A Quantitative Analysis of Pricing Behavior In California's Wholesale Electricity Market During Summer 2000

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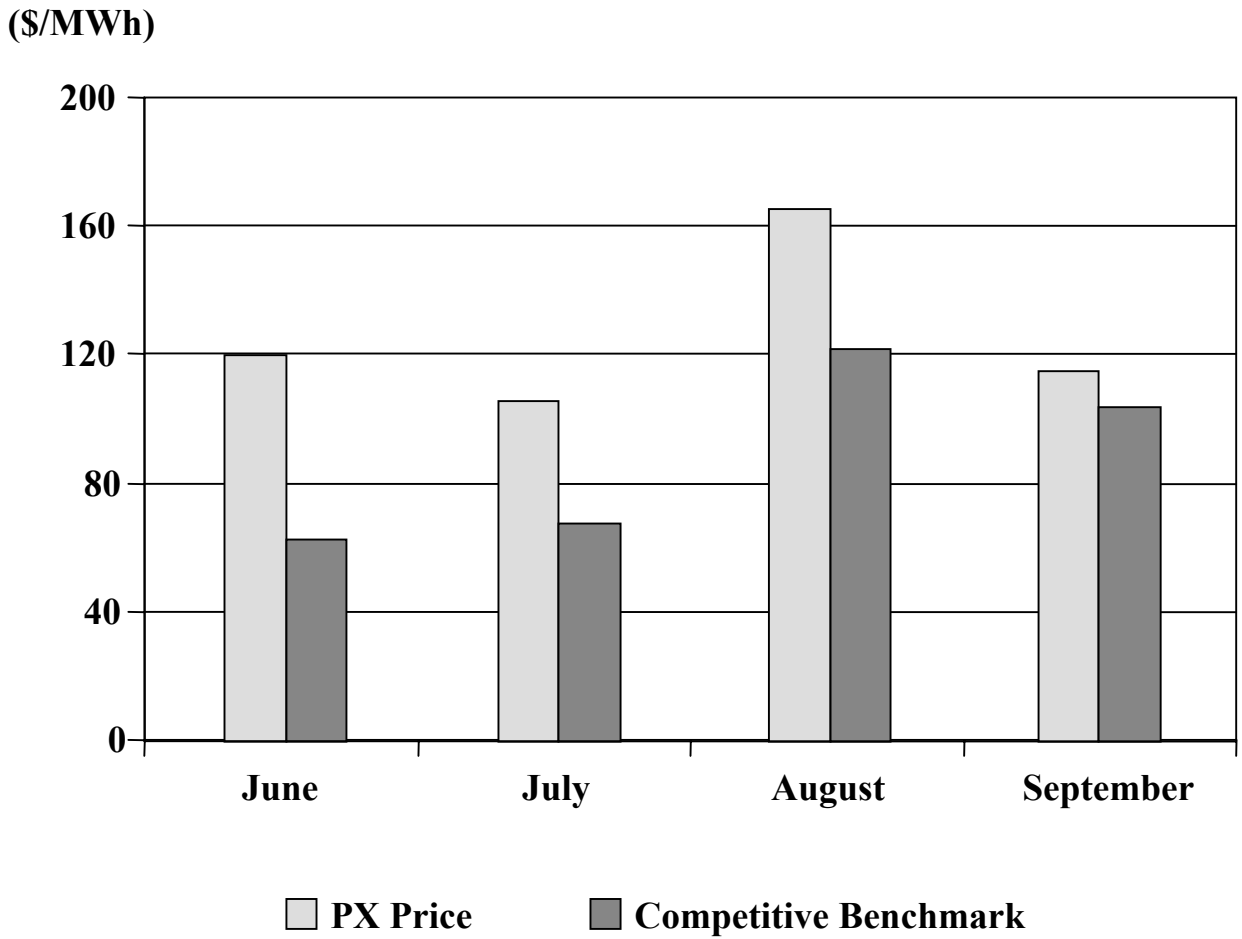
Approach

- Use publicly available data on loads, market prices and generation
- Quantify combined effects of "market fundamentals" on market prices
- Calculate "price gap" (difference between actual prices and market benchmarks)
- Quantify effects of ISO's ancillary services requirements and forced outages on generation output for units likely to be setting prices during high priced hours
- Calculate "output gap" for high priced hours (difference between observed and maximum levels of generation)

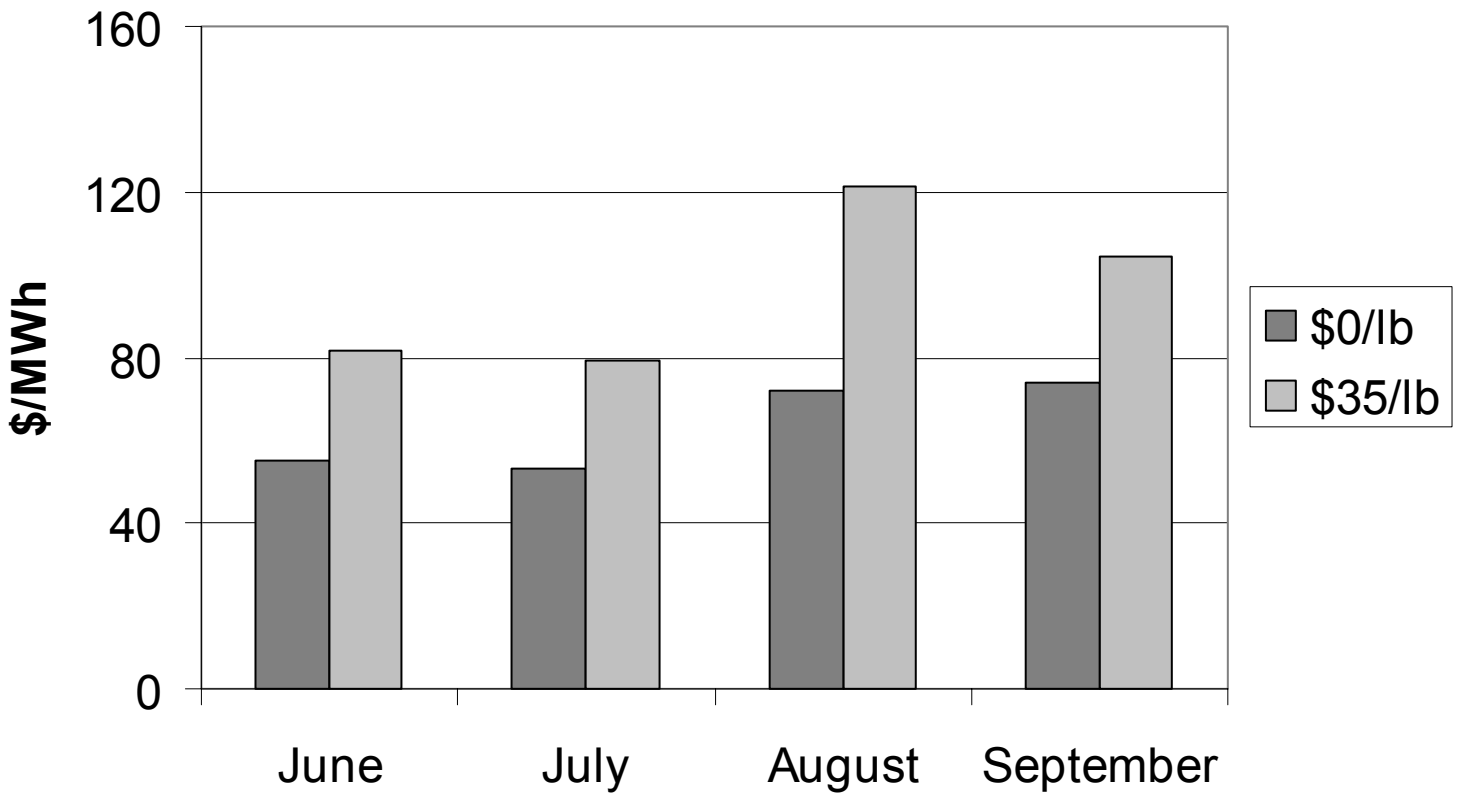
Study Results

- Wholesale market prices during Summer 2000 period far exceeded competitive benchmark prices
- NOx RTC prices in the SCAQMD explain some of the gap between actual market prices and previous estimates of competitive benchmark prices
- Competitive prices in the California electricity market in Summer 2000 period would have been substantially lower than actual prices
- Likely that prices would have been higher in the absence of price caps; no evidence that price caps actually led to higher prices
- Price setting units produced much less energy than could have been produced at marginal costs below observed market clearing prices
- Output gap cannot be explained by ISO's demand for ancillary services

Actual PX Prices Far Exceeded Competitive Benchmark Prices for Summer 2000

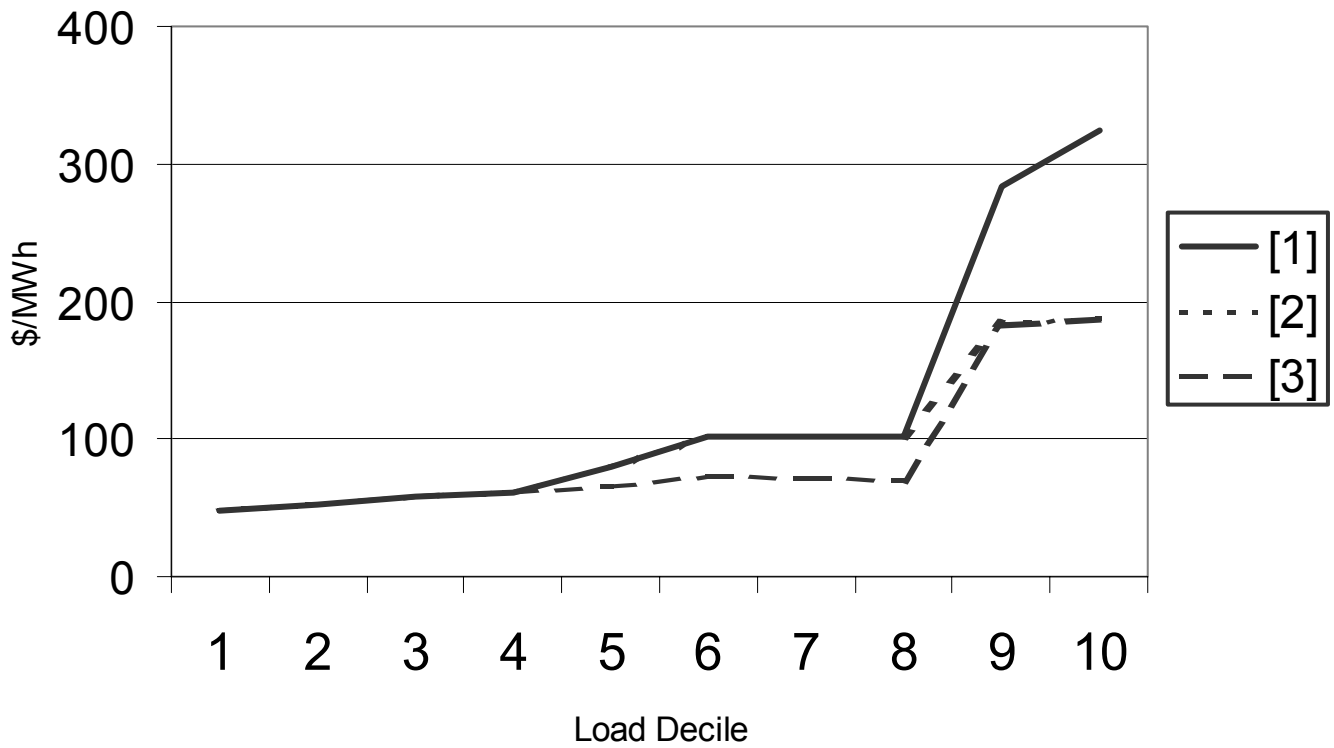


Increases in NOx RTC Prices Part Increase Competitive Benchmark Prices



Competitive Benchmark Prices Expected to Decrease with Installation of NOx Controls

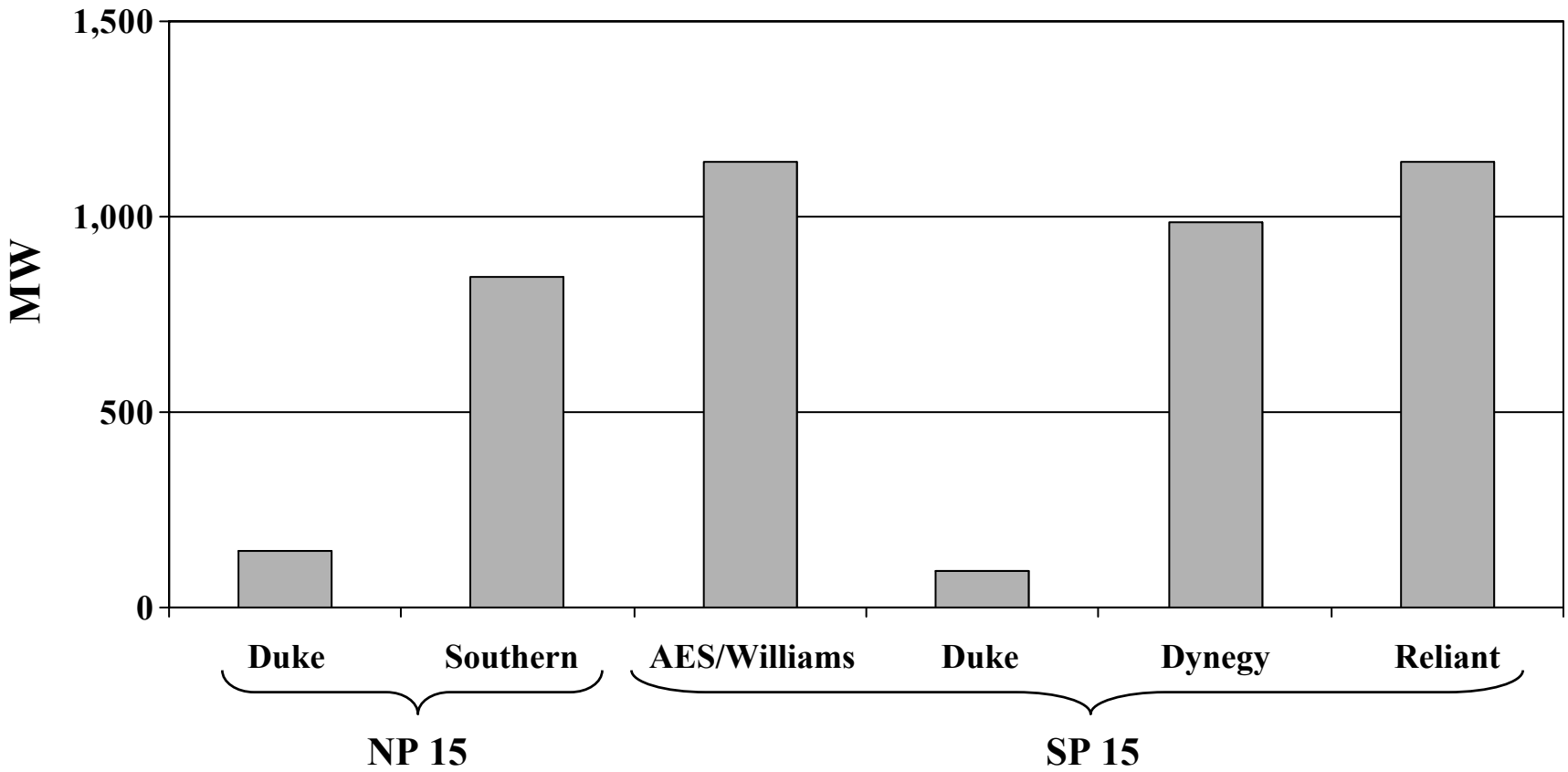
(Competitive Benchmark Prices for August 2000 with $35/Ton NOx RTC Price for SCAQMD Units)



[1] Market Competitive Price with existing emissions rates.
[2] Market Competitive Price with emissions rates of units producing more than 4.5 lbs/MWh of NOx reducted by 65%
[3] Market Competitive Price with emissions rates of units producing more than 4.5 lbs/MWh of NOx reducted by 65% and emissions rates of all steam units reducted to 0.15 lbs/MWh.

Substantial Output Gap for Most New Owners of Price-Setting Units

(Difference between Maximum Output and Average Actual Output for High Priced Hours for June 2000, EPA data)



Details of Empirical Analysis

- Competitive Benchmark Price Analysis
- Physical Withholding Analysis

Competitive Benchmark Price Analysis - Competitive Counterfactual by NOx RTC Price

(Comparison of average monthly prices for Summer 2000 for assumed NOx RTC prices)

	Average PX Price ($/MWh)	Average Market Benchmark Price ($/MWh)					Average Gas Prices ($/MMBtu)	
		Assumed NOx RTC Price						
Month		$0/lb	$10/lb	$20/lb	$30/lb	$35/lb	North	South
May	47.23	**47.05**	53.55	58.40	64.82	68.17	3.77	4.11
June	120.20	55.19	**62.60**	70.12	77.78	81.85	4.59	4.99
July	105.72	53.38	61.49	**67.98**	75.52	79.09	4.35	4.97
August	166.24	71.96	87.01	102.49	114.13	**121.50**	4.84	5.69
September	114.87	73.72	83.41	91.59	99.99	**104.36**	5.88	6.64

Competitive Benchmark Price Analysis - Net Import Sensitivity

(Competitive benchmark market prices (MCP) for August 2000 for net import and NOx emissions price assumptions)

		June	July	August	September
1999 actual average hourly net imports (MWh)		7426	8146	7874	8323
2000 actual average hourly net imports (MWh)		4973	4250	2892	4472
MCP with 1999 net imports ($)	NOx $0/lb	53.35	48.24	60.83	63.56
MCP with 2000 net imports ($)		55.19	53.38	71.96	73.72
MCP with 1999 net imports ($)	NOx $10/lb	60.52	49.64	65.59	66.47
MCP with 2000 net imports ($)		62.60	61.49	87.01	83.41
MCP with 1999 net imports ($)	NOx $20/lb	63.87	51.11	72.89	68.10
MCP with 2000 net imports ($)		70.12	67.98	102.49	91.59
MCP with 1999 net imports ($)	NOx $30/lb	69.80	52.59	69.67	68.86
MCP with 2000 net imports ($)		77.78	75.52	114.13	99.99
MCP with 1999 net imports ($)	NOx $35/lb	72.64	52.94	70.87	69.09
MCP with 2000 net imports ($)		81.85	79.09	121.50	104.36

Competitive Benchmark Price Analysis - Implications of Different NOx Controls

(Average monthly competitive benchmark market prices (MCP) for Summer 2000 with Different NOx Controls and NOx emissions prices for SCAQMD plants.]

	[1]	[2]	[3]
NOx at $10/lb			
June	62.6	58.92	57.72
July	61.49	57.84	55.97
August	87.01	79.9	76.31
September	83.41	79.74	76.41
NOx at $20/lb			
June	70.12	62.77	60.12
July	67.98	60.67	58.72
August	102.49	88.27	80.62
September	91.59	84.25	78.98
NOx at $30/lb			
June	81.85	67.9	63.91
July	79.09	65.21	62.77
August	121.5	97.82	87.09
September	104.36	90.99	83.04

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[3] Market Competitive Price with emissions rates of units producing more than 4.5 lbs/MWh of NOx reducted by 65% and emissions rates of all steam units reducted to 0.15 lbs/MWh.

Physical Withholding Analysis - Approach

- Plant and unit level output data used for price setting firms
  - EPA Continuous Emissions Monitory (CEMS) data base
  - WSCC Extra High Voltage (EHV) data base
- Analysis restricted to high priced hours
  - High priced hours defined using monthly thresholds for PX DA prices (Note: scarcity definition is not same as ISO's DMA definition)
- Observed levels of production compared to maximum generating capacities for generating units likely to be setting prices during high priced hours
- Explanations for "output gap" (e.g., ancillary service requirements, forced outages, transmission constraints) tested

Physical Withholding Analysis - Definition of Price Thresholds

- High priced hours defined using month-specific PX Day Ahead Unconstrained Prices
  - June $120/MWh
  - July $90/MWh
  - August $130/MWh
  - September $110/MWh

Physical Withholding Analysis - Empirical Tests of Output Gap

- Ancillary services requirements
  - Compare CAISO ancillary services requirement to output gap
  - Account for CAISO dispatch of replacement reserves
- Forced outages
  - Feasible with EPA data but not with WSCC data
  - Three outage tests
- Interzonal transmission constraints
  - Review congestion during high priced hours that might limit economic dispatch of units
  - Production should not be affected during unconstrained hours

Physical Withholding Analysis - Output Gap for High-Price Hours

(Mean level of output gap for June 2000, EPA data)

Zone	Owner	Mean output (MWh)	Max output (MWh)	Mean output gap (MWh)	Mean AS Demand (MWh)
All hours					
NP15	Duke	2422	2563	141	
	Southern	2090	2932	842	
	Total			983	1510
SP15	AES	2542	3681	1139	
	Duke	643	733	90	
	Dynegy	1014	2000	986	
	Reliant	2351	3487	1136	
	Total			3351	1672
High-price hours are hours for which the PX price exceeded $120/MWh					

Physical Withholding Analysis - Potential Output and Mean Output Gap

(Maximum potential output and mean output gap (MW) for alternative outages definitions, June 2000, EPA Data)

		Test 1		Test 2		Test 3	
Zone	Owner	Max output (MWh)	Mean output gap (MWh)	Max output (MWh)	Mean output gap (MWh)	Max output (MWh)	Mean output gap (MWh)
NP15	Duke	2541	119	2563	141	2563	141
	Southern	2395	571	2765	675	2767	676
	Total		690		816		818
SP15	AES	2945	403	3120	577	3157	615
	Duke	723	79	733	90	733	90
	Dynegy	1611	597	1646	632	1684	670
	Reliant	3225	874	3286	935	3330	979
	Total		1954		2234		2354

High price hours are hours for which the PX price exceeded $120/MWh

Test 1 includes all units with positive production in a specific hour in the calculation of maximum potential output for that hour.

Test 2 includes all units with positive production in the same day in the calculation of maximum potential output for an hour.

Test 3 includes all units with positive production in the current or previous day in the calculation of maximum potential output for an hour.

Physical Withholding Analysis - SP 15 Output Gap for Summer 2000

(SP Output Gap for High Price Hours, June-September 2000, EHV data)

Month	Mean output gap	Mean AS	Mean AS net of replacement	Mean output gap net of AS	Mean output gap net of non-replacement AS	# of hours
	[1]	[2]	[3]	[1]-[2]	[1]-[3]	
All hours						
June	4330	1672	1044	2658	3286	137
July	3652	1002	794	2650	2858	194
August	3322	1318	970	2004	2352	411
September	3798	883	724	2914	3073	233
Hours without south to north congestion						
June	4300	1679	1046	2621	3253	125
July	3623	1018	799	2604	2824	175
August	3028	1429	1021	1599	2007	297
September	3349	941	750	2408	2599	159

High price hours are hours for which the PX price exceeded $120/MWh in June, $90/MWh in July, $120/MWh in August, and $110/MWh in September.

Data for September are through September 20.