ELECTRICITY MARKET DESIGN: RESOURCE ADEQUACY

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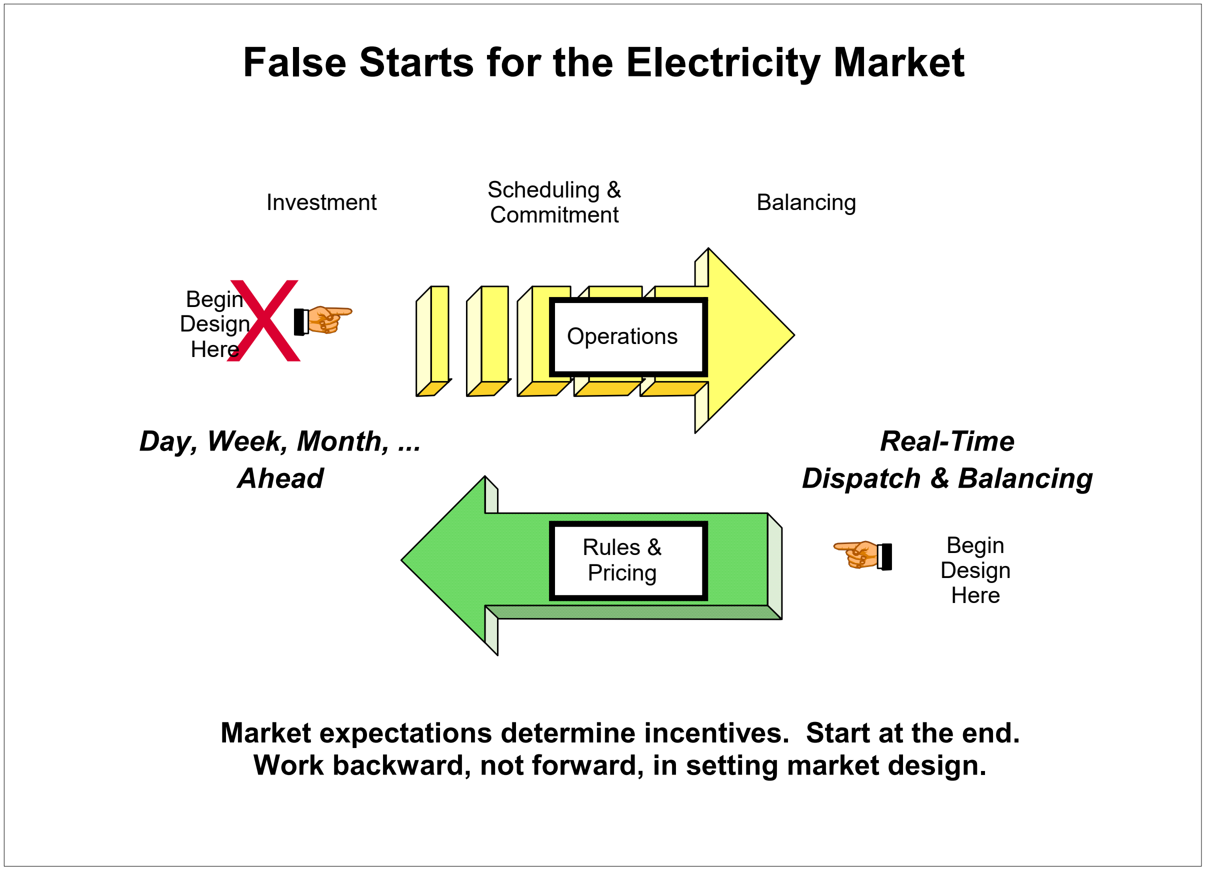
A core challenge for all electricity systems is between monopoly provision and market operations. Electricity market design depends on critical choices. There is no escape from the fundamentals.

Integrated Monopoly	Competitive Markets
• Mandated	• Voluntary
• Closed Access	• Open Access
• Discrimination	• Non-discrimination
• Central Planning	• Independent Investment
• Few Choices	• Many Choices
• Spending Other People's Money	• Spending Your Own Money
• Average Cost Pricing	• Marginal Cost Pricing

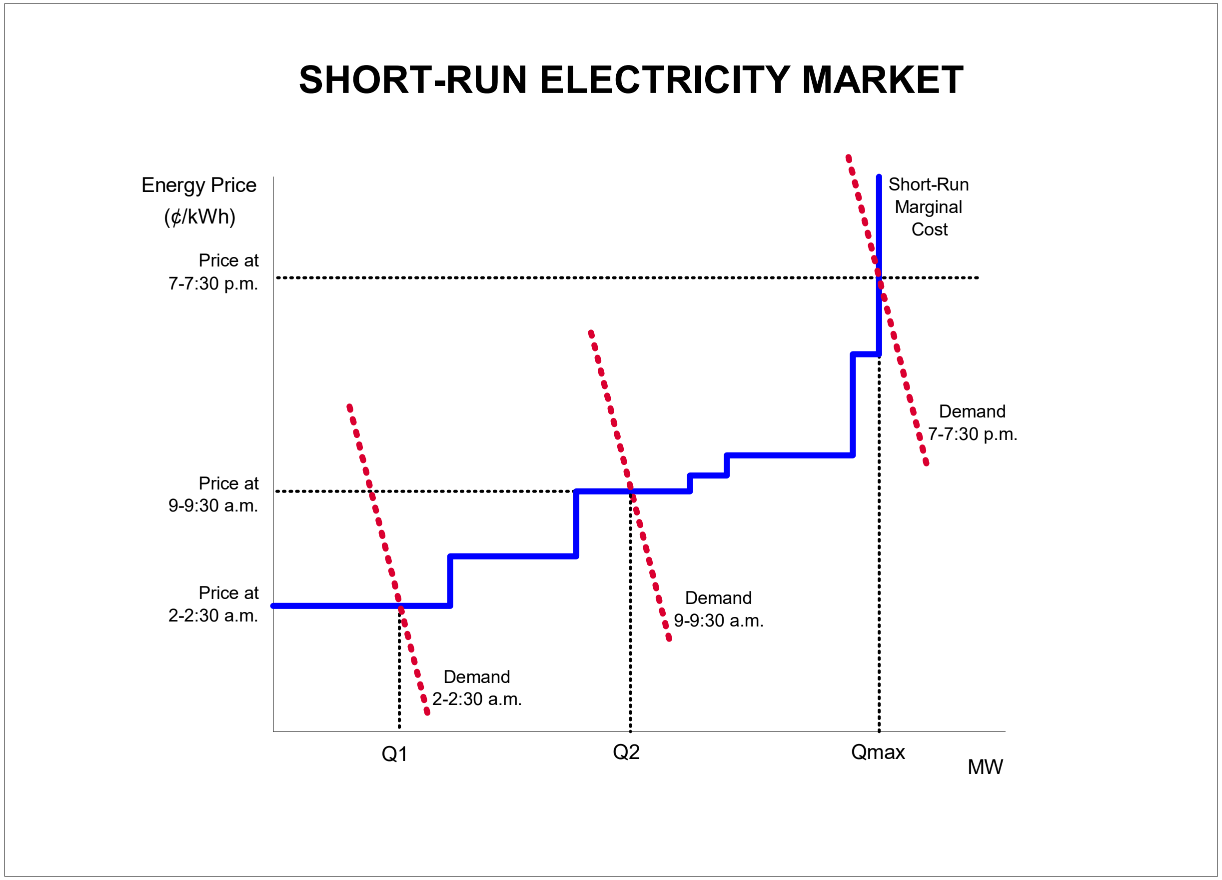
A Key Market Design Objective

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

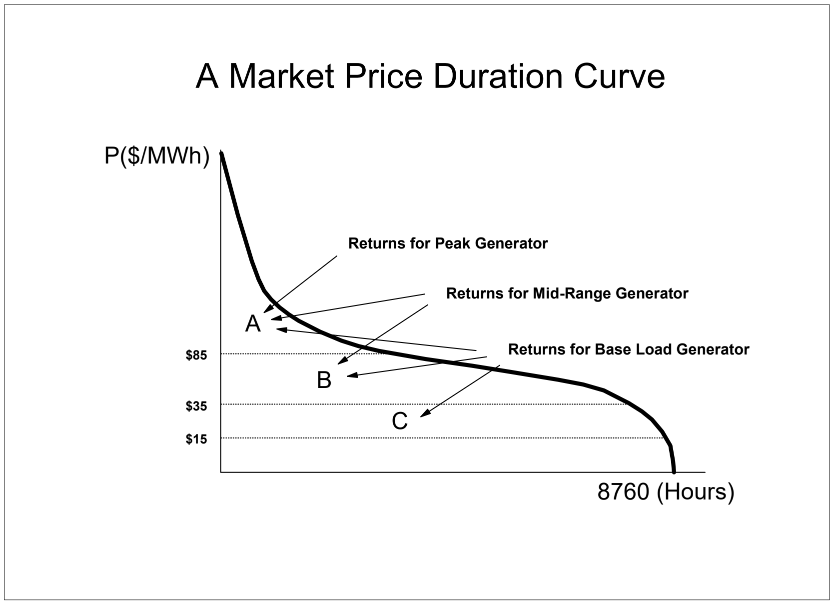
The solution to open access and non-discrimination inherently involves market design. Good design begins with the real-time market and works backward. A common failure mode starts with the forward market, without specifying the rules and prices that would apply in real time.

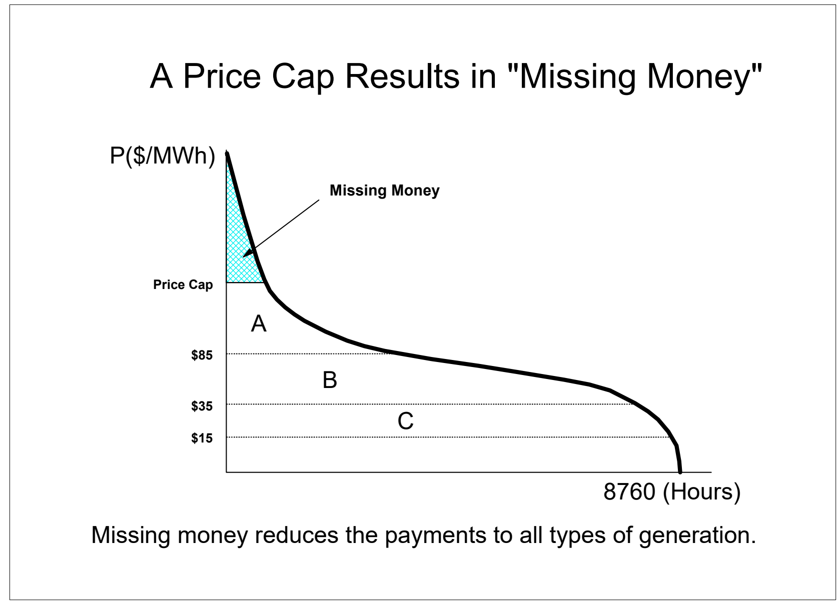


An efficient short-run electricity market determines a market clearing price based on conditions of supply and demand balanced in an economic dispatch. Everyone pays or is paid the same price. The same principles apply in an electric network. (Schweppe, Caramanis, Tabors, & Bohn, 1988)



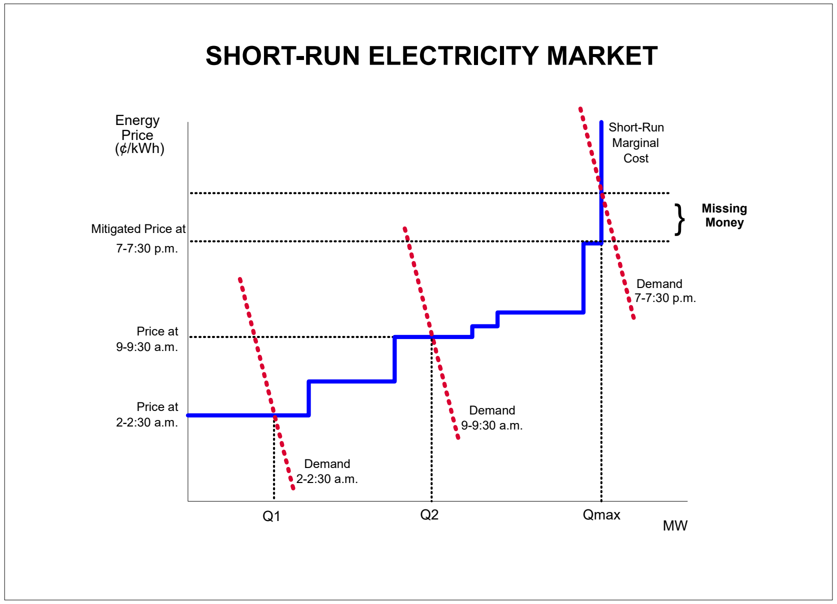
A variety of market rules for spot markets interact to create *de jure* or *de facto* price caps. The resulting "missing money" reduces payments to all types of generation.

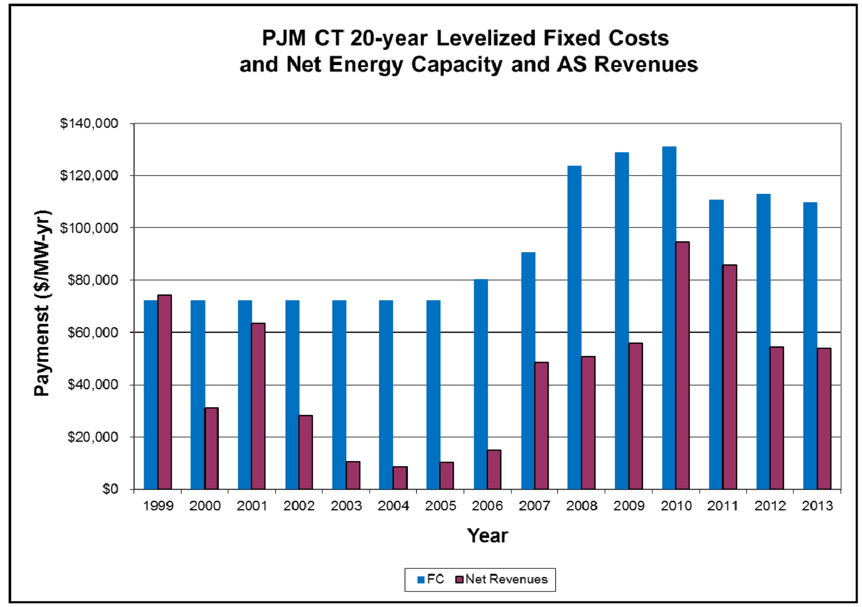




If market prices do not provide adequate incentives for generation investment, the result is a market failure. The market design defect creates the pressure for regulators to intervene to mandate generation investment.

Early market designs presumed a significant demand response. Absent this demand participation most markets implemented inadequate pricing rules, such as equating prices to marginal costs even when capacity is constrained. This produces a "missing money" problem.





PJM, State of Market Report, 2010, Vol. 2, p. 176; 2013, Vol.2, p.223)

The "missing money" problem results in too little generation and infrastructure investment. The policy responses illustrate the tension between market design and regulation.

- **Regulated investment in new generation.**
  - SPP and balanced scheduling requirements.
  - State procurement initiatives for renewables and other new capacity.
- **Capacity Markets.**
  - PJM and the Reliability Pricing Model (RPM).
  - New England and the Forward Capacity Market (FCM).
  - NYISO and the Installed Capacity Market (ICAP).
  - SWIS and Reserve Capacity Mechanism (RCM) in Australia.
- **Energy pricing reforms.**
  - High offer caps (as of 2015) in Australia ($13,500/MWh), Texas ($9,000/MWh) and PJM ($2,700/MWh).
  - Operating Reserve Demand Curves (ORDC) in ERCOT, PJM, New York, New England and the Midwest.
  - Conservative ORDC parameters for resource adequacy as in ERCOT. (Walker, 2019)

Different Regions have taken different approaches to achieving resource adequacy.

Administrative and Market-based Constructs for Resource Adequacy

	Administrative Mechanisms (Customers Bear Most Risk)			**Market-based Mechanisms (Suppliers Bear Most Risk)**		
	Regulated Utilities	Administrative Contracting	Capacity Payments	LSE RA Requirement	Capacity Markets	Energy-Only Markets
Examples	SPP, BC Hydro, most of WECC and SERC	Ontario	Spain, South America	California, MISO (both also have regulated IRP)	PJM, NYISO, ISO-NE, Brazil, Italy, Russia	ERCOT, Alberta, Australia's NEM, Scandinavia
Resource Adequacy Requirement?	Yes (Utility IRP)	Yes (Administrative IRP)	Yes (Rules for Payment Size and Eligibility)	Yes (Creates Bilateral Capacity Market)	Yes (Mandatory Capacity Auction)	No (Resource Adequacy not Assured)
How are Capital Costs Recovered?	Rate Recovery	Energy Market plus Administrative Contracts	Energy Market plus Capacity Payments	Bilateral Capacity Payments plus Energy Market	Capacity plus Energy Markets	Energy Market

Notes: For a more detailed discussion of these various approaches to resource adequacy see Pfeifenberger, et al. (2009). Several markets have a mix of regulated and market constructs within their borders and so are not perfectly represented under any one of these categories. For example, MISO's footprint contains predominantly regulated utilities that conduct integrated resource planning, but a resource adequacy requirement is imposed on all LSEs, which include both regulated utilities and competitive suppliers. MISO will also conduct short-term backstop capacity auctions starting 2013/14.

Spees, K., Newell, S., & Pfeifenberger, J. P. (2013). Capacity Markets - Lessons Learned from the First Decade. *Economics of Energy & Environmental Policy*, 2(2), p. 4.

Simulations for the ERCOT market illustrate the connection between the missing money and reliability standards.

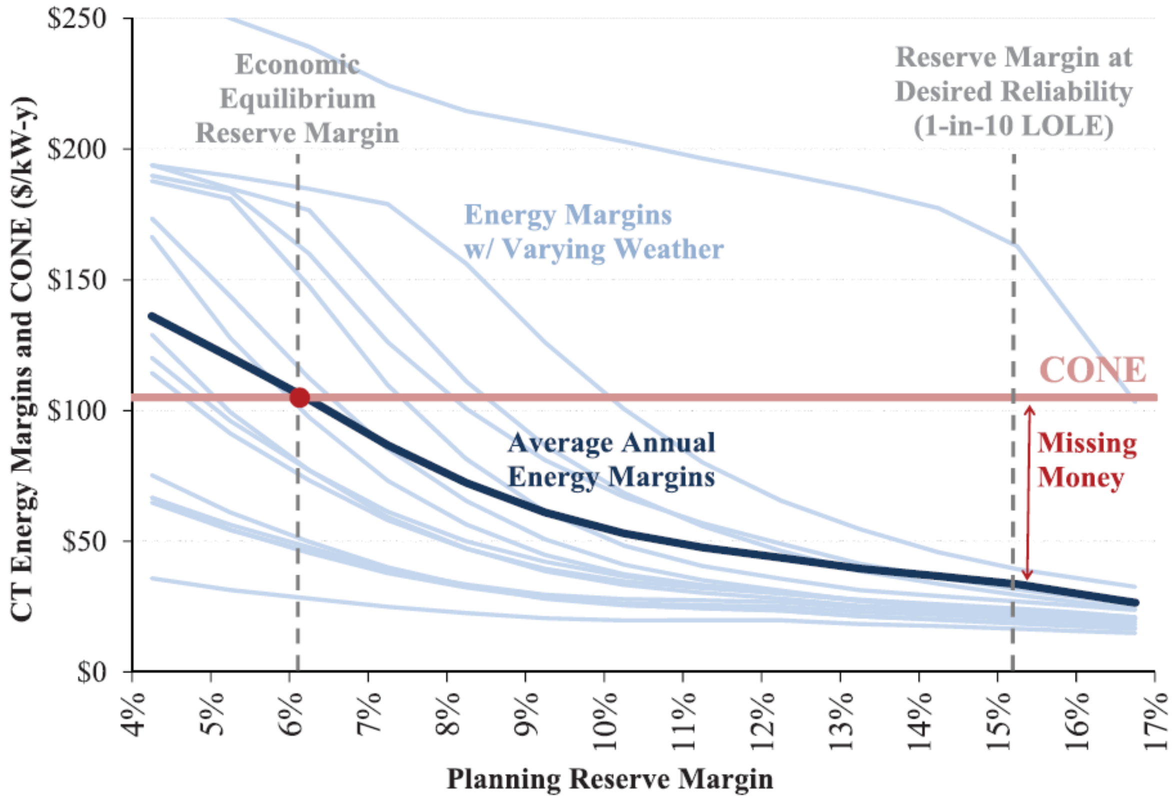


FIGURE 1

Equilibrium Reserve Margin and Missing Money in ERCOT's Energy-Only Market

Spees, K., Newell, S., & Pfeifenberger, J. P. (2013). Capacity Markets - Lessons Learned from the First Decade. *Economics of Energy & Environmental Policy*, 2(2), p. 7. See also (Telson, 1973) (Wilson, 2010)

Capacity market design presents many challenges and difficult questions. In essence, a good forward capacity market design for months to years ahead requires addressing issues that are difficult to consider when looking only a few hours or days ahead.

- **Capacity Definition(s).** Traditional dispatchable plants, intermittent resources, demand response.
- **Horizon and Duration.** Annual to multiple years, with short term adjustments and true ups.
- **Capacity Requirements.** Uncertain conditions and complicated reliability standards.
- **Transmission Constraints.**
  - **Locational requirements.** Difficult to define and model locational requirements.
  - **Integrated expansion plans.** Timing and accountability for transmission expansion.
- **Cost of New Entry.** Marginal source of capacity depends on existing mix.
- **Energy Revenues.** Ex ante (PJM) or ex post (ISONE) determination.
- **Demand Curves.** Fixed capacity requirements, price collars, variable demand slope.
- **Capacity Cost Recovery.** Locational, socialized payments.
- **Performance and Penalties.** Outages rates, exemptions, transition payments, penalties.

The role of contracts and related forward arrangements extends beyond strictly bilateral agreements intended to replace long-term purchase power agreements.

- **Stranded Asset Allocations.** Transition arrangements to assign the costs of out-of-market assets that have unrecovered fixed costs.
- **Vesting Contracts.** Transition contracts to assign the economic value of existing power plants.
- **Market Power Mitigation.** Similar to vesting contracts, but with terms and conditions designed to mitigate market power of generators.
- **Coordinated Day-Ahead Markets.** A multi-settlement market coordinated by the system operator to include economic unit commitment, reliability unit commitments and reconfiguration of financial transmission rights.
- **Virtual Trading.** Voluntary contracts identified explicitly as financial to be cashed out at real-time prices.
- **Capacity Obligations.** Create incentive for capacity investment along with capacity performance obligations.
- **Default Service Arrangements.** Forward procurement arrangements to provide a hedged default service, typically for residential and small commercial customers.

Real electric systems are free flowing grids, and it can be difficult to disconnect or control the power taken by the users. A common problem arises in setting the rules for default service. A default rate applies unless the customer chooses some other tariff or pricing mechanism. The default is important, especially for residential and small commercial operations. The "nudge" arguments support the view that most customers will stick with the default. (Thaler and Sunstein)

- **Time-of-Use Rates.** There are many variants of TOU rates. The most efficient would be real-time prices. There is no hedge. Customers would see the right incentives for short-term consumption but would face volatile prices. Customers can "opt out" by arranging a separate financial contract for differences. The default rate design can give retail customers access to wholesale markets (a.k.a. "Direct Access"). (Faruqui, A., Hledik, R., & Lessem, N. (2014). "Smart by Default." *Public Utilities Fortnightly*, August, pp. 24–32.)

- **Forward Hedges.** Forward contracts arranged by the provider. Loads can "opt out" to seek real-time prices. The form of the forward contract allows for a great deal of variation. The New Jersey Basic Generation Service is an innovative approach that addresses many of the problems of default service.

New Jersey operates a Basic Generation Service (BGS) to set default rates for residential and small commercial customers. The BGS design incorporates the risks in the auction pricing and leaves the utility arranging the service without any exposure and without any discretion.

- **Financial Contract.** The BGS is a financial contract with no connection to the generation source of the power. In effect, this is a contract for differences.

- **Delivered Prices.** The contract is set in terms of the price of energy at the customers' location. The problem of arranging "delivery" or hedging locational prices rests with the suppliers.

- **Full Requirements Service.** The contract is for the full energy and ancillary services requirements.

- **Tranche Auction.** Suppliers compete in a "descending block" auction to meet the requirements across multiple locations. (http://www.bgs-auction.com/bgs.auction.overview.asp)

  - **Three Year Rolling Auction.** The steady state auction procures one-third of the next three-year requirement. This keeps prices connected to expected spot-market prices, but substantial reduces price volatility.

  - **Tranche Auction.** The contract awards are for a fraction of the full requirements ("a tranche") of the customers who do not opt out. The contract quantity risk is incorporated in the offers of the suppliers.

- **Successful Operation.** The BGS auction has been operating for many years. Most eligible customers accept the default. Evaluations have concluded that the auction prices results are competitive.

The NJ Basic Generation Service results in 2014 included multiple awards to a range of suppliers.

The BGS-FP Auction began on February 10, 2014 and finished on February 11, 2014 after sixteen (16) rounds. (http://www.bgs-auction.com/documents/2014_BGS_Auction_Results.pdf)

Public Service Electric & Gas Company **9.739 (cents/kWh)**	**Jersey Central Power & Light Company** **8.444 (cents/kWh)**
BP Energy Company Citigroup Energy Inc. Exelon Generation Company, LLC NextEra Energy Power Marketing, LLC Noble Americas Gas & Power Corp. PSEG Energy Resources & Trade LLC TransCanada Power Marketing Ltd.	BP Energy Company Exelon Generation Company, LLC Noble Americas Gas & Power Corp. NRG Power Marketing LLC PSEG Energy Resources & Trade LLC TransCanada Power Marketing Ltd.
Atlantic City Electric Company **8.780 (cents/kWh)**	**Rockland Electric Company** **9.561 (cents/kWh)**
Exelon Generation Company, LLC NextEra Energy Power Marketing, LLC PSEG Energy Resources & Trade LLC TransCanada Power Marketing Ltd.	Exelon Generation Company, LLC NextEra Energy Power Marketing, LLC

The New Jersey BGS model provides and example of a forward contracting regime designed to utilize a compatible and efficient spot market. The key issues include:

- **Consistent Economic and Reliability Standards.** If the implied or explicit reliability standard is based on measures like 1-day-in-ten-years, then the implied value of lost load is much higher than the actual willingness-to-pay. An efficient market design based on economic principles will not be enough to support the investment needed to meet the reliability standard.

- **Capacity Mechanisms Encompass Multiple Objectives.** Goals include (i) providing strong investment incentives, (ii) meeting administrative reliability standards, (iii) ensuring efficient investment and operation; (iv) supporting innovation. This may be too hard.

- **Capacity Performance Mechanisms.** The actual occasions when capacity is needed are relatively rare. The system needs performance incentives that have proven to be a problem in practice.

- **Efficient Market Design.** Everything is made easier through efficient markets for real-time operations. Capacity mechanisms should build on an be compatible with spot markets.

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