

# **ELECTRICITY MARKET DESIGN: California ISO/PX “Fundamentally Flawed”**

**William W. Hogan**

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

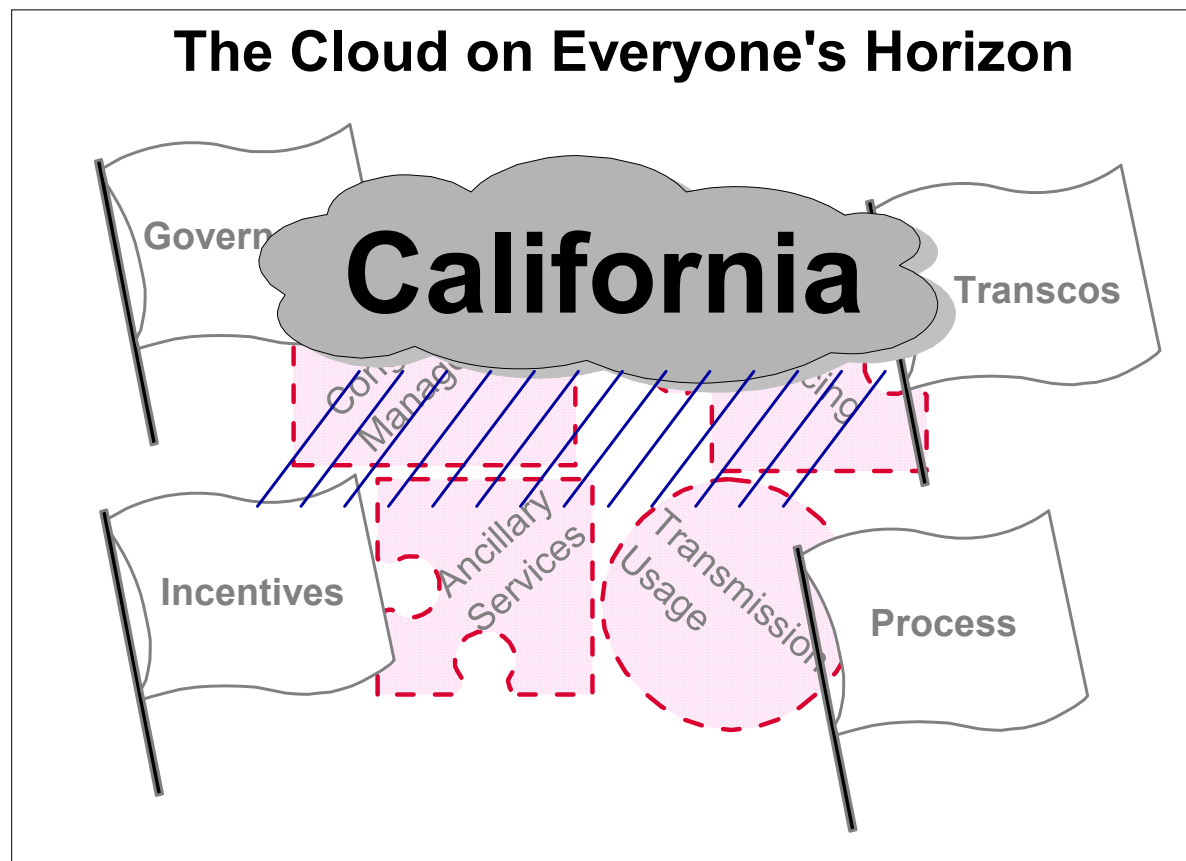
**Harvard Electricity Policy Group  
California Electricity Crisis (2000-2001): Legacy and Lessons**

**October 1, 2019**

## ELECTRICITY MARKET

## California Developments

The crisis in California became the cloud on everyone's horizon. The problems were serious and surprising. The experience affected the speed and content of electricity restructuring developments everywhere. A key issue was the underlying market design that set the stage for the California crisis of 2000-2001. The market design has already been found “fundamentally flawed” before prices rose.



# **ELECTRICITY MARKET**

# **Energy Reform Challenges**

**A core challenge for all electricity systems is between monopoly provision and market operations. Electricity market design depends on critical choices. There is no escape from the fundamentals.**

<b>Integrated Monopoly</b>	<b>Competitive Markets</b>
<ul style="list-style-type: none"><li>• Mandated</li><li>• Closed Access</li><li>• Discrimination</li><li>• Central Planning</li><li>• Few Choices</li><li>• Spending Other People's Money</li><li>• Average Cost Pricing</li></ul>	<ul style="list-style-type: none"><li>• Voluntary</li><li>• Open Access</li><li>• Non-discrimination</li><li>• Independent Investment</li><li>• Many Choices</li><li>• Spending Your Own Money</li><li>• Marginal Cost Pricing</li></ul>

## **A Key Market Design Objective**

**Supporting the Solution:** Given the prices and settlement payments, individual optimal behavior is consistent with the aggregate optimal solution.

# ELECTRICITY MARKET

# Energy Market Design

The U.S. experience illustrates successful market design and remaining challenges for both theory and implementation.

- **Design Principle: Integrate Market Design and System Operations**

Provide good short-run operating incentives.

Support forward markets and long-run investments.

- **Design Framework: Bid-Based, Security Constrained Economic Dispatch**

Locational Marginal Prices (LMP) with granularity to match system operations.

Financial Transmission Rights (FTRs).

- **Design Implementation: Pricing Evolution**

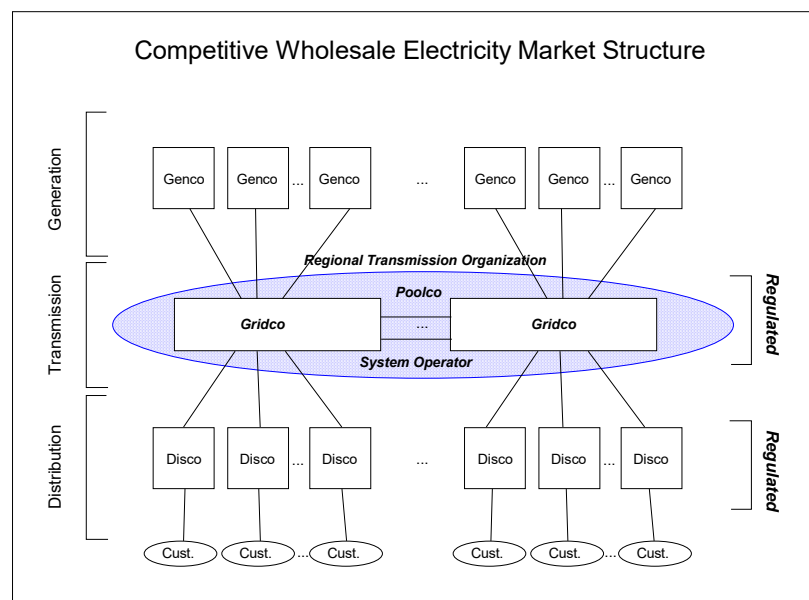
Better scarcity pricing to support resource adequacy.

Unit commitment and lumpy decisions with coordination, bid guarantees and uplift payments.

- **Design Challenge: Infrastructure Investment**

Hybrid models to accommodate both market-based and regulated transmission investments.

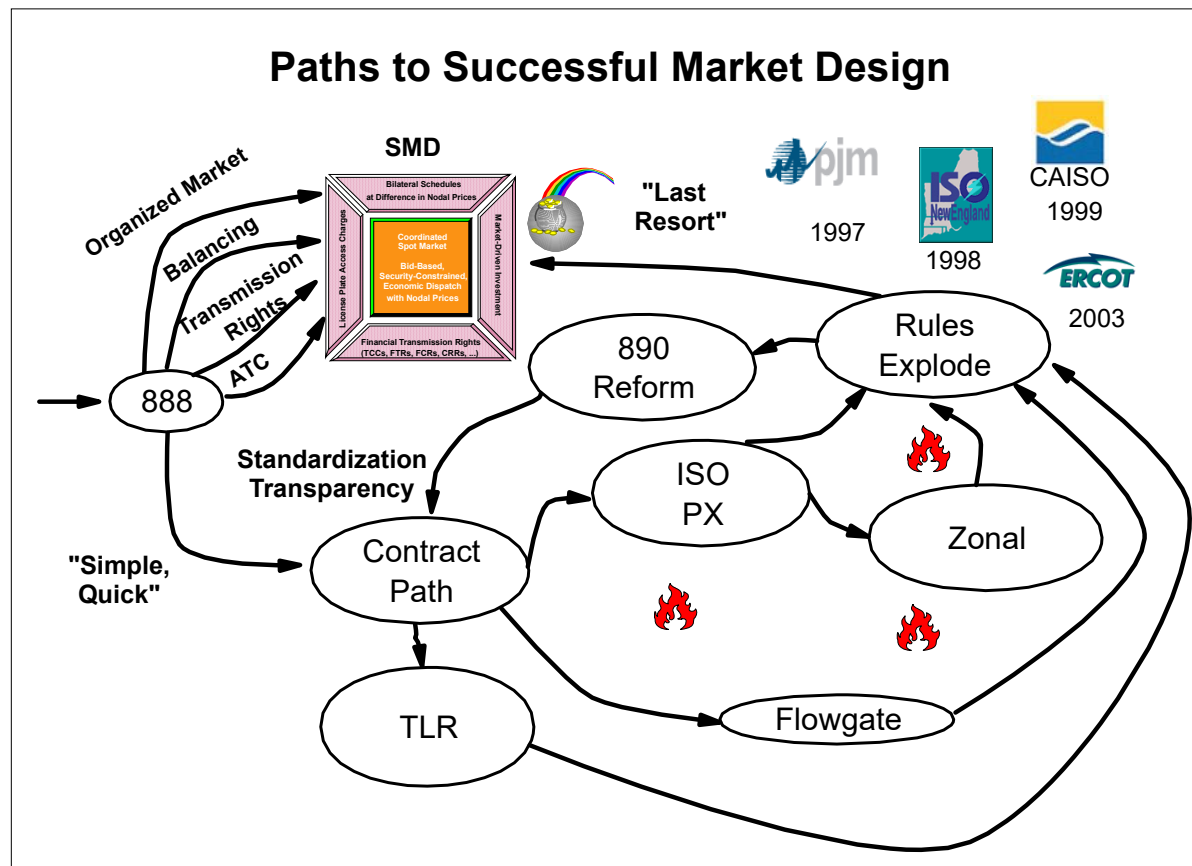
Beneficiary-pays principle to support integration with rest of the market design.



# ELECTRICITY MARKET

# Path Dependence

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. Early attempts with contract path, flowgate and zonal models led to design failures in PJM (’97), New England (’98), California (’99), and Texas (’03). Regional aggregation creates conflicts with system operations. Successful market design integrates the market with system operations.

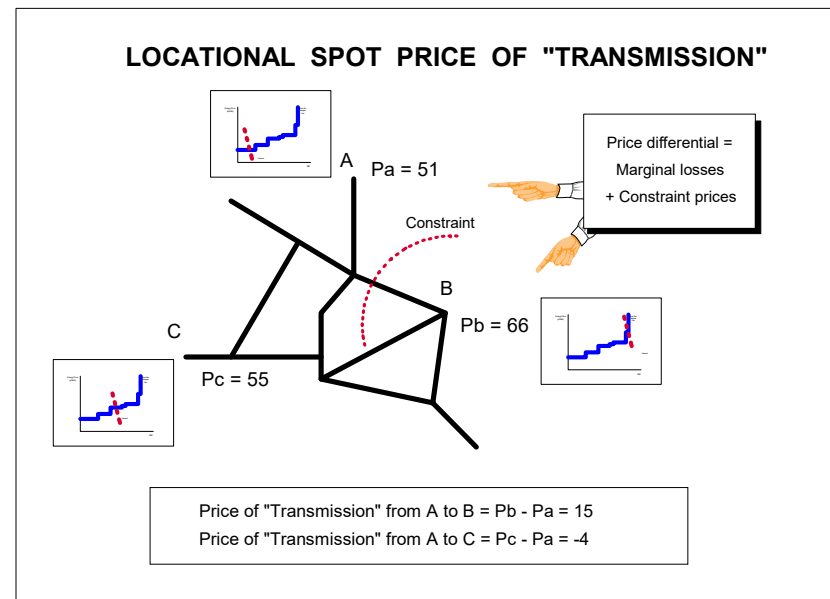
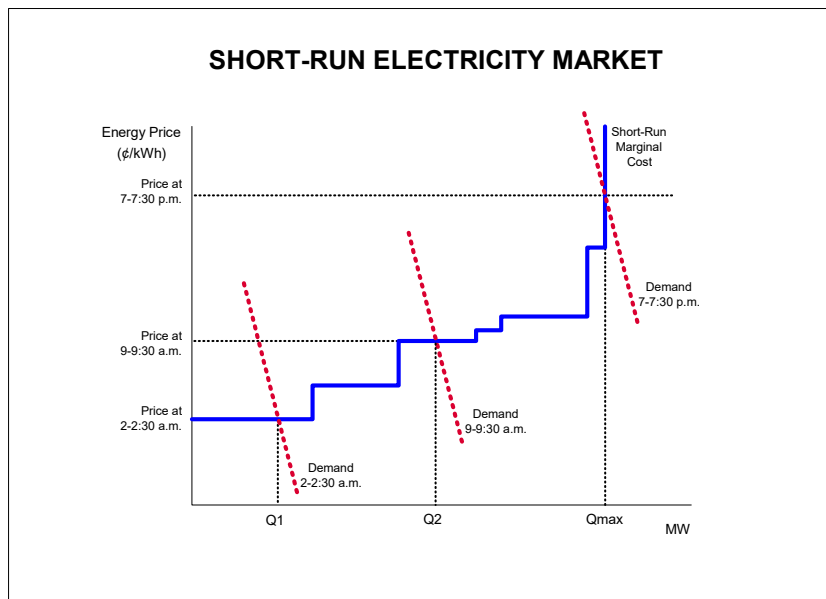


# ELECTRICITY MARKET

# Electricity Restructuring

The evolution of electricity restructuring thread was prominent in California. The basic challenge of efficient market design included was wrongly cast as a choice between bilateral markets and a pool.

**California Blue Book, 1994.** "An Efficient Bilateral Market Needs a Pool."<sup>1</sup> A good design driven by regulators and opposed by prominent market participants (e.g., Enron). (Hogan, 1994)



<sup>1</sup> William W. Hogan, "An Efficient Bilateral Market Needs a Pool," testimony before California Public Utilities Commission, August 4, 1994.

**The evolution of electricity restructuring thread include the initial directions from the California Public Utilities Commission and the “Ten Commandments” for the successful operation of the ISO.**

**California Public Utilities Commission. (1994).** Order Instituting Rulemaking on the Commission’s Proposed Policies Governing Restructuring California’s Electric Services Industry and Reforming Regulation.

“The filing should incorporate the principles delineated below, which we believe are critical to the successful operation of the ISO. ...

7. The ISO will coordinate the scheduled nominations from the Power Exchange and the bilateral transactions to determine any redispatch that would be necessary to meet the twin objectives of assuring operational reliability and achieving least cost use of the system. Along with this redispatch, the ISO will determine the locational marginal costs incorporating the cost of generation, losses and congestion that will define the market clearing prices for the Power Exchange and the price of transmission use for the bilateral transactions. The marginal costs of redispatching to provide an increment of load at each location will define the purchase and sale prices through the Power Exchange. The differences in the locational marginal costs between source and destination will define the price of transmission applied to the bilateral transactions. The ISO will notify the Power Exchange and the bilateral participants of the final redispatch for the scheduled nominations and the associated prices that will be charged for transactions.” (California Public Utilities Commission, 1994, p. 24).

**Separation of the California Independent System Operator and Power Exchange created avoidable and anticipated problems. Separation would preclude economic dispatch.**

**The Separation Fallacy.** “The argument that the system operator should provide transmission services without any involvement in operating the dispatch and spot market is a seriously flawed idea.” (Hogan, 1995a) (Hogan, 1995b)

**The independent system operator provides a dispatch function. Three questions remain. Just say yes, and the market can decide on the split between bilateral and coordinated exchange.**

- **Should the system operator be allowed to offer an economic dispatch service for some plants?**

The alternative would be to define a set of administrative procedures and rules for system balancing that purposely ignore the information about the costs of running particular plants. It seems more natural that the system operator considers customer bids and provides economic dispatch for some plants.

- **Should the system operator apply marginal cost prices for power provided through the dispatch?**

Under an economic dispatch for the flexible plants and loads, it is a straightforward matter to determine the locational marginal costs of additional power. These marginal costs are also the prices that would apply in the case of a perfect competitive market at equilibrium. In addition, these locational marginal cost prices provide the consistent foundation for the design of a comparable transmission tariff.

- **Should generators and customers be allowed to participate in the economic dispatch offered by the system operator?**

The natural extension of open access and the principles of choice would suggest that participation should be voluntary. Market participants can evaluate their own economic situation and make their own choice about participating in the operator's economic dispatch or finding similar services elsewhere.



## **ELECTRICITY MARKET**

## **Electricity Restructuring**

**The evolution of electricity restructuring thread included a continued discussion of the essential elements of successful market design.**

**California Memorandum of Understanding (MOU), 1995.** Ignored the principles laid out by the CPUC and created a sharp separation of Power Exchange (PX) and System Operator (CAISO). A bad design emerging from stakeholder negotiations with reluctant acquiescence by regulators. The basic design was then then implemented in 1998. (California Manufacturers Association, California Large Energy Consumers Association, Independent Energy Producers, Californians For Competitive Electricity, & Southern California Edison, 1995)

"Professor Hogan can also be read to suggest that the ISO should become the 'pool' by taking schedules which include not just quantity information, but also include price information so that the ISO can select 'the most economically efficient' requests from among the schedules, as if the schedules were bids into the pool. This proposal would essentially re-create the pool in the guise of the ISO. Again, there can be no doubt that the parties intended to foreclose this situation. Indeed, the parties went to great lengths in the MOU to allow buyers and sellers to purchase unbundled transmission rights, to make quantity-only schedules, and not to disclose pricing information to the ISO or subject their transactions to 'economic dispatch.'"<sup>2</sup>

---

<sup>2</sup> (Enron et al., "Comments of Enron Capital & Trade Resources, Wickland Power Services, Destec Power Services, inc., Illinova Power Marketing, Inc., Coastal Electric Services, and Electric Clearinghouse, Inc., on the Memorandum of Understanding filed September 11, 1995," dated October 2, 1995, and filed with the CPUC, p. 13.)

**The evolution of electricity restructuring thread included a continued discussion of the essential elements of successful market design.**

**What Should Power Marketers Want?** “We have found first that power marketers should oppose a Poolco system that requires all wholesale trades to be made through the pool. ... Second, if there is still going to be a publicly run power exchange (PX), power marketers should demand that the ISO not be allowed to clear the entire market while doing congestion management. This will eliminate the natural advantage of a centralized market and leave the PX with only the disadvantages of regulation. This should be sufficient to assure the early demise of the PX. ... Lastly, large power marketers should favor rules that prohibit the ISO from facilitating trades between small power marketers as this would allow small power marketers to more effectively capture some of returns to scale and scope enjoyed by large power marketers.” (Stoft, 1997) (See also (Stoft, 1996))

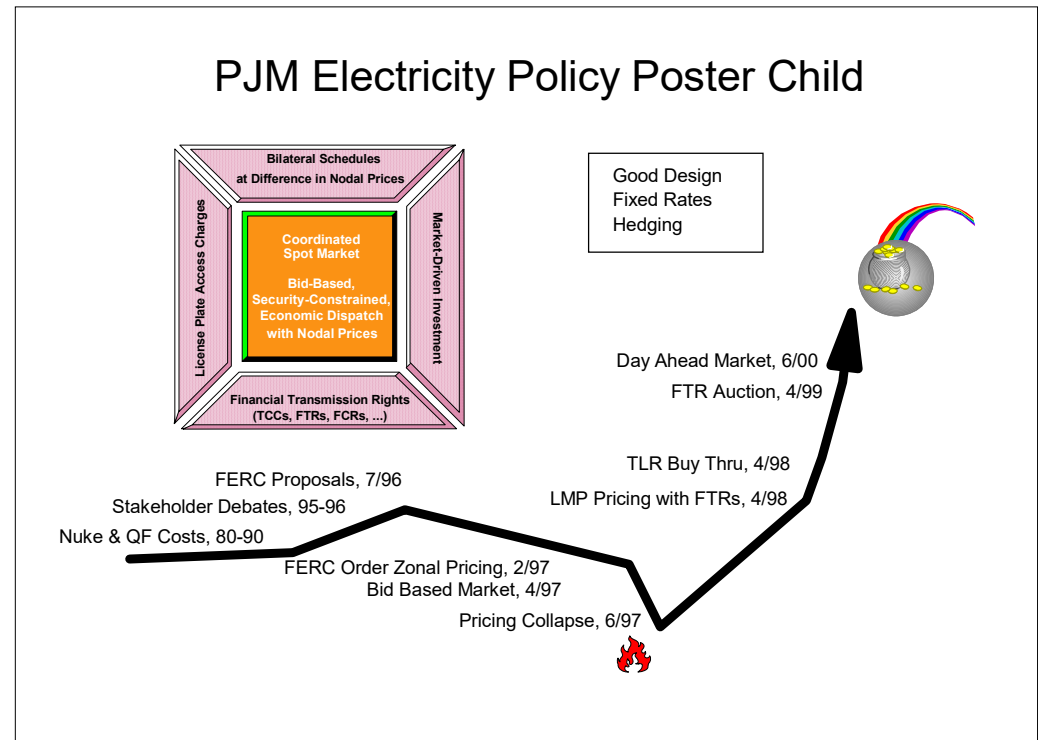
**WEPEX: What's Wrong With Least Cost?** “Unfortunately, WEPEX has not said "yes" [to economic dispatch]. Rather, the WEPEX response is better characterized as "whenever it makes a difference, the answer is no." There are restrictions on least cost dispatch, but the WEPEX sponsors contend that the market will solve the problem and therefore economic dispatch is not necessary. This is the old "bilateral only" argument reborn. But if the market cannot solve the problem, then the WEPEX restrictions apply to prevent the system operator from clearing the market.” (Hogan, 1998)

# ELECTRICITY MARKET

# Electricity Restructuring

The evolution of electricity restructuring thread of market design problems was not only in California.

- **PJM, 1997 & 1998.** Demonstrates the importance of good congestion management under the visible hand. A bad design in 1997 failed. A good design in 1998 set the standard for others. Same approach soon adopted in New York. A similar false start and reform experienced in New England.
- **Order 2000, 1999.** Regional Transmission Organizations, the 'Millennium Order.' A major step forward. Incorporated principles to support coherent market design, but the design was still implicit and far from clear. And relied on "voluntary" participation.



# ELECTRICITY MARKET

# Electricity Restructuring

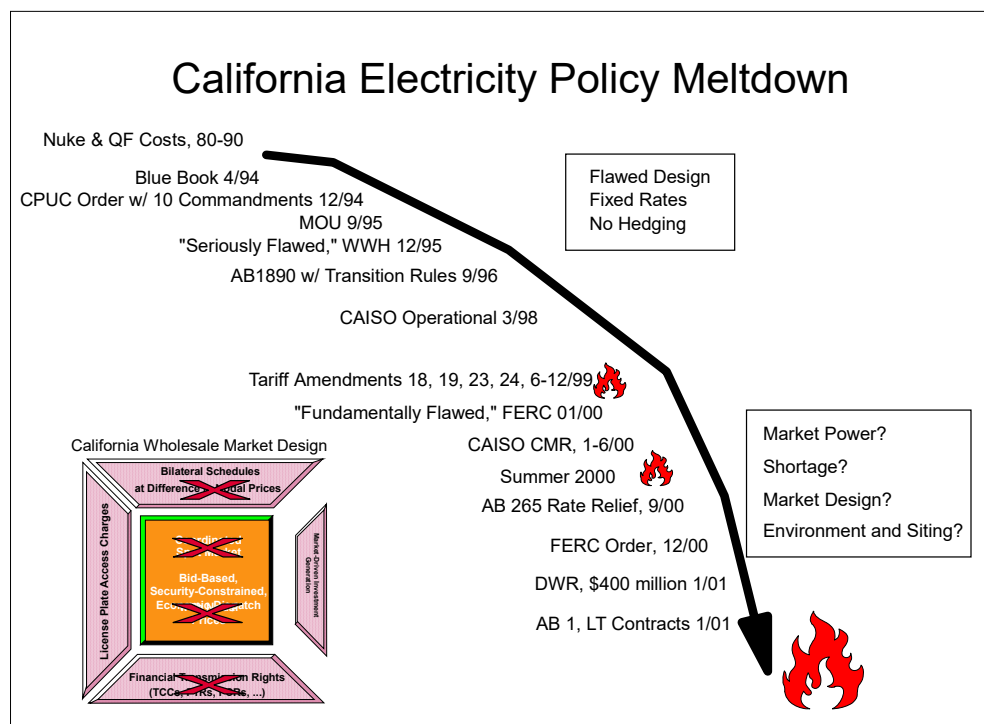
The evolution of electricity restructuring thread identified problems in California well before the meltdown.

**California CMR, 1999.** Congestion Management Reform to Comprehensive Market Redesign.

FERC rejects the series of CAISO Amendments directed at patch work solutions. "The problem facing the [California] ISO is that the existing congestion management approach is **fundamentally flawed** and needs to be overhauled or replaced."<sup>3</sup> (FERC, 2000) (emphasis added.)

**California Meltdown, 2000.** Bad policy, bad luck, and bad news.

**Bankruptcy, 2001.** PG&E and Enron, bankruptcy bookends for the "annus horribilis." The California meltdown and Enron's fiasco of shady trading and accounting scandals strike at the core of the credibility of markets.



<sup>3</sup> Federal Energy Regulatory Commission, "Order Accepting for Filing in Part and Rejecting in Part Proposed Tariff Amendment and Directing Reevaluation of Approach to Addressing Intrazonal Congestion," Docket ER00-555-000, 90 FERC 61, 000, Washington DC, January 7, 2000, p. 9. See also Federal Energy Regulatory Commission, "Order Denying Requests for Clarifications and Rehearing," 91 FERC 61, 026, Docket ER00-555-001, Washington DC, April 12, 2000, p. 4.

**The evolution of electricity restructuring thread in California eventually returned to first principles and the core problems of Successful Market Design.**

- **California Market Redesign, 2002.** In January 2002, the CAISO recognizes the fundamental flaws in its market design.<sup>4</sup>

“Upon reexamination of the [Congestion Management Reform] proposal ... we find that some of the crucial assumptions underlying the [Locational Pricing Areas] concept break down.”(CAISO, p. 13) “...in reality, the ‘simplicity’ of the zonal system only appears so because the complexity is assumed away, allowing market participants to ignore it in scheduling while the CAISO must manage it through real time adjustments and periodic modifications to the rules to mitigate novel gaming strategies as they arrive. ... it will be far simpler, and more transparent, to design forward [congestion management] procedures to be as consistent as possible with the real-time operating needs of the grid.”(CAISO, p. 14)

---

<sup>4</sup> CAISO proposal, “Market Design 2002 Project: Preliminary Draft Comprehensive Design Proposal,” January 8, 2002.

**A word on market power and market manipulation: fundamentally flawed market design creates opportunities for bad outcomes.**

- **Market Power.**

Control of generation sources or demand scheduling can create standard market power problems. Generators can withhold supply or loads can withhold demand to affect market-clearing prices. The evidence of loads withholding demand from the PX is strong. The evidence for generators withholding supply is more controversial.

- **Market Manipulation.**

When prices and dispatch are inconsistent, there are opportunities to manipulate in order to arbitrage the price differentials. There is no need to have market power to exploit such opportunities, and there was ample evidence of such manipulation in the California meltdown.

- **Patchwork Regulations.**

When markets implode, regulators must respond. But with a flawed market design, it is very difficult to find interventions that do more good than harm.

Addressing these issues involves the analysis of what happened during the crisis, building on an understanding of what came before.

## **MARKET POWER AND PRICES**

## **Gap Analysis**

**Direct examination of the output of individual plants avoids the necessity of building a network based simulation model. However, it does not avoid the necessity of dealing with the many complications of electricity operations. In the California crisis, there were many attempts to compare the data for actual generation against capacity, defining the difference as the gap. The most important case is the study done by the California regulators, addressed by the California system operator and reviewed by the FERC staff.<sup>5</sup>**

“This is the Commission staff’s analysis of the “Investigative Report on Wholesale Electric Generation” (Report) by the California Public Utilities Commission (CPUC) in which the CPUC analyzed data on electric power production and bidding behavior of five electric generators on 38 days from November 2000 through May 2001 during which California experienced interruptions of firm or non-firm service. The CPUC concluded, in that Report and elsewhere, that the merchant generators in California engaged in significant physical withholding (reducing the amount of generation made available to the market to increase the value of their remaining generation) and economic withholding (raising the asking price for their generation to levels well above marginal costs).

“In the narrow context of staff’s review of the Report, staff concludes that the CPUC significantly overstated the degree to which the generators held power out of the market on those days when firm service was interrupted. This is a very narrow conclusion. The Commission has not concluded its investigations of whether physical and economic withholding occurred in California or its magnitude and effect. The conclusion here, that the merchant generators were not withholding during the six days of firm service interruptions, does not mean that staff or the Commission have determined that no physical or economic withholding occurred during 2000 or 2001.”

---

<sup>5</sup> Staff of the Federal Energy Regulatory Commission “Staff’s Review of California Public Utilities Commission’s September 17, 2002 Investigative Report On Wholesale Electric Generation,” March 26, 2003.

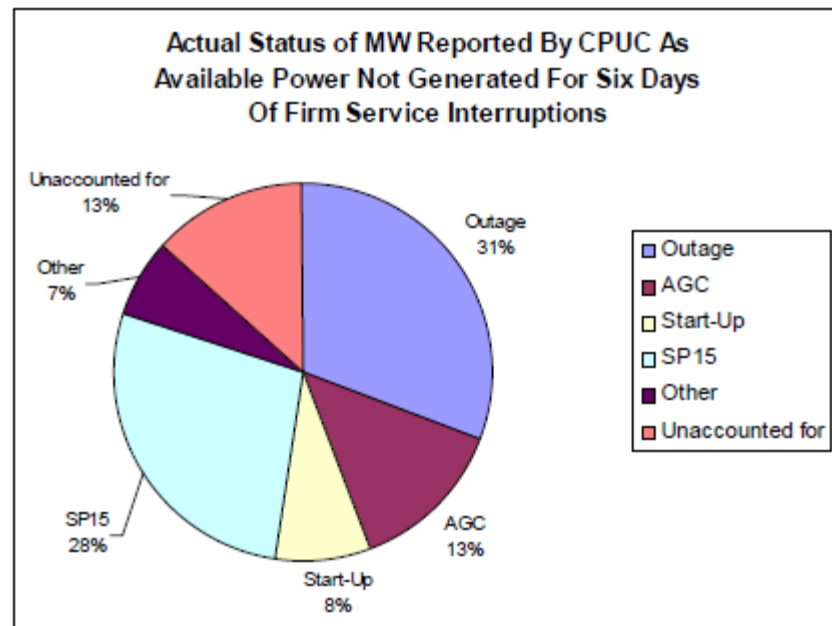
## MARKET POWER AND PRICES

## Gap Analysis

The FERC staff analysis of the reasons for the CPUC overstatement of the output “gap” reflects the basic importance of recognizing and incorporating the underlying engineering detail of electricity system operations.

“Staff found that most of the power that the CPUC concluded was available and withheld by the generators was actually unavailable because a generating unit was:

- experiencing an outage;
- operating at least some of its capacity under the Automatic Generation Control (AGC) of the California Independent System Operator (CAISO), and being dispatched by the CAISO to decrease power in order to control the grid;
- the unit was starting up from having been off-line due to a repair or having tripped (an automatic shutdown) such that it was not yet capable of producing its full capacity;
- located south of an overloaded transmission path that prevented the transmission of energy to the area suffering firm service interruptions; or
- experiencing other constraints limiting its generation.”



This was an important moment. ***With respect to the California crisis, there are no confirmed cases of withholding to exercise market power and manipulate prices.***

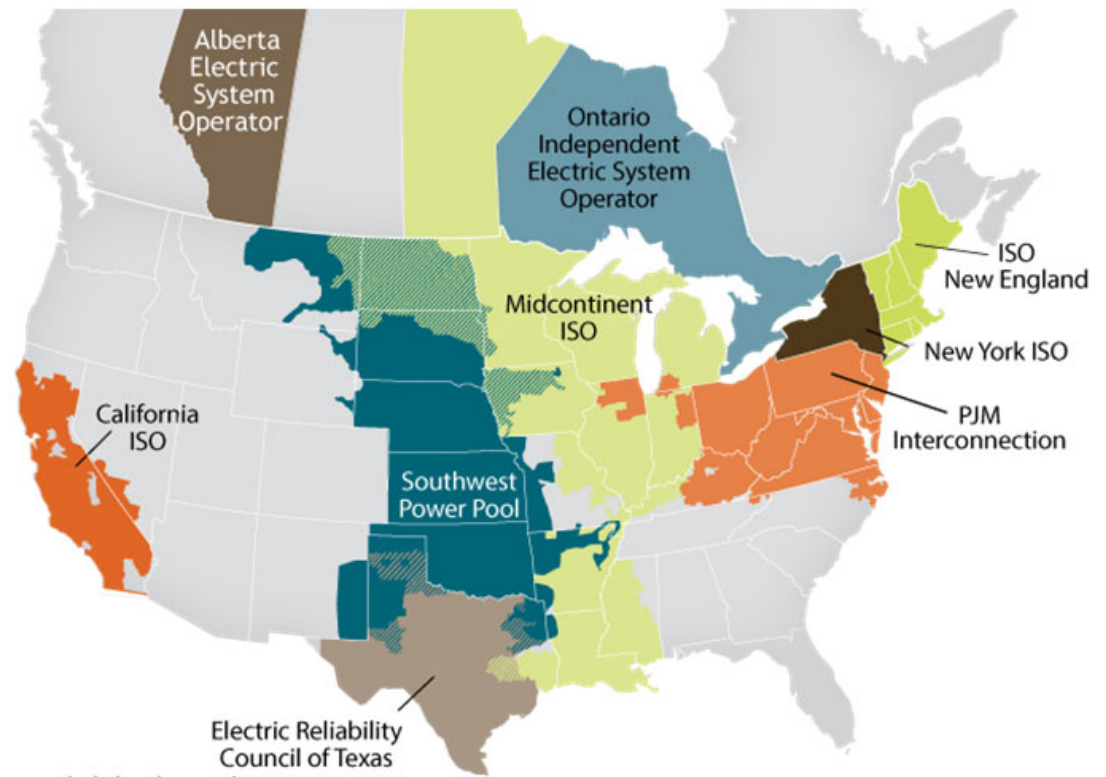
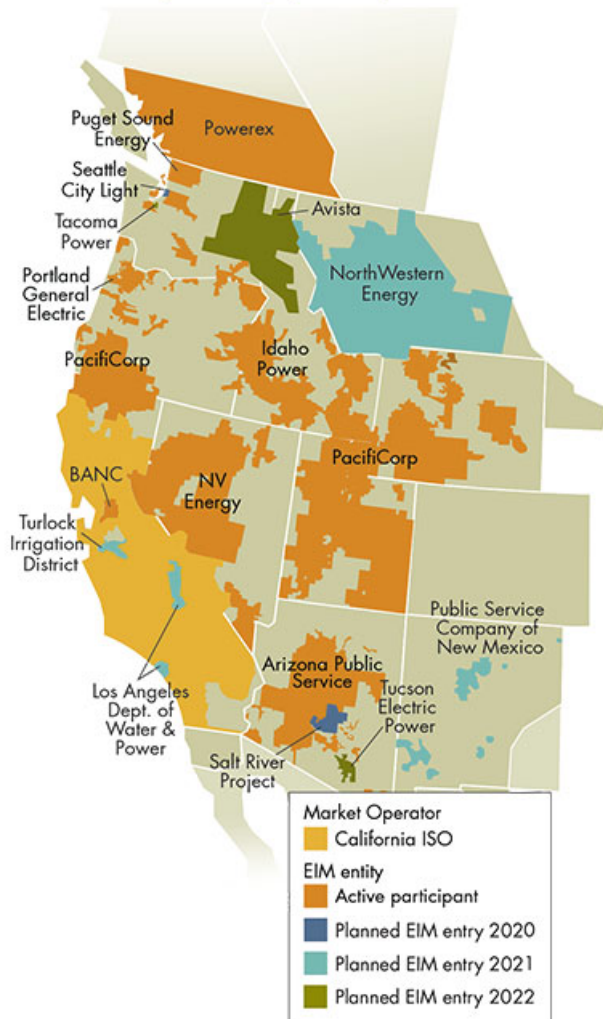


# ELECTRICITY MARKET

# A Consistent Framework

The basic model for Successful Market Design covers the existing Regional Transmission Organizations and is expanding through the Western Energy Imbalance Market. ([www.westerneim.com](http://www.westerneim.com))

Active and pending participants



## References

- California Manufacturers Association, California Large Energy Consumers Association, Independent Energy Producers, Californians For Competitive Electricity, & Southern California Edison. (1995). Memorandum Of Understanding On Joint Recommendations, California Public Utilities Commission, Dockets No. R94-04-031/I. 94-04-032 (September 11, 1995). Retrieved from <https://ei.haas.berkeley.edu/programs/UCEI/Restructuring Archive/MOU.pdf>
- California Public Utilities Commission. (1994). Order Instituting Rulemaking on the Commission's Proposed Policies Governing Restructuring California's Electric Services Industry and Reforming Regulation. Retrieved from [https://ei.haas.berkeley.edu/programs/UCEI/Restructuring Archive/CPUC\\_Restructuring\\_Policy\\_Decision.pdf](https://ei.haas.berkeley.edu/programs/UCEI/Restructuring Archive/CPUC_Restructuring_Policy_Decision.pdf)
- FERC. (2000). Order Accepting for Filing in Part and Rejecting in Part Proposed Tariff Amendment and Directing Reevaluation of Approach to Addressing Intrazonal Congestion, ER00-555-000, (January 7). Retrieved from [http://www.caiso.com/Documents/January7\\_2000\\_OrderAccepting\\_FilinginPartandRejectinginPartProposedTariffAmendmentinDocketNo\\_ER00-555-000.pdf](http://www.caiso.com/Documents/January7_2000_OrderAccepting_FilinginPartandRejectinginPartProposedTariffAmendmentinDocketNo_ER00-555-000.pdf)
- Hogan, W. W. (1994). An Efficient Bilateral Market Needs A POOL, CPUC Testimony, August 4. Retrieved from <https://sites.hks.harvard.edu/fs/whogan/wmkt08041994.pdf>
- Hogan, W. W. (1995a). A wholesale pool spot market must be administered by the independent system operator: Avoiding the separation fallacy. *The Electricity Journal*. Retrieved from <http://www.sciencedirect.com/science/article/pii/1040619095901396>
- Hogan, W. W. (1995b). To Pool or Not to Pool: A Distracting Debate. *Public Utilities Fortnightly*, (January 1). Retrieved from <https://www.fortnightly.com/fortnightly/1995/01/pool-or-not-pool-distracting-debate>
- Hogan, W. W. (1998). Rethinking WEPEX: What's Wrong with Least Cost? *Public Utilities Fortnightly*. Retrieved from <https://www.fortnightly.com/fortnightly/1998/01/rethinking-wepex-whats-wrong-least-cost>
- Stoft, S. (1996). California's ISO: Why not clear the market? *Electricity Journal*, 9(10), 38–43. [https://doi.org/10.1016/S1040-6190\(96\)80155-2](https://doi.org/10.1016/S1040-6190(96)80155-2)
- Stoft, S. (1997). What should a power marketer want? *The Electricity Journal*, 10(5), 34–45. [https://doi.org/10.1016/S1040-6190\(97\)80528-3](https://doi.org/10.1016/S1040-6190(97)80528-3)

William W. Hogan is the Raymond Plank Research Professor of Global Energy Policy, John F. Kennedy School of Government, Harvard University. This paper draws on research for the Harvard Electricity Policy Group and for 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, Aquila, AQUIND Limited, Atlantic Wind Connection, Australian Gas Light Company, Avista Corporation, Avista Utilities, Avista Energy, Barclays Bank PLC, Brazil Power Exchange Administrator (ASMAE), British National Grid Company, California Independent Energy Producers Association, California Independent System Operator, California Suppliers Group, Calpine Corporation, CAM Energy, Canadian Imperial Bank of Commerce, Centerpoint Energy, Central Maine Power Company, Chubu Electric Power Company, Citigroup, City Power Marketing LLC, Cobalt Capital Management LLC, Comision Reguladora De Energia (CRE, Mexico), Commonwealth Edison Company, COMPETE Coalition, Conectiv, Constellation Energy, Constellation Energy Commodities Group, Constellation Power Source, Coral Power, Credit First Suisse Boston, DC Energy, Detroit Edison Company, Deutsche Bank, Deutsche Bank Energy Trading LLC, Duquesne Light Company, Dyon LLC, Dynegy, Edison Electric Institute, Edison Mission Energy, Electricity Authority New Zealand, Electricity Corporation of New Zealand, Electric Power Supply Association, El Paso Electric, Energy Endeavors LP, Exelon, Financial Marketers Coalition, FirstEnergy Corporation, FTI Consulting, GenOn Energy, GPU Inc. (and the Supporting Companies of PJM), GPU PowerNet Pty Ltd., GDF SUEZ Energy Resources NA, Great Bay Energy LLC, GWF Energy, Independent Energy Producers Assn, ISO New England, Israel Public Utility Authority-Electricity, Koch Energy Trading, Inc., JP Morgan, LECG LLC, Luz del Sur, Maine Public Advocate, Maine Public Utilities Commission, Merrill Lynch, Midwest ISO, Mirant Corporation, MIT Grid Study, Monterey Enterprises LLC, MPS Merchant Services, Inc. (f/k/a Aquila Power Corporation), JP Morgan Ventures Energy Corp., Morgan Stanley Capital Group, Morrison & Foerster LLP, 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 Attorney General, Ontario IMO, Ontario Ministries of Energy and Infrastructure, Pepco, Pinpoint Power, PJM Office of Interconnection, PJM Power Provider (P3) Group, Powerex Corp., Powhatan Energy Fund LLC, PPL Corporation, PPL Montana LLC, PPL EnergyPlus LLC, Public Service Company of Colorado, Public Service Electric & Gas Company, Public Service New Mexico, PSEG Companies, Red Wolf Energy Trading, Reliant Energy, Rhode Island Public Utilities Commission, Round Rock Energy LP, San Diego Gas & Electric Company, Secretaría de Energía (SENER, Mexico), Sempra Energy, SESCO LLC, Shell Energy North America (U.S.) L.P., SPP, Texas Genco, Texas Utilities Co, Tokyo Electric Power Company, Toronto Dominion Bank, Transalta, TransAlta Energy Marketing (California), TransAlta Energy Marketing (U.S.) Inc., Transcanada, TransCanada Energy LTD., TransÉnergie, Transpower of New Zealand, Tucson Electric Power, Twin Cities Power LLC, Vitol Inc., Westbrook Power, Western Power Trading Forum, Williams Energy Group, Wisconsin Electric Power Company, and XO Energy. 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](http://www.whogan.com)).