Statistical Background Data

- Interest Rates and Other Financial Information
- Capital Expenditures in the Energy Sector
- Energy Shares of Rail and Waterborne Transport
- Historical Federal Spending on Energy R&D
- Energy Sector Contributions to Selected Environmental Problems
- Summary of Cost Studies of Environmental Problems and Regulation
- Conversion Data Used to Generate Subsidy Intensity Estimates
- Electricity Mix in 1989

Interest Rates and Economic Indicators Worksheet

Year	Treasury Securities (Constant Maturities) 1 year (1)	3 year (2)	10 year (1)	20 year (1)	30 year (3)	Last Refinan. (4)	Refin. Rate (5)	High-Grade Munic. (S&P) (6)	Prime Rate (7)	Federal Funds Rate (8)	Corporate Bonds (Aaa) (Moodys) (9)	(Baa) (Moodys) (9)	Public Utility Bonds (AA) (S&P) (10)	(A) (S&P) (10)	(BBB) (S&P) (10)	Light, Pow., Gas Moody's Wgtd. Ave. (11)	Utility Last Refinance Year (12)	Rate at Last Refin. (5)	GNP Implicit Price Defl. (1982=100) (13)	Bond-Buyer High Grade Bonds (14)
1909						1969	0.06320										1969	0.07980		
1910						1970	0.06870										1970	0.08790		
1911						1971	0.06120										1971	0.07700		
1912						1972	0.06010										1972	0.07500		
1913						1973	0.07120										1973	0.07910		
1914						1974	0.08060										1974	0.09590		
1915						1975	0.07990										1975	0.09970		
1916						1976	0.07610										1976	0.08920		
1917						1977	0.07750										1977	0.08430		
1918						1978	0.08490										1978	0.09300		
1919					0.04730	1979	0.09280										1979	0.10850		
1920					0.05320	1980	0.11270										1980	0.13460		0.0497
1921					0.05090	1981	0.13450										1981	0.16310		0.0502
1922					0.04300	1982	0.12760													
1923					0.04360	1983	0.11180									0.06020	1982	0.14930		0.0419
1924					0.04060	1984	0.12410									0.06140	1983	0.12700		0.0423
1925					0.03860	1985	0.10790									0.05900	1984	0.14250		0.0419
1926					0.03680	1986	0.07780									0.05500	1985	0.11830		0.0409
1927					0.03340	1987	0.08590									0.05400	1986	0.09610		0.0408
1928					0.03330	1988	0.08960									0.05110	1987	0.09740		0.0397
1929					0.03600	1959	0.04130	0.04270	0.05750		0.04730	0.05900				0.05010	1988	0.10030		0.0398
1930					0.03290	1960	0.04060									0.05370	1959	0.04920	15.0	0.0429
1931					0.03340	1961	0.03920									0.05110	1960	0.04720	14.6	0.0408
1932					0.03680	1962	0.03990									0.04650	1961	0.04720	13.3	0.0388
1933					0.03310	1963	0.04050	0.04710	0.02750		0.04490	0.07760				0.05660	1962	0.04400	11.9	0.0433
1934					0.03120	1964	0.04190									0.04950	1963	0.04400	11.7	0.043
1935					0.02790	1965	0.04270									0.04810	1964	0.04550	12.5	0.0373
1936					0.02690	1966	0.04770									0.03920	1965	0.04610	12.7	0.0299
1937					0.02740	1967	0.05010									0.03560	1966	0.05530	12.7	0.0263
1938					0.02610	1968	0.05450									0.03560	1967	0.06070	13.2	0.0267
1939					0.02410	1969	0.06320	0.02760	0.01500		0.03100	0.04960				0.03490	1968	0.06800	13.0	0.0258
1940					0.02260	1970	0.06870	0.02500	0.01500		0.02840	0.04750				0.03450	1969	0.07980	12.7	0.0242
1941					0.02050	1971	0.06120	0.02100	0.01500		0.02770	0.04330	0.02812	0.02995	0.03451	0.03090	1970	0.08790	13.0	0.022
1942					0.02460	1972	0.06010	0.02360	0.01500		0.02830	0.04280	0.02865	0.02998	0.03400	0.03150	1971	0.07700	13.8	0.018
1943					0.02470	1973	0.07120	0.02060	0.01500		0.02730	0.03910	0.02729	0.02927	0.03165	0.03350	1972	0.07500	14.7	0.0188
1944					0.02480	1974	0.08060	0.01860	0.01500		0.02720	0.03610	0.02712	0.02921	0.03126	0.03260	1973	0.07910	15.1	0.0158
1945					0.02370	1975	0.07990	0.01670	0.01500		0.02620	0.03290	0.02650	0.02800	0.02925	0.02970	1974	0.09590	15.3	0.0134
1946					0.02190	1976	0.07610	0.01640	0.01500		0.02530	0.03050	0.02571	0.02662	0.02812	0.02870	1975	0.09970	15.7	0.0121
1947					0.02250	1977	0.07750	0.02010	0.01625		0.02610	0.03240	0.02654	0.02730	0.02897	0.02740	1976	0.08920	19.4	0.0123
1948					0.02440	1978	0.08490	0.02400	0.01875		0.02820	0.03470	0.02910	0.03020	0.03213	0.02790	1977	0.08430	22.1	
1949					0.02310	1979	0.09280	0.02210	0.02000		0.02660	0.03420	0.02744	0.02867	0.03157	0.03070	1978	0.09300	23.6	
1950					0.02320	1980	0.11270	0.01980	0.02070		0.02620	0.03240	0.02666	0.02743	0.03065	0.03060	1979	0.10850	23.5	
1951					0.02570	1981	0.13450	0.02000	0.02560		0.02860	0.03410	0.02941	0.03107	0.03430	0.02860	1980	0.13460	23.9	
1952					0.02680	1982	0.12760	0.02190	0.03000		0.02960	0.03520	0.03046	0.03224	0.03488	0.03250	1981	0.16310	25.1	
1953	0.02140	0.02470	0.02850	0.03060		1983	0.11180	0.02720	0.03170		0.03200	0.03740	0.03327	0.03468	0.03716	0.03360	1982	0.14930	25.5	
1954	0.01050	0.01630	0.02400	0.02640		1984	0.12410	0.02370	0.03050		0.02900	0.03510	0.02979	0.03149	0.03407	0.03750	1983	0.12700	25.9	
1955	0.02040	0.02470	0.02820	0.02900		1985	0.10790	0.02530	0.03160	0.01780	0.03060	0.03530	0.03139	0.03302	0.03417	0.03110	1984	0.14250	26.3	
1956	0.02990	0.03190	0.03180	0.03140		1986	0.07780	0.02930	0.03770	0.02730	0.03360	0.03880	0.03479	0.03689	0.03830	0.03300	1985	0.11830	27.2	
1957	0.03620	0.03980	0.03650	0.03540		1987	0.08590	0.03600	0.04200	0.03110	0.03890	0.04710	0.04052	0.04350	0.04674	0.03860	1986	0.09610	28.1	
1958	0.02270	0.02840	0.03320	0.03480		1988	0.08960	0.03560	0.03830	0.01570	0.03790	0.04730	0.03904	0.04119	0.04533	0.04800	1987	0.09740	29.1	
1959	0.04240	0.04460	0.04330	0.04130		1959	0.04130	0.03950	0.04480	0.03300	0.04380	0.05050	0.04533	0.04689	0.04996	0.04180	1988	0.10030	29.7	
1960	0.03630	0.03980	0.04120	0.04060		1960	0.04060	0.03730	0.04820	0.03220	0.04410	0.05190	0.04543	0.04659	0.04817	0.04920	1959	0.04920	30.4	
1961	0.02980	0.03540	0.03880	0.03920		1961	0.03920	0.03460	0.04500	0.01960	0.04350	0.05080	0.04517	0.04611	0.04699	0.04720	1960	0.04720	30.9	
1962	0.03100	0.03470	0.03950	0.03990		1962	0.03990	0.03180	0.04500	0.02680	0.04330	0.05020	0.04336	0.04423	0.00453	0.04720	1961	0.04720	31.2	
1963	0.03360	0.03670	0.04000	0.04050		1963	0.04050	0.03230	0.04500	0.03180	0.04260	0.04860	0.04316	0.04374	0.04454	0.04400	1962	0.04400	31.9	
1964	0.03850	0.04030	0.04190	0.04190		1964	0.04190	0.03220	0.04500	0.03500	0.04400	0.04830	0.04435	0.04501	0.04597	0.04400	1963	0.04400	32.4	
1965	0.04150	0.04220	0.04280	0.04270		1965	0.04270	0.03270	0.04540	0.04070	0.04490	0.04870	0.04547	0.04631	0.04766	0.04550	1964	0.04550	32.9	
1966	0.05200	0.05230	0.04920	0.04770		1966	0.04770	0.03820	0.05630	0.05110	0.05130	0.05670	0.05232	0.05369	0.05641	0.04610	1965	0.04610	33.8	
1967	0.04880	0.05030	0.05070	0.05010		1967	0.05010	0.03980	0.05610	0.04220	0.05510	0.06230	0.05667	0.05804	0.06068	0.05530	1966	0.05530	35.0	
1968	0.05690	0.05680	0.05650	0.05450		1968	0.05450	0.04510	0.06300	0.05660	0.06180	0.06940	0.06360	0.06556	0.06878	0.06070	1967	0.06070	35.9	
1969	0.07120	0.07020	0.06670	0.06320		1969	0.06320	0.05810	0.07960	0.08200	0.07030	0.07810	0.07394	0.07574	0.07902	0.06800	1968	0.06800	37.7	
1970	0.06900	0.07290	0.07350	0.06870		1970	0.06870	0.06510	0.07910	0.07180	0.06040	0.09110	0.08347	0.08698	0.09115	0.07980	1969	0.07980	39.8	
1971	0.04890	0.05650	0.06160	0.06120		1971	0.06120	0.00570	0.05720	0.04660	0.07390	0.08560	0.07712	0.08238	0.08615	0.06790	1970	0.06790	42.0	
1972	0.04950	0.05720	0.06210	0.06010		1972	0.06010	0.05270	0.05250	0.04430	0.07210	0.08160	0.07525	0.07796	0.08047	0.07700	1971	0.07700	44.4	
1973	0.07320	0.06950	0.06850	0.07120		1973	0.07120	0.05180	0.08030	0.06730	0.07440	0.08240	0.07829	0.08034	0.08173	0.07500	1972	0.07500	46.5	
1974	0.08200	0.07820	0.07560	0.08060		1974	0.08060	0.06090	0.10810	0.10500	0.08570	0.09500	0.08634	0.08748	0.09084	0.07910	1973	0.07910	49.5	
																0.09590	1974	0.09590	54.0	

Interest Rates and Economic Indicators Worksheet

Year	Treasury Securities 1 year (Constant Maturities)	3 year	10 year	20 year	30 year	Last Refinan.	Refin. Rate	High-Grade Munic. (S&P)	Prime Rate	Federal Funds Rate	Corporate Bonds (Aaa) (Moodys)	(Baa) (Moodys)	Public Utility Bonds (AA) (S&P)	(A) (S&P)	(BBB) (S&P)	Light, Pow., Gas Moody's Wgtd. Ave.	Utility Last Refinance Year	Rate at Last Refin.	GNP Implicit Price Defl. (1982=100)	Bond-Buyer High Grade Bonds
	(1)	(2)	(1)	(1)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(9)	(10)	(10)	(10)	(11)	(12)	(5)	(13)	(14)
1975	0.06780	0.07490	0.07990	0.08200	0.07990	1975	0.07990	0.06890	0.07860	0.05820	0.08830	0.10610	0.09172	0.09499	0.10210	0.09970	1975	0.09970	59.3	
1976	0.05880	0.06770	0.07610	0.07860	0.07610	1976	0.07610	0.06490	0.06840	0.05040	0.08430	0.09750	0.08815	0.09045	0.09638	0.08920	1976	0.08920	63.1	
1977	0.06080	0.06690	0.07420	0.07670	0.07750	1977	0.07750	0.05560	0.06830	0.05540	0.08020	0.08970	0.08443	0.08596	0.08857	0.08430	1977	0.08430	67.3	
1978	0.08340	0.08290	0.08410	0.08480	0.08490	1978	0.08490	0.05900	0.09060	0.07930	0.08730	0.09490	0.09057	0.09198	0.09477	0.09300	1978	0.09300	72.2	
1979	0.10650	0.09710	0.09430	0.09320	0.09280	1979	0.09280	0.06390	0.12670	0.11190	0.09630	0.10690	0.09969	0.10170	0.10690	0.10850	1979	0.10850	78.6	
1980	0.12000	0.11550	0.11430	0.11360	0.11270	1980	0.11270	0.08510	0.15270	0.13360	0.11940	0.13670	0.12256	0.12469	0.13560	0.13460	1980	0.13460	85.7	
1981	0.14800	0.14440	0.13920	0.13720	0.13450	1981	0.13450	0.11230	0.18870	0.16380	0.14170	0.16040	0.14670	0.14910	0.15969	0.16310	1981	0.16310	94.0	
1982	0.12270	0.12920	0.13010	0.12920	0.12760	1982	0.12760	0.11570	0.14860	0.12260	0.13790	0.16110	0.14037	0.14362	0.15312	0.14930	1982	0.14930	100.0	
1983	0.09580	0.10450	0.11100	0.11340	0.11180	1983	0.11180	0.09470	0.10790	0.09090	0.12040	0.13550	0.12012	0.12287	0.12812	0.12700	1983	0.12700	103.9	
1984	0.10910	0.11890	0.12460	0.12490	0.12410	1984	0.12410	0.10150	0.12040	0.10230	0.12710	0.14190	0.13084	0.13382	0.14087	0.14250	1984	0.14250	107.7	
1985	0.08420	0.09640	0.10620	0.10970	0.10790	1985	0.10790	0.09160	0.09930	0.08100	0.11370	0.12720	0.11373	0.11772	0.12112	0.11830	1985	0.11830	110.9	
1986	0.06450	0.07060	0.07670	0.07840	0.07780	1986	0.07780	0.07380	0.08330	0.06810	0.09020	0.10390	0.09230	0.09600	0.10000	0.09610	1986	0.09610	113.8	
1987	0.06770	0.07680	0.08390		0.08590	1987	0.08590	0.07730	0.08210	0.06660	0.09380	0.10580	0.09550	0.09860	0.10290	0.09740	1987	0.09740	117.4	
1988	0.07650	0.08260	0.08850		0.08960	1988	0.08960	0.07760	0.09320	0.07570	0.09710	0.10830	0.09930	0.10210	0.10520	0.10030	1988	0.10030	121.3	
1989	0.08530	0.08550	0.08490		0.08450	1989	0.08450	0.07240	0.10870	0.09210	0.09260	0.10180	0.09430	0.09720	0.09930	0.09920	1989	0.09920	126.3	
1990	0.07890	0.08260	0.08550		0.08610	1990	0.08610	0.07250	0.10010	0.08100	0.09320	0.10360				0.09820			131.5	
1991	0.05860		0.07860		0.08140	1991	0.0814													

Other Financial Spread Information

	Low End	High End
Committment Fee for Lines of Credit	0.125%	0.750% (Note 15)

Notes:

(1) Constant maturities. Data from 1953-1962 are from the Federal Reserve Bulletin, "Annual Statistical Digest, 1978 Edition," p. 117. Data on 1962-present provided by the Federal Reserve System, Division of Monetary Affairs, January 1992.

(2) Constant maturities. Data from 1953-1962 are from the "1991 Economic Report of the President," p. 368.

(3) Data on 30-year Treasury Bond yields for the early part of the century are not printed in time series produced by the Federal Reserve, Moody's, Standard & Poors, or the Economic Report of the President. Generally, a "long-term" rate is listed, which aggregates yields on issues which exceed between 8 and 12 years, depending on the year in question. According to the Center for Research and Security Prices at the University of Chicago Business School, however, the U.S. Government has issued 30-year bonds since 1929. We therefore use the long-term bond data available historically, and assume that the duration of the bonds were 30-years for the purpose of imputed refinancing calculations. This assumption is a conservative one since with a few exceptions long-term bond rates after 1930 generally exceeded shorter term ones. Therefore, using short-term yields will likely understate the actual cost of funds to some degree. In addition, we assume that these 30-year notes were generally available, which we do not know was the case. This assumption is also conservative since it reduces the number of refinancings necessary during the high inflation 1980s. Finally, the error from this assumption is not likely to be very large. Between 1919 and 1952 (when data on 20-year bond yields begins), the variation on basic yields of corporate bonds of 10 versus 30 years in duration was generally less than 0.5%. Data sources are as follow: 1919-1952 are from the U.S. Department of Commerce, "Historical Statistics of the United States, Colonial Times to 1970," Series X-474 - X-491. Unweighted averages of yields, with durations of 8 years or more through 1925, 12 years or more from 1925-1934, and 15 years from 1935-1952. Data on 30-year bonds after this date were provided by the Federal Reserve System, Division of Monetary Affairs in January 1992, and refer to constant maturities.

(4) The last refinancing column lists the date at which money borrowed at the date shown in the first column would have last been refinanced. This date is used to assess the refinancing risk borne by the federal government by lending for terms longer than generally available in the market. The refinancing date ignores reverse-yield curves and mid-term refinancings and assumes that the longest term bonds available at each refinancing were purchased. The longest generally available bonds were 30-year issues (see Debt Technical Appendix for more detail on this assumption). Therefore, funds borrowed in 1925 would be refinanced in both 1955 and 1985, with 1985 listed as the last refinancing date.

(5) The refinancing rate is the yield on the longest term bonds at the time of last refinancing. The subsidy associated with these loans is measured as the difference between the rate the money was lent at, and the interest paid on bonds at last refinancing (see note 3).

(6) Data are Standard & Poor's taken from the 1991 "Economic Report of the President," p. 368.

(7) Data are generally the average monthly rate, although the years 1929, 1930, 1947, and 1948 are the simple average of the range. Data are from the 1991 "Economic Report of the President," p. 368.

(8) "Economic Report of the President," 1991, p. 368. Prior to 1975, data are the average of daily averages comprised of the "most representative rate;" beginning in 1975, the weighted average of transactions is presented.

(9) "Economic Report of the President," 1991, p. 368.

(10) Public Power Bond rates are from Standard & Poor's Statistical Service, "Security Price Index Record", 1990 Edition, pp. 237-239. According to Standard & Poor, this data set uses 20-year bond issues. Although longer-term power bonds are issued, S&P does not systematically track them.

(11) Data reflect the weighted average interest rates on new capital for light, power, and gas utility bonds from "Moody's Public Utility Manual." Includes borrowing by government-owned enterprises; Rates paid by investor-owned utilities may be higher on average, although most new municipal issues are revenue bonds, which are not guaranteed by the power to tax. This would tend to reduce the spread between municipal and private borrowers.

(12) The last refinancing year is the same as described above in Note 4. Although the yield data are for 20-year issues, we conservatively assume they are for 30-years in our imputed refinancing calculations. See Note 3 for more detail on the implications of this assumption.

(13) Data for 1929-1938 are from the U.S. Department of Commerce, "Historical Statistics of the United States, Colonial Times to 1970," Series E 1-22. Later data are from the 1991 "Economic Report of the President," p. 290. Earlier data were scaled from a 1958 base year to a 1982 base year and do not match the later data exactly.

(14) Annual averages. From Sidney Homer, "A History of Interest Rates," Rutgers University Press, 1977.

Interest Rate Premium for Tax-Exempt Bonds

Value of Government Intermediation in Borrowing

Year	Corporate (Moody's (Aaa) (1)	Municipals (Moody's (Aaa) (2)	Munic./ Corporate (2/1)	Corporate - Munic. (1-2)	Max. Tax Bracket (3)	Rate Reduction Net of Tax Shield (4)	Short-Term Debt 6-Month Treasury Bill (5)	6-Month Commercial Paper (6)	Commercial Mnus Gov't (6-5)	Long-Term Debt 30-year Treasury Bonds (7)	Moody's Corporate (Aaa) (1)	Highest Grade Commercial Mnus Gov't (7-1)
1971	0.0739						0.04511	0.0511	0.599%	0	0.0739	
1972	0.0721						0.04466	0.0473	0.264%	0	0.0721	
1973	0.0744						0.07178	0.0815	0.972%	0	0.0744	
1974	0.0857						0.07926	0.0984	1.914%	0	0.0857	
1975	0.0883						0.06122	0.0632	0.196%	0.0799	0.0883	0.0084
1976	0.0843						0.05266	0.0534	0.074%	0.0761	0.0843	0.0082
1977	0.0802						0.0551	0.0561	0.100%	0.0775	0.0802	0.0027
1978	0.0873						0.07572	0.0799	0.418%	0.0849	0.0873	0.0024
1979	0.0963						0.10017	0.1091	0.893%	0.0928	0.0963	0.0035
1980	0.1194	0.07846	65.71%	4.09%	0.46	2.21%	0.11374	0.1229	0.916%	0.1127	0.1194	0.0067
1981	0.1417	0.10423	73.55%	3.75%	0.46	2.02%	0.13776	0.1476	0.984%	0.1345	0.1417	0.0072
1982	0.1379	0.10875	78.86%	2.91%	0.46	1.57%	0.11084	0.1189	0.806%	0.1276	0.1379	0.0103
1983	0.1204	0.08800	73.09%	3.24%	0.46	1.75%	0.0875	0.0889	0.140%	0.1118	0.1204	0.0086
1984	0.1271	0.09608	75.59%	3.10%	0.46	1.68%	0.098	0.1016	0.360%	0.1241	0.1271	0.003
1985	0.1137	0.08603	75.67%	2.77%	0.46	1.49%	0.0766	0.0801	0.350%	0.1079	0.1137	0.0058
1986	0.0902	0.06951	77.06%	2.07%	0.46	1.12%	0.0603	0.0639	0.360%	0.0778	0.0902	0.0124
1987	0.0938	0.07124	75.95%	2.26%	0.34	1.49%	0.0605	0.0685	0.800%	0.0859	0.0938	0.0079
1988	0.0971	0.07357	75.76%	2.35%	0.34	1.55%	0.0692	0.0768	0.760%	0.0896	0.0971	0.0075
1989	0.0926	0.06995	75.54%	2.27%	0.34	1.49%	0.0804	0.088	0.760%	0.0845	0.0926	0.0081
		Average	74.68%	2.88%	Average	1.64%	0.0747			Ave., 1975-89		0.006847

Historical Studies of Spread (Note 8):

1946-68 74.1250% Prime municipals/long governments
1946-68 63.5417% Prime municipals/new callable utilities

Source: Homer and Johannesen, 119.

1952-67 71.5356% Aaa Municipals/Aaa seasoned corporate bonds
1967-76 70.6434% Aaa Municipals/Aaa seasoned corporate bonds

Source: Mussa and Kormendi, 66.

(1) "Economic Report of the President," 1991, p. 368.
(2) "Moody's Municipal & Government Manual," Municipal Bond Yield Averages, average of monthly figures. 1991, V. 2, pp. a6-a10.
(3) Tax bracket figures assume maximum corporate rate, which dropped in the Tax Reform Act of 1986.
(4) The "tax shield" refers to the portion of the higher interest costs that would have been deductible from taxable income, and therefore not constituted an out-of-pocket expense to the borrower. The interest rate benefit net of the tax shield is (1-tax rate)(interest rate spread between taxable and tax-exempt bonds).
(5) "Economic Report of the President," 1991, p. 368.
(6) "Economic Report of the President," 1991, p. 368.
(7) From RATES2.WK1, previous page.
(8) Sidney Homer and Richard Johannesen, "The Price of Money, 1946 to 1969," Rutgers University Press, 1969. Michael Mussa and Roger Kormendi, "The Taxation of Municipal Bonds: An Economic Appraisal." Washington, DC: American Enterprise Institute, 1979.
(9) Spreads tend to be lower on longer term issues.

Historical Data on Real Rates of Return

Instrument	Period	Nominal Yield		Real Yield, Pre-Tax		Real Yield, After-Tax		Source
		Arithmetic	Geometric	Arithmetic	Geometric	Arithmetic	Geometric	
L-T Gov't Bonds	1926-1990	0.049	0.046	0.018	0.014	0.006	0.002	Siegel, 31
	1946-1990	0.049	0.045	0.005	-0.01	-0.011	-0.016	Siegel, 31
	1966-1981	0.028	0.025	-0.039	-0.042	-0.056	-0.059	Siegel, 31
	1966-1990	0.074	0.068	0.016	0.009	-0.007	-0.013	Siegel, 31
	1982-1990	0.157	0.149	0.113	0.105	0.079	0.073	Siegel, 31
S-T Gov't Bonds	1926-1990			0.006	0.005	-0.002	-0.003	Siegel, 31
	1946-1990			0.004	0.003	-0.008	-0.009	Siegel, 31
	1966-1981			-0.001	-0.002	-0.019	-0.019	Siegel, 31
	1966-1990			0.013	0.012	-0.005	-0.006	Siegel, 31
	1982-1990			0.037	0.037	0.018	0.018	Siegel, 31
Stocks	1926-1990	0.119	0.098			0.074	0.053	Siegel, 30; real after tax yield includes dividends and capital gains
	1946-1990	0.12	0.111			0.06	0.049	Siegel, 30; real after tax yield includes dividends and capital gains
	1966-1981	0.073	0.062			-0.009	-0.018	Siegel, 30; real after tax yield includes dividends and capital gains
	1966-1990	0.107	0.096			0.033	0.022	Siegel, 30; real after tax yield includes dividends and capital gains
	1982-1990	0.167	0.159			0.105	0.098	Siegel, 30; real after tax yield includes dividends and capital gains
L-T Corporate Bonds	1926-1990		0.052		0.002			Ibbotson, 74

Notes:

(1) "L-T" refers to "Long-Term;" "S-T" refers to "Short-Term."

Sources:

(1) Ibbotson Associates. "Stocks, Bonds, Bills and Inflation, 1991 Yearbook," Market Results for 1926-1990. (Chicago, IL: Ibbotson Associates, 1991).

(2) Jeremy Siegel. "The Equity Premium: Stock and Bond Returns Since 1802." Financial Analysts Journal, Jan./Feb. 1992, pp. 28-38.

Summary Table: Energy Shares of Capital Spending Between 1980 and 1989

Energy Type	Amount ($Mils)	Share of Energy Cap. Spending	Comments
Crude Oil	273,042	31.47%	
Natural Gas	192,637	22.20%	
Coal	74,052	8.53%	
Solar (Off-grid)	356	0.04%	Includes active and passive solar and off-grid photovoltaic.
Ethanol	2,560	0.30%	
Biomass (Off-grid)	1,163	0.13%	Virtually all wood.
Electric			
Coal-Electric	86,457	9.96%	
Oil-Electric	2,433	0.28%	
Gas-Electric	5,646	0.65%	
Fission-Electric & Fuel Cycle	189,051	21.79%	
Hydro-Electric	5,201	0.60%	
Waste-to-Energy	6,491	0.75%	Electricity share only.
Geothermal-Electric	5,413	0.62%	
Biomass-Electric	7,663	0.88%	
Wind-Electric	2,070	0.24%	
Solar-Electric	794	0.09%	Includes solar-thermal and photovoltaic.
Fusion-Electric	0	0.00%	
Efficiency			
Utility DSM, Capitalized	0	0.00%	Only capitalized portions are eligible for capital spending-based tax subsidies.
End-Use Effic., Capitalized			
Low Estimate	8,400		Excludes capitalized residential spending on efficiency, since these do not get ITCs and ACRS treatment.
High Estimate	16,800		
Average	12,600	1.45%	
Total Energy			
Low Estimate	863,428		
High Estimate	871,828		
Average	867,628	100.00%	

Capital Spending in the Energy Sector as a Share of Total Capital Spending

Part 1: Determination of Energy Share of Overall Capital Spending ($Billions of Current Dollars)

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	Total 1980-89 (1a)	Energy Share	Source/Notes
Differing Measures of Aggregate Capital Spending by the Private Sector (See Note 1)													
All Industries	286.40	324.73	326.19	321.16	373.83	410.12	399.36	410.52	455.49	507.40	3,815.20		(2)
Less Spending by Electric Cooperatives											(43.90)		(2a)
											3,771.30	23.01%	
Nonresidential Fixed Investment	322.80	369.20	366.70	356.90	416.00	442.90	435.20	444.90	488.40	511.90	4,154.90		(3)
Component of GNP (NRFI)													
Less Spending by Electric Cooperatives											(43.90)		(2a)
											4,111.00	21.11%	
All Plant & Equipment Expenditures,	339.30	384.10	385.30	377.30	430.00	455.80	445.00	460.70	505.70	562.70	4,345.90		(4)
plus adjustments to NRFI basis													
Less Spending by Electric Cooperatives											(43.90)		(2a)
											4,302.00	20.17%	

Notes to Part 1:

(1) U.S. Department of Commerce, "Plant and Equipment Expenditures and Plans, Revised Estimates for 1978 to 1989," Sept. 13, 1990. Department of Commerce data were used wherever available to determine the energy share of total capital spending because we could identify no other aggregated capital spending data sources. To have the data internally consistent to the extent possible, we used Commerce breakouts of energy spending wherever possible. For spending categories not clearly disaggregated by Commerce, we had to rely on other information sources. These are clearly noted. The Commerce data has a number of problems which affect the accuracy of our estimates. Primarily, while they measure only sector spending, this includes capital investment by some non-taxpaying entities. In the energy sector, this includes cooperative utilities, which we were able to remove. However, the aggregate spending figure includes spending by cooperative financial service and telecommunications companies, cooperative farmers and food processors, and nonprofit organizations such as hospitals and universities. No data series for tax paying entities only was available. Given the limitations in data availability, further refinement is not feasible. However, the implicit assumption in using this measure of the proportion of energy capital spending is that the ratio of capital spending in the energy/total economy is the same for both the taxable enterprises and the tax-exempt private enterprises. The Commerce data series attempt to exclude capital spending by publicly-owned utilities. To incorporate the range of estimates for aggregate capital investment, we generate a range of energy shares as explained in the notes below.

1a) The energy share represents the average aggregate capital spending on energy divided by the various measures of aggregate capital spending in the economy during the 1980-89 period. The energy share of total capital spending was calculated over a ten year average for a number of reasons. First, tax benefits associated with capital spending such as investment tax credits and accelerated depreciation, are used over a number of years. Tax expenditure estimates for these provisions reflect multiple years of purchases. Second, averaging will help to reduce some of the errors associated with multiple data sources, even for the same fuel type.

(2) This measure includes all regularly-surveyed industries by the Department of Commerce. It contains some unknown portion of spending by privately-owned but tax-exempt financial service, communications, electric power, and food-related industries. (U.S. Department of Commerce, 9/13/90). It excludes less-frequently surveyed small businesses, hospitals and educational facilities (many of which pay no taxes), farm investment, and capital costs which may be expensed.

(2a) Aggregate capital investment data from Commerce includes spending by cooperative enterprises that, although privately owned, do not pay taxes. We deduct the spending by cooperative electric utilities since they are not eligible for the tax benefits we use the capital spending mix to allocate. Spending by other cooperative enterprises remain in the Commerce numbers, understating the energy share of total capital-based tax benefits. Data provided by Don Smith, National Rural Electric Cooperatives Association, 2/8/93.

(3) The nonresidential fixed investment measure of capital spending is slightly higher than the above measure, and includes the items excluded in Note 2, as well as net margins on purchases of used equipment and some capital that is held for a short period of time. (U.S. Dept. of Commerce, 9/13/90, Table 3).

(4) This measure adjusts aggregate Commerce investment data by including all items included in nonresidential fixed investment. This measure is higher than the "all industries" because it includes spending by non-profit hospitals and educational facilities, as well as for-profit small businesses and hospitals. In addition, it includes farm spending, capital costs that are expensed, and the other items described in the above note. (U.S. Dept. of Commerce, 9/13/90, Table 3).

Part 2: Capital Spending on Energy Supply by the Private Sector, 1980-89 (Millions of Current Dollars)

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	Total, 1980-89 (1)	Note
Oil and Gas												
Exploration and Production	37,980	51,177	52,932	33,724	33,880	31,813	16,618	12,171	14,164	13,410		(2)
Other Capital Investment	7,720	11,143	10,846	9,022	7,985	8,528	6,068	6,251	8,107	8,703		(3)
Calculation of Oil vs. Gas Shares												
Percentage shares of new wells drilled, 1980-90:				OIL:	68.17%	GAS:	31.83%	From O&GTAX.WK1				(4)
Crude Oil Estimate												
Crude Share of Exploration, Production, Other Capital Investment	31,155.8	42,486.4	43,480.4	29,141.9	28,541.3	27,502.3	15,466.1	12,559.1	15,183.2	15,075.5		
Oil Pipelines	1,777.0	2,052.0	1,320.0	2,456.0	1,689.0	1,137.0	435.0	733.0	400.0	451.0		(5)
Total Crude Oil	32,932.8	44,538.4	44,800.4	31,597.9	30,230.3	28,639.3	15,901.1	13,292.1	15,583.2	15,526.5	273,042	(2)
Natural Gas Estimate												
Gas Share of Exploration, Production, Other Capital Investment	14,544.2	19,833.6	20,297.6	13,604.1	13,323.7	12,838.7	7,219.9	5,862.9	7,087.8	7,037.5		
Gas Utilities	3,767.0	4,037.0	4,018.0	3,013.0	3,344.0	4,109.0	3,894.0	4,033.0	4,598.0	5,260.0		(5)
Gas Pipelines	3,642.0	4,947.0	6,070.0	4,707.0	3,971.0	2,084.0	1,309.0	1,556.0	1,659.0	969.0		(6)
Total Gas	21,953.2	28,817.6	30,385.6	21,324.1	20,638.7	19,031.7	12,422.9	11,451.9	13,344.8	13,266.5	192,637	(2)
Coal: Mining	8,399.0	10,447.6	9,324.2	7,031.1	7,837.3	7,929.8	5,385.7	5,471.6	6,139.0	6,086.2	74,052	(7)

		1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	Total 1980-89 (1)	Note (8)
Electric Investment by Investor Owned Utilities, by Prime Mover													
Electric-Total													
Generation - All Types		19,238.0	20,912.0	25,339.0	24,935.0	23,939.0	21,372.0	18,483.0	14,395.0	9,959.0	9,903.0	188,475	
Steam		7,498	7,221	7,828	5,860	5,569	4,725	4,333	4,478	3,946	4,044	55,502	
Nuclear		11,045	12,785	16,461	18,208	17,478	15,553	13,426	9,239	5,272	4,768	124,235	
Other		695	906	1,050	868	893	1,095	724	678	740	1,091	8,740	
Transmission, Distrib., Other		7,773.0	8,212.0	8,263.0	8,881.0	9,504.0	9,719.0	10,817.0	11,108.0	11,891.0	13,194.0	99,362	(9)
Investor Owned Utilities - "Other" Capacity Additions by Fuel (Megawatts)													(9a)
Oil		1,238	150	25	108	18	21	4	12	66	663	2,304	
Natural Gas		1,031	2,025	216		247		119	268	570	871	5,348	
Hydroelectric		570	56	50	368	1,093	2,489		204	91	5	4,926	
Wind						0.040		0.2			0.2	0.4	
Solar							0.1				1.0	1.1	
Biomass					50.7							50.7	
Other		264		248		26	248					786	
Total IOU Capac. Additions		3,102	2,231	539	527	1,385	2,758	123	484	727	1,540	13,416	
Assignment of Fuels to Prime Mover													
Steam to Coal		7,498.0	7,221.0	7,828.0	5,860.0	5,569.0	4,725.0	4,333.0	4,478.0	3,946.0	4,044.0	55,502.0	
Nuclear to Nuclear		11,045.0	12,785.0	16,461.0	18,208.0	17,478.0	15,553.0	13,426.0	9,239.0	5,272.0	4,768.0	124,235.0	
Other fuels assigned in proportion to capacity additions during the 1980s:													(10)
Oil	17.17%	119.4	155.6	180.3	149.1	153.4	188.1	124.3	116.4	127.1	187.4	1,501.0	
Nat. Gas	39.86%	277.0	361.1	418.5	346.0	356.0	436.5	288.6	270.3	295.0	434.9	3,483.8	
Hydro	36.72%	255.2	332.7	385.5	318.7	327.9	402.1	265.8	249.0	271.7	400.6	3,209.2	
Wind	0.00%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	
Solar	0.01%	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.7	
Biomass	0.38%	2.6	3.4	4.0	3.3	3.4	4.1	2.7	2.6	2.8	4.1	33.0	
Other	5.86%	40.7	53.1	61.5	50.8	52.3	64.1	42.4	39.7	43.3	63.9	512.0	
		695.0	906.0	1,050.0	868.0	893.0	1,095.0	724.0	678.0	740.0	1,091.0	8,740.0	
Summary of Electric Spending by Fuel													
Coal-Electric													
Generation Equipment		7,498.0	7,221.0	7,828.0	5,860.0	5,569.0	4,725.0	4,333.0	4,478.0	3,946.0	4,044.0		(9)
Share of T&D		3,029.5	2,835.6	2,552.7	2,067.1	2,210.9	2,148.7	2,535.8	3,455.5	4,711.5	5,387.9		
Total, Coal-Electric		10,527.5	10,056.6	10,380.7	7,947.1	7,779.9	6,873.7	6,868.8	7,933.5	8,657.5	9,431.9	86,457	
Oil-Electric													(9)
Generation Equipment		119.4	155.6	180.3	149.1	153.4	188.1	124.3	116.4	127.1	187.4		
Share of T&D		48.2	61.1	58.8	53.1	60.9	85.5	72.8	89.9	151.7	249.6		
Total, Oil-Electric		167.6	216.7	239.1	202.2	214.3	273.6	197.1	206.3	278.8	437.0	2,433	
Gas-Electric													(10)
Generation Equipment		277.0	361.1	418.5	346.0	356.0	436.5	288.6	270.3	295.0	434.9		
Share of T&D		111.9	141.8	136.5	123.2	141.3	198.5	168.9	208.5	352.2	579.4		
Total, Gas-Electric		389.0	502.9	555.0	469.2	497.3	635.0	457.5	478.8	647.2	1,014.3	5,646	
Fission-Electric													(11)
Generation Equipment		11,045.0	12,785.0	16,461.0	18,208.0	17,478.0	15,553.0	13,426.0	9,239.0	5,272.0	4,768.0		
Share of T&D		4,462.7	5,020.6	5,367.9	6,485.1	6,938.9	7,072.8	7,857.4	7,129.3	6,294.7	6,352.5		
Uranium Mining		949.0	461.0	173.0	67.0	37.0	32.0	25.0	54.0	36.4	0.0		(12)
Total, Fission		16,456.7	18,266.6	22,001.9	24,760.1	24,453.9	22,657.8	21,308.4	16,422.3	11,603.1	11,120.5	189,051	
Hydro-electric													(10)
Generation Equipment		255.2	332.7	385.5	318.7	327.9	402.1	265.8	249.0	271.7	400.6		
Share of T&D		103.1	130.6	125.7	113.5	130.2	182.8	155.6	192.1	324.4	533.7		
Total, Hydro		358.3	463.3	511.3	432.2	458.1	584.9	421.4	441.1	596.1	934.3	5,201	
Renewables and Efficiency		- To avoid double-counting, spending on Solar, wind, and biomass is based on values calculated from RENEWCAP.WK1. Please refer there for details.											(13)

Notes and Sources to Part 2:

(1) The energy share of total capital spending was calculated over a ten year average for a number of reasons. First, tax benefits associated with capital spending such as investment tax credits and accelerated depreciation, are used over a number of years. Tax expenditure estimates for these provisions reflect multiple years of purchases. Second, averaging will help to reduce some of the errors associated with multiple data sources, even for the same fuel type.

(2) Capital spending on oil and gas are from the "Oil and Gas Journal" annual capital spending survey. Data here represent the oldest data set in each issue (2 years prior to the magazine year), as historical figures are sometimes revised by O&GJ. Spending on exploration, production, and "other" capital investment is mixed oil and gas. See Note 7 for methodology of disaggregation. Specific issues are as follows:
Oil and Gas Journal, Annual Capital Spending Surveys - 2/18/80, p. 56; 2/16/81, p. 58; 2/15/82, p. 61; 2/28/83, p. 40; 2/27/84, p. 44; 2/25/85, p. 45; 2/24/86, p. 26; 2/23/87, p. 31; 2/22/88, p. 18; 2/20/89, p. 14; 2/19/90, p. 21.

(3) "Other" spending includes investments into refining, marketing outlet infrastructure, and vehicle fleets. OCS lease bonuses and investments into petrochemicals, mining, or other energy sources are excluded from this data set.

(4) Oil and gas expenditures are disaggregated on the basis of historical shares of wells drilled, derived in O&GTAX.WK1. This allocation method incorporates some aspects of the relative activity in each market. However, costs, and thus investment, will depend on many other factors, such as well depth and location, and the volume of oil requiring refining and distribution infrastructure. Additional research could improve this procedure.

(5) Shares of exploration, production, and other equal the total oil and gas investment multiplied by the estimated oil and gas shares shown in the above lines.

(6) Data on gas utility investments are from "Gas Facts," by the American Gas Association, 1991, Table 16-1. Transmission estimates have been deducted from the Gas Utility totals to avoid double-counting with the gas pipeline expenditures from the "Oil and Gas Journal" survey. (Based on input from Donna Baricus, AGA, 1/15/93).

(7) Capital spending on the coal mining was derived from limited data presented in the Data Resources Inc. "Annual DRI/McGraw Hill Survey of Business Plans for New Plant and Equipment," for 1987, 1988, and 1989. We assumed that the ratio of coal mining to total mining spending would remain fairly constant over the 1980s. Then, using the DRI ratio of coal:total mining, derived coal mining estimates based on total mining estimates from the Bureau of Census. Census data was used since we could not obtain DRI data for all the 1980s, and the DRI data that was available differed significantly from the Census figures. The derivation is presented below:

DRI Coal Mining:Total Mining Ratio

	Coal	Tot. Mining	Percent	
1986	3361	5394	62.31%	*DRI Projections
1987	3764	5694	66.10%	
1988*	3543	5265	67.29%	
1989*	3501	5102	68.62%	
		Ave.	66.08%	

(8) Capital spending on electric generation data are from the EEI "Statistical Yearbook of the Electric Utility Industry," 1990, Table 70. "Steam" is virtually all coal capacity (Jack Cashin, EEI, personal communication, 1/12/93). "Other" includes hydro, natural gas, oil, and geothermal plants. Generation data include capitalized interest in the form of the Allowance for Funds Used During Construction (AFUDC). This is appropriate because, according to the IRS, capitalized interest was eligible for tax benefits. (Rick Robinson, IRS investment tax credit specialist, personal communication, 2/3/93).

(9) Transmission, distribution, and "other" spending are from the EEI yearbook, and were allocated to particular fuels in proportion to spending on generation plant. The implicit assumption is that higher spending means more plants, which require more T&D. This assumption is not always valid, such as with nuclear plant cost overruns. The "other" category includes some intangible plant which could not be disaggregated.

(9a) From "Generator Nameplate Capacity Additions by Year, 1980-89, As of Yearend 1991," computer run provided by Elsie Bess, DOE, EIA, January 27, 1993. Includes private utilities only.

(10) Spending classified by EEI as "other" generating plant were broken into source fuels based on capacity increases during the 1980s, as shown above. This allocation method assumes equal capital costs per unit of capacity, and therefore may understate spending on hydro.

(11) Spending on nuclear excludes capitalized nuclear fuel, since we judged the difference between tax and service lifes to be too small to provide significant tax benefits.

(12) Capital spending on uranium mining includes exploration, mining and milling. Data for 1988 are from EIA, "Domestic Uranium Mining and Milling Industry Viability Assessment, 1988," p. 17. Data for prior years are from the U.S. Department of Commerce, "Statistical Abstract of the United States," 1990, Table 1240.

(13) Renewables data are presented in detail in RENEWCAP.WK1. Data are quite poor, so estimates could have a significant range of error.

Estimated Capital Spending on Renewable Energy and Efficiency, 1980-89

Part 1: Energy Technologies Attached to the Electrical Grid

A. Geothermal

Year	Capacity (MW)	Source/Notes
1980	909	Rader, II-24
1984	1,386	Williams, 24
1988a	2,594	Rader, II-24
1988b	2,310	Williams, 24
1989	2,655	Note 1
1990	3,000	EIA '92 Outlook, 25,45

Capital Cost: $Mil/MW plant capacity		
Low	2.4	Jenkins et al, E1-11
High	3.8	Jenkins et al, E1-11
Average	3.1	

Capital Spending	
Increase in Capacity, 1980-1989 (MW)	1,746
Ave. cap. cost $Mil/MW	3.1
Capital investement ($Mils)	5,412.6

Notes:

(1) Assumes that capacity increases in 1989 and 1990 were equal, and uses the Williams 1988 survey estimate, which was based on more rigorous survey data.

B. Wind

Year	Capacity (MW)	Source/Notes
1981	10	Rader, II-54
1984	604	Williams, 24
1988	821	Williams, 24
1989	1,500	Rader, II-54
1990	2,000	EIA '92 Outlook, 25,45

Capital Cost: $Mil/MW plant capacity		
Cap. Cost, Current	0.78	Jenkins et al, E1-11
Cap. Cost, mid 1980s	1.380	Jenkins et al, E1-11

Capital Spending		Assumptions
Increase in Capacity, 1980-1989 (MW)	1,500	Installed capacity in 1980 was zero.
Ave. cap. cost $Mil/MW	1.380	Plant built through 1989 had the higher capital costs
Capital investement ($Mils)	2,070.0	

C. Solar Thermal

Year	Capacity (MW)	Source/Notes
1980	0	Note 1
1984	22	Williams, 24
1985	44	Rader, II-40; Luz only
1988	205	Williams, 24
1989	194	Rader, II-50; Luz only
	80	Sched. to come on-line in '89; Rader, II-50
Tot	274	

Capital Cost: $Mil/MW plant capacity		
Mid-1980s	2.692	Jenkins et al, E1-11
Current	2.327	Jenkins et al, E1-11

Capital Spending		Assumptions
Increase in Capacity, 1980-1988 (MW)	205	Installed capacity in 1980 was zero.
Cap. Cost, $Mil/MW	2.692	Construction through 1988 had the higher capital costs
Capital investement ($Mils)	551.9	
Increase in Capacity, 1989	69	Assumes plant came on line as scheduled.
Cap. Cost, $Mil/MW	2.327	Plant in 1989 had the lower capital costs
Capital investement ($Mils)	160.6	
Total Capital Investment ($Mil)	712.4	

Notes:

(1) Luz represents 90% of the world's solar thermal capacity and virtually 100% of U.S. capacity. It's first plant came on line in 1984. Therefore, U.S. capacity prior to that data is assumed to be zero.

D. Waste-to-Energy

	Amount ($Mils)	Notes	Sources
Capital spending on waste-to-energy plants, 1960-88	11,117.7	(1)	Gov't Advis. Assoc. Database (Data through 1988 only)
Bond Issues for Solid Waste/Resource Recovery facilities, 1989	1,863.9	(2)	IDD/PSA Database
Total	12,981.6		
Estimated Share benefitting energy	50%	(3)	
Energy share of capital spending	6,490.8		

(1) Includes initial capital and additional capital spending for all operating, near operating, or temporarily closed facilities during 1980-1988.
(2) The use of this as a capital spending proxy assumes that bond receipts were immediately spent, and that the facilities were not also financed with equity.
(3) Waste-to-Energy facilities serve two purposes: solid waste disposal and electricity generation. Spending has arbitrarily been split between the two.

E. Photovoltaic

Most photovoltaic is non-grid power; the grid portion is estimated in Part 2, on PV, non-grid investments.

F. Biomass - Wood Power on Electric Grid

Year	MW Capac.	Source	Cost, $Mil/MW of Capacity		
1980	200	Rader, II-19	Low	1.638	Sehti, 11/4/92
1988	4,554	Rader, II-19	High	2.238	Sehti, 11/4/92
1990	5,000	EIA, '92 Egy Outlook, 45	Average	1.938	
1989 Est.	4,777				

Capital Spending

Cost of Capacity: $Mil/MW	1.938
Capacity Increase (MW)	4,554
Est. Capital Spending ($Mil)	8,826

Breakout of Grid vs. Non-Grid Power

Mix of Capacity in 1988	MW	Pct.	
Grid Wood Energy	3954	87%	Includes utilities and commercial facilities hooked into the power grid
Non-Grid Wood Energy	600	13%	Data on breakout of grid/non-grid from Rader, II-19

Wood Energy Capital Spending Mix	$Mil
Grid	7,663
Non-Grid	1,163

Part 2: Capital Spending on Non-Grid Renewables

A. Solar - Thermal Water Heaters and Passive Construction

Year	Capacity (Quads)	Source/Notes	Cost, $Mil/Btu		
1986 - Thermal	0.017	Rader, II-43	Low	0	Rader, II-40
1986 - Building	0.035	Rader, II-43; note 1	High	10	Rader, II-40
1986 - Total	0.052		Ave.	5	
1990	0.050				

Capital Spending

Increase in Capacity, 1980-1989 (Quads)	0.050	Installed capacity in 1980 was zero; EIA numbers accurately measure passive solar contrib.
Mil Btu/Quad	1.00E+09	
Capac. Increase, Mil Btu	5.0E+07	
Ave. cap. cost: $/Mil Btu	5.000	Ave. cost of avail. technologies is a fair proxy for the mix of technologies installed.
Capital investment ($Mils)	250.0	

Assumptions

Notes:
(1) Capacity of passive solar in 1986 was estimated to range from .02-.05; we used the average.

B. Biomass - Ethanol

Years	Capacity (Mil. Gals)	
1979	20	Alcohol Fuels 1989 AR, 2
1989	1,300	Alcohol Fuels 1991 AR, 2

Capital Costs of Ethanol Production

Ave. Dollars/gallon of plant capacity	$2.00	(USDA, p. 27)

Capital Spending

Increase in Capacity, 1980-1989 (Mil Gals)	1,280	Plants that closed during the 1980s didn't get to use their tax benefits.
Ave. cap. cost: $/gal of capacity	$2.00	Ave. cost of avail. technologies is a fair proxy for the mix of technologies installed.
Capital investement ($Mils)	2,560.0	

C. Photovoltaic

Year	MW Capac.		Source
1982	1		Rader, II-36
1989	13	Grid	Rader, II-36
	17	Non-grid	

Cost/kW of Capacity

Est. 1995	3,172	Jenkins, E1-12
Late 1980s	4,175	Jenkins, E1-12
Production breakthrough, late 1980s, reduced system costs by 50% (Rader, II-34)		
Pre-breakthrough est.	6,263	

Capital Spending

Cost of Capacity: $Mil/MW	6.263	Assumes infrastructure built at higher cost
Capacity Increase, Grid (MW)	13	Assumes no PV capacity in 1980
Capacity Increase, Non-Grid (MW)	17	Assumes no PV capacity in 1980
Spending, Grid PV ($Mil)	81.4	
Spending, Non-Grid PV ($Mil)	106.5	

D. Biomass - Wood Energy

	$Mil	
Non-Grid Wood Energy	1,163	From Part 1F above
Residential use	0	Residential investments into wood consumption, unlike similar business investments, are generally ineligible for tax subsidies for capital.

Part 3: Demand-Side Management Programs and Energy Efficiency

A. Utility Demand-Side Management Programs

Year	Load Reductions: Ave. Peak (MW)	Load Reductions: Power Saved (Mil. kWh)	DSM Spending ($Mil)	Incremental Peak MW Saved	Cost/MW Saved ($Mil) (2)	Source
1986	21					OTA, 58
1989	13,331	14,776	886.7			Prete et al., 27
1990	16,700	17,029	1,205.7	3,369	0.36	Prete et al., 27

Estimated load reductions, 1980	0	Assumes that since only 21 MW in 1986, there were zero in 1980.
Estimated load reductions, 1989	13,331	
Net Change	13,331	
Est. Cost, $Mil/MW reduced	0.36	From above
Est. Tot. DSM spending	4,771	

Notes:

(1) DSM spending is generally expensed and therefore does not benefit from capital-spending based tax benefits.

(2) The cost/MW saved figure is equal to the increase in average peak MW saved between 1989 and 1990, divided by the incremental cost. This cost is assumed constant throughout the 1980s and used to derive an estimate of total DSM spending.

B. Private Sector Investments into Energy Efficiency, 1989

Data on private sector investments into energy efficiency are highly uncertain. This is due both to a lack of data collection, as well as to measurement difficulties regarding the efficiency component. Often when efficiency numbers are reported, there are two errors. First, total spending on efficient appliances or upgrades is counted, rather than simply the incremental cost over the "regular" appliance. Second, new purchases may be made for multiple reasons, of which improved energy efficiency is but one. For example, new machine tools may be more energy efficient, faster, more precise, and computer-linked to a computer-aided manufacturing system. Ascribing all of the incremental costs to energy efficiency of such a purchase would be incorrect. Thus, we are left with numbers that are really simply educated guesses. Future research to improve this data is necessary.

Incremental Investments into Energy Efficiency

Sector	Low Estimate	High Estimate	Est. % Capitalized (2)	Notes
Industrial				
Private Spending	2,000	4,000	40.00%	
DSM Share	177	177	0.00%	(1)
Total	2,177	4,177		
Total Capitalized	800	1,600		
Commercial				
Private Spending	1,000	2,000	40.00%	
DSM Share	177	177	0.00%	(1)
Total	1,177	2,177		
Total Capitalized	400	800		
Residential				
Private	1,500	2,500		
Retrofit share	80%	80%	25.00%	(3, 4)
New Construct. Share	20%	20%	75.00%	(3)
DSM Share	532	532	0.00%	(1)
Total	2,032	3,032		
Total Capitalized	525	875		
Tot. Capitalized Effic.	1,725	3,275		

Est. Spending, 1980-89	All Sectors			Comm. & Indust. Sector		Residential Sector	
1980-84 and 1989	10,350	19,650	(5)	7,200	14,400	3,150	5,250
1985-1988	1,725	3,275	(5)	1,200	2,400	525	875
Total	12,075	22,925		8,400	16,800	3,675	6,125

Notes:

(1) DSM shares are based on DSM spending in 1989 from Part 3A, with 20% each going to the industrial and commercial sectors and 60% going to the residential sector. Shares based on Alliance judgment. A number of energy efficiency experts with whom we spoke mentioned that utilities regularly expense DSM costs. These expenditures, therefore, would not benefit from capital subsidies.

(2) Efficiency improvements from changes in management practicies, or from inexpensive capital investments (e.g., thermostats) which are expensed and therefore ineligible for capital subsidies account for the 40% capitalization share. This figure is based on conversations with a series of corporate energy managers.

(3) Retrofit and new construction shares of residential efficiency improvements based on work done by Bion Howard at the Alliance to Save Energy

(4) The capitalized share of housing retrofits is lower than for the other sectors since many of the improvements are paid for with cash or credit. Only the improvements financed with home equity loans are eligible for housing tax benefits.

(5) Efficiency investments vary depending on energy prices and other concerns. Spending was high through about 1984 due to high energy prices, and began to pick up again in 1989 due to environmental concerns. Spending between 1985 and 1988 was low after energy prices collapsed, and is assumed to equal 25% of the prior level.

Part 4: Summary of Capital Investments

Electrical Grid-Related Spending

	$Millions
Geothermal	5,413
Wind	2,070
Solar Thermal	712
Photovoltaics	81
Solar-Grid Total	794
Waste-to-Energy	6,491
Biomass	7,663
Utility DSM - Total	4,771
Utility DSM - Capitalized	0

Dispersed Renewables

	$Millions		
Solar - Thermal & Passive	250		
Photovoltaics	106		
Total Solar - Non-Grid	356		
Biomass - Ethanol	2,560		
Biomass - Other	1,163		
	Low	High	
End-Use Effic. - Capitalized	8,400	16,800	Excludes capitalized residential spending, which
Effic. Including Residential	12,075	22,925	
Tot. Renewables and Efficiency	34,909	43,309	

Sources:

(1) Government Advisory Associates, "1988-89 Resource Recovery Database," 1989.

(2) IDD/PSA Municipal Bond Issue Database, New Bond Issues for Energy. Data run of May 1992.

(3) Jenkins, Alec, et al. "Technology Characterization - Final Report," (CA: California Energy Commission), Nov. 22, 1992.

(4) Prete, Lawrence, Janet Gordon, and Linda Bromley. "Electric Utility Demand-Side Management," Electric Power Monthly (DOE, EIA), April 1992.

(5) Rader, Nancy. "Power Surge: The Status and Near-Term Potential of Renewable Energy Technologies," (Wash., DC: Public Citizen, May 1989).

(6) Sehti, Prab. California Energy Commission, personal communication, 11/4/92.

(7) U.S. Department of Agriculture, Economic Research Service. "Ethanol: Economic and Policy Tradeoffs," April 1988.

(8) U.S. DOE, Energy Information Administration. "Annual Energy Outlook 1992," pp. 25, 45.

(9) U.S. DOE, Energy Information Administration. "Estimates of U.S. Biofuels Consumption, 1990," pp. vii, 6.

(10) U.S. DOE, Office of Alcohol Fuels. "Annual Report on the Use of Alcohol in Fuels," for the years 1988-1991.

(11) U.S. Office of Technology Assessment. "Energy Technology Choices: Shaping Our Future," July 1991.

(12) Williams, Susan. "Renewables at a Crossroads," Independent Energy, November 1989, p. 24

Energy Sector Use of Transportation Infrastructure

Energy Commodity Shipments Via Rail

Code	Product	Shipments by Volume (Carloads) 1990	% Share	Shipments by Value ($Millions) 1990	% Share	
11	Coal	8,460,496	27.13%	7,106.5	23.75%	
13	Crude Petrol & Natural Gas	40,188	0.13%	34.2	0.11%	
291	Petroleum, refined oil products	573,895	1.84%	252.0	0.84%	Excludes lubricating oils, asphalt, and code 2912
2912	Liquified Petroleum Gases & Coal	156,392	0.50%	212.3	0.71%	
29911	Coal and coke briquets	2,982	0.01%	3.4	0.01%	
29913	Petroleum coke, excl. briquettes	124,313	0.40%	118.7	0.40%	
29914	Coke from coal	235,986	0.76%	160.0	0.53%	
361	Electrical trans. & distr. equip.	2,895	0.01%	12.0	0.04%	
364	Electrical lighting & wiring equip.	9,722	0.03%	8.6	0.03%	
	Total, All Shipments	31,185,671		29,928.4		Value total includes shipments of fractional carloads
	Totals by fuel type					
	Coal	8,777,660	28.15%	7,376.1	24.65%	Includes codes 11, 29911, 29914, and 1/2 of 2912
	Oil	796498	2.55%	493.9	1.65%	Includes codes 291, 29913, and 1/2 of codes 13 and 2912.
	Natural Gas	20094	0.06%	17.1	0.06%	Includes 1/2 of code 13.
	Electricity - General	12617	0.04%	20.6	0.07%	Includes codes 361, 364
	Total, Energy-Related		30.81%		26.42%	

Notes:

(1) Volumes are total freight traffic in carloads, since volume rather than weight generally limits rail transport. AAR data sums transfers between lines, so total freight figures may include some double-counting of shipping volumes.

(2) Values reflect gross freight revenues.

Source: Association of American Railroads, "Freight Commodity Statistics, Annual," 1990.

Energy Commodity Shipments Via Water, 1989 (Millions of Tons)

Code	Product	Oceanborne Commerce: Imports	Exports	Total	Coastwise	Lakewise	Inland Waterways	Total Domestic
	Total, All Commodities	589.5	448.4	1,037.9	302	109.1	606	1017.1
Shipments of Oil								
1211	Crude Petroleum	298.8	0.1	298.9	132.2		45.9	178.1
2911	Gasoline	19.8	1.9	21.7	43.7	0.6	32.0	76.3
2912	Jet Fuel	0.0	0.0	0.0	7.1	0.1	4.7	11.897
2913	Kerosene	3.5	1.3	4.8	0.6	0.0	0.8	1.405
2914	Distillate Fuel Oil	12.9	4.2	17.1	24.3	0.4	21.5	46.2
2915	Residual Fuel Oil	42.8	13.2	56.0	28.2	0.4	38.8	67.4
2920	Coke, Petroleum Coke	3.1	17.5	20.6	0.1	0.2	6.2	6.5
	Oil Share (1/2 of total)	1.6	8.8	10.3	0.1	0.1	3.1	3.25
	Total Oil	379.4	29.5	408.8	236.1	1.6	146.8	384.6
	Oil % of Tot. Shipments	64.35%	6.57%	39.39%	78.20%	1.47%	24.22%	37.81%
Shipments of Coal								
1121	Coal and Lignite	2.4	98.7	101.1	12.8	19.2	166.8	198.8
2920	Coke, Petroleum Coke	3.1	17.5	20.6	0.1	0.2	6.2	6.5
	Coal Share (1/2 of total)	1.6	8.8	10.3	0.1	0.1	3.1	3.25
	Total Coal	4.0	107.5	111.4	12.9	19.3	169.9	202.1
	Coal % of Tot. Shipments	0.67%	23.96%	10.73%	4.25%	17.69%	28.04%	19.87%

Source: U.S. Army Corps of Engineers, "Waterborne Commerce of the United States, 1989," National Summary, Table 2.

Historical Spending on Energy Research and Development, by Energy Type
(Millions of 1989$ - See Note 1)

	Year	Nuclear Fission (2)	Nuclear Fusion (2)	Fossil (3)	Renewables (4)	Efficiency (4)	Total	GNP Implicit Price Defl. (1982=100) (5)	Data Year (6)	GNP Inflator (7)
	1950	16.4	0.0	96.2	0.0	0.0	112.6	23.9	1950	5.285
1951		25.7	0.0	91.6	0.0	0.0	117.2	25.1	1951	5.032
1952		31.2	0.0	90.1	0.0	0.0	121.3	25.5	1952	4.953
1953		49.3	0.0	90.7	0.0	0.0	140.0	25.9	1953	4.876
1954		90.8	0.0	80.7	0.0	0.0	171.4	26.3	1954	4.802
	1955	138.8	0.0	55.7	0.0	0.0	194.6	27.2	1955	4.643
1956		247.7	32.4	86.7	0.0	0.0	366.8	28.1	1956	4.495
1957		423.2	50.3	91.6	0.0	0.0	565.1	29.1	1957	4.340
1958		629.8	84.6	159.9	0.0	0.0	874.3	29.7	1958	4.253
1959		767.4	149.6	130.0	0.0	0.0	1,047.0	30.4	1959	4.155
	1960	996.5	131.2	128.8	0.0	0.0	1,256.5	30.9	1960	4.067
1961		1,143.6	121.8	145.3	0.0	0.0	1,410.8	31.2	1961	4.048
1962		1,076.1	99.0	144.9	0.0	0.0	1,320.0	31.9	1962	3.959
1963		1,034.6	102.1	303.7	0.0	0.0	1,440.4	32.4	1963	3.898
1964		1,135.5	87.9	245.7	0.0	0.0	1,469.1	32.9	1964	3.839
	1965	1,116.9	87.4	133.8	0.0	0.0	1,338.1	33.8	1965	3.737
1966		1,002.8	87.0	128.1	0.0	0.0	1,217.9	35	1966	3.609
1967		1,005.1	88.3	199.1	0.0	0.0	1,292.6	35.9	1967	3.518
1968		1,121.0	92.8	130.0	0.0	0.0	1,343.7	37.7	1968	3.350
1969		960.9	95.5	155.8	0.0	0.0	1,212.2	39.8	1969	3.173
	1970	844.1	95.0	151.9	0.0	1.5	1,092.5	42	1970	3.007
1971		856.2	92.4	214.2	0.0	6.3	1,169.1	44.4	1971	2.845
1972		967.2	98.1	287.6	6.5	14.9	1,374.4	46.5	1972	2.716
1973		1,039.4	103.7	0.0	0.0	0.0	1,143.1	49.5	1982	1.263
1974		1,204.1	139.2	191.7	50.4	3.7	1,589.1	54	1982	1.263
	1975	1,384.2	240.0	313.7	164.9	12.3	2,115.1	59.3	1982	1.263
1976		1,954.4	410.1	712.7	405.7	99.3	3,582.1	63.1	1982	1.263
1977		2,006.7	595.4	1,008.1	634.8	296.2	4,541.1	67.3	1982	1.263
1978		1,850.8	483.1	1,264.6	925.8	404.9	4,929.2	72.2	1982	1.263
1979		1,752.8	565.3	1,216.3	1,082.3	540.4	5,157.1	78.6	1982	1.263
	1980	1,635.5	626.4	1,092.0	1,070.9	512.3	4,937.1	85.7	1982	1.263
1981		1,527.3	566.7	1,242.0	959.5	406.7	4,702.3	94	1982	1.263
1982		1,342.2	546.5	228.7	347.3	110.1	2,574.9	100	1982	1.263
1983		1,029.3	571.3	269.1	308.7	136.5	2,315.0	103.9	1982	1.263
1984		885.0	543.3	323.8	241.6	177.7	2,171.5	107.7	1982	1.263
	1985	680.1	486.1	338.5	227.1	198.2	1,930.0	110.9	1982	1.263
1986		649.9	398.5	454.6	187.6	182.4	1,872.9	113.8	1982	1.263
1987		646.5	369.0	476.3	155.5	166.3	1,813.7	117.4	1982	1.263
1988		604.7	347.6	567.6	122.1	158.3	1,800.3	121.3	1982	1.263
1989		608.8	334.4	570.2	115.4	160.0	1,788.9	126.3	1982	1.263
	1990	574.8	319.0	841.0	109.1	183.0	2,027.0	131.5	1982	1.263
1991		226.5	203.5	629.9	149.0	211.0	1,420.0		1982	1.263
1992		336.7	337.1	859.3	257.3	325.6	2,116.0		1982	1.263
1993	'93 Approp.	311.5	339.7	666.2	261.3	411.9	1,990.6		1982	1.263
	Total	37,932.0	10,121.5	16,606.6	7,782.8	4,719.4	77,164.4			
	% - All Years	49.16%	13.12%	21.52%	10.09%	6.12%	100.00%			
	% of 1989	34.03%	18.70%	31.88%	6.45%	8.95%	100.00%			

Notes:

(1) This table was constructed using a number of sources. As a result, not all data are consistent. Data from 1973-1991 are from Sissine, and include DOE spending only. Data for earlier years include multiple federal agencies. Data for 1989 may not match our estimates for DOE exactly due to different decisions on specific programs and different classifications. Sissine data includes separate categories for spending on electricity, energy storage, and environment. While these areas may be directly linked to particular fuels, there was not enough detail with which to allocate. Therefore, these categories are excluded from the totals shown here.

(2) Data prior to 1973 are from Bowring, p. 31. Data from 1973 to the present are from Sissine. Military reactor R&D is excluded.

(3) Fossil includes spending on fossil R&D and clean coal research. Data prior to 1973 are from Battelle, pp. 162 and 192, and include spending by DOI, EPA, ERDA, Coast Guard, and NSF. Data from 1973 to present from Sissine and includes DOE spending only.

(4) Data includes both supply and end-use efficiency and all renewables. Data prior to 1973 are from NSF, p. 41. Post-1973 data are from Sissine.

(5) GNP data are from RATES2.WK1, derived from the 1991 "Economic Report of the President," p. 290.

(6) Data year refers to the base year of the raw data. All Sissine data were in 1982$ (converted to 1989$ here).

(7) GNP inflator values are equal to the GNP Price Deflator in 1989 divided by the GNP Implicit Price Deflator in the data year. This value was used to convert nominal dollars to constant 1989$.

Sources:

(1) Joseph Bowring. "Federal Subsidies to Nuclear Power: Reactor Design and the Fuel Cycle," (Washington, DC: Energy Information Administration of DOE, March 1980). Pre-publication draft.

(2) B.W. Cone, et al. "An Analysis of Federal Incentives Used to Stimulate Energy Production," (Richland, Washington: Battelle Memorial Institute, December 1978).

(3) National Science Foundation, "An Analysis of Federal R&D by Function, FY 1969-1977," pp. 23-41

(4) Fred Sissine. "Energy Conservation: Technical Efficiency and Program Effectiveness," (Washington, DC: Congressional Research Service, Jan. 6, 1992), p. 19. CRS IB85130; and 10/23/92, CRS IB92062, p. 4

Energy Shares of Environmental and Health Externalities

CONTRIBUTION TO RADIATIVE FLUX CHANGES (LATE 1980s)

	Total Program	Total Energy	Coal	Oil	Gas	Electric. Oil	Electric. Coal	Electric Gas
Relative Shares of Fossil Fuels Used in the U.S. for Electricity			75.18%	10.41%	13.57%			
Carbon Dioxide	66.00%	50.16%	21.12%	20.46%	8.58%			
Contribution Shares to CO2 loading		50.16%	5.24%	18.33%	7.42%	2.13%	15.88%	1.16%
Methane	17.00%	3.40%			3.40%			
Primarily natural gas; allocated on basis of gas used for electric vs. used via end-user.								
Contribution Shares to Methane Loading		3.40%			2.94%			0.46%
Chlorofluorocarbons	12.00%	0.00%						
Nitrous Oxide	5.00%	0.80%						
Contribution Shares, from above								
Utility Contribution		0.28%				0.01%	0.27%	0.00%
Automobile Contribution (oil)		0.34%		0.34%				
Remainder split between oil & coal		0.17%	0.09%	0.09%				
Net Contribution to NOx		0.80%	0.09%	0.43%	0.00%	0.01%	0.27%	0.00%
Overall Energy Contribution to Global Warming		54.36%	5.33%	18.76%	10.35%	2.14%	16.15%	1.63%
		54.36%						

Sources and Notes:

1) Fossil fuel shares of electricity from EIA, Monthly Energy Review, 2/90, p. 5
2) Contributions to radiative flux changes data from John Holdren, "Population and the Energy Problem," in Population and Environment. A Journal of Interdisciplinary Studies, V. 12, #3, Spring 1991, pp. 231-255; John Holdren, "Energy in Transition," Scientific American, September 1990, pp. 157-163.
3) Breakout of fossil fuels used in the electricity sector was done using the percent of particular fuels consumed by utilities.

ENERGY SHARE OF TOXICS EMISSIONS

Releases to Various Media, Millions of Pounds in 1989

Sector	Air	Water	Land	Underground	Other	Total
Petroleum	71	5	3	38	27	145
Chemical	777	111	125	1,092	723	2,827
Total	2,417	188	462	1,181	1,553	5,800
Petroleum Sector as % of Total	2.95%	2.87%	0.69%	3.22%	1.75%	2.50%

Notes:

(1) TRI data is an approximation of releases, but contains volume information rather than toxicity. In addition, the Office of Technology Assessment has has estimated that up to 95% of toxic releases do not appear in the Toxic Release Inventory. (Cited in GAO, 26).

Sources:

(1) U.S. EPA, Toxic Release Inventory 1989 data, in Citizens Fund, "Manufacturing Pollution: A Survey of the Nation's Toxic Polluters," July 1991.

(2) U.S. GAO. "Toxic Chemicals: EPA's Toxic Release Inventory is Useful but Can Be Improved," June 1991. GAO/RCED-91-121.

MIX OF UNDERGROUND STORAGE TANKS (USTs)

	# Tanks (000s)	Pct.*	Source
Petroleum USTs, other than gasoline stations	651.0	46.50%	Federal Register (FR), 4/17/87, 12795
Petroleum USTs, retail gasoline	695.0	49.64%	FR, 4/17/87, 12792
Chemical storage	54.0	3.86%	FR, 2/9/88, 3819
Total Regulated Universe	1,400.0		
Home heating oil	1,000.0		Low est.; currently unregulated
Total Percentage of Tanks Holding Oil		96.14%	

*Percentages exclude the currently unregulated home heating oil tanks, since they do not require EPA effort.

Sources: "Underground Storage Tanks Containing Petroleum; Financial Responsibility Requirements," Federal Register, 4/17/87.
"Underground Storage Tanks Containing Hazardous Substances; Financial Responsibility Requirements; Advance Notice of Proposed Rulemaking," Federal Register, 2/9/88.

HAZARDOUS WASTE

Industries with Highest Average Number of Superfund National Priority List Sites per Company

Industry	Ave. NPL Sites/Firm	Tot. NPL Sites for Industry
Automobile	27.0	82.0
International Oil	27.0	136.0
Chemical	22.0	246.0
Pollution Control	20.0	78.0
Conglomerates	17.0	87.0
Domestic Oil	13.0	154.0

Source: Investor Responsibility Research Center, "Corporate Environmental Profiles," 1992, p. 39.

HIGHEST PENALTIES ASSESSED FOR VIOLATING ENVIRONMENTAL LAWS, 1987-1989 ($Millions)

Law Violated	Domestic Oil		International Oil		Oil Well Equip. & Serv.		Elect. Equip.		Electric Cos.		
	$Mils	Top 10 Rank	$Mils	Top 10 Rank	$Mils	Top 10 Rank	$Mils	Top 10 Rank	$Mils	Top 10 Rank	Page
Resource Conservation and Recovery Act	10.6	1.0	9.8	2			0.6	10			54
Clean Air Act	2.7	4.0	1.2	8							56
Clean Water Act	0.9	3.0	1.6	1			0.1	10			
Safe Drinking Water Act	0.5	1.0	0.0	4	0.0	6					61
Toxic Substances Control Act and Federal Insecticide, Fungicide, and Rodenticide Act	0.1	6.0					0.1	4	0.1	7	62
Atomic Energy Act Assessments					0.0	4	0.0	3	7.9	1	64
Occupational Health and Safety Admin. Violations	0.2	6.0					0.1	8			65
Mine Safety and Health Administration Penalties	Industry distribution is based on ownership of coal mining operations.										

Notes.

(1) Classification by industry is crude. Penalties assessed on conglomerate's energy operations will not always be reflected in the total penalties shown for the energy sectors listed above. The Mine Safety and Health Administration illustrates this point clearly. Virtually all assessments are against coal mines, although the industrial classifications of the corporate parents is much more diverse.

Source: Investor Responsibility Research Center, "Corporate Environmental Profiles," 1992, pages shown in table.

Air Pollution: Contributions to Cancer

	Total	Energy Share	Oil	Coal	Biomass	Notes
Motor Vehicles (oil)	56.00%	56.00%	56.00%			
Woodsmoke (biomass)	4.00%	4.00%			4.00%	
Gasoline Marketing (oil)	3.00%	3.00%	3.00%			
Coal & Oil Combust. (1/2 oil; 1/2 coal)	1.00%	1.00%	0.50%	0.50%		
Secondary Formaldehyde (30% oil)	7.00%	2.10%	2.10%			30% is associated with motor vehicle use.
Other (non-energy rel.)	29.00%	0.00%				
Total	100.00%	66.10%	61.60%	0.50%	4.00%	

ource:

U.S. EPA, "Strategic Plan for EPA's Toxic Air Pollutant Program," November 29, 1989.
Prepared by the Office of Air Quality Planning and Standards.

Externalities and the Cost of Regulation: Do We Clean Too Much or Clean Too Little?

Category	Cost/Year, Billions of 1989$ Low Estimate	High Estimate	Notes	Comments or Study Cited	Source Used
The Partial Cost of Not Cleaning Up:					
Emissions from Electricity Generation					
Coal	14.9	73.0	(4)	Compilation	Yim, Evans, and Wilson; GAO/RCED-92-13
Oil	2.7	6.4	(4)	Compilation	Yim, Evans, and Wilson
Natural Gas	1.7	3.3	(4)	Compilation	Yim, Evans, and Wilson
Nuclear	0.1	0.8	(4)	Compilation	Yim, Evans, and Wilson
All Automotive Air Pollutants	4.6	200.0		DeLuchi et al; Sperling and DeLuchi	Cannon; MacKenzie
Pollution from Agriculture					
Erosion, Offsite Impacts	2.2	8.6		Clark et al; USDA (1987)	Proj. '88, Rnd. I; NRC (1989)
Erosion, Onsite Impacts	0.5	19.4		NRC (1989); Pimental; USDA (19	NRC (1989)
Honeybee Industry Damage from Pesticides	0.2	0.2		Pimental (1980)	NRC (1989)
Air Toxics	3.0	3.0	(5)		GAO/RCED-91-143
Total Costs for Environmental Problems Listed	29.9	314.7			
Total Global Costs of Stratospheric Ozone Depletion	$6.3 trillion by 2075 without chemical phaseout				EPA, Ozone, p. 3
The Cost of Cleaning:					
All Federal Environmental Regulation	89.3	89.3		Hopkins	Hopkins
Aggregate Pollution Control Costs	104.7	104.7		EPA, Cost of Clean	EPA, Cost of Clean, 2-2
Examples of Cost-Increasing Regulation (Note 3)					
Oil Overcharge Funds ($Millions)	293.4	293.4		Taxes oil; benefits effic.	Other Interventions Chapter
Gas Guzzler Tax ($Millions)	109.7	109.7		Taxes large cars	Tax Expenditures Chapter
Auto Fuel Efficiency & Emissions Standards ($Millions)	2,848.5	15,220.4		Increases car price	GAO/RCED-92-100; Greene and Liu

Notes:

(1) Total cost of pollution shown above does not include all pollution problems. For example, costs of global climate change, stratospheric ozone depletion, forest losses and water pollution from excess timbering, and many others are not included.

(2) Estimates for both categories should be taken with a grain of salt. The assumptions one makes about the value of damage to human health, and especially the discount rate chosen to convert future damanges into present costs, can dramatically affect the resultant cost or benefit. Further, all figures are total, not marginal costs/damages; therefore they provide any information on the optimal control level.

(3) The cost-increasing regulation is included in the overall estimate for the cost of environmental regulations.

(4) This data was provided as a cost per kilowatt hour and converted to annual totals using 1989 net generation data.

(5) The source ascribed 3,000 additional fatal cancers each year to air toxics, a $3 billion cost at $1 million/life. While some air toxics come from power plants and refineries, most do not. Thus, double counting should not be significant.

Sources of Citations and Reference:

(1) Cannon, James. "The Health Costs of Air Pollution: A Survey of Studies Published 1984-1989," Pre-Publication Edition. (Washington, DC: American Lung Association, 1990).

(2) Clark, E.H., J. Haverkamp and W. Chapman. "Eroding Soils, the Off-Farm Impacts," (Washington, DC: The Conservation Foundation, 1985).

(3) DeLuchi, Mark et al. "A Comparative Analysis of Future Transportation Fuels," (Berkely, CA: Institute of Transportation Studies, UCAL-Berkely, Oct. 1987).

(4) Greene, David and Jin-Tan Liu. "Automotive Fuel Economy Improvements and Consumers' Surplus," Transportation Res.-A., Vo. 22A, #3, PP. 203-218, 1988.

(5) Hopkins, Thomas. "Cost of Federal Regulation," in "Regulatory Policy in Canada and the United States," Conference Proceedings, Rochester Institute of Technology, May 1992, pp. 3-6.

(6) MacKenzie, James, Roger Dower and Donald Chen. "The Going Rate: What it Really Costs to Drive," (Washington, DC: World Resources Institute, June 1992).

(7) National Research Council. "Alternative Agriculture," (Washington, DC: National Academy Press, 1989).

(8) Pimental, David, et al. "Environmental and Social Costs of Pesticides: A Preliminary Assessment," Oikos 34: 127-140, 1980.

(9) "Project 88: Harnessing Market Forces to Protect Our Environment," Washington, DC: Dec. 1988.

(10) Sperling, Daniel and Mark DeLuchi. "Tranportation Energy Futures," Annual Review of Energy, 1989. 14: 375-424.

(11) U.S. Department of Agriculture, " Agricultural Resources - Cropland, Water, and Conservation - Situation and Outlook Report," AR-8. Economic Research Service, 1987.

(12) U.S. EPA. "Environmental Investments: The Cost of A Clean Environment," Summary, Dec. 1990.

(13) U.S. EPA. "Strategic Plan for Ozone Depletion," November 28, 1989.

(14) U.S. GAO. "Air Pollution: EPA's Strategy and Resources May Be Inadequate to Control Air Toxics," June 1991. GAO/RCED-91-143.

(15) U.S. GAO. "Motor Vehicle Regulations: Regulatory Cost Estimates Could be Improved," July 1992. GAO/RCED-92-100.

(16) Yim, Man-Sung, John Evans, and Richard Wilson. "Health and Environmental Risks of Energy Systems," (Boston, MA: Harvard School of Public Health, 1991).

Part 1: Summary of Subsidy Intensity by End-Use in 1989

Fuel	Subsidy ($Mils) (1)	Consumption Input (Quads) (2)	Output (Quads) (3)	Standard Units (4)	Subsidy/Unit Energy Output $/MMbtu	Std. Unit	Unit	Price in 1989 $/mmBtu (5)	$/Standard Unit (5)		Subsidy as a % of Market Price
Electricity											
Coal	7399.9	15.99	5.25	1554 bil Kwh	$1.41	0.476	cents/kWh				
Oil	646.7	1.69	0.56	158 bil Kwh	$1.16	0.409	cents/kWh				
Natural Gas	996.2	2.87	0.94	267 bil Kwh	$1.06	0.373	cents/kWh				
Fission	10578.9	5.68	1.81	529 bil Kwh	$5.84	2.000	cents/kWh				
Hydro	623.4	2.88	0.9	265 bil Kwh	$0.69	0.235	cents/kWh				
Ave., All Non-Renew. Electric.	20245.1	29.11	9.46	2773 bil Kwh	$2.14	0.730	cents/kWh	18.18	6.47	cents/kWh	11.28%
Direct Consumption											
Coal	642.9		2.95	123.7 mm sh ton	$0.22	5.197	$/short ton	1.68	39.99	$/short ton	13.00%
Oil	8111.5		32.52	254.3 bil gals	$0.25	0.032	$/gallon	6.54	0.84	$/gallon	3.81%
Natural Gas	3279		16.51	15.6 tril cu ft	$0.20	0.211	$/mcf	3.83	4.06	$/mcf	5.19%
Ethanol (8)	879.3			810 mm gals		1.086	$/gallon				See Gasohol
End-Use Efficiency	983.3		15.2		$0.06						
Derived Fuels											
Gasoline	2,584.3		10.8	86.4 bil gals	$0.24	0.03	$/gallon	8.48	1.06	gallon	2.82%
Gasohol (8)	1,079.4		0.9	7.5 bil gals	$1.15	0.14	$/gallon	8.48	1.06	gallon	13.58%

Subsidies to Carbon (Note 7) 19,612.3 From NEWFULL.WK1, print range "carbon"; includes subsidies to carbon using capital infrastructure & R&D.

mm tons of carbon emitted from fossil fuel combustion in 1989

5,783

Subsidy/ton 3.39

Notes:

(1) Coal, oil, natural gas split between direct consumption & raw fuel on the basis on consumption by each sector (see Part 2).

(2) Fuels consumed for electricity generation are given in terms of heat equivalents of input fuels. EIA, AER '91, tab. 95, 217; and tab. 94, 215; hydro electric data from EIA, AER '91, Table 1.

(3) Heat values of net electricity generation are significantly lower than input heat values due to losses in conversion and transmission of about 2/3.

(4) EIA, Annual Energy Review 1991, Tables 63, 79, 85, 92.

(5) Prices per mmBtu represent the weighted average of consumption in commercial, residential, industrial and transportation sectors in 1989, based on data in EIA Annual Energy Review, 1991, Tables 31, 63, 79 and 85. Prices per standard unit are derived from mmbtu prices, except for the electricity sector. $/mmbtu values for electricity represent the cost of heating potential at end use, and reflect generation and transmission losses. Data on the retail price of electricity are from EIA, AER 1991, Table 102.

(6) Conversion rates, calculated by standard units/mm Btu consumption for each energy type:
Coal: 123.7 mm short tons = 2.95 Quad; 1 short ton = 23.85 mmbtu
Oil: 32.519 Quad = 6,055.4 mm bbl/yr; 1 gal oil = .128 mmbtu
Nat. Gas: 15.57 tril cf = 16.516 quad of non-utility use; 1 cf = 1,061 btu/cf

(7) Based on conversion rates of 102 mm tons/Quad for coal, 80 mm tons/Q for oil and 57.5 mm tons/quad for natural gas, in John Justus, "Global Climate Change," Congressional Research Service, 8/28/90, p. 8.

(8) DOE, Office of Alcohol Fuels, "11th Annual Report on the Use of Alcohol in Fuels," 1990. Gasohol estimate assumes 10% ethanol, and the same mmBtu/gal and price/gal. as for gasoline.

Part 2: Derivation of Shares to Electricity

	Total Consumption In 1989 (Quads) (1)	Quads Used for Electricity (2)	Pct. Electric	Pct. Direct
Coal	18.94	15.99	84.42%	15.58%
Oil	34.21	1.69	4.94%	95.06%
Natural Gas	19.38	2.87	14.81%	85.19%

(1) EIA, Annual Energy Review 1991, Table 3.
(2) EIA, Annual Energy Review, 1991, Table 92, p. 211

Part 3A: Derivation of Weighted Averages for Prices

Sector	Resident. & Commer.	Indust. & Misc.	Transport	Util.	Total	Source
Coal (mm short tons)						
Consumption	6.2	117.5	0	766.9	890.6	EIA, AER '91, Table 85, p. 193.
Percent Shares	0.70%	13.19%	0.00%	86.11%		
% Non-Utility	5.01%	94.99%	0.00%			
Prices, $ mm Btu	1.99	1.66	0	1.45		EIA, AER '91, Table 31
Wghtd Ave., non-util.					1.68	
Natural Gas (tril. cf)						
Consumption	7.05	7.89	0.63	2.79	18.36	EIA, AER '91, Table 79, p. 177.
Percent Shares	38.40%	42.97%	3.43%	15.20%		
% Non-Utility	45.28%	50.67%	4.05%			
Prices, $ mm Btu	5.16	2.94	No data	2.36		EIA, AER '91, Table 31
Wghtd Ave., non-util.					3.83	
Petroleum Products (mm b/d)						
Consumption	1.32	4.26	11.01	0.074	16.664	EIA, AER '91, Table 63, p. 141.
Percent Shares	7.92%	25.56%	66.07%	0.44%		
% Non-Utility	7.96%	25.68%	66.37%			
Prices, $ mm Btu	6.81	4.69	7.22	2.95		EIA, AER '91, Table 31
Wghtd Ave., non-util.					6.54	
Electricity Sales (bil kWh)						
Consumption	1632	926	90	0	2648	EIA, AER '91, Table 96.
Percent Shares	61.63%	34.97%	3.40%	0.00%		
Prices, $ mm Btu	21.64	13.85	22.96	0		EIA, AER '91, Table 31.
Wghtd Ave., non-util.					18.1803549	Transport includes some street lighting.
Prices, cents/kWh	7.4	4.7	6.2	0		EIA, AER '91, Table 102
					6.415	

Part 3b. Derivation of Subsidies to Motor Fuel

Consumption of transport fuels, 1989	7,437.00	k bbl/day	EIA, AER '91, Table 24
	114.01	bil gal/yr	Includes ethanol, aviation fuel
Aviation fuel as % refinery output in 1989	17.60%		EIA, AER '91, Table 59.
Gasoline	93.94	bil gal/yr	
Less gasohol	7.5	bil gal/yr	Assumes 10% ethanol/gal. From ETHANOL.WK1; based on sales, not production, since excise tax exemption occurs
Net gasoline	86.4		
Heat content, gasoline	0.125	mm btu/gallon	EIA, AER, Table A1.
Quads of Gasoline + Gasohol	11.742948	Quadrillion btu	"Gasoline" line x btu/gal (Includes ethanol; excludes diesel and aviation fuel)
Quads of Oil Consumed in '89	34.21		From above
Gasoline/total oil	34.33%		
Gasoline share	92.81%	31.86%	2nd col. = % share of oil used in gasoline.
Gasohol Share	7.19%	2.47%	Pro-rated to reflect 90% gasoline/10% ethanol mix; 2nd col. =% of tot. oil used in gasohol.
Ave. price for gasoline, 1989	1.06	$/gal	EIA, AER '91, Table 73.

ELECTRICITY MIX ALLOCATION BASE FOR 1989

Allocation Base 1989 Data Unless Otherwise Noted	Total Program	Total Energy	Electric. Fission	Electric. Oil	Electric. Coal	Electric. Gas	Electric. Hydro	Conserv./ Effic.	Biomass	Wind	Solar	Geotherm.	Waste-to-Energy
ENERGY CAPACITY MEASURES													
ELECTRICITY MIX													
Renewables Elect. Net Gen. Mix (Mil. kWh)	11,309.3								1,017.1	0.5	2.6	9,341.7	947.5
Percent	100.00%								8.99%	0.00%	0.02%	82.60%	8.38%
Renewables data from EIA, Form 759, Monthly Powerplant Report. Does not include wind farms that sell power to utilities.												Total:	
Electricty Mix (Net Gener., Bil. KWh)	2784	2784	529	158	1554	267	265	0.00	1.02	0.00	0.00	9.34	0.95
Percent	100.0%		19.00%	5.68%	55.82%	9.59%	9.52%	0.00%	0.04%	0.00%	0.00%	0.34%	0.03%
EIA, Annual Energy Review, Feb. 1991, p. 211.													

Federal Energy Subsidies:

Energy, Environmental, and Fiscal Impacts

Technical Appendix
(Appendix B)

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April 1993

The Alliance to Save Energy
Energy Price and Tax Program
Mary Beth Zimmerman, Program Manager