TEXAS NODAL MARKET DESIGN:
Observations and Comments

William W. Hogan

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

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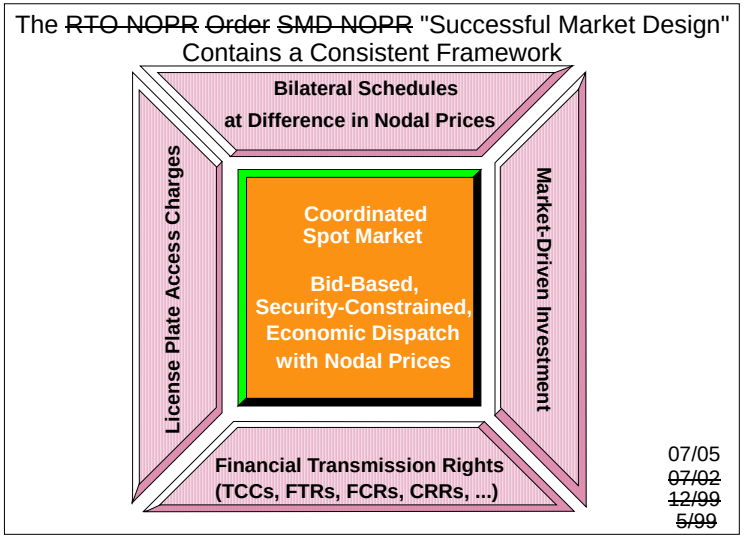
ELECTRICITY MARKET ERCOT: A Consistent Framework

Good news:

ERCOT's proposed Texas nodal market design employs key elements of "Successful Market Design." This provides a workable market framework that is working in other organized markets like New York, PJM in the Mid-Atlantic Region, New England, and the Midwest.

1. **Efficient spot market with locational prices.**
2. **Financial transmission rights.**
3. **Bilateral schedules.**
4. **Voluntary day-ahead market with unit commitment and binding transactions.**
5. **Virtual bidding.**
6. **Uplift charges applied to real-time loads.**
7. **Market power mitigation.**
8. **(Good documentation on nodal.ercot.com)**



ERCOT's proposed market design reflects serious work and is a major step forward. Of course, the details matter.

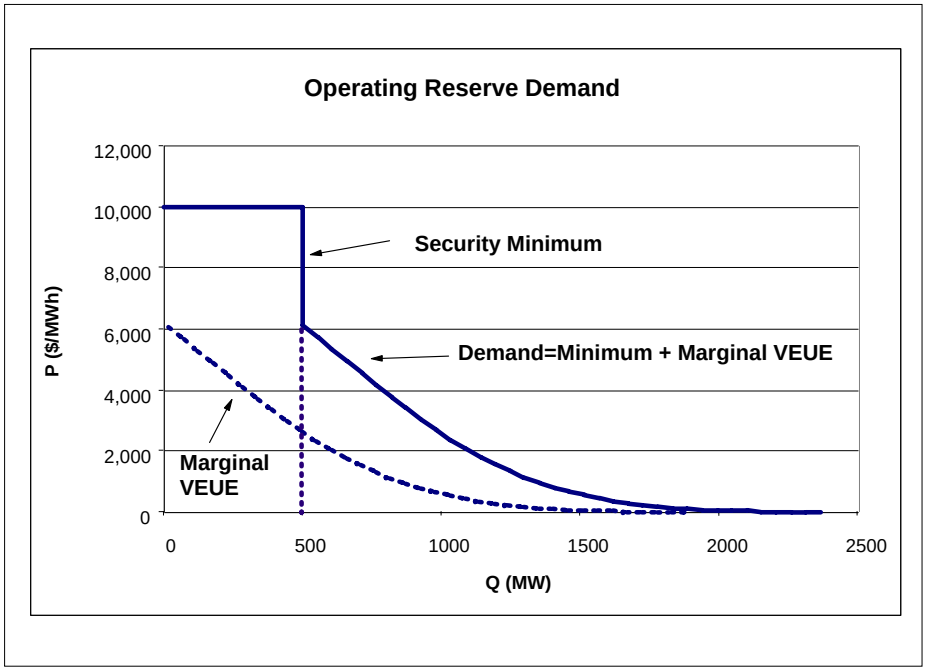
Other news:

Like other advanced organized electricity markets, the ERCOT market design is a work-in-progress. Three components illustrate problems and challenges.

- **Scarcity Pricing.**
  - Energy only market, missing money and resource adequacy.
  - Market power mitigation and scarcity rents.
- **Congestion Revenue Right (CRR) Protocols.**
  - Settlements Sausage.
  - Transmission investment.
- **Day-ahead (DAM) Commitment, Dispatch and Pricing.**
  - Reliability unit commitment (RUC) and bidding incentives.
  - Energy pricing and make-whole uplift charges.

The ERCOT market design is an "energy only" market. There is no separate capacity market payment. This raises concerns about the familiar "missing money" problem.

- In principle, load bids might provide a mechanism for discovering scarcity prices and providing adequate energy revenues. However, the ERCOT design does not seem to anticipate substantial dispatchable real-time load.
- The apparent hope is that an increased energy offer cap ($3000/MWh) will provide enough room to allow some generator to exercise a little market power and bid high enough to reflect the scarcity rent.
- Relying on unmitigated offers to provide scarcity rents will conflict with the Texas "two step" mitigation rules.
- An alternative would be to implement an operating reserve demand curve with integrated energy and reserve pricing, a feature found in other organized markets.



ELECTRICITY MARKET — Better Scarcity Pricing

An explicit operating reserve demand curve can address demand response and mitigated supply offers while achieving efficient scarcity pricing.

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.

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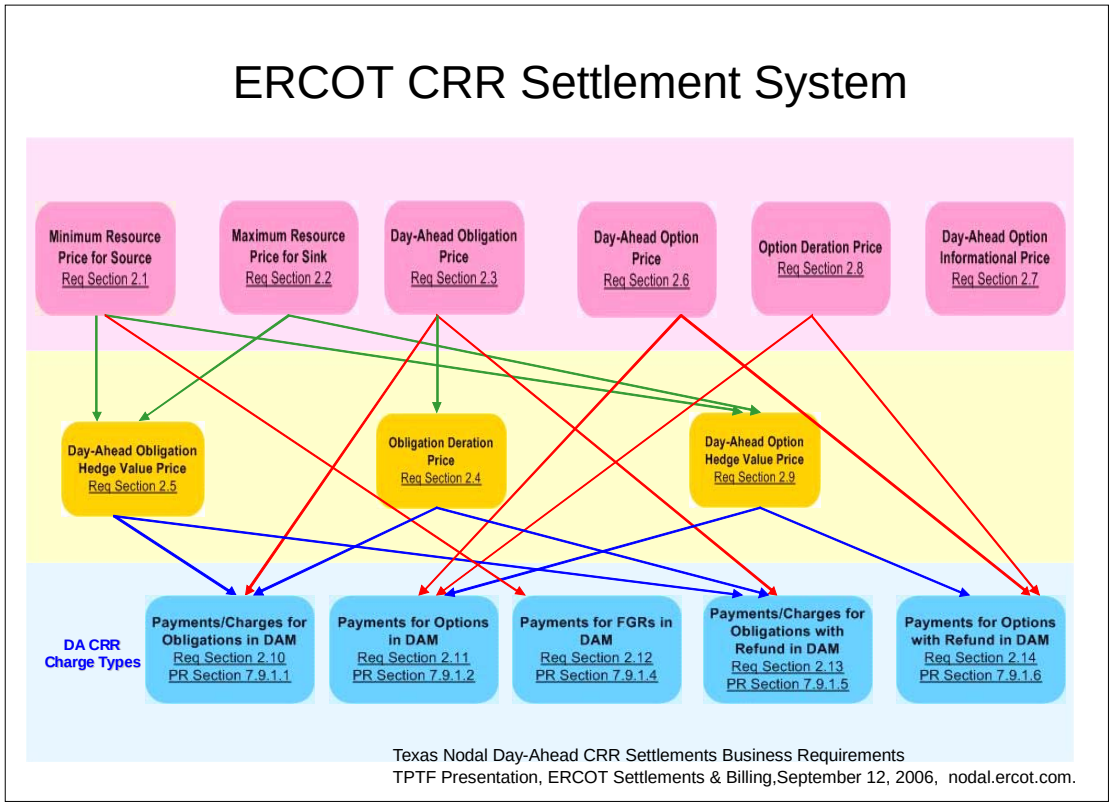
Reliability: Market operating incentives would be better aligned with reliability requirements.

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.

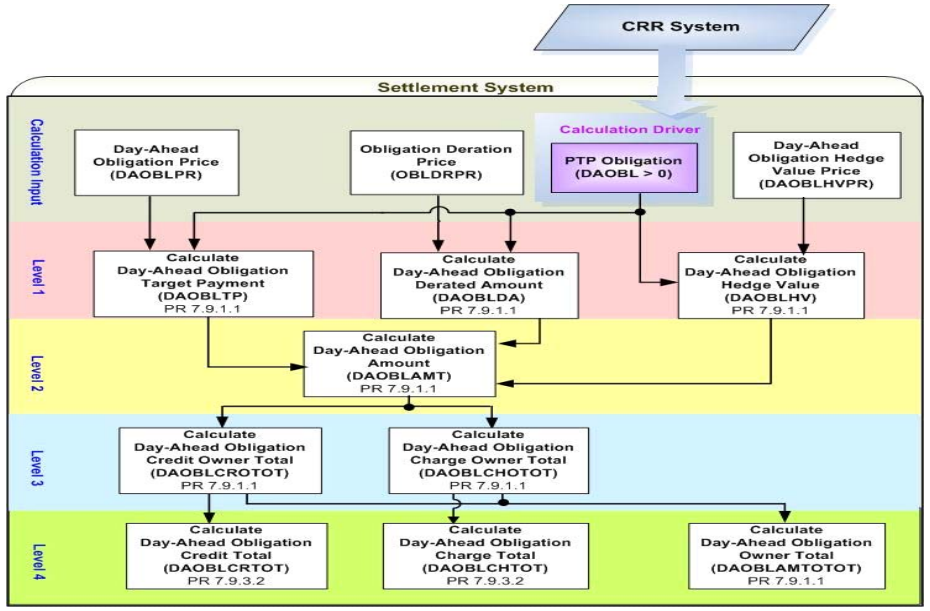
The ERCOT Congestion Revenue Right (CRR) settlement system introduces new features not found in other organized markets to deal with "hedging" and constraint deratings.



Texas Nodal Day-Ahead CRR Settlements Business Requirements
TPTF Presentation, ERCOT Settlements & Billing,September 12, 2006, nodal.ercot.com.

The details for CRR obligation settlements remind of the admonition never to look at how sausage is made. What is going on here, why, and what are the incentives?

CRR Obligation Settlement Sausage



Texas Nodal Day-Ahead CRR Settlements Business Requirements
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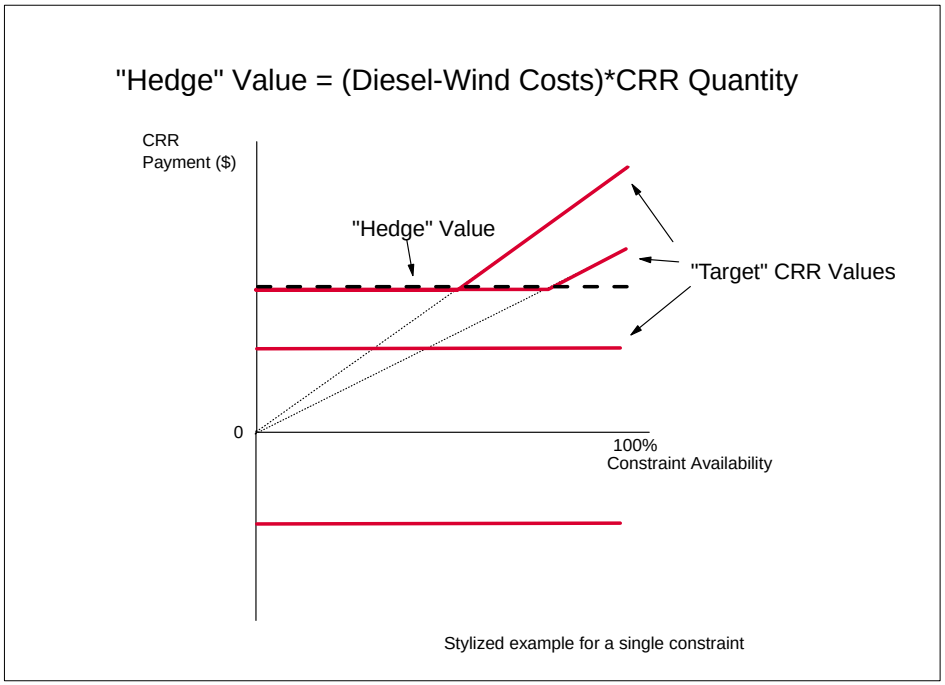
The "hedging" and derating adjustments of CRR payments appear to reflect a worry about excess allocation in the CRR auction, and an assumption that the CRR holder should bear the cost.

- The "hedge" value puts a floor on the CRR value that can be recovered when there is a derating.
- The derating methodology treats the constraint impacts as independent radial schedules. In fact, the schedules are point-to-point and the constraint impacts are joint.
- Material derating with payments withheld on the individual constraints could increase the risks for CRR holders.
- There is an incentive for every CRR holder to install a diesel generator at the sink location, to ensure the maximum hedge floor.



[DAOBLAMT o, (j, k) = (-1) * Max ((DAOBLTPo, (j, k) – DAOBLDAo, (j, k)), Min (DAOBLTP o, (j, k), DAOBLHV o, (j, k)))]

The CRR allocation provides no direct connection to transmission investment.

- Maximum duration of auction allocations is two years.
- Investment in transmission does not result in receipt of incremental CRRs.
- Transmission investment is not integrated with the ERCOT nodal market design.
- Socialized transmission investment creates a “slippery slope” problem that could undermine the ERCOT energy-only market design intent.
- The Argentine experience identifies an alternative transmission investment framework that mitigates socialization of costs and supports the energy market.

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.

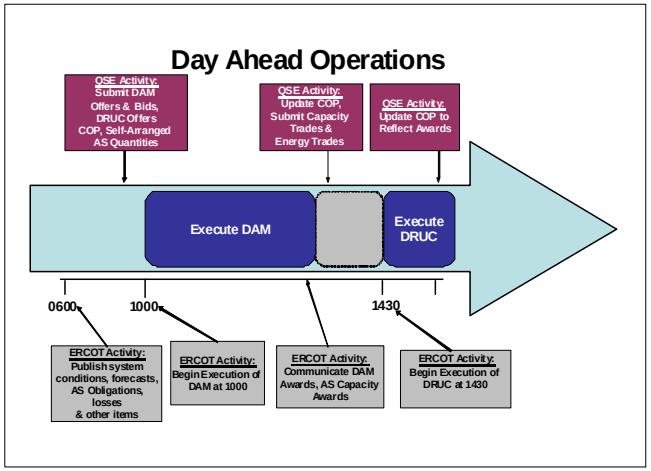
- **Voluntary Investment by Contract Between Parties**. Allow merchant generation and demand investment with voluntary participant funding. This is the easy case.

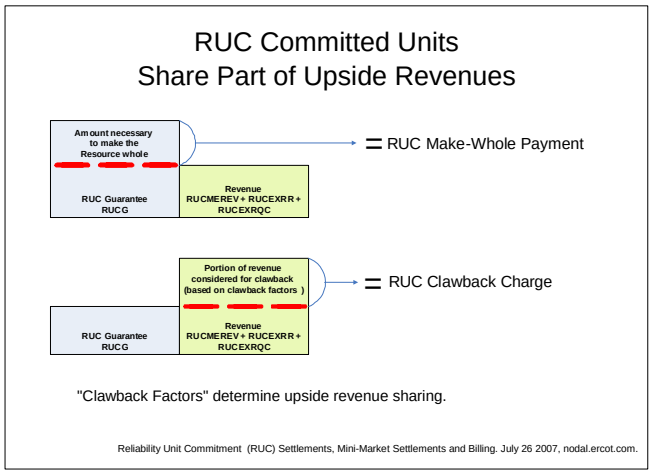
- **Major Investments by "Public Contest" Method**. Overcoming market failure without overturning markets.
  - Regulator applies the "Golden Rule" (Cost-Benefit Test). Use the same economic cost benefit analysis to identify expected beneficiaries.
  - 30%-30% Rule. At least 30% of beneficiaries must 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.

The day-ahead market with unit commitment is followed by a reliability unit commitment (RUC). There are some features that differ from the approaches in other organized markets.

- RUC Commitment is an important part of reliability assurance. However, the RUC commitment is difficult to integrate in a market setting.
- ERCOT RUC commitment is based on three-part bids including energy, without a full commitment dispatch.
- Other organized markets minimize commitment costs, and often include a final full commitment dispatch. (e.g. Attachment B to the NYISO Services Tariff).
- The ERCOT design proposal socializes part of the RUC unit real-time revenues through "clawback" rules.
- Other organized markets cover make-whole payments for committed units, but do not recapture operating profits.
- The goal in other organized markets is to provide an incentive for day-ahead schedules and load bids, and to contribute to scarcity rents for generators.
- The ERCOT design provides incentive to understate load and rely on real-time dispatch. With offer mitigation rules, the ERCOT proposal could operate more like cost-of-service real-time pricing.

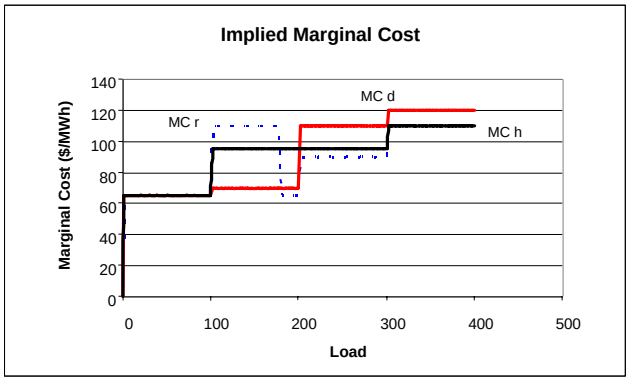




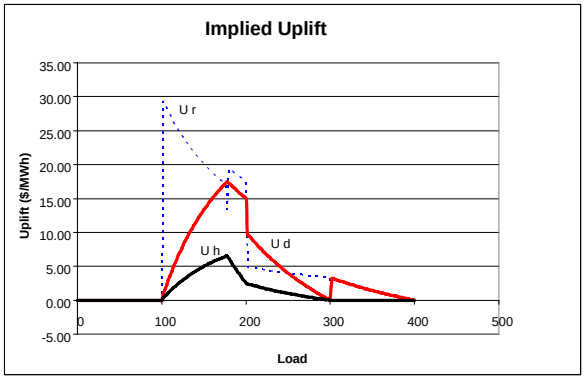
The ERCOT DAM and RUC market design does not explain the protocols for determining locational energy prices.

- For unit commitment models, there may be no set of energy prices that supports the solution.
- The energy pricing ambiguity arises just in those cases where the unit commitment matters.
- Alternative locational energy pricing rules provide different incentives for using energy prices or relying on uplift.
- Minimum-uplift pricing smoothes the implied aggregate generator offer curve and determines energy prices that depend on the offers but are independent of the actual DAM and RUC commitment and dispatch.

Comparison of Example Marginal Costs



Comparison of Example Uplift Costs



ELECTRICITY MARKET ERCOT: Unsolicited Recommendations

The ERCOT market design presents opportunities for immediate and important changes.

- **Implement an Operating Reserve Demand Curve.** Inadequate scarcity pricing has been a principal defect of organized market design implementations. This domino knocks over much of the other underpinnings of the market and creates pressure for more and more regulatory intervention to support resource adequacy. Fix this NOW!

- **Develop long-term CRRs and integrate with transmission investment rules.** Transmission investment rules can incorporate a market need for long-term rights. There must be a principled limit on socialized transmission investment in order to stem the pressures to subsidize and socialize all competing investment. The Argentine model points to a workable solution.

- **Revise RUC commitment criterion and associated day-ahead energy pricing to support market and minimize uplift.** The RUC commitment, dispatch and pricing rules in other organized markets offer simpler methods that provide incentives to support the integrated market. The innovations in the ERCOT design move in the wrong direction.

- **Maintain the basic market design framework.** Evaluate all proposed changes for compatibility with the basic necessary elements of bid-based, security-constrained, economic dispatch, with nodal prices.

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).