

How Transmission Affects Market Power in Reserve Services

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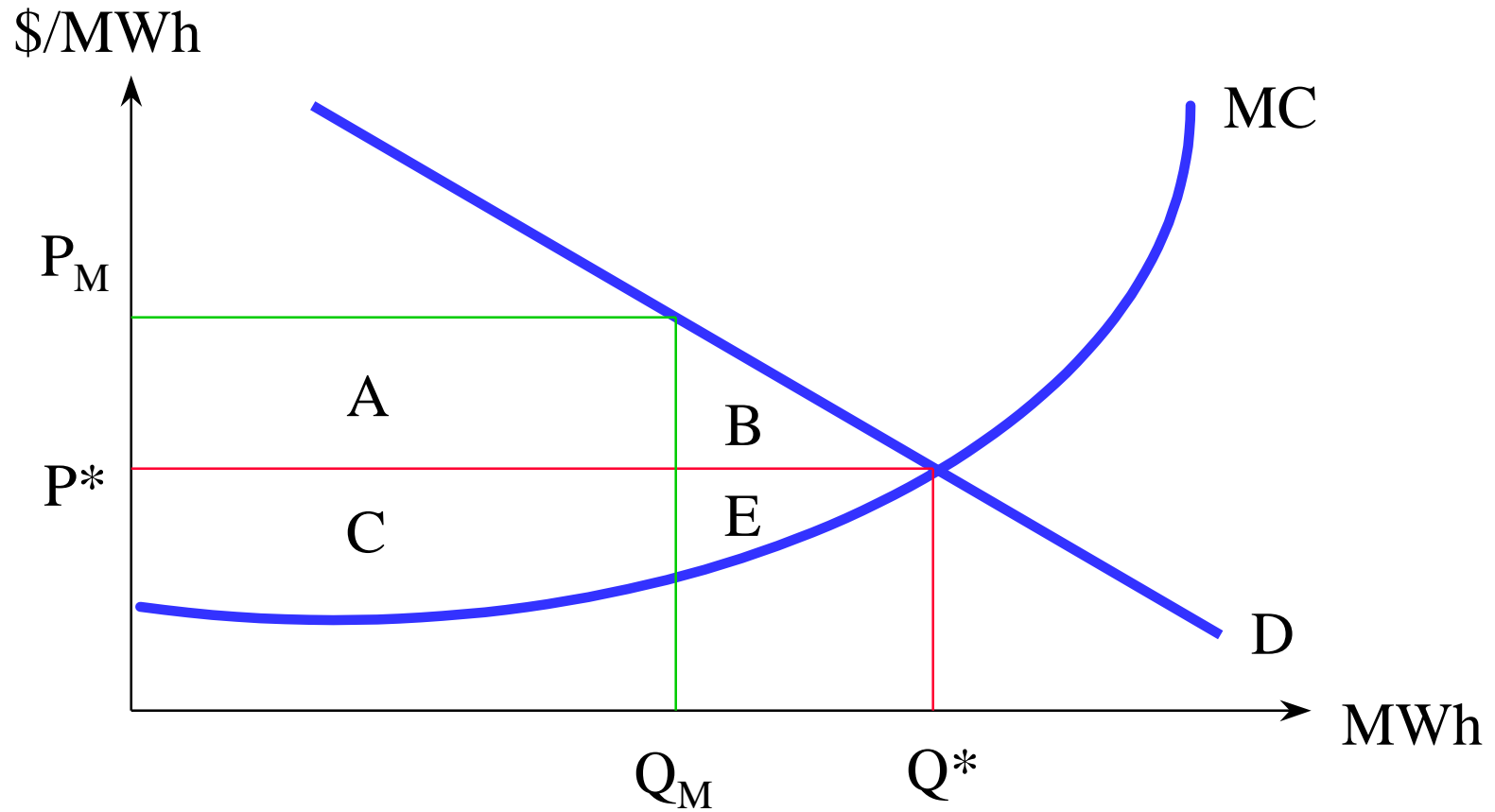
Palo Alto, California
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Defining Market Power


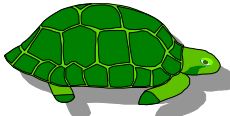
Market power is:

- *defined* as the ability of a market participant to influence price
- *measured* by the amount by which price exceeds marginal cost
- *exercised* by restricting supply *and* bidding high

Exercising Market Power



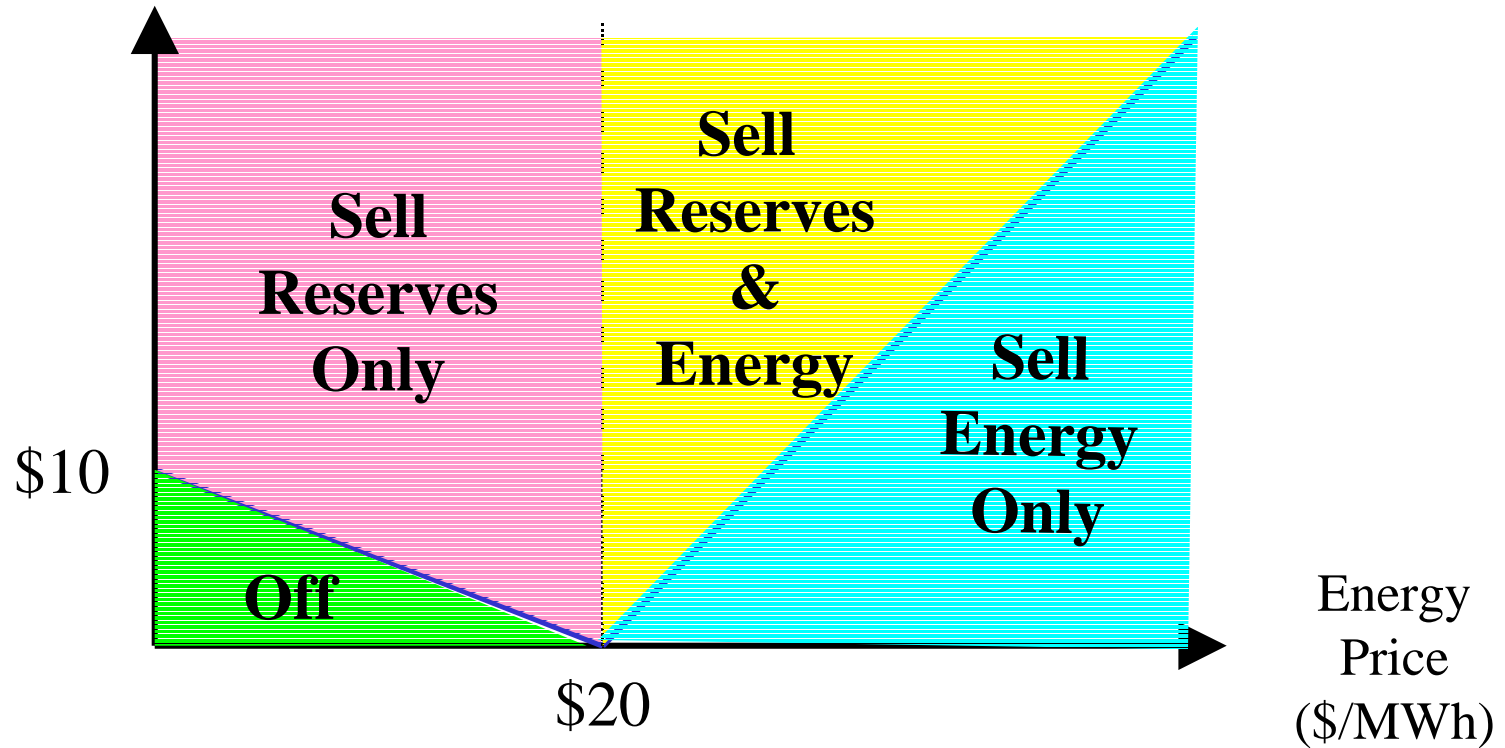
Defining Operating Reserve Services

Reserve Type	Speed	Duration
Regulation 	instantaneous	≤ 10 minutes
Spinning	near instantaneous	$\leq 30-120$ minutes
Supplemental	≤ 10 minutes	$\leq 30-120$ minutes
Backup 	$\leq 30-60$ minutes	hours to days

Relationships Among Energy and Reserve Markets

(IC=\$20 , no start-up costs, reserve capability = 2 x minimum load)

Reserve Price
(\$/MW/hr)



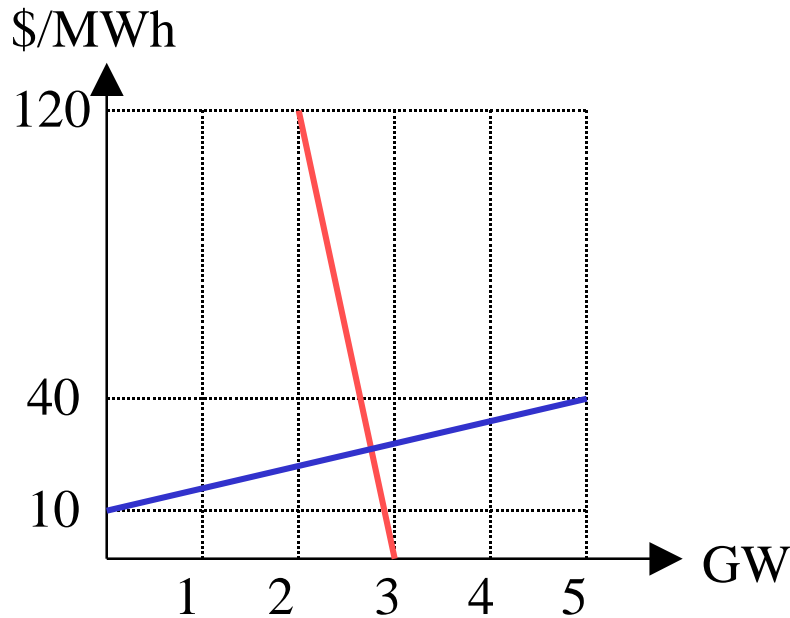
Effects of Transmission

- **Losses**
 - wholesale reserve availability and usage costs should be adjusted by a location-specific loss factor
- **Congestion**
 - regionalize system into different sub-systems
 - analysis performed for each sub-system

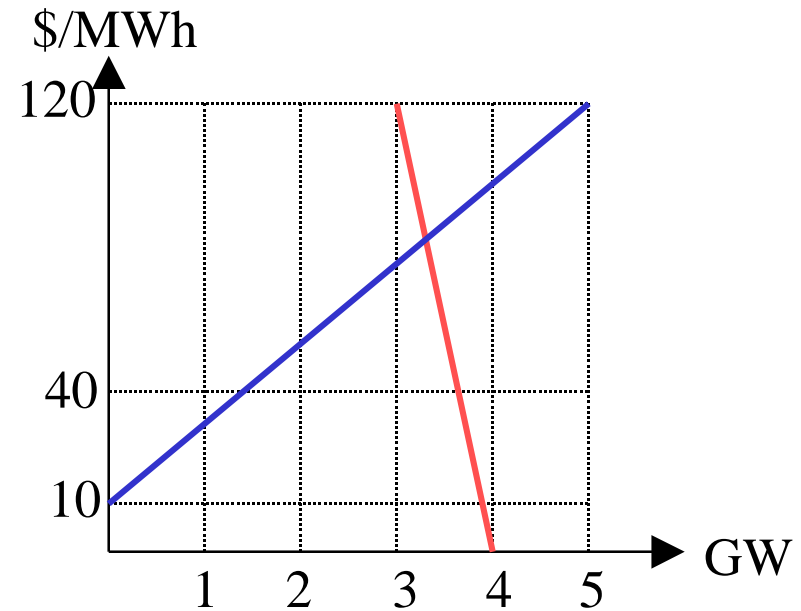
Transmission Effects on Market Power in Energy Supply

- Without transmission constraints, all generators can serve all loads
- With constraints:
 - *generators that are **upstream** from constraints* can only serve upstream loads
 - *generators that are **downstream** from constraints* can serve all loads, need not fear competition from upstream generators in serving downstream loads

Example -- Market Supply & Demand Without Firm X and Without Interregional Trade



Western Region



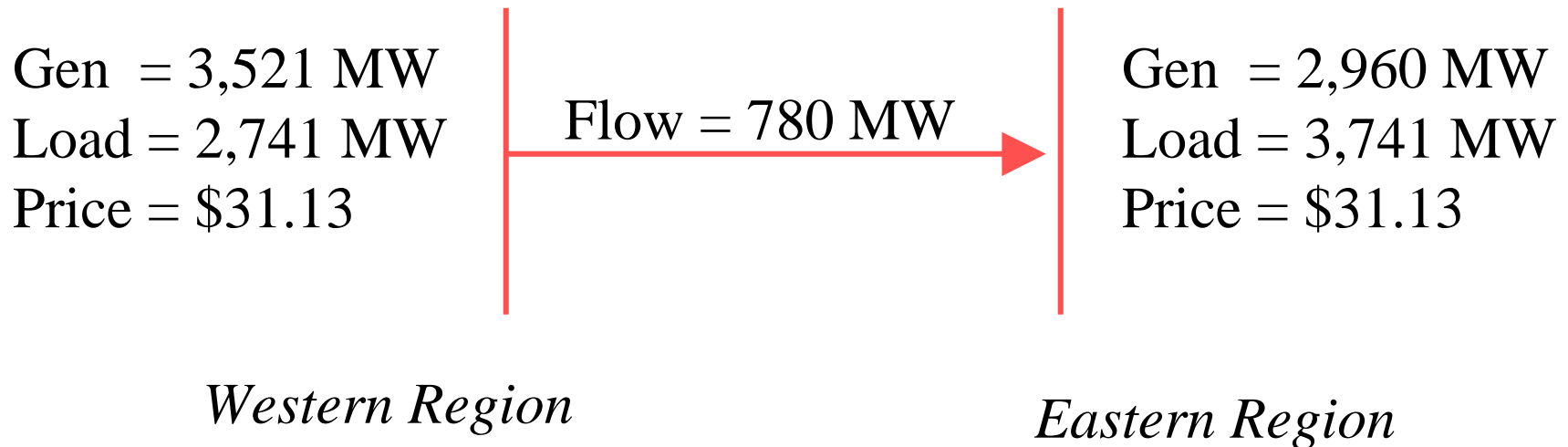
Eastern Region

Example -- Characteristics of Firm X

- Located in Eastern Region
- 2000 MW capacity
- Incremental cost is \$20/MWh for all output

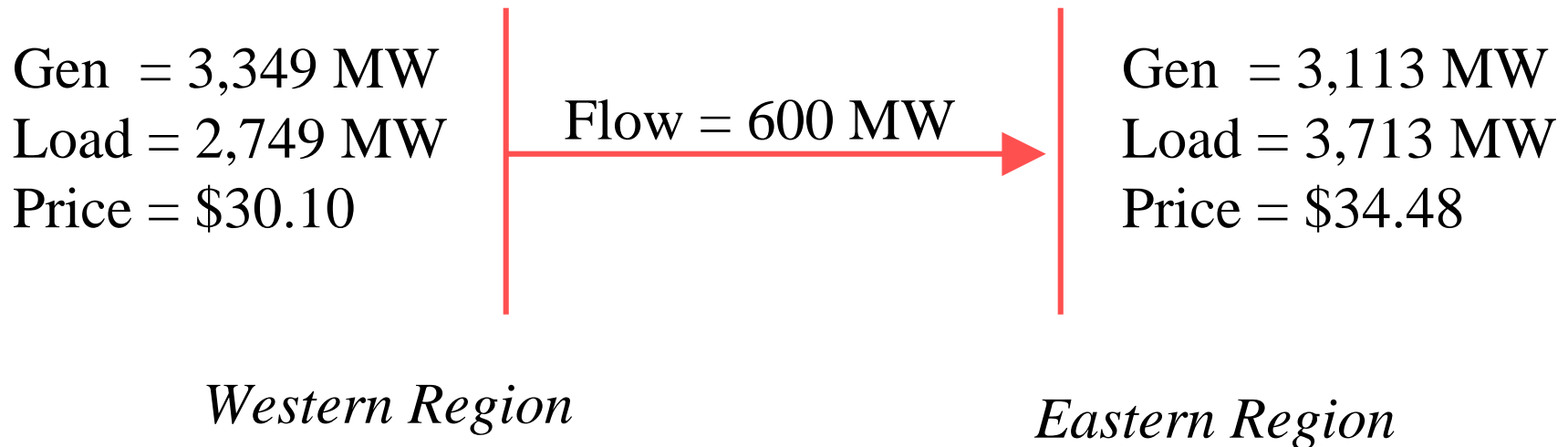
Example -- No Transmission Constraint

Firm X's most profitable strategy is to provide 2000 MW of energy



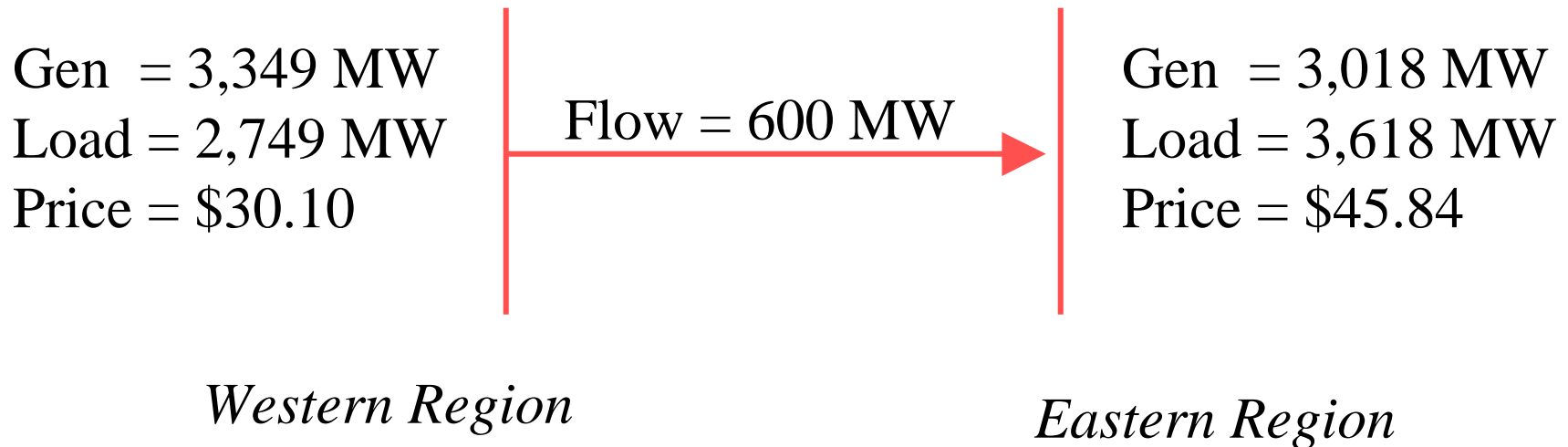
Example -- With 600 MW Transmission Constraint (social optimum)

For society it would be best if Firm X to provide 2,000 MW of energy



Example -- With 600 MW Transmission Constraint (Firm X exercises market power)

It is most profitable for Firm X to provide only 1,389 MW of energy



Example -- Welfare Effects of Firm X Exercising Market Power

(with transmission constraint, without reserve market)

	Comp	M.P	Net
Firm X	\$ 28,958	\$ 35,889	\$ 6,932
Other Eastern suppliers	\$ 13,618	\$ 29,191	\$ 15,572
Eastern Consumers			\$ (41,637)
Total			\$ (19,133)

Transmission Effects on Market Power in Reserve Service Supply

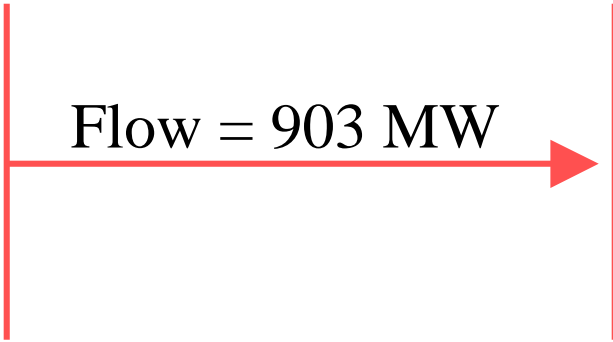
- Transmission constraints affect generator market access in both energy and reserve markets
- But number of units that can provide particular reserve services is smaller than for energy
 - This might complicate market power problems

Example -- No Transmission Constraint (social optimum)*

For society it would be best if Firm X provides
1,833 MW of energy and 167 MW of reserves

Gen = 3,627 MW
Res = 261 MW
Load = 2,724 MW
 $P_{\text{ENR}} = \$33.07$
 $P_{\text{RES}} = \$13.07$

Flow = 903 MW



Gen = 2,821 MW
Res = 239 MW
Load = 3,724 MW
 $P_{\text{ENR}} = \$33.07$
 $P_{\text{RES}} = \$13.07$

Western Region

Eastern Region

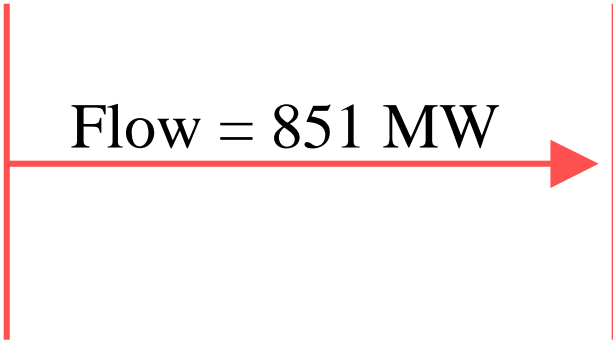
* -- 500 MW systemwide reserve requirement

Example -- No Transmission Constraint (Firm X exercises market power)*

It is most profitable for Firm X to provide 1,898 MW of energy and 102 MW of reserves

Gen = 3,576 MW
Res = 313 MW
Load = 2,725 MW
 $P_{\text{ENR}} = \$33.02$
 $P_{\text{RES}} = \$15.64$

Flow = 851 MW



Gen = 2,874 MW
Res = 187 MW
Load = 3,725 MW
 $P_{\text{ENR}} = \$33.02$
 $P_{\text{RES}} = \$15.64$

Western Region

Eastern Region

* -- 500 MW systemwide reserve requirement

Example -- Effects of Firm X Exercising Market Power

Firm X profits from shifting output toward energy and away from reserves.

	Comp	M.P	Net
Firm X Energy Sales (MW)	1,833	1,898	3.57%
Energy Price (\$/MWh)	33.07	33.02	-0.14%
Firm X Reserve Sales (MW)	167	102	-39.05%
Reserve Price (\$/MW/hr)	13.07	15.64	19.64%
Firm X Energy Profits	\$ 23,951	\$ 24,714	\$ 764
Firm X Reserve Profits	\$ 2,187	\$ 1,595	\$ (592)
Firm X Total Profits	\$ 26,138	\$ 26,309	\$ 172

Example -- With 600 MW Transmission Constraint (social optimum)*

For society it would be best if Firm X provides 1,808 MW of energy and 192 MW of reserves

Gen = 3,341 MW
 Res = 200 MW
 Load = 2,741 MW
 $P_{\text{ENR}} = \$31.05$
 $P_{\text{RES}} = \$10.00$

Flow = 600 MW



Gen = 3,069 MW
 Res = 300 MW
 Load = 3,669 MW
 $P_{\text{ENR}} = \$39.72$
 $P_{\text{RES}} = \$19.72$

Western Region

Eastern Region

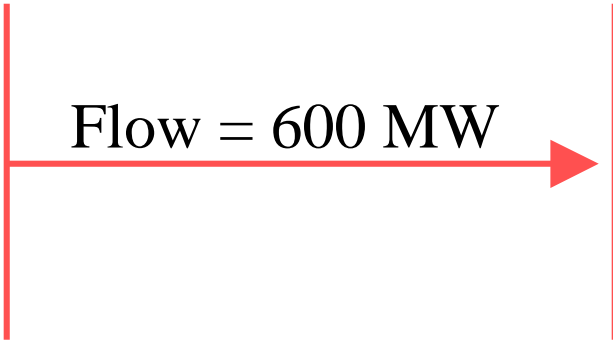
* -- reserve requirements: 200 in West, 300 in East

Example -- With 600 MW Transmission Constraint (Firm X exercises market power)*

It is most profitable for Firm X to provide 1,587 MW of energy and 78 MW of reserves

Gen = 3,341 MW
 Res = 200 MW
 Load = 2,741 MW
 $P_{\text{ENR}} = \$31.05$
 $P_{\text{RES}} = \$10.00$

Flow = 600 MW



Gen = 3,026 MW
 Res = 300 MW
 Load = 3,626 MW
 $P_{\text{ENR}} = \$44.83$
 $P_{\text{RES}} = \$85.87$

Western Region

Eastern Region

* -- reserve requirements: 200 in West, 300 in East

Example -- Effects of Firm X Exercising Market Power

Firm X profits from reducing both energy and reserve output.

	Comp	M.P	Net
Firm X Energy Sales (MW)	1,808	1,587	-12.20%
Energy Price (\$/MWh)	39.72	44.83	12.86%
Firm X Reserve Sales (MW)	192	78	-59.46%
Reserve Price (\$/MW/hr)	19.72	85.87	335.38%
Firm X Energy Profits	\$ 71,803	\$ 71,150	\$ (652)
Firm X Reserve Profits	\$ 3,795	\$ 6,698	\$ 2,903
Firm X Total Profits	\$ 75,598	\$ 77,848	\$ 2,251

Ways of Evaluating Market Power in Reserve Services

Structural Measures

- Number of competitors
- Market shares of competitors (“concentration”)
- Market shares that may be provided by particular suppliers (CA,NY)

Behavioral Measures

- Pivotal bid frequency (CA)
- Ratios of bid volumes to “required” volumes (CA)
- Ratios of actual prices to competitive prices

Technical Difficulties with Evaluating Market Power

- Defining relevant markets
 - transmission constraints are key
- Accounting for interrelated markets
 - substitution possibilities among services
 - substitution possibilities over time
- Considering potential entry
 - What are the real barriers to entry?

Mitigating Market Power in Reserve Services (1)

- Encourage new competition
 - allow wider geographic participation in markets
 - reduce barriers against new generating units and upgrades of existing units
- Make trading processes more flexible
 - develop forward markets

Mitigating Market Power in Reserve Services (2)

- **Make reserve requirements flexible**
 - develop requirements that better reflect probabilities
 - allow requirements to depend upon market prices
 - substitute reserve services for one other
- **Create administrative limitations on supplier bids**
 - set minimum MW requirements for bids
 - set price caps on bids