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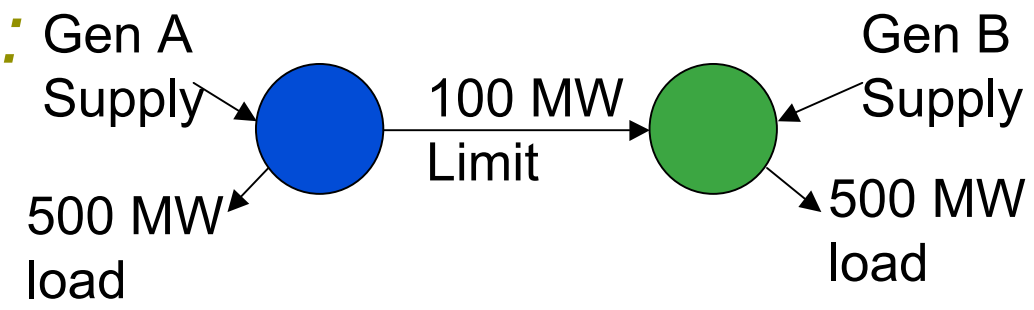
Research Interests

Electric Energy Markets
Congestion Costs
Market Power Monitoring
Performance-Based Monitoring and Control

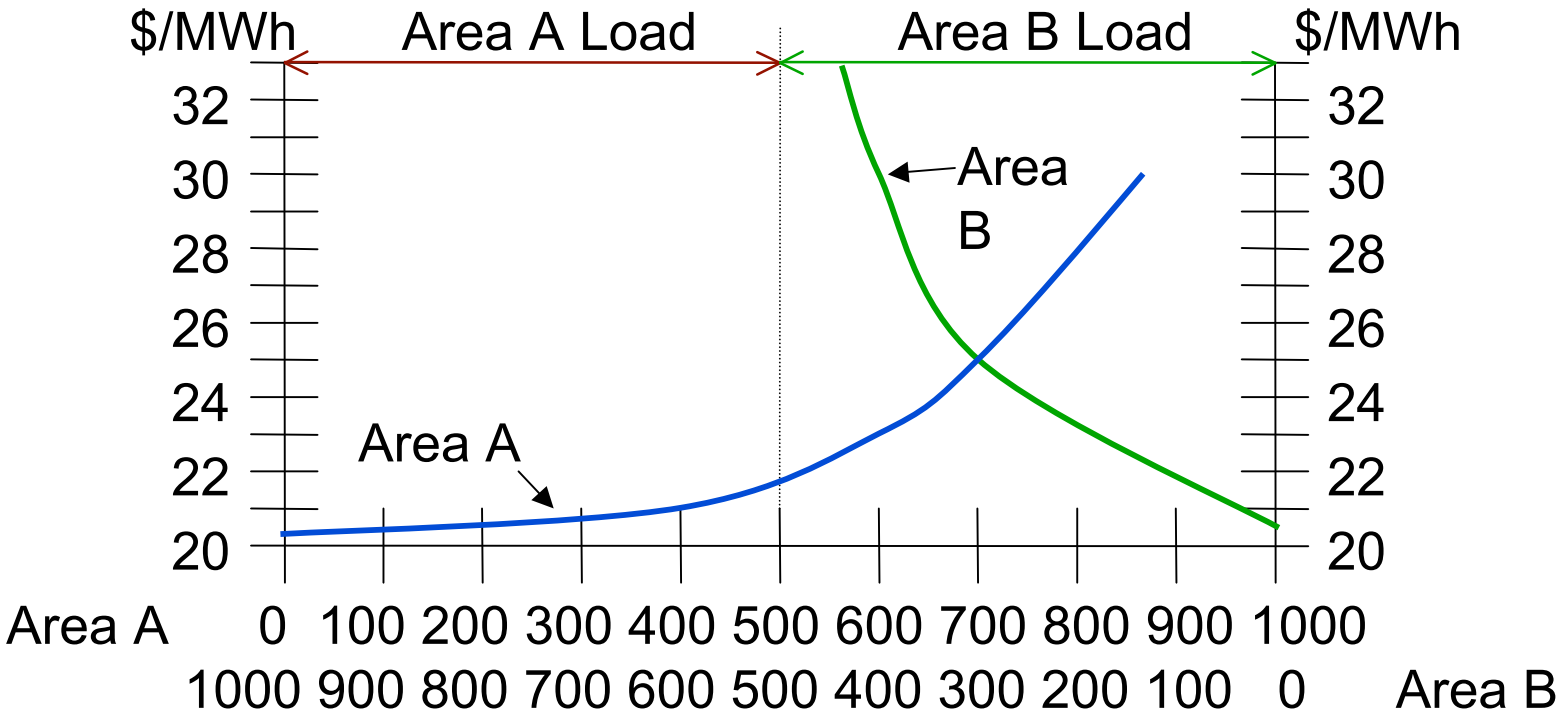
Congestions Costs in Electricity Markets

Table EX-1. Summary of Congestion Costs Reported by ISOs, DOE, and FERC			
	Period	Congestion Costs	Congestion Cost-Calculation Method(s)
PJM [1]	1999	$53 M	Congestion Revenues
PJM [1]	2000	132 M	
PJM [1]	2001	271 M	
PJM [2]	2002	430 M	
ISO-NE [3]	5/99-4/00	$99 M	Uplift Charges[a]
ISO-NE [3]	5/00-4/01	120 M	
ISO-NE [4]	2003	50 – 300 M	System Redispatch Payments
CAISO [5]	2000	$391 M	Congestion Revenues
CAISO [5]	2001	107 M	
CAISO [6]	2002	42 M	
CAISO [7,8]	2005	-7.47 – 306 M	System Redispatch Payments + Congestion Revenues
NYISO [9]	2000	$1,240 M	System Redispatch Payments (est) + Congestion Revenues
NYISO [9]	2001	570 M	
NYISO [10]	2000	517 M	Congestion Revenues
NYISO [10]	2001	310 M	
NYISO [11]	2002	525 M	
FERC [12]	6/00-8/00	$891 M	System Redispatch Payments (partial) + Congestion Revenues
DOE [13]		$157 M – 457 M	System Redispatch Payments + Congestion Revenues

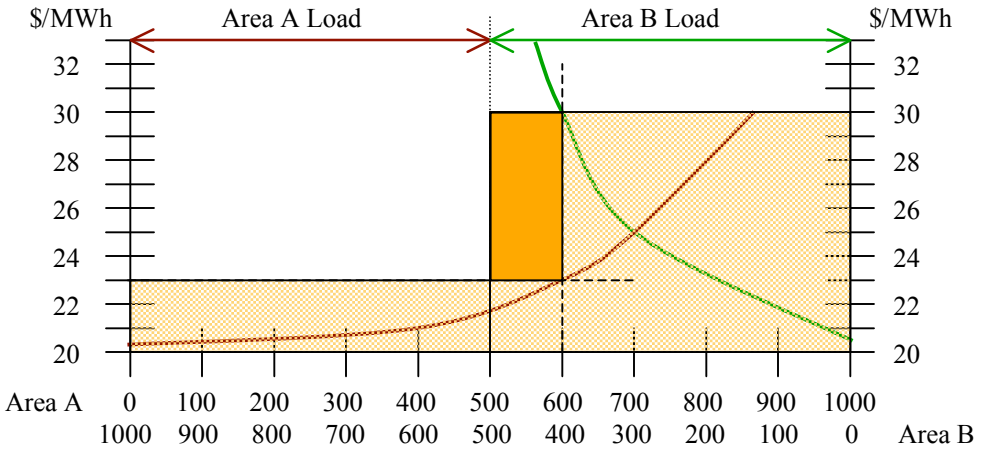
Two-Area Example:



Aggregate Supply Curves



Congestion Rent/Charges/Costs



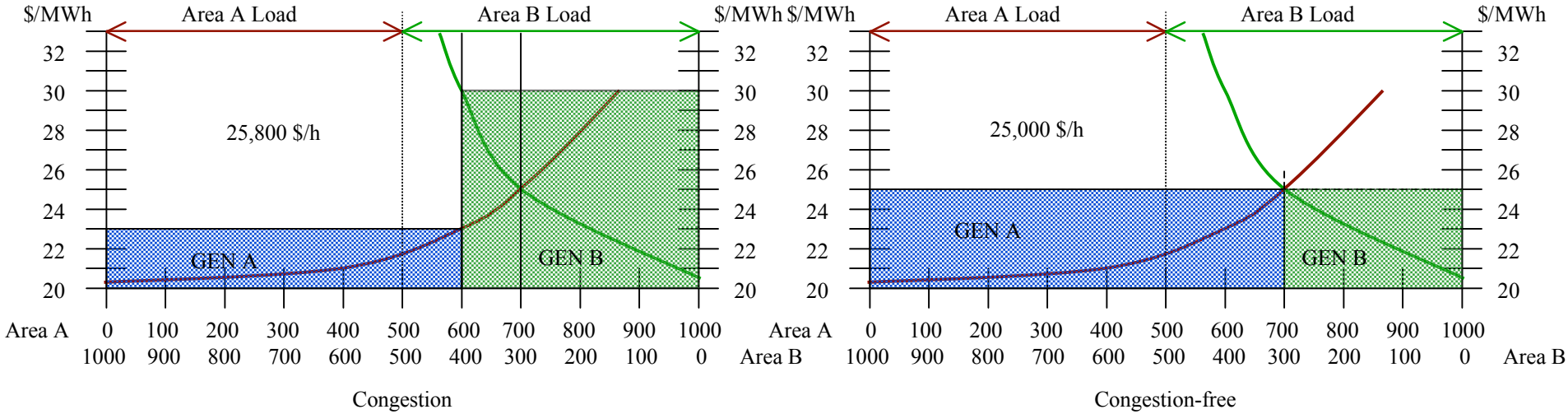
Due to congestion, loads pay more for energy than the generators receive. *The difference equals the product of power transfer and price difference.*

Collection and distribution of congestion charges (rents) are necessarily part of the ISO settlement policy. They are collected from loads and paid to holders of Congestion Revenue Rights (CRRs, aka TCCs aka FTRs aka FTRs).

These rents are what ISOs typically report as Congestion Costs.

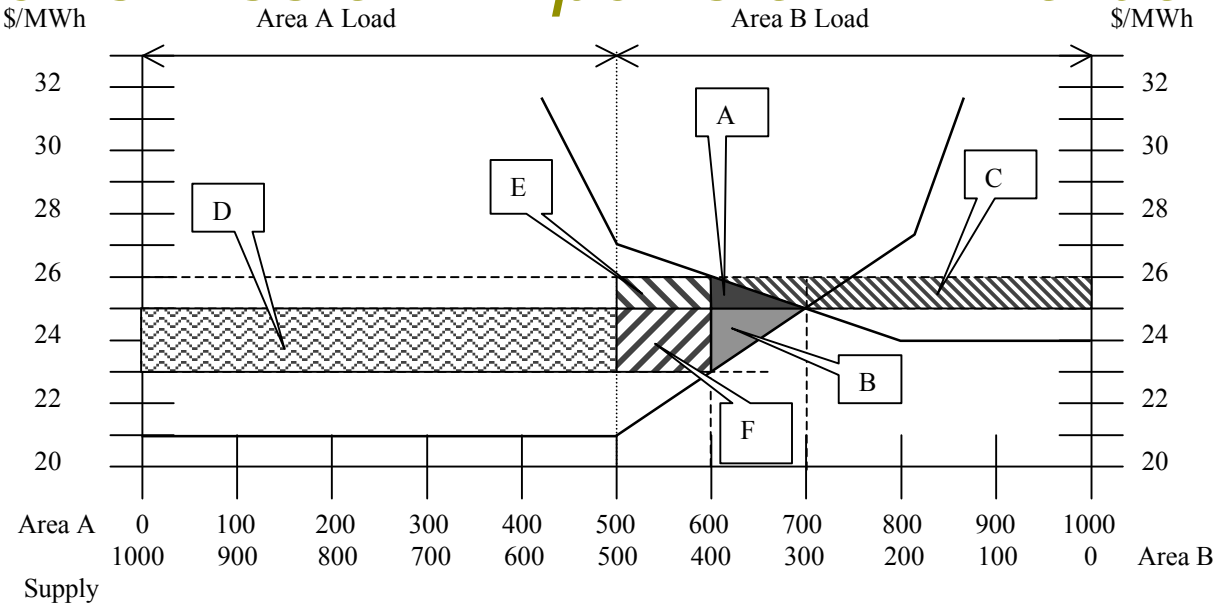
System Dispatch Payments

Compare the change in generator dispatch payments, with and without congestion.



In this example, increasing transmission capacity decreases dispatch costs paid to generators.

Transmission Expansion: Who benefits?



A. An absolute increase in consumer surplus due to increased transmission capacity,
B. An absolute increase in producer surplus due to increased transmission capacity,
C. A transfer from producer surplus to consumer surplus,
D. A transfer from consumer surplus to producer surplus,
E. Consumer surplus from a portion of congestion revenues,
F. Producer surplus from a portion of congestion revenues.

Revenue Sensitivities and Market Power

Research Approach: examine dispatch and revenue sensitivities to identify market participants who are able to exploit locational advantage in a market.

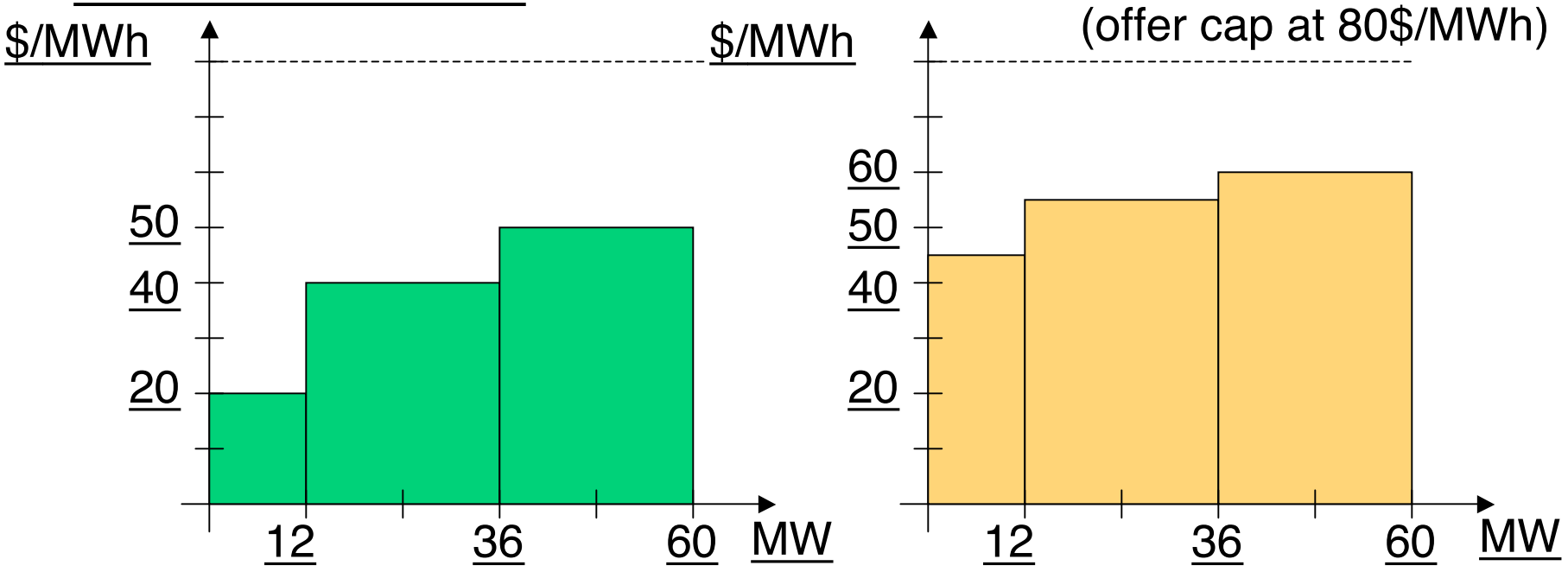
Goal: to develop a tool for real-time market power monitoring.

In this paper we focus on those individuals or groups with the ability to simultaneously increase **revenue** and **price**.

Market Experiments

- People represent each generator.
- They choose offer prices for blocks of power.
- They are paid (in real dollars) in proportion in proportion to their profit.

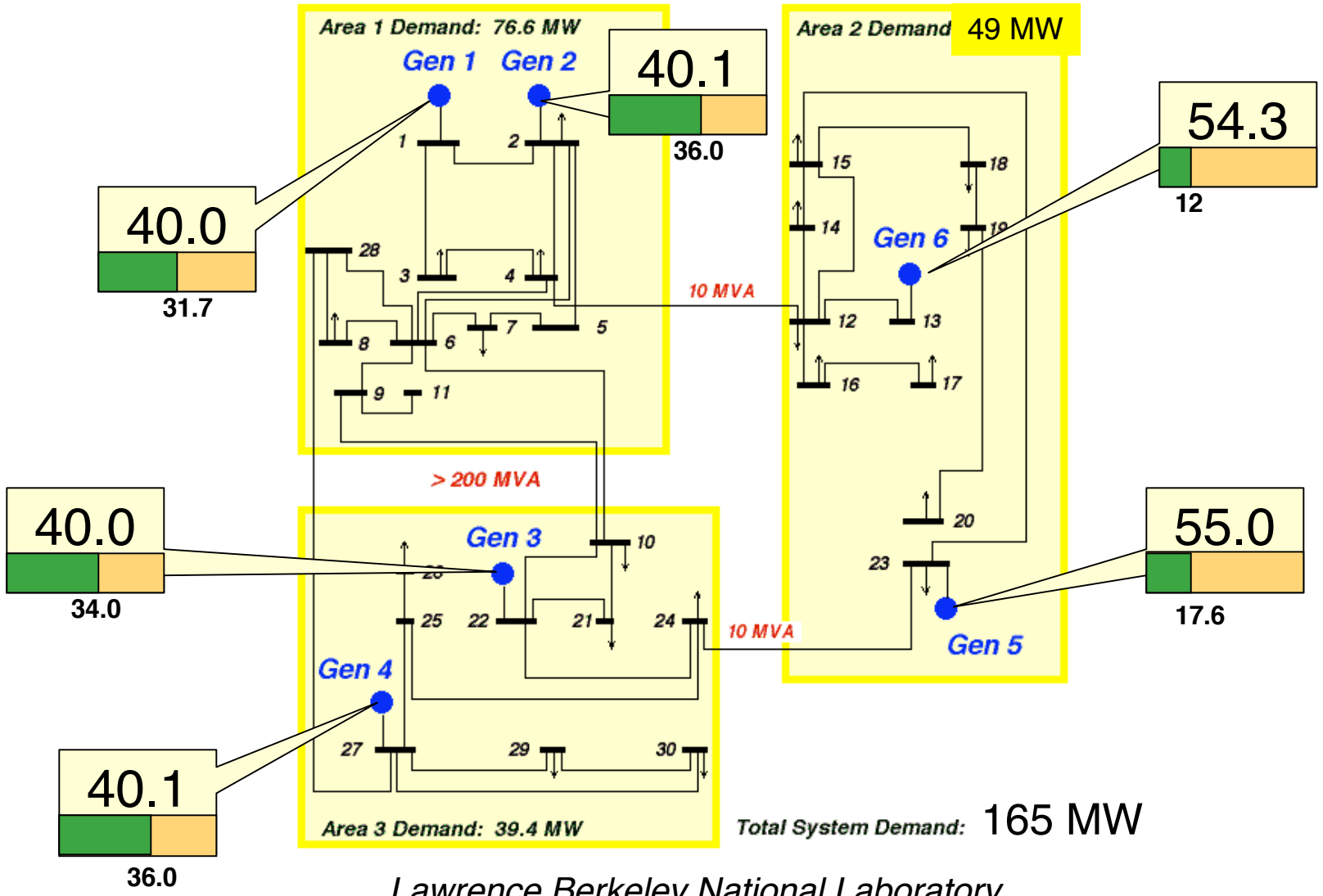
Base Case Offers:



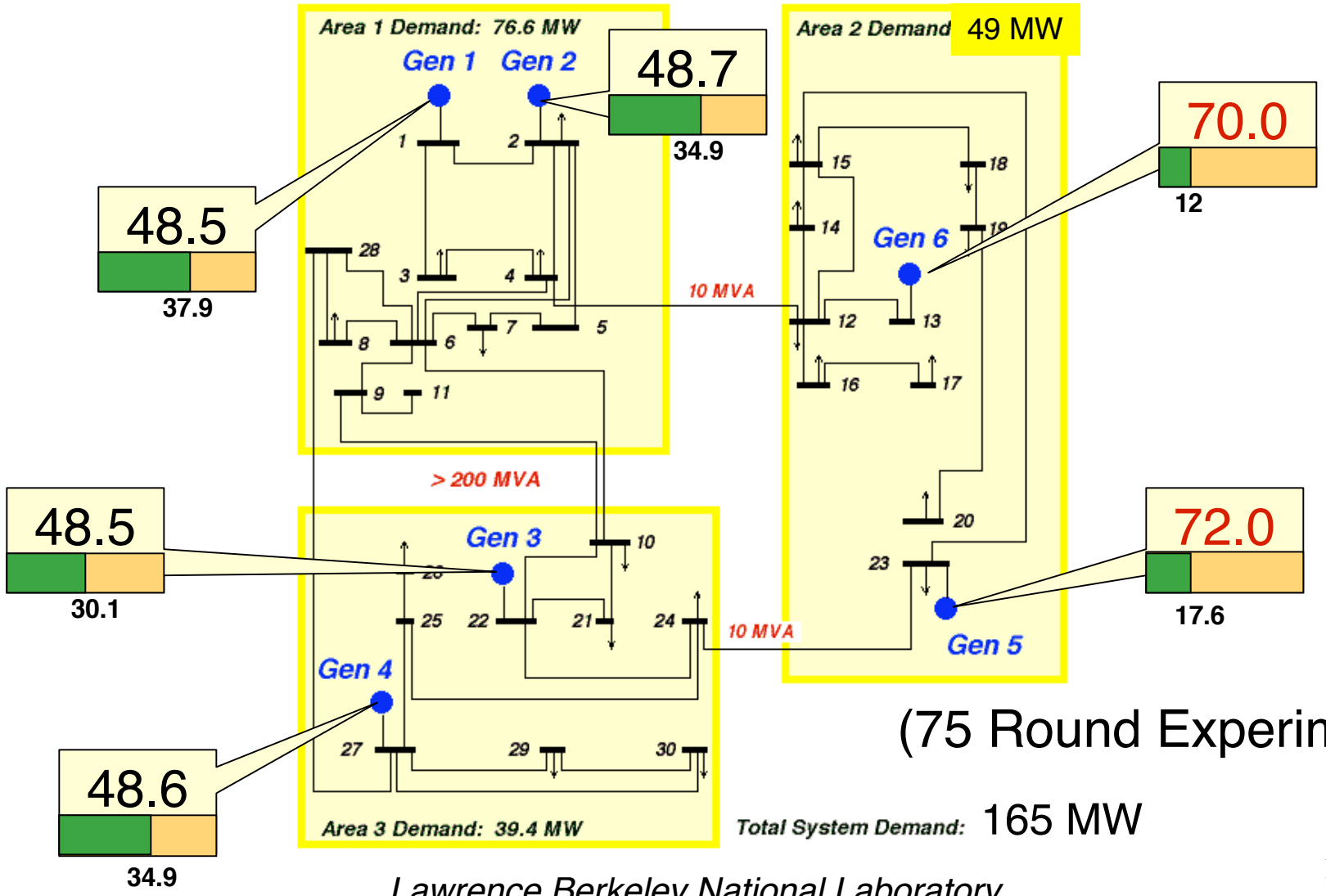
Generators 1-4

Generators 5-6

Base Case Solution: price and dispatch



Experimental Results: price and dispatch



(75 Round Experiment)

Matrix of Revenue/Offer Sensitivities

Base Case Solution

$$\begin{bmatrix} r_1 \\ r_2 \\ r_3 \\ r_4 \\ r_5 \\ r_6 \end{bmatrix} = \left[\begin{array}{cccc|cc} 3298 & 3231 & 31 & 65 & 52 & -49 \\ 3219 & -3695 & 244 & 263 & 315 & -310 \\ 31 & 244 & -544 & 308 & -234 & 229 \\ 65 & 263 & 307 & -597 & -127 & 125 \\ \hline 38 & 230 & -170 & -93 & -160 & 173 \\ -36 & -229 & 169 & 92 & 175 & -159 \end{array}\right] \begin{bmatrix} \Delta_1 \\ \Delta_2 \\ \Delta_3 \\ \Delta_4 \\ \Delta_5 \\ \Delta_6 \end{bmatrix}$$

- If any supplier, acting alone, raises its price, that supplier will lose revenue (note diagonal entries).
- If all suppliers, acting together, raise (offer) prices, everyone's revenue increases (note row sums).
- If the load pocket generators (5 and 6) raise their prices together, their own revenues increase with almost no effect on the other revenues.

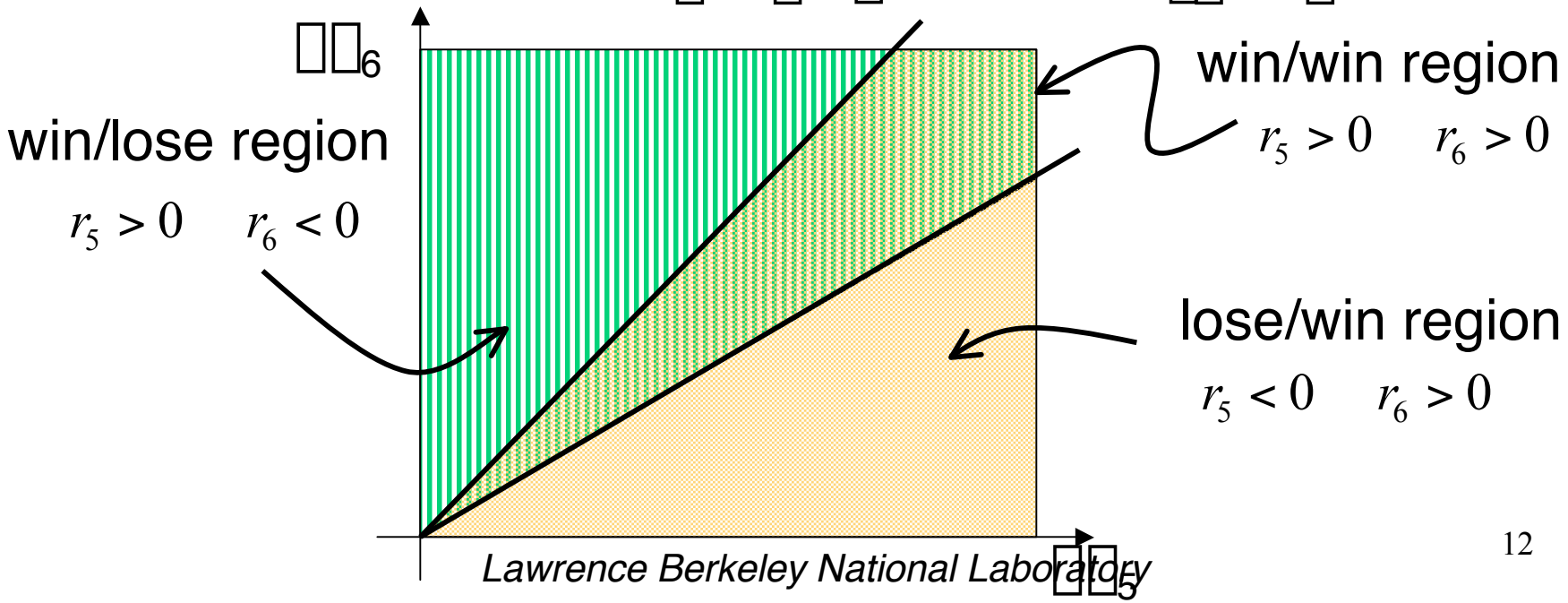
Load Pocket Market Power

Generators 5 and 6 have potential market power, and experiments show they can exploit this potential.

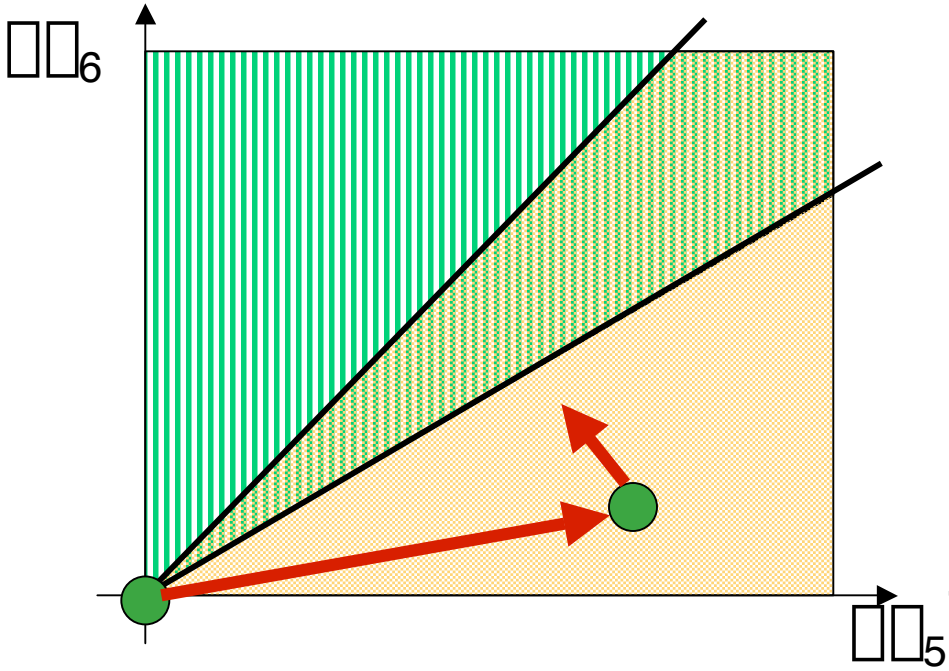
How do they do it without direct collusion?

Closer examination:

$$\begin{bmatrix} r_5 \\ r_6 \end{bmatrix} = \begin{bmatrix} 160 & 173 \\ 175 & 159 \end{bmatrix} \begin{bmatrix} \cdot_5 \\ \cdot_6 \end{bmatrix}$$



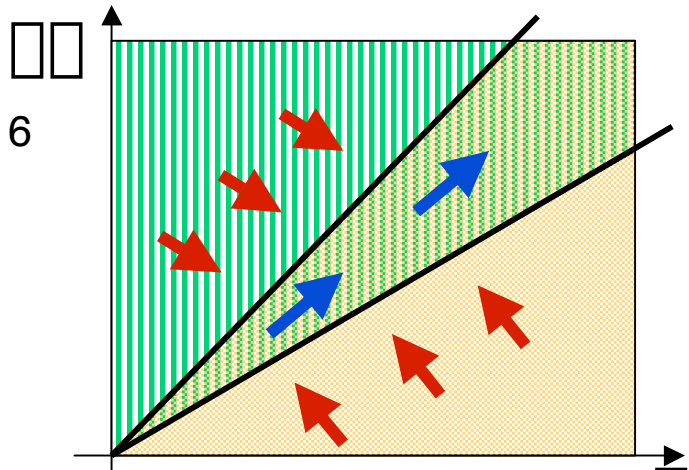
Load Pocket Market Power



Consider:
(1) both increase offers and
generator 5 loses revenue
generator 6 gains revenue
Then
(2) Generator 5 decreases offer,
generator 6 increases offer and
they move to the win/win region.

It will take time, but
- prices will increase and
- revenues will increase,

without direct collusion.



Relative Market Power (RMP)

A measure of how much market power is being exploited.

$$\mathrm{RMP} = \frac{\lambda_{\mathrm{actual}} - \lambda_{\mathrm{NMP}}}{\lambda_{\mathrm{FMP}} - \lambda_{\mathrm{NMP}}}$$

$\lambda_{\mathrm{actual}}$ observed nodal price

λ_{NMP} (lower) price at which No Market Power is evident

λ_{FMP} (higher) price at which Full Market Power is achieved (at price cap).

RMP for 6 supplier example

	Gen5	Gen6
Base Case	0.32	0.32
Experiment*	0.70	0.66