



Counterfactual Forecasts of the Retail Prices of Electricity in Regions with Restructured Wholesale Markets

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OBJECTIVE AND OUTLINE



- OBJECTIVES

- Estimate an econometric model of retail electricity prices using observations for regulated state/years only for Residential and Commercial/Industrial customers
- Create counterfactual forecasts for retail prices for state/years after restructuring
- Compute the differences for restructured state/years between the forecasted retail prices and the observed retail prices

- OUTLINE

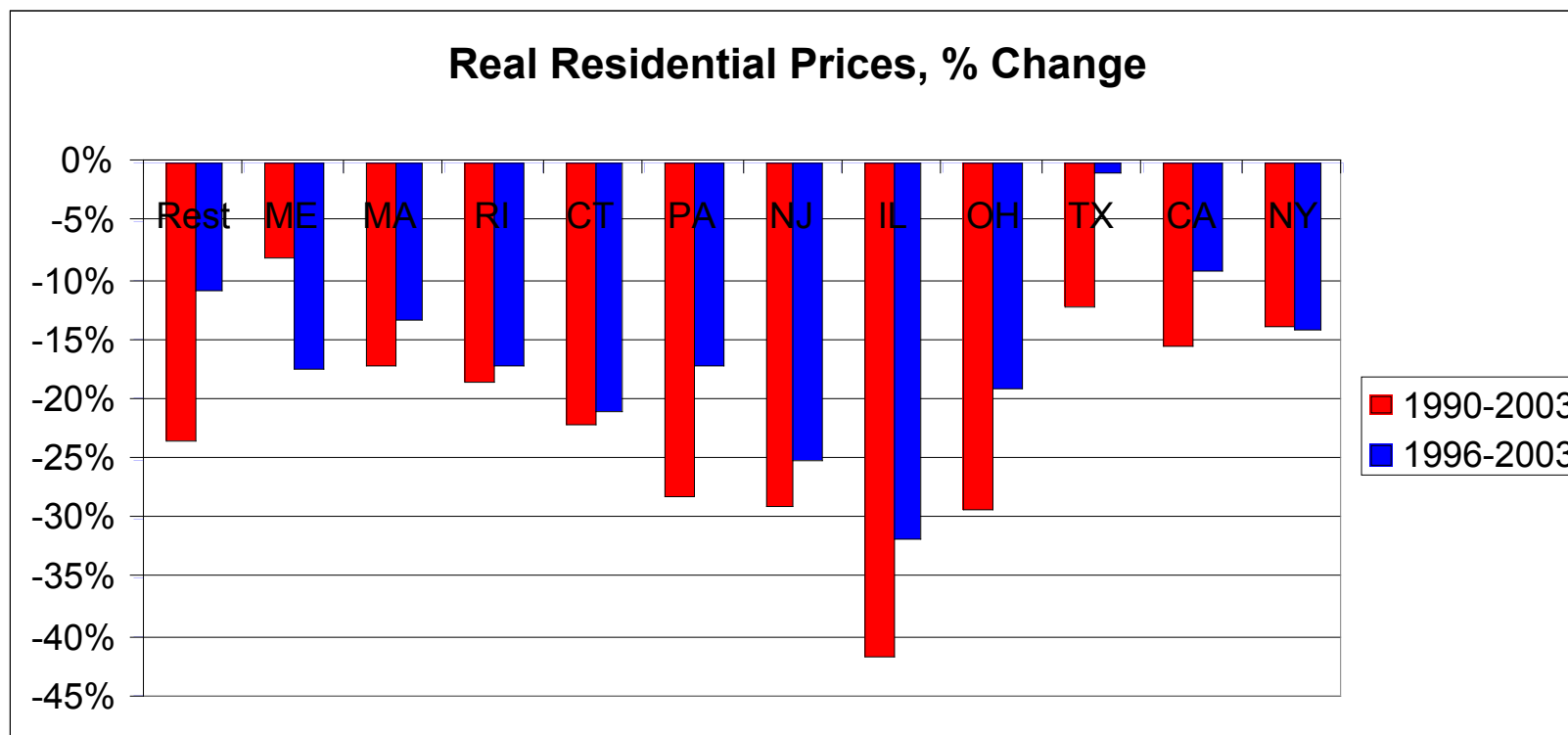
- Observed Electricity Prices
- Econometric Model
- Econometric Results
- Forecasts by ISO
- Forecast Summary



DEREGULATION



The Importance of the Initial Year



Econometric Model



$$P_e = \alpha_0 + \alpha_1 \text{HDD} + \alpha_2 \text{CDD} + \alpha_3 \text{TG} + \sum_j \alpha_{4j} \text{ISO}_j + \sum_k \alpha_{5k} \text{NERC}_k + \sum_k \alpha_{6k} \text{NERCTREND} + \sum_i \alpha_{7i} w_i P_i + \sum_i \alpha_{8i} w_i + \alpha_9 \text{OCC} + \alpha_{10} \text{INCT}$$

Where P_e is the average nominal retail price;
HDD and CDD are heating-degree-days and cooling-degree-days;
TG is total in-state generation;
ISO is a dummy variable for states in j that introduce restructured markets;
NERC is a dummy variable for NERC region k ;
NERCTREND is an inverse trend for NERC region k ;
 $w_i P_i$ is the price of fuel i weighted by the proportion of generation;
 w_i is the proportion of generation from fuel i ;
OCC is the To-Date Owner Capacity Change for nuclear plants;
INCT is the Inverse Nuclear Capacity Trend;



Econometric Model, II



- Annual, state-level data for all regulated states (except Alaska, Hawaii, Nebraska and Utah) and all restructured states prior to the creation of restructured wholesale markets are used to estimate random-effects models for Residential and for Commercial/Industrial customers.
- Mix of Generation, Fuel Prices, NERC and ISO Regions, Efficiency Improvements, Nuclear Ownership and Depreciation of Book Values of Nuclear Capacity are included in the models.
- Average annual retail electricity prices for each state for customers of both public and private utilities are used due to the questionable data for the revenues of privately-held utilities.



Residential Electricity Price Results



Variable	Estimate	Standard Error	T-Statistic	R ²	0.3870
Intercept	7.9035	1.2037	6.57	Cross Sections	46
Total State Generation	-6.36E-09	2.07E-09	-3.08		
Coal Share	-0.6404	0.3056	-2.1	Time Series Length	16
Natural Gas Share	-0.9507	0.5413	-1.76		
Nuclear Share	-0.1261	0.4280	-0.29		
Oil Share	-2.6414	1.0308	-2.56		
Other Renewables Share	6.2789	2.3992	2.62		
Hydropower Share	1.0979	0.6572	1.67		
Nuclear Capacity Change	-1.70E-04	7.30E-05	-2.27		
Inverse Nuclear Trend	2.47E-04	6.40E-05	3.86		
Coal Cost Ratio	1.43E-03	2.29E-03	0.62		
Natural Gas Cost Ratio	3.51E-03	6.85E-04	5.13		
Oil Cost Ratio	8.87E-03	3.33E-03	2.66		
Heating Degree Days	-7.00E-05	5.70E-05	-1.27		
Cooling Degree Days	-9.00E-05	1.28E-04	-0.68		
CAISO	4.0668	2.0268	2.01		
PJM	-0.8453	2.1088	-0.4		
ERCOT	2.2385	2.2786	0.98		
ISO-NE	5.5601	1.4082	3.95		
NYISO	7.7935	2.2196	3.51		



Residential Electricity Price Results, II



ECAR Trend	0.3636	0.5091	0.71
ERCOT Trend	-2.7318	1.3316	-2.05
FRCC Trend	-0.7599	0.9018	-0.84
MAAC Trend	-2.1680	0.6872	-3.15
MAIN Trend	0.0846	0.5029	0.17
MRO Trend	-0.6270	0.4867	-1.29
NPCC Trend	-5.2763	0.6727	-7.84
SERC Trend	-0.2339	0.4625	-0.51
SPP Trend	2.5424	0.4483	5.67
WECC Trend	-1.0006	0.4722	-2.12
ECAR Intercept	0.6113	1.2394	0.49
FRCC Intercept	1.4742	2.0323	0.73
MAAC Intercept	3.9830	2.3145	1.72
MAIN Intercept	1.2645	1.1032	1.15
MRO Intercept	-0.1390	1.0970	-0.13
SERC Intercept	0.1965	1.1715	0.17
SPP Intercept	0.4118	1.0583	0.39
WECC Intercept	-0.0771	1.1735	-0.07



Commercial and Industrial Price Results



Variable	Estimate	Standard Error	T-Statistic
Intercept	5.5818	0.9876	5.65
Total State Generation	-9.12E-09	1.79E-09	-5.11
Coal Share	-1.2438	0.2648	-4.7
Natural Gas Share	-1.6639	0.4682	-3.55
Nuclear Share	0.3937	0.3699	1.06
Oil Share	-2.2703	0.8932	-2.54
Other Renewables Share	6.1715	2.0785	2.97
Hydropower Share	1.1897	0.5673	2.1
Nuclear Capacity Change	8.30E-05	6.30E-05	1.31
Inverse Nuclear Trend	1.06E-04	5.50E-05	1.91
Coal Cost Ratio	2.59E-03	1.98E-03	1.31
Natural Gas Cost Ratio	3.73E-03	5.94E-04	6.29
Oil Cost Ratio	6.52E-03	2.88E-03	2.26
Heating Degree Days	2.20E-06	4.90E-05	0.04
Cooling Degree Days	8.90E-05	1.10E-04	0.81
CAISO	4.1939	1.6564	2.53
PJM	-0.2898	1.7205	-0.17
ERCOT	2.1307	1.8687	1.14
ISO-NE	4.3095	1.1516	3.74
NYISO	5.7651	1.8119	3.18

R ²	0.3696
Cross Sections	46
Time Series Length	16



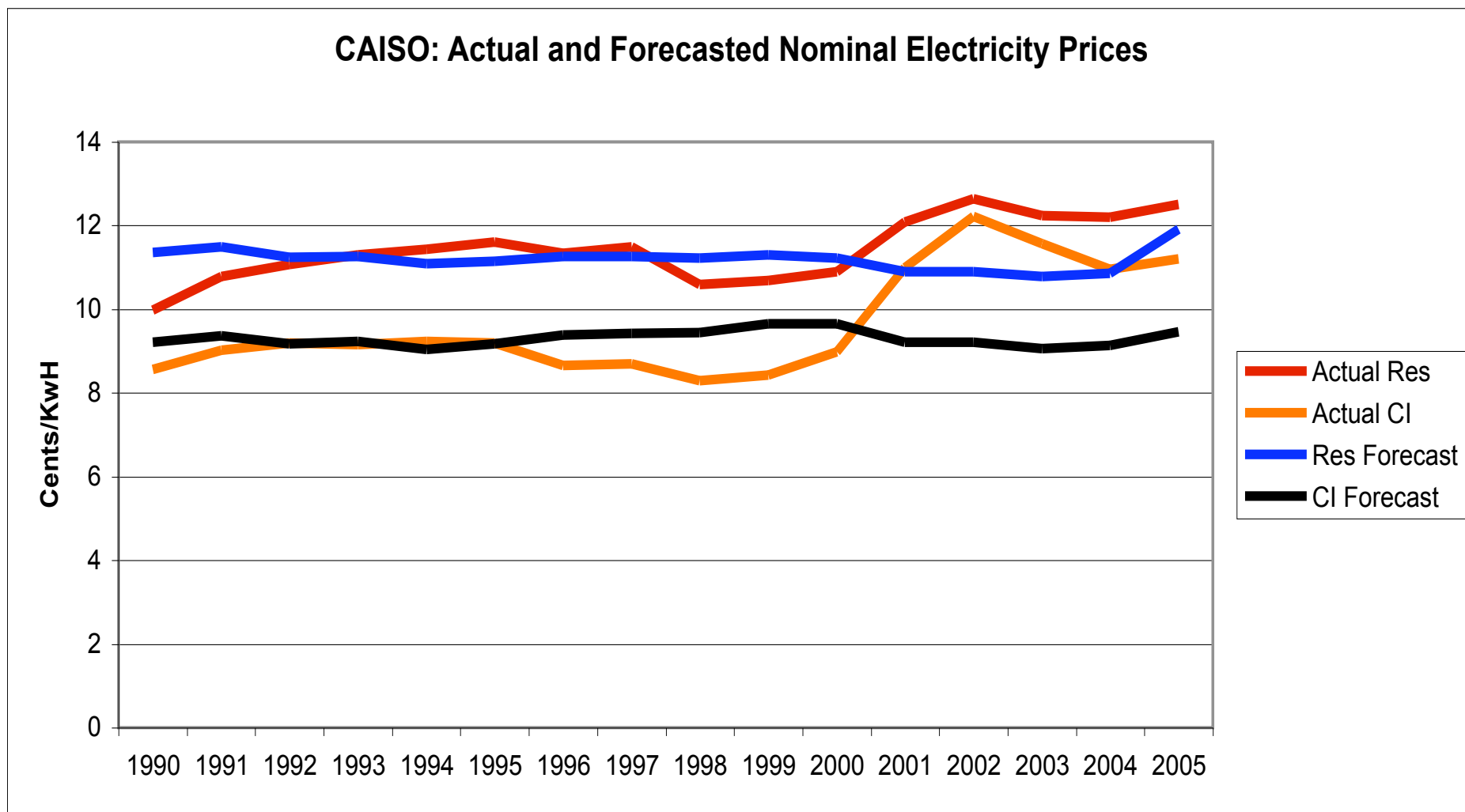
Commercial and Industrial Price Results, II



ECAR Trend	0.1666	0.4400	0.38
ERCOT Trend	-1.6886	1.1545	-1.46
FRCC Trend	-0.7122	0.7819	-0.91
MAAC Trend	-1.2020	0.5951	-2.02
MAIN Trend	0.4109	0.4358	0.94
MRO Trend	-0.2356	0.4212	-0.56
NPCC Trend	-2.8390	0.5813	-4.88
SERC Trend	0.2523	0.3995	0.63
SPP Trend	1.5106	0.3880	3.89
WECC Trend	-0.9959	0.4076	-2.44
ECAR Intercept	0.7453	1.0125	0.74
FRCC Intercept	1.8953	1.6613	1.14
MAAC Intercept	2.5401	1.8895	1.34
MAIN Intercept	0.8476	0.9004	0.94
MRO Intercept	-0.3522	0.8966	-0.39
SERC Intercept	0.2076	0.9566	0.22
SPP Intercept	0.3332	0.8640	0.39
WECC Intercept	0.1623	0.9576	0.17



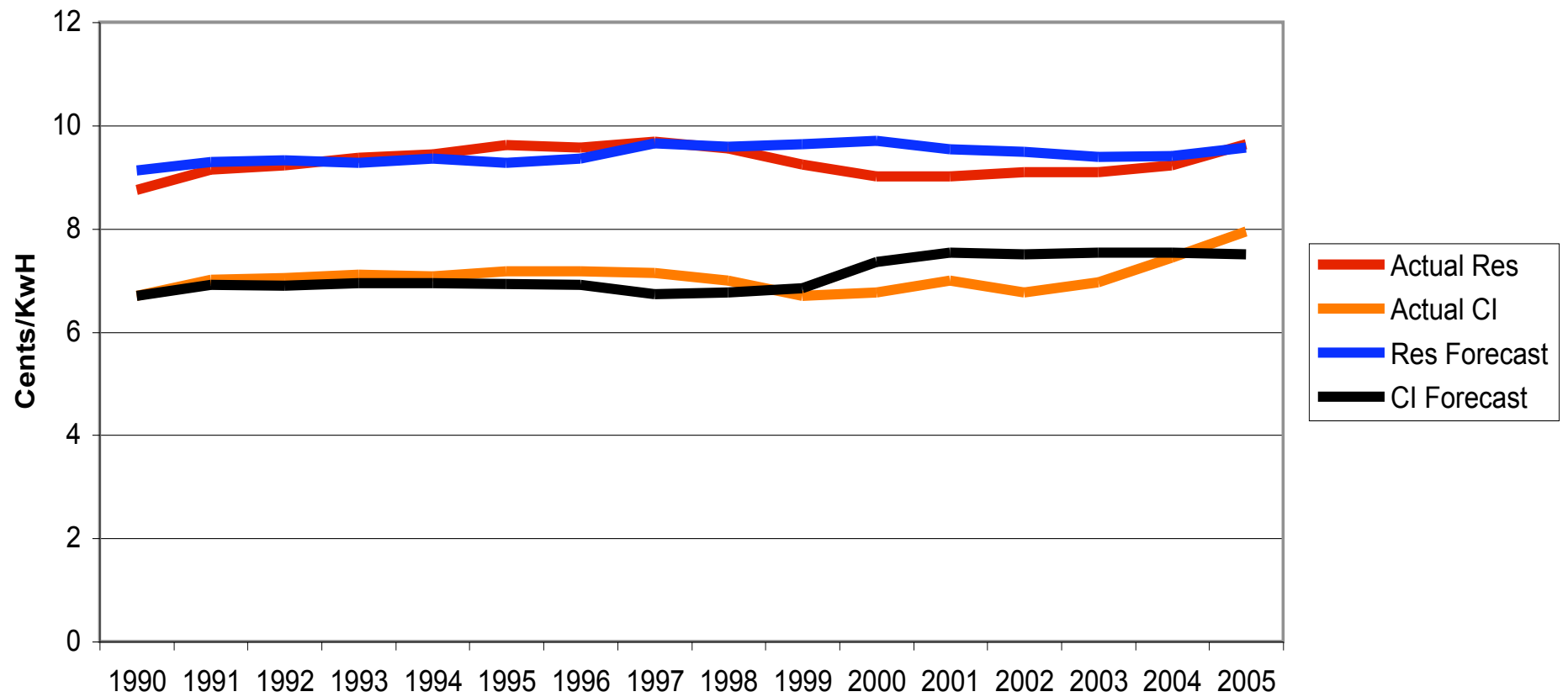
California ISO: Actual and Forecasted Electricity Prices



PJM: Actual and Forecasted Electricity Prices



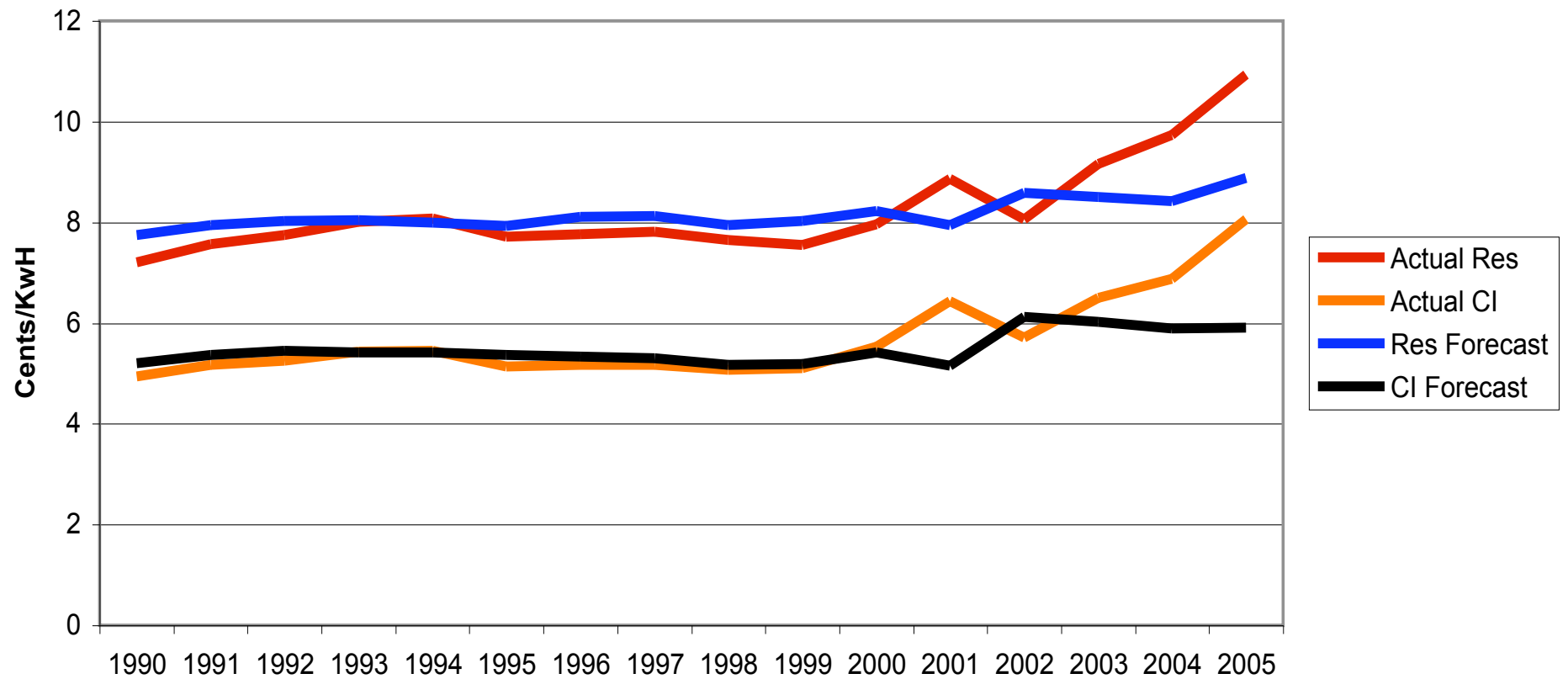
PJM: Actual and Forecasted Nominal Electricity Prices



ERCOT: Actual and Forecasted Electricity Prices



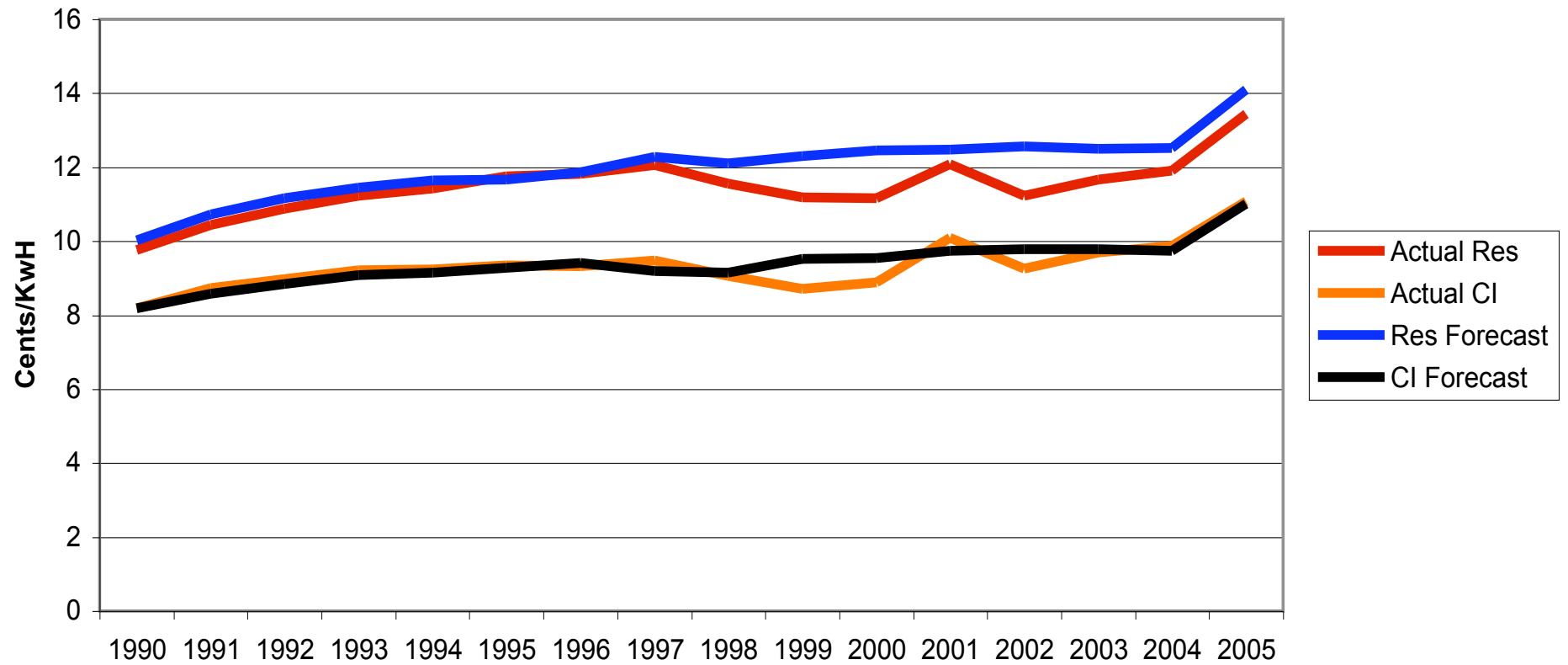
ERCOT: Actual and Forecasted Nominal Electricity Prices



ISO New England: Actual and Forecasted Electricity Prices



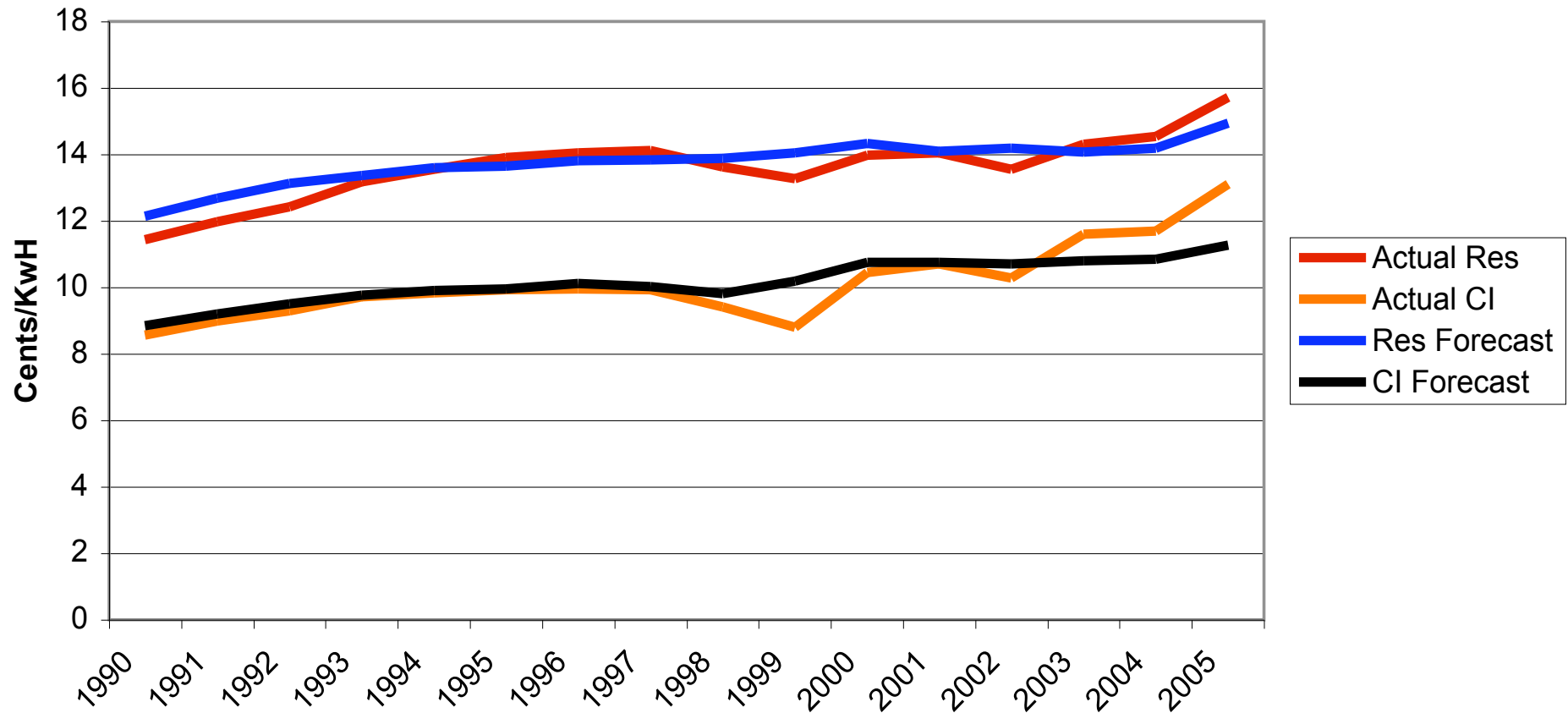
ISO-NE: Actual and Forecasted Nominal Electricity Prices



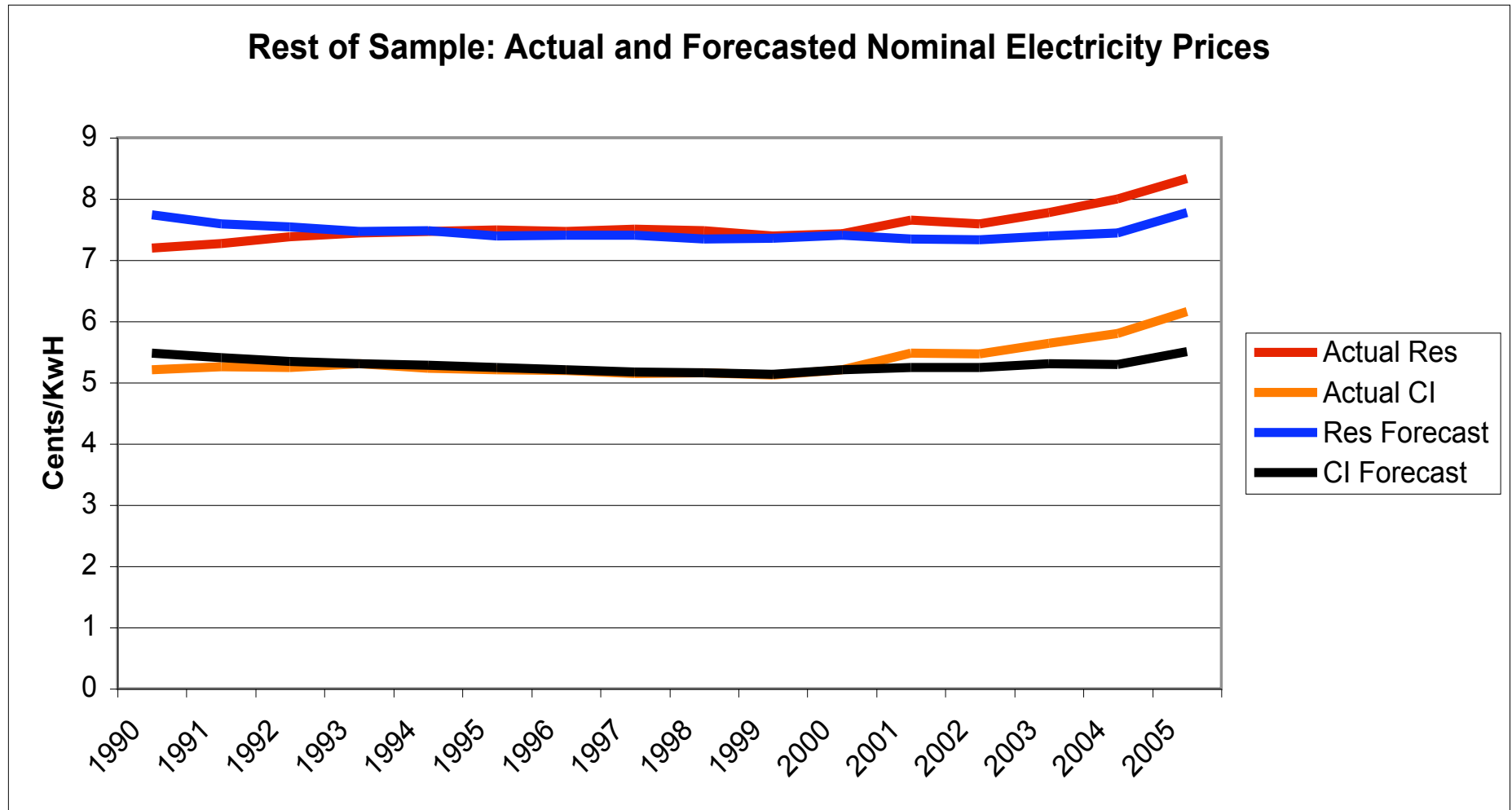
NYISO: Actual and Forecasted Electricity Prices



NYISO: Actual and Forecasted Nominal Electricity Prices



Rest of Sample: Actual and Forecasted Electricity Prices



Forecasting Errors for Residential Prices

100(Observed – Forecast)/Forecast



Year	CAISO	PJM	ERCOT	ISO-NE	NYISO
1996	0.62%		-4.31%		
1997	2.13%	0.41%	-3.69%	-0.34%	
1998	-5.70%	-0.42%	-3.77%	-1.79%	-1.94%
1999	-5.49%	-4.05%	-5.86%	-4.46%	-5.48%
2000	-2.94%	-7.01%	-3.16%	-9.19%	-2.51%
2001	11.02%	-5.56%	11.59%	-10.35%	-0.28%
2002	15.96%	-4.11%	-6.29%	-3.13%	-4.51%
2003	13.56%	-3.19%	7.64%	-10.52%	1.63%
2004	12.34%	-1.91%	15.42%	-6.56%	2.47%
2005	5.13%	0.63%	22.95%	-4.95%	5.29%



Forecasting Errors for Commercial/Industrial Prices

100(Observed – Forecast)/Forecast



Year	CAISO	PJM	ERCOT	ISO-NE	NYISO
1996	-7.68%		-3.18%		
1997	-7.75%	6.24%	-2.64%	-0.96%	
1998	-12.28%	3.40%	-1.93%	3.05%	-4.07%
1999	-12.64%	-2.19%	-1.54%	-0.88%	-13.46%
2000	-6.94%	-8.03%	2.21%	-8.60%	-2.70%
2001	19.33%	-7.17%	24.81%	-6.91%	-0.37%
2002	32.68%	-9.73%	-6.85%	3.80%	-4.01%
2003	27.70%	-7.56%	8.14%	-5.42%	7.31%
2004	19.93%	-1.33%	16.81%	-1.02%	7.84%
2005	18.50%	6.00%	36.38%	1.23%	16.25%



Conclusions



- The forecasting models control for changes in the generation mix, fuel prices, efficiency improvements, nuclear ownership and the depreciation of the book values of nuclear capacity
- Actual prices are **ABOVE** the forecasted prices for all ISOs and customer classes by the **END of the SAMPLE PERIOD in 2005** except for Residential customers in ISO New England
- Initial levels of retail prices after restructuring were partially determined by “transition” prices, but more recently the market prices are high because they are **now determined by the high marginal prices of natural gas rather than the average cost of production**



A Potential Problem?

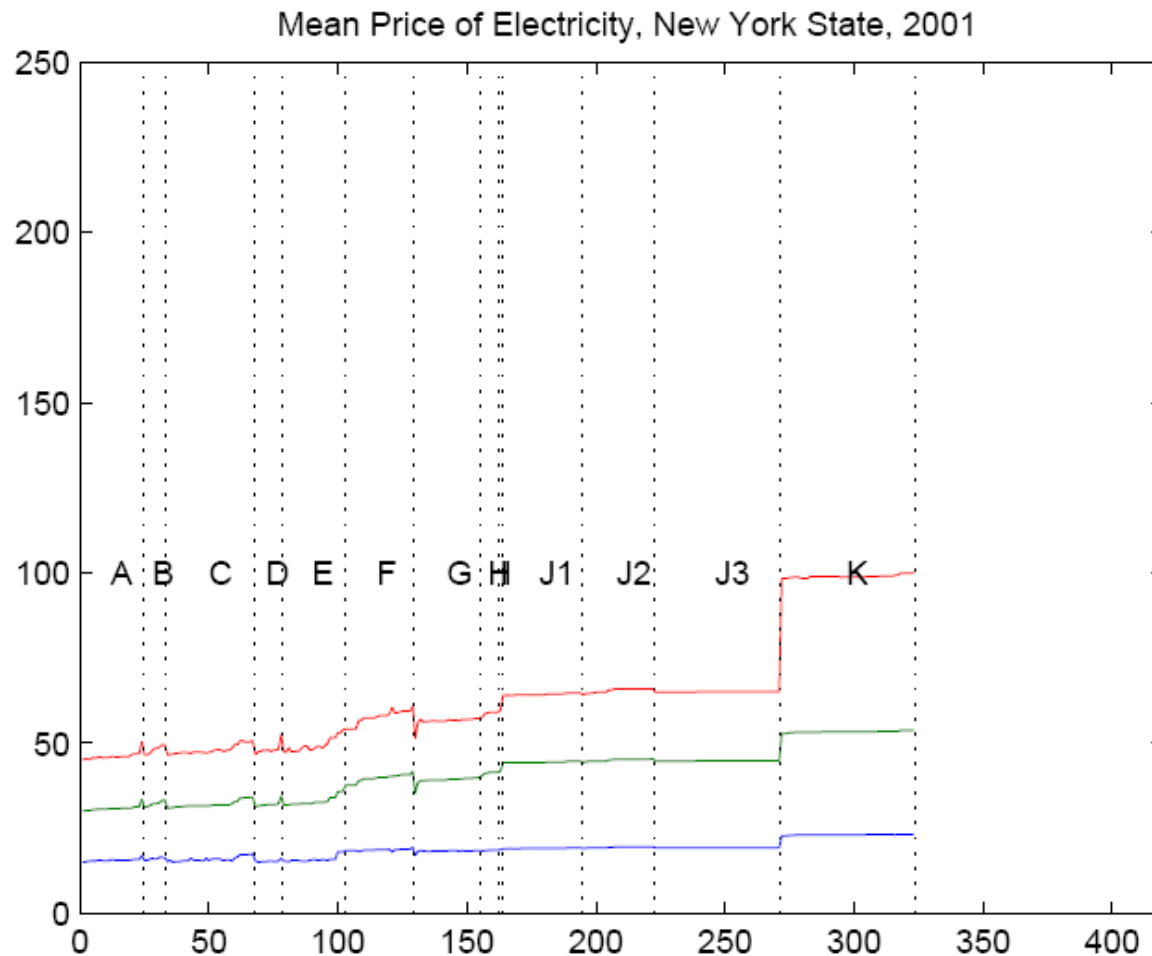


Type of Generator	Capital Cost (\$/kW/Year)	Net-Profit Low Cost of Natural Gas (\$/kW/Year)	Net-Profit High Cost of Natural Gas (\$/kW/Year)
1. Peaking	80	-80	-80
2. Shoulder	159	-80	78
3. Baseload	238	-80	117

Example taken from an APPA report on Capacity Markets in New York State



Ranked Nodal Prices in 2001



Ranked Nodal Prices in 2005

