application of effective transmission investment planning, siting and regulatory institutions is a work in progress

# TRANSMISSION INVESTMENT

- A comprehensive “wide area” regional transmission planning process is necessary to support an efficient transmission investment program
  - Reflect physical realities of meshed AC networks not political and regulatory jurisdictional boundaries
  - Should be transparent
  - Should reflect market price signals and not undermine competitive markets
  - Should accommodate but not rely on private initiative projects
- Transmission investment today is driven almost entirely by reliability criteria
  - Reliability criteria are important in light of unusual physical attributes of electricity networks
  - Reality: “Reliability” and “economic” criteria are interdependent
  - Reliability criteria should reflect sensible balance of costs and benefits based on market valuations
  - Economic criteria and market solutions should play a larger role
  - Engineers and economists need better communication

# TRANSMISSION INVESTMENT

- “NIMBY” or “BNANA” is a major constraint on getting permission to build new transmission lines
  - Utilize the existing footprint more intensively and turn to new technologies to do so
  - Apply advanced monitoring and control technology to relieve “contingency” constraints
  - Expand active demand side
  - Facilitate location of generation to reflect challenges of adding major new links
  - Reform siting process and supporting regulatory institutions without undermining appropriate considerations of real environmental issues

# WHAT IS MERCHANT TRANSMISSION?

- Prices and related terms and conditions are not subject to cost-of-service regulation.
  - Projects supported by long term contracts with state-owned or regulated monopoly entities that can pass along costs to customers chosen through RFP process (e.g. LIPA, Tasmania)
  - Projects supported by spot market (difference in LMPs) and/or ongoing bilateral contract sales with unregulated market participants (e.g. MurrayLink)
- Merchant investment in transmission will play a small role in meeting transmission investment needs
  - The spot market arbitrage model for major investments is dead
  - Integrating merchant proposals into planning and regulatory processes is desirable
  - PJM has a good model in place to do so

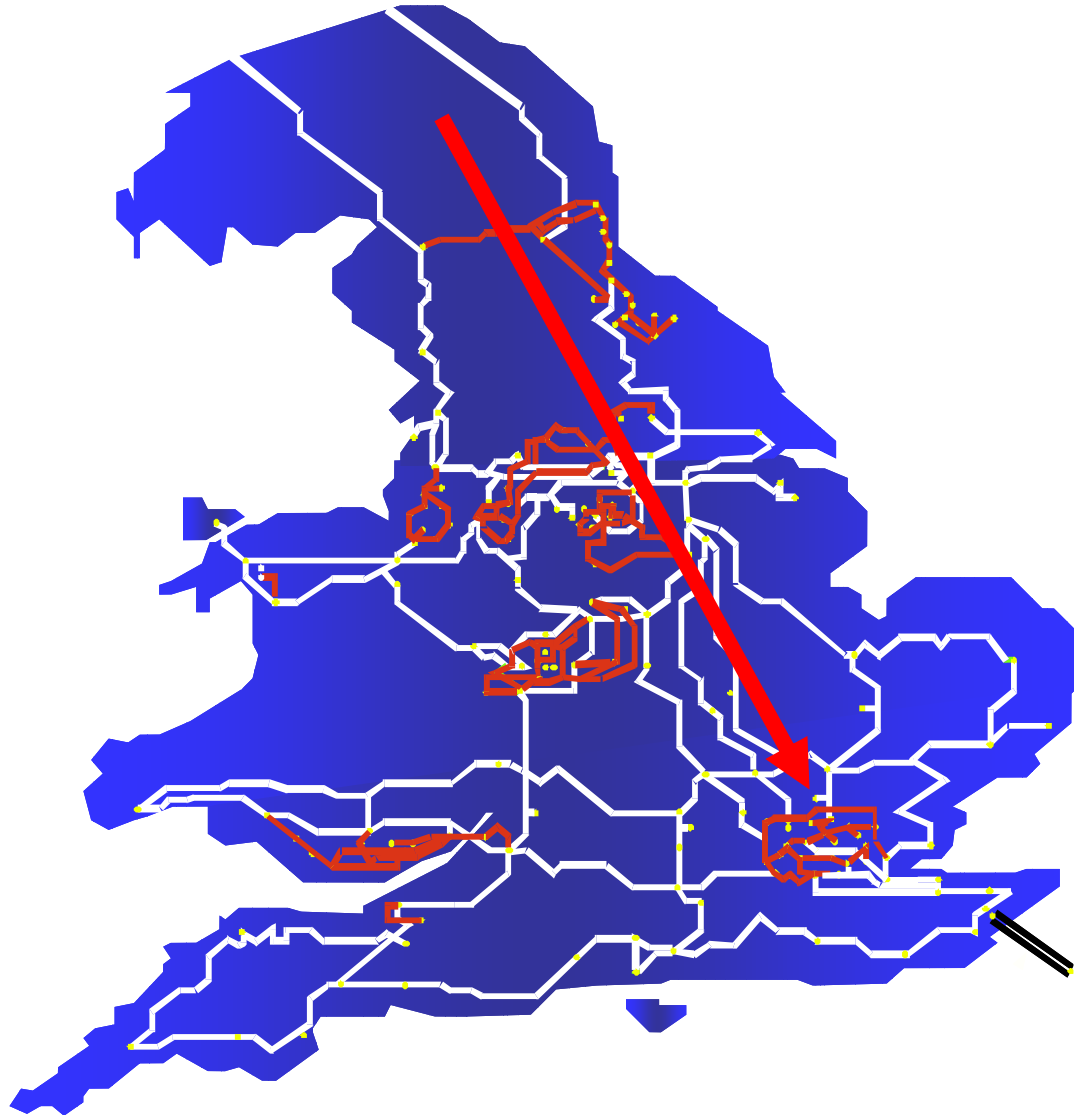
# ORGANIZATIONAL AND INCENTIVE ISSUES

- Separation of system operator (SO) from transmission owners (TO) responsible for physical operation and maintenance creates potential inefficiencies
- Absence of compatible performance based regulatory system (PBR) for TO and SO creates potential efficiency losses
- Affects availability, responses to outages, direct network operating costs, and “low cost” opportunities to reduce congestion and ancillary network support costs
- Order 2000 encourages RTOs to develop PBR programs for TOs but this has not happened to date
- What incentives does ISO respond to in the long run when the innovative enthusiasm fades?

# REGULATION

- A sound, stable, and credible regulatory framework for transmission investment is necessary to support efficient network operations and investment consistent with reliability standards
- Developing and applying a credible and consistent regulatory framework continues to be a challenge especially with multiple regulatory jurisdictions
  - Identifying socially beneficial investment opportunities
  - Defining who pays: incentive and equity considerations
  - Investors must expect to recover their costs, including the risk adjusted opportunity cost of capital, regardless of who pays
  - Well designed PBR mechanisms can enhance operating and investment efficiency
  - We could do a better job applying transmission pricing rules that align cost responsibility with economic decision makers and beneficiaries (e.g. Order 2003)

# ENGLAND & WALES





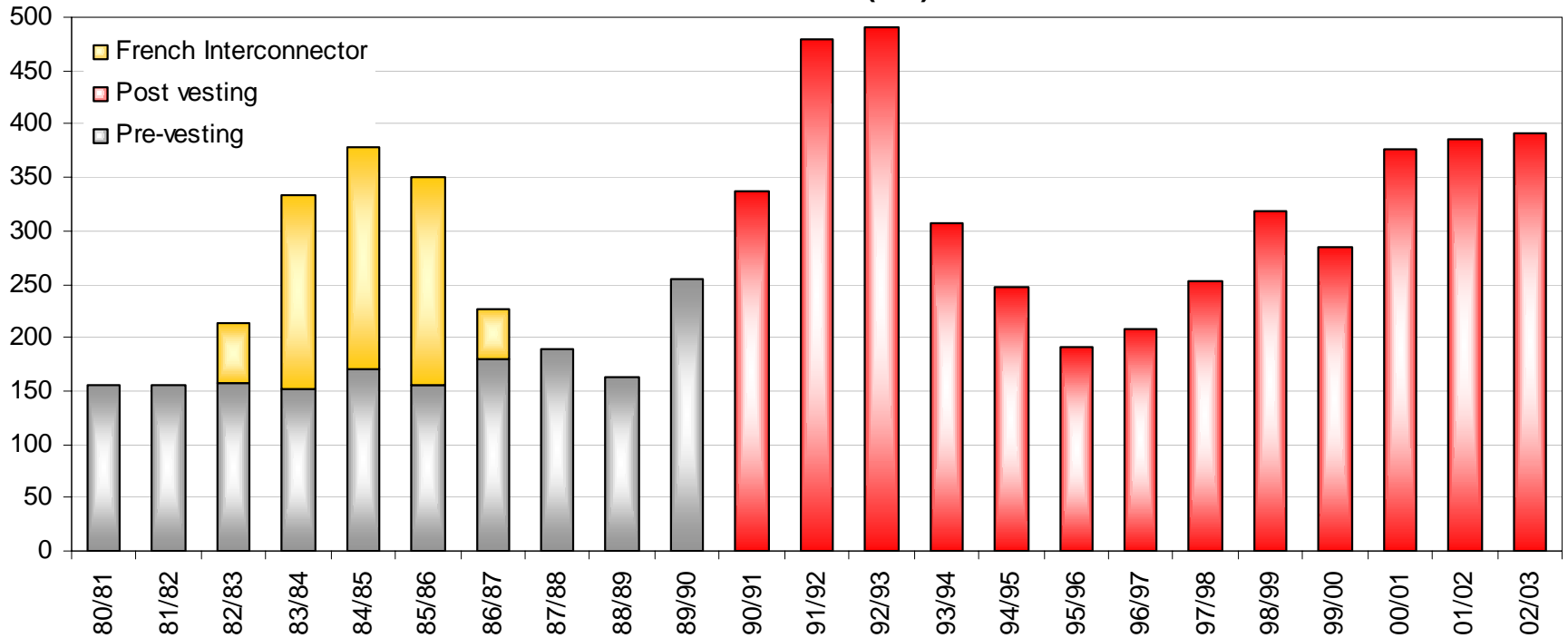
**Schedule of Transmission Network Use of System Generation Charges (£/kW) in  
2004/2005**

Generation Zone	Zone Area	Generation Tariff (£/kW)	Short Term Generation Tariff (£/kW)		
			STTEC Period = 28 days	STTEC Period = 35 days	STTEC Period = 42 days
1	Northern	9.009237	1.891940	2.364925	2.837910
2	Humberside	5.767201	1.211112	1.513890	1.816668
3	North West	6.222266	1.306676	1.633345	1.960014
4	Pennines & North Wales	4.121912	0.865602	1.082002	1.298402
5	Dinorwig	10.715347	2.250223	2.812779	3.375334
6	Anglesey	7.011370	1.472388	1.840485	2.208582
7	East Anglia	2.889748	0.606847	0.758559	0.910271
8	West Midlands	2.032089	0.426739	0.533423	0.640108
9	South Wales & Gloucs	-2.150590	0.000000	0.000000	0.000000
10	Oxon & Bucks	0.004330	0.000909	0.001137	0.001364
11	Estuary	1.733641	0.364065	0.455081	0.546097
12	Central & SW London	-6.604821	0.000000	0.000000	0.000000
13	South Coast	-1.507146	0.000000	0.000000	0.000000
14	Wessex	-3.829097	0.000000	0.000000	0.000000
15	Peninsula	-6.836065	0.000000	0.000000	0.000000

**Schedule of Transmission Network Use of System Demand Charges (£/kW) and Energy Consumption Charges (p/kWh) for 2004/2005**

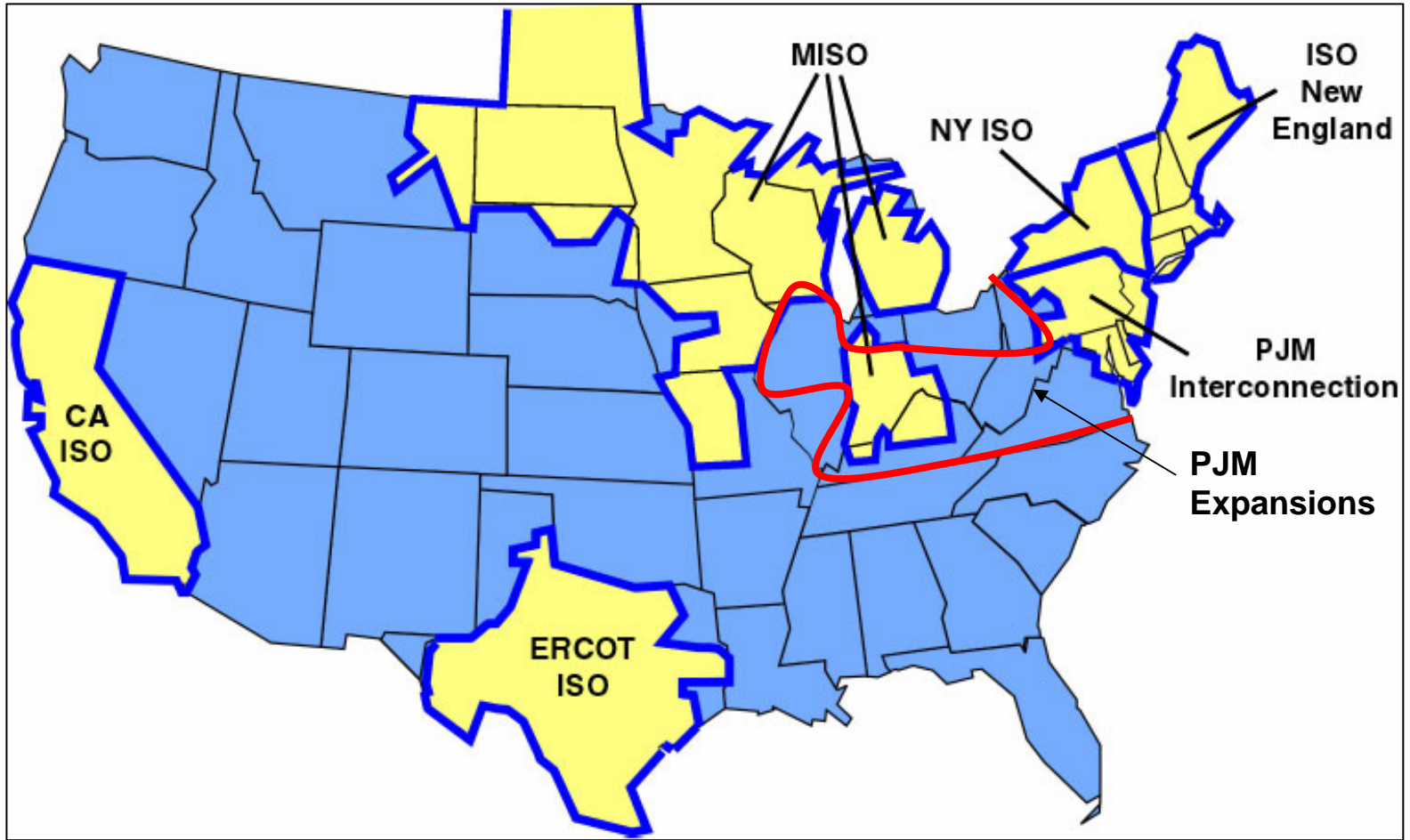
<b>Demand Zone</b>	<b>Zone area</b>	<b>Demand Tariff (£/kW)</b>	<b>Energy Consumption Tariff (p/kWh)</b>
1	Northern	4.940866	0.656585
2	North West	8.325173	1.100254
3	Yorkshire	8.455923	1.171611
4	North Wales and Mersey	8.709914	1.107068
5	East Midlands	10.771600	1.479424
6	Midlands	12.600874	1.733413
7	Eastern	11.007104	1.394934
8	South Wales	16.130442	2.228075
9	South East	14.321101	1.773924
10	London	16.761568	2.430277
11	Southern	15.679987	2.076489
12	South Western	17.798154	2.198679

### NGC's Transmission Investment (£m) - 2002-03 Prices



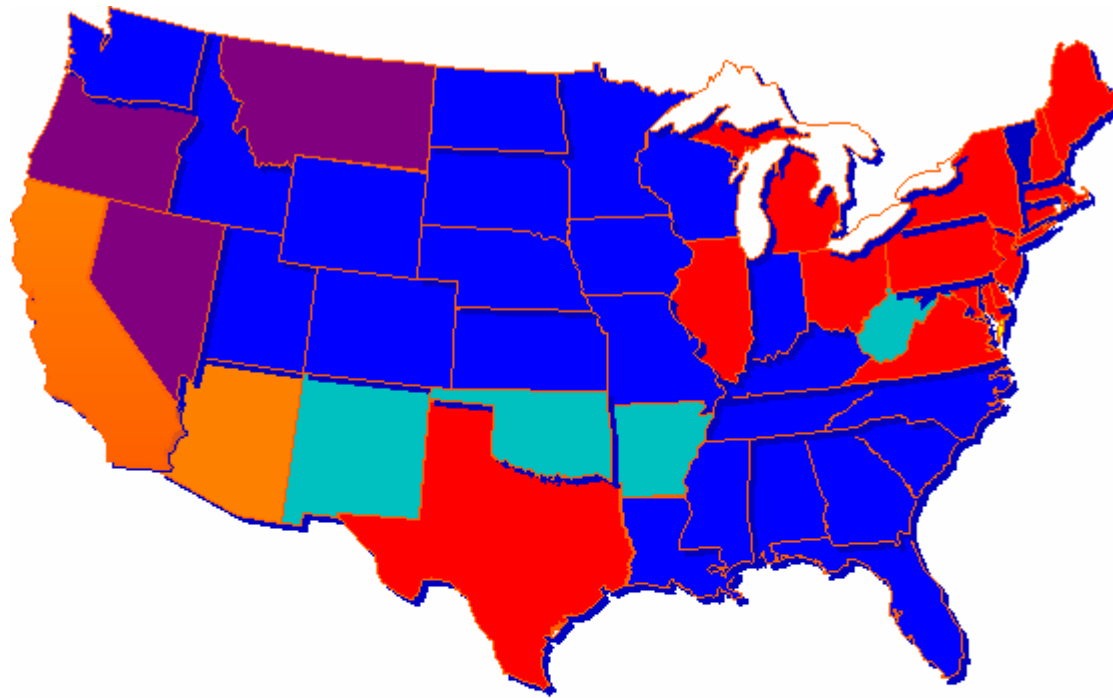
# REGULATION

- Overlapping regulatory jurisdictions and policy regimes undermine efficient transmission investment and application of good regulatory mechanisms in many areas of the U.S.
  - Too many control areas
  - Diversity of market and regulatory policies
  - Conflicts between federal, state and local regulators
  - Maybe an interregional experiment with different models will yield long term benefits but it could be costly as well



Source: EIA

# STATUS OF RETAIL COMPETITION AND RESTRUCTURING REFORMS 2004



**No retail competition**



**Retail competition for all classes**



**Retail competition for (selected) large customers only**

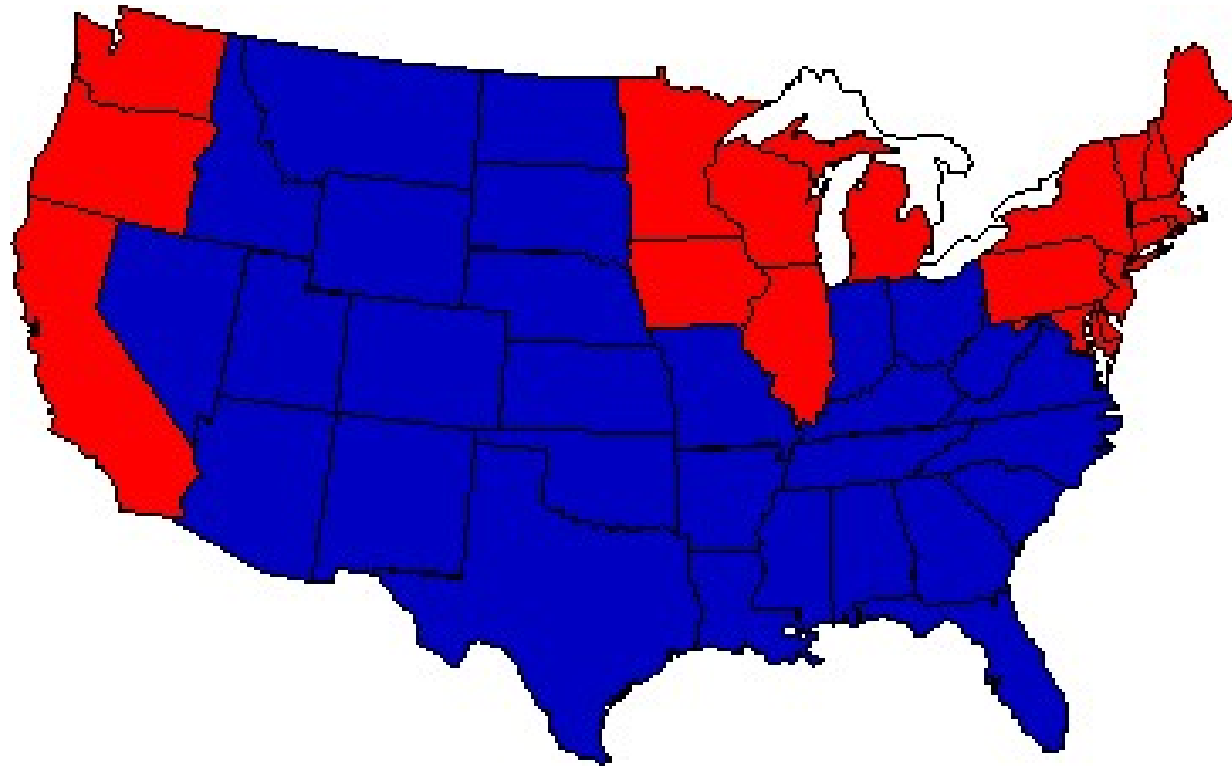


**No Retail competition Restructuring law repealed or delayed**



**Restructuring and retail competition suspended**

# BUSH V. KERRY 2004

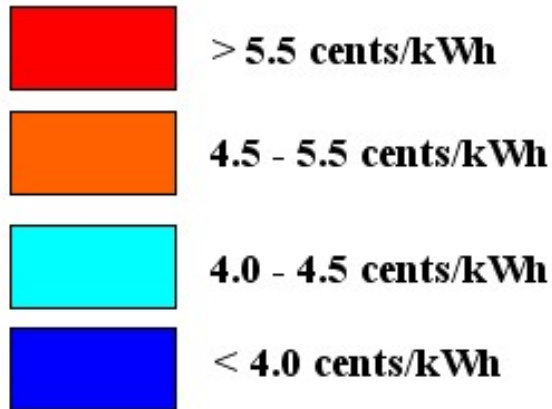
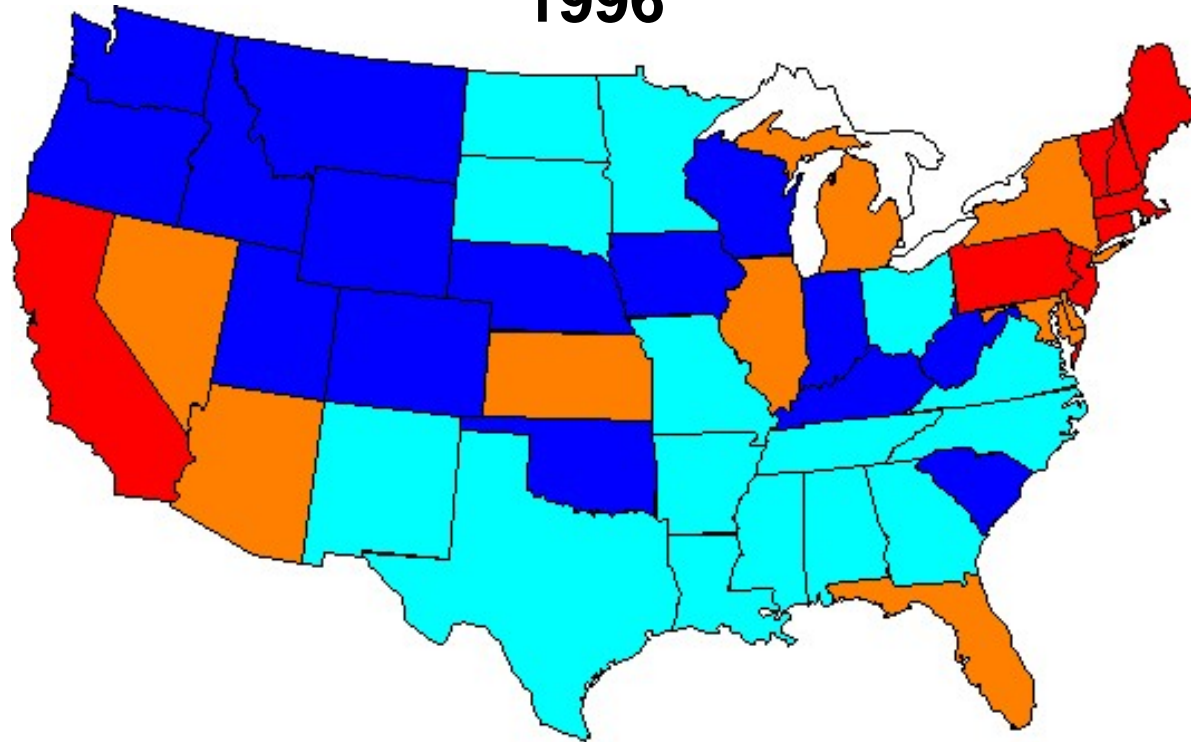


BUSH



KERRY

# AVERAGE PRE-REFORM INDUSTRIAL PRICES 1996





# WHY PBR?

- Performance of the transmission (and distribution) networks have significant impacts on the performance of competitive power markets
  - network reliability
  - network congestion
  - physical losses
  - response time to outages
  - geographic expanse of competition and market power
- The vast bulk of the transmission network (TO) is and will be regulated
- All regulatory systems create performance incentives
  - Are the incentives by design or default?
  - Are they driven by clearly articulated performance goals?
  - If you must regulate you should aim to regulate well

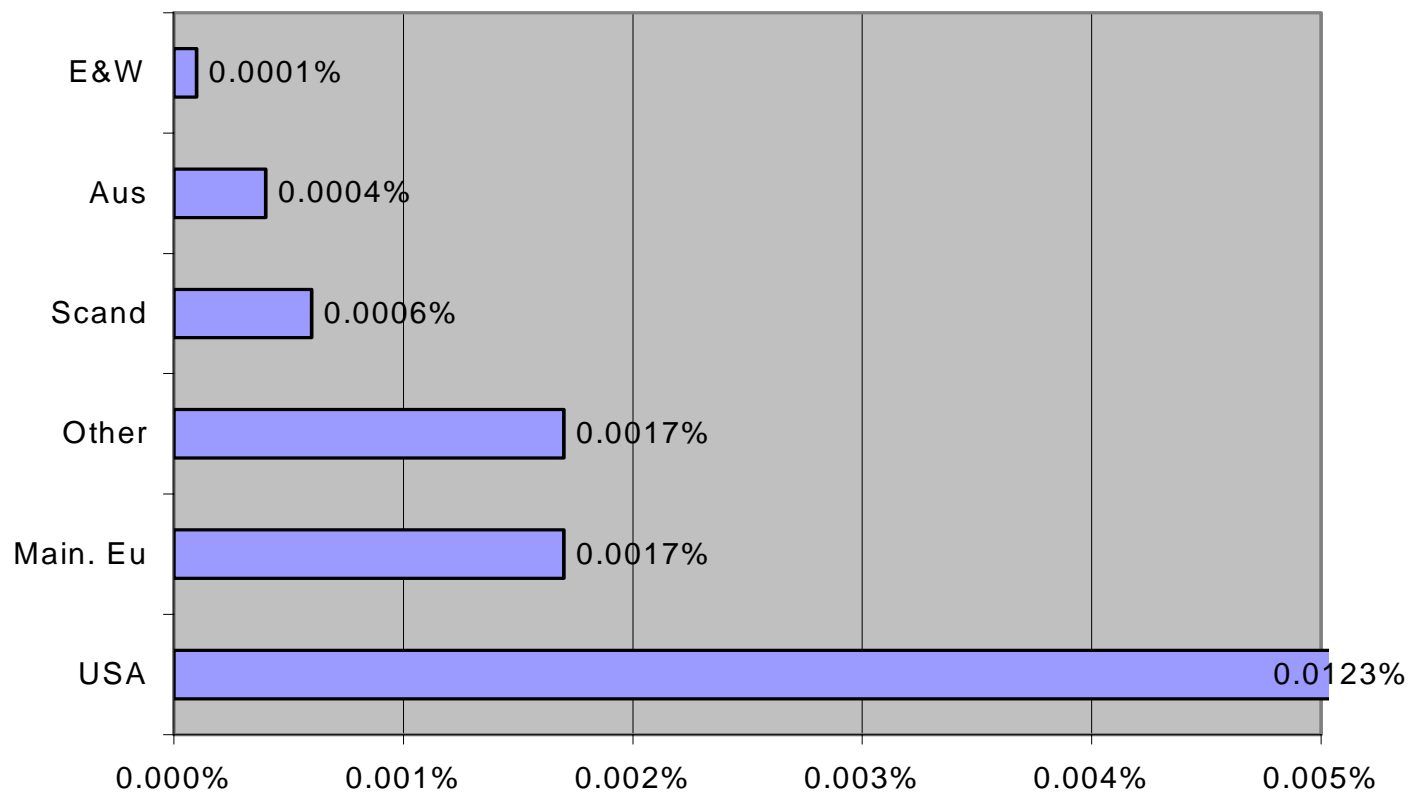
# WHY PBR?

- There appear to be large variations in transmission system performance
- PBR Works!
- Well designed PBR mechanisms reduce costs, encourage innovation and can improve system performance in other dimensions

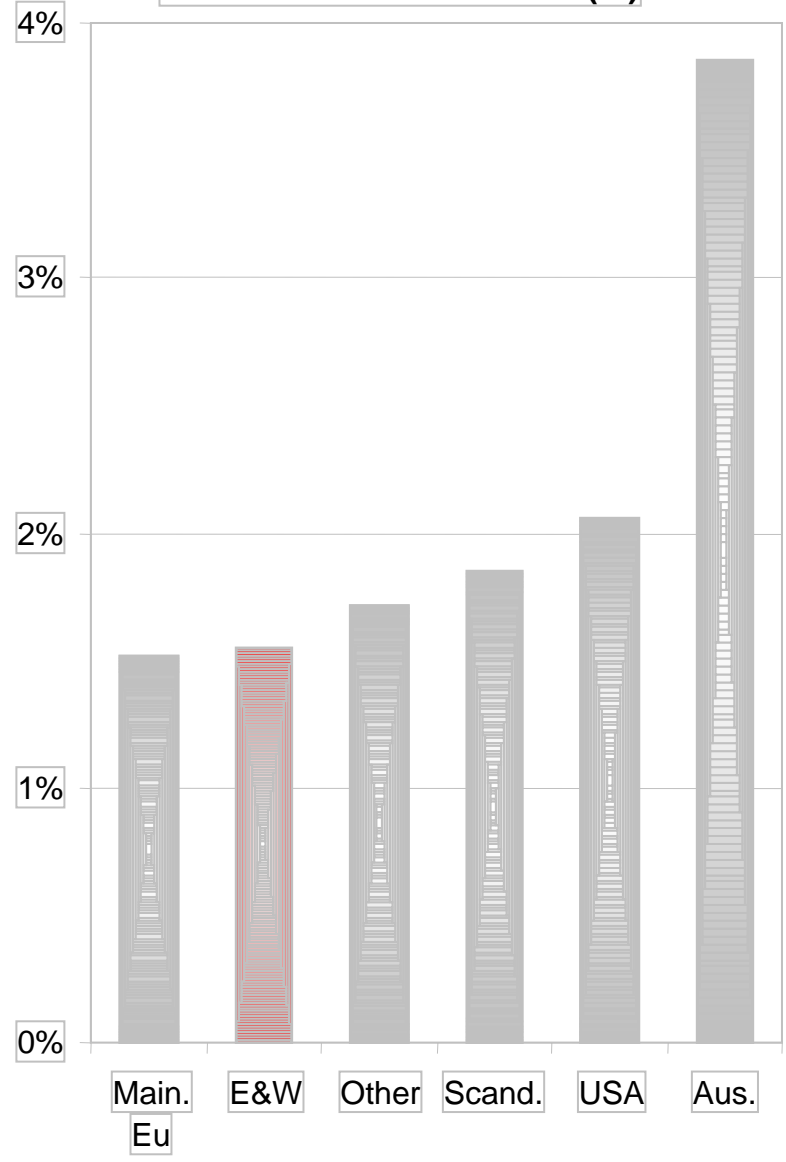
# THE KEY INGREDIENTS

- Benchmarking performance and specification of performance norms
- Credible sharing of performance changes relative to benchmarks between a regulated firm's shareholders and consumers
- Balanced incentives for cost reduction and service quality enhancements
- Learning from experience and credible application of “ratchets” to balance incentives and consumer benefits

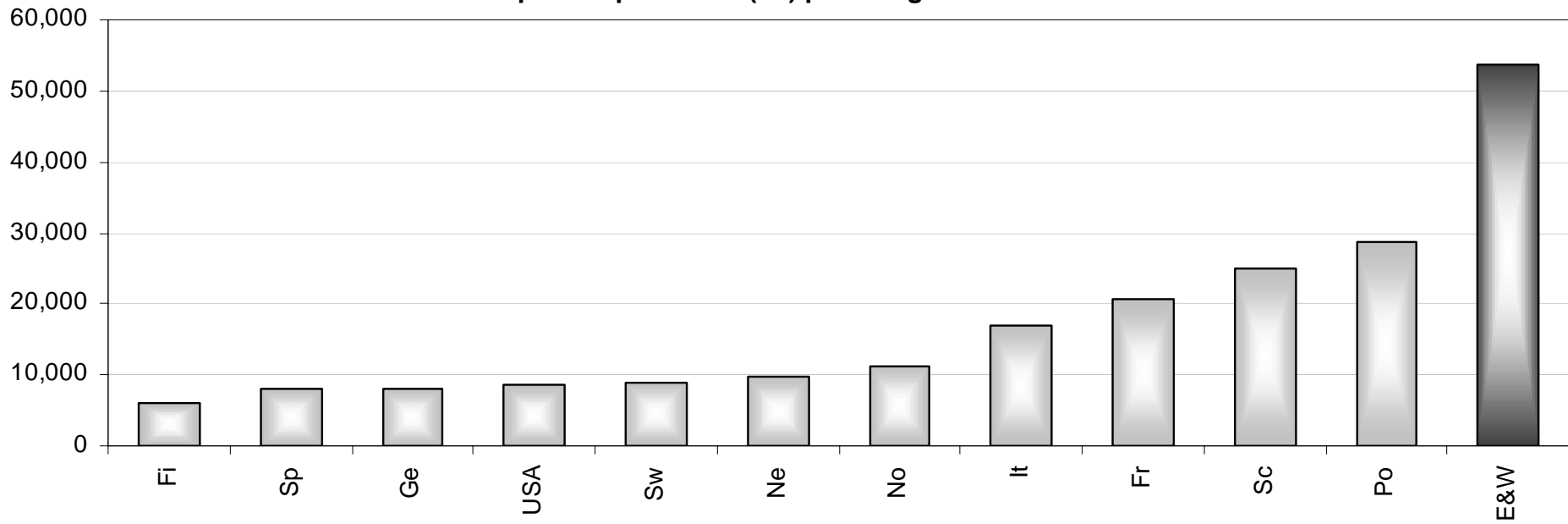
**Figure 5: Energy Unsupplied (% of energy transmitted)**  
Source: ICTSO (2001)



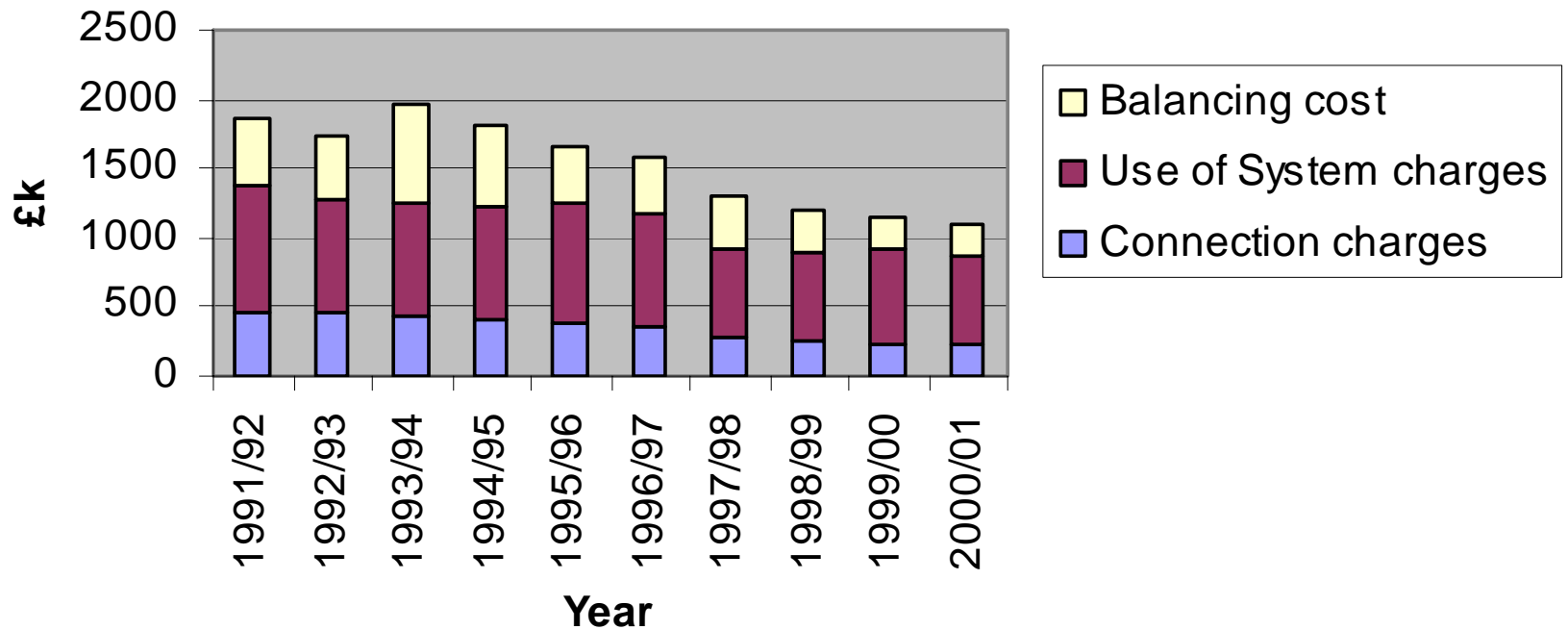
**BENCHMARKED  
TRANSMISSION LOSSES (%)**



**Capital Expenditure (Eu) per Weighted Line km**

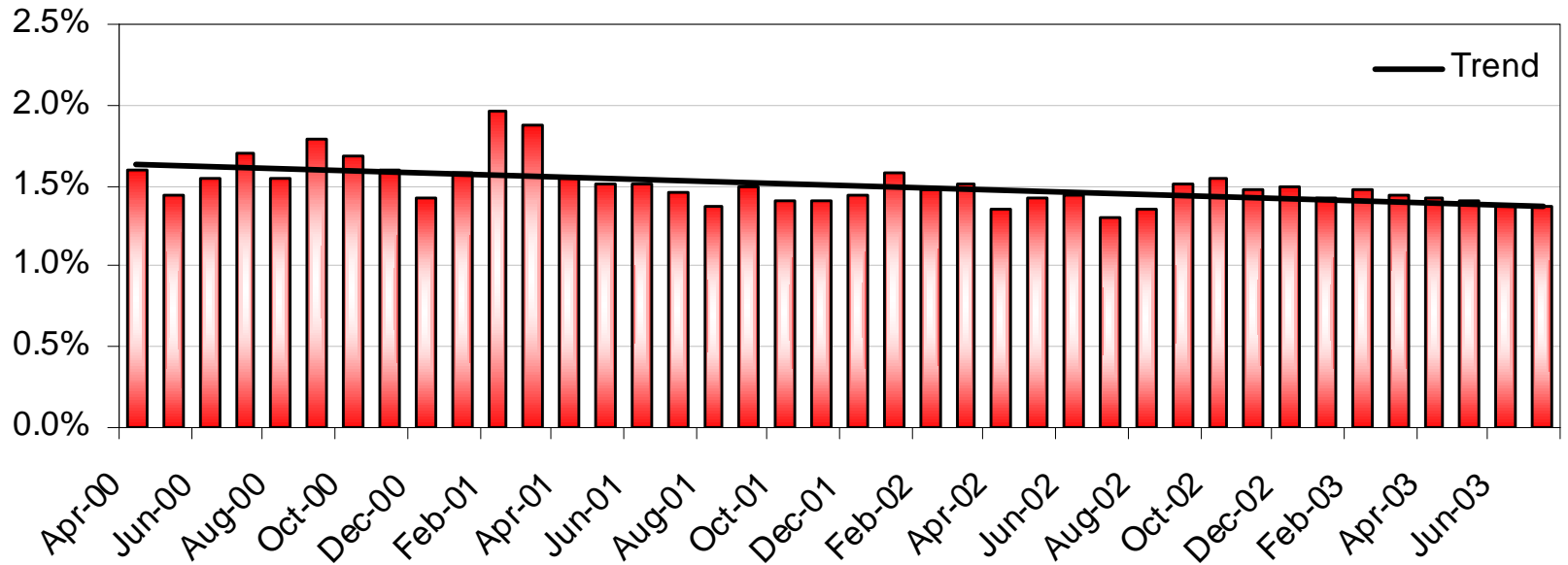


## National Grid UK Revenue Trends



Source: NGC

### NGC TRANSMISSION RESISTIVE LOSSES (%)



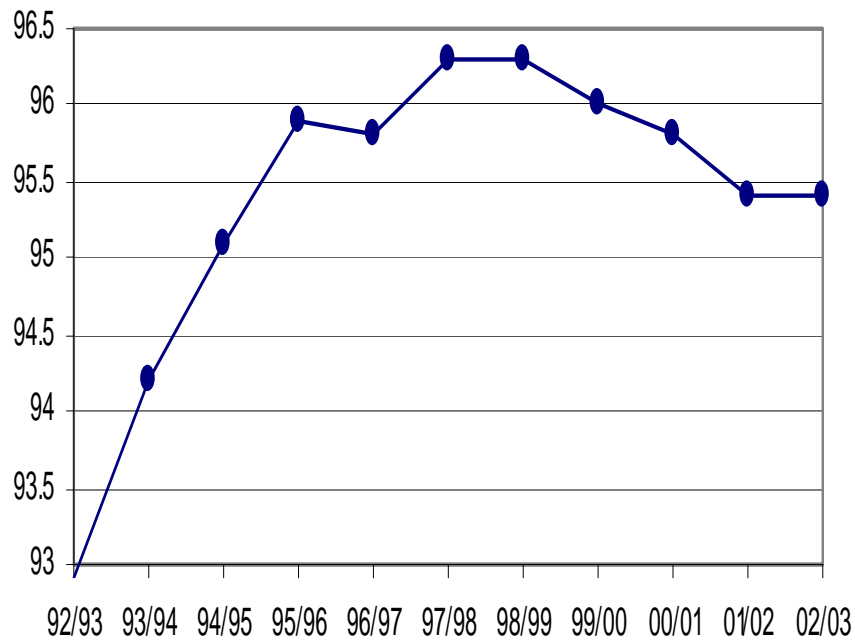
Source: NGC



# UK TRANSMISSION RELIABILITY

## Average Transmission System Availability (%)

Source: National Grid



Source: Newbery, OFGEM, DTI

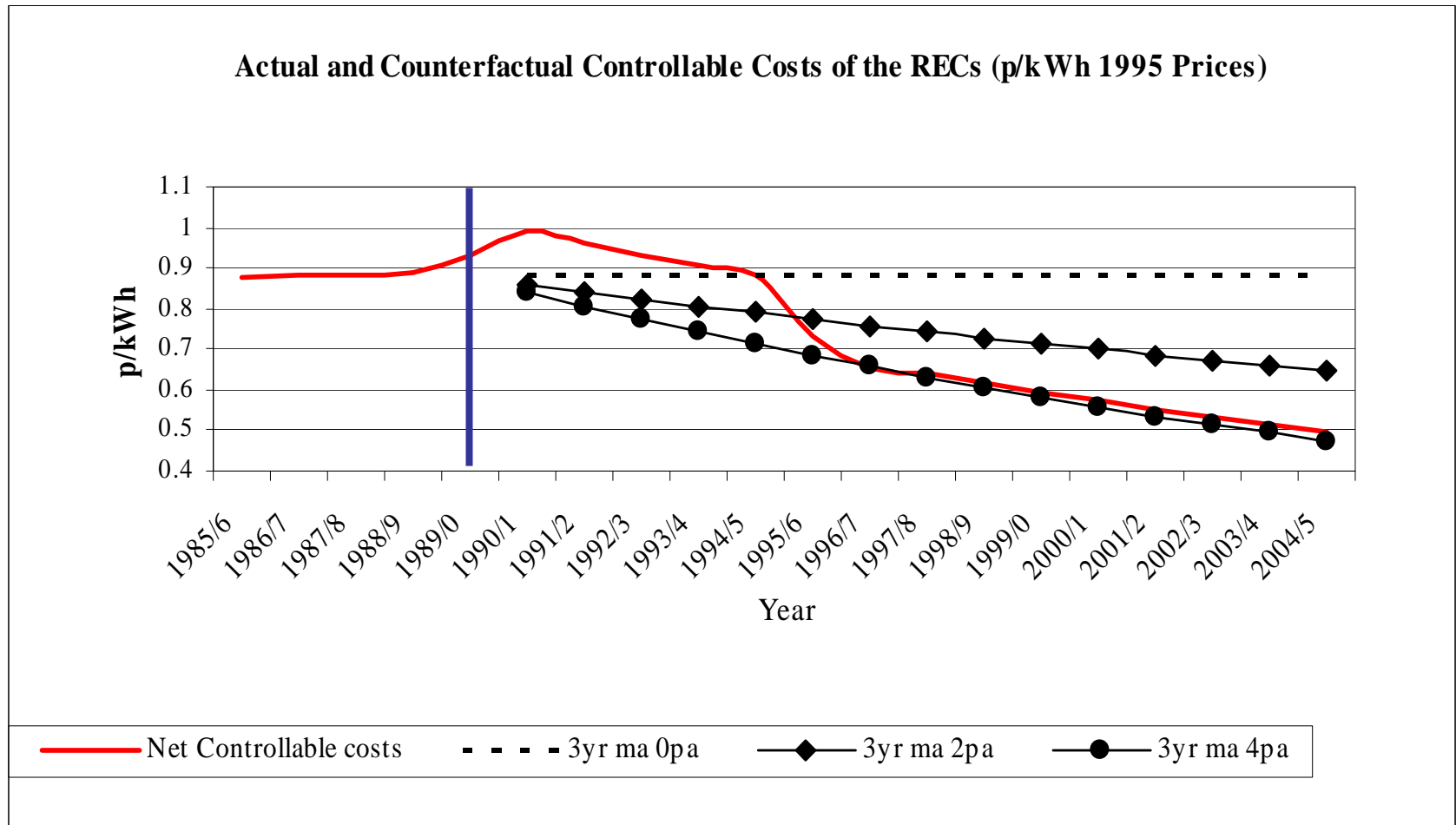
# CHALLENGES FOR TRANSMISSION PBR IN THE U.S.

- Failure to fully unbundle transmission from other electricity supply segments
- Mix of federal and state regulation
- Separation of SO and TO functions
- Many TOs in the same regions
- No FERC tradition of comprehensive regulation of transmission network performance
  - performance variable definition
  - performance data
  - performance norms/benchmarks
  - See December 2004 EIA Report

# DISTRIBUTION

- Distribution charges represent a large component of the average customer's bill
- Creation of competitive power markets narrows the scope of regulation and allows state regulators to focus attention on distribution
- Productivity improvements in distribution have accounted for a large fraction of the social benefits of reform in many other countries
- Benchmarking and PBR methods are well developed around the world
- But U.S. regulatory practice may qualify for a World Bank assistance grant

# Distribution Costs in the UK

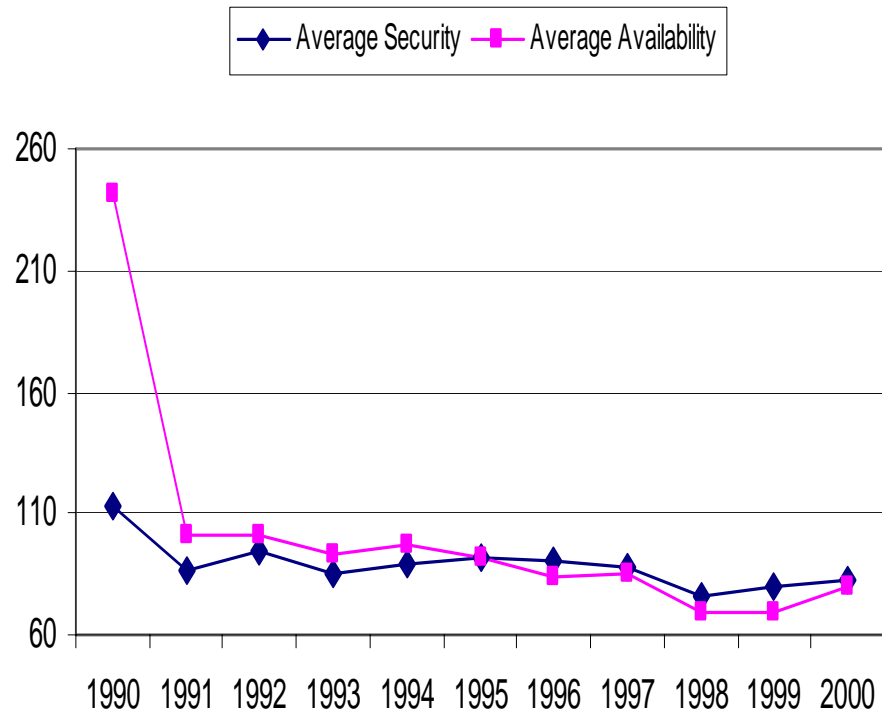


Source: Domah and Pollitt (2001)

# UK DISTRIBUTION COMPANY RELIABILITY

## DNOs supply interruptions (min/year)

Source: Ofgem

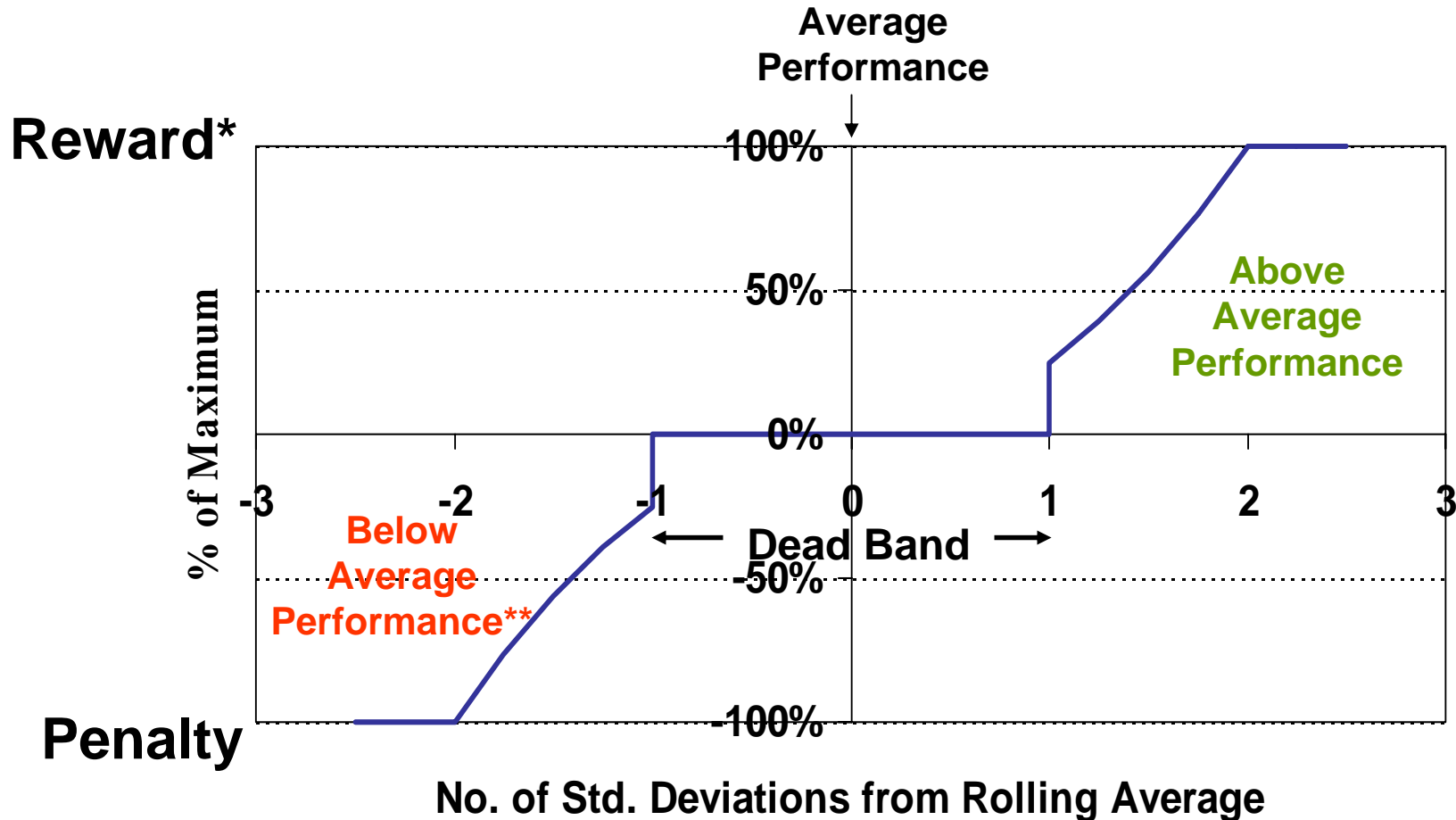


# Mass. DTE's Service Quality Plans

	Performance Measure	Weight	Penalty or Offset
<b>Operations</b>	Frequency of outages	22.5%	\$3.0 M
	Duration of outages	22.5%	3.0 M
<b>Customer Service</b>	On cycle meter reads	10%	1.3 M
	Timely call answering (w/in 20 seconds)	10%	1.7 M
	Service appointments met	10%	1.7 M
	Complaints to regulators	5%	0.7 M
	Billing Adjustments	5%	0.7 M
<b>Safety</b>	Lost Work Time Accidents	10%	1.3 M
	Risk/Reward Potential	100%	\$13.4 M *

\* Based on 2% of T&D revenues (using Mass Electric as an example)

# Rewards and Penalties Under Mass. Electric's SQ Plan



\*\* Trigger for penalties updated each year, but never relaxed, & potentially doubled for consistently poor reliability

# Results to Date Under Mass. Electric's Service Quality Plan

	<b>Performance Measure</b>	2002 Incentive/ (Penalty)	2003 Incentive/ (Penalty)
<b>Operations</b>	Frequency of outages	(\$3.0 M)	
	Duration of outages	(3.0 M)	
	On cycle meter reads		\$ 0.7 M
<b>Customer Service</b>	Timely call answering	0.8 M	1.7 M
	Service appointments met		
	Complaints to regulators	0.3 M	0.7 M
<b>Safety</b>	Billing Adjustments		0.7 M
	Lost Work Time Accidents		
	<b>Total Incentive/(Penalty)</b>	<b>(\$4.9 M)</b>	<b>\$3.8 M</b>

Source: Massachusetts Electric Company



# OTHER CHALLENGES FOR DISTRIBUTION

- Installation of advanced metering and control equipment to support efficient demand response
- Distributed generation
- Power quality
- Default service obligations
- Where do we draw the line between “regulated” activities and “market” activities?