REGRESSION RELATING CAPITAL COSTS FOR NUCLEAR UNITS WHICH RECEIVED A CONSTRUCTION PERMIT PRIOR TO 1972 TO SELECTED CHARACTERISTICS

Sources and Notes

[1]The dependent variable in the regression is the natural log of capital cost per kilowatt. Actual costs have been adjusted to reflect the costs of constructing the plants at labor and materials costs prevailing in 1984 with no allowance for funds used during construction. Results are based on all nuclear units, including demo and turnkey units, which received construction permits prior to 1972.

[2]The variable mean is the average value of each of the variables in the analysis for the sample used to estimate the regression equation.

[3]The regression coefficient describes the effect of a one-unit change in the independent variable on the dependent variable.

[4]The t-statistic is the ratio of the mean of the coefficient to its standard error. It measures the reliability with which the coefficient is measured. A t-statistic of 1.96 or higher indicates that the coefficient is significantly different from zero at the 5 percent level. A t-statistic of 1.64 or higher indicates significance at the 10 percent level.

[5]Size is the natural log of the net design electric rating as reported in U.S. NRC, Licensed Operating Reactors, at the time the unit received its operating permit.

[6]The wage rate is a composite of 1981 wages plus fringe benefits for crafts used in constructing nuclear power plants. The composite consists of the following crafts: pipefitters (30 percent), electricians (19 percent), common laborers (18 percent), carpenters (12 percent), steelworkers (10 percent), operating engineers (7 percent), boilermakers (2 percent) and millwrights (2 percent). Wages for these crafts were obtained from R. S. Means Co., Inc., 1978 Labor Rates for the Construction Industry, for the communities from which construction labor was hired. The wage is expressed as an index relative to the national average.

[7]The indicator is equal to 1 if the unit is a subsequent unit built of a multi-unit plant and 0 otherwise.

[8]The indicator is equal to 1 if the unit is the first of a multi-unit plant and 0 otherwise.

[9]The indicator is equal to 1 if the unit is a turnkey or demo unit and 0 otherwise. Unit status is taken from N.U.S. Corporation, Commercial Nuclear Power Plants, Edition No. 16, February 1984.

REGRESSION RELATING CAPITAL COSTS FOR NUCLEAR UNITS WHICH RECEIVED A CONSTRUCTION PERMIT PRIOR TO 1972 TO SELECTED CHARACTERISTICS

Sources and Notes

[10] The indicator is equal to 1 if the unit is in Connecticut, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont or Washington, D.C. and 0 otherwise. Locations are from U.S. Department of Energy, U.S. Central Station Nuclear Electric Generating Units; Significant Milestones (Status as of July 1, 1983), DOE/NE-0030/9, October 1983.

[11] The indicator is equal to 1 if unit received its construction permit in the year or years indicated and 0 otherwise. Yearle 66 equals 1 if unit received permit in 1967. Construction permit date is taken from U.S. Department of Energy, U.S. Central Station Nuclear Electric Generating Units; Significant Milestones (Status as of July 1, 1983), DOE/NE-0030/9, October 1983.

REGRESSION RELATING CAPITAL COST FOR NUCLEAR UNITS WHICH RECEIVED A CONSTRUCTION PERMIT IN 1972 OR LATER TO SELECTED CHARACTERISTICS[1]

	Variable Mean[2] (1)	Regression Coefficient[3] (2)	t-Statistic[4] (3)
Log of Construction Cost	7.4925	-	-
Constant	1.0000	7.7510	-
Log of Wage Index[5]	-0.1040	0.3708	2.421
Subsequent Unit Indicator[6]	0.4068	-0.4186	8.368
Single Unit BWR Indicator[7]	0.1186	0.2020	2.462
Rock Foundation Indicator[8]	0.6271	-0.1516	2.642
Cooling Tower Indicator[9]	0.6102	0.0678	1.322
Utility is Constructor Indicator[10]	0.2373	-0.2560	4.275
Northeast Indicator[11]	0.1864	0.2191	3.344
Number of Observations		59	
Adjusted R^2		0.7915	
Standard Error		0.1775	

REGRESSION RELATING CAPITAL COST FOR NUCLEAR UNITS WHICH RECEIVED A CONSTRUCTION PERMIT IN 1972 OR LATER TO SELECTED CHARACTERISTICS[1]

Sources and Notes

[1]The dependent variable in the regression is the natural log of capital cost per kilowatt. Actual costs have been adjusted to reflect the cost of constructing the plants at labor and materials costs prevailing in 1984 with no allowance for funds used during construction. The data are from a September 1984 TVA survey, or from a NERA survey of individual utilities if TVA did not report costs for a unit.

[2]The variable mean is the average value of each of the variables in the analysis for the sample used to estimate the regression equation.

[3]The regression coefficient describes the effect of a one-unit change in the independent variable on the dependent variable.

[4]A t-statistic is the ratio of the mean of the coefficient to its standard error. It measures the reliability with which the coefficient is measured. A t-statistic of 2.01 or higher indicates that the coefficient is significantly different from zero at the 5 percent level. A t-statistic of 1.68 or higher indicates significance at the 10 percent level.

[5]The wage rate is a composite of 1981 wages plus fringe benefits for crafts used in constructing nuclear power plants. The composite consists of the following crafts: steamfitters (30 percent), electricians (19 percent), common laborers (18 percent), carpenters (12 percent), steelworkers (10 percent), operating engineers (7 percent), boilermakers (2 percent) and millwrights (2 percent). The wage is expressed as an index relative to the national average. Wages for these crafts were obtained from R.S. Means Co., Inc., 1978 Labor Rates for the Construction Industry for the communities from which construction labor was hired.

[6]The indicator is equal to 1 if the unit is a subsequent unit of a series built at a site and 0 otherwise.

[7]The indicator is equal to 1 if the unit is a single unit plant with a boiling water reactor and 0 otherwise. BWR classification is taken from U.S. Department of Energy, U.S. Central Station Nuclear Electric Generating Units; Significant Milestones (Status as of July 1, 1983), DOE/NE-0030/9, October 1983.

[8]The indicator is equal to 1 if the unit is built on a rock foundation and 0 otherwise. Rock or soil site classification was provided to NERA from Burns & Roe in March 1984.

[9]The indicator is equal to 1 if the unit has a cooling tower and 0 otherwise. Cooling tower data are from NUS Corporation, Commercial Nuclear Power Plants, Edition No. 16, February 1984.

[10]The indicator is equal to 1 if the utility is the construction manager and either TVA, Duke Power Company, or Commonwealth Edison Company. Otherwise, the indicator is equal to 0. Construction manager data are from NUS Corporation, Commercial Nuclear Power Plants, Edition No. 16, February 1984.

[11]The indicator is equal to 1 if the unit is in Connecticut, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont or Washington, D.C. and 0 otherwise. Locations are from U.S. Department of Energy, U.S. Central Station Nuclear Electric Generating Units; Significant Milestones (Status as of July 1, 1983), DOE/NE-0030/9, October 1983.

DERIVATION OF CAPITAL COST FOR A SUBCRITICAL COAL ALTERNATIVE TO LIMERICK 1 IN 1980

Variable	Regression Coefficient[1] (1)	Plant Characteristic[2] (2)	Cross Product[3] (3)
Constant	4.3978	1	4.3978
First Unit Indicator	0.2934	0.5	0.1467
Lagged First Unit Indicator	0.1392	0	0
Log of Net Size in Megawatts	-0.2081	5.9915	-1.2467
Log of Wage Index	0.5671	0.0446	0.0253
Operation Date	0.0401	80	3.2064
Supercritical Indicator	0.8501	0	0
Supercritical Size Trend	-0.1263	0	0
Low Sulfur Indicator	0.0786	0	0
Outdoor Boiler Indicator	-0.0664	0	0
Cooling Tower Indicator	0.0575	1	0.0575
Mountain Indicator	-0.8529	0	0
Mountain Time Trend	0.0124	0	0
Southwest Indicator	-2.2217	0	0
Southwest Time Trend	0.0270	0	0
Northeast Indicator	-1.8695	1	-1.8695
Northeast Time Trend	0.0279	80	2.2281
Architect/Engineer Indicator:			
A/E-B	0.1362	0.0949	0.0129
A/E-S	0.2324	0.0678	0.0158
Utility-A	0.0802	0.0271	0.0022
Utility-T	0.3830	0.0169	0.0065
Log of Plant Capital Cost in 1980:			6.9828
Scrubber Capital Cost			
Constant	4.1752	1	4.1752
Subsequent Unit Indicator	-0.2093	0.5	-0.1047
Lime/Limestone Scrubber Indicator	-0.3396	1	-0.3396
Percent Sulfur Removal	0.0158	89.39	1.4124
1972-1977 On-Line Year Indicator	0.5990	0	0
Log of Scrubber Capital Cost in 1980:			5.1433
Particulate Capital Cost			
Constant	5.6399	1	5.6399
Log of Size (MW)	-0.2000	5.9915	-1.1983
Log of Wage Index	0.5000	0.0446	0.0223
Percent Sulfur in Coal	-0.0660	2.7	-0.1782
Particulate Emission Limit	-5.0950	0.03	-0.1529
Log of Particulate Capital Cost in 1980:			4.1329
Coal Capital Cost in 1980 (1984 $/kW):[4]			
Plant Cost:			$1,077.97
Scrubber Cost:			171.28
Particulate Cost:			62.36
Total Plant Cost:			$1,311.60

DERIVATION OF CAPITAL COST FOR A SUBCRITICAL COAL ALTERNATIVE TO LIMERICK 1 IN 1980

Sources and Notes

[1]The regression coefficients for the plant capital cost equation are taken from the regression equation shown at page 3 of this schedule. The regression equation for the scrubber capital cost is shown at page 6. The footnotes to those tables contain a detailed description of the definition of each variable included in the regression equations. The constant for the plant capital cost equation shown here has been adjusted downward by 3 percent to remove the cost of simple particulate control systems included in the plant cost data. The parameters of the particulate cost equation are based upon estimates presented in "Impact of Particulate Emission Regulations on the Economics of Power Production for New, Large, Coal-Fired Power Plants" prepared by Stearns-Roger for EPRI, October 1977.

[2]The coal alternative is assumed to consist of two 400 MW subcritical units with indoor boilers, cooling towers and lime/limestone scrubbers burning coal with 2.7 percent sulfur content. The journeymen's wage index is for Philadelphia, PA and is equal to 1.0456. For architect/engineer the average values for subcritical coal plants in the U.S. which began commercial operation between 1965 and 1983 are used.

[3]The capital cost is derived by multiplying the regression coefficient for each variable by the corresponding characteristic of the coal alternative. The sum of these cross products is equal to the natural log of the capital cost; the antilog of this sum yields the capital cost in mid-1984 dollars per kilowatt.

[4]The total plant capital cost for the coal alternative is equal to the sum of the plant, scrubber and particulate capital cost.

REGRESSION RELATING CAPITAL COSTS FOR COAL PLANTS TO SELECTED CHARACTERISTICS[1]

	Variable Mean[2]	Regression Coefficient[3]	t-Statistic[4]
	(1)	(2)	(3)
Log of Capital Cost	6.2862	-	-
Constant	1.0000	4.4278	-
First Unit Indicator[5]	0.3322	0.2934	9.728
Lagged First Unit Indicator[6]	0.2305	0.1392	4.079
Log of Net Size in Megawatts[7]	6.1271	-0.2081	6.406
Log of Wage Index[8]	-0.0738	0.5671	3.984
Operation Date[9]	-73.5390	0.0401	11.082
Supercritical Indicator[10]	0.3254	0.8501	1.486
Supercritical Size Trend[11]	2.1162	-0.1263	1.420
Scrubber Indicator[12]	0.1492	0.1762	4.217
Low Sulfur Indicator[13]	0.4203	0.0786	2.501
Outdoor Boiler Indicator[14]	0.3763	-0.0664	2.084
Cooling Tower Indicator[15]	0.4508	0.0575	1.877
Mountain Indicator[16]	0.1220	-0.8529	1.260
Mountain Time Trend[16]	9.2339	0.0124	1.395
Southwest Indicator[17]	0.0847	-2.2217	1.223
Southwest Time Trend[17]	6.7322	0.0270	1.181
Northeast Indicator[18]	0.0814	-1.8695	2.171
Northeast Time Trend[18]	5.7254	0.0279	2.284
Architect/Engineer Indicator[19]			
A/E - B	0.0949	0.1362	2.950
A/E - S	0.0678	0.2324	4.375
Utility - A	0.0271	0.0802	0.907
Utility - T	0.0169	0.3830	3.740
Number of Observations		295	
Adjusted R^2		0.6931	
Standard Error		0.2078	

REGRESSION RELATING CAPITAL COSTS FOR COAL PLANTS TO SELECTED CHARACTERISTICS[1]

Sources and Notes

[1]The dependent variable in the regression is the natural log of capital cost per kilowatt. Actual costs have been adjusted to reflect the costs of constructing the plants at labor and materials costs prevailing in 1984 with no allowance for funds used during construction. Cost data are taken from FERC (FPC) Form 1 for the year in which the unit first came on-line. Unless otherwise noted, all other data are from USFPC, Steam Electric Plant Construction Cost and Annual Production Expenses, annually.

[2]The variable mean is the average value of each of the variables in the analysis for the sample used to estimate the regression equation.

[3]The regression coefficient describes the effect of a one-unit change in the independent variable on the dependent variable.

[4]A t-statistic is the ratio of the mean of the coefficient to its standard error. It measures the reliability with which the coefficient is measured. A t-statistic of 1.96 or higher indicates that the coefficient is significantly different from zero at the 5 percent level. A t-statistic of 1.64 or higher indicates significance at the 10 percent level.

[5]The indicator is equal to 1 if the unit is the first unit of a series built at a site and 0 otherwise.

[6]The indicator is equal to 1 if the unit is not the first unit of a series at site but came on-line 3 or more years later or differs in size by 10 percent or more than the previous unit at that size and 0 otherwise.

[7]Size is the natural log of the net electrical rating. To derive a net rating data reflecting the gross generator nameplate rating as reported to the FPC were multiplied by 0.9 if the unit had a scrubber and 0.93 otherwise.

[8]The wage rate represents the average wage plus employer contributions to funds for journeymen in the construction industry of the SMSA nearest to the plant. The wage is expressed as an index relative to the U.S. average. Wages are taken from U.S. Bureau of Labor Statistics, Union Wages and Benefits: Building Trades, July 3, 1978, Bulletin 2038, Table 16.

[9]The operation date is the year the plant came on-line minus 1900.

[10]The indicator is equal to 1 if the unit is a supercritical unit and 0 otherwise.

[11]The supercritical size trend is the product of the supercritical indicator and the natural log of the net size of the unit.

[12]The indicator is equal to 1 if the unit has a scrubber and 0 otherwise. Scrubber data are taken from U.S. Department of Energy, Cost and Quality of Fuels for Utility Plants, annually.

[13]This indicator is equal to 1 if the coal sulfur content is less than 1 percent and 0 otherwise.

[14]The indicator is equal to 1 if the unit is built with an outdoor boiler and 0 otherwise.

REGRESSION RELATING CAPITAL COSTS FOR COAL PLANTS TO SELECTED CHARACTERISTICS[1]

Sources and Notes

[15] The indicator is equal to 1 if the unit has a cooling tower and 0 otherwise.

[16] The indicator is equal to 1 if the unit located in Arizona, Colorado, Montana, Nevada, New Mexico or Wyoming and 0 otherwise. The Mountain time trend variable is the product of the mountain indicator and the operation date.

[17] The indicator is equal to 1 if the unit is located in Arkansas, Oklahoma or Texas and 0 otherwise. The southwest time trend is the product of the southwest indicator and the operation date.

[18] The indicator is equal to 1 if the unit is located in Connecticut, Maine, Massachussetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island or Vermont and 0 otherwise. The northeast time trend is the product of the northeast indicator and the operation date.

[19] This indicator is equal to 1 if the plant was built by this particular architect or utility and 0 otherwise. Codes beginning with utility indicate that the utility was its own A/E. A/E data are taken from Power Engineering, New Generating Plants (annually) or from Kidder Peabody, Status Report on Engineers and Construction Managers for Electric Utility Nuclear Reactors and Fossil Boilers.

REGRESSION RELATING SCRUBBER CAPITAL COSTS FOR COAL PLANTS TO SELECTED CHARACTERISTICS[1]

	Variable Mean[2] (1)	Regression Coefficient[3] (2)	t-statistic[4] (3)
Log of Scrubber Capital Cost	5.3182	-	-
Constant	1.0000	4.1752	-
Subsequent Unit Indicator[5]	0.3077	-0.2093	1.774
Lime/Limestone Scrubber Indicator[6]	0.7231	-0.3396	2.823
Percent Sulfur Removal[7]	75.7831	0.0158	4.708
1972-1977 On-line Year Indicator[8]	0.4308	0.5990	5.428
Number of Observations		65	
Adjusted R^2		0.4999	
Standard Error		0.4316	

Sources and Notes

[1]The dependent variable in the regression is the natural log of scrubber capital cost per kilowatt. Actual costs have been adjusted to reflect the costs of constructing the plants at labor and materials costs prevailing in 1984 with no allowance for funds used during construction. Data are taken from U.S. Department of Energy, Cost and Quality of Fuels for Electric Utility Plants, 1981 Annual, September 1982.

[2]The variable mean is the average value of each of the variables in the analysis for the sample used to estimate the regression equation.

[3]The regression coefficient describes the effect of a one-unit change in the independent variable on the dependent variable.

[4]A t-statistic is the ratio of the mean of the coefficient to its standard error. It measures the reliability with which the coefficient is measured. A t-statistic of 1.96 or higher indicates that the coefficient is significantly different from zero at the 5 percent level. A t-statistic of 1.64 or higher indicates significance at the 10 percent level.

[5]The indicator is equal to 1 if the unit is a subsequent unit at a site and 0 otherwise.

[6]The indicator is equal to 1 if the unit uses lime/limestone with the sulfur removal system and 0 otherwise.

[7]Indicates the percentage sulfur removed by the sulfur removal system.

[8]The indicator is equal to one for units which began commercial operation in the particular years indicated and 0 otherwise.

ACTUAL YIELDS ON LONG-TERM DEBT AND ACTUAL INFLATION RATES

Year	Yield on Long-Term Debt[1]	Inflation Rate[2]
	---------(Percent)---------	
	(1)	(2)
1971	7.70%	3.48%
1972	7.65	3.56
1973	8.08	7.65
1974	9.72	11.41
1975	10.74	7.18
1976	9.54	4.75
1977	9.08	6.21
1978	10.25	8.19
1979	11.44	6.89
1980	14.23	9.76

Sources and Notes

[1] This is the actual yield to maturity on selected Philadelphia Electric Company unsubordinated debt outstanding in each year as reported in Moody's Public Utility Manual, annual issues.

[2] This is the annual percent change from 4th quarter to 4th quarter in the GNP implicit price deflator. See the Economic Report of the President, February 1985 (Washington, D.C.: U.S. Government Printing Office, 1985): Table B-3, p. 236.

CAPITAL STRUCTURE BY YEAR[1]

Year	Common Equity	Preferred Equity	Long-Term Debt
	(Percent)		
	(1)	(2)	(3)
1971	35.07%	11.74%	53.19%
1972	35.32	13.32	51.35
1973	37.06	14.42	48.52
1974	33.13	14.95	51.92
1975	34.48	13.70	51.82
1976	34.58	13.96	51.47
1977	35.24	13.86	51.66
1978	34.43	13.61	51.95
1979	34.89	12.79	53.32
1980	35.50	13.25	51.25

Sources and Notes

[1]Year-end book values as reported for Philadelphia Electric Company in Moody's Public Utility Manual, annual issues.

ACTUAL FEDERAL AND STATE INCOME TAX RATES

Year	Income Tax Rates Federal	Income Tax Rates State
	--------(Percent)--------	
	(1)	(2)
1975	48.0%	9.50%
1976	48.0	9.50
1977	48.0	10.50
1978	48.0	10.50
1979	46.0	10.50
1980	46.0	10.50

EXPECTED COST OF MONEY, DISCOUNT RATE AND INFLATION RATE BY YEAR OF ANALYSIS

	Expected Cost of Money			Expected	Expected
Year of Analysis	Long-Term Debt[1]	Common Equity[2]	Preferred Equity[3]	Discount Rate[4]	Inflation Rate[5]
	(Percent)				
	(1)	(2)	(3)	(4)	(5)
1975	8.77%	11.03%	8.72%	7.14%	6.62%
1976	9.14	11.98	9.24	7.65	6.88
1977	9.43	12.83	9.58	8.04	7.42
1978	9.86	13.45	9.98	8.37	7.52
1979	10.21	13.95	10.18	8.75	6.64
1980	10.89	14.06	10.63	9.10	7.15

Sources and Notes

[1] This is the five-year geometric mean of the actual yields on long-term debt given on page 1 of this schedule. The average includes the yield in the year of analysis plus the previous four years.

[2] A discounted cash flow method was used to estimate the required rate of return for a large number of U.S. electric utilities. For those utilities we calculated the differential between the long-term debt rate and the required rate of return. This premium was added to the expected debt rate in column (1) to obtain the required return on common equity.

[3] A procedure similar to that outlined in footnote 2 was used for preferred equity.

[4] The expected discount rate is the weighted average after-tax cost of money. This rate is also used as the AFDC rate in calculating the booked capital cost for Limerick and the coal alternative.

[5] The expected inflation rate for each year of analysis is the geometric mean of the actual inflation rate in that year and the preceding four years. Actual annual inflation rates are on page 1 of this schedule.

OTHER FINANCIAL ASSUMPTIONS

	Limerick	Coal & Oil Alternative
Book Life (years)	30	30
Tax Life (years)	10	15
Decommissioning Charge as Percent of Booked Cost	0.5%	-
Property Tax Rate During Operating Period as Percent of Net Plant	0.48%	0.48%
Accounting Treatment[1]		
Liberalized Depreciation	Normalized	Normalized
Treatment of ITC	Ratable	Ratable

Sources and Notes

[1]Based on the actual accounting treatment applied by PECO.

INVESTMENT TAX CREDIT RATE
BY YEAR OF ANALYSIS

	Expected ITC Rates			
	Limerick		Coal Alternative	
	Plant	Unit 1	Plant	Unit 1
	(Percent)			
	(1)	(2)	(3)	(4)
1975	10.0%	9.0%	10.%	8.8%
1976	8.0	7.4	8.0	6.0
1977	7.6	7.0	8.0	6.0
1978	10.0	10.0	10.0	10.0
1979	10.0	10.0	10.0	10.0
1980	10.0	10.0	10.0	10.0

Sources and Notes

[1]The ITC rates for each year of analysis are the average rates expected to prevail through the construction period.

DERIVATION OF CAPITAL ADDITIONS FOR LIMERICK SYSTEM

AVERAGE ANNUAL CAPITAL ADDITIONS FOR LIMERICK 1 & 2 AND OTHER NUCLEAR PLANTS

Year of Analysis	Average Annual[1] Capital Additions (1984 $/kW) (1)	Limerick Plant[2] Capital Additions (1984 $/kW) (2)
1975	$ 6.51	$ 3.43
1976	6.76	4.05
1977	10.93	7.14
1978	10.20	6.72
1979	9.89	7.35
1980	17.34	13.95

DERIVATION OF CAPITAL ADDITIONS FOR LIMERICK 1 & 2 IN 1980

Average Capital Additions Cost For Units in 1980:

1984 $/kW	$17.34
Log	2.853

	Limerick[3] Characteristic (1)	Average Annual[4] Characteristic (2)	Regression[5] Coefficient (3)	Adjustment[6] Factor ((1)-(2)*(3) (4)
Adjusted for Limerick's Characteristics:				
Log of Number of Units	0.693	0.290	-0.3925	-0.158
Log of Average Size	6.961	6.633	-0.6461	-0.213
Reciprocal of Unit Age	1	0.190	1.2747	1.033
Log of Wage Index	-0.050	-0.102	1.0962	0.056
Northeast Indicator	1	0.293	0.2132	0.151
South Indicator	0	0.317	-0.0512	0.016
Saltwater Indicator	0	0.317	0.2198	-0.070
Total Adjustment Factor:				0.814
Log of Limerick Capital Additions in 1980:				3.667
Limerick Capital Additions in 1980: (1984 $/kW)				$39.15

CAPITAL ADDITIONS BY YEAR OF OPERATION

Year	Capital Additions (1984 $/kW)
1	$39.15
5	14.11
10	12.42
30	11.41
Levelized Capital Additions	$13.95

DERIVATION OF CAPITAL ADDITIONS COST FOR LIMERICK

Sources and Notes

[1]To derive the capital additions cost for Limerick for each year of analysis the average cost of plants operating in each year is adjusted to reflect Limerick's characteristics.

[2]This column represents the capital additions for Limerick, levelized over a 30 year life, in each year of analysis.

[3]Limerick is a two unit plant with an average unit size of 1,055 MW. The utility wage index is for Philadelphia, PA and is equal to 0.952.

[4]This column describes the average characteristics of plants operating in 1980.

[5]The regression coefficients are taken from the regression equation shown at page 3 of this schedule. The footnotes to that table contain a detailed description of the definition of each of the variables in the equation.

[6]The capital additions for Limerick is derived by multiplying the regression coefficient for each variable by the difference between Limerick's characteristic and the corresponding characteristic of plants operating in 1980. The sum of these adjustment factors added to the log of the average capital additions of plants operating in 1980 is equal to the log of capital additions for Limerick; the antilog of this value yields the first year capital additions in mid-1984 dollars per kilowatt.

REGRESSION RELATING CAPITAL ADDITIONS FOR NUCLEAR PLANTS TO SELECTED CHARACTERISTICS[1]

	Variable Mean[2] (1)	Regression Coefficient[3] (2)	t-Statistic[4] (3)
Log of Capital Additions	2.5173	-	-
Constant	1.0000	4.5023	-
Log of Number of Units	0.2690	-0.3925	2.117
Log of Average Size[5]	6.5646	-0.6461	2.412
Reciprocal of Unit Age[6]	0.2393	1.2747	4.014
Log of Wage Index[7]	-0.1047	1.0962	1.722
Northeast Indicator[8]	0.3289	0.2132	1.210
South Indicator[8]	0.2763	-0.0512	0.201
Saltwater Cooling Indicator[9]	0.3237	0.2198	1.520
Year Indicators:[10]			
1971	0.0105	0.1666	0.219
1972	0.0184	0.1252	0.188
1973	0.0342	0.5559	0.921
1974	0.0368	1.0314	1.724
1975	0.0632	1.1232	1.971
1976	0.0763	1.2850	2.273
1977	0.0737	1.8547	3.256
1978	0.0974	1.7906	3.197
1979	0.0921	1.8574	3.281
1980	0.0974	2.5016	4.409
1981	0.1000	2.7032	4.765
1982	0.1132	2.5357	4.493
1983	0.0921	2.8812	5.023
1984	0.0816	3.2657	5.649
Number of Observations		380	
Adjusted R^2		0.2590	
Standard Error		1.1259	

REGRESSION RELATING CAPITAL ADDITIONS FOR NUCLEAR PLANTS TO SELECTED CHARACTERISTICS[1]

Sources and Notes

[1]The dependent variable in the regression is the natural log of capital additions (capital costs that occur after the plant has come on-line) in 1984 dollars per kilowatt. With the exception of the wage indices, the 1965-1978 data are from the Federal Power Commission (now Federal Energy Regulatory Commission), Steam-Electric Plant Construction Cost and Annual Production Expenses, and the 1979-1984 data are from Schedule 432 of Federal Power Commission, Form 1, "Annual Report of Privately Owned Electric Utilities, Classes A and B."

[2]The variable mean is the average value of each of the variables in the analysis for the sample used to estimate the regression equation.

[3]The regression coefficient describes the effect of a one-unit change in the independent variable on the dependent variable.

[4]The t-statistic is the ratio of the mean of the coefficient to its standard error. It measures the reliability with which the coefficient is measured. A t-statistic of 1.96 or higher indicates that the coefficient is significantly different from zero at the 5 percent level. A t-statistic of 1.64 or higher indicates significance at the 10 percent level.

[5]Size is the natural log of the net design electric rating as reported in U.S. NRC, Licensed Operating Reactors, at the time the unit received its operating permit.

[6]Age is defined as the average age of units operating at the site and is entered as the reciprocal of age. Unit age is equal to the year of observation minus the commercial operation date.

[7]The wage rate is a composite of 1981 wages plus fringe benefits for crafts used in constructing nuclear power plants. The composite consists of the following crafts: pipefitters (30 percent), electricians (19 percent), common laborers (18 percent), carpenters (12 percent), steelworkers (10 percent), operating engineers (7 percent), boilermakers (2 percent) and millwrights (2 percent). Wages for these crafts were obtained from R.S. Means Co., Inc., 1978 Labor Rates for the Construction Industry, for the communities from which construction labor was hired. The wage is expressed as an index relative to the national average.

[8]The indicator is equal to 1 if the plant is located in the region and 0 otherwise. The regions are defined as follows:

Northeast:	Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont.
South:	Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, West Virginia.

[9]The indicator is equal to 1 if saltwater is used as cooling water and 0 otherwise.

[10]The indicator is equal to 1 if the observation is for that particular operating year and 0 otherwise.

DERIVATION OF FIXED O&M COST FOR LIMERICK SYSTEM

AVERAGE ANNUAL O&M COST FOR LIMERICK 1 & 2 AND OTHER NUCLEAR UNITS

Year of Analysis	Average Annual[1] Fixed O&M	Limerick[2] Fixed O&M
	(1984 $/kW)	
	(1)	(2)
1975	$14.32	$12.46
1976	19.11	16.01
1977	21.50	18.17
1978	24.16	20.23
1979	27.68	22.81
1980	33.19	27.75

DERIVATION OF FIXED O&M COST FOR LIMERICK 1 & 2 IN 1980

Average Fixed O&M Cost in 1980:

1984 $/kW	$33.19
Log	3.502

	Limerick[3] Characteristic	Average Annual[4] Characteristic	Regression[5] Coefficient	Adjustment[6] Factor ((1)-(2)*(3))
	(1)	(2)	(3)	(4)
Adjusted for Limerick's Characteristics:				
Log of Number of Units	0.693	0.290	-0.4156	-0.167
Log of Average Size	6.961	6.633	-0.4707	-0.155
Log of Plant Age	0	1.794	0.0868	-0.156
Log of Wage Index	-0.050	-0.102	0.6263	0.033
Northeast Indicator	1	0.293	0.2263	0.160
South Indicator	0	0.317	0.1838	-0.058
Saltwater Indicator	0	0.317	0.1396	-0.044
Total Adjustment Factor:				-0.387
Log of Limerick Fixed O&M Cost in 1980:				3.115
Limerick Fixed O&M Cost in 1980: (1984 $/kW)				$22.54

FIXED O&M COST BY YEAR OF OPERATION

Year	Fixed O&M Cost (1984 $/kW)
1	$22.54
5	25.91
10	27.52
30	30.27
Levelized O&M Cost	$27.75

DERIVATION OF FIXED O&M COST FOR LIMERICK

Sources and Notes

[1]To derive the fixed O&M cost for Limerick for each year of analysis the average cost of plants operating in each year is adjusted to reflect Limerick's characteristics.

[2]This column represents the fixed O&M cost for Limerick, levelized over a 30 year life, in each year of analysis.

[3]Limerick is a two unit plant with an average unit size of 1,055 MW. The utility wage index is for Philadelphia, PA and is equal to 0.952.

[4]This column describes the average characteristics of plants operating in 1980.

[5]The regression coefficients are taken from the regression equation shown at page 3 of this schedule. The footnotes to that table contain a detailed description of the definition of each of the variables in the equation.

[6]The fixed O&M cost for Limerick is derived by multiplying the regression coefficient for each variable by the difference between Limerick's characteristic and the corresponding characteristic of plants operating in 1980. The sum of these adjustment factors added to the log of the average O&M cost of plants operating in 1980 is equal to the log of O&M cost for Limerick; the antilog of this value yields the first year O&M cost in mid-1984 dollars per kilowatt.

REGRESSION RELATING FIXED OPERATING AND MAINTENANCE COSTS FOR NUCLEAR PLANTS TO SELECTED CHARACTERISTICS[1]

	Variable Mean[2]	Regression Coefficient[3]	t-Statistic[4]
	(1)	(2)	(3)
Log of O&M Cost	3.2936	-	-
Constant	1.0000	5.0628	-
Log of Number of Units	0.2810	-0.4156	7.560
Log of Average Size[5]	6.5797	-0.4707	5.235
Log of Average Age[6]	1.5789	0.0868	2.299
Log of Wage Index[7]	-0.1041	0.6263	3.373
Northeast Indicator[8]	0.3326	0.2263	4.371
South Indicator[8]	0.2764	0.1838	2.445
Saltwater Cooling Indicator[9]	0.3191	0.1396	3.236
Year Indicators:[10]			
1971	0.0180	0.0572	0.301
1972	0.0247	0.1465	0.820
1973	0.0382	0.4407	2.639
1974	0.0472	0.6172	3.787
1975	0.0562	0.6135	3.801
1976	0.0742	0.8654	5.444
1977	0.0831	0.9911	6.227
1978	0.0944	1.0997	6.910
1979	0.0966	1.2267	7.600
1980	0.0921	1.4219	8.673
1981	0.0944	1.5532	9.403
1982	0.1011	1.6101	9.712
1983	0.0831	1.7820	10.486
1984	0.0809	1.9718	11.490
Number of Observations		445	
Adjusted R^2		0.7001	
Standard Error		0.3658	

REGRESSION RELATING FIXED OPERATING AND MAINTENANCE COSTS FOR NUCLEAR PLANTS TO SELECTED CHARACTERISTICS

Sources and Notes

[1]The dependent variable in the regression is the natural log of expensed non-fuel operating and maintenance cost, in 1984 dollars per kilowatt. With the exception of the wage indices, the 1965-1978 data are from the Federal Power Commission (now Federal Energy Regulatory Commission), Steam-Electric Plant Construction Cost and Annual Production Expenses, and the 1979-1984 data are from Schedule 432 of Federal Power Commission, Form 1, "Annual Report of Privately Owned Electric Utilities, Classes A and B."

[2]The variable mean is the average value of each of the variables in the analysis for the sample used to estimate the regression equation.

[3]The regression coefficient describes the effect of a one-unit change in the independent variable on the dependent variable.

[4]The t-statistic is the ratio of the mean of the coefficient to its standard error. It measures the reliability with which the coefficient is measured. A t-statistic of 1.96 or higher indicates that the coefficient is significantly different from zero at the 5 percent level. A t-statistic of 1.64 or higher indicates significance at the 10 percent level.

[5]Size is the natural log of the net design electric rating as reported in U.S. NRC, Licensed Operating Reactors, at the time the unit received its operating permit.

[6]Age is defined as the average age, of units operating at the site and is entered as the natural log of age. Unit age is equal to the year of observation minus the commerical operating date.

[7]The wage rate is a composite of 1981 wages plus fringe benefits for crafts used in constructing nuclear power plants. The composite consists of the following crafts: pipefitters (30 percent), electricians (19 percent), common laborers (18 percent), carpenters (12 percent), steelworkers (10 percent), operating engineers (7 percent), boilermakers (2 percent) and millwrights (2 percent). Wages for these crafts were obtained from R.S. means Co., Inc., 1978 Labor Rates for the Construction Industry, for the communities from which construction labor was hired. The wage is expressed as an index relative to the national average.

[8]The indicator is equal to 1 if the plant is located in the region and 0 otherwise. The regions are defined as follows:

Northeast:	Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont.
South:	Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, West Virginia.

[9]The indicator is equal to 1 if saltwater is used as cooling water and 0 otherwise.

[10]The indicator is equal to 1 if the observation is for that particular operating year and 0 otherwise.

DERIVATION OF FIXED O&M COST FOR A SUBCRITICAL COAL ALTERNATIVE TO LIMERICK 1 IN 1980

Variable	Regression Coefficient[1] (1)	Plant Characteristic[2] (2)	Cross Product[3] (3)
Constant	6.4976	1	6.498
Log of Number of Units	-0.0922	0.693	-0.064
Log of Average Size	-1.8934	5.992	-11.344
Log of Average Size, Squared	0.1731	35.898	6.213
Log of Plant Age	0.3397	0	0
Reciprocal of Plant Age	0.3299	1	0.330
Time	0.0289	16	0.462
Log of Wage Index	0.8881	0.045	0.040
Northeast Indicator	0.1383	1	0.138
South Indicator	0.0552	0	0
West Indicator	0.2323	0	0

Log of Coal O&M Cost: 2.272

First Year Coal O&M Cost: (1984 $/kW) $ 9.70

Coal Fixed O&M By Year of Operation

Year	O&M Cost (1984 $/kW)
1	$ 9.70
5	12.87
10	15.76
30	22.39

Levelized Fixed O&M Cost: (1984 $/kW) $16.84

DERIVATION OF FIXED O&M COST FOR A SUBCRITICAL COAL ALTERNATIVE TO LIMERICK 1 IN 1980

Sources and Notes

[1]The regression coefficients are taken from the regression equation shown at page 3 of this schedule. The sources and notes to that table contain a detailed description of the definition of each of the variables in the equation. Since a separate equation is used to estimate scrubber O&M costs the scrubber indicator in this equation is not used.

[2]The coal alternative to Limerick is assumed to consist of two 400 MW units. The time variable is expressed as the year minus 1964, which for the year 1980 is equal to 16. The wage index used is for Philadelphia, PA and is equal to 1.0456.

[3]The predicted O&M cost is derived by multiplying the regression coefficient for each variable by the corresponding characteristic of the coal alternative. The sum of these cross products is equal to the natural log of the first year O&M cost; the antilog of this sum yields the first year O&M cost in mid-1984 dollars per kilowatt.

REGRESSION RELATING FIXED OPERATING AND MAINTENANCE COSTS FOR COAL PLANTS TO SELECTED CHARACTERISTICS[1]

	Variable Mean[2]	Regression Coefficient[3]	t-Statistic[4]
	(1)	(2)	(3)
Log of O&M Cost	2.4150	-	-
Constant	1.0000	6.4976	-
Log of Number of Units	0.6220	-0.0922	2.340
Log of Average Size[5]	6.0238	-1.8934	3.920
Log of Average Size, Squared	36.5808	0.1731	4.138
Log of Plant Age[6]	1.7430	0.3397	5.283
Reciprocal of Plant Age[6]	0.2514	0.3299	1.969
Time[7]	12.0166	0.0289	5.767
Log of Wage Index[8]	-0.0775	0.8881	3.103
Proportion of Plant Scrubbed[9]	0.0310	0.5679	5.223
Northeast Indicator[10]	0.2118	0.1383	2.756
South Indicator[10]	0.3661	0.0552	0.843
West Indicator[10]	0.1210	0.2323	4.024
Number of Observations		661	
Adjusted R^2		0.4429	
Standard Error		0.4012	

REGRESSION RELATING FIXED OPERATING AND MAINTENANCE COSTS FOR COAL PLANTS TO SELECTED CHARACTERISTICS

Sources and Notes

[1]The dependent variable in the regression is the natural log of expensed non-f -l operating and maintenance costs, in 1984 dollars per kilowatt. With the exception of the wage indices, the 1965-1978 data are from the Federal Power Commission (now Federal Energy Regulatory Commission), Steam-Electric Plant Construction Cost and Annual Production Expenses, and the 1979-1981 data are from Schedule 432 of Federal Power Commission, Form 1, "Annual Report of Privately Owned Electric Utilities, Classes A and B."

[2]The variable mean is the average value of each of the variables in the analysis for the sample used to estimate the regression equation.

[3]The regression coefficient describes the effect of a one-unit change in the independent variable on the dependent variable.

[4]The t-statistic is the ratio of the mean of the coefficient to its standard error. It measures the reliability with which the coefficient is measured. A t-statistic of 1.96 or higher indicates that the coefficient is significantly different from zero at the 5 percent level. A t-statistic of 1.64 or higher indicates significance at the 10 percent level.

[5]Average size is the average unit size at the plant based on the gross nameplate capacity as reported to the FPC. Net size is derived by multiplying gross size by 0.9 for scrubber units and 0.93 otherwise.

[6]Age is measured as full calendar years of operation. The age variables are constructed as the reciprocal of age and the natural log of age.

[7]Time is measured as the year of the observation minus 1964.

[8]The wage rate represents the average wage plus employer contributions to funds for journeymen in the construction industry for the SMSA nearest to the plant. The wage is expressed as an index relative to the U.S. average. Wages are taken from U.S. Bureau of Labor Statistics, Union Wages and Benefits: Building Trades, July 3, 1978, Bulletin 2038, Table 16.

[9]Proportion of plant scrubbed is derived as the ratio of the portion of the plant with scrubber to the total plant (in megawatts) in each year.

[10]The indicator is equal to 1 if the plant is located in the region and 0 otherwise. The regions are defined as follows:

Northeast:	Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont.
South:	Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, West Virginia.
West:	Arizona, California, Colorado, Idaho, Montana, Utah, Washington, Wyoming.

DERIVATION OF SCRUBBER O&M COST FOR A SUBCRITICAL COAL ALTERNATIVE TO LIMERICK IN 1980

Variable	Regression Coefficient[1] (1)	Plant Characteristic[2] (2)	Cross Product[3] (3)
Constant	0.0644	1	0.064
Design Percent Removal	0.0429	89.39	3.835
Lime/Limestone Indicator	-0.9740	1	-0.974
Quantity of Sulfur Removed	0.1136	4.0	0.454
Scrubber O&M Cost in 1984 mills/kWh			3.38

Sources and Notes

[1] The regression coefficients are based on the regression equation shown at page 2 of this schedule. The values shown here have been adjusted downward by 61 percent to reflect the observed difference in scrubber O&M cost between plants with and without a scrubber and to convert to 1984 dollars. The sources and notes to that table contain a detailed description of the definition of each of the variables in the equation.

[2] The coal alternative to Limerick is assumed to burn bituminous coal with a sulfur content of 2.7 percent and a heat content of 12,064 Btu/lb. The quantity of sulfur removed, based on a design percent removal of 89.39 percent, is 4.0 lbs./MMBtu.

[3] The predicted scrubber O&M cost is derived by multiplying the regression coefficient for each variable by the corresponding characteristic of the coal alternative. The sum of these cross products is equal to scrubber O&M cost in 1984 mills per kilowatt hour.

REGRESSION RELATING SCRUBBER O&M COST FOR COAL PLANTS TO SELECTED CHARACTERISTICS[1]

	Variable Mean[2] (1)	Regression Coefficient[3] (2)	t-Statistic[4] (3)
Scrubber O&M Cost	7.3986	-	-
Constant	1.0000	0.1650	-
Design Percent Removal[5]	75.3317	0.1100	3.128
Lime/Limestone Scrubber Indicator[6]	0.7143	-2.4974	2.462
Quantity of Sulfur Removed[7]	2.5213	0.2912	1.136

Number of Observations	63
Adjusted R^2	0.2990
Standard Error	3.5295

Sources and Notes

[1]The dependent variable in the regression is scrubber operating and maintenance cost in 1979 mills/kWh. Data are taken from U.S. Department of Energy, Cost and Quality of Fuels for Electric Utility Plants, 1981, September 1982.

[2]The variable mean is the average value of each of the variables in the analysis for the sample used to estimate the regression equation.

[3]The regression coefficient describes the effect of a one-unit change in the independent variable on the dependent variable.

[4]The t-statistic is the ratio of the mean of the coefficient to its standard error. It measures the reliability with which the coefficient is measured. A t-statistic of 1.96 or higher indicates that the coefficient is significantly different from zero at the 5 percent level. A t-statistic of 1.64 or higher indicates significance at the 10 percent level.

[5]Design percent removal is the sulfur percent removal the scrubber was designed to achieve.

[6]The indicator is equal to 1 if the unit uses lime or limestone in the scrubber and 0 otherwise.

[7]The quantity of sulfur removed is equal to the sulfur content of the coal, expressed as pounds of SO_2 per MMBtu, multiplied by the design percent removal (expressed as a proportion).

DERIVATION OF CAPACITY FACTOR FOR A SUBCRITICAL COAL ALTERNATIVE TO LIMERICK 1 IN 1980

Variable	Regression Coefficient[1] (1)	Plant Characteristic[2] (2)	Cross Product[3] (3)
Constant	176.1880	1	176.188
Log of Net Size	-12.6082	5.992	-75.542
Reciprocal of Age	-20.2009	1	-20.201
Log of Age	-7.3757	0	0
Vintage Indicators:			
1961 or Earlier	-	-	-
1962-1971	-4.3260	0	0
1972 or Later	-2.5554	1	-2.555
Post-1974 Operating Year Indicator	-5.5160	1	-5.516
Log of Sulfur Content	-1.1788	0.993	-1.711
Cyclone Indicator	-4.5902	0	0
Balanced Draft Indicator	3.0564	1	3.056
Boiler Manufacturer Indicator:			
Combustion Engineering	-2.7526	0.532	-1.466
Foster Wheeler	-10.4096	0.087	-0.907
Riley	-5.3342	0.056	-0.301
Architect/Engineer Indicator:			
A/E-B	-2.0778	0.071	-0.148
A/E-S	-4.6569	0.081	-0.377
A/E Utility-S	0.5539	0.068	0.038
A/E Utility-D	3.8561	0.039	0.149
A/E Utility-A	0.1323	0.094	0.012
A/E Utiltiy-T	-3.4080	0.156	-0.530
A/E Utility-C	-14.3542	0.075	-1.071
A/E Utility Other or Unknown	1.0019	0.391	0.392

First Year Equivalent Availability: 70.05%
First Year Capacity Factor:[4] 65.15%

Capacity Factor By Year of Operation

Year	Equivalent Availability	Capacity Factor
1	70.05%	65.15%
5	74.34	69.14
10	71.25	66.26
30	64.49	59.98

Levelized Capacity Factor: 64.83

DERIVATION OF CAPACITY FACTOR FOR A SUBCRITICAL COAL ALTERNATIVE TO LIMERICK 1 IN 1980

Sources and Notes

[1]The regression coefficients are taken from the regression equation reported at page 3 of this schedule. The footnotes to that table contain a detailed description of the definition of each of the variables in the equation.

[2]The characteristics assumed for the coal alternative to Limerick. The coal plant is assumed to consist of two 400 MW balanced draft units, burning coal with a 2.7 percent sulfur content. For the boiler manufacturer and architect/engineer variables, the value used in the average for all subcritical coal plants located in the United States, which began commercial operation between 1965 and 1989.

[3]Equivalent availability for the Limerick coal alternative is derived by multiplying the regression coefficient for each variable by the corresponding characteristic of the coal alternative. The sum of these cross products is equal to the first year equivalent availability.

[4]The first year capacity factor is derived by multiplying the first year equivalent availability by 0.93, the observed ratio of capacity factor to equivalent availability for large baseload coal units.

REGRESSION RELATING EQUIVALENT AVAILABILITY FOR SUBCRITICAL COAL UNITS TO SELECTED CHARACTERISTICS[1]

	Variable Mean[2] (1)	Regression Coefficient[3] (2)	t-Statistic[4] (3)
Equivalent Availability	75.0977	-	-
Constant	1.0000	176.1880	-
Log of Net Size[5]	5.6794	-12.6082	10.294
Reciprocal of Age[6]	0.1715	-20.2009	4.671
Log of Age[6]	2.1968	-7.3757	4.409
Vintage Indicators:[7]			
1961 or earlier	0.4334	-	-
1962-1971	0.3969	-4.3260	3.240
1972 or later	0.1697	-2.5554	1.244
Post-1974 Operating Year Indicator[8]	0.6868	-5.5160	5.915
Log of Sulfur Content[9]	0.5648	-1.1788	2.142
Cyclone Indicator[10]	0.1515	-4.5902	4.285
Balanced Draft Indicator[11]	0.5530	3.0564	3.683
Boiler Manufacturer Indicators:[12]			
Combustion Engineering	0.5319	-2.7526	2.993
Foster Wheeler	0.0871	-10.4096	7.519
Riley	0.0564	-5.3342	3.356
Architect/Engineer Indicators:[13]			
A/E - B	0.0712	-2.0778	1.562
A/E - S	0.0809	-4.6569	3.643
A/E Utility - S	0.0683	0.5539	0.412
A/E Utility - D	0.0387	3.8561	2.214
A/E Utility - A	0.0940	0.1323	0.089
A/E Utility - T	0.1555	-3.4080	2.967
A/E Utility - C	0.0746	-14.3542	10.161
A/E Utility Other or Unknown	0.3912	1.0019	0.856
Number of Observations		1,756	
Adjusted R^2		0.3023	
Standard Error		12.9920	

REGRESSION RELATING EQUIVALENT AVAILABILITY FOR SUBCRITICAL COAL UNITS TO SELECTED CHARACTERISTICS[1]

Sources and Notes

[1]The dependent variable in the regression is coal equivalent availability (expressed as a percent) for a large sample of subcritical coal units operating from 1969 to 1980. Initial partial years of operation were excluded as were years in which equivalent availability was less than or equal to 0.10 percent and years when a fuel other than coal was burned. Data are from NERC, Generating Availability Data System, Report on Equipment Availability, 1982, unless otherwise indicated.

[2]The variable mean is the average value of each of the variables in the analysis for the sample used to estimate the regression equation.

[3]The regression coefficient describes the effect of a one-unit change in the independent variable on the dependent variable.

[4]The t-statistic is the ratio of the mean of the coefficient to its standard error. It measures the reliability with which the coefficient is measured. A t-statistic of 1.96 or higher indicates that the coefficient is significantly different from zero at the 5 percent level. A t-statistic of 1.64 or higher indicates significance at the 10 percent level.

[5]Size is based on gross generator nameplate rating in megawatts as reported to the FPC, and is entered as the natural log of size. To convert to net it is multiplied by 0.9 for scrubber units and 0.93 otherwise.

[6]Age is measured as full calendar years of operation. The age variables are constructed as the reciprocal of age and the natural log of age.

[7]The indicator is equal to 1 if the unit began commercial operation in the particular years indicated and 0 otherwise. Units which came on-line prior to 1962 are treated as the reference group and are not explicitly included in the regression equation.

[8]The indicator is equal to 1 for 1974 and later operating years and 0 otherwise.

[9]Sulfur content is measured as percent by weight and is entered as the natural log of sulfur content. Coal sulfur content data are taken from FERC Form 67.

[10]The indicator is equal to 1 if the unit has a cyclone boiler and 0 otherwise. Cyclone boiler data are from S.M. Stoller Corporation, SMSC Pedigree Data for Fossil Units.

[11]The indicator is equal to 1 if the unit was built with a balanced draft boiler and 0 otherwise. This data was obtained from Electric World, Steam Station Design Survey, annually.

[12]The indicator is equal to 1 if the boiler was manufactured by the particular manufacturer indicated and 0 otherwise. Boiler manufacturer data were obtained from Kidder, Peabody & Co., Electric Utility Generating Equipment Data Base, or from Power Engineering, New Generating Plant, annually.

[13]The indicator is equal to 1 if the unit was built by the particular architect/engineer represented and 0 otherwise. Codes beginning with utility indicate that the utility was its own A/E for the unit. (Unknown indicates that A/E data for that unit were not available.) A/E data were obtained from the same sources as boiler manufacturer, which are listed in footnote 12.

ASSUMED PRICES FOR NUCLEAR FUEL CYCLE COMPONENTS BY YEAR OF ANALYSIS[1]

Year of Analysis	U_3O_8[2] (1984 $/lb) (1)	Conversion[3] (1984 $/Kg) (2)	Enrichment[4] (1984 $/SWU) (3)	Fuel Fabrication[5] (1984 $/Kg) (4)	Waste Disposal & Transportation[6] (1984 $/Kg) (5)
1975	$53.85	$8.85	$ 95.18	$212.37	$336.25
1976	67.12	8.85	107.00	212.37	336.25
1977	65.81	8.85	113.01	212.37	336.25
1978	61.35	8.85	119.90	212.37	336.25
1979	49.49	8.85	128.76	212.37	336.25
1980	33.75	8.85	135.19	212.37	336.25

Sources and Notes

[1]In deriving the fuel cost for Limerick the following assumptions were made. Assumed characteristics for nuclear fuel:

Enrichment Percentage	3.05%
Tails Assay Percentage	0.20%
Specific Power	23.30 MW/MT
Burnup	27,550 MWD (thermal)/MT

In calculating the cost for specific nuclear fuel components the following leads or lags between purchase and use were assumed:

Component	Lead or (Lag)
U_3O_8	3 years
Conversion	3 years
Enrichment	1.5 years
Fuel Fabrication	0.5 years
Waste Disposal	(5) years

ASSUMED PRICES FOR NUCLEAR FUEL CYCLE COMPONENTS BY YEAR OF ANALYSIS

Sources and Notes

We also assumed the following losses of fuel at each stage of processing:

Mining and milling	1.5%
Conversion and enrichment	0.5%
Fabrication	1.0%

[2]The nominal price per pound of U_3O_8 adjusted to mid-1984 dollars at actual general inflation rates. The prices are the average market prices as of the end of each analysis year published in NUEXCO, "Monthly Report on the Nuclear Fuel Market," No. 197 (January 1985): p. 22. In the analysis, U_3O_8 was assumed to escalate at 2.0 percent above the anticipated rate of general inflation.

[3]The nominal price per kilogram for conversion of U_3O_8 to UF_6 or uranium hexafloride, adjusted to mid-1984 dollars at actual general inflation rates. Prices are based on an estimate prepared by NUS Corporation. See NUS Corporation, "Draft Testimony of the NUS Corporation in the Matter of Generic and Environment Statement on Mixed Oxide Fuel" (November 1976): Exhibit 1.

[4]The nominal price per SWU for enrichment services adjusted to mid-1984 dollars at actual general inflation rates. The prices are the volume weighted averages of U.S. Department of Energy charges for enrichment services in each analysis year. The data were supplied to NERA by the Colorado Nuclear Corporation.

[5]The nominal price per kilogram for fuel fabrication adjusted to mid-1984 dollars at actual general inflation rates. The prices were obtained from the NUS Corporation (see footnote 3, ibid).

[6]The projected nominal price for nuclear waste transportation and disposal adjusted to mid-1984 dollars at actual general inflation rates. See NUS Corporation , ibid.

ASSUMED FUEL PRICES FOR COAL AND OIL ALTERNATIVES TO LIMERICK[1]

Analysis Year	Delivered Cost of Coal (1984 $/MMBtu) (1)	Delivered Cost of Coal (1984 $/ton) (2)	Delivered Cost of Oil (1984 $/MMBtu) (3)
1975	$ 2.14	$51.67	$ 3.47
1976	1.93	46.50	3.50
1977	1.89	45.71	3.46
1978	1.92	46.36	3.88
1979	1.96	47.37	5.16
1980	2.02	48.74	6.01

Sources and Notes

[1]Coal price data reflect the average cost of coal with a sulfur content greater than 1.5 percent delivered to the Eastern PJM region in each year. Cost data are taken from FERC Form 423. The coal price is converted to dollars per ton using a heat content of 12,064 BTU/lb.

[2]Oil prices are the average price of oil delivered to utilities in each analysis year, taken from U.S. Department of Energy, Cost and Quality of Fuels For Electic Utilities in the United States, annually.

DERIVATION OF HEAT RATE FOR A SUBCRITICAL COAL ALTERNATIVE TO LIMERICK 1 IN 1980

Variable	Regression Coefficient[1] (1)	Plant Characteristic[2] (2)	Cross Product[3] (3)
Constant	5,988.872	1	5,988.872
Log of Net Size	1,240.123	5.992	7,430.153
Reciprocal of Size	402,141	0.003	1,005.353
Log of Age	208.881	0	0
Reciprocal of Age	278.459	1	278.459
Vintage Indicators:			
1963 or Earlier	-		
1964-1970	303.626	0	0
1971-1975	442.311	0	0
1969 or Later	795.808	1	795.808
Log of Output Factor	-895.783	4.533	-4,060.226
Equivalent Availability	-6.282	70.054	-440.079
Log of Heat Content	-649.955	2.490	-1,618.535
Cyclone Indicator	130.175	0	0
Boiler Manufacturer Indicator:			
Combustion Engineering	80.807	0.544	43.943
Foster Wheeler	800.200	0.079	23.596
Riley	116.159	0.044	5.053
Turbine Manufacturer Indicator:			
Westinghouse	78.540	0.331	26.005
Allis-Chalmers	-31.244	0.033	-1.044
Architect/Engineer Indicator:			
A/E-B	26.009	0.068	1.766
A/E-S	-33.340	0.069	-2.304
A/E Utility-S	95.047	0.071	6.739
A/E Utility-D	-282.061	0.040	-11.254
A/E Utility-A	-52.228	0.098	-5.103
A/E Utiltiy-T	-106.702	0.163	-17.350
A/E Utility-C	-56.620	0.078	-4.416
A/E Utility Other or Unknown	42.440	0.408	17.316
First Year Gross Heat Rate: (Btu/kWh)			9,463
First Year Net Heat Rate[4]: (Btu/kWh)			10,175

Heat Rate By Year of Operation

Year	Gross Heat Rate	Net Heat Rate
	---------(Btu/kWh)---------	
1	9,463	10,175
5	9,576	10,297
10	9,693	10,423
30	9,904	10,649
Levelized Heat Rate:		10,446

DERIVATION OF HEAT RATE FOR A SUBCRITICAL COAL ALTERNATIVE TO LIMERICK 1 IN 1980

Sources and Notes

[1]The regression coefficients are taken from the regression equation reported at page 3 of this schedule. The footnotes to that table contain a detailed description of the definition of each of the variables in the equation.

[2]The characteristics assumed for the coal alternative to Limerick. The coal plant is assumed to consist of two 400 MW units burning coal with a heat content of 12,064 Btu/lb. Equivalent availability is derived as shown in page 1 of Schedule 16. For the boiler manufacturer, turbine manufacturer and the architect/engineer variables the values used are the averages for all subcritical coal plants located in the U.S. which began commercial operation from 1965 through 1979.

[3]The gross heat rate for the Limerick coal alternative is derived by multiplying the regression coefficient for each variable by the corresponding characteristic of the coal alternative. The sum of these cross products is equal to the first year gross heat rate.

[4]First year net heat rate is the gross heat rate divided by 0.93. Ninety-three percent is the average ratio of gross to net for coal-fired plants.

REGRESSION RELATING GROSS HEAT RATE FOR SUBCRITICAL COAL UNITS TO SELECTED CHARACTERISTICS[1]

	Variable Mean[2] (1)	Regression Coefficient[3] (2)	t-Statistic[4] (3)
Gross Heat Rate	9,355.70	-	-
Constant	1.0000	5,988.872	-
Log of Net Size[5]	5.6788	1240.123	6.119
Reciprocal of Size[5]	0.0037	402,141	6.305
Log of Age[6]	2.2230	208.881	3.993
Reciprocal of Age[6]	0.1659	278.459	1.844
Vintage Indicators:[7]			
1963 or earlier	0.5474	-	-
1964-1970	0.2752	303.626	6.952
1971-1975	0.1298	442.311	6.960
1976 or later	0.0476	795.808	9.250
Log of Output Factor[8]	4.3628	-895.783	9.675
Equivalent Availability[9]	75.2976	-6.282	6.962
Log of Heat Content[10]	2.3979	-649.955	4.755
Cyclone Indicator[11]	0.1549	130.175	3.384
Boiler Manufacturer Indicators:[12]			
Combustion Engineering	0.5438	80.807	2.365
Foster Wheeler	0.0786	300.200	5.337
Riley	0.0435	116.159	1.770
Turbine Manufacturer Indicators:[13]			
Westinghouse	0.3311	78.540	2.802
Allis-Chalmers	0.0334	-31.244	0.435
Architect/Engineer Indicators:[14]			
A/E - B	0.0679	26.009	0.504
A/E - S	0.0691	-33.340	0.647
A/E Utility - S	0.0709	95.047	1.894
A/E Utility - D	0.0399	-282.061	4.289
A/E Utility - A	0.0977	-52.228	1.001
A/E Utility - T	0.1626	-106.702	2.468
A/E Utility - C	0.0780	-56.620	1.015
A/E Utility-Other or Unknown	0.4080	42.440	1.125
Number of Observations		1679	
Adjusted R^2		0.3419	
Standard Error		467.560	

REGRESSION RELATING GROSS HEAT RATE FOR SUBCRITICAL COAL UNITS TO SELECTED CHARACTERISTICS

Sources and Notes

[1] The dependent variable in the regression is gross heat rate (Btu per kilowatt-hour) and was calculated using boiler-specific fuel consumption data from FERC Form 67. The data for the independent variables were obtained from NERC, Generating Availability Data System, Report on Equipment Availability, 1981, unless otherwise noted. The regression is based on a sample of subcritical coal units operating from 1969 through 1980. Initial partial years of operation were excluded as were years in which equivalent availability was less than or equal to 0.10 percent. Observations for which the coal heat, ash or moisture content was not available were also excluded.

[2] The variable mean is the average value of each of the variables in the analysis for the sample used to estimate the regression equation.

[3] The regression coefficient describes the effect of a one-unit change in the independent variable on the dependent variable.

[4] The t-statistic is the ratio of the mean of the coefficient to its standard error. It measures the reliability with which the coefficient is measured. A t-statistic of 1.96 or higher indicates that the coefficient is statistically different from zero at the 5 percent level. A t-statistic of 1.64 or higher indicates significance at the 10 percent level.

[5] Size is based on gross generator nameplate rating in megawatts as reported to the FPC, and is entered as the natural log of size and the reciprocal of size. To convert to net it is multiplied by 0.9 for scrubber units and 0.93 otherwise.

[6] Age is measured as full calendar years of operation. The age variables are constructed as the reciprocal of age and the natural log of age.

[7] The indicator is equal to 1 if the unit began commercial operation in the particular years indicated and 0 otherwise. Units which came on-line prior to 1964 are treated as the reference group and are not explicitly included in the regression equation.

[8] The output factor is defined as (Capacity Factor)/(Service Hours/Period Hours) and is entered as the natural log of the output factor.

[9] Equivalent availability is measured as a percent.

[10] Heat content is the average heat content of coal expressed as MBTU/lb and is entered as the natural log of heat content. Heat content data are obtained from FERC Form 67.

[11] The indicator is equal to 1 if the unit has a cyclone boiler and 0 otherwise. Cyclone boiler data are from S.M. Stoller Corporation, SMSC Pedigree Data for Fossil Units.

[12] The indicator is equal to 1 if the boiler was built by the particular manufacturer indicated and 0 otherwise. Boiler manufacturer data were obtained from Kidder, Peabody & Co., Electric Utility Generating Equipment Data Base, or from Power Engineering, New Generating Plant, annual.

[13] The indicator is equal to 1 if the turbine was built by the particular manufacturer indicated and 0 otherwise. Turbine manufacturer data are from the same sources as boiler manufacturer data which are listed in footnote 12.

REGRESSION RELATING GROSS HEAT RATE FOR SUBCRITICAL COAL UNITS TO SELECTED CHARACTERISTICS

Sources and Notes

[14]The indicator is equal to 1 if the unit was built by the particular architect/engineer represented and 0 otherwise. Codes beginning with utility indicate that the utility was its own architect/engineer for the unit. A/E data were obtained from the same sources as boiler manufacturer data listed in footnote 12.

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Dr. Perl has been responsible for a variety of studies relating to the economics of energy and the environment. These include analyses of the costs of air and water pollution control for the electric utility industry and for the copper, lead, and zinc industry, as well as various comparisons of the costs and benefits of specific environmental programs. He has also directed a number of econometric studies of the elasticity of demand for electricity, the elasticity of demand for telephone service, and the price of uranium. He has also been involved in the development of a model for projecting coal prices and a variety of studies evaluating the economics of alternative energy sources.

Dr. Perl has also been extensively involved in research on the economics of the labor market and particularly on the economic analysis of employee discrimination problems. He has assisted clients in evaluating their labor market practices, in developing constructive responses to charges of labor market discrimination brought by the EEOC and in developing Affirmative Action Programs.

1968-1972 — CORNELL UNIVERSITY--Ithaca, New York

Dr. Perl taught economics at the New York School of Industrial and Labor Relations. His fields of specialization were labor economics, econometrics and economic history.

EDUCATIONAL BACKGROUND:

UNIVERSITY OF CALIFORNIA AT BERKELEY
Ph.D., Economics, 1970
Dissertation Title: "The Role of Educational Investment and Family Background in the Production and Distribution of Educational Services"

UNIVERSITY OF CALIFORNIA AT BERKELEY
M.A., Economics, 1968

CORNELL UNIVERSITY
B.S., Industrial and Labor Relations, 1963

NUCLEAR-COAL

Publications:

with Frederick C. Dunbar, "Indexing Coal and Other Mineral Contracts," Eastern Mineral Law Foundation, Proceedings of the Third Annual Institute, (New York, New York: Matthew Bender, 1982), pp. 1-1 to 1-18.

Workshop on Concepts of Uranium Resources and Producibility, a report prepared by the Panel on Concepts of Uranium Resources (Washington, D.C.: National Academy of Sciences, 1978), pp. 126-147.

"Nuclear Power: Let's Not Pull the Plug," The Los Angeles Times, January 17, 1978.

"The Future of Nuclear Power in the Electric Utility Industry," Nuclear News, Vol. 17, No. 15, December 1974.

Speeches:

"The Economics of Nuclear Power," presented at the 1982 Annual Conference sponsored by the Atomic Industrial Forum, Washington, D.C., November 15, 1982.

"The Current Economics of Electric Generation from Coal in the U.S. and Western Europe," presented before the International Scientific Forum on 'Reassessing the World's Energy Prospects: The Critical Questions,' Paris, France, October 26, 1982.

"The Economics of Nuclear Power," presented at 'The Economics of Nuclear Power: Should Construction Proceed?' Seminar sponsored by National Economic Research Associates, Inc., New York, New York, June 3, 1982.

"Cost Comparisons Among Nuclear Plants Under Construction," presented at 'The Economics of Nuclear Power: Should Construction Proceed?' Seminar sponsored by National Economic Research Associates, Inc., New York, New York, June 3, 1982.

"The Economics of Canceling Nuclear Construction Projects," presented at 'The Economics of Nuclear Power: Should Construction Proceed?' Seminar sponsored by National Economic Research Associates, Inc., New York, New York, June 3, 1982.

"Planning to Meet Needs in An Optimal Way: Nuclear vs. Coal vs. the Other Sources," summary of remarks before 'Utility Planning and Management in An Era of Increasing Constraints,' a seminar sponsored by National Economic Research Associates, Inc. and Kidder, Peabody & Co., Inc., The Wigwam, Litchfield Park, Arizona, November 5-7, 1979.

"Wage and Benefit Comparisons for the United States Postal Service-- A Preliminary Analysis of Feasibility," prepared for the United States Postal Service, September 1973.

"Estimated Costs of Coal and Nuclear Generation," presented at a seminar sponsored by The New York Society of Security Analysts on 'Energy--The Next Steps: Policy, Pricing and Future Supply,' Downtown Athletic Club, New York, New York, December 12, 1978.

Exhibits on the economic considerations in energy production prepared for a seminar for the Atomic Safety and Licensing Board Panel Members, U.S. Nuclear Regulatory Commission, sponsored by the National Center for Administrative Justice, Bethesda, Maryland, December 1, 1978.

"The Impact of Nuclear Constraints on the Costs of Electric Generation," presented at The American Nuclear Society Executive Conference on the 'The Economic Viability of the Nuclear Industry,' Del Webb's Towne House, Phoenix, Arizona, October 17, 1978.

"Nuclear, Coal, or Both?— An Economic-Environmental Evaluation," before an Energy Seminar sponsored by the Louisiana Press Association, Baton Rouge, Louisiana, September 23-24, 1977.

"The Cost of Regulatory Uncertainties to the Nuclear Industry," before a Conference on Nuclear Power Financial Considerations sponsored by the Atomic Industrial Forum, Seattle, Washington, July 27, 1977.

"The Economic Viability of Nuclear Energy," before a Seminar for Members of Congress and Their Staffs sponsored by The Scientists' Institute for Public Information, Washington, D.C., June 7, 1976.

Testimonies:

Rebuttal testimony, commenting on the testimonies of Messrs. Charles Komanoff, Randall Falkenberg, Rudolph Yanuck and C. Hoff Stauffer, on behalf of Philadelphia Electric Company, Docket No. I-840381, March 18, 1985.

Testimony, with John H. Wile, estimating the cost of electric generation to CMP consumers using a market rule to determine the price of electricity from all units on the CMP system, on behalf of Central Maine Power Company, February 4, 1985.

Testimony, with John H. Wile, evaluating the economics of completing the Limerick 2 nuclear unit on behalf of the Philadelphia Electric Company, December 3, 1984.

Rejoinder testimony examining the responses in surrebuttal testimony of Mr. Rudolph Bertschi and Staff and responding to criticisms of Mr. Charles Komanoff on behalf of Long Island Lighting Company, October 29, 1984.

Rebuttal testimony describing changes in the analysis of Seabrook 1 completion to reflect Seabrook sales option discussed in the hearings, responding to inquiries about the savings from completing Seabrook and discussing methodological errors in the testimonies of Messrs. Rosen and Chernick on behalf of Central Maine Power Company, Bangor Hydro-Electric Company and Maine Public Service Company, October 5, 1984.

Rebuttal testimony examining the appropriateness of the method proposed by Charles Komanoff for establishing a cap on capital cost for Palo Verde on behalf of Arizona Public Service, ACC Docket No. U-1345-83-155, Part II, October, 1984.

Testimony discussing the appropriate methodology for evaluating the economic viability of the Seabrook 1 nuclear plant on behalf of United Illuminating, Docket No. DPUC 84-06-17, September 20, 1984.

Rebuttal testimony reviewing estimates of costs for Grand Gulf and a coal alternative presented by Mr. Thomas Flaherty and Mr. Thomas Weiss, on behalf of Mississippi Power and Light Company and Middle South Energy, Inc., September 10, 1984.

Testimony summarizing the results of Central Maine Power Company's capacity expansion plan based on their new modifications and projections, on behalf of the Central Maine Power Company, August 31, 1984.

Testimony, with John H. Wile, summarizing the results of our evaluation of the benefits of Seabrook 1 to Bangor Hydro-Electric Company's customers, on behalf of the Bangor Hydro-Electric Company, August 31, 1984.

Testimony, with John H. Wile, summarizing the results of our evaluation of the benefits of Seabrook 1 to Maine Public Service Company's customers, on behalf of the Maine Public Service Company, Docket No. 84-80 and the Maine Public Utilities Commission, Docket No. 84-113, August 31, 1984.

Testimony examining the economic benefits to consumers from past decisions to build the Seabrook 2 nuclear unit and from subsequent decisions to continue construction on that unit, on behalf of the owners of the Seabrook 1 project, August 27, 1984.

Rebuttal testimony reviewing testimony presented by Charles Komanoff before the Washington Utilities and Transportation Commission, on behalf of Puget Sound Power & Light Company, June 29, 1984.

Rebuttal testimony comparing the results of our statistical review of the costs of Shoreham to statistical reviews of such costs contained in the quantification testimony previously submitted by the New York State Public Service Commission Staff and Suffolk County, on behalf of the Long Island Lighting Company, May 25, 1984.

Testimony regarding a determination of whether the cost of the Schahfer 17 is in line with the costs of other coal-fired power plants and compariing the levelized costs for different size units to see if lower per kilowatt-hour costs could have been achieved by building a larger facility, on behalf of the Northern Indiana Public Service Company, May 1, 1984.

Testimony presenting the results of an analysis of the economic consequences of cancelling the Skagit/Hanford nuclear project and reflecting the cost of money faced by Washington Water Power Company and the effect of these changes, on behalf of the Washington Water Power Company, May 1, 1984.

Testimony examining the prudence of past decisions to continue the construction of Grand Gulf 2 and regarding the current economics of completing Grand Gulf 2, on behalf of Mississippi Power and Light Company and Middle South Energy, Inc., February 27, 1984.

Testimony regarding the economics of the Skagit/Hanford nuclear plant before the Washington Utilities and Transportation Commission, on behalf of Puget Sound Power & Light Company, November 3, 1983.

Testimony regarding the basis for the conclusions of NERA's 1980 study concerning the continued operation of VEPCO's North Anna Nuclear Plant Unit #3 and the cancellation of Unit #4, before the State Corporation Commission of Virginia, Case No. PUE830041, on behalf of the Virginia Electric and Power Co., July 25, 1983.

Testimony regarding the savings to consumers from the operation of the Grand Gulf nuclear project and an evaluation of the prudency of the original decision to build the plant, before the Mississippi Public Service Commission, on behalf of Mississippi Power & Light Co. and Middle South Energy, Inc., Docket No. U-4285, April 29, 1983.

Testimony regarding the future cost of oil and, based on that forecast, an evaluation of the proposal to trend revenue requirements for the Grand Gulf nuclear project, before the Louisiana Public Service Commission, on behalf of the Louisiana Power & Light Co., January 17, 1983.

Testimony regarding the future cost of oil and, based on that forecast, an evaluation of the proposal to trend revenue requirements for the Grand Gulf nuclear project, before the Louisiana Public Service Commission, on behalf of New Orleans Public Service, Inc., January 17, 1983.

Testimony to evaluate the economic impact on electric customers in Pennsylvania of allowing Lukens Steel to switch electricity suppliers, before the Pennsylvania Public Utility Commission, on behalf of Philadelphia Electric Co., Docket No. P-810310, December 22, 1982.

Testimony regarding an estimation of savings to consumers from the operation of the Grand Gulf nuclear project and an evaluation of the prudency of the original decision to build this unit, before the Federal Energy Regulatory Commission, on behalf of Middle South Energy, Inc., Docket No. ER 82-616, October 15, 1982.

Testimony regarding the cost of the proposed Limerick nuclear project vs. the cost of abandoning Limerick and meeting electricity needs from alternative sources, before the Pennsylvania Public Utility Commission, Docket No. 1-80100341, on behalf of Philadelphia Electric Company, Revised April 9, 1981.

Testimony examining the need for and desirability of the Allens Creek nuclear plant as a component of Houston Lighting & Power Company's generation expansion plan in the next decade, before the Nuclear Regulatory Commission Docket No. 50-466, on behalf of Houston Lighting & Power Company, December 18, 1980.

Oversight hearing on nuclear economics before the Ninety-Sixth Congress, Congress of the United States, United States House of Representatives, Subcommittee on Energy and the Environment of the Committee on Interior and Insular Affairs, July 12, 1979.

Testimony regarding the prospective cost of electricity from coal and nuclear plants in Ohio, before the Power Siting Commission, State of Ohio, in the matter of Ohio Edison Company, Erie Nuclear Power Plant Units 1 and 2, Case No. 01-00003, June 26, 1978.

Testimony regarding nuclear and coal capacity factors and their influence on the cost of electricity, before the Ninety-Fifth Congress, Congress of the United States, United States House of Representatives, Environment, Energy and Natural Resources Subcommittee of the Committee on Government Operations, September 15, 1977.

Testimony regarding assessment of the costs of electric generation for alternative unit sizes at the Sundesert Nuclear site in the matter of San Diego Gas & Electric Company, Docket No. 76-NOI-2, July 27, 1977.

Testimony regarding a general methodology for evaluating the economics of coal and nuclear-fired generating plants in New York in the matter of proceeding on motion of the Commission as to the comparative economics of nuclear and fossil fueled generating facilities before the State of New York Public Service Commission, Case No. 26974, June 17, 1977.

Testimony evaluating the comparison of nuclear and coal-fired alternatives in the matter of San Diego Gas & Electric Company, Docket No. 76-NOI-2, November 1, 1976.

Consulting Reports:

"An Evaluation of Capacity Planning and Load Forecasting for Central Maine Power Company," prepared for Central Maine Power Company, February 17, 1984.

"An Evaluation of the Economics of the Skagit/Hanford Nuclear Project," prepared for Puget Sound Power & Light Company, Pacific Power & Light Company, Portland General Electric Company, and Washington Water Power Company, September 15, 1983.

"An Analysis of the Grand Gulf Nuclear Project," prepared for Mississippi Power & Light Company, January 11, 1983.

"An Economic Evaluation of the Marble Hill Nuclear Project," prepared for the Staff of the Public Service Commission, State of Indiana in Commission Cause No. 36818, October 4, 1982.

"Estimated Market Prices of Coal Alternatives to Production from the Quarto Mine, 1980-2000," prepared for Ohio Edison Company, July 1980.

"A Comparison of the Projected Cost of Electricity from the Palo Verde Nuclear Plant and Selected Coal-Fired Alternatives, Part II: A Review and Critique of 'Energy Options for the Southwest: Part 1, Nuclear and Coal Power' (A Study Endorsed by Arizonans for Safe Energy)," prepared for Arizona Public Service Company, July 11, 1979.

"A Comparison of the Projected Costs of Electricity from the Palo Verde Nuclear Plant and Selected Coal-Fired Alternatives: Final Report," prepared for Arizona Public Service Company, April 30, 1979.

"An Analysis of the Economic Comparability of Alternatives to the Sundesert Nuclear Facility," prepared for San Diego Gas & Electric Company, March 1, 1978.

"Projected Construction Costs and Capacity Factors for the Sundesert Plant," prepared for San Diego Gas & Electric Company, December 20, 1977.

with Alan J. Fishbein, "The National Energy Plan and the Demand for and Economics of Electric Utility Coal Conversion," August 1977.

ELECTRICITY DEMAND

Publications:

"Why Utilities Can't Build the Power Plants We Need," Nation's Business, September 1975.

with Irwin M. Stelzer, "Energy Use and Population Growth," position paper prepared for Division 1, Ninth World Energy Conference, Detroit, Michigan, September 22-27, 1974.

Speeches:

"Planning in a World of Uncertainty," presented at Edison Electric Institute's Seventeenth Financial Conference, Coronado, California, October 19, 1982.

"Electric Utility Fuel Consumption in 1980," presented before 'Energy Outlook: The Next Two Years'; a conference sponsored by The Conference Board, New York, New York, December 7, 1977.

Testimonies:

Testimony examining the need for and desirability of the Allens Creek nuclear plant as a component of Houston Lighting & Power Company's generation expansion plan in the next decade, before the Nuclear Regulatory Commission Docket No. 50-466, on behalf of Houston Lighting & Power Company, December 18, 1980.

Testimony regarding the appropriate criteria for evaluating the need for the economic desirability of the Big Bend generating unit, before the Florida Public Service Commission, Docket No. 800595-EW, on behalf of Tampa Electric Company, December 4, 1980.

Testimony regarding load forecasting and capacity planning in California, before the Joint Committee on the State's Economy, San Diego, California, October 22, 1979.

Need for power testimony in the matter of Houston Lighting & Power Company (South Texas Project, Units 1 and 2), Docket Nos. 50-498, 50-499, April 1975.

Need for power testimony in the matter of Houston Lighting & Power Company (Allens Creek Nuclear Generating Station, Units 1 and 2), Docket Nos. 50-466, 50-467, March 1975.

Need for power testimony in the matter of Public Service Company of New Hampshire (Seabrook Station, Units 1 and 2), Docket Nos. 50-443, 50-444, January 1975.

Consulting Reports:

with Kent P. Anderson, "The Costs of Electricity Shortages and the Determination of Optimal System Reliability," January 17, 1980.

with Kent P. Anderson, "The Reliability of Electricity Generation, Reserve Margins and the Costs of Capacity Shortages Circa 1990," October 1, 1979.

OTHER ELECTRIC

Speeches:

"Incentive Effects of Utility Rate Trending," presented at the Workshop on "Alternative Electric Power Plant Financing and Cost Recovery Methods," National Science Foundation, Washington, D.C., May 7, 1984.

"Building to Minimize Generating Cost: Can We Afford It?", presented at a Workshop on the Electric Imperative, sponsored by Atomic Industrial Forum, Monterey, California, June 16, 1981.

Exhibits on the economic considerations in energy production prepared for a seminar for the Atomic Safety and Licensing Board Panel Members, U.S. Nuclear Regulatory Commission, sponsored by the National Center for Administrative Justice, Bethesda, Maryland, December 1, 1978.

"The Impact of Nuclear Constraints on the Costs of Electric Generation," presented at The American Nuclear Society Executive Conference on the 'The Economic Viability of the Nuclear Industry,' Del Webb's Towne House, Phoenix, Arizona, October 17, 1978.

"The Impact of Environmental Standards on the Financial Viability of the Electric Utility Industry," presented at the Edison Electric Institute's Financial Division Annual Meeting, New York, New York, May 19, 1978.

"Cost of Alternative Air Pollution Strategies for the Electric Utility Industry," before the Annual Meeting of the Air Pollution Control Association, Portland, Oregon, June 29, 1976.

"Growth of the Electric Utility Industry in the Decade of the 1970s," before the Financial Analysts Federation Fall Conference, Detroit, Michigan, October 8, 1974.

Testimonies:

Testimony regarding the inclusion of construction work in progress (CWIP) in rate base, before the Pennsylvania Public Utility Commission, on behalf of Philadelphia Electric Company, Docket No. R-811626, Revised December 22, 1981.

Testimony concerning the regulation of the fuel cost adjustment clause contained within the rate schedules of the Ohio Edison Company, before the State of Ohio, Public Utilities Commission, Case No. 80-235-EL-FAC, on behalf of Ohio Edison Company, July 1980.

Testimony regarding the determination of appropriate rentals to be paid for the Pelton hydroelectric site during the period 1978 to 1987, before the Federal Energy Regulatory Commission, Project No. 2030, on behalf of Portland General Electric Company, January 30, 1980.

Testimony evaluating costs of alternative sources of electrical generation before the Wisconsin Public Service Commission, October 28, 1977.

Testimony on the costs and environmental benefits of closed cycle cooling systems in the matter of Carolina Power & Light Company (Brunswick Steam Electric Plants, Units 1 and 2), June 1976.

Consulting Reports

with David M. Blitzer, "An Examination of the Economic Issues Raised by Interim Regulations Issued by the Economic Regulatory Administration Under the Powerplant and Industrial Fuel Use Act of 1978," prepared for Edison Electric Institute, October 31, 1979.

with Kent P. Anderson, "The Reliability of Electricity Generation, Reserve Margins and the Costs of Capacity Shortages Circa 1990," October 1, 1979.

with John H. Wile, "Further Comments on the Economic Impacts of EPA's September 19, 1978 Proposed Revision to New Source Performance Standards for Electric Utility Steam Generating Units", prepared for the Utility Air Regulatory Group, January 15, 1979.

with John H. Wile, "Comments on the Economic Impacts of EPA's September 19, 1978 Proposed Revision to New Source Performance Standards for Electric Utility Steam Generating Units," prepared for the Utility Air Regulatory Group, January 12, 1979.

with John H. Wile, "Analysis of the Economic Impacts of Alternative Proposed Revisions to New Source Performance Standards," prepared for the Utility Air Regulatory Group of Edison Electric Institute, September 5, 1978.

with Kent P. Anderson, "An Evaluation of Electricity Supply Alternatives for California," prepared for The California Council for Environmental and Economic Balance, July 16, 1978.

with David M. Blitzer, "Status of Present and Planned Intake and Discharge Systems for the Electric Utility Industry: The Results of a Survey," prepared for the Utility Water Act Group, May 15, 1978.

with David M. Blitzer, "Costs and Economic Impacts of Steam Electric Pretreatment Standards," prepared for the Utility Water Act Group Task Force, August 11, 1977.

"An Analysis of the Economic and Environmental Costs of Alternative SO_2 Control Systems for Public Service Indiana," prepared for Public Service Company of Indiana, September 22, 1976.

"Estimated Costs for the Electric Utility Industry of Non-Significant Deterioration Amendments Currently Considered by the United States House of Representatives," prepared for the Clean Air Coordinating Committee of the Electric Utility Industry, July 15, 1976.

"Estimated Costs for the Electric Utility Industry of Non-Significant Deterioration Amendments Currently Considered by the United States Senate," prepared for the Clean Air Coordinating Committee of the Electric Utility Industry, April 16, 1976.

"An Analysis of the Costs to the Electric Utility Industry of House and Senate Significant Deterioration Proposals," prepared for the Clean Air Coordinating Committee of the Electric Utility Industry, December 12, 1975.

"The Costs of Reducing SO_2 Emissions from Electric Generating Plants," prepared for the Clean Air Coordinating Committee of the Electric Utility Industry, June 1975.

"Comments on the Economic Impact of the Environmental Protection Agency's Proposed Effluent Guidelines," prepared for Edison Electric Institute Ad Hoc Water Quality Group and Utility Water Act Group, June 26, 1974.

"Estimates of the Value of Changes in Aquatic Life Resulting from Reductions in Thermal Effluent," prepared for Edison Electric Institute Ad Hoc Water Quality Group and Utility Water Act Group, June 26, 1974.

"Costs and Benefits of Thermal Effluent Reduction," prepared for Edison Electric Institute Ad Hoc Water Quality Group and Utility Water Act Group, June 26, 1974.