

Prices in Electricity Markets

Presented to:
MIT Energy Club

Presented by:
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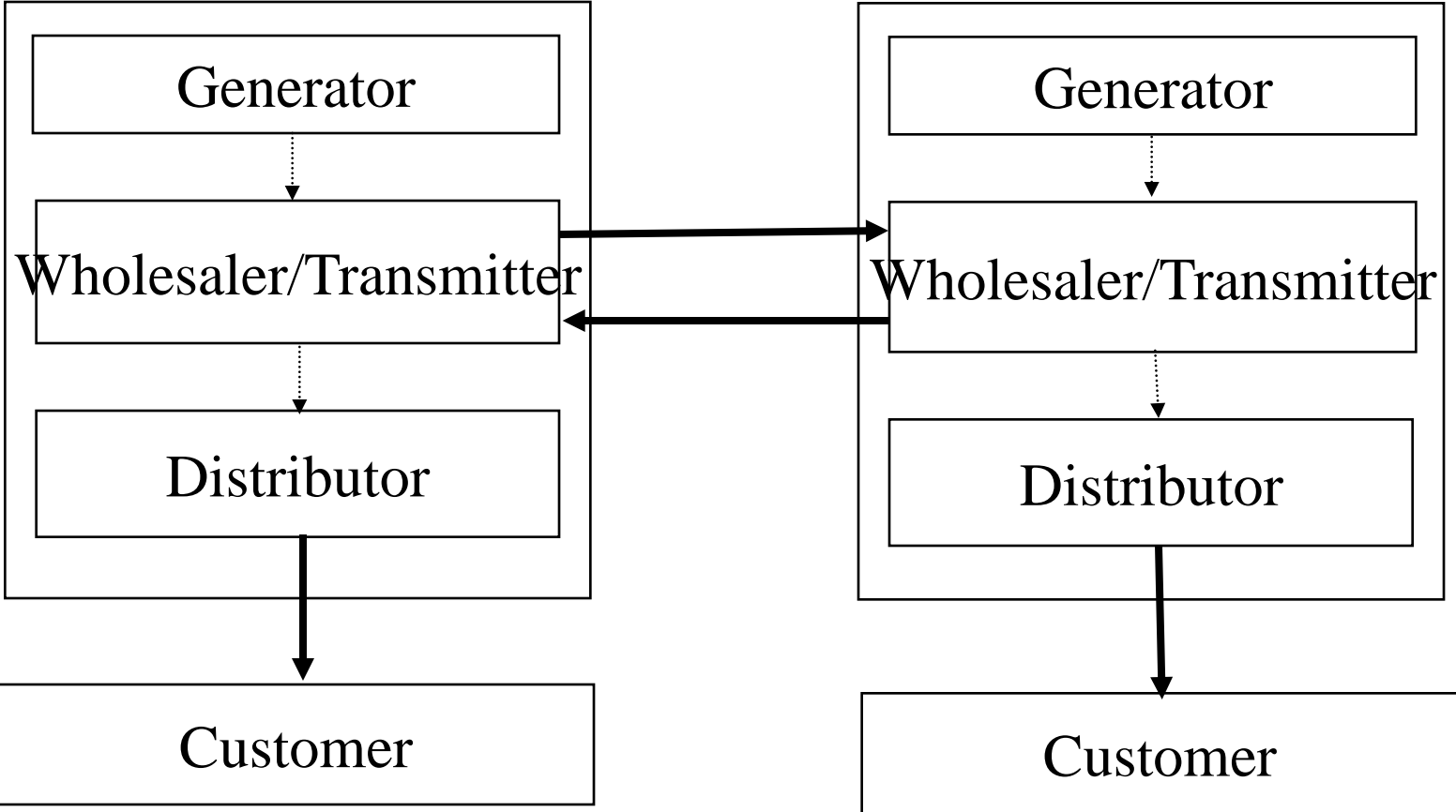
What we will hope to talk about today

- ◆ **Two kinds of markets**
 - ◆ Traditional
 - ◆ Restructured
- ◆ **Traditional markets and how they are organized**
- ◆ **Restructured markets**
 - ◆ Market organization
 - ◆ Price setting generally
 - ◆ Locational marginal pricing
- ◆ *Retail prices*
 - ◆ Traditional markets
 - ◆ Restructured markets

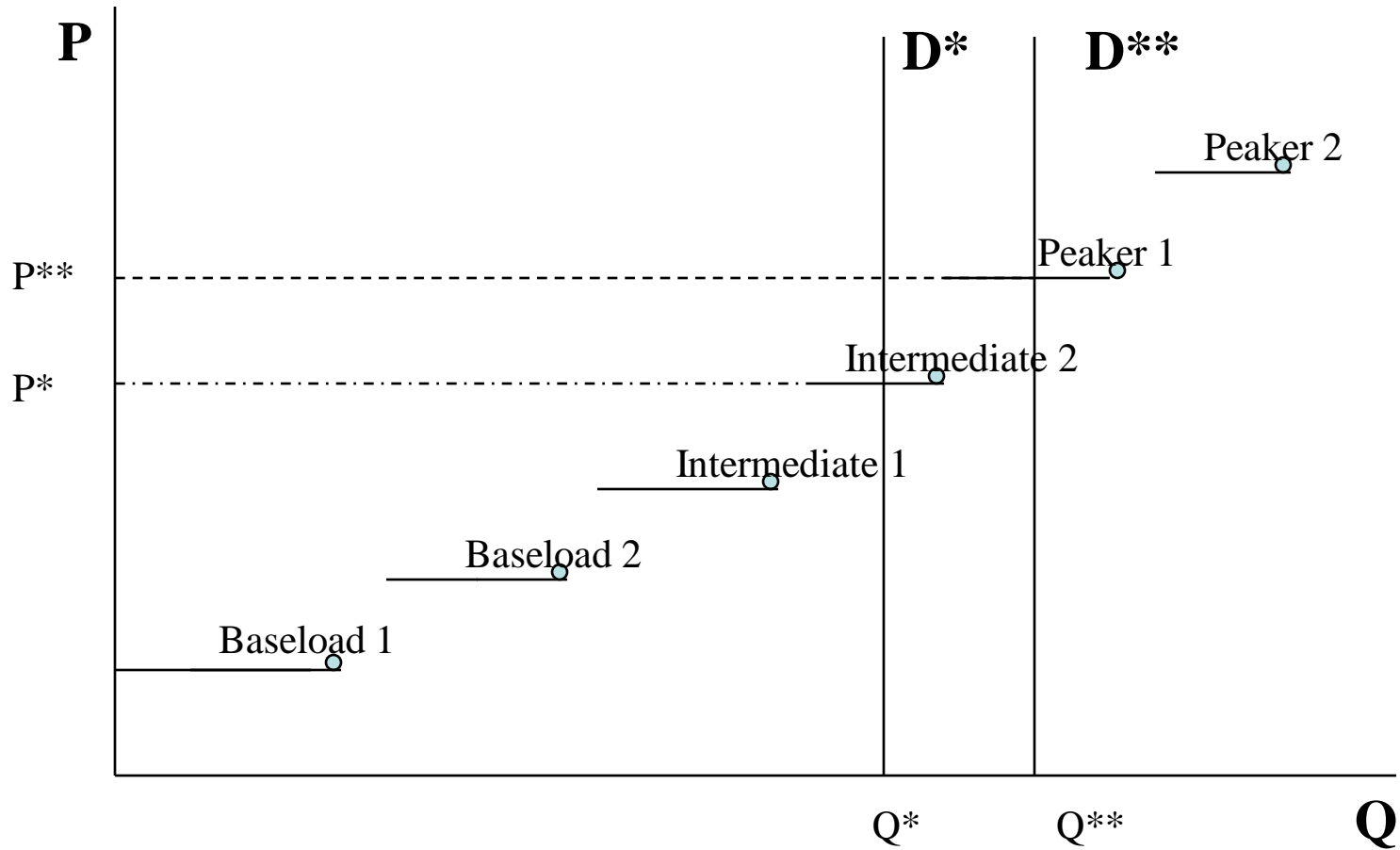
Traditional Markets

- ◆ Traditional Markets
 - Comprised of your standard integrated utility
 - Price formation is entirely through regulation by public utility commissions.
- ◆ Utility performs the following functions
 - Distribution
 - Low voltage wires providing service to ultimate customer – residential, commercial, small industrial
 - Transmission
 - Bulk power system
 - ◆ Provides “highway” connecting generation to distribution system
 - ◆ Largest customers connect at the voltage levels of transmission system
 - ◆ Interconnection to other utilities provides reliability enhancement and potential for economic interchange
 - Generation
 - Owned by utility
 - Economic dispatch

Traditional Markets



Economic Dispatch



Three Primary Generation Types

◆ Baseload

- High capital costs, low marginal energy costs
 - Coal, nuclear

◆ Intermediate

- Capital costs lower than baseload, but higher marginal energy costs
- Usually fairly flexible in varying output levels
 - Combined cycle gas turbine (CCGT) is typical unit

◆ Peaking

- Low capital costs and short lead times to build
- High marginal energy costs
 - Natural gas combustion turbine (CT) is typical unit

Other Generation

- ◆ Large scale hydroelectric
 - Big dams
 - 000's MW
 - Pondage provides storage
- ◆ Smaller scale hydroelectric
 - Run-of-river
 - Typically small MW's – a few to 100
- ◆ Biomass – waste-to-energy – primarily cogenerators selling power to utility
- ◆ Renewable resources
 - Typically characterized as high capital costs, but very low marginal energy costs, sometimes zero
 - Characterized by intermittency of output
 - Predictable, but largely controllable
 - Geographic-specific
 - Wind, solar thermal solar PV

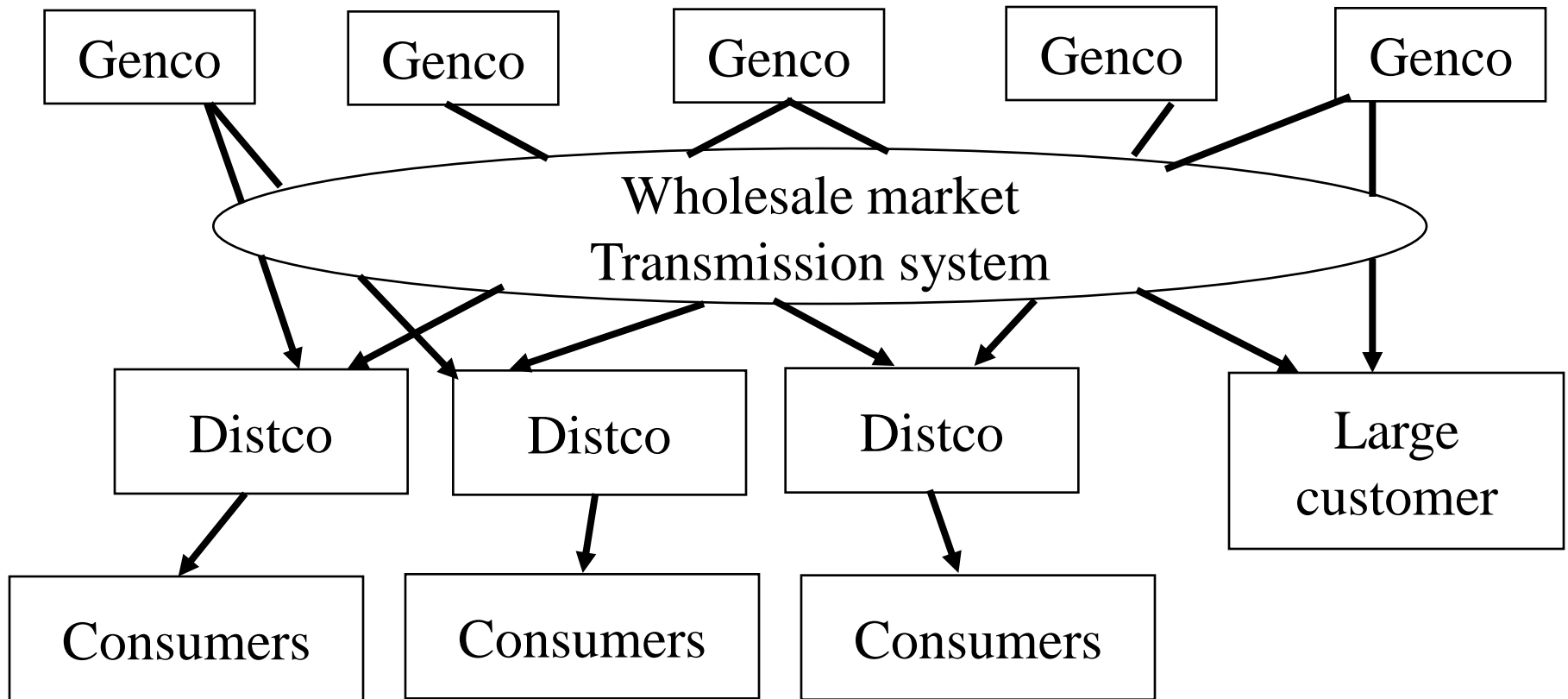
Restructured Markets

◆ Restructured Markets

- Transmission system operated by independent system operator
 - Utilities retain TX ownership, requirement for maintenance, expansion
 - Federal Energy Regulatory Commission (FERC) sets rate and regulates
- Generation bid into market
 - Some utilities have retained generation ownership
 - New entrants
 - Very loosely regulated by FERC
- Residual traditional utility, now known as a local distribution company (LDC), operates and maintains the wires to retail customers
 - Under wholesale competition
 - ◆ Retains supplier role, purchasing on behalf of customers
 - Under retail competition
 - ◆ Residual obligations, Provider of Last Resort (POLR)
 - In both approaches regulated by state public utility commissions

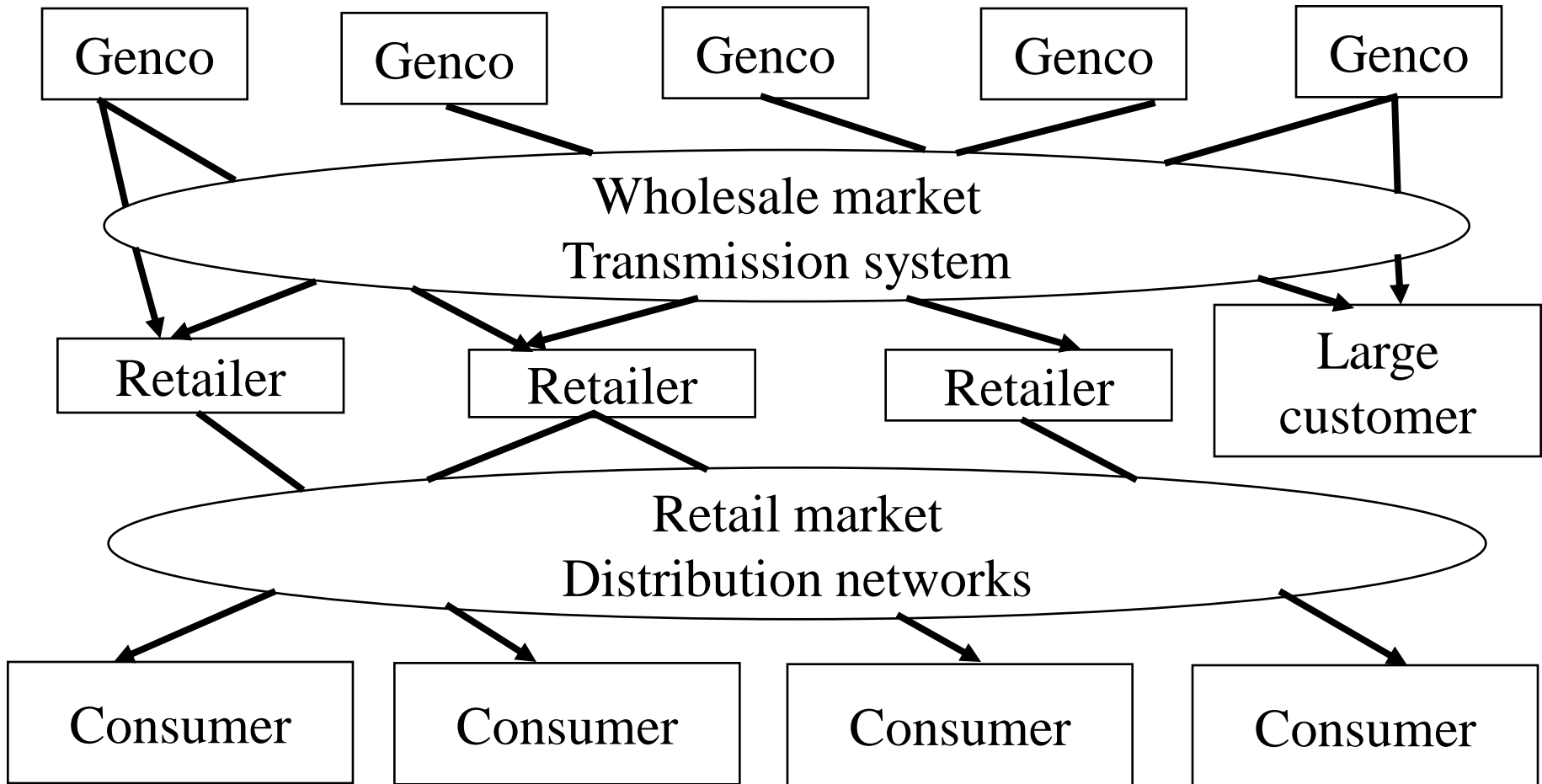
Restructured Markets

Wholesale competition



Restructured Markets

Retail competition



Restructured Wholesale Market

- ◆ ISO is market-maker
- ◆ Multi-settlement market
 - Day-ahead hourly market
 - Real-time
 - Deviations from generation schedules (unscheduled outages)
 - Deviations from forecasted bids or demand
 - Day-after
 - Generators paid based on schedule, LSEs pay based on projected or bid demands
 - Suppliers and demanders charged for increased costs resulting from deviations from schedule by settling at real time prices
- ◆ Ancillary services markets
 - Operating reserves
 - Transmission-related
 - VARs
 - Capacity/Forward reserves market

Price Setting (For an hour)

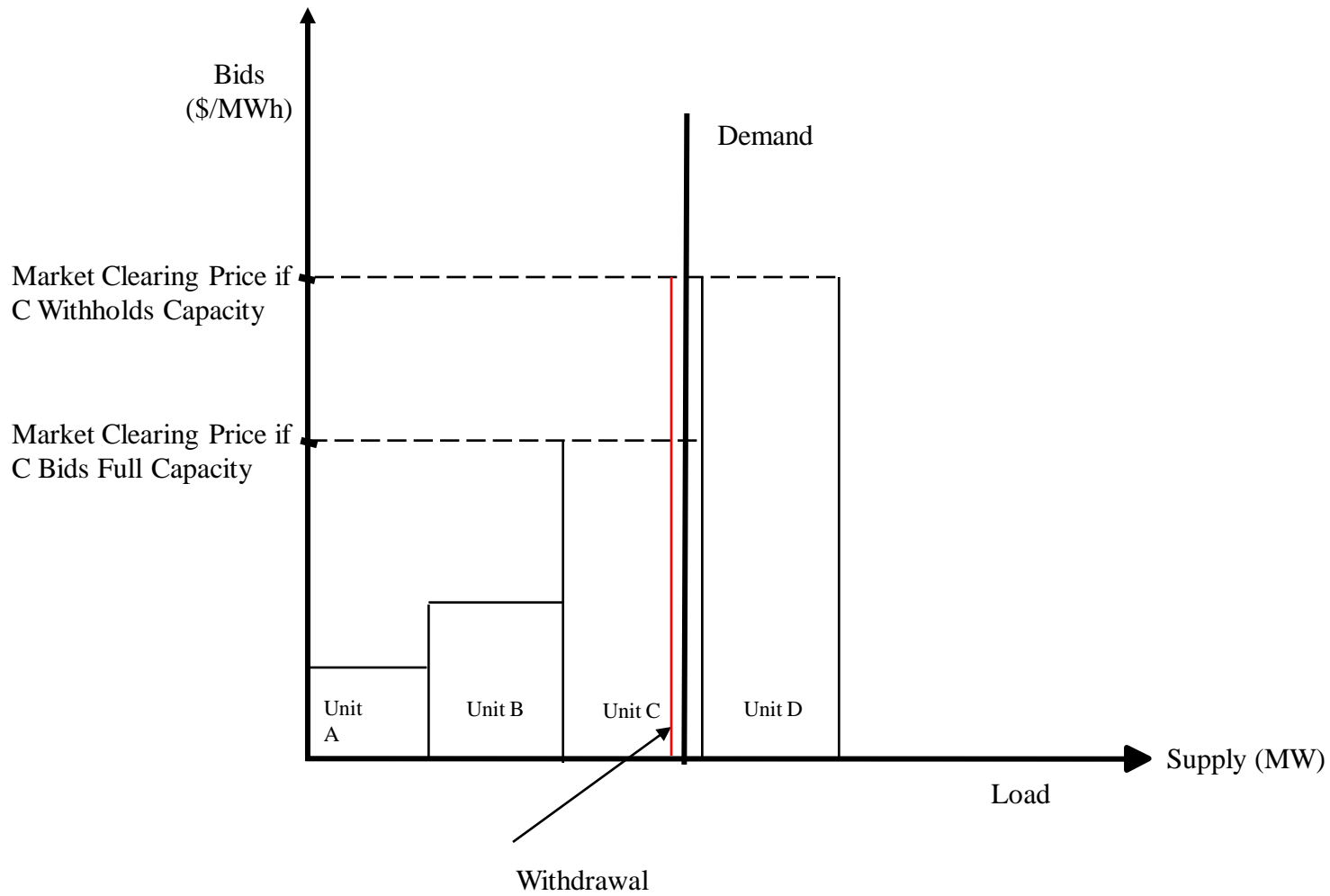
◆ Generation

- Generators bid into market, typically a marginal energy cost schedule for a day
 - Bid accepted
 - Price is set by last generators

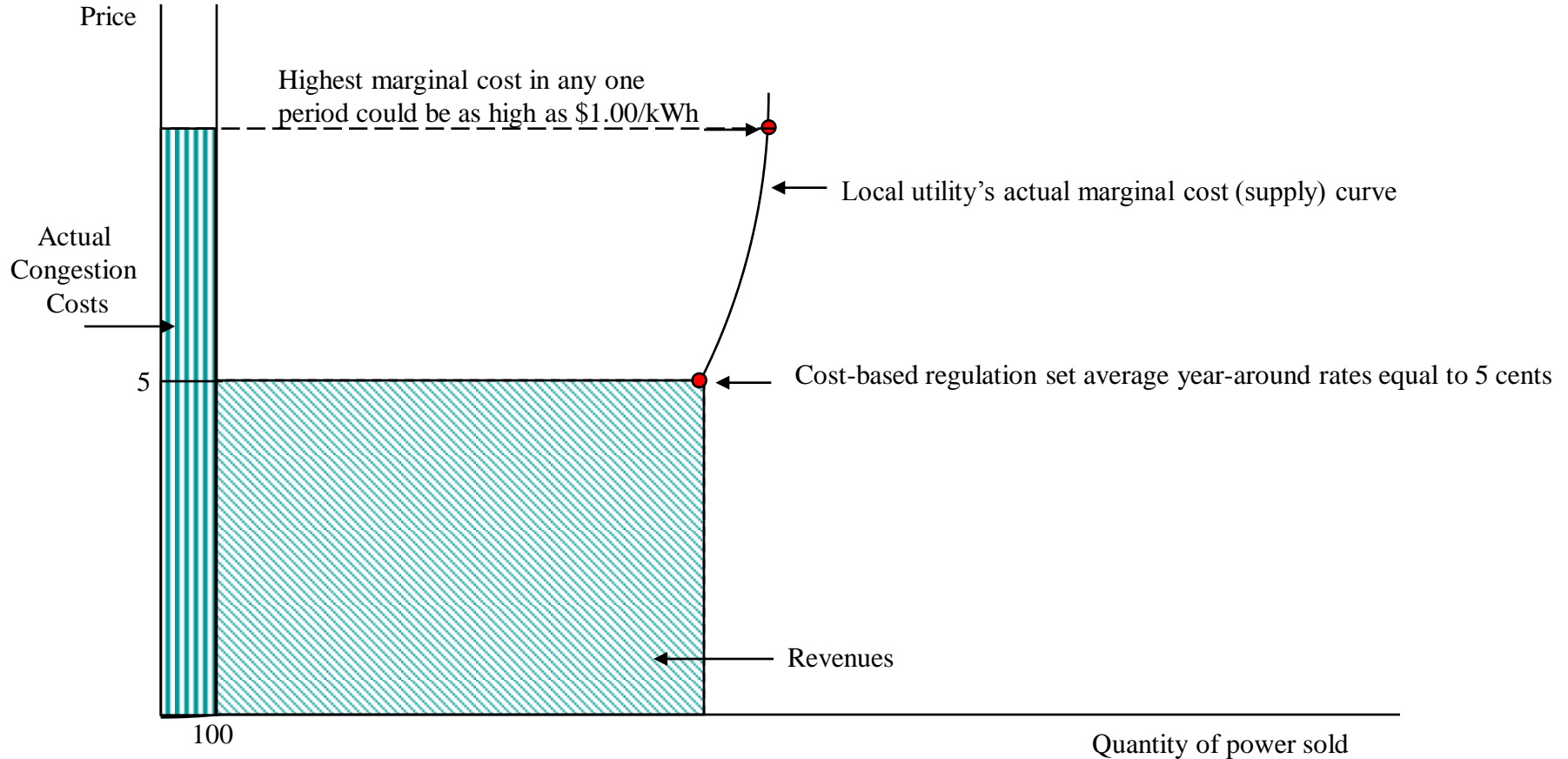
◆ Market power concerns

- Transmission system constraints aggravate the problem by creating isolated mini-markets

Uniform Price Auction (Withholding Effect)

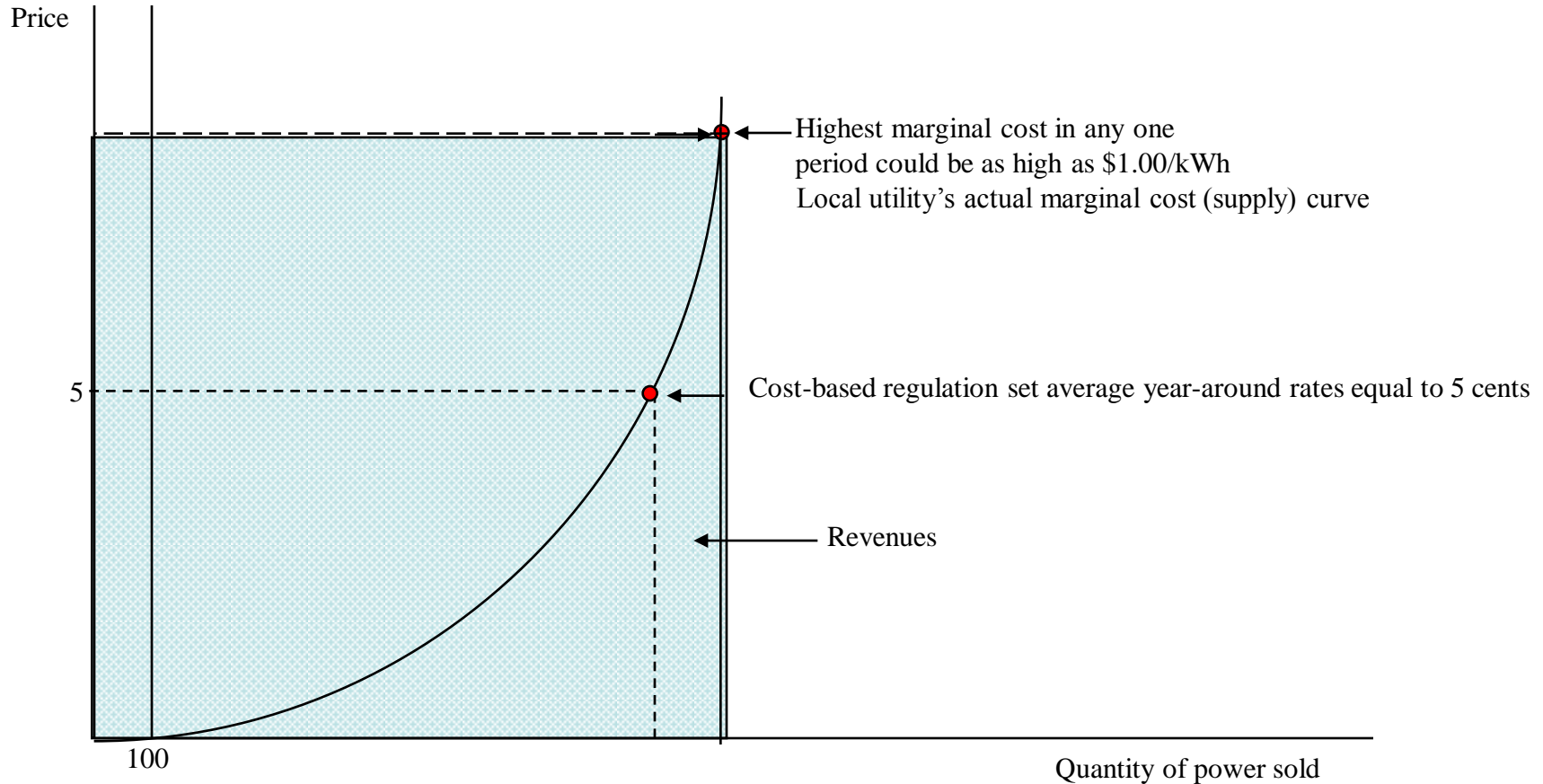


Traditional Market Pricing



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

Restructured Markets (Uniform Price Auction)



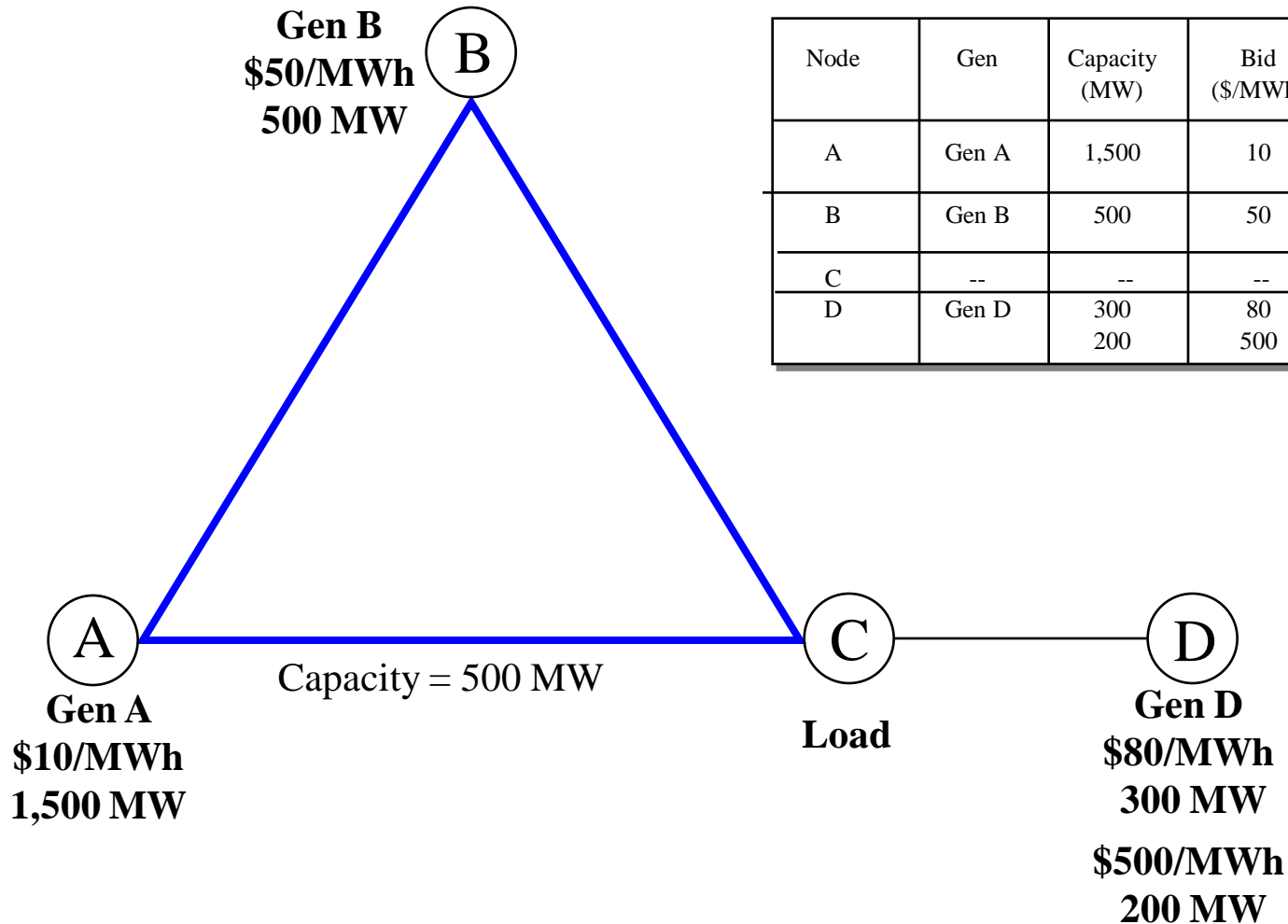
If power plants with a cost of \$1.00/kWh have to produce 100 kWh to relieve congestion, ratepayers are charged, more than the actual costs of relief.

Restructured Markets – Locational Marginal Pricing

◆ Locational marginal pricing

- ◆ Fully economic dispatch may not be possible due to transmission constraints
 - Thermal - Power flowing down a transmission line heats the conductor and causes it to sag. If the conductor sags too much it will fault to the ground and the line will be inoperable.
 - Electrical – The power flowing down a line can become unstable. Too complicated to explain here.
- ◆ Generation must be redispatched to ensure all demands are met subject to the transmission system's constraints
 - Security-constrained unit commitment and dispatch

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

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

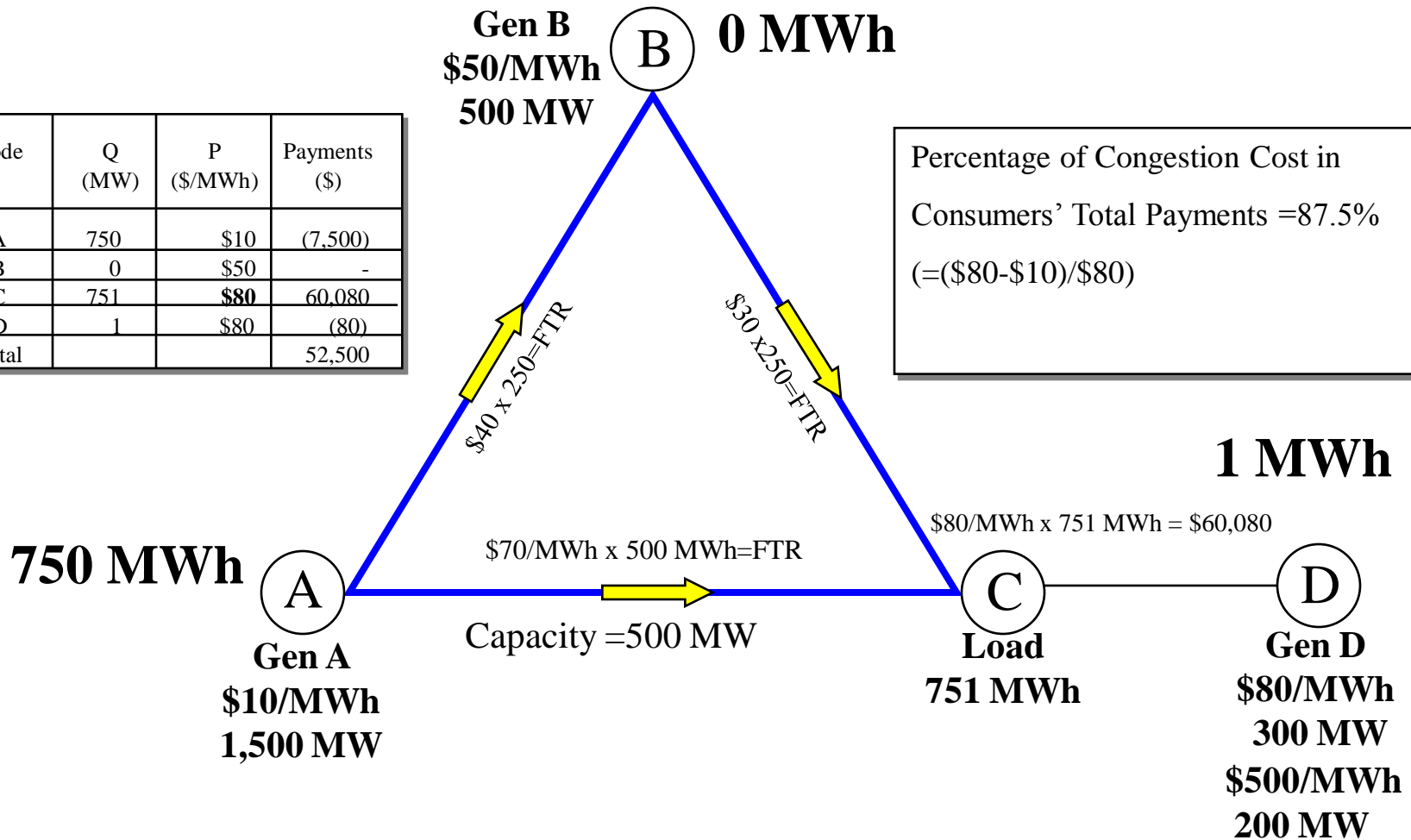
Gen D
\$80/MWh
300 MW

\$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)

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)

Retail prices – Traditional Markets

◆ Rates

- ◆ Set by public utility commission for investor-owned utilities and set by boards for public power
- ◆ Cost of service standard
 - Utility submits an estimate of its overall revenue requirement
 - Allows for recovery of all anticipated operating expenses, plus depreciation, plus return on capital
 - ◆ Commission sets Allowed Rate of Return on Equity (ARORE) and utility estimates cost of debt
 - Costs are allocated on a functional basis – distribution, transmission, generation, customer
 - Functionalized costs are allocated to customer classes- residential, small commercial, large commercial, small industrial, large industrial
- ◆ Rates are designed based on cost of service study

Retail Prices – Restructured Markets

- ◆ **Customer bill broken into component parts - unbundling**
- ◆ Distribution charges set by public utility commission
 - Usually consists of a wires fee, customer charge, and stranded cost recovery charge
 - Stranded cost charge is a result of restructuring – selling off of utility generation assets that were above market
 - Cost of service standard
- ◆ Transmission charge is pretty much a pass-through based on FERC-determined ISO transmission charges
- ◆ Energy/commodity charge
 - Energy may be provided by third party
 - LDC procures power for all customers without third party provider through periodic auctions
 - So-called residual obligation or Provider of Last Resort

Retail Prices – Restructured Markets

◆ Metering technology issues

- ◆ Mass market customers largely receive a much-delayed price signal which provides essentially no information about how their consumption relates to their costs except in the grossest of terms
- ◆ Large customers receive hourly price signals
- ◆ Why?

Thank you!!!!!!

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The Brattle Group – Company Overview

- ◆ Consulting and expert testimony in economics, finance, and regulation to corporations, law firms, and governments
- ◆ 200 people in five offices: Boston, Washington DC, San Francisco, London and Brussels + affiliations with leading academics
- ◆ Several practice areas:
 - Energy and Utilities – approximately half the firm
 - Commercial and Financial Litigation
 - Tax, Valuation, Securities
 - Other network industries

The Brattle Group – Services to Utility Clients

- ◆ Climate Change Policy and Planning
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- ◆ Demand Response and Energy Efficiency
- ◆ Electricity Market Modeling
- ◆ Energy Asset Valuation
- ◆ Energy Contract Litigation
- ◆ Environmental Compliance
- ◆ Fuel and Power Procurement
- ◆ Incentive Regulation
- ◆ Rate Design, Cost Allocation, and Rate Structure
- ◆ Regulatory Strategy and Litigation Support
- ◆ Resource Planning
- ◆ Renewables
- ◆ Retail Access and Restructuring
- ◆ Risk Management
- ◆ Market-Based Rates
- ◆ Market Design and Competitive Analysis
- ◆ Mergers and Acquisitions
- ◆ Transmission

Contact Us

We will be at MIT interviewing undergraduate students on 23 October 2008 and MBA candidates on 5 November 2008. If you have any interest, please contact *Angela Gilbert* at our Washington, D.C number below or by e-mailing her at recruiting@brattle.com .

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