Market Power Analysis in the Presence of Transmission Constraints

INFORMS Fall 1999 Meeting

Philadelphia, PA

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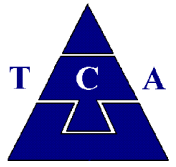
November 7, 1999



Presentation Outline

- Definition of Market Power
- How and why it is an issue ?
- Competition or Regulation
- Measurement of Monopoly Power
- Model-based Approach
- Illustrative Examples

What is Market Power?

- **Definition: Ability of single firm or group of competing firms in a market to profitably raise prices above competitive levels and restrict output below competitive levels for a sustained period of time.**

Why Do We Care?

- **Mitigation of market power is essential for successful implementation of the de-regulation of the electric power industry.**
- **Important for**
  - **the consumers to realize the benefits of de-regulating the industry, and**
  - **for efficient operation of generation market.**

Vertical Market Power

- Same entity owns resources across production levels (generation, transmission, distribution).
- Structural solutions to vertical market power require vertical disintegration or functional unbundling (GenCo, TransCo, DistCo) while maintaining the transmission system regulated (Transmission Open Access).
- TransCos and/or ISOs are a major step in addressing vertical market power problems.

Horizontal Market Power

- **Same entity owns resources at the same production level (generation).**
- **Transmission open access with RTOs mitigates some of the institutional horizontal market power problems (eliminate pancaking, increases competing capacity).**
- **There is no general structural solution that fits all areas.**
- **Requires detailed analysis on a case by case basis using a standard approach focusing on profitability of strategic behaviour.**

Non-Cooperative Oligopoly

- **Definition:**
  - **few relatively large firms**
  - **modest or high entry barriers**
  - **mutual interdependence of firms**
  - **similar or identical products**

Regulation vs. Market

- **Regulation at its best can reach the outcome of competitive markets.**
- **Willing to live with less than perfect competitive markets (workably competitive) if the social welfare loss is less than the cost of regulation**
  - **"Choice between imperfect and costly regulation versus market imperfections"**
- **It is preferable to have:**
  - **Market-based mitigation options, and**
  - **Minimal residual regulation when none of market-based mitigation options work.**

Structural Indices

- **Structural concentration: Herfindahl-Hirschman Index (HHI).**
  - **Sum of squares of market shares**
  - **Acceptable levels (1000-1800)**
- **Market shares (one criterion would be less than 30%)**
- **How good are these indices?**
  - **do not take into account potential competition or market realities such as transmission constraints, and**
  - **cannot capture potential strategic behaviour.**

Behavioral Indices

- **Lerner Index is a measure of the prices above competitive levels (Price-Cost Margin Index):**

$$L_i = (P_i - C_i')/P_i = 1/e_i^d$$

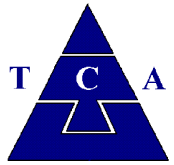
e_i^d is the elasticity of demand facing the firm i

Behavioral Analysis

- **Should capture**
  - **Short-term as well as medium-term and long-term dynamics**
  - **Barriers to entry (or lack of) and other market realities**
  - **Transmission constraints**

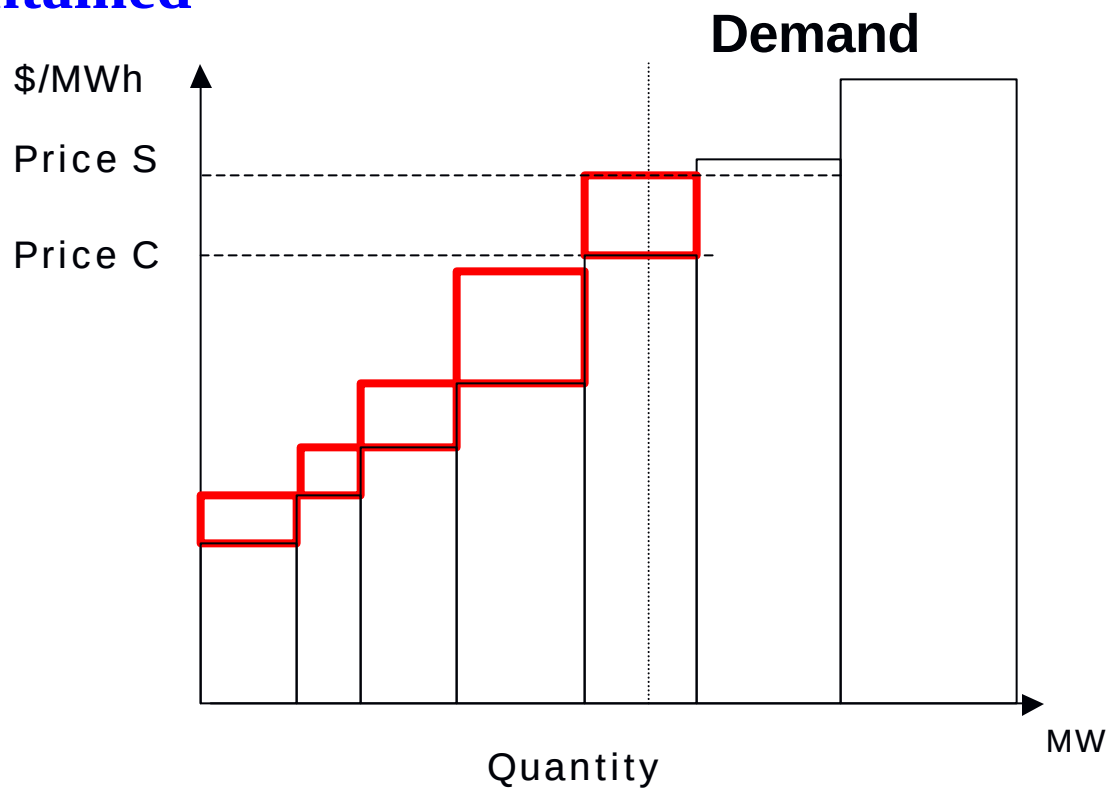
Profitability & Market Equilibria

- **Behavioral analysis measures increase in profitability under different market equilibria.**
- **Nash: A player maximizing its own payoff given the strategies followed by all opposing players (General equilibrium)**
  - **Cournot: Set of outputs for which each firm maximizes profit given the outputs of the remaining firms**
  - **Bertrand: Set of outputs for which each firm maximizes profit given the prices of the remaining firms**
  - **Supply Function: Set of outputs for which each firm maximizes profit given the supply curves of the remaining firms**



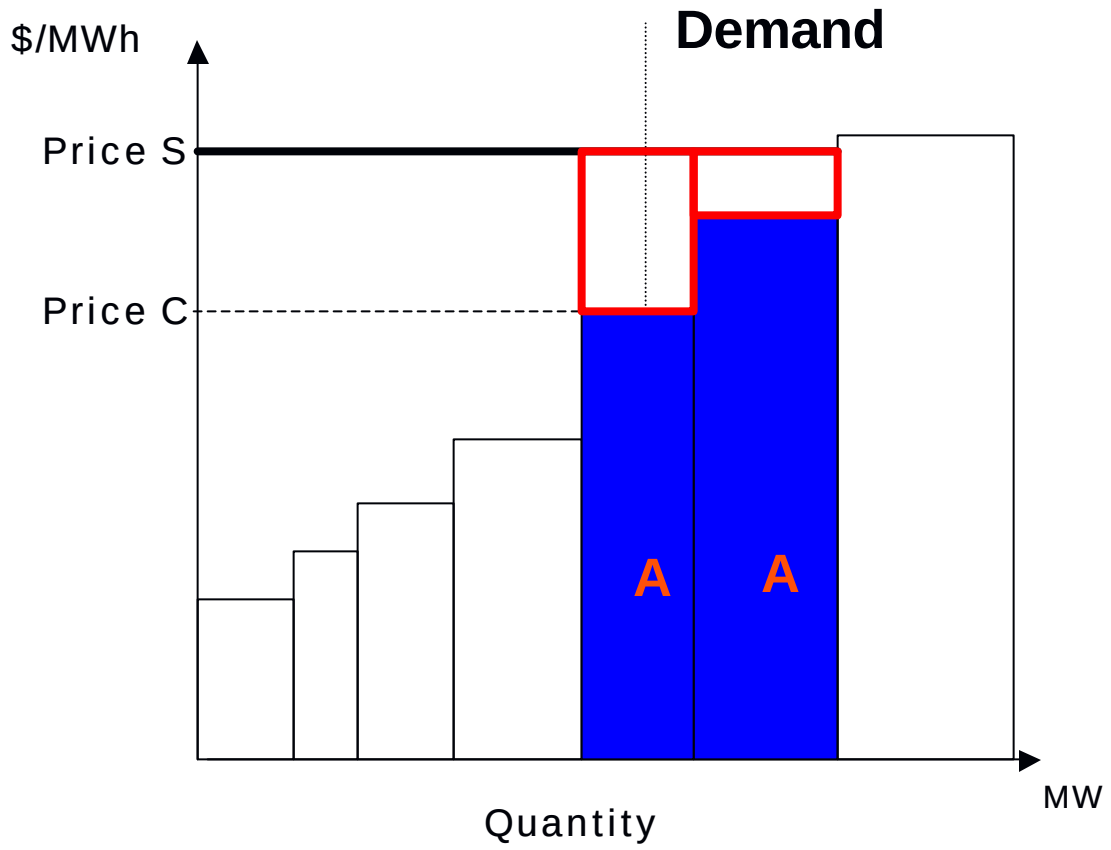
Strategic Bidding- Strategy One

- **Strategy One: Bid up to the next unit in the merit order.**
- **This strategy increase generators profits without risking losing revenues, since same unit merit order is maintained**



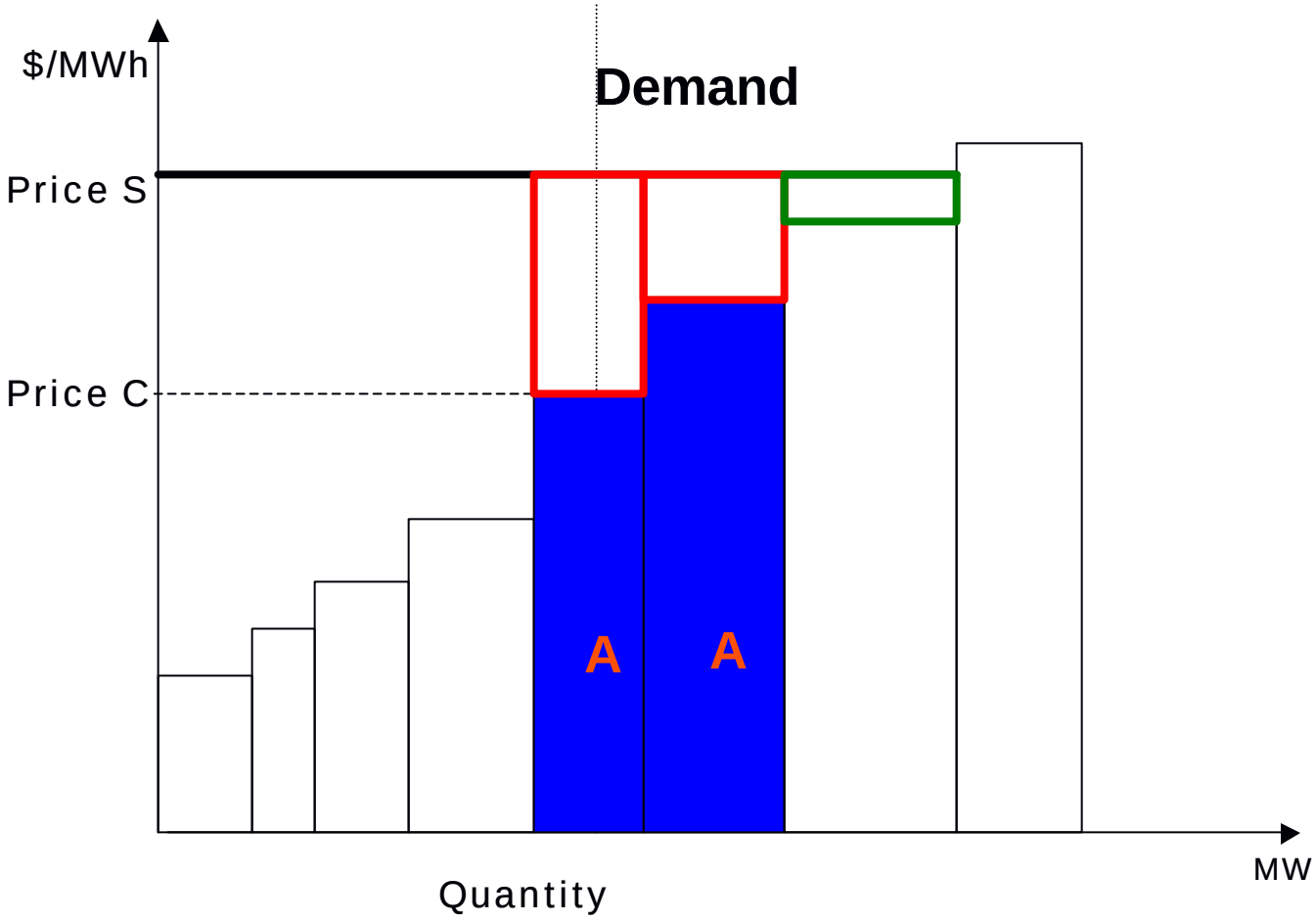
Strategic Bidding- Strategy Two

- Bid up to the next owner in the merit order.
- Generation companies can increase market clearing prices without risking losing any profits since they are maintain the same company merit order



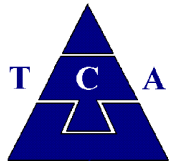
Strategic Bidding- Strategy Three

- **Bid up anticipating that your competitors will follow a strategy (any of the above strategies).**



Equilibrium Strategies

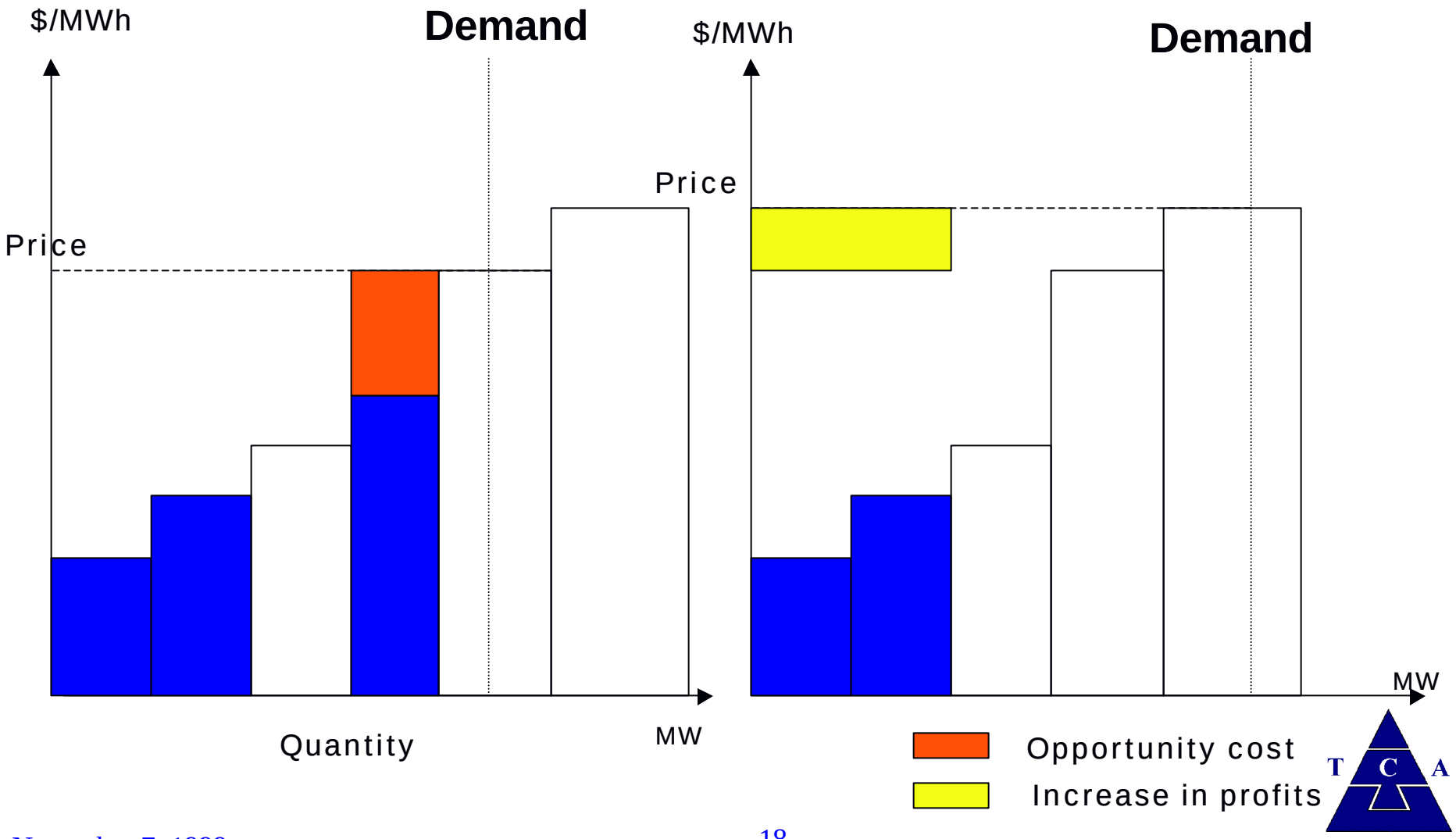
- The SFE approach is a sophisticated form of strategy three where the units maintain the same unit merit order.
- Cournot equilibrium involves changing the merit order and effectively withdrawing capacity.
- Prof. Hogan adds strategic behavior by transmission right owners.



Generation Capacity Withholding

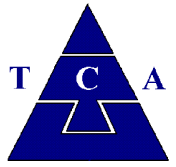
- Generation companies have incentives to withhold capacity and increase market clearing prices only if they can increase their profits
- Generation company increase their profits by withholding units only if the increase in revenues is higher than the lost opportunity costs

Profitability for BlueCo

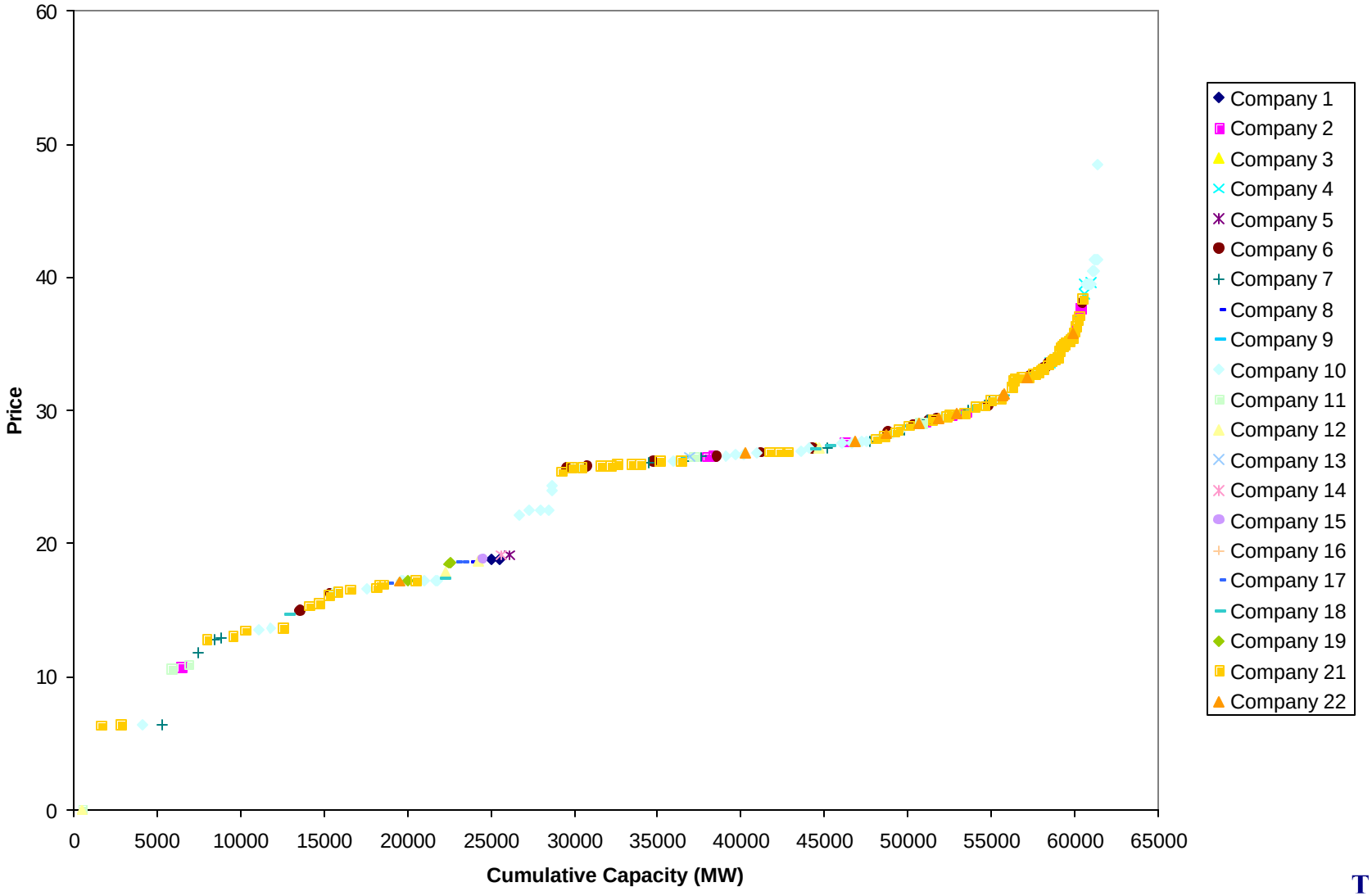


Profitable Strategic Bidding

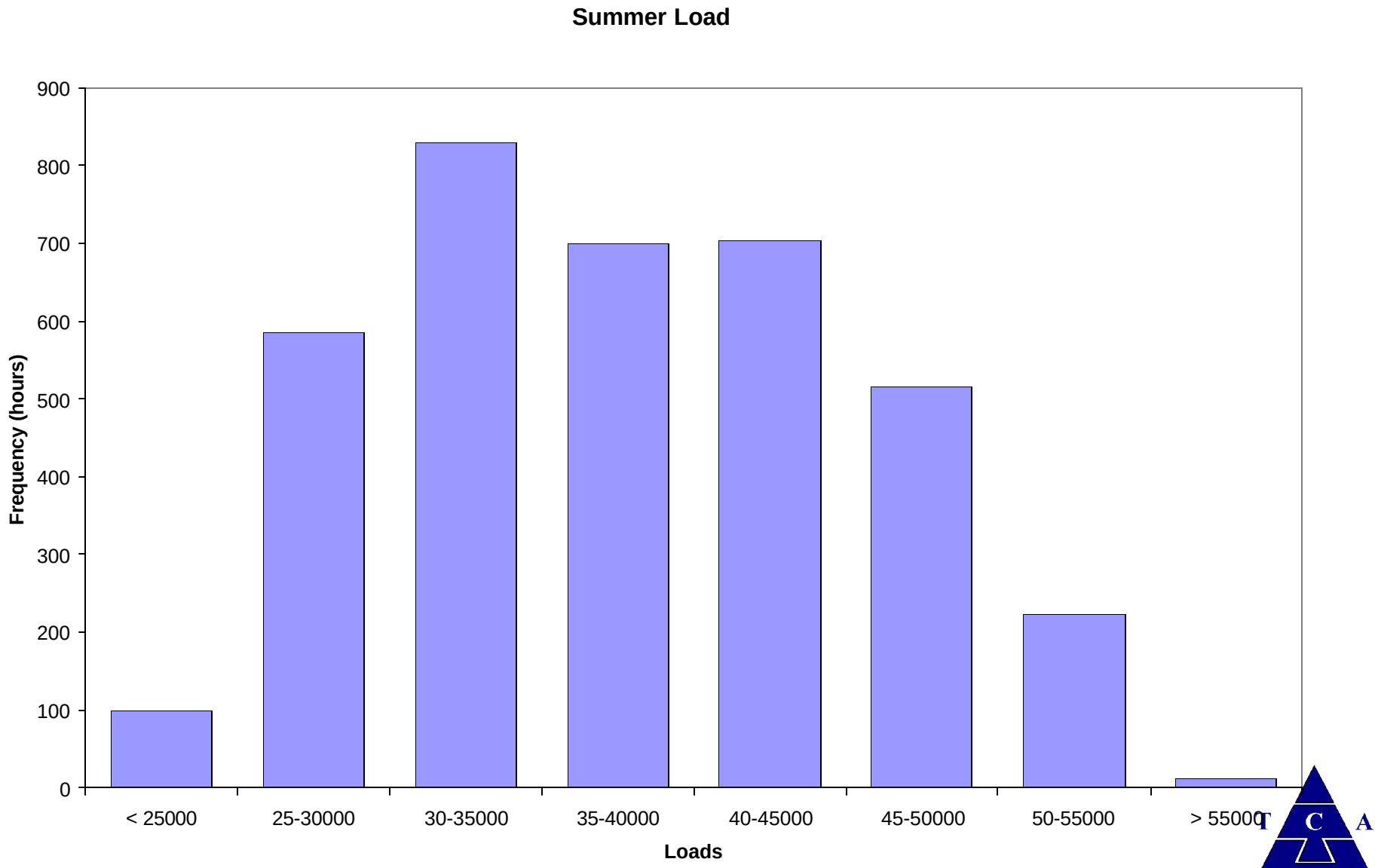
- **A generation company may profitably withhold capacity or strategically bid if any of the following is true:**
  - **it owns many generating units and has a relatively large market share**
  - **its units are strategically located on the supply curve (many base-load and marginal units)**
  - **it can implicitly collude with other generating companies to reach a market equilibrium**



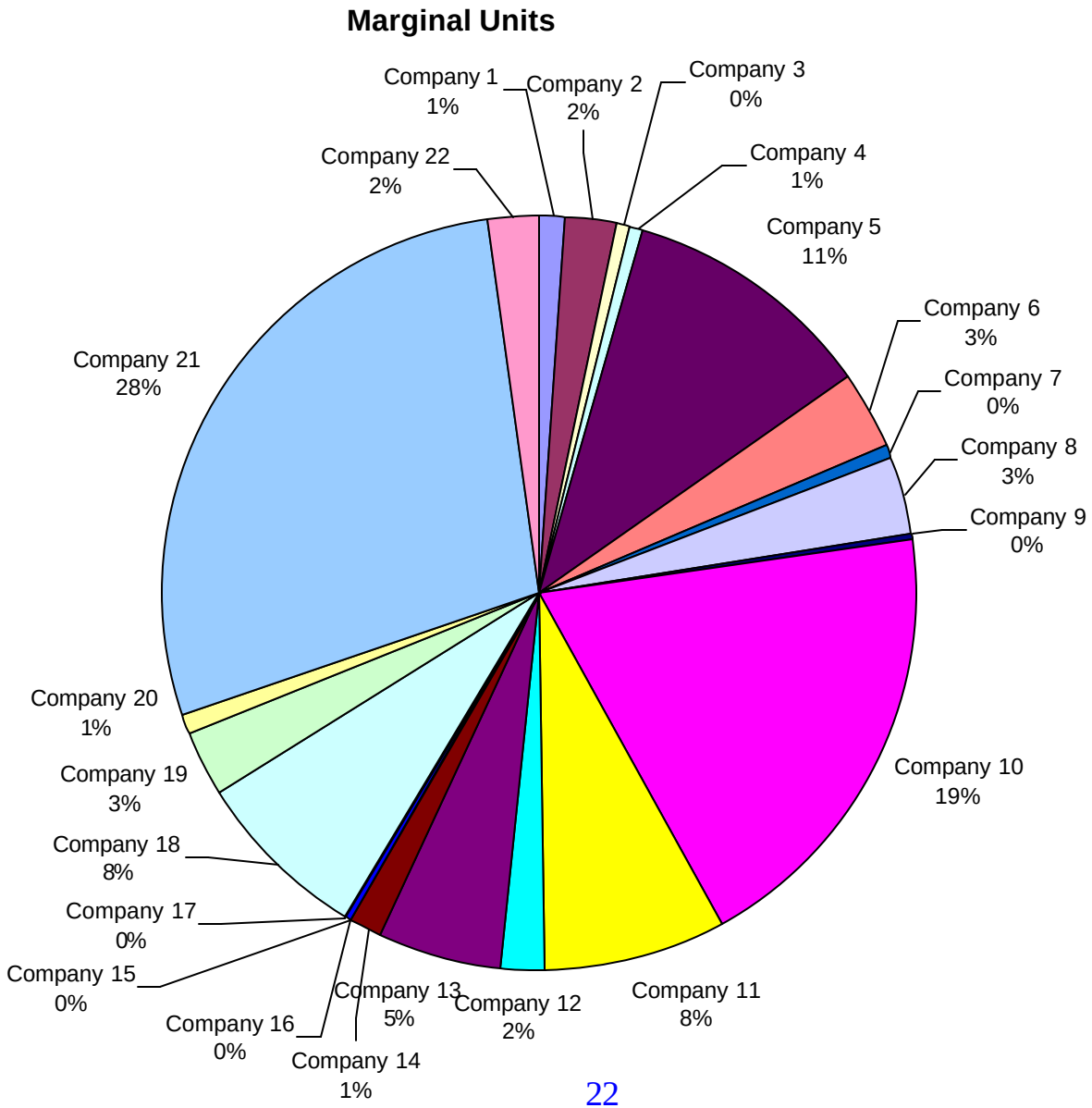
Ownership of Generation Units



Load Histogram



Ownership of Marginal Units



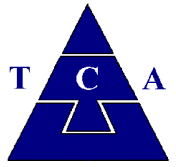
MAPS-Based Modeling

- **Hypothesis: Company GEN$ can exercise market power by increasing its bids**
  - **Use a market power model (Nash equilibrium) to determine bidding strategy**
- **Test Hypothesis given market, generation, transmission system and regulatory conditions**
  - **Use bids provided by the market power model in MAPS**
  - **Determine profits and validate the strategy with transmission constraints**

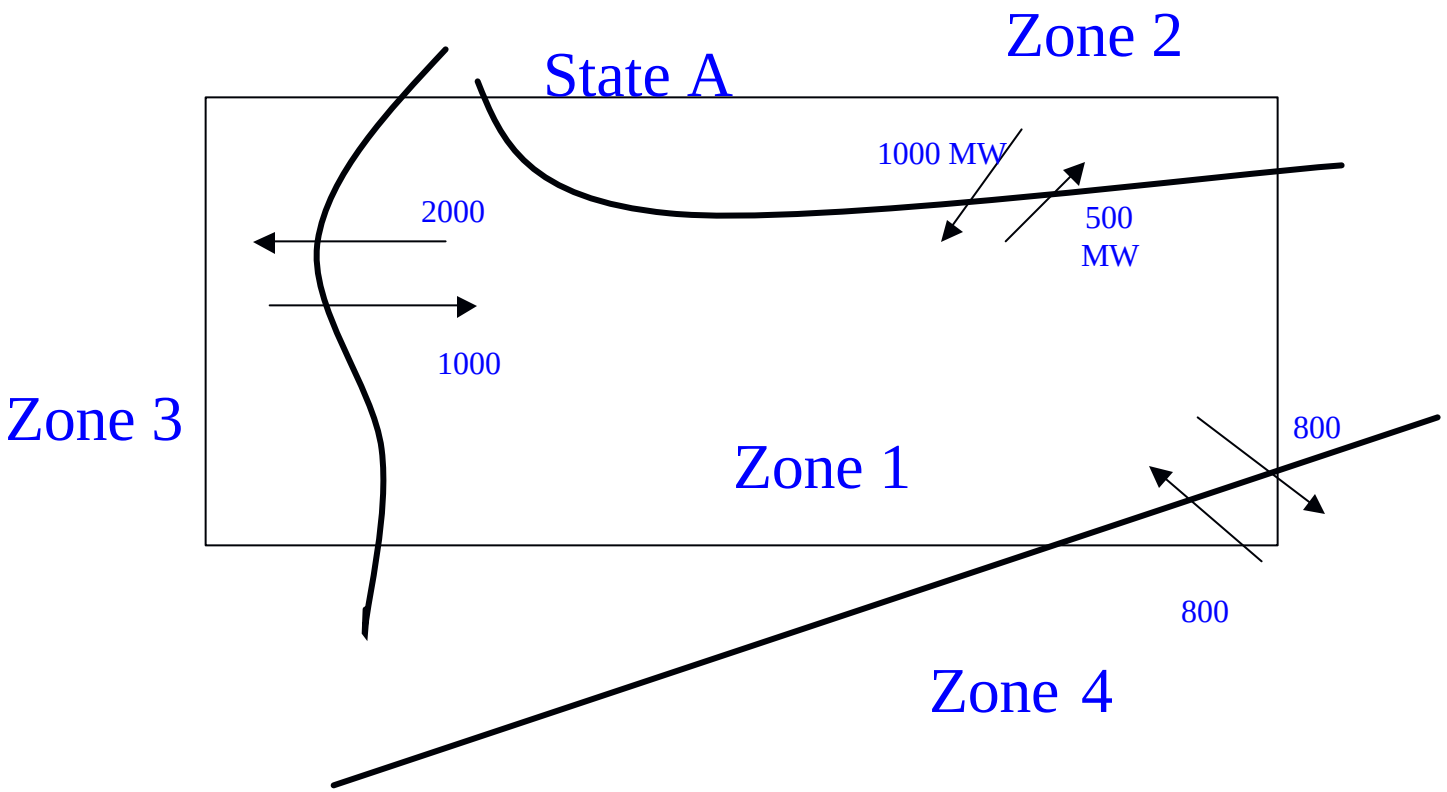
Overview of MAPS Modeling Process

- **TCA obtains the MAPS databases from GE and**
  - **Validates against reliable, public, sources**
  - **Validates against the Client database**
- **MAPS Database**
  - **Load forecast**
  - **Thermal units characteristics**
  - **Fuel price forecast**
  - **Transmission system representation**
  - **Conventional hydro and pump storage units**
  - **Supply curves for neighboring systems**

Illustrative Example

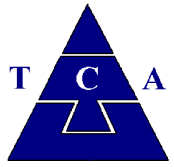


Identify Major Interfaces (Geographic Markets)



Scenario Analysis

- **Base Case runs- All units in region bid "competitively" with bids set at marginal costs.**
  - **to validate MAPS assumptions and outputs against practical judgement**
  - **also to provide detailed data for comparison and analysis of scenarios**
- **Market Power and Mitigation Runs are performed to examine the degree of market power and the ability to mitigate**
  - **Market Power Case - All non-GEN$ units bid as in base case, but GEN$ units bid higher trying to exercise market power, OR all units bid strategically. Ownership as in Base Case**
  - **Mitigation Case - GEN$ bidding continues to bid high, but some (Y%) of its plants are divested or regulated (cost-based bids or must-run contracts)**

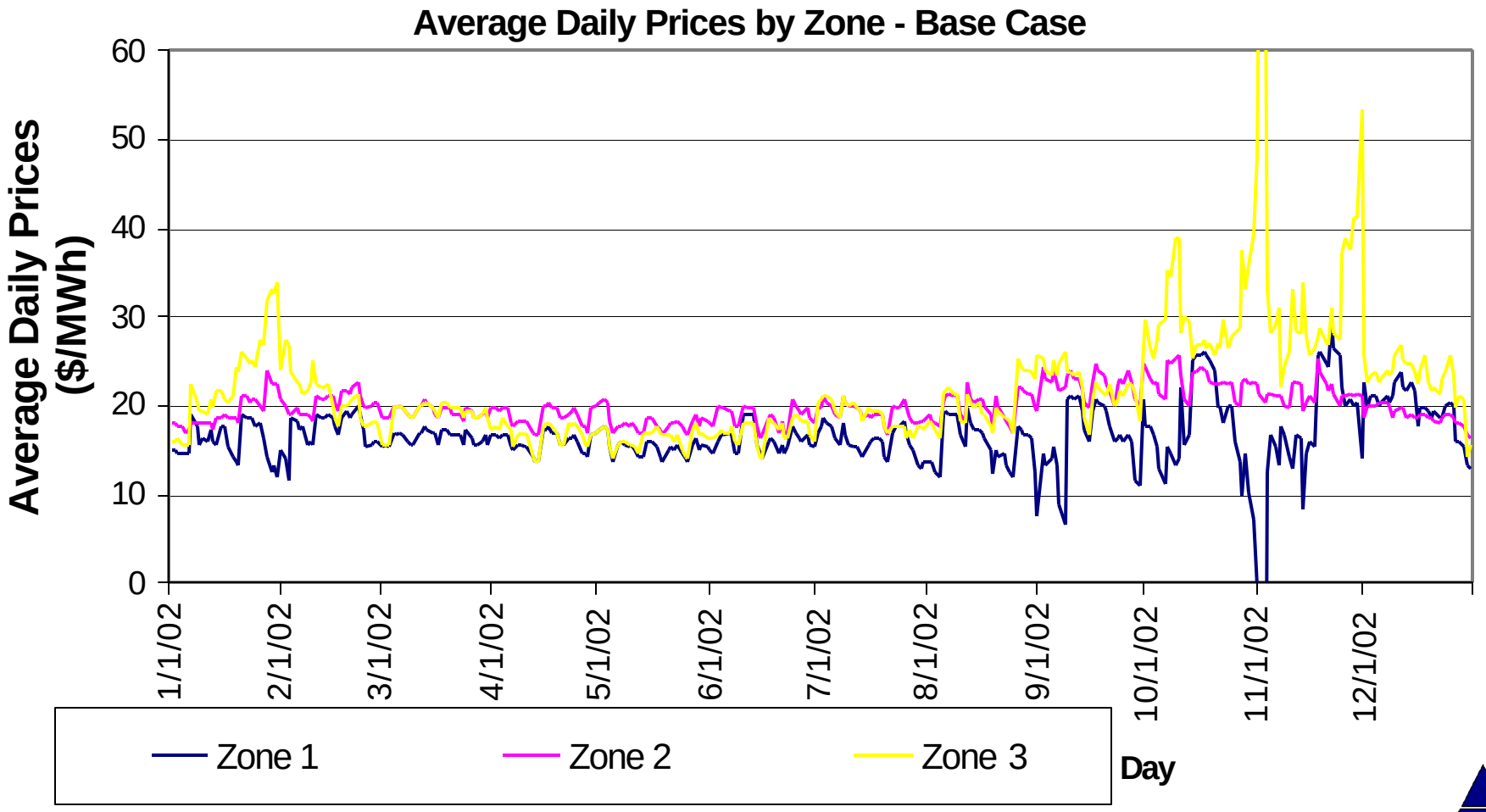


Market Power and Mitigation Effect

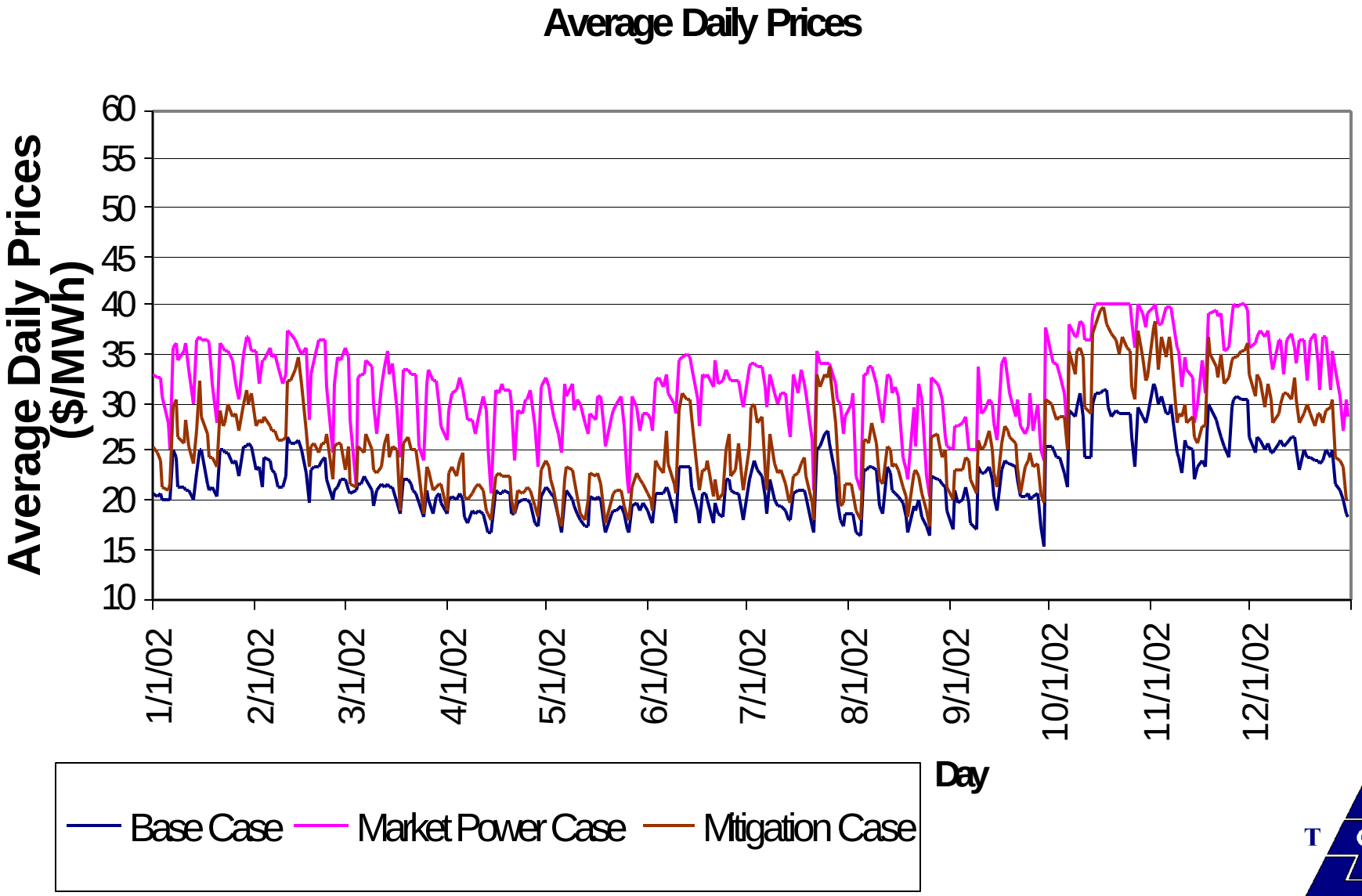
Margins shown are for that subset of units which is retained by GEN$ during the mitigation case, but are consistent with the results using all units

	Case		
	Base	Market Power	Mitigation
Avg. Margin ($/MWh)	$5.42	$14.42	$5.60

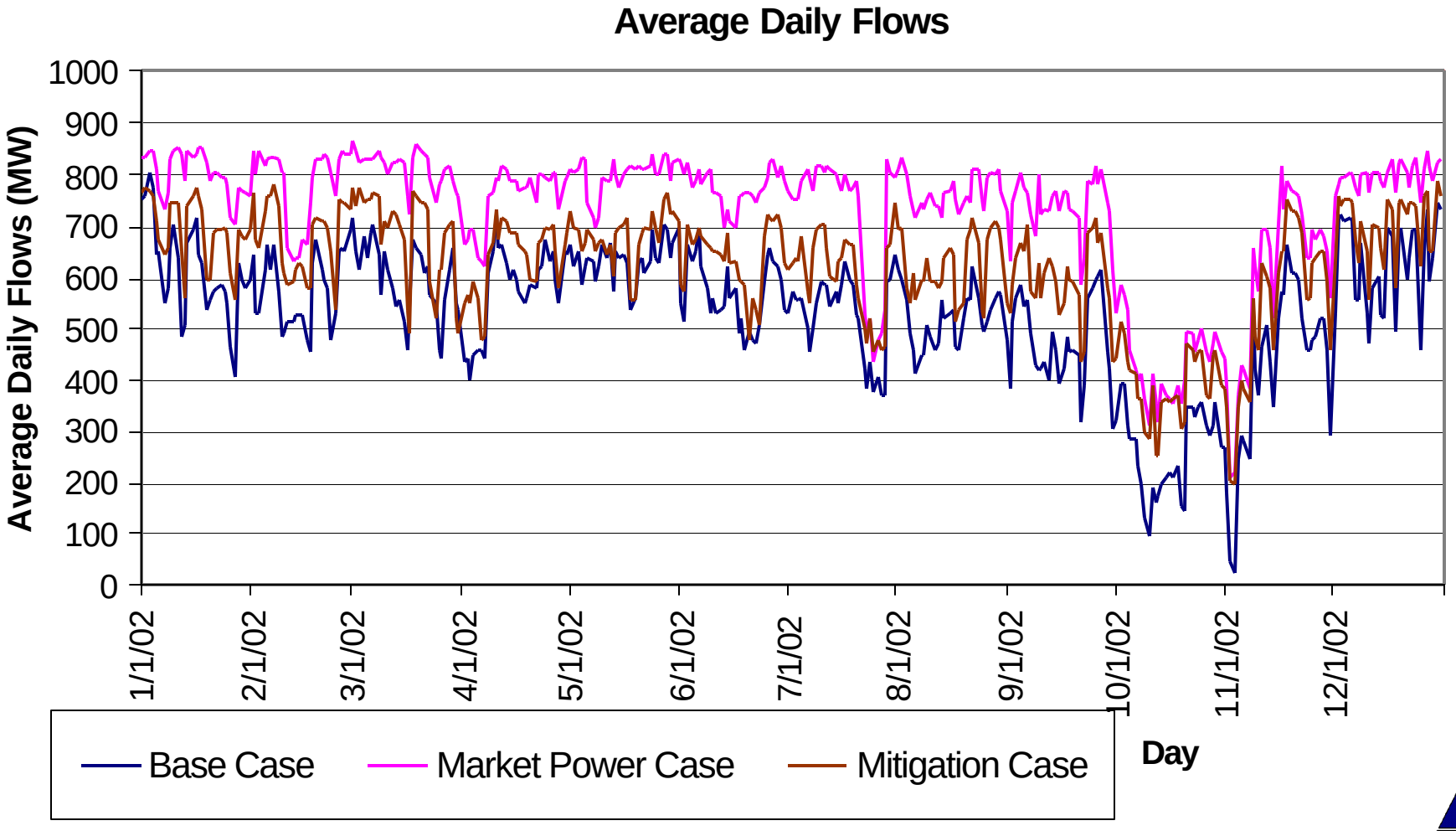
Energy Prices



Energy Prices by Scenario



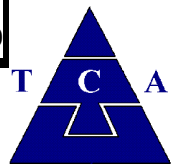
Interface Flows



Congested Transmission Interfaces

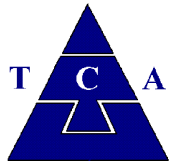
Interface Loading Levels

Interface	INT 1	INT 2	INT 3
Capacity (MW)	1000	800	1000
Base Case			
Load Factor 100% (% of yr)	0.0%	2.5%	0.8%
Load Factor >80% (% of yr)	10.0%	10.0%	8.0%
Load Factor >50% (% of yr)	80.0%	20.0%	20.0%
Market Power Case			
Load Factor 100% (% of yr)	15.1%	0.1%	9.3%
Load Factor >80% (% of yr)	70.0%	20.0%	30.0%
Load Factor >50% (% of yr)	95.0%	30.0%	90.0%
Mitigation Case			
Load Factor 100% (% of yr)	2.2%	0.5%	6.3%
Load Factor >80% (% of yr)	40.0%	15.0%	30.0%
Load Factor >50% (% of yr)	85.0%	25.0%	70.0%



Detailed MAPS Results

	Base Case			Market Power Case			Mitigation Case	
	Plants to be retained	Plants to be divested	All Plants	Plants to be retained	Plants to be divested	All Plants	Plants retained	Plants divested
Sum of Generation (GWh)	1,050	1,340	2,390	740	1,175	1,915	532	1,420
Sum of Fuel by Gen ($K)	$13,535	$16,400	$29,935	$12,965	$17,984	30,949	$7,259	$21,717
Sum of O&M ($K)	$920	$1,755	$2,675	$716	$1,787	2,503	$450	$1,958
Sum of Generation Cost ($k)	$14,500	$18,160	$32,660	$13,680	$19,770	33,450	$7,700	$23,677
Sum of Energy Revenue ($K)	$19,890	$24,400	$44,290	$29,740	$47,166	76,906	$7,500	$20,000
Sum of Energy Margin ($K)	$5,430	$6,240	$11,670	$16,055	$27,395	43,450	$3,500	$8,000
Avg. Revenue ($/MWh)	$18.94	$18.21	$18.53	$40.19	$40.14	$40.16	$14.10	$14.08
Avg. Margin ($/MWh)	$5.17	$4.66	$4.88	$21.70	$23.31	$22.69	$6.58	$5.63



Market-based Remedies (Mitigation)

- Regulation should be minimal
- Price caps
- Divestiture
- Must-run cost-based bids
- Control delegation (long-term operation control)
- Contract for differences
- Transmission reinforcements
- Transmission rights for load

Are Electric Generation Markets Contestable?

- Contestability: Little entry and exit costs
- Long term equilibrium: contestable markets are equivalent to Bertrand equilibrium where prices are capped at the cost of new entry or long-run average cost
- How much contestable?
- Are there barriers to entry ?
- What about new generation technologies ? Distributed generation ?

Where is the Cutoff?

- Where do you draw the line between economic rent and market power rent?
- If the market is competitive with no significant barriers to entry would not the average price be naturally capped by the long-run cost of energy production ? If it is higher, it is an invitation for new entry.

Conclusions

- An accurate representation of the electricity markets including physical, operation and market design constraints is essential for proper analysis of market power in these markets.
- Transmission constraints are very important in defining geographic markets.
- Structural indices are not a good measure of market power in the presence of transmission constraints.
- The most effective solution to market power is elimination of barriers to entry especially transmission related barriers (new interconnection and open access).