ELECTRICITY MARKET HYBRIDS: MIXED MARKET DESIGNS AND INFRASTRUCTURE INVESTMENTS

William W. Hogan

Mossavar-Rahmani Center for Business and Government
John F. Kennedy School of Government
Harvard University
Cambridge, Massachusetts 02138

27th USAEE/IAEE North American Conference

Houston, TX

September 18, 2007

ELECTRICITY MARKET — Electricity Restructuring

The case of electricity restructuring presents examples of fundamental problems that challenge regulation of markets.

- **Marriage of Engineering and Economics.**
  - **Loop Flow.**
  - **Reliability Requirements.**
  - **Incentives and Equilibrium.**

- **Devilish Details.**
  - **Market Power Mitigation.**
  - **Coordination for Competition.**

- **Jurisdictional Disputes.**
  - **US State vs. Federal Regulators.**
  - **European Subsidiarity Principle.**

The Federal Energy Regulatory Commission has responsibility for regulating wholesale electricity markets. The stated framework emphasizes support for competition in wholesale markets as a clear and continuing national policy:

> "National policy for many years has been, and continues to be, to foster competition in wholesale power markets. As the third major federal law enacted in the last 30 years to embrace wholesale competition, the Energy Policy Act of 2005 (EPAct 2005) strengthened the legal framework for continuing wholesale competition as federal policy for this country.
>
> The Commission's core responsibility is to 'guard the consumer from exploitation by non-competitive electric power companies.' The Commission has always used two general approaches to meet this responsibility—regulation and competition. The first was the primary approach for most of the last century and remains the primary approach for wholesale transmission service, and the second has been the primary approach in recent years for wholesale generation service.
>
> The Commission has never relied exclusively on competition to assure just and reasonable rates and has never withdrawn from regulation of wholesale electric markets. Rather, the Commission has shifted the balance of the two approaches over time as circumstances changed. Advances in technology, exhaustion of economies of scale in most electric generation, and new federal and state laws have changed our views of the right mix of these two approaches. Our goal has always been to find the best possible mix of regulation and competition to protect consumers from the exercise of monopoly power."[1]

A task for regulation is to support this policy framework while developing hybrid markets and dealing with both the limits of markets and the failures of market designs.

---

[1] Federal Energy Regulatory Commission, "Wholesale Competition in Regions with Organized Electricity Markets," Advanced Notice of Proposed Rulemaking, Dockets RM07-19-000 and AD07-7-000, June 22, 2007, pp. 4-5.

There is a tension in choosing regulation to address immediate market problems and to deal with the continuing challenge of improving electricity market design.

- **Little "r' regulation:**

  Design rules and policies that are the "best possible mix" to support competitive wholesale electricity markets. A key requirement is to relate any proposed solution to the larger framework and to ask for alternatives that better support or are complementary to the market design. Many seemingly innocuous decisions appear isolated and *sui generis*, but on closer inspection are fundamentally incompatible with and undermine the larger framework.

- **Big "R" regulation:**

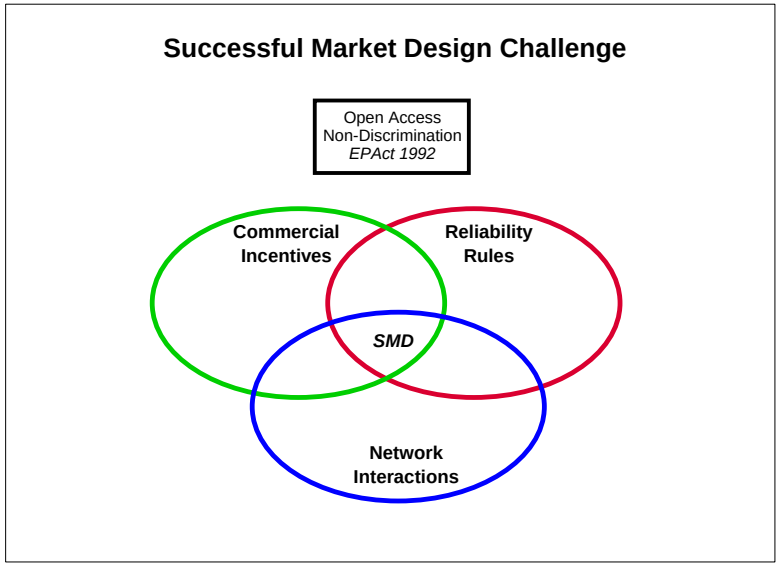
  Frame every problem in its own terms—inadequate demand response, insufficient infrastructure investment, or market power—and design ad hoc regulatory fixes that accumulate to undermine market incentives. This creates a larger slippery slope problem, where one ad hoc solution creates the need for another, and regulators are driven more and more to intervene in ever more ad hoc ways.

For example, socialized costs for preferred infrastructure investment can easily reduce the incentives for other market-based investments, thereby increasing the need for regulators to select among additional appropriate investments and socialize even more costs.

The public policy debate over reshaping the electricity industry confronts major challenges in balancing public interests and reliance on markets.

> "The need for additional attention to reliability is not necessarily at odds with increasing competition and the improved economic efficiency it brings to bulk power markets. Reliability and economic efficiency can be compatible, but this outcome requires more than reliance on the laws of physics and the principles of economics. It requires sustained, focused efforts by regulators, policy makers, and industry leaders to strengthen and maintain the institutions and rules needed to protect both of these important goals. Regulators must ensure that competition does not erode incentives to comply with reliability requirements, and that reliability requirements do not serve as a smokescreen for noncompetitive practices." (Blackout Task Force Report, April 2004, p. 140.)

- The emphasis should be on investment incentives and innovation, not short-run operational efficiency.
- With workable markets, market participants spending their own money would be better overall in balancing risks and rewards than would central planners spending other people's money.
- If not, electricity restructuring itself would fail the cost-benefit test.



ELECTRICITY MARKET — Electricity Restructuring

There have been repeated attempts to rethink the role of markets and Regional Transmission Organizations (RTOs). The demands of electricity markets impose many requirements and challenges. As a regulated provider of monopoly services, an RTO will never have complete freedom of action. An RTO must provide certain functions to support markets under open access and non-discrimination.

- **Necessary functions for energy markets.**
  - Real-time, bid-based, security constrained economic dispatch with locational prices.
- **Necessary functions for energy markets with effective long-term hedges.**
  - Financial transmission rights (FTRs).
- **Valuable functions for energy markets with effective long-term hedges.**
  - Day-ahead energy market with associated reliability unit commitment.
  - Transmission planning and investment protocols.
- **Necessary features of everything else**
  - Rules and pricing incentives compatible with the above.
    - Ancillary Services
    - Resource Adequacy

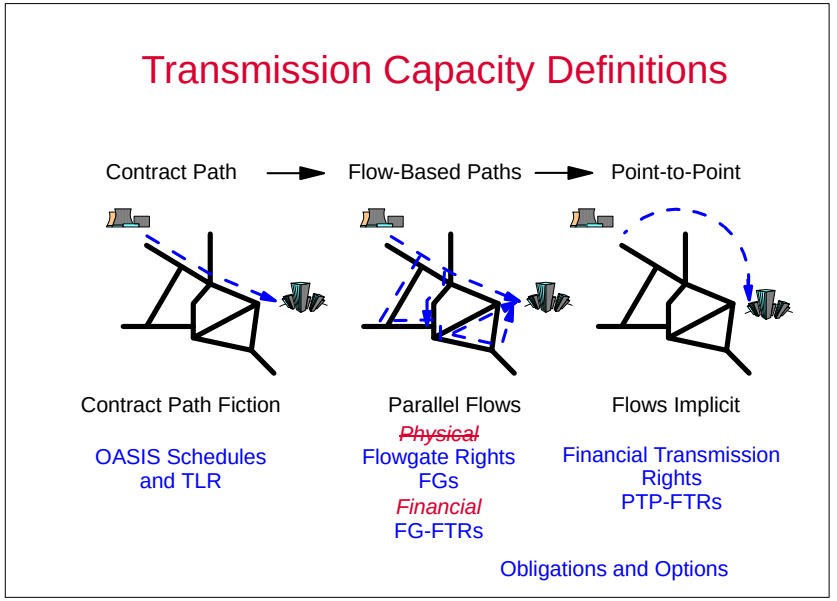
This is not new news. A review highlights the key issues.

The evolution of electricity restructuring thread ...

The "Contract Path" won't work in theory, but will it work in practice?

- **Order 888, 1996.** Non-discrimination, Open Access to Transmission. Contract path fiction would not work in theory.
- **Capacity Reservation Tariff (CRT), 1996.** A new model.

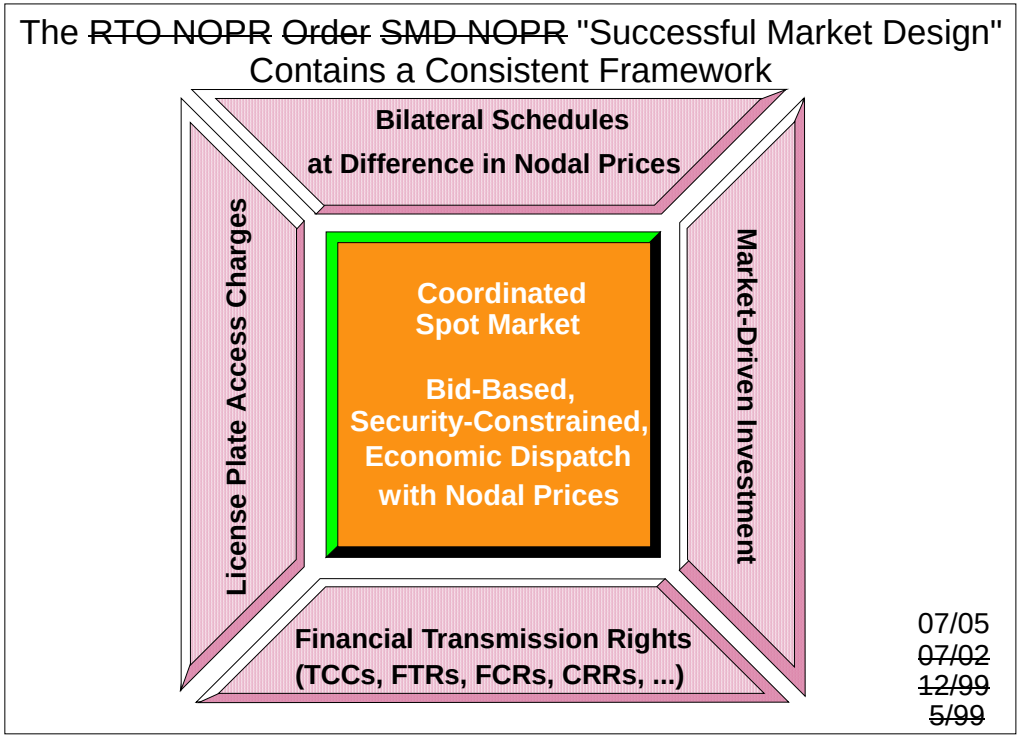
  "The proposed capacity reservation open access transmission tariff, if adopted, would replace the open access transmission tariff required by the Commission ..."[2]
- **NERC Transmission Loading Relief (TLR), 1997.** The unscheduling system to complement Order 888.
- **EPAct 2005.** Continued support for competitive markets but conflicting signals on market design.
- **Order 890 Reform 2007.** Too little. Too late?



[2] Federal Energy Regulatory Commission, "Capacity Reservation Open Access Transmission Tariffs," Notice of Proposed Rulemaking, RM96-11-000, Washington DC, April 24, 1996, p. 1.

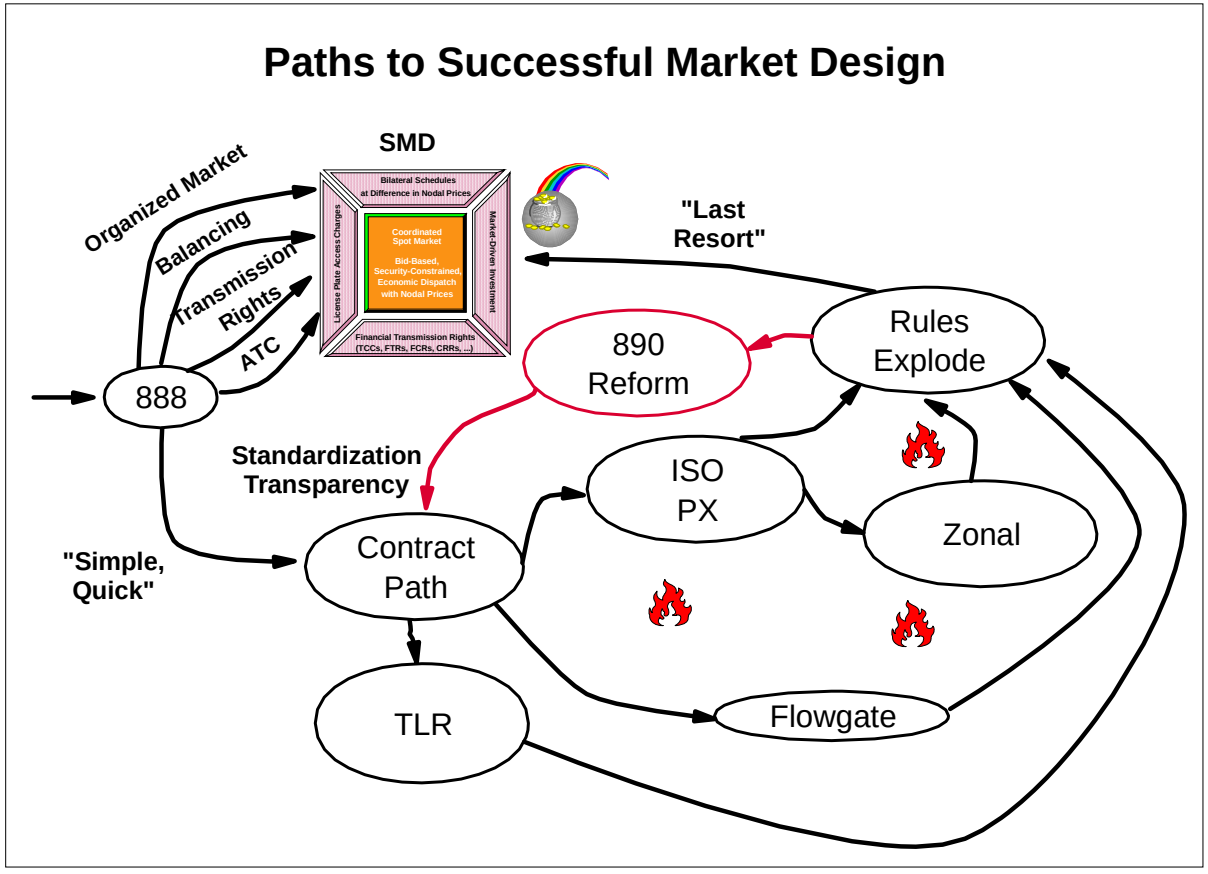
ELECTRICITY MARKET A Consistent Framework

The example of successful central coordination, ~~CRT, Regional Transmission Organization (RTO) Millennium Order (Order 2000) Standard Market Design (SMD) Notice of Proposed Rulemaking (NOPR),~~ "Successful Market Design" provides a workable market framework that is working in places like New York, PJM in the Mid-Atlantic Region, New England, and the Midwest.



Poolco…OPCO…ISO…IMO…Transco…RTO… ITP…WMP…: "A rose by any other name …"

The path to successful market design can be circuitous and costly. The FERC "reforms" in Order 890 illustrate "path dependence," where the path chosen constrains the choices ahead. Can Order 890 be reformed to overcome its own logic? Or is FERC trapped in its own loop flow?



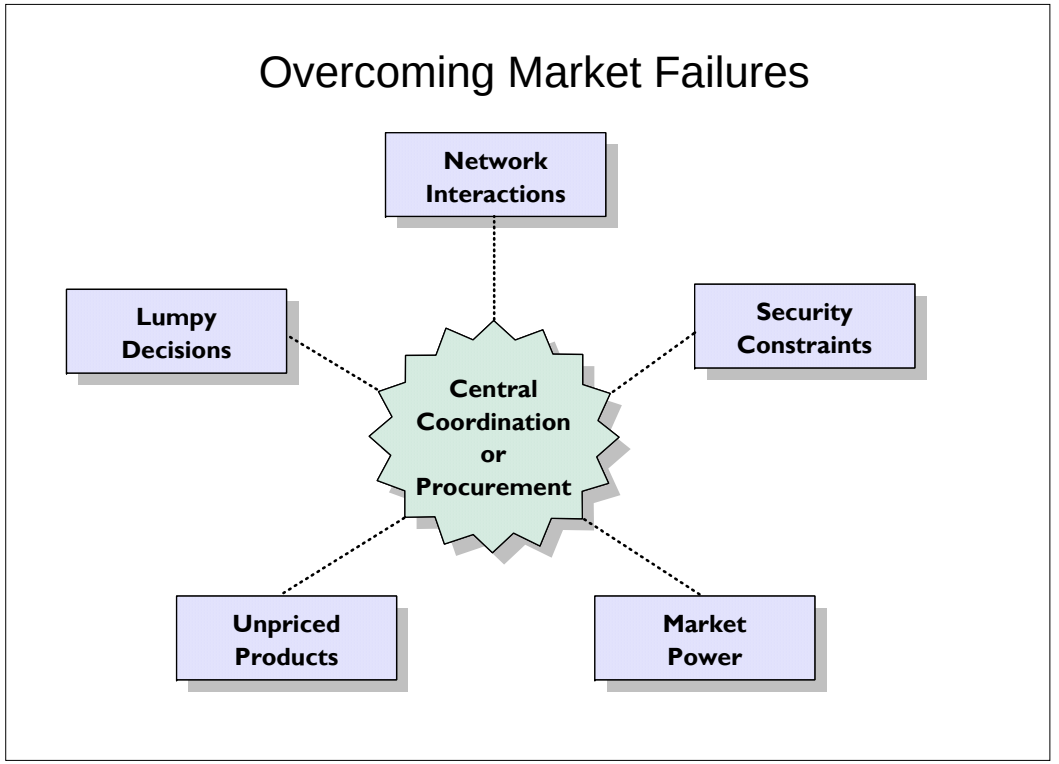
The need for central institutions arises from the existence of prominent forms of market failure. The challenge is to address market failures while preserving the market as the default.

Market defects rise in practical implementation. Approximations and misplaced assumptions revealed through operating experience.

Market failures are inherent from the limits of markets. Real markets transcend the fuzzy boundaries of workable competitive markets.

A dangerous definition of market failure: "The market fails to do what the central planner wants."

Focus on market design and market failures. Better to fix a bad design than to micromanage bad decisions.



Be afraid of the reflexive market intervention that sows the seeds of more intervention. Intervene where needed, and know how to stop. There are examples of interventions that fix market defects or overcome market failure without overturning the market.

ELECTRICITY MARKET Market Design Criteria

Guidelines for design of electricity market institutions include:

- Define Products and Services Consistent with Real Operations.
- Create Property Rights.
- Establish Consistent Pricing Mechanisms.
- Design Central Institutions to Emulate Efficient Market Operations and Incentives.
- Target Structure and Scope of Central Interventions to Address Market Failures.
- Set Principled Limits for Interventions Based on the Nature of the Market Failure.
- Maintain the Goal of Workable, not Perfect, Markets.

The demand for action by regulators
demands that regulators keep their eye on the ball.

Focus on market design and market failures. Better to fix a bad design than to micromanage bad decisions.

Be afraid of the reflexive market intervention that sows the seeds of intervention. Good advice might be: "Don't just do something, stand there." Better advice would be: "Look, and look hard, before you leap."

Intervene where needed, and know how to stop!

ELECTRICITY MARKET Reform Challenges

Wherever market participants have a choice, it is critical to define property rights and get the prices right. Wherever there are central mandates, it is important to design the rules and prices to be consistent with the fundamental market design. For example:

- **Get the Prices Right**
  - Scarcity pricing, demand participation, and resource adequacy.
  - Operating reserve demand curves.
  - Minimum uplift pricing and lumpy decisions.
- **Support Investment**
  - Transmission planning and investment.
  - Argentine transmission investment model.
- **Mitigate Market Power**
  - Protect consumers from the exercise of market power.
  - Bid caps with adequate scarcity pricing.
  - Hedging contracts for default service.

Balancing little "r" regulation through market design and decentralized decisions, and big "R" regulation through mandates and socialized costs.

ELECTRICITY MARKET Market Defects and Market Failures

Consider two cases of interest that present difficult challenges for regulators.

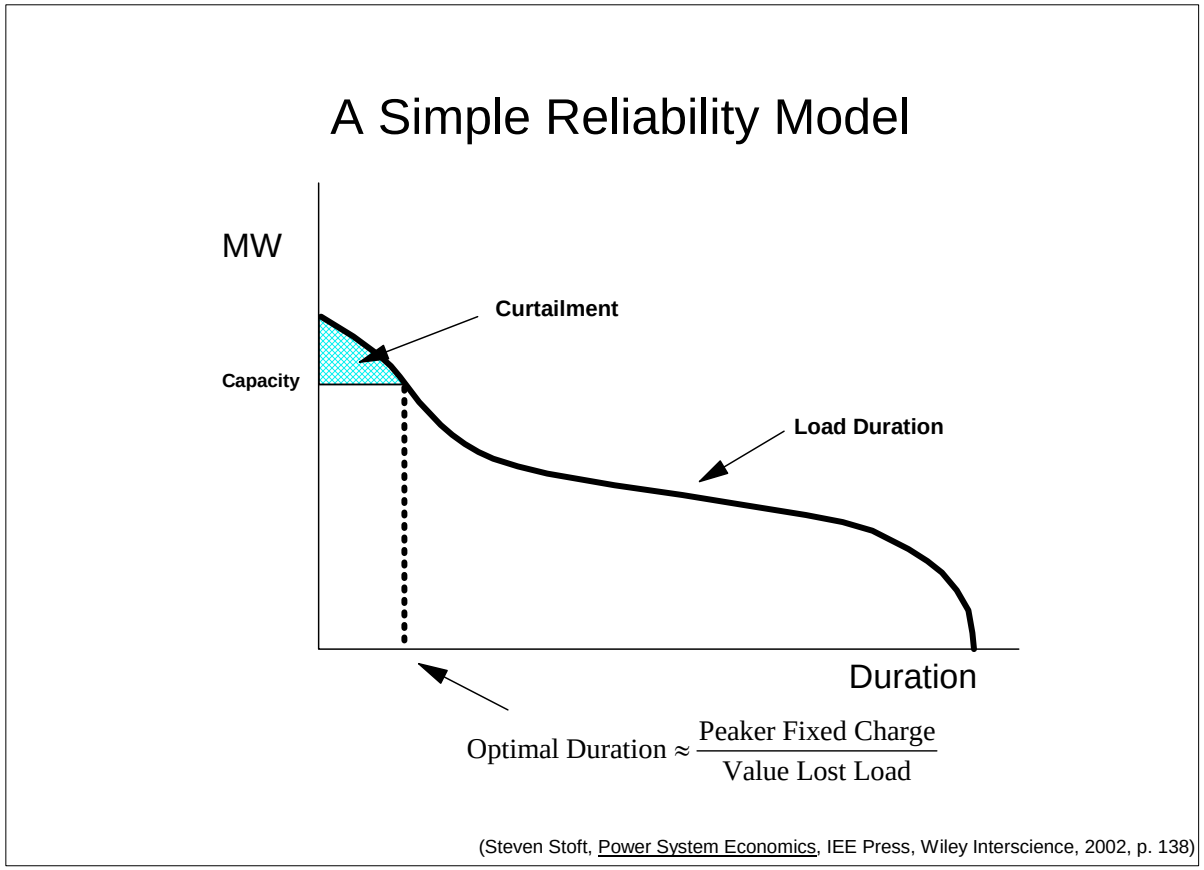
- **Market Defect: Scarcity Pricing**

  Better scarcity pricing to support resource adequacy.

- **Market Failure: Transmission Investment**

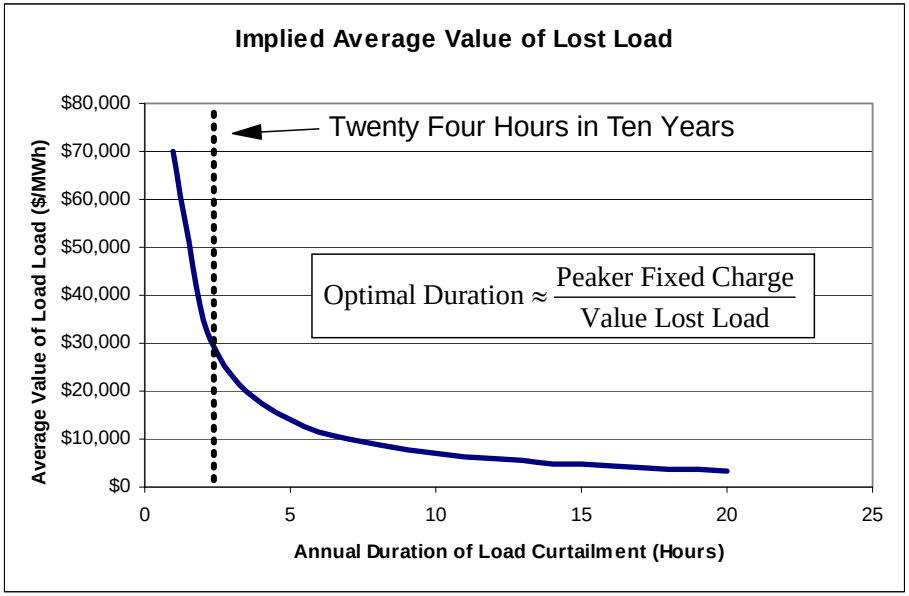
  Regulatory mandates for lumpy transmission mixed with market-based investments.

There is a simple stylized connection between reliability standards and resource economics. Defining expected load shedding duration, choosing installed capacity, or estimating value of lost load address different facets of the same problem.



The simple connection between reliability planning standards and resource economics illustrates a major disconnect between market pricing and the implied value of lost load.

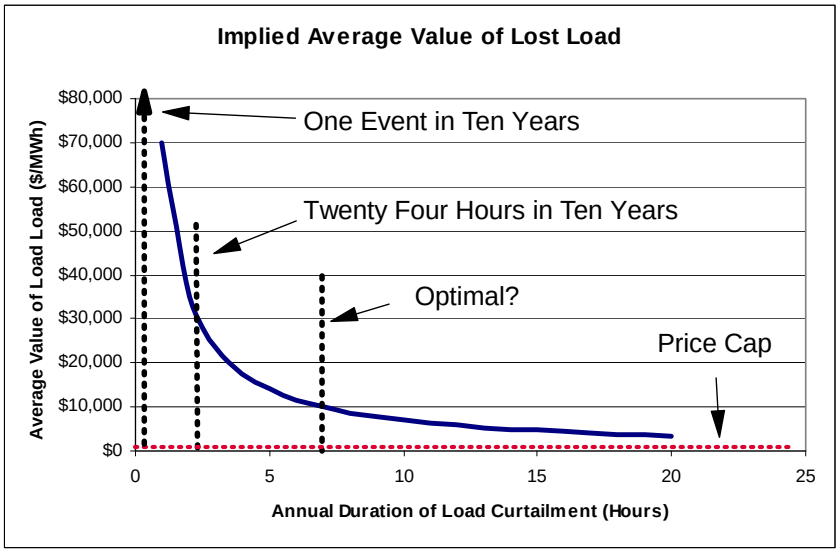
Reliability Planning Standard and Value of Lost Load



Peaker fixed charge at $65,000/MW-yr.

There is a large disconnect between long-term planning standards and market design. The installed capacity market analyses illustrate the gap between prices and implied values. The larger disconnect is between the operating reserve market design and the implied reliability standard.

Reliability Standard and Market Disconnect

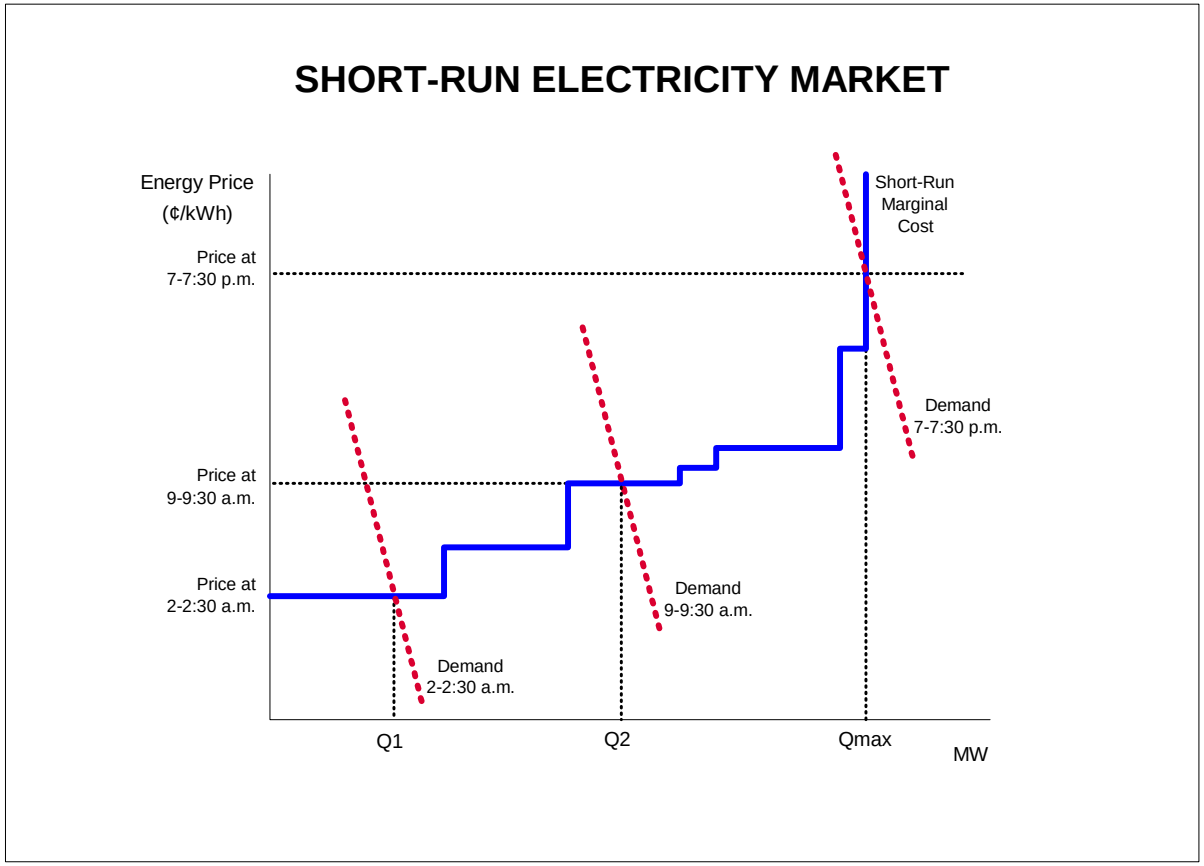


Peaker fixed charge at $65,000/MW-yr.

Implied prices differ by orders of magnitude. $\left(\text{Price Cap} \approx \$10^3;\ \text{VOLL} \approx \$10^4;\ \text{Reliability Standard} \approx \$10^5\right)$

ELECTRICITY MARKET — Pricing and Demand Response

Early market designs presumed a significant demand response. Absent this demand participation most markets implemented inadequate pricing rules equating prices to marginal costs even when capacity is constrained. This produces a "missing money" problem. The big "R" regulatory solution calls for capacity mandates. The small "r" approach addresses the pricing problem.



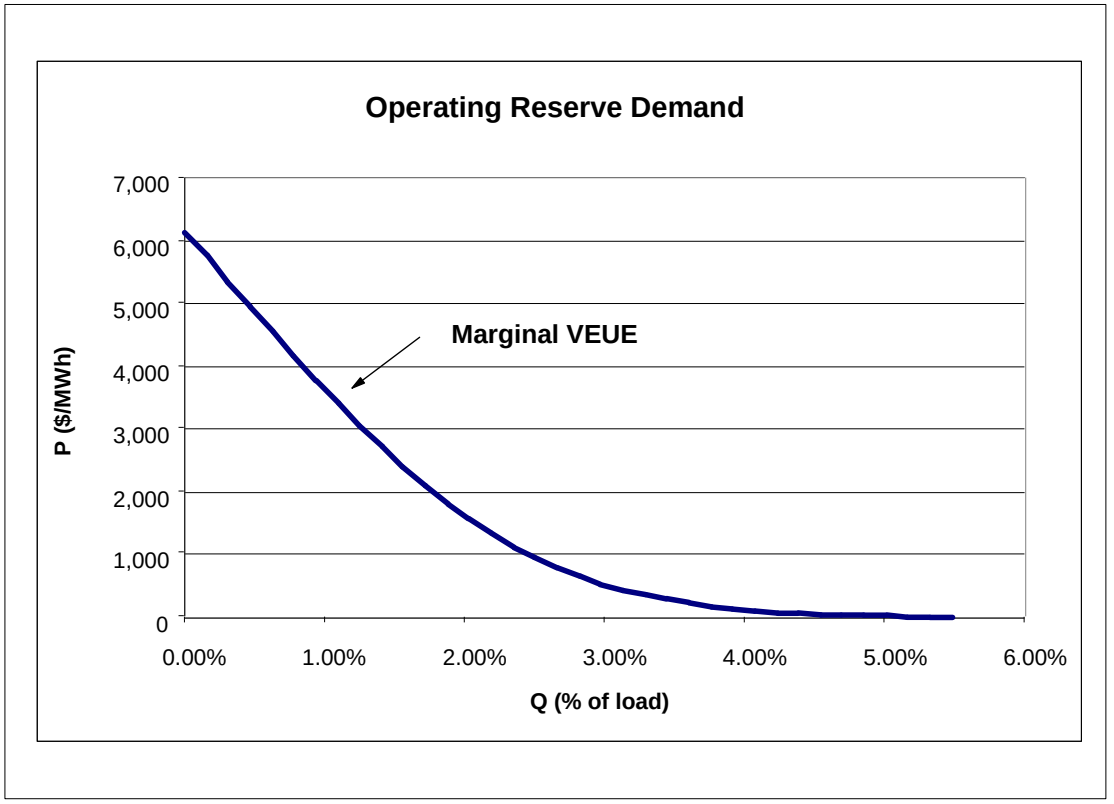
ELECTRICITY MARKET — Operating Reserve Demand

Operating reserve demand is a complement to energy demand for electricity. The probabilistic demand for operating reserves reflects the cost and probability of lost load. Pricing operating reserves could provide the missing money.

Example Assumptions

Expected Load (MW)	34000
Std Dev %	1.50%
Expected Outage %	0.45%
Std Dev %	0.45%
Expected Total (MW)	153
Std Dev (MW)	532.46
VOLL ($/MWh)	10000

Under the simplifying assumptions, if the dispersion of the LOLP distribution is proportional to the expected load, the operating reserve demand is proportional to the expected load. Total value is of same magnitude as the cost of meeting load.



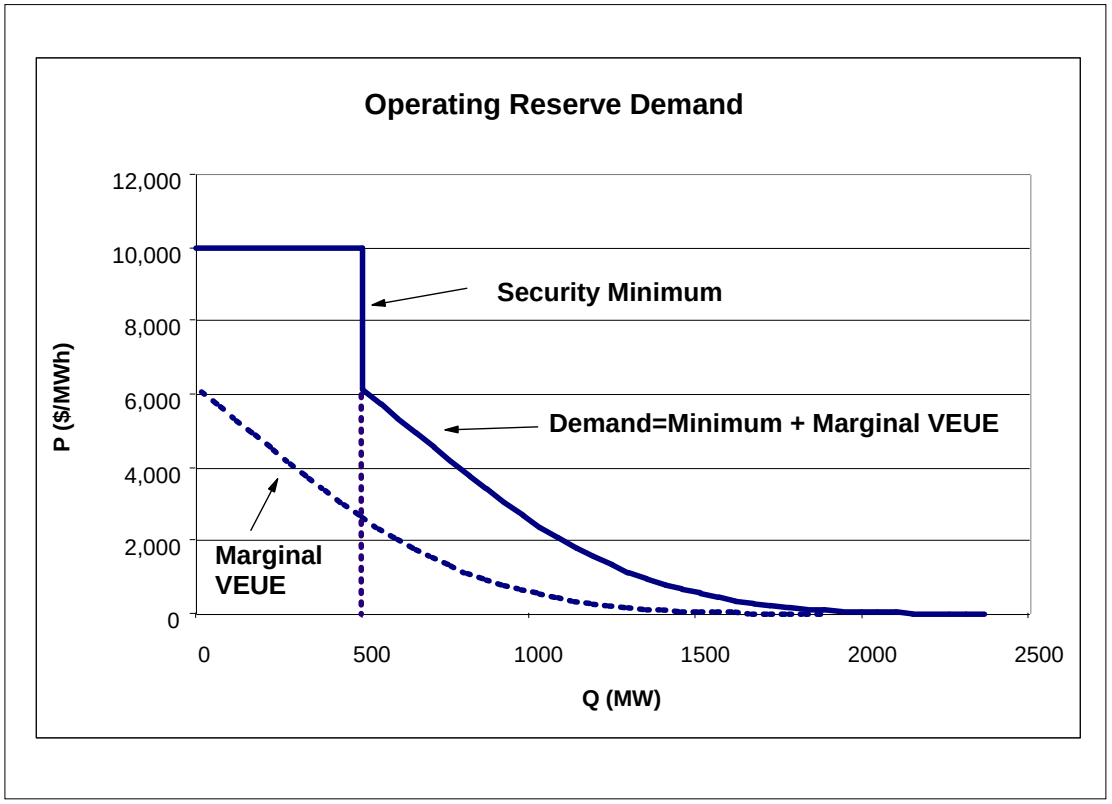
ELECTRICITY MARKET — Operating Reserve Demand

Existing market designs underprice scarcity and provide poor signals for investment. Hence we have the resource adequacy debate. A market would approached would be reinforced by adopting an explicit operating reserve demand curve.

The maximum generation outage contingency quantity provides a vertical demand curve that adds horizontally to a probabilistic operating reserve demand curve.

If the security minimum will always be maintained over the monitored period, the VEUE price at r=0 applies. If the outage shocks allow excursions below the security minimum during the period, the VEUE starts at the security minimum.

A realistic operating reserve demand curve would address the missing money problem and help jump start greater demand participation.



Improved pricing through an explicit operating reserve demand curve raises a number of issues.

Demand Response: Better pricing implemented through the operating reserve demand curve would provide an important signal and incentive for flexible demand participation in spot markets.

Price Spikes: A higher price would be part of the solution. Furthermore, the contribution to the "missing money" from better pricing would involve many more hours and smaller price increases.

Practical Implementation: The NYISO and ISONE implementations dispose of any argument that it would be impractical to implement an operating reserve demand curve. The only issue is the level of the appropriate price.

Operating Procedures: Implementing an operating reserve demand curve does not require changing the practices of system operators. Reserve and energy prices would be determined simultaneously treating decisions by the operators as being consistent with the adopted operating reserve demand curve.

Multiple Locations: Transmission limitations mean that there are locational differences in the need for and efficacy of operating reserves. This would continue to be true with different demand curves for different locations.

Multiple Reserves: The demand curve would include different kinds of operating reserves, from spinning reserves to standby reserves.

Reliability: Market operating incentives would be better aligned with reliability requirements.

Market Power: Better pricing would remove ambiguity from analyses of high prices and distinguish (inefficient) economic withholding through high offers from (efficient) scarcity pricing derived from the operating reserve demand curve.

Hedging: The Basic Generation Service auction in New Jersey provides a prominent example that would yield an easy means for hedging small customers with better pricing.

Increased Costs: The higher average energy costs from use of an operating reserve demand curve do not automatically translate into higher costs for customers. In the aggregate, there is an argument that costs would be lower.

Transmission investment presents the most difficult challenges for an electricity market. In practice and in theory, market failures can be significant. If regulatory intervention is required to plan, coordinate and mandate transmission investment, how can the intervention reinforce the larger market design? A focus on market failures provides a framework that might work in theory. Comparison with the Argentine experience suggests the framework would work in practice. Getting this right is important, with implications for the ultimate success of electricity restructuring.

- **Level Playing Field.** A fundamental assumption of electricity restructuring is that market incentives and decentralized decisions would serve better than regulated decisions in determining investment and allocating risk.
    - Get the prices right.
    - Allow the market to determine the balance among investment alternatives.
    - Recognize that transmission is both a complement and a substitute for other investments.
- **Slippery Slopes.** Mandated investments not supported by market signals reveal or create requirements for expanding the scope of central planning and regulatory rather than market decisions.
    - All investments change the economics of all other investments.
    - Mandated investments tend to reinforce the distortions in price signals.
    - The regulatory cure could be worse than the market disease.

TRANSMISSION INVESTMENT — Argentine Approach

An outline of the Argentine experience bears directly on the debate in the United States and elsewhere. (For details, see Stephen C. Littlechild and Carlos J. Skerk, "Regulation of Transmission Expansion in Argentina Part I: State Ownership, Reform and the Fourth Line," CMI EP 61, 2004, pp. 27-28.)

- **Coordinated Spot Market.** Organized under an Independent System Operator with Locational Marginal Pricing.

- **Expansion of Transmission Capacity by Contract Between Parties**. Allowed merchant transmission with voluntary participant funding.

- **Minor Expansions of Transmission Capacity (<$2M)**. Included regulated investment with assignment of cost, either through negotiation or allocation to beneficiaries as determined by regulator, with mandatory participant funding.

- **Major Expansions of Transmission by "Public Contest" Method**. Overcame market failure without overturning markets.
  - Regulator applies the "Golden Rule" (the traditional Cost-Benefit Test).
  - 30%-30% Rule. At least 30% of beneficiaries must be proponents. No more than 30% of beneficiaries can be opponents.
  - Assignment of costs to beneficiaries with mandatory participant funding under "area of influence" methodology.
  - No award of Financial Transmission Rights!
  - Allocation of accumulated congestion rents to reduce cost of construction ("Salex" funds).

TRANSMISSION INVESTMENT Argentine Approach

What impact did the Argentine approach have on transmission investment?

"To illustrate the change in emphasis on investment, over the period 1993 to 2003 the length of transmission lines increased by 20 per cent, main transformers by 21 per cent, compensators by 27 per cent and substations by 37 per cent, whereas series capacitors increased by 176 per cent. As a result, transmission capacity limits increased by 105 per cent, more than sufficient to meet the increase in system demand of over 50 per cent." (Stephen C. Littlechild and Carlos J. Skerk, "Regulation of Transmission Expansion in Argentina Part II: State Ownership, Reform and the Fourth Line," CMI EP 61, 2004, p. 56.)

Lessons

- **Transmission investment could be compatible with SMD incentives.**
- **Beneficiaries could be defined.**
- **Participant funding could support a market.**
- **Award of FTRs or ARRs would be an obvious enhancement.**

TRANSMISSION INVESTMENT Supporting Markets

How would the Argentine model translate into the Unites States context?

- **Coordinated Spot Market.** Organized under an Independent System Operator with Locational Marginal Pricing. The Successful Market Design with financial transmission rights.

- **Expansion of Transmission Capacity by Contract Between Parties**. Allow merchant transmission with voluntary participant funding. This is the easy case. Allocate long-term financial transmission rights for the transmission expansion.

- **Minor Expansions of Transmission Capacity (<$2M)**. Includes regulated investment with assignment of cost either through negotiation or assignment to beneficiaries as determined by regulator with mandatory participant funding. Leaves small investments to the initiative of the existing wires companies. Auction incremental FTRs along with FTRs for existing system.

- **Major Expansions of Transmission by "Public Contest" Method**. Overcoming market failure without overturning markets.
  - Regulator applies the "Golden Rule" (Cost-Benefit Test). Use the same economic cost benefit analysis to identify expected beneficiaries.
  - 30%-30% Rule. At least 30% of beneficiaries must be proponents. No more than 30% of beneficiaries can be opponents. This provides an alternative, or a complement, to the "Market Failure Test" to help the regulators limit intervention and support the broader market.
  - Assign costs to beneficiaries with mandatory participant funding.
  - Award either Auction Revenue Rights or long term FTRs to beneficiaries along with costs.

TRANSMISSION INVESTMENT Supporting Markets

Apply the same general rules to all generation and demand investments that compete with transmission.

- **Coordinated Spot Market.** Organized under an Independent System Operator with Locational Marginal Pricing. The Successful Market Design with financial transmission rights.

- **Voluntary Investment by Contract Between Parties**. Allow merchant generation and demand investment with voluntary participant funding. This is the easy case.

- **Major Investments by "Public Contest" Method**. Overcoming market failure without overturning markets.
  - Regulator applies the "Golden Rule" (Cost-Benefit Test). Use the same economic cost benefit analysis to identify expected beneficiaries.
  - 30%-30% Rule. At least 30% of beneficiaries must be proponents. No more than 30% of beneficiaries can be opponents. Absent a very lumpy investment, the beneficiaries should be a very limited group. Virtually all demand investments and most generation investments would have a single beneficiary.
  - Assign costs to beneficiaries with mandatory participant funding.

In principle, this provides a level playing field while recognizing that there may be market failures that require regulated investments.

William W. Hogan is the Raymond Plank Professor of Global Energy Policy, John F. Kennedy School of Government, Harvard University and a Director of LECG, LLC. This paper draws on work for the Harvard Electricity Policy Group and the Harvard-Japan Project on Energy and the Environment. The author is or has been a consultant on electric market reform and transmission issues for Allegheny Electric Global Market, American Electric Power, American National Power, Australian Gas Light Company, Avista Energy, Barclays, Brazil Power Exchange Administrator (ASMAE), British National Grid Company, California Independent Energy Producers Association, California Independent System Operator, Calpine Corporation, Canadian Imperial Bank of Commerce, Centerpoint Energy, Central Maine Power Company, Chubu Electric Power Company, Citigroup, Comision Reguladora De Energia (CRE, Mexico), Commonwealth Edison Company, Conectiv, Constellation Power Source, Coral Power, Credit First Suisse Boston, Detroit Edison Company, Deutsche Bank, Duquesne Light Company, Dynegy, Edison Electric Institute, Edison Mission Energy, Electricity Corporation of New Zealand, Electric Power Supply Association, El Paso Electric, GPU Inc. (and the Supporting Companies of PJM), Exelon, GPU PowerNet Pty Ltd., GWF Energy, Independent Energy Producers Assn, ISO New England, Luz del Sur, Maine Public Advocate, Maine Public Utilities Commission, Merrill Lynch, Midwest ISO, Mirant Corporation, JP Morgan, Morgan Stanley Capital Group, National Independent Energy Producers, New England Power Company, New York Independent System Operator, New York Power Pool, New York Utilities Collaborative, Niagara Mohawk Corporation, NRG Energy, Inc., Ontario IMO, Pepco, Pinpoint Power, PJM Office of Interconnection, PPL Corporation, Public Service Electric & Gas Company, PSEG Companies, Reliant Energy, Rhode Island Public Utilities Commission, San Diego Gas & Electric Corporation, Sempra Energy, SPP, Texas Genco, Texas Utilities Co, Tokyo Electric Power Company, Toronto Dominion Bank, TransÉnergie, Transpower of New Zealand, Westbrook Power, Western Power Trading Forum, Williams Energy Group, and Wisconsin Electric Power Company. The views presented here are not necessarily attributable to any of those mentioned, and any remaining errors are solely the responsibility of the author. (Related papers can be found on the web at www.whogan.com).