
Standard Market Design in the Electric Market: Some Cautionary Thoughts

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Prepared by:

Philip Hanser

Metin Celebi

Peter Fox-Penner

The Brattle Group

Introduction

The “standard market design” about to be proposed by the Federal Energy Regulatory Commission (FERC) appears to have the following elements:

- Locational/nodal pricing for spot energy based upon a uniform price auction,
- Mechanisms to promote price responsive demand,
- Financial transmission rights,
- Monitoring of markets for market power,
- and a Regional Transmission Organization (RTO) to oversee the market(s).

Where are we going?

This talk will focus on some issues with the elements of the “standard market design” that require some consideration before its uniform adoption by all RTOs/ISOs. Particularly,

- Some differences between theory and application
- The potential for transferring market surplus across participants
- The incentives, or the lack thereof, for efficient behavior and investment that may arise out of the design
- The readiness of organizations to take on the roles that appear to be necessary for an efficient market

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Locational Marginal Pricing (LMP)

- LMP is a method of setting different market prices for every location on an electric power grid on prices that every generator bids into a central market.
- Theoretically, each location-based price equals the economically efficient market value of electricity at that point, factoring into account constraints everywhere in the system.
- The FERC wants to use LMP as the “price” of relieving congestion.
- It is also known as spot pricing (Schweppe, Bohn, Caramanis, and Tabors, 1988) nodal pricing, or location-based marginal cost pricing.

From LBMCP to LMP

- Nodal prices are not the usual market prices. They are derived as the shadow prices from an optimization model. In effect the model mimics a market without the usual “tâtonnement,” *i.e.* learning on the part of consumers and producers as they move to equate supply and demand.
- Schweppe, *et al.*’s original derivation of LMP was based upon a social welfare maximization objective. That objective has been transformed into minimizing security-constrained dispatch costs for fixed levels of demand.

LMP Concerns

- LMPs effectively transfer market surplus (i.e. consumer surplus and producer surplus) from consumers to producers via:
 - ▶ Charging all customers for the price of the marginal MW dispatched.
 - ▶ Due to low price responsiveness of demand.
- LMPs are complex; the complaints of traders are common.
- LMPs do not readily incentivize investment.
- LMPs are opaque
- LMPs do not prevent strategic bidding.
- LMP programs do not account for optionality or flexibility (such as tolerance on transmission limits and generation capabilities).

Uniform Price Auction

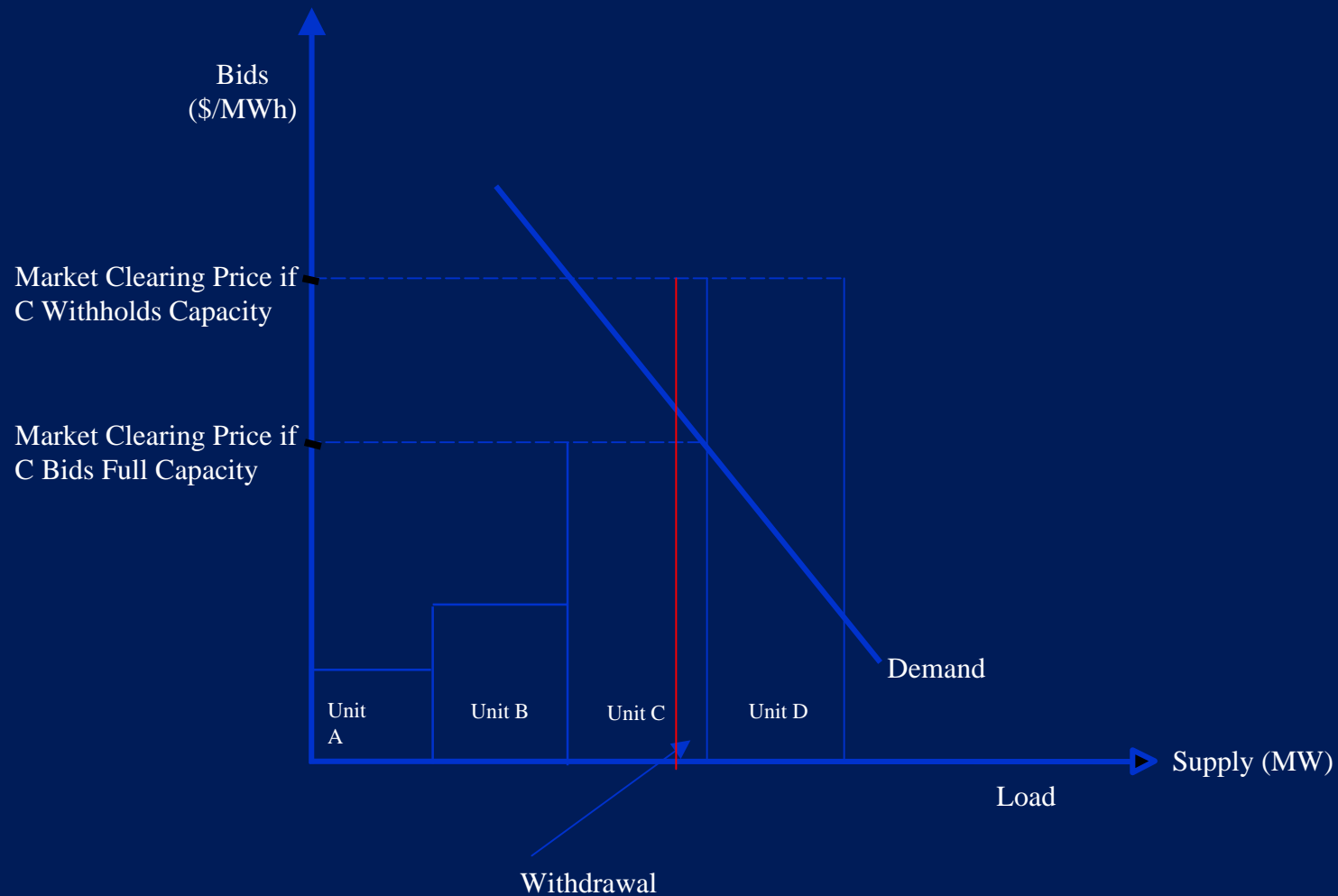
Uniform price auction has a disadvantage:

- Potential for large leverage effects (see next slide) when a supplier has portfolio of generation with varied costs.

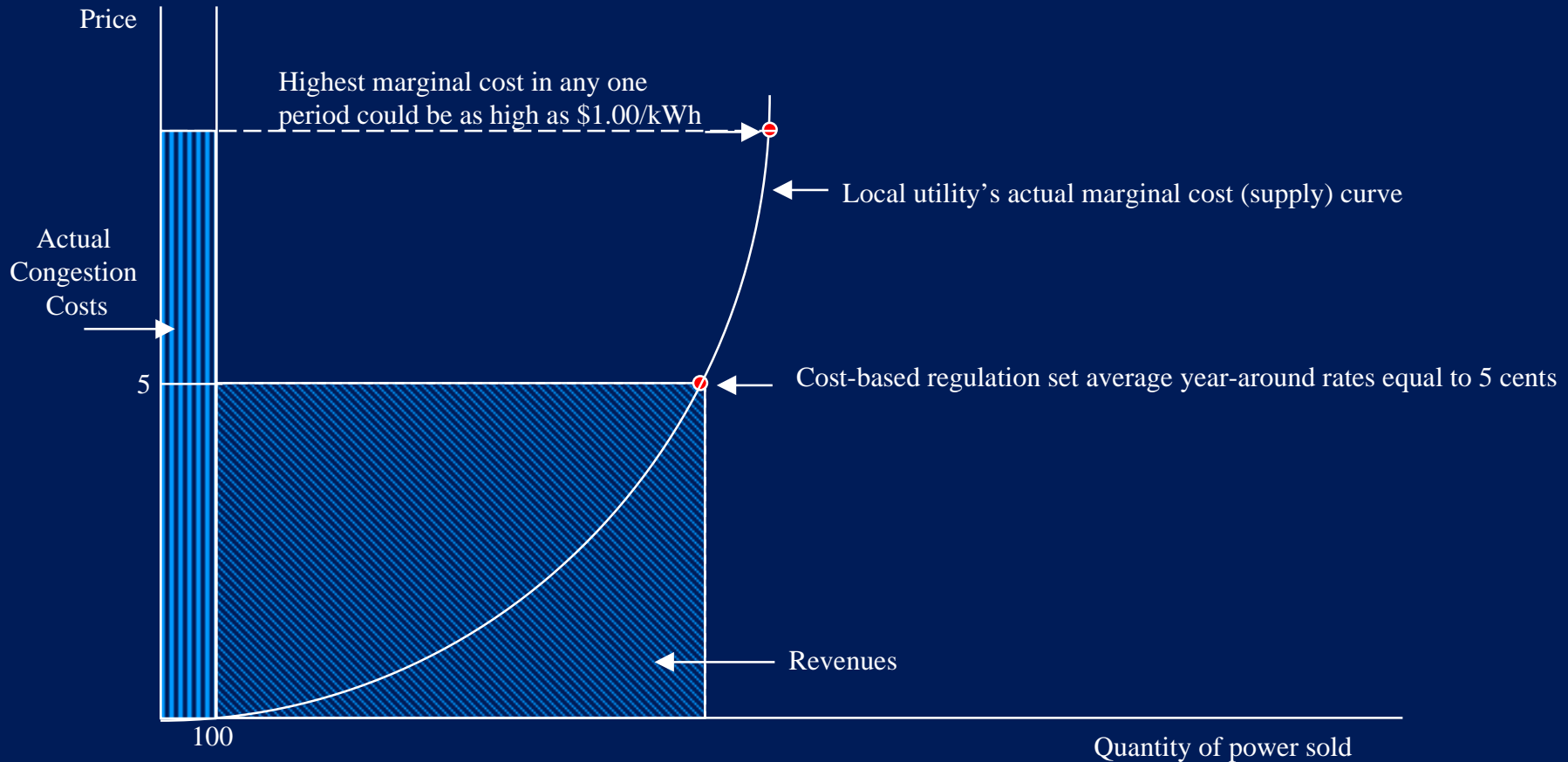
Pay-as-you-bid auction

- Bidders will tend to bid what they think clearing price will be rather than their costs, hence potential inefficiencies.
- Most common bid mechanism in commodity markets characterized by bilateral transactions.

Uniform Price Auction (Leverage Effect)



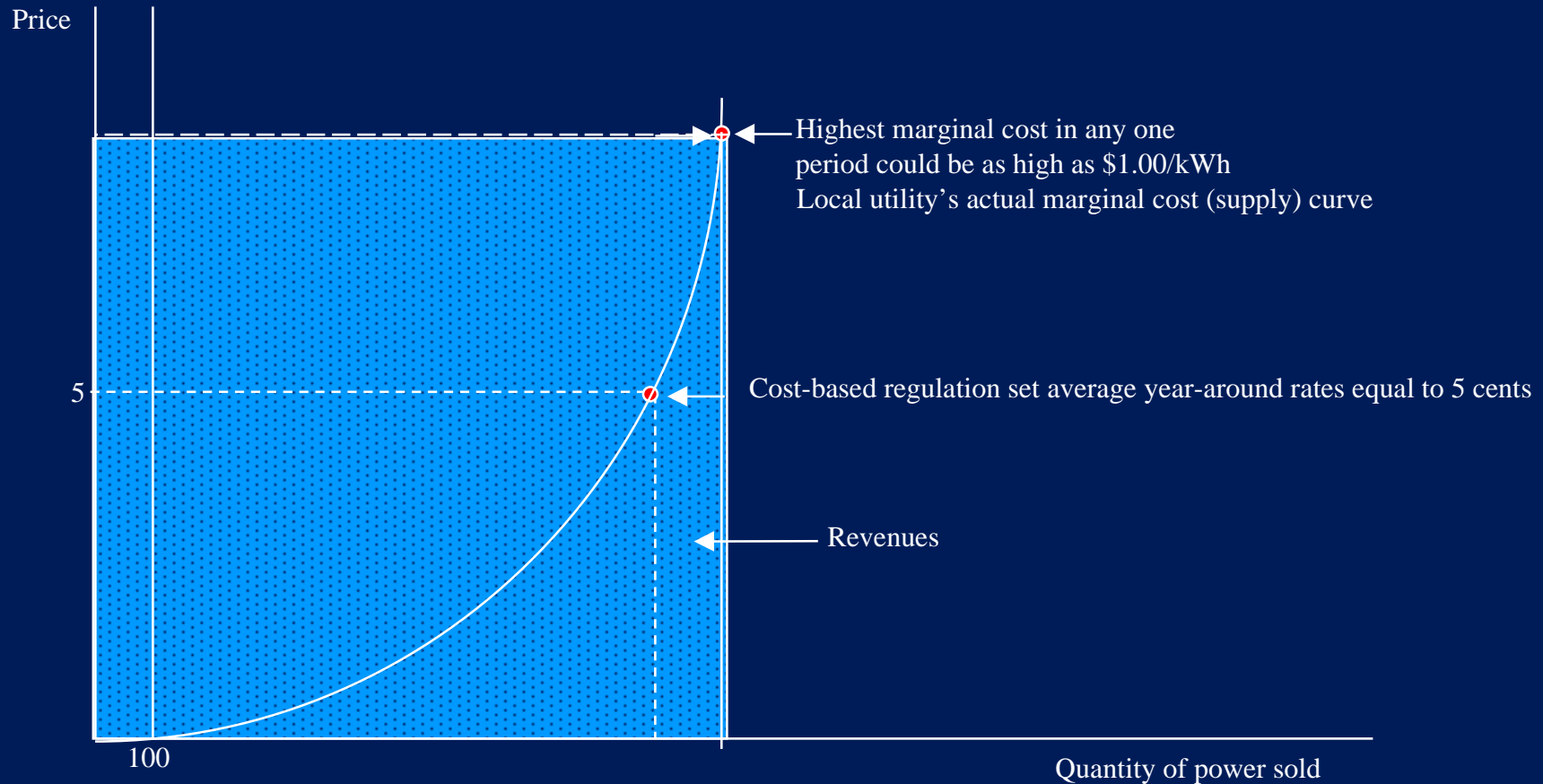
Traditional Pricing



**If power plants with a cost of \$1.00/kWh had to produce 100 kWh to relieve congestion, ratepayers were charged the actual costs of relief:
 $100\text{kWh} \times \$1.00/\text{kWh} = \100**

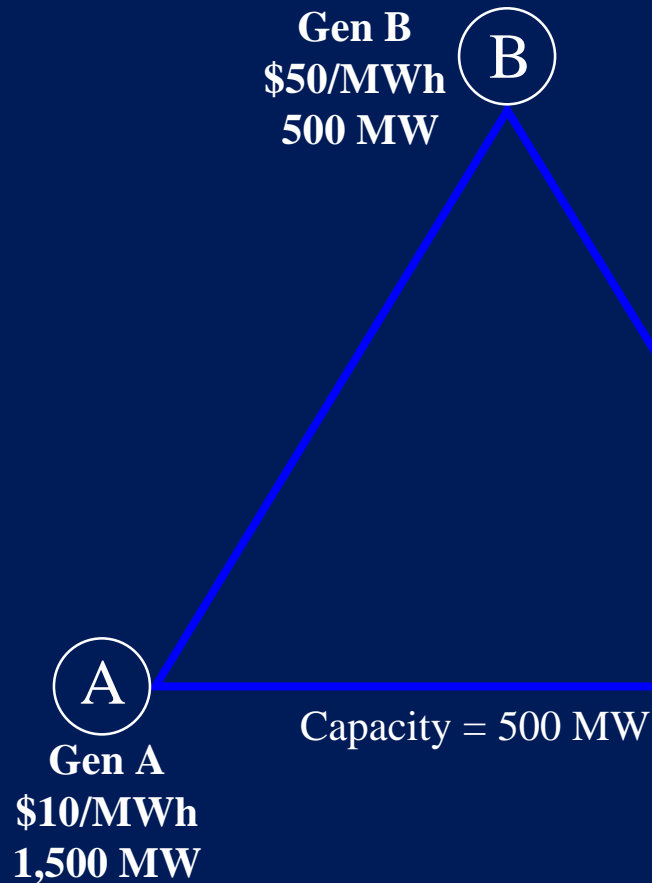
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Under LMP (Uniform Price Auction)



If power plants with a cost of \$1.00/kWh have to produce 100 kWh to relieve congestion, ratepayers are charged (under LMP), more than the actual costs of relief.

LMP - Example Data



Node	Gen	Capacity (MW)	Bid (\$/MWh)	Load (MW)
A	Gen A	1,500	10	0
B	Gen B	500	50	0
C	--	--	--	Varies
D	Gen D	300 200	80 500	0

Node D:
Gen D
\$80/MWh
300 MW
\$500/MWh
200 MW

LMP Example — Unconstrained Case (Load = 700 MW)

Node	Q (MW)	P (\$/MWh)	Payments (\$)
Gen A	700	\$10	(7,000)
Gen B	—	\$10	—
C-Load	700	\$10	7,000
Gen D	—	\$10	—
Total			0

0 MWh

Gen B
\$50/MWh
500 MW

B

Percentage of Congestion Cost in
Consumers' Total Payments = 0%

700 MWh

A

Gen A
\$10/MWh
1,500 MW

Capacity = 500 MW

C

Load
700 MWh

D

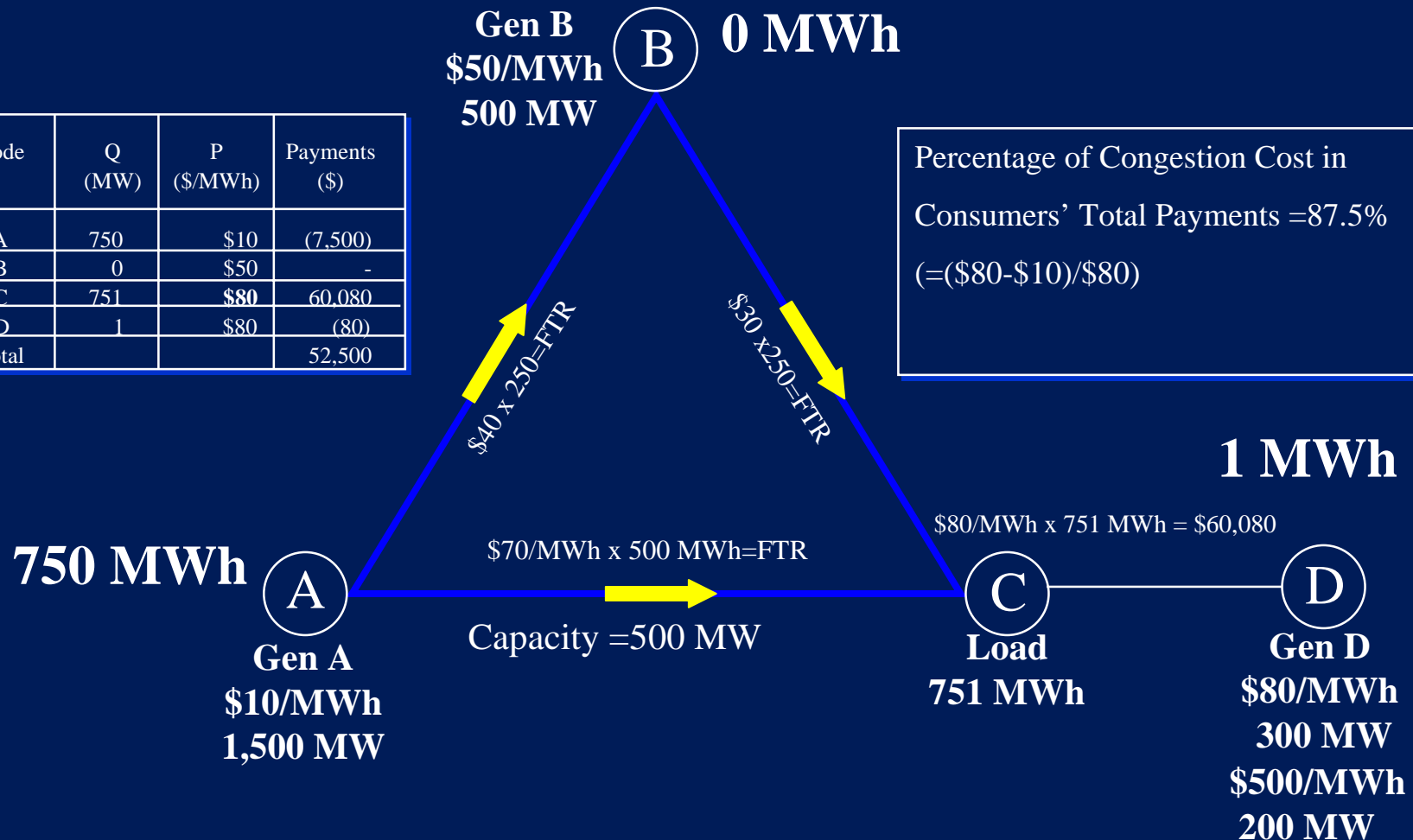
Gen D
\$80/MWh
300 MW
\$500/MWh
200 MW

- Gen A sets LBMP at \$10/MWh for all nodes.
- Gen A cannot generate > 750 MWh (2/3 of its power flow on line A-C)

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LMP Example — Constrained Case (Load = 751 MW)

Node	Q (MW)	P (\$/MWh)	Payments (\$)
A	750	\$10	(7,500)
B	0	\$50	-
C	751	\$80	60,080
D	1	\$80	(80)
Total			52,500



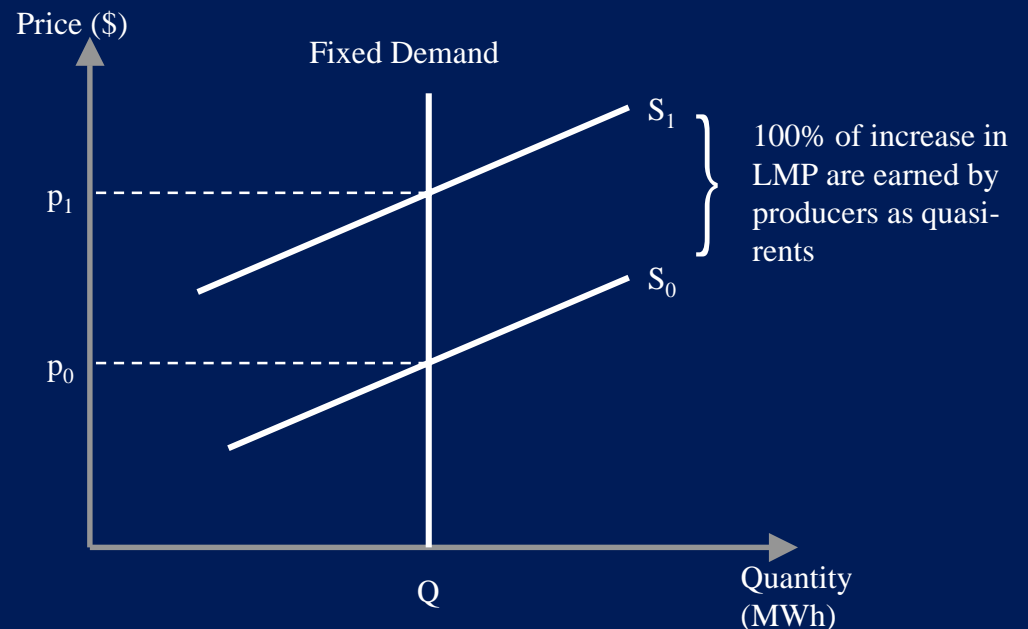
- **Uniform Price!:** Although the cost of redispatch is just \$70 (=80-10), the consumers pay \$52,570 (=751*(80-10)) for the additional 1 MWh that causes the constraint violation.
- Gen B cannot be dispatched (its power will also flow on line A-C)

Price-Responsiveness of Demand

- On a real-time basis, difficult to present to most consumers a price signal and expect a response as quickly as a generators' output can be modified.
 - ▶ This is the much-vaunted “price responsiveness” that FERC would like to see.
 - ▶ Some utilities (*e.g.* Puget Sound Energy) and States (PA) are introducing real-time pricing with hourly prices.
 - ▶ All RTOs are also implementing programs.
- Even if there is a lack of real-time responsiveness, demand-responsiveness may be useful in projected equilibria of day-ahead markets.

Transferring Market Surplus to Producer — Demand Response

Lack of real-time responsiveness by consumers contributes to the transfers from consumers to producers or transmission owner.



Transferring Market Surplus Comments

Final

- No question that requiring all consumers to pay “marginal (competitive) prices” is economically efficient, at least in the static sense.
- However, customers located where congestion is high can experience huge price shifts under LMP.
- The power grid was engineered for integrated monopoly utilization under cost-of-service regulation. Had the grid anticipated standard market design (or deregulation), it would have been built differently. Is it fair to “penalize” customers who chose locations before they knew the true costs?

Transferring Market Surplus

Comments

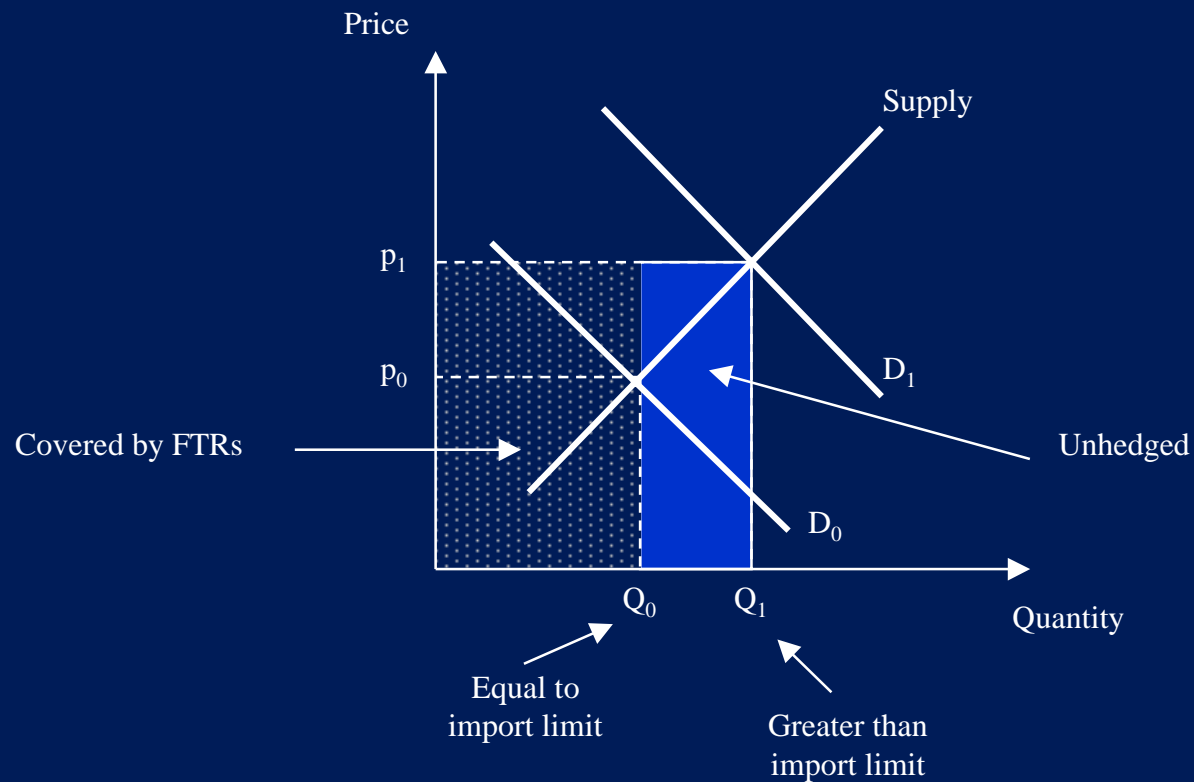
Final

Price signals are needed to send signals to investors to expand generation within or transmission into congested areas. However,

- In some congested areas it is not the lack of a price signal blocking expansion, it is siting. Will LMP just “reward” producers with scarcity rents forever?
- LMP signals are not viewed as particularly good investment signals (see below).
- The transfer of market surplus is larger than the true aggregate congestion, so the “total signal” is much larger than it needs to be.

Financial Transmission Rights (FTRs)

FTRs were created to deal with problem of spiky LMP prices.



FTRs are not full hedge against congestion

Financial Transmission Rights (FTRs)

Question: Does who owns the FTRs matter?

- **Generator ownership may increase generators' incentive to exercise market power. In addition, in auction settings for FTRs, the generators may have greater liquidity and financial wherewithal to bid for FTRs.**
- **Thus, in an open auction, generators could outbid Load Serving Entities (LSEs). If LSEs continue to need to offer fixed-price standard offer service, this could be a financial hardship.**
- **Solution: Monitor the FTR markets carefully?**

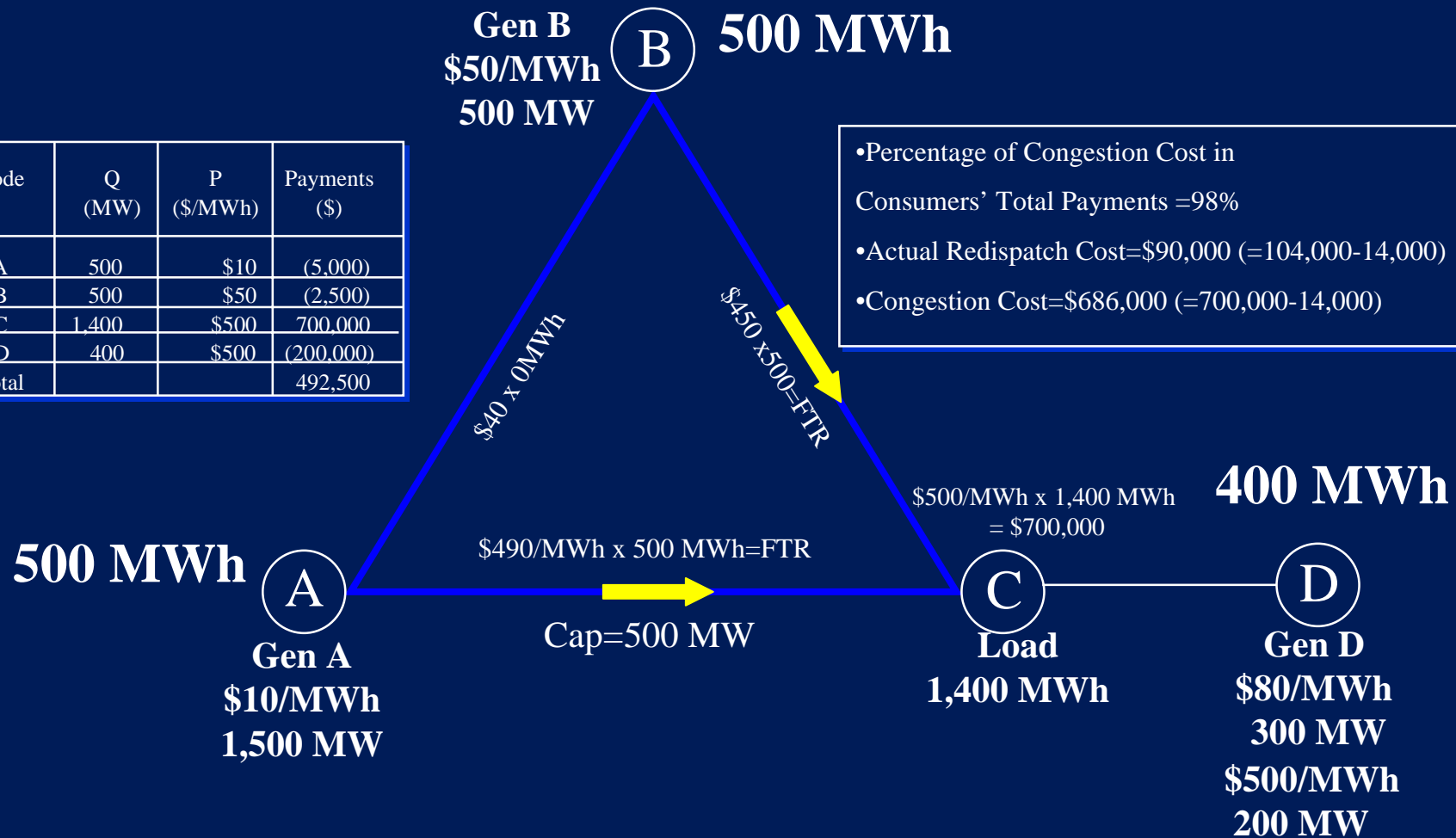
Market Power Concerns

- Electricity Markets are not yet fully competitive
 - ▶ California, ISO-NE, PJM?
- Question: Could the congestion gaming that appeared to occur in California by some suppliers happen under LMP? Possibly. LMP provides more opportunities for creating congestion opportunistically, and profiting from it. Prevention requires either real-time monitoring at levels RTOs or FERC must be capable of or rules that force participants into contracts or modify their bids.
- Vigilant independent market monitors, possibly operating in real-time? Alternatively, what happens to the efficiency of the market when participants are forced into contracts or alternative bids?

Market Power Concerns

LMP Example— Constrained Case (Load = 1,400 MW)

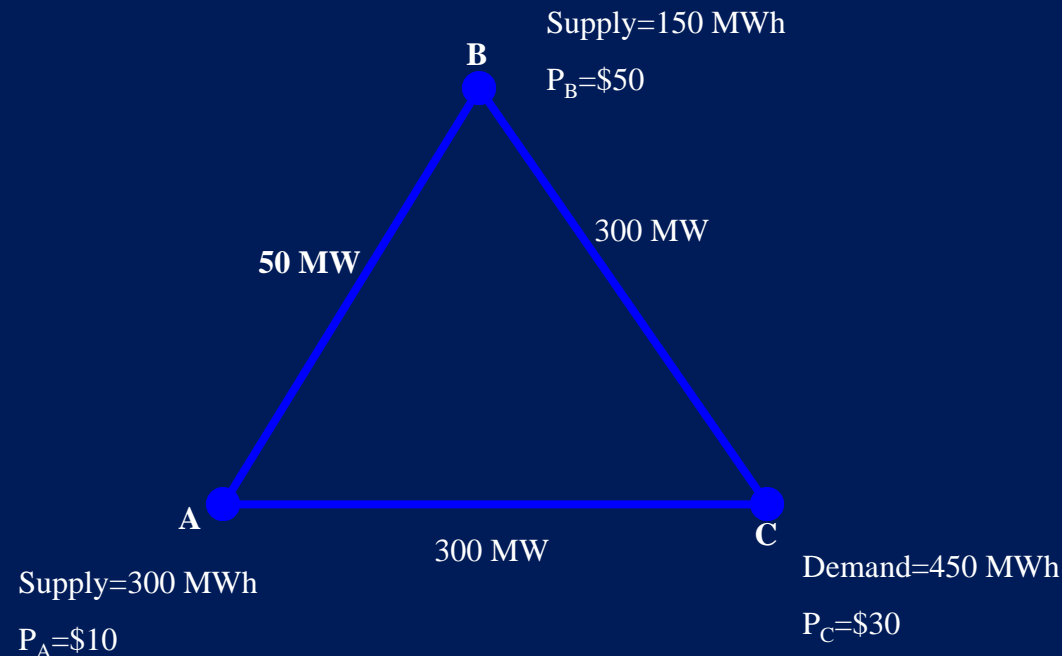
Node	Q (MW)	P (\$/MWh)	Payments (\$)
A	500	\$10	(5,000)
B	500	\$50	(2,500)
C	1,400	\$500	700,000
D	400	\$500	(200,000)
Total			492,500



- The generator in D has locational market power! Bids \$500/MWh to set the price when load exceeds 1,300 MWh.

Incentives for Transmission Investment

Nodal pricing does not point to the source of constraints directly. For example:



Prices in A and C differ, but the line between them is not congested. The electric transmission system is not like a highway system: price differences between nodes can occur because of constraints distant from the nodes.

Incentives for Transmission Investment

- **Question: Does nodal pricing provide efficient price signals for investment in the transmission system? Yes, but not for any particular interface between nodes, but for the transmission system as a whole.**
 - ▶ **Note that price differences are not usually sufficient to cover investment costs in transmission system (see Schweppe, *et al.*)**
- **FTRs based upon rights to receive revenues (or pay) for price differences between nodes also provide diffuse price signals for transmission investment**

What character do you want your ISO to have?

No ISO is willing to share its algorithms for calculation of LMPs (non-transparent price mechanism).

- For example, all RTOs/ISOs treat their software as proprietary and have no mechanism for sharing it among their members.

Is the RTO/ISO a regulator or an entrepreneur?

- RTO/ISO is responsible for market monitoring, new market rules, *etc.* which are all regulatory functions.
- RTO/ISO is ultimate arbitrator of reliability.
- Both of these functions are at base regulatory.

What incentive mechanisms can be designed for RTO/ISO to act efficiently? Avoid undue influence by wealthiest participants?

Conclusions

Practical implications of Standard Market Design raise significant questions:

- **Demand is not real-time responsive yet**
- **Electricity markets are not perfectly competitive**
- **Potential for large market surplus transfers**
- **Efficiency versus equity trade-off**
- **Resolving the question of transmission rights**
- **Market monitoring capability is very important**
- **Institutional character of ISO is important**