Savings Generated by the Industrial Assessment Center Program: Fiscal Year 2001

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I. Introduction

Established in 1976 as a result of oil shortages and the increased awareness of the importance of energy conservation, the Energy Analysis and Diagnostic Center (EADC) program grew from the original four schools to thirty in Fiscal Year 1994. The Centers conducted energy audits for small to medium sized manufacturers through funding provided by the Office of Industrial Technologies (OIT) of the U.S. Department of Energy.

Since the inception of the program, there have been 38 Universities involved with the program. Nearly 100 faculty members have had the opportunity to enhance their classroom activities by taking students into the field, or more accurately, the factory floor. Most importantly, perhaps is the continued contribution that the over 2500 students who have "graduated' from the program are making to the industrial and commercial sector in which they now work.

In FY94, the EADC program was modified to include waste reduction and pollution prevention, with new combination Centers called "Industrial Assessment Centers" (IAC). It was decided to start with a small group of experienced Centers to provide a smooth transitional period. For this first year, the six IACs each conducted a minimum of ten combination, or industrial, assessments.

The remaining experienced EADCs were trained in August of 1994 to bring them into the IAC program with the start of Fiscal Year 1995. By Fiscal Year 1996 all centers were conducting "Industrial Assessments" and the title "Energy and Diagnostic Center" (EADC) was retired in favor of Industrial Assessment Center. In FY2001, the 26 Centers performed 588 assessments (formerly called energy audits), including recommendations for both energy conservation and waste reduction/pollution prevention.

In FY96, changes were made to the reporting of electricity use and savings to better reflect the method of billing by most electric utilities. In the past, average cost of electricity (per kilowatt/hour) was used; starting in FY96 this value was broken up into electric consumption (kwh), demand charges (kw-month/year), and other electric fees. Also in August of 1996 the center directors were trained in productivity enhancing recommendations.

IAC assessments consist of faculty led teams from accredited engineering universities performing mostly one-day audits to a manufacturing plant following an extensive data gathering function. Manufacturers qualified for assessments if they met three of these four requirements: employment was under 500 persons at the site, annual sales were less than $100 million, annual energy bills under $2 million, and no professional staff was on hand to do the analyses.

Introduction (continued)

The resulting report produced for the manufacturer included data about the plant's energy use, waste production, processes and other information.

In addition, the reports produced contained several assessment recommendations, written with sufficient detail to provide anticipated energy, waste, or productivity cost savings, as well as implementation costs and simple paybacks. Within one year the staff of each Center conducted a survey of the assessed manufacturers to determine which recommended conservation measures were adopted.

II. Program Statistics

A. General

In Fiscal Year 2001, 588 assessments were performed, bringing the program database total to 10,363 assessments since FY1981, the first year these records were kept. As only fifteen assessments were performed in FY1981, the data shown in this report date back to 1982. The number of assessments in this data set is 10,348. Unless otherwise noted, figures are for FY2001. Table 1 shows the number of assessments performed by Fiscal Year.

Fiscal Year	Total No. of Assessments Performed	No. of Industrial Assessments Performed
1982	253	n/a
1983	211	n/a
1984	248	n/a
1985	368	n/a
1986	298	n/a
1987	324	n/a
1988	388	n/a
1989	340	n/a
1990	360	n/a
1991	455	n/a
1992	531	n/a
1993	585	n/a
1994	776	61
1995	879	237
1996	867	867
1997	720	720
1998	723	723
1999	734	734
2000	700	700
2001	588	588
Total	**10,348**	**4,630**

Table 1. Assessments Performed by Fiscal Year

The total amount of recommended Energy Conservation measures in FY2001 was approximately 9,370,000 Million British Thermal Units (MMBTU) with a dollar value of $61 million. Waste Reduction and Pollution Prevention cost savings amounted to almost $11 million, and Productivity recommendations were over $86 million. The resultant total recommended savings were almost $160 million.

The FY2001 implementation survey conducted by the Centers revealed that the amount of energy saved by manufacturers through implementation of recommendations contained in reports resulting from assessments, as reported by the clients, was 2,512,000 MMBTU, with a dollar value of $14 million. This equates to 425,000 barrels of oil measured in barrels of oil equivalent (BOE), and 52,000 metric tons of carbon avoided measured in carbon equivalent (CE).[1] . The implemented Waste Reduction and Pollution Prevention (P2) measures amounted to $1.5 million and Productivity measures realized almost $22 million. The total amount of money saved by clients as a result of implemented measures was over $37 million. If all implemented energy saving recommendations made over the past 7 years are still in place, the energy savings to the clients would be 14,650,000 MMBTU's.

[1] Carbon avoidance is a generally accepted method of quantifying the production of Carbon Dioxide (CO_2), a known "greenhouse" gas, by the combustion of fossil fuels.

B. Client Profile

Each Center operates in a geographic area based on its location and the state that it resides in. The distribution of assessments in FY2001 is shown in the following table by state. In FY2001, the IACs served manufacturers in 36 states.

STATE	No. of Assessments Performed in Each State	Industrial Assessment Center	No. of Assessments Performed by Each IAC	Percent of Assessments Performed in Each State
Arizona	25	Arizona State University	25	100%
Arkansas	4	Oklahoma State University	4	100%
California	69	Loyola Marymount University	22	32%
		Oregon State University	1	1%
		San Diego State University	24	35%
		San Francisco State University	22	32%
Colorado	13	Colorado State University	13	100%
Connecticut	1	University of Massachusetts	1	100%
Florida	49	University of Florida	24	49%
		University of Miami	25	51%
Georgia	14	Georgia Tech. Research Institute	14	100%
Idaho	3	Oregon State University	3	100%
Illinois	48	Bradley University	22	46%
		University of Illinois at Chicago	24	50%
		Univ. of Wisconsin - Milwaukee	2	4%
Indiana	1	University of Dayton	1	100%
Iowa	18	Iowa State University	18	100%
Kansas	3	Oklahoma State University	3	100%
Louisiana	25	Univ. of Louisiana at Layfayette	25	100%
Maine	1	University of Massachusetts	1	100%
Massachusetts	10	University of Massachusetts	10	100%
Michigan	19	University of Michigan-Ann Arbor	19	100%
Minnesota	3	Iowa State University	3	100%
Mississippi	23	Mississippi State University	23	100%

Table 2. Geographic Distribution of Assessments by State

STATE	No. of Assessments Performed in Each State	Industrial Assessment Center	No. of Assessments Performed by Each IAC	Percent of Assessments Performed in Each State
Nebraska	1	Iowa State University	1	100%
New Hampshire	7	University of Massachusetts	7	100%
New Jersey	5	Lehigh University	5	100%
New Mexico	4	Colorado State University	4	100%
New York	25	Syracuse University	25	100%
North Carolina	22	Georgia Tech. Research Institute	2	9%
		North Carolina State University	20	91%
Ohio	32	University of Dayton	24	75%
		University of Michigan-Ann Arbor	3	9%
		West Virginia University	5	16%
Oklahoma	16	Oklahoma State University	16	100%
Oregon	9	Oregon State University	9	100%
Pennsylvania	30	Lehigh University	20	67%
		West Virginia University	10	33%
South Carolina	3	Georgia Tech. Research Institute	2	67%
South Carolina		North Carolina State University	1	33%
Texas	40	University of Texas at Arlington	20	50%
		Texas A&M - College Station	20	50%
Utah	22	Colorado State University	2	9%
		Oregon State University	1	5%
		Texas A&M - College Station	1	5%
		University of Utah	18	82%
Vermont	4	University of Massachusetts	4	100%
Virginia	1	North Carolina State University	1	25%
Washington	6	Oregon State University	6	100%
West Virginia	9	West Virginia University	9	100%
Wisconsin	22	Univ. of Wisconsin - Milwaukee	22	100%
Wyoming	1	Colorado State University	1	100%

Table 2. (continued) Geographic Distribution of Assessments by

Table 3 indicates the geographic distribution of the assessments broken down by IAC.

Industrial Assessment Center	No. of Assessments Performed by Each IAC	STATE	No. of Assessments Performed in Each State	Percent of Assessments Performed by IAC in a State
Arizona State University	25	Arizona	25	100%
Bradley University	22	Illinois	22	100%
Colorado State University	20	Colorado	13	65%
		New Mexico	4	20%
		Utah	2	10%
		Wyoming	1	5%
Georgia Tech. Research Institute	18	Georgia	14	78%
		North Carolina	2	11%
		South Carolina	2	11%
Iowa State University	22	Iowa	18	82%
		Minnesota	3	14%
		Nebraska	1	5%
Lehigh University	25	New Jersey	5	20%
		Pennsylvania	20	80%
Loyola Marymount University	22	California	22	100%
Mississippi State University	23	Mississippi	23	100%
North Carolina State University	22	North Carolina	20	91%
		South Carolina	1	5%
		Virginia	1	5%
Oklahoma State Univ.	23	Arkansas	4	17%
		Kansas	3	13%
		Oklahoma	16	70%
Oregon State University	20	California	1	5%
		Idaho	3	15%
		Oregon	9	45%
		Utah	1	5%
		Washington	6	30%

Table 3. Geographic Distribution of Assessments by Center

Industrial Assessment Center	No. of Assessments Performed by Each IAC	STATE	No. of Assessments Performed in Each State	Percent of Assessments Performed by IAC in a State
San Diego State University	24	California	24	100%
San Francisco State Univ.	22	California	22	100%
Syracuse University	25	New York	25	100%
Texas A&M - College Station	21	Texas Utah	20 1	95% 5%
University of Dayton	25	Indiana Ohio	1 24	4% 96%
University of Florida	24	Florida	24	100%
University of Illionis at Chicago	24	Illinois	24	100%
Univ. of Louisiana at Layafayette	25	Indiana	25	100%
University of Massachusetts	23	Connecticut Maine Massachusetts New Hampshire Vermont	1 1 10 7 4	4% 4% 43% 30% 17%
University of Miami	25	Florida	25	100%
Univ. of Michigan - Ann Arbor	22	Michigan Ohio	19 3	86% 14%
University Texas at Arlington	20	Texas	20	100%
University of Utah	18	Utah	18	100%
Univ. of Wisconsin - Milwaukee	24	Illinois Wisconsin	2 22	8% 92%
West Virginia University	24	Ohio Pennsylvania West Virginia	5 10 9	21% 42% 38%

Table 3. (continued) Geographic Distribution of Assessments by Center

The IAC program serves manufacturers with a two digit Standard Industrial Classification (SIC) from 20 to 39 inclusive (Table 4) with 3 exceptions mandated by the Department of Energy. Figure 1 shows the distribution of assessments performed in each classification for FY2001.

2-digit SIC Code	Industry	No. of Assessments Performed
10	Metal Mining	1
12	Coal Mining	1
14	Mining And Quarrying Of Nonmetallic Minerals	1
20	Food and Kindred Products	38
22	Textile Mill Products	13
23	Apparel and Other Textile Products	9
24	Lumber and Wood Products	36
25	Furniture and Fixtures	11
26	Paper and Allied Products	32
27	Printing and Publishing	20
28	Chemicals and Allied Products	38
29	Petroleum and Coal Products	4
30	Rubber and Misc. Plastics Products	58
31	Leather and Leather Products	2
32	Stone, Clay, and Glass Products	18
33	Primary Metal Industries	66
34	Fabricated Metal Products	95
35	Industrial Machinery and Equipment	69
36	Electronic and Other Electric Equipment	28
37	Transportation Equipment	23
38	Instruments and Related Products	16
39	Miscellaneous Manufacturing Industries	9
Total		**588**

Table 4. Number of Assessments Performed by Industry Type

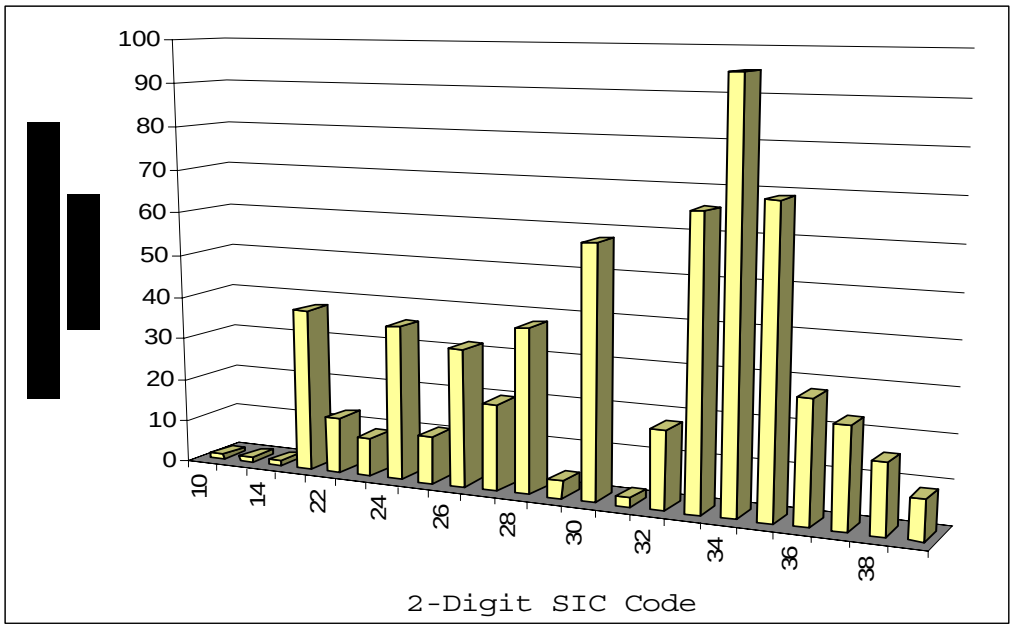


Figure 1. Plants Served in FY2001 by Industry Type

Assessments are available for small to medium size plants that meet three of the following requirements:

- Gross sales below $100 million
- A maximum of 500 employees at the site
- Annual energy bills below $2.0 million
- Lack of professional staff to do energy analyses

In FY2001, the total energy usage of the clients was 94 million MMBTU, costing $ 437 million. There was an average of 168 employees at each location. The companies had total sales of $ 13 billion.

The average sales and energy use of the clients by Fiscal Year is shown in Table 5.

Fiscal Year	Average Yearly Sales($)	Average Yearly Energy Usage (MMBtu)	Average Yearly Energy Cost ($)
1982	16,558,654	59,472	231,913
1983	15,439,405	76,980	320,200
1984	13,543,984	65,989	312,849
1985	14,308,457	76,586	329,205
1986	21,558,916	96,056	416,228
1987	19,438,333	81,140	334,472
1988	18,515,013	104,010	361,374
1989	23,309,162	105,757	413,965
1990	25,126,931	116,491	441,287
1991	25,707,204	104,961	382,786
1992	24,500,738	143,617	428,295
1993	27,333,166	129,428	499,311
1994	28,090,421	97,942	437,531
1995	29,077,218	90,974	412,759
1996	30,609,175	93,666	419,120
1997	29,801,416	82,995	386,008
1998	31,756,512	109,053	481,024
1999	28,255,145	105,316	451,489
2000	32,994,566	119,236	514,351
2001	35,561,539	159,653	740,555

Table 5. Average Client Energy Use and Sales by Fiscal Year

Figure 2 shows the average sales figures for the IAC clients over the years since FY1982.

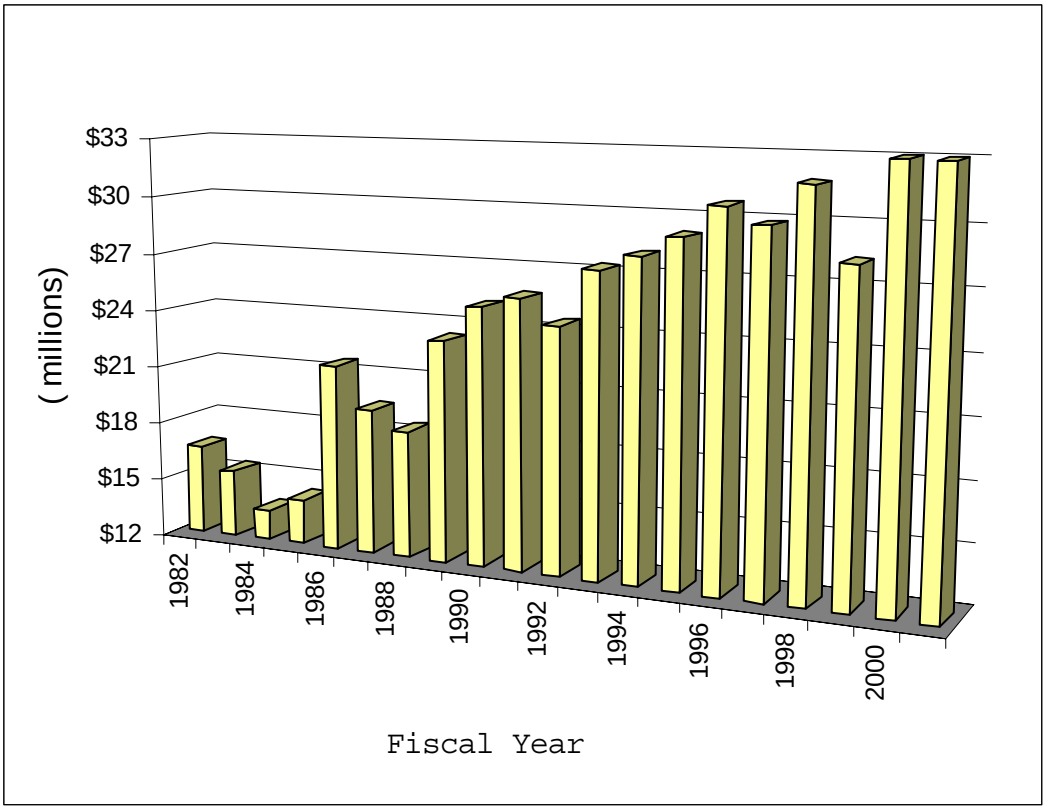


Figure 2. Average Client Sales by Fiscal Year

The average plant served in FY2001 had purchased energy use of 160,000 MMBTU (Source Electric and Site Fuels) with an associated cost of $740,000. Electricity cost the typical client $16.14/ MMBTU (Site) and natural gas cost $5.15/ MMBTU. (Site) The average energy use and associated costs are shown in Figures 3 and 4. The DOE estimates that it takes 10,250 BTU's of thermal energy to get 1 KWH of electricity this equals an efficiency of about 33.29%.

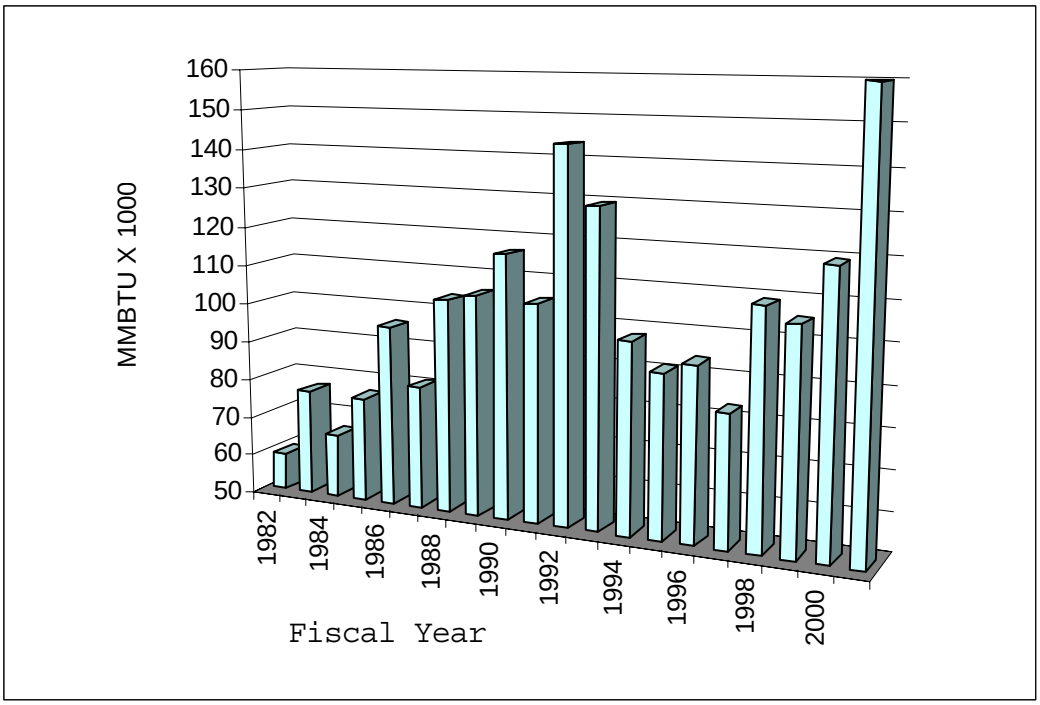


Figure 3. Average Client Energy Usage by Fiscal Year

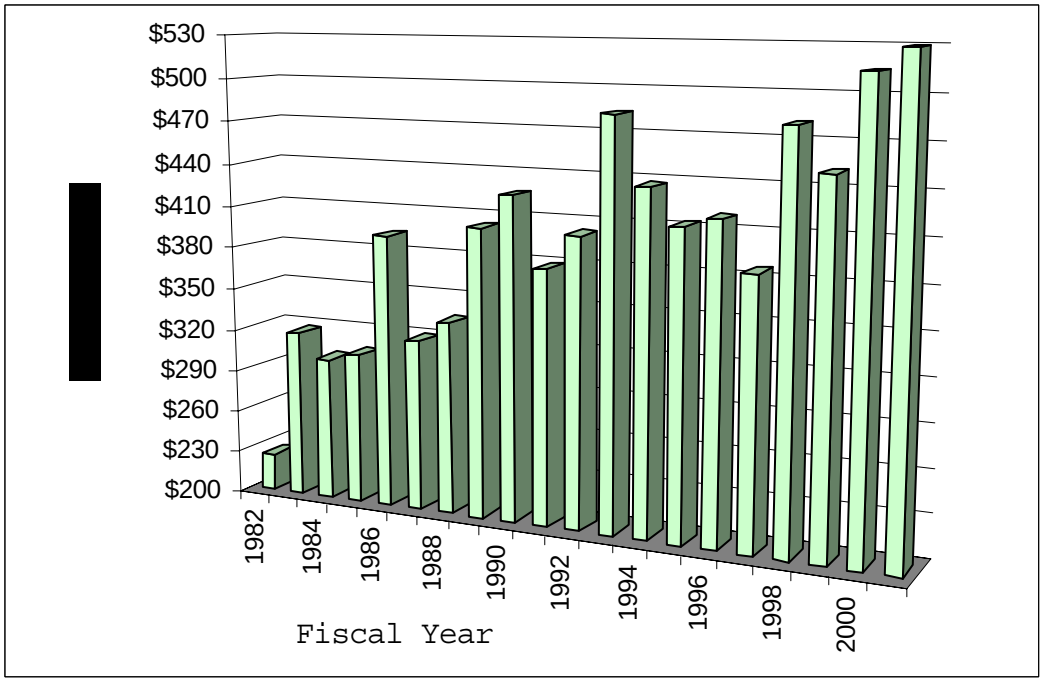


Figure 4. Average Client Energy Costs by Fiscal Year

The program database breaks energy use into eleven specific streams and one category for "other" energy. “Other Energy” in FY2001 was mainly coke. The breakdown of the different energy streams is shown in Table 6, and Figures 5 and 6.

Energy Stream	Energy Usage (MMBtu)	Total Cost ($)
Electricity		
Demand	11,805,535 KW-months/yr	66,241,937
Fees		11,937,932
Consumption		
Site(KWH)	4,575,603,796	173,726,009
Source(MMBtu)	47,134,714	
Natural Gas	28,381,666	146,231,264
L. P. G.	30,267	246,162
Fuel Oil #1	0	0
Fuel Oil #2	450,387	1,495,679
Fuel Oil #4	139,870	576,353
Fuel Oil #6	4,743,495	18,282,667
Coal	11,088,473	15,974,539
Wood	815,112	795,695
Paper	0	0
Other Gas	595	7,424
Other Energy	1,091,115	1,292,710
Totals	**93,875,694**	**436,808,371**

Table 6. Energy Use and Cost by Energy Streams

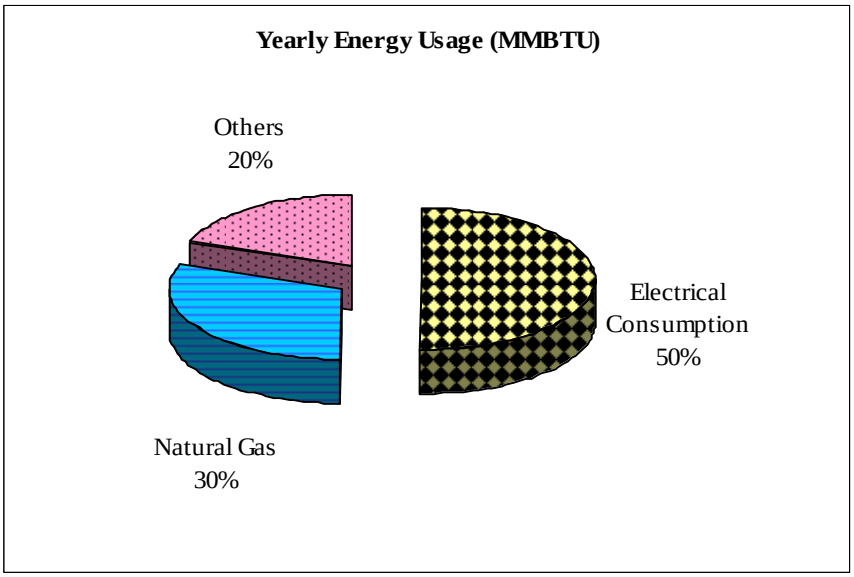


Figure 5. Energy Use of Plants Served in FY2001 by Energy Stream

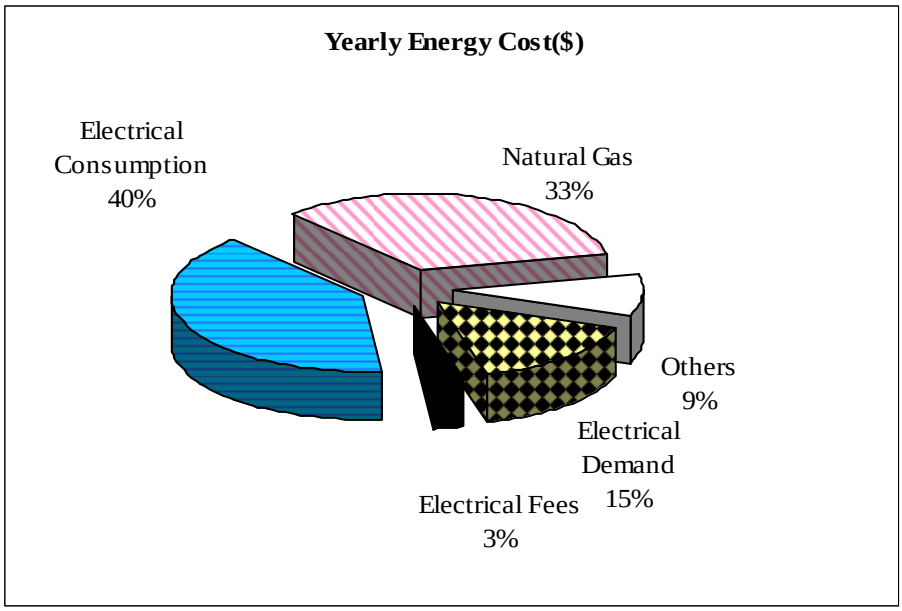


Figure 6. Energy Costs of Plants Served in FY2001 by Energy Stream

C. Assessment Recommendations

i. General

Table 7 indicates the recommended energy saved in millions of BTUs, dollars, barrels of oil equivalent, and carbon equivalent, for FY2001 and previous years. Due to the growth of the program into conducting Industrial Assessments, non-energy savings (water, waste, administrative savings, etc.) were recorded separately in the program database beginning in FY1993. Starting in FY1999 the total energy savings is calculated using both the energy needed to generate electricity at the source and the site use of other fuels.

Fiscal Year	Recommended Energy Conservation						Recommended Cost Savings ($)			
	Site (KWH)	Source Electric (MMBtu)	Site Fuels (MMBtu)	Total (MMBtu)	(B.O.E.)	(C.E., mt)	Energy	Waste	Productivity	Total
1982	62,096,114	636,439	894,877	1,531,316	260,428	35,418	6,699,075	n/a	n/a	6,699,075
1983	60,832,937	633,505	1,313,411	1,946,916	331,108	45,031	8,712,422	n/a	n/a	8,712,422
1984	59,031,622	605,003	1,078,172	1,683,175	286,254	38,931	8,970,862	n/a	n/a	8,970,862
1985	119,194,572	1,221,632	1,779,864	3,001,496	510,459	69,422	13,917,009	n/a	n/a	13,917,009
1986	165,818,543	1,699,559	1,097,081	2,796,640	475,619	64,684	13,670,029	n/a	n/a	13,670,029
1987	140,209,513	1,437,032	623,132	2,060,164	350,368	47,650	10,742,173	n/a	n/a	10,742,173
1988	185,648,245	1,902,772	868,209	2,770,981	471,255	64,091	13,585,868	n/a	n/a	13,585,868
1989	135,267,821	1,386,395	1,310,232	2,696,627	458,610	62,371	13,052,451	n/a	n/a	13,052,451
1990	160,188,406	1,641,815	1,019,706	2,661,521	452,640	61,559	13,970,285	n/a	n/a	13,970,285
1991	230,266,921	2,360,082	504,660	2,864,742	487,201	66,259	17,369,605	n/a	n/a	17,369,605
1992	275,096,064	2,819,542	1,089,038	3,908,580	664,724	90,403	21,749,395	n/a	n/a	21,749,395
1993	341,994,623	3,505,204	1,263,902	4,769,106	811,072	110,306	26,253,156	66,793	3,323,992	29,643,941
1994	505,826,680	5,184,444	1,796,790	6,981,234	1,187,285	161,471	34,764,310	3,410,391	3,463,564	41,638,265
1995	471,717,398	4,834,817	1,041,729	5,876,546	999,413	132,281	32,918,127	10,459,571	6,741,345	50,119,043
1996	306,900,235	3,145,448	682,091	3,827,539	650,942	84,129	24,058,513	26,439,503	14,500,898	64,998,914
1997	256,344,303	2,627,338	1,685,195	4,312,533	733,424	88,364	22,714,504	15,088,878	104,680,156	142,483,538
1998	360,308,430	3,692,982	772,447	4,465,429	759,427	100,427	25,795,731	22,597,667	88,077,156	136,470,554
1999	483,100,888	5,001,902	1,455,191	6,457,093	1,098,145	142,766	31,741,824	12,911,453	89,982,644	134,635,921
2000	528,330,379	5,416,472	673,368	6,089,840	1,035,687	138,361	35,491,661	11,381,081	91,478,751	138,351,493
2001	851,972,749	8,732,713	635,930	9,368,643	1,593,307	200,395	61,072,617	10,772,945	86,260,462	158,106,024
Totals	5,700,146,443	58,485,096	21,585,025	80,070,121	13,617,368	1,804,320	437,249,617	113,128,282	488,508,968	1,038,886,867

Table 7. Recommended Savings Figures by Fiscal Year

The Figures 7 through 11, and Table 8 show average recommended savings figures per assessment by Fiscal Year.

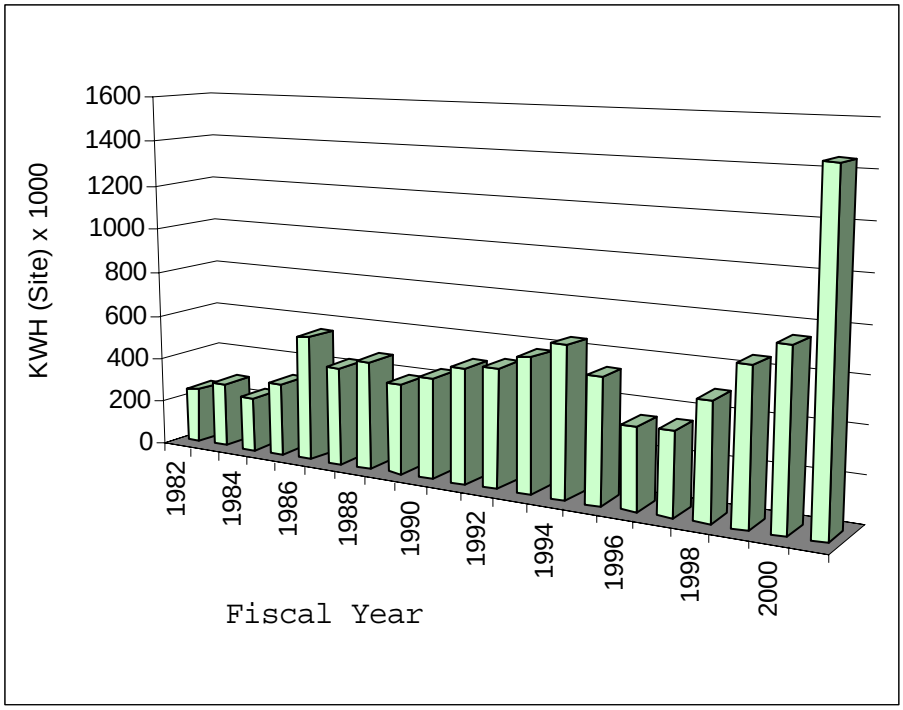


Figure 7: Average Recommended Electric Consumption Conserved Per Assessment by Fiscal Year

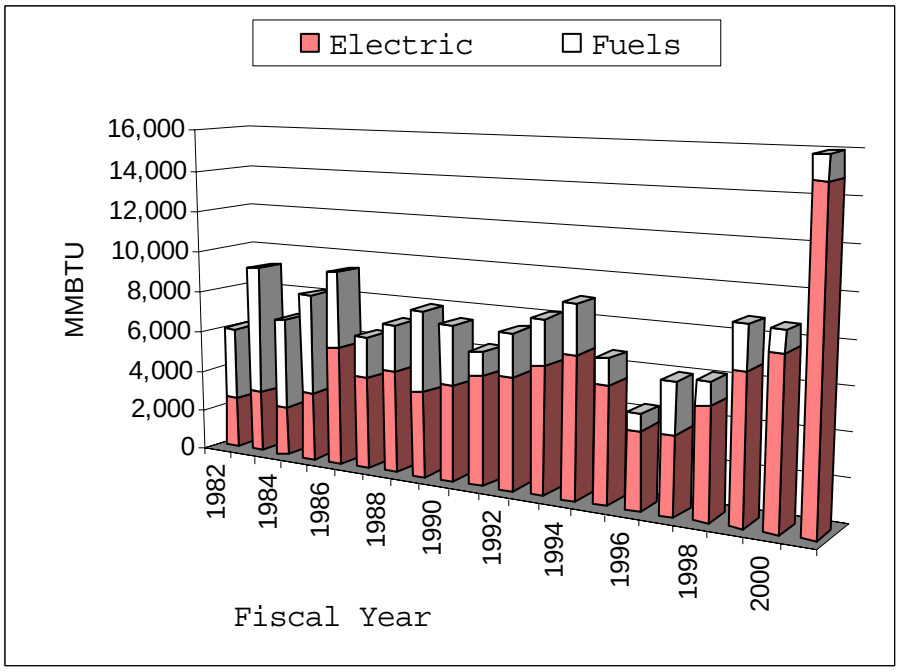


Figure 8. Average Recommended Energy Conserved by Fiscal Year

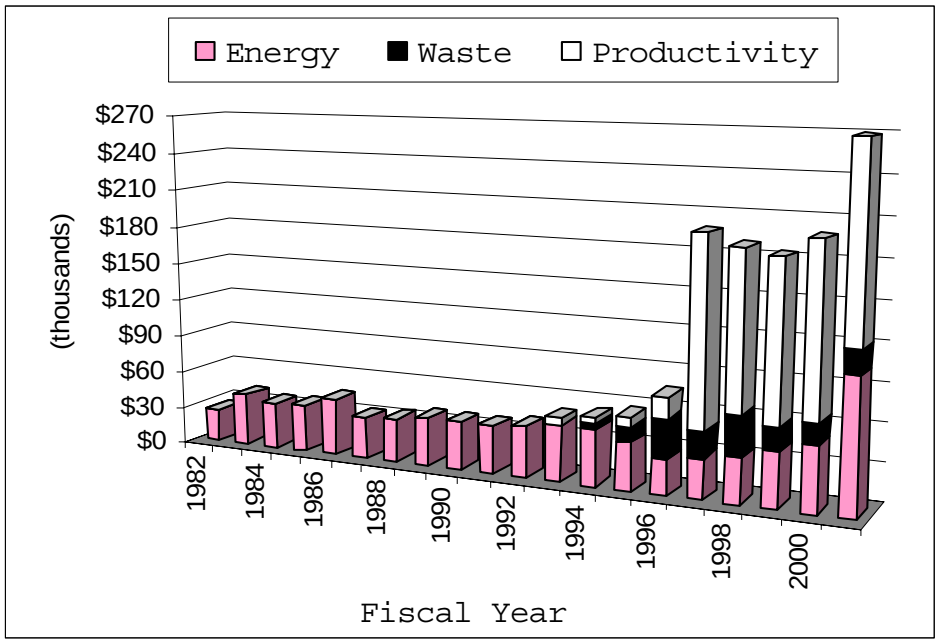


Figure 9. Average Recommended Cost Savings by Fiscal Year

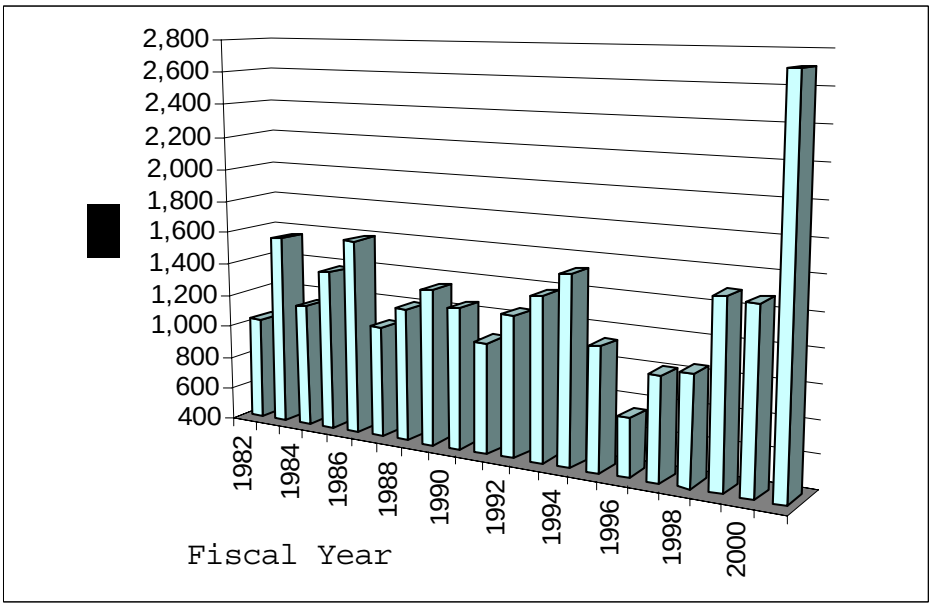


Figure 10. Average Recommended Barrels of Oil Avoided by Fiscal Year

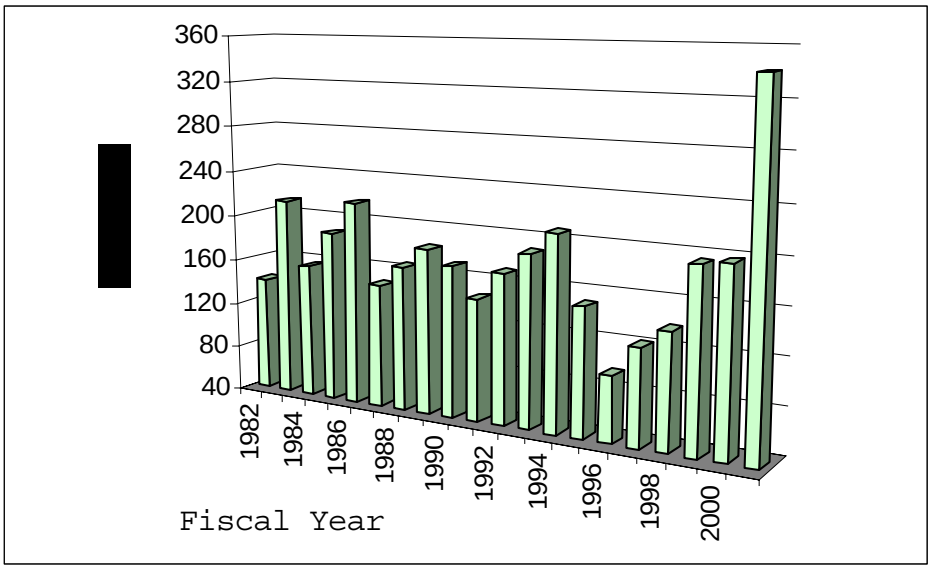


Figure 11. Average Recommended Carbon Avoided by Fiscal Year

Fiscal Year	Recommended Energy Conservation						Recommended Cost Savings ($)			
	Site (KWH)	Source Electric (MMBTU)	Site Fuels (MMBTU)	(MMBtu)	(B.O.E.)	(C.E., mt)	Energy	Waste	Productivity	Total
1982	245,439	2,516	3,537	6,053	1,029	140	26,479	N/A	N/A	26,479
1983	288,308	3,002	6,225	9,227	1,569	213	41,291	N/A	N/A	41,291
1984	238,031	2,440	4,347	6,787	1,154	157	36,173	N/A	N/A	36,173
1985	323,898	3,320	4,837	8,156	1,387	189	37,818	N/A	N/A	37,818
1986	556,438	5,703	3,681	9,385	1,596	217	45,873	N/A	N/A	45,873
1987	432,745	4,435	1,923	6,359	1,081	147	33,155	N/A	N/A	33,155
1988	478,475	4,904	2,238	7,142	1,215	165	35,015	N/A	N/A	35,015
1989	397,847	4,078	3,854	7,931	1,349	183	38,390	N/A	N/A	38,390
1990	444,968	4,561	2,833	7,393	1,257	171	38,806	N/A	N/A	38,806
1991	506,081	5,187	1,109	6,296	1,071	146	38,175	N/A	N/A	38,175
1992	518,072	5,310	2,051	7,361	1,252	170	40,959	N/A	N/A	40,959
1993	584,606	5,992	2,161	8,152	1,386	189	44,877	114	5,682	50,673
1994	651,839	6,681	2,315	8,996	1,530	208	44,799	4,395	4,463	53,658
1995	536,652	5,500	1,185	6,685	1,137	150	37,450	11,899	7,669	57,018
1996	353,980	3,628	787	4,415	751	97	27,749	30,495	16,725	74,970
1997	356,034	3,649	2,341	5,990	1,019	123	31,548	20,957	145,389	197,894
1998	498,352	5,108	1,068	6,176	1,050	139	35,679	31,255	121,822	188,756
1999	658,176	6,815	1,983	8,797	1,496	195	43,245	17,591	122,592	183,428
2000	754,758	7,738	962	8,700	1,480	198	50,702	16,259	130,684	197,645
2001	1,448,933	14,852	1,082	15,933	2,710	341	103,865	18,321	146,701	268,888
Totals	513,682	5,271	2,526	7,797	1,326	177	41,602	20,968	98,798	84,253

Table 8. Average Recommended Energy Conservation and Cost Savings

ii. Recommended Savings by Industry Type

Savings recommended by industry type in Fiscal Year 2001 is shown in Table 9 and Figures 12 through 16. The largest amount of recommended energy conserved occurred during SIC 28 (Paper and Allied Products) assessments replacing SIC 28 (Chemical Products) in FY2000. The largest recommended cost savings was SIC 26 (Paper and Allied Products) There were no recommendations performed for SIC 21 (Tobacco Products). There were also single recommendations not shown on table 9 for SIC 10 (Metal Mining) SIC 12 (Coal Mining) and SIC 14 (Mining And Quarrying Of Nonmetallic Minerals) since there numbers were not significant.

		Recommended Energy Conservation						Recommended Cost Savings ($)			
SIC Code	Industry Description	Site (KWH)	Source Electric (MMBtu)	Site Fuels (MMBtu)	Total (MMBtu)	(B.O.E.)	(C.E., mt)	Energy	Waste	Productivity	Total
20	Tobacco Prod.	19,848,920	203,447	-57,061	146,386	24,896	3,131	842,786	136,967	4,031,708	5,011,461
22	Textile Mills	13,969,802	143,194	332,964	476,158	80,979	10,185	3,762,852	165,516	303,910	4,232,278
23	Apparel	2,709,047	27,683	10,449	38,132	6,485	816	246,814	109,069	350,829	706,712
24	Wood Prod.	29,755,457	304,996	113,025	418,021	71,092	8,941	2,443,421	213,706	18,671,912	21,329,039
25	Furniture	4,232,254	43,382	42,055	85,437	14,530	1,827	502,029	9,915	1,008,049	1,519,993
26	Paper Prod.	57,943,199	593,922	1,723,054	2,316,976	394,044	49,560	7,290,108	514,443	4,667,065	12,471,616
27	Printing	4,883,764	50,068	5,366	55,434	9,428	1,186	375,804	83,947	1,037,102	1,496,853
28	Chemical Prod.	42,958,012	440,326	490,607	930,933	158,322	19,913	4,746,089	279,683	3,027,817	8,053,589
29	Petroleum	-1,787,992	-18,327	239,160	220,833	37,557	4,724	1,156,100	55,440	192,735	1,404,275
30	Rubber & Plast.	60,065,300	615,668	-270,774	344,894	58,655	7,377	3,527,105	787,768	6,186,334	10,501,207
31	Leather Prod.	278,852	2,858	1,102	3,960	673	85	39,277	0	16,520	55,797
32	Stone & Glass	77,901,115	798,486	184,419	982,905	167,161	21,024	6,330,089	335,688	1,189,300	7,855,077
33	Primary Metal	34,781,020	356,497	827,320	1,183,817	201,329	25,322	6,026,094	1,601,705	9,450,416	17,078,215
34	Fab. Metal	85,315,562	874,483	179,570	1,054,053	179,261	22,546	5,790,886	1,662,250	15,551,104	23,004,240
35	Ind. Machinery	33,727,661	345,712	117,393	463,105	78,759	9,906	2,883,463	581,705	6,579,283	10,044,451
36	Electronics	21,778,868	223,232	55,959	279,191	47,481	5,972	2,406,541	116,554	2,776,970	5,300,065
37	Trans. Equip.	18,618,168	190,820	263,354	454,174	77,240	9,715	4,038,548	3,194,869	6,471,108	13,704,525
38	Instruments	12,829,062	131,499	3,397	134,896	22,941	2,885	750,745	879,784	2,334,664	3,965,193
39	Misc. Manuf.	1,760,576	18,044	-12,833	5,211	886	111	192,659	43,936	637,903	874,498
Totals		**521,568,647**	**5,345,990**	**4,248,526**	**9,594,516**	**1,631,720**	**205,227**	**53,351,410**	**10,772,945**	**84,484,729**	**148,609,084**

Table 9. Recommended Cost and Energy Savings by Industry Type

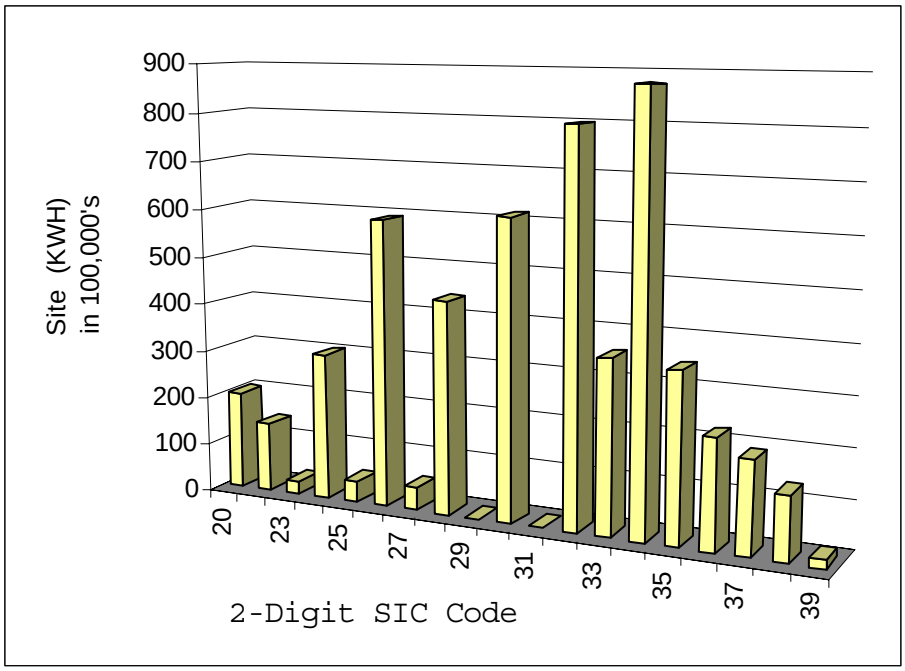


Figure 12. Recommended Electric Consumption Conserved by Industry Type

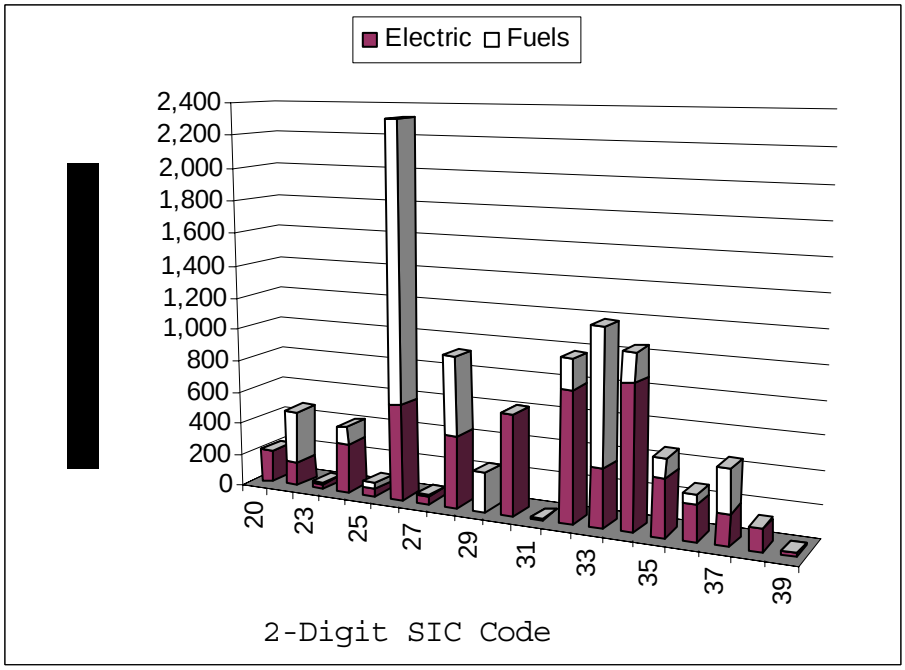


Figure 13. Recommended Energy Conserved by Industry Type

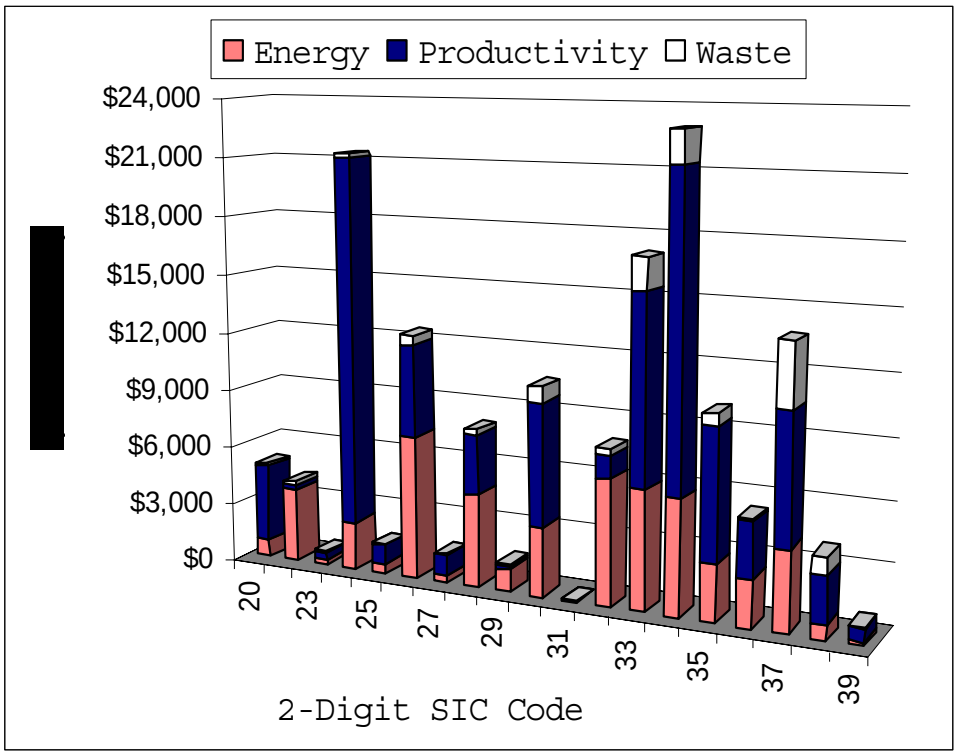


Figure 14. Recommended Cost Savings by Industry Type

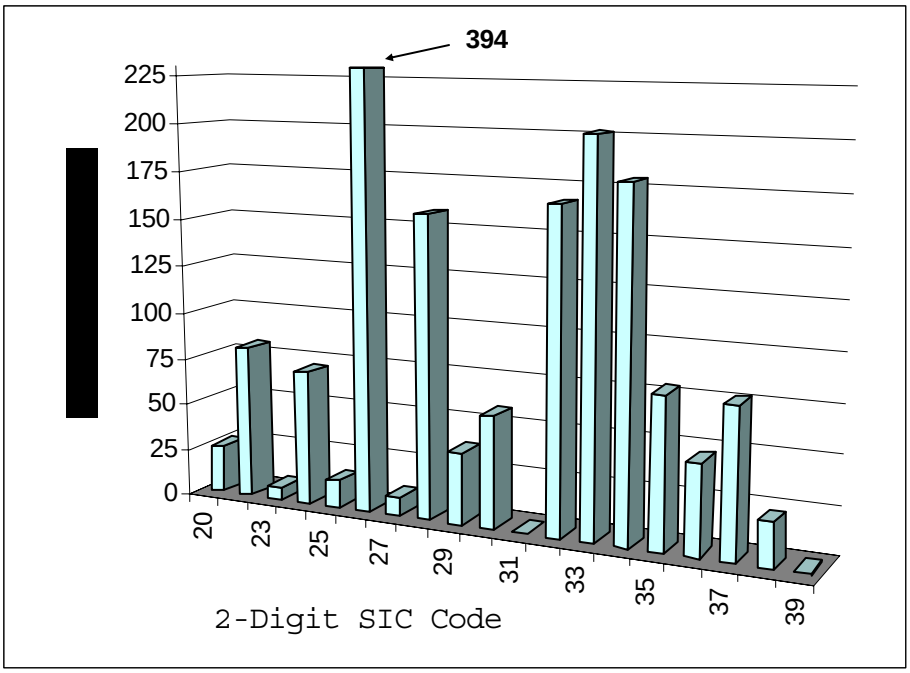


Figure 15. Recommended Barrels of Oil Avoided by Industry Type

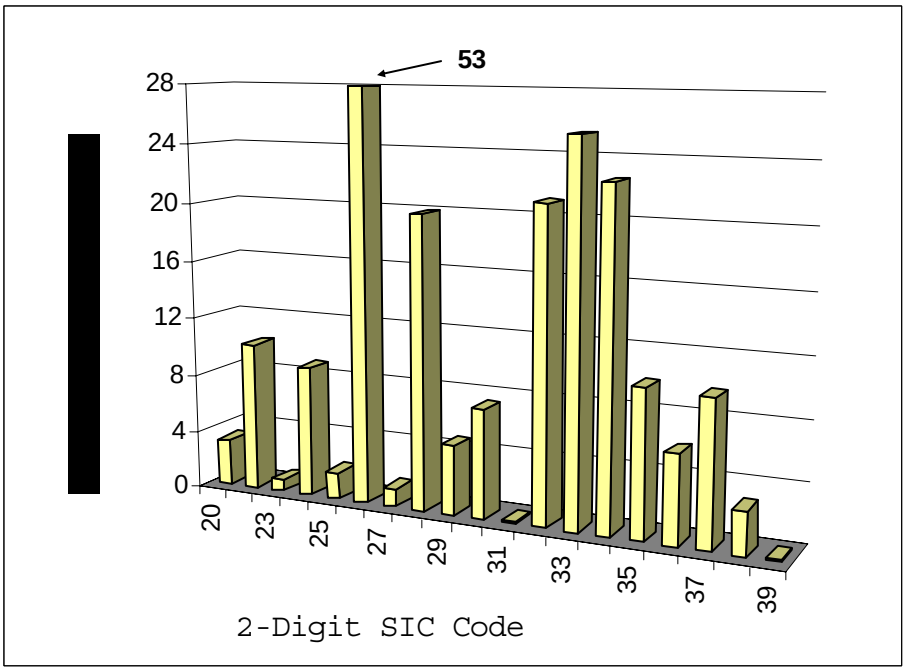
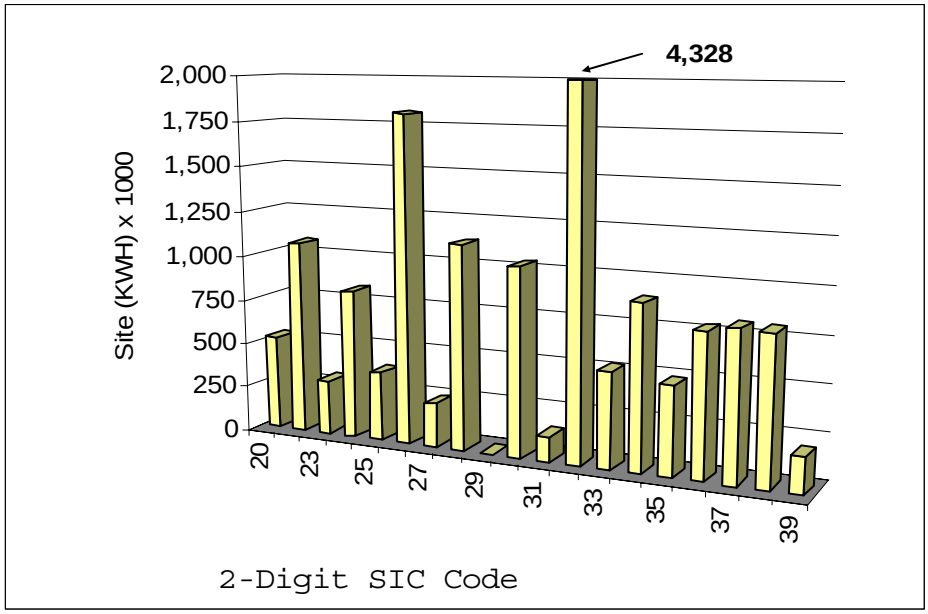


Figure 16. Recommended Carbon Avoided by Industry Type

Average recommended figures per assessment are shown in Table 10, and Figures 15 through 18.

SIC Code	Industry Description	Recommended Energy Conservation						Recommended Cost Savings ($)			
		Site (KWH)	Source Electric (MMBtu)	Site Fuels (MMBtu)	Total (MMBtu)	(B.O.E.)	(C.E., mt)	Energy	Waste	Productivity	Total
20	Foods	522,340	5,354	-1,502	3,852	655	82	22,179	3,604	106,098	131,881
22	Textile Mills	1,074,600	11,015	25,613	36,628	6,229	783	289,450	12,732	23,378	325,560
23	Apparel	301,005	3,076	1,161	4,237	721	91	27,424	12,119	38,981	78,524
24	Wood Prod.	826,540	8,472	3,140	11,612	1,975	248	67,873	5,936	518,664	592,473
25	Furniture	384,750	3,944	3,823	7,767	1,321	166	45,639	901	91,641	138,181
26	Paper Prod.	1,810,725	18,560	53,845	72,406	12,314	1,549	227,816	16,076	145,846	389,738
27	Printing	244,188	2,503	268	2,772	471	59	18,790	4,197	51,855	74,843
28	Chemical Prod.	1,130,474	11,588	12,911	24,498	4,166	524	124,897	7,360	79,679	211,937
29	Petroleum	-446,998	-4,582	59,790	55,208	9,389	1,181	289,025	13,860	48,184	351,069
30	Rubber & Plast.	1,035,609	10,615	-4,669	5,946	1,011	127	60,812	13,582	106,661	181,055
31	Leather Prod.	139,426	1,429	551	1,980	337	42	19,639	0	8,260	27,899
32	Stone & Glass	4,327,840	44,360	10,246	54,606	9,287	1,168	351,672	18,649	66,072	436,393
33	Primary Metal	526,985	5,401	12,535	17,937	3,050	384	91,304	24,268	143,188	258,761
34	Fab. Metal	898,059	9,205	1,890	11,095	1,887	237	60,957	17,497	163,696	242,150
35	Ind. Machinery	488,807	5,010	1,701	6,712	1,141	144	41,789	8,431	95,352	145,572
36	Electronics	777,817	7,973	1,999	9,971	1,696	213	85,948	4,163	99,178	189,288
37	Trans. Equip.	809,486	8,297	11,450	19,747	3,358	422	175,589	138,907	281,353	595,849
38	Instruments	801,816	8,219	212	8,431	1,434	180	46,922	54,987	145,917	247,825
39	Misc. Manuf.	195,620	2,005	-1,426	579	98	12	21,407	4,882	70,878	97,166
Average		**891,570**	**9,138**	**7,262**	**16,401**	**2,789**	**351**	**91,199**	**18,415**	**144,418**	**254,033**

Table 10. Average Recommended Conservation and Cost Savings by Industry Type Figure



17. Average Recommended Electric Consumption Conserved by Industry Type

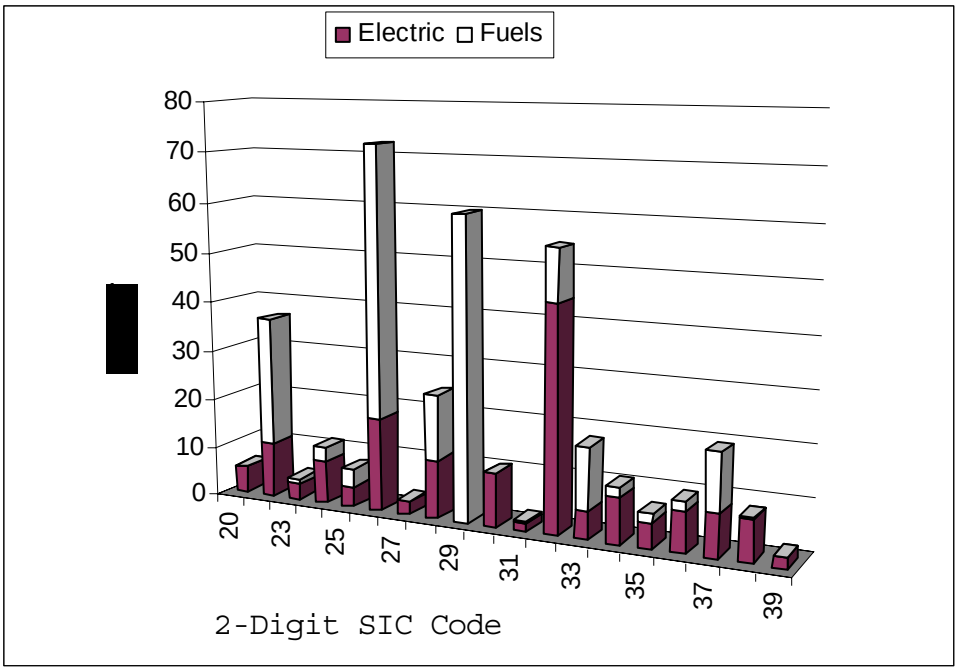


Figure 18. Average Recommended Energy Saved by Industry Type

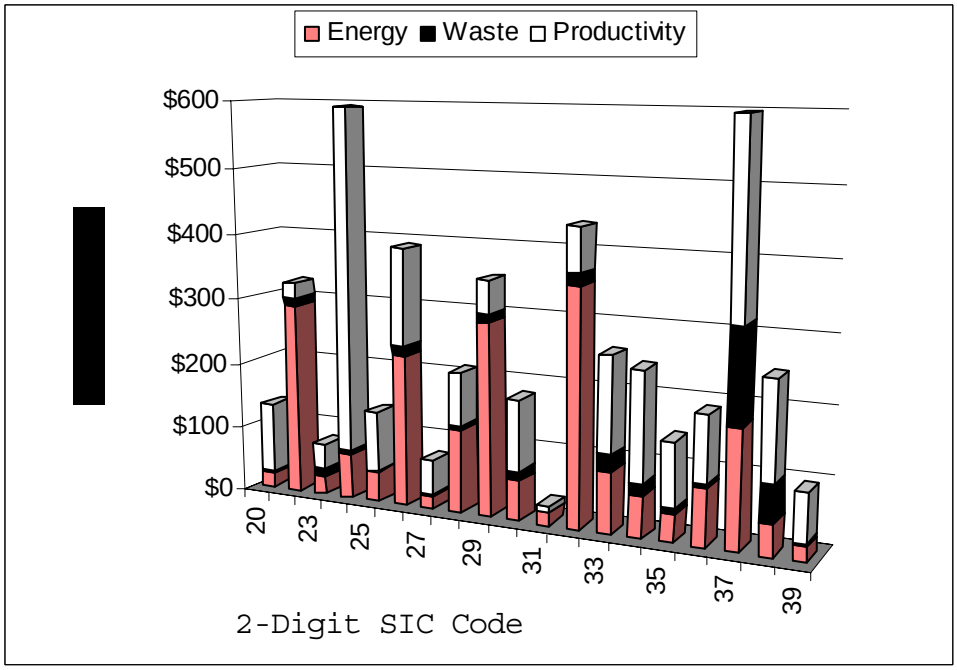


Figure 19. Average Recommended Cost Savings by Industry Type

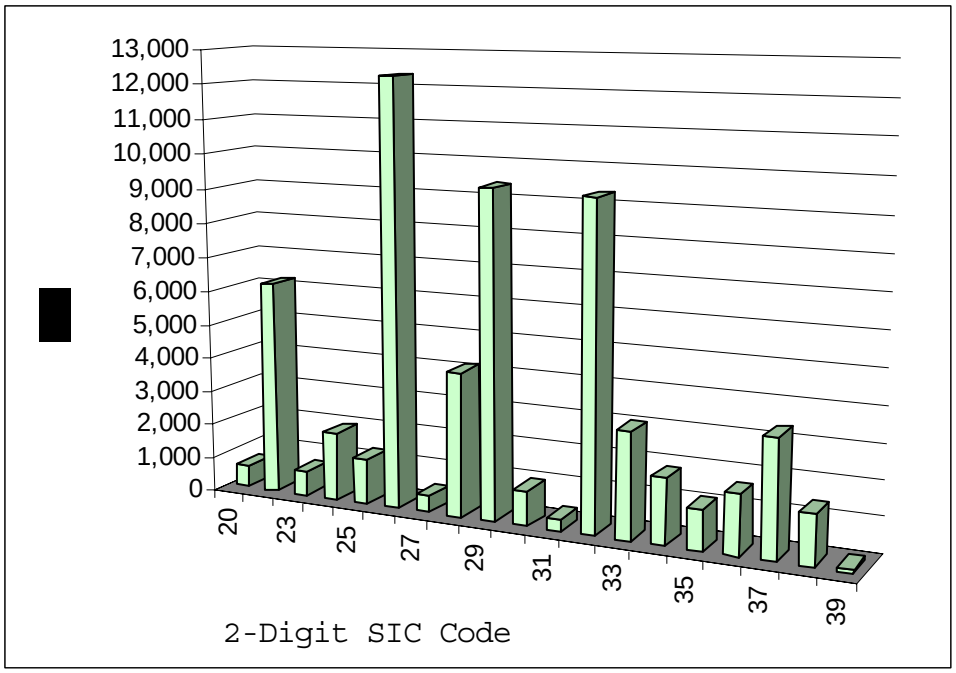


Figure 20. Average Recommended Barrels of Oil Saved by Industry Type

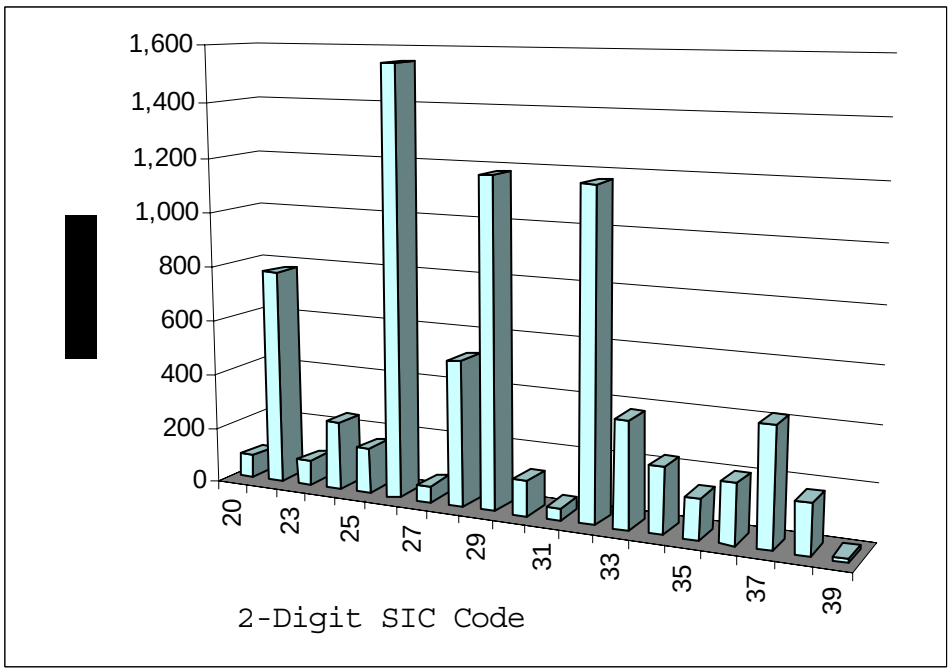


Figure 21. Average Recommended Carbon Avoided by Industry Type

iii. Recommended Savings by Resource Stream

Energy recommendations are broken into 12 different fuel types: Electricity, Natural Gas, Liquid Petroleum Gas, Fuel Oil (#1, #2, #4, #6), Coal, Wood, Paper, Other Gas, and a general category for "Other Energy". Starting in FY93, non-energy savings were separately tracked. The amount of energy savings recommended in FY2001 was 9.4 million MMBTUs, with a dollar amount of almost $61 Million. Including non-energy dollars, the total recommended savings in FY2001 amounted to $233 Million. This data is shown in Table 11, with the percentages by energy type in Figures 19 and 20. For the sake of clarity, it should be pointed out that some recommendations, such as co-generation and fuel switching, result in increased energy consumption (negative energy savings) coal savings is an example of this.

Energy Stream	Recommended Energy Conservation (MMBTU)	Recommended Energy Cost Savings ($)
Electricity		
Demand	1,210,624 KW-months/yr	6,937,143
Fees		1,508,958
Consumption - Site	851,972,749 KWH	
Consumption - Source	8,732,713	34,314,289
Natural Gas	3,915,302	21,236,750
L. P. G.	6,695	30,634
Fuel Oil #1	6,559	49,783
Fuel Oil #2	-111,328	-572,074
Fuel Oil #4	23,048	93,276
Fuel Oil #6	262,377	1,035,860
Coal	-3,645,700	-3,902,215
Wood	46,658	70,024
Other Gas	595	5,096
Other Energy	131,724	265,093
Energy Totals	**9,368,643**	**61,072,617**
Waste	n/a	10,772,945
Productivity	n/a	86,260,462
Program Totals	**635,930**	**158,106,024**

Table 11. Recommended Conservation and Cost Savings by Resource Stream

Examination of the data shows that electricity and natural gas comprise the vast majority of energy and dollar savings.

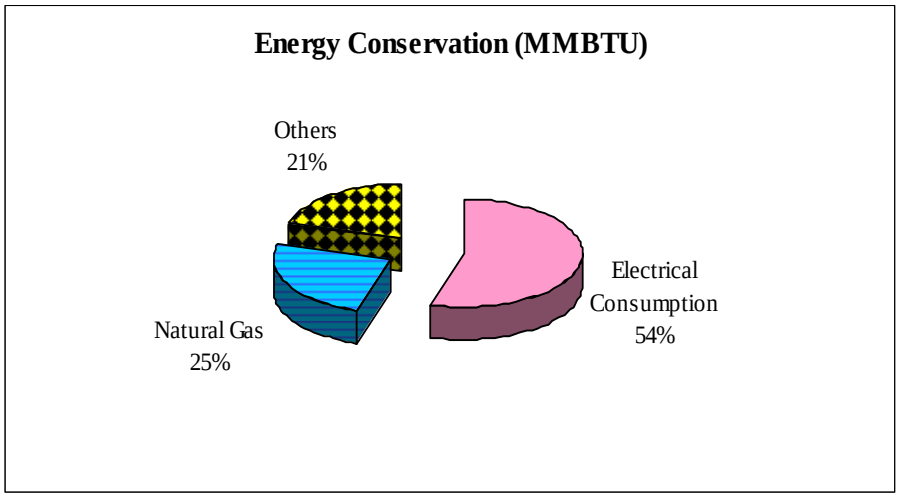


Figure 22. Composition of Recommended Energy Conserved by Energy Stream

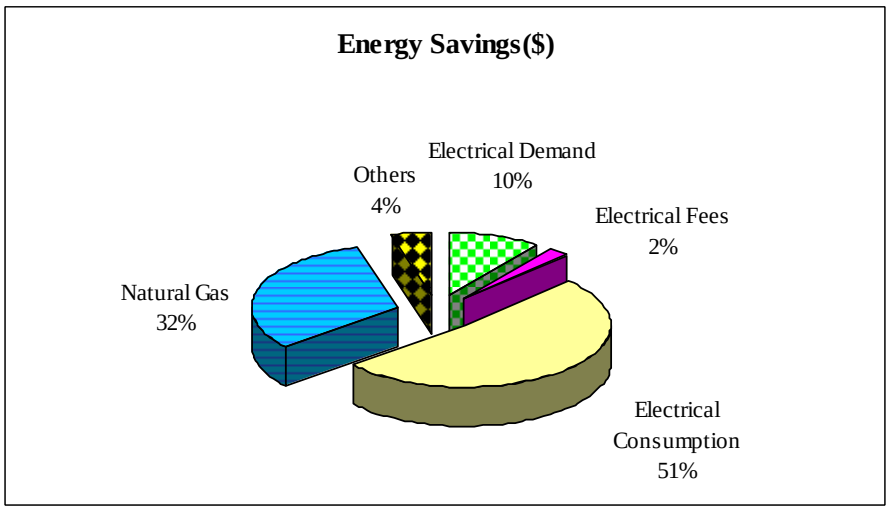


Figure 23. Composition of Recommended Cost Savings by Energy Stream

The database is broken into four resource stream types: energy, waste reduction, resource costs, and production. Table 12 shows the recommended cost savings grouped by non-energy resource type. Figure 24 shows the composition of the recommended non-energy cost savings.

Stream Type	Total Recommended Non-Energy Cost Savings ($)
Production	
Primary Product	20,746,833
Byproduct Production	298,135
Resource Costs	
Personnel Changes	25,620,061
Administrative Costs	24,456,668
Primary Raw Material	2,618,851
Ancillary Material Cost	4,507,685
Water Consumption	190,399
One Time Revenue or Avoided Cost	7,821,830
Waste Reduction	
Water Disposal	1,435,162
Other Liquid (non-haz)	498,070
Other Liquid (haz)	1,714,076
Solid Waste (non-haz)	3,966,890
Solid Waste (haz)	3,158,747
Gaseous Waste (haz)	0
Non-Energy Total	**97,033,407**

Table 12. Recommended Non-Energy Cost Savings by Resource Type

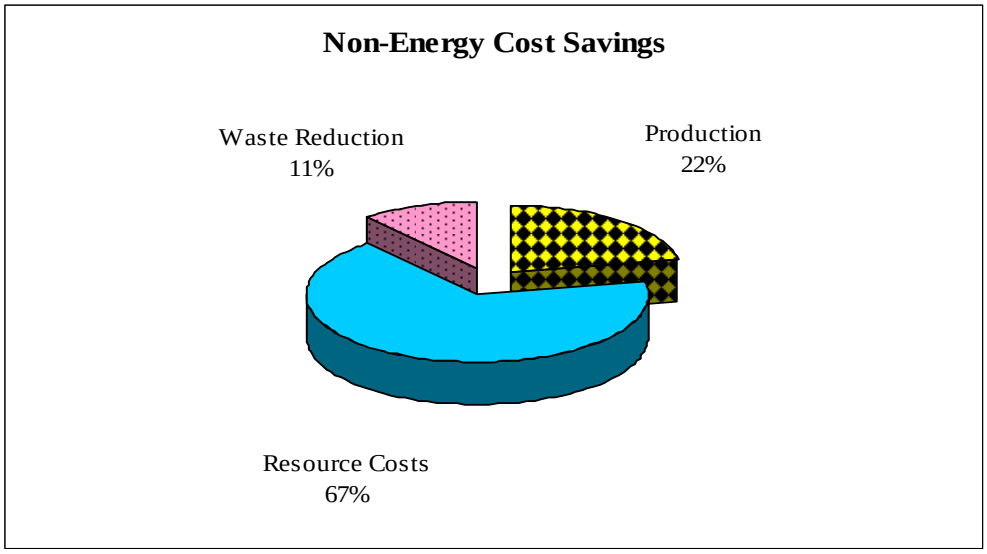


Figure 24. Recommended Non-Energy Cost Savings

Figure 24 indicates the composition of the total recommendations by resource stream for FY2001.

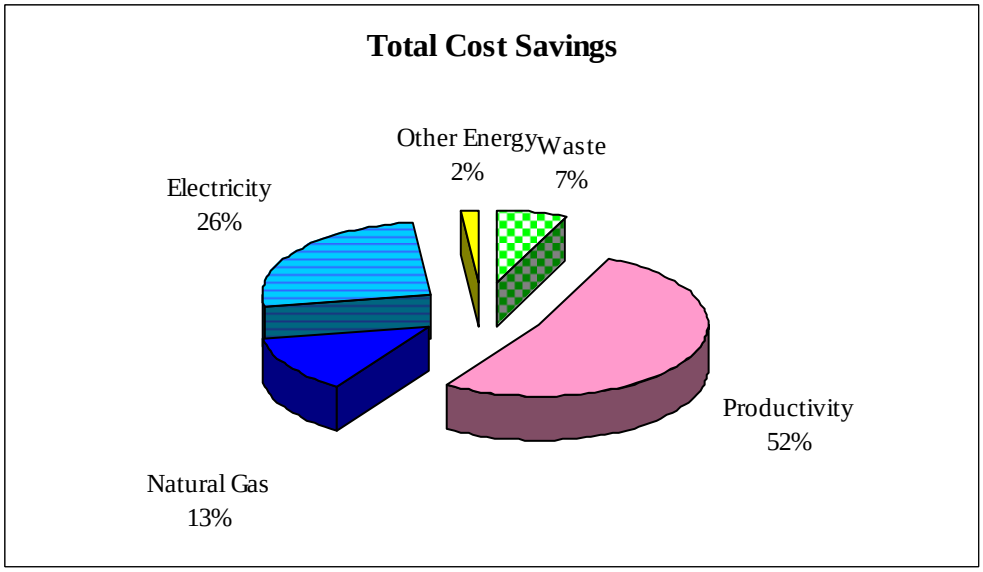


Figure 25. Recommended Cost Savings by Resource Stream

iv. Recommended Savings by Recommendation Type

Energy conservation recommendations are categorized by use of a detailed expert system known as Assessment Recommendation Codes (ARC). There were more than 400 coded recommendations broken into 9 major 2-digit categories for energy. Fiscal Year 1994 saw the introduction of the single digit categories 3 (waste minimization and pollution prevention) and 4 (productivity enhancements). There were over 350 different recommendations in these categories. Table 13 shows the category description and number of recommendations by assessment recommendation (AR) type for FY2000. Figure 23 shows the frequency of the recommendations.. The average number of recommendations was about eight. 95 recommendations were used only once. And 191 recommendations were used three or less times. A review of Table 13 and Figure 26 further illustrate the fact that most recommendations were process oriented.

2-Digit ARC Code	Category Description	No. of Recommendations
2.1	Combustion Systems	188
2.2	Thermal Systems	526
2.3	Electrical Power	226
2.4	Motor Systems	1211
2.5	Industrial Design	12
2.6	Operations	169
2.7	Buildings and Grounds	1123
2.8	Ancillary Costs	96
2.9	Alternate Energy Use	2
3.1	Operations	39
3.2	Equipment	18
3.3	Post Generation Treatment/Minimization	26
3.4	Water Use	104
3.5	Recycling	174
3.6	Waste Disposal	108
3.7	Maintenance	25
3.8	Raw Materials	24
4.1	Manufacturing Enhancements	123
4.2	Purchasing	16
4.3	Inventory	37
4.4	Labor Optimization	200
4.5	Space Utilization	60
4.6	Reduction of Downtime	95
4.7	Management Practices	10
4.8	Other Administrative Savings	34
	Total	**4646**

Table 13. Recommendations by Recommendation Type

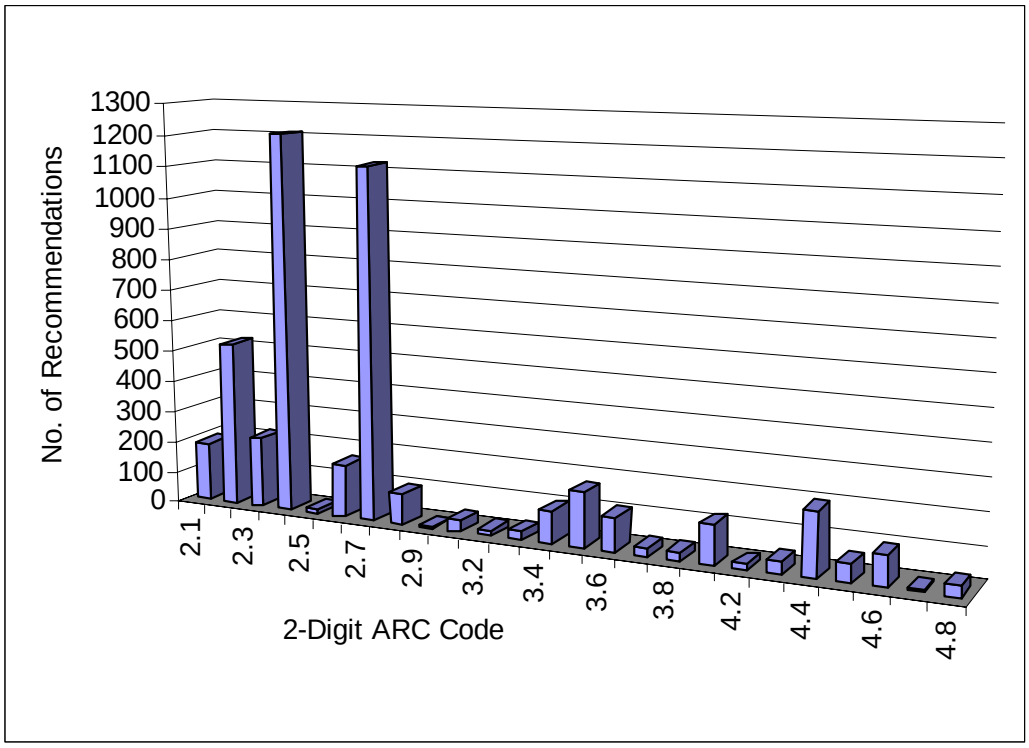


Figure 26. Number of Recommendations by Recommendation Type

D. Implementation Results

i. General

The IAC program has historically enjoyed a high rate of implementation of recommendations. The results of the 2001 program year showed an implementation rate of almost 45%. This rate represents the ratio of the number of recommendations that are adopted, as reported by the clients, to the number of recommendations with known results made by the Centers. The implementation rate as defined as the amount of energy (MMBTU) saved compared to the amount recommended was 46%, and as energy cost ($) saved to recommended was 23%. Tables 14 through 24, and Figures 27 through 57 are all related to implementation results.

Fiscal year	Energy Recommendations			Waste Recommendations			Productivity Recommendations			All Recommendations		
	Recommendations with Known Results	Implemented	% Implemented	Recommendations with Known Results	Implemented	% Implemented	Recommendations with Known Results	Implemented	% Implemented	Recommendations with Known Results	Implemented	% Implemented
1982	1,152	317	28%	N/A	N/A	N/A	N/A	N/A	N/A	1,152	317	28%
1983	1,150	352	31%	N/A	N/A	N/A	N/A	N/A	N/A	1,150	352	31%
1984	1,746	1,050	60%	N/A	N/A	N/A	N/A	N/A	N/A	1,746	1,050	60%
1985	2,377	1,400	59%	N/A	N/A	N/A	N/A	N/A	N/A	2,377	1,400	59%
1986	1,998	1,254	63%	N/A	N/A	N/A	N/A	N/A	N/A	1,998	1,254	63%
1987	2,175	1,404	65%	N/A	N/A	N/A	N/A	N/A	N/A	2,175	1,404	65%
1988	2,629	1,581	60%	N/A	N/A	N/A	N/A	N/A	N/A	2,629	1,581	60%
1989	2,380	1,402	59%	N/A	N/A	N/A	N/A	N/A	N/A	2,380	1,402	59%
1990	2,417	1,395	58%	N/A	N/A	N/A	N/A	N/A	N/A	2,417	1,395	58%
1991	3,091	1,766	57%	N/A	N/A	N/A	N/A	N/A	N/A	3,091	1,766	57%
1992	3,749	1,828	49%	N/A	N/A	N/A	N/A	N/A	N/A	3,749	1,828	49%
1993	3,963	2,041	52%	29	11	38%	1	0	0%	3,993	2,052	51%
1994	5,104	2,516	49%	169	66	39%	8	3	38%	5,281	2,585	49%
1995	5,339	2,846	53%	475	203	43%	12	7	58%	5,826	3,056	52%
1996	4,912	2,715	55%	1,267	573	45%	59	33	56%	6,238	3,321	53%
1997	3,532	1,866	53%	1,304	537	41%	678	328	48%	5,514	2,731	50%
1998	3,624	1,853	51%	1,155	486	42%	791	356	45%	5,570	2,695	48%
1999	3,358	1,513	45%	950	354	37%	797	321	40%	5,105	2,188	43%
2000	3,379	1,562	46%	802	299	37%	749	239	32%	4,930	2,100	43%
2001	3,352	1,553	46%	486	176	36%	539	213	40%	4,377	1,942	44%
Totals	**61,427**	**32,214**	**52%**	**6,637**	**2,705**	**41%**	**3,634**	**1,500**	**41%**	**71,698**	**36,419**	**51%**

Table 14. No. of Recommendations and Implemented Recommendations by Fiscal Year

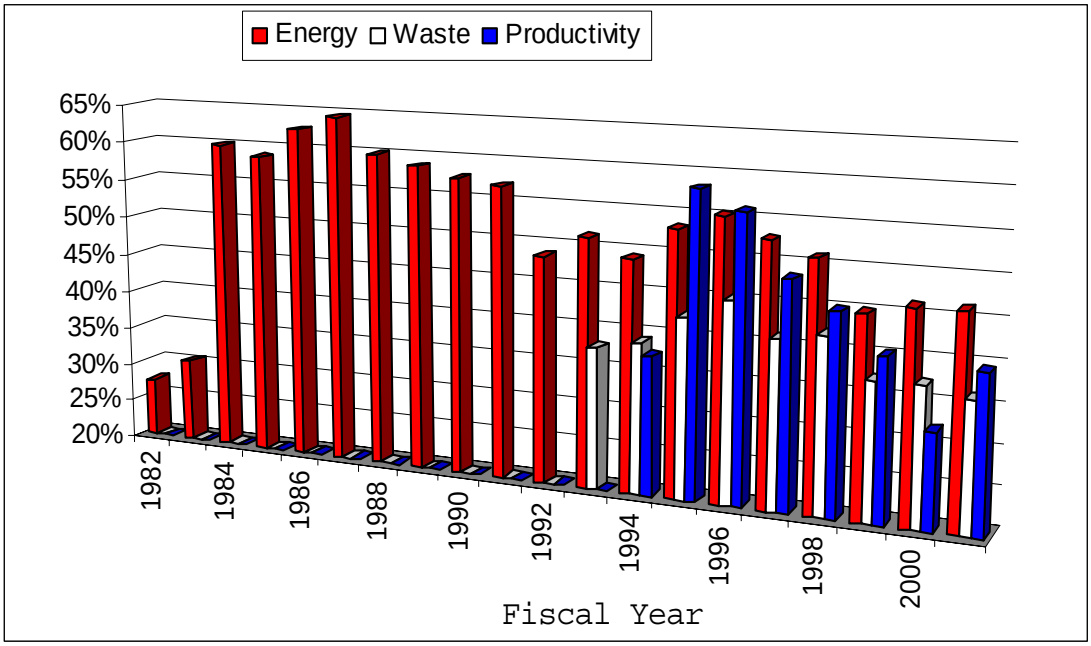


Figure 27. Percent of Recommendations Implemented by Fiscal Year

Fiscal Year	Implemented Energy Conservation						Implemented Cost Savings ($)			
	Site (KWH)	Source Electric (MMBtu)	Site Fuels (MMBtu)	Total (MMBtu)	(B.O.E.)	(C.E., mt)	Energy	Waste	Productivity	Total
1982	13,269,047	135,989	308,724	444,713	75,631	10,286	1,839,122	N/A	N/A	1,839,122
1983	11,012,604	112,873	313,856	426,729	72,573	9,870	1,923,834	N/A	N/A	1,923,834
1984	29,029,583	297,507	557,897	855,404	145,477	19,785	4,583,098	N/A	N/A	4,583,098
1985	57,900,606	593,407	928,192	1,521,599	258,775	35,193	7,006,147	N/A	N/A	7,006,147
1986	60,748,216	622,620	696,206	1,318,826	224,290	30,503	6,667,801	N/A	N/A	6,667,801
1987	59,721,543	612,062	623,212	1,235,274	210,081	28,571	5,866,646	N/A	N/A	5,866,646
1988	60,931,075	624,469	838,100	1,462,569	248,736	33,828	6,132,078	N/A	N/A	6,132,078
1989	84,842,878	869,577	697,287	1,566,864	266,473	36,240	7,479,996	N/A	N/A	7,479,996
1990	70,986,485	727,539	615,259	1,342,798	228,367	31,058	6,570,825	N/A	N/A	6,570,825
1991	91,441,640	937,190	479,719	1,416,909	240,971	32,772	8,460,459	N/A	N/A	8,460,459
1992	125,912,635	1,290,512	744,351	2,034,863	346,065	47,065	10,168,974	N/A	N/A	10,168,974
1993	107,599,596	1,102,764	786,084	1,888,848	321,233	43,688	9,366,098	15,800	1,591,917	10,973,815
1994	154,128,321	1,579,680	734,560	2,314,240	393,578	53,527	12,107,654	1,688,656	1,488,956	15,285,266
1995	185,512,579	1,901,352	630,148	2,531,500	430,527	54,782	13,242,626	4,557,805	2,637,179	20,437,610
1996	190,188,971	1,949,277	564,934	2,514,211	427,587	54,734	13,279,344	7,061,972	6,873,028	27,214,344
1997	115,360,456	1,182,335	563,999	1,746,334	296,996	36,952	9,171,212	5,207,156	24,571,027	38,949,395
1998	109,050,528	1,117,669	411,651	1,529,320	260,088	32,269	7,938,914	4,811,688	29,958,462	42,709,064
1999	108,686,666	1,164,247	956,361	2,120,608	360,648	45,275	8,239,198	5,634,303	25,734,089	39,607,590
2000	106,884,790	1,096,768	599,590	1,696,358	288,496	34,928	8,718,942	2,998,661	16,818,741	28,536,344
2001	148,809,164	1,525,291	987,014	2,512,305	427,263	51,653	14,058,448	1,573,542	21,652,650	37,284,640
Totals	1,892,017,383	19,443,128	13,037,144	32,480,272	5,523,856	722,979	162,821,416	33,549,583	131,326,049	327,697,048

Table 15. Implemented Savings by Fiscal Year

Figure 28 and Table 16 show a comparison of the simple payback of the measures recommended to the simple payback of the measures that were implemented. In FY2001, the directors used over 383 different recommendations, of which 265 were implemented

Fiscal Year	Recommended Quantities			Implemented Quantities			% of Recommended Cost Savings Implemented
	Cost Savings ($)	Implemention Cost ($)	Simple Payback Period (years)	Cost Savings ($)	Implemention Cost ($)	Simple Payback Period (years)	
1982	6,699,075	9,158,809	1.4	1,839,122	2,047,222	1.1	27%
1983	8,449,809	10,385,259	1.2	1,924,094	1,708,454	0.9	23%
1984	8,991,122	8,847,422	1.0	4,598,839	3,222,790	0.7	51%
1985	14,153,056	18,538,810	1.3	7,022,498	4,517,755	0.6	50%
1986	13,945,808	17,469,216	1.3	6,880,489	3,984,805	0.6	49%
1987	11,517,583	15,057,528	1.3	5,947,899	7,613,376	1.3	52%
1988	13,942,973	16,533,416	1.2	6,550,084	4,392,033	0.7	47%
1989	14,562,259	16,496,742	1.1	8,027,428	6,338,466	0.8	55%
1990	14,919,268	19,176,962	1.3	7,588,905	7,191,266	0.9	51%
1991	18,148,895	16,303,282	0.9	8,862,728	8,155,209	0.9	49%
1992	22,441,561	35,954,528	1.6	11,179,352	16,777,959	1.5	50%
1993	29,643,941	45,521,405	1.5	10,973,815	9,447,658	0.9	37%
1994	41,638,265	65,574,847	1.6	15,285,266	16,990,827	1.1	37%
1995	50,119,043	72,855,526	1.5	20,437,610	23,834,919	1.2	41%
1996	64,998,914	71,511,907	1.1	27,214,344	29,659,638	1.1	42%
1997	142,483,538	100,564,895	0.7	38,949,395	26,314,346	0.7	27%
1998	136,470,554	143,787,752	1.1	42,709,064	31,014,386	0.7	31%
1999	134,635,921	149,689,551	1.1	39,607,590	24,469,410	0.6	29%
2000	138,351,493	162,980,146	1.2	28,536,344	18,660,452	0.7	21%
2001	158,106,024	146,418,135	0.9	37,284,640	18,769,413	0.5	24%
Totals	**1,044,219,102**	**1,142,826,138**	**1.1**	**331,419,506**	**265,110,384**	**0.8**	**32%**

Table 16. Recommended and Implemented Simple Payback

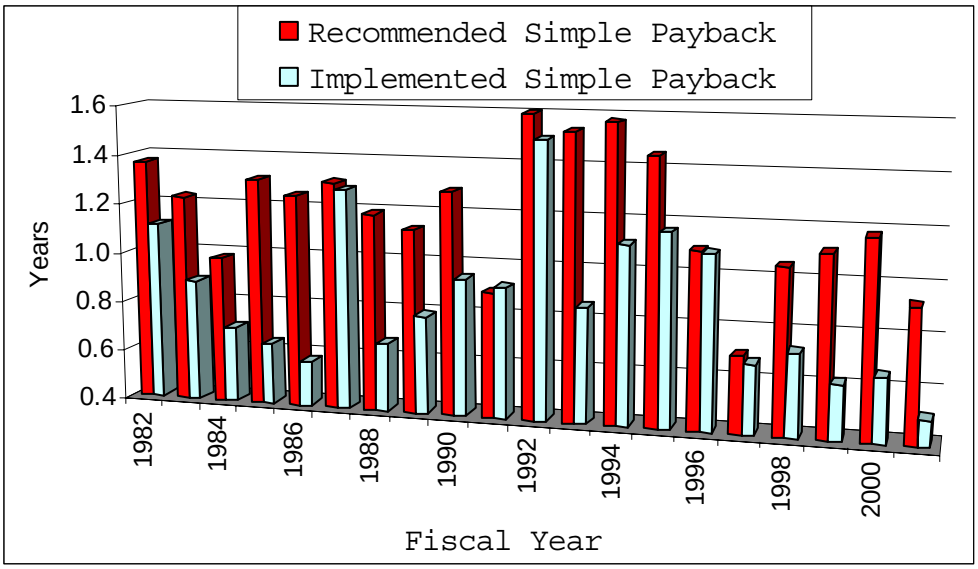


Figure 28. Recommended vs. Implemented Simple Payback

Assuming that the useful life of any one implemented energy conservation measure is not indefinite; Table 17 and Figures 29 through 32 show the cumulative effect of these measures if each remained in place over a seven-year time frame.

Fiscal Year	Implemented Energy Conservation (in thousands)						Implemented Cost Savings ($) (in thousands)			
	Site (KWH)	Source Electric (MMBtu)	Site Fuels (MMBtu)	Total (MMBtu)	(B.O.E.)	(C.E., mt)	Energy	Waste	Productivity	Total
82	13,269	136	309	445	76	10	1,839	N/A	N/A	1,839
82-83	24,282	249	623	871	150	20	3,763	N/A	N/A	3,763
82-84	53,311	546	1,180	1,727	296	40	8,346	N/A	N/A	8,346
82-85	111,212	1,140	2,109	3,248	558	75	15,352	N/A	N/A	15,352
82-86	171,960	1,762	2,805	4,567	784	106	22,020	N/A	N/A	22,020
82-87	231,682	2,374	3,428	5,803	996	134	27,887	N/A	N/A	27,887
82-88	292,613	2,999	4,266	7,265	1,247	168	34,019	N/A	N/A	34,019
83-89	364,187	3,733	4,655	8,387	1,440	194	39,660	N/A	N/A	39,660
84-90	424,160	4,347	4,956	9,303	1,597	215	44,307	N/A	N/A	44,307
85-91	486,572	4,987	4,878	9,865	1,694	228	48,184	N/A	N/A	48,184
86-92	554,584	5,684	4,694	10,378	1,782	240	51,347	N/A	N/A	51,347
87-93	601,436	6,164	4,784	10,948	1,880	253	54,045	16	1,592	55,653
88-94	695,843	7,132	4,895	12,027	2,065	278	60,286	1,704	3,081	65,071
89-95	820,424	8,409	4,687	13,096	2,248	299	67,397	6,262	5,718	79,377
90-96	925,770	9,488	4,555	14,043	2,411	318	73,196	13,324	12,591	99,111
91-97	970,144	9,943	4,504	14,447	2,480	324	75,796	18,531	37,162	131,490
92-98	987,753	10,124	4,436	14,559	2,476	323	75,275	23,343	66,996	165,614
93-99	970,527	9,997	4,648	14,645	2,491	321	73,345	28,977	92,147	194,469
94-00	969,812	9,991	4,461	14,453	2,458	312	72,698	31,960	106,524	211,182
95-01	964,493	9,937	4,714	14,651	2,492	311	74,649	31,845	126,021	232,514
Totals	10,634,035	109,142	75,587	184,729	31,620	4,170	923,409	155,964	451,831	1,531,204

Table 17. Seven Year Cumulative Conservation and Cost Savings

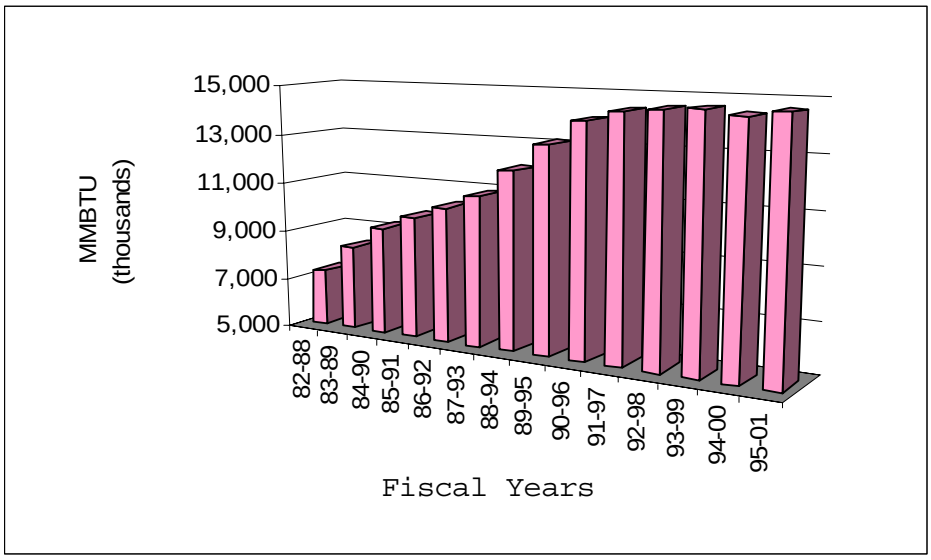


Figure 29. Seven Year Cumulative Energy Savings

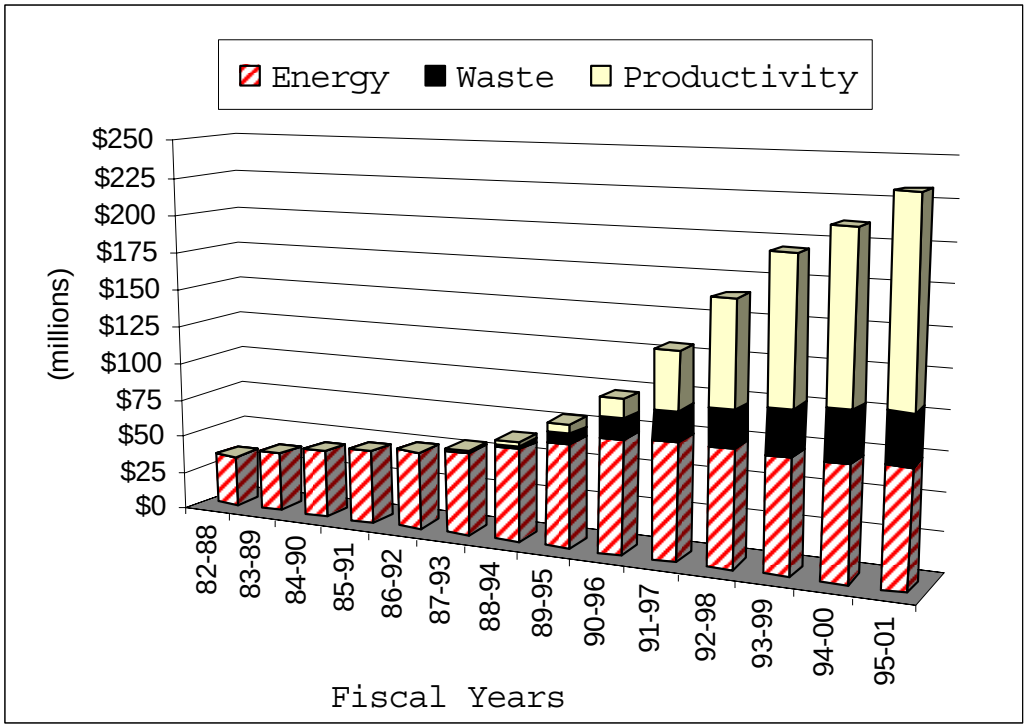


Figure 30. Seven Year Cumulative Cost Savings

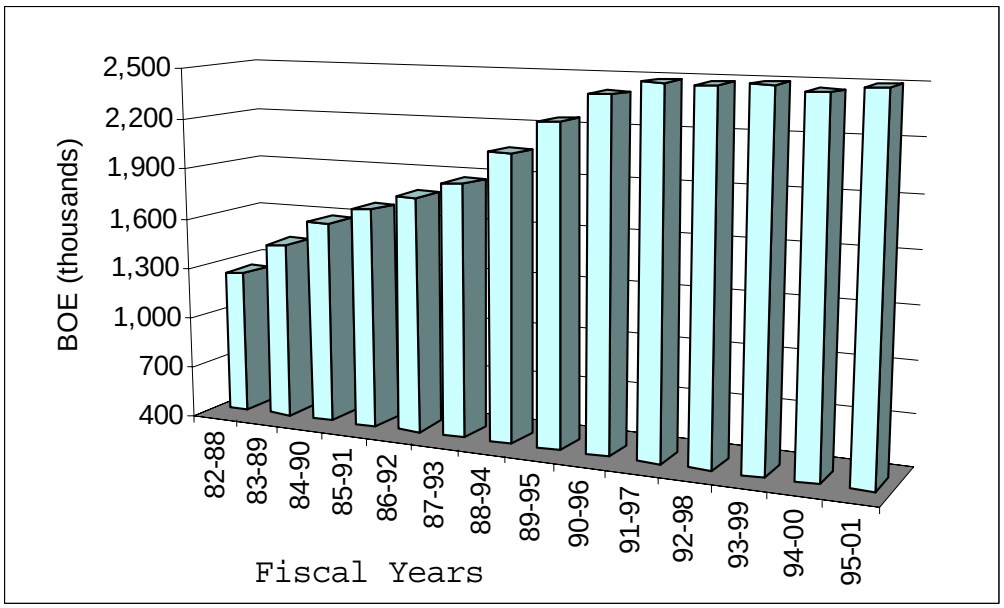


Figure 31. Seven Year Cumulative Barrels of Oil Avoided

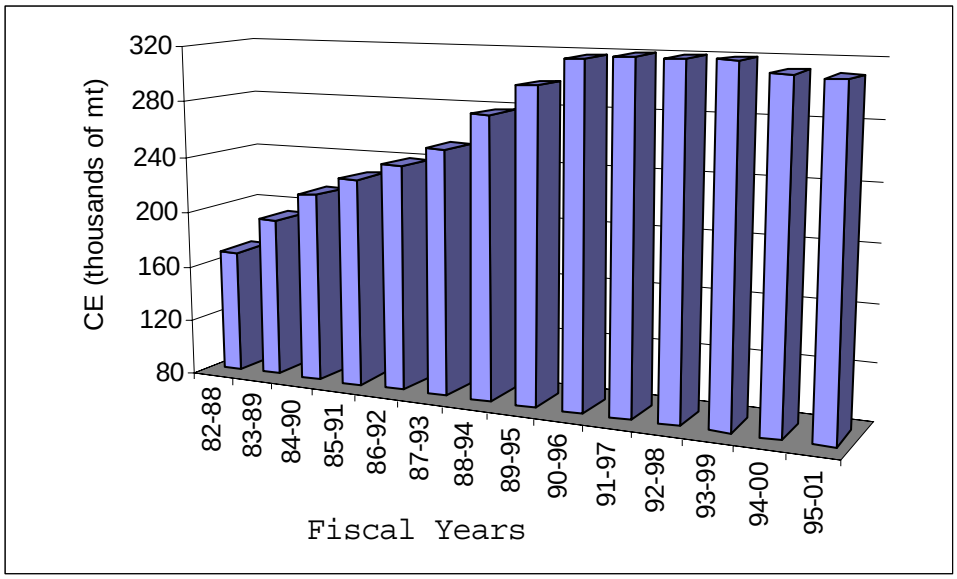


Figure 32. Seven Year Cumulative Carbon Avoided

Similar to the charts in the previous section showing recommended savings, the average and median energy and cost saved due to the implementation of recommended measures is shown per assessment for FY2001 and as a three year average. This can be seen in Table 18-19 and Figures 33-40.

Fiscal Year	Implemented Energy Conservation						Implemented Cost Savings ($)			
	Site (KWH)	Source Electric (MMBtu)	Site Fuels (MMBtu)	Total (MMBtu)	(B.O.E.)	(C.E., mt)	Energy	Waste	Productivity	Total
1982	52,447	538	1,220	1,758	299	41	7,269	N/A	N/A	7,269
1983	52,192	535	1,487	2,022	344	47	9,118	N/A	N/A	9,118
1984	117,055	1,200	2,250	3,449	587	80	18,480	N/A	N/A	18,480
1985	157,339	1,613	2,522	4,135	703	96	19,038	N/A	N/A	19,038
1986	203,853	2,089	2,336	4,426	753	102	22,375	N/A	N/A	22,375
1987	184,326	1,889	1,923	3,813	648	88	18,107	N/A	N/A	18,107
1988	157,039	1,609	2,160	3,770	641	87	15,804	N/A	N/A	15,804
1989	249,538	2,558	2,051	4,608	784	107	22,000	N/A	N/A	22,000
1990	197,185	2,021	1,709	3,730	634	86	18,252	N/A	N/A	18,252
1991	200,971	2,060	1,054	3,114	530	72	18,594	N/A	N/A	18,594
1992	238,923	2,449	1,412	3,861	657	89	19,296	N/A	N/A	19,296
1993	190,105	1,948	1,389	3,337	568	77	16,548	28	2,813	19,388
1994	206,054	2,112	982	3,094	526	72	16,187	2,258	1,991	20,435
1995	218,507	2,240	742	2,982	507	65	15,598	5,368	3,106	24,073
1996	224,810	2,304	668	2,972	505	65	15,697	8,347	8,124	32,168
1997	174,789	1,791	855	2,646	450	56	13,896	7,890	37,229	59,014
1998	158,966	1,629	600	2,229	379	47	11,573	7,014	43,671	62,258
1999	157,746	1,690	1,388	3,078	523	66	11,958	8,178	37,350	57,486
2000	166,487	1,708	934	2,642	449	54	13,581	4,671	26,197	44,449
2001	269,094	2,758	1,785	4,543	773	93	25,422	2,845	39,155	67,422

Table 18. Average Implemented Energy and Cost Savings by Fiscal Year

Fiscal Year	Implemented Energy Conservation			Implemented Cost Savings ($)
	(MMBtu)	(B.O.E.)	(C.E., mt)	Energy
1982	415	71	10	5,502
1983	593	101	14	7,954
1984	562	96	13	11,447
1985	663	113	15	10,669
1986	913	155	21	12,621
1987	727	124	17	10,224
1988	796	135	18	9,808
1989	871	148	20	11,658
1990	865	147	20	11,643
1991	1,370	233	32	18,234
1992	949	161	22	9,545
1993	1,069	182	25	10,330
1994	1,243	211	29	10,000
1995	1,153	196	25	9,322
1996	1,105	188	24	9,073
1997	934	159	20	7,674
1998	874	149	18	7,087
1999	875	149	19	6,817
2000	1,103	188	23	7,371
2001	1,302	221	27	11,461

Table 19. Median Implemented Energy and Cost Savings by Fiscal Year

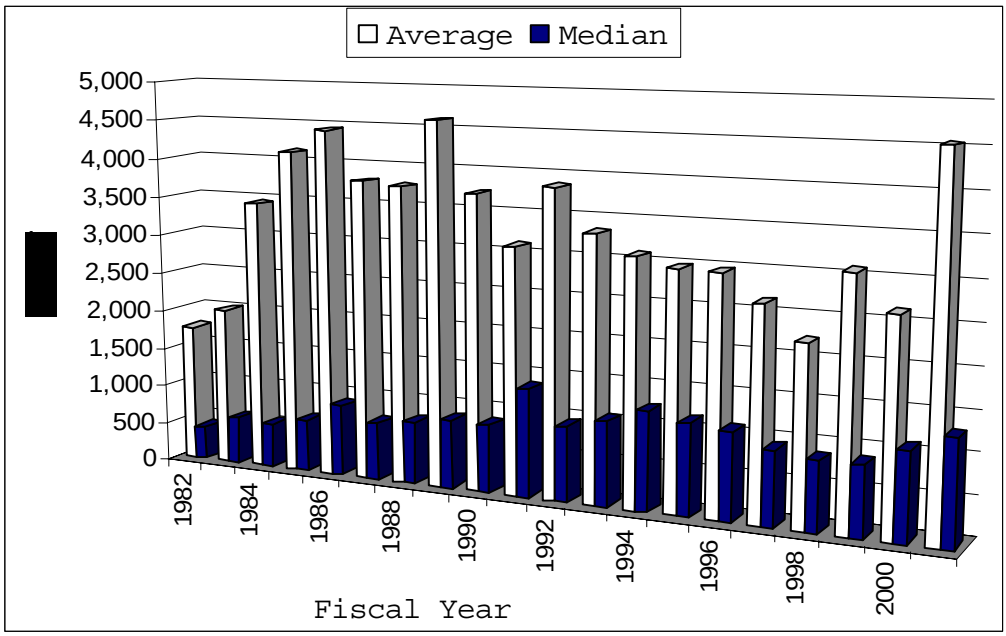


Figure 33. Average and Median Implemented Energy Conservation by Fiscal Year

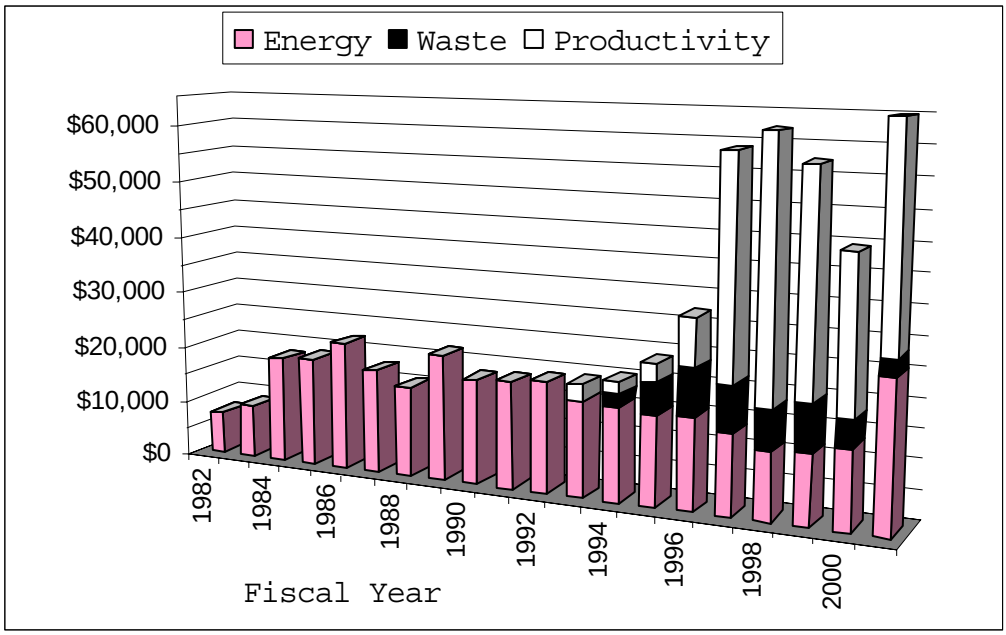


Figure 34. Average Implemented Cost Savings by Fiscal Year

Due to the low distribution of data, the values of median dollars approach zero, and therefore are not shown in Figure 34.

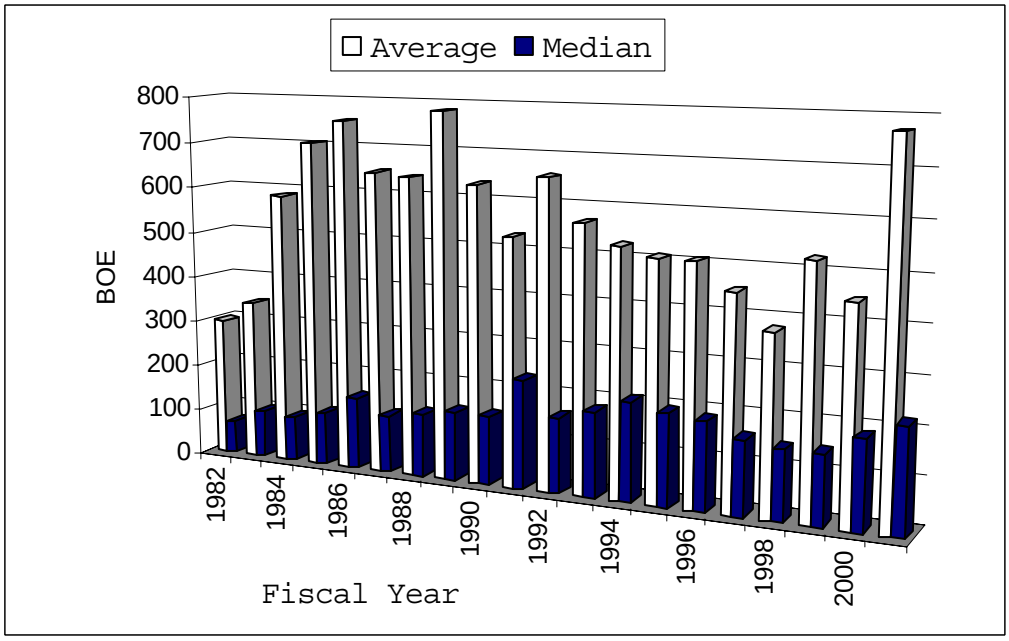


Figure 35. Average Implemented Barrels of Oil Avoided by Fiscal Year

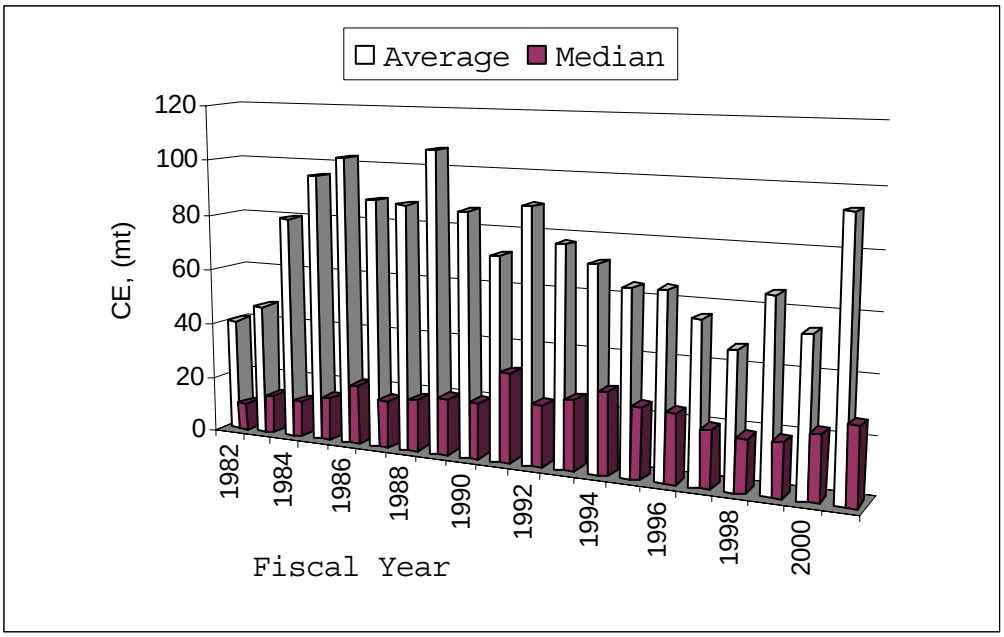


Figure 36. Average Implemented Carbon Avoided by Fiscal Year

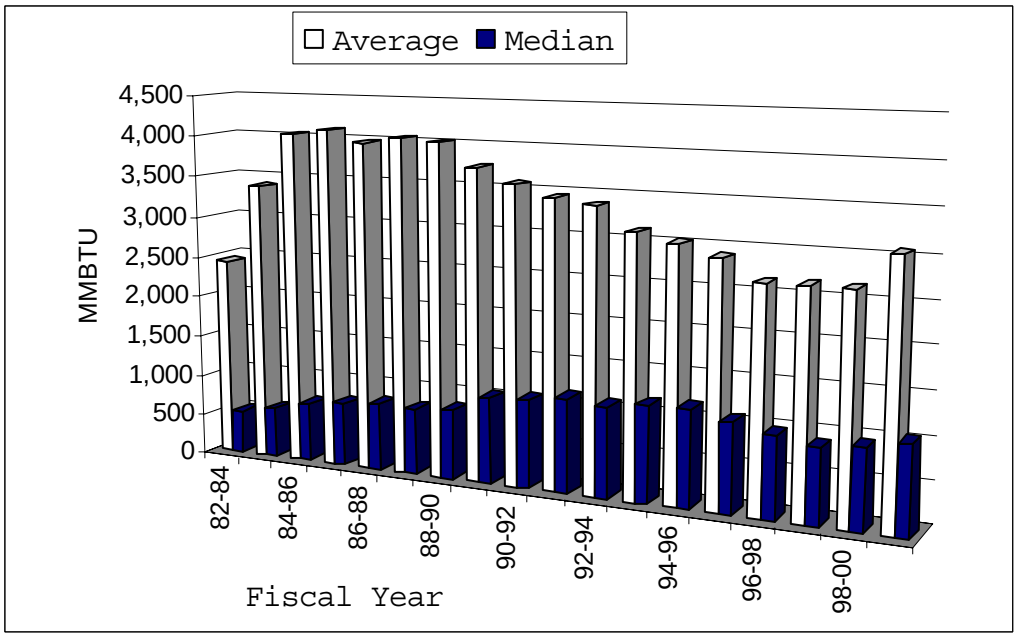


Figure 37. Average and Median Implemented Energy Conserved Per Assessment (3 Year Average)

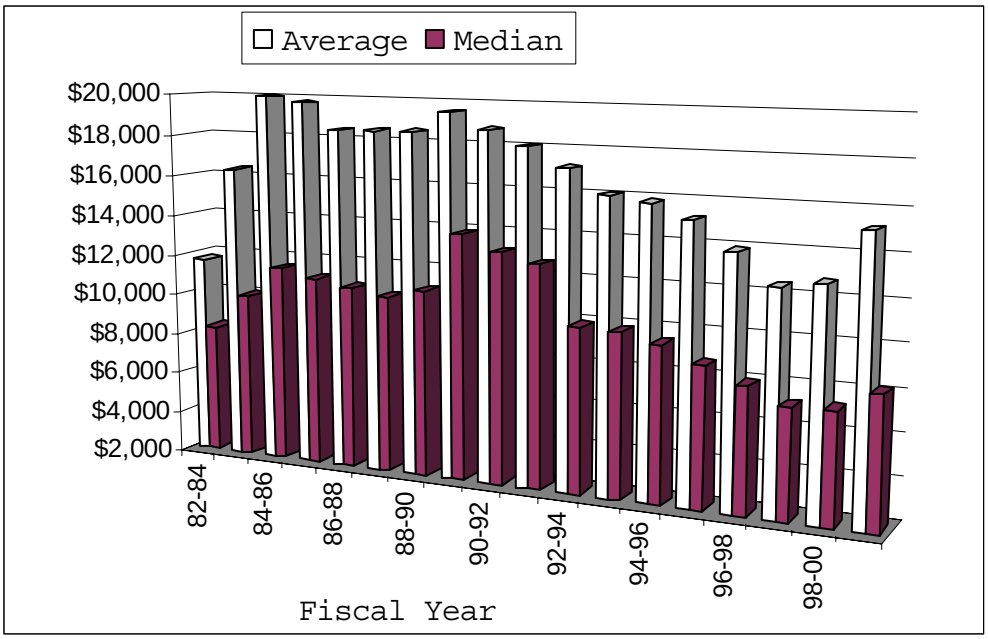


Figure 38. Average and Median Implemented Energy Cost Savings Per Assessment (3 Year Average)

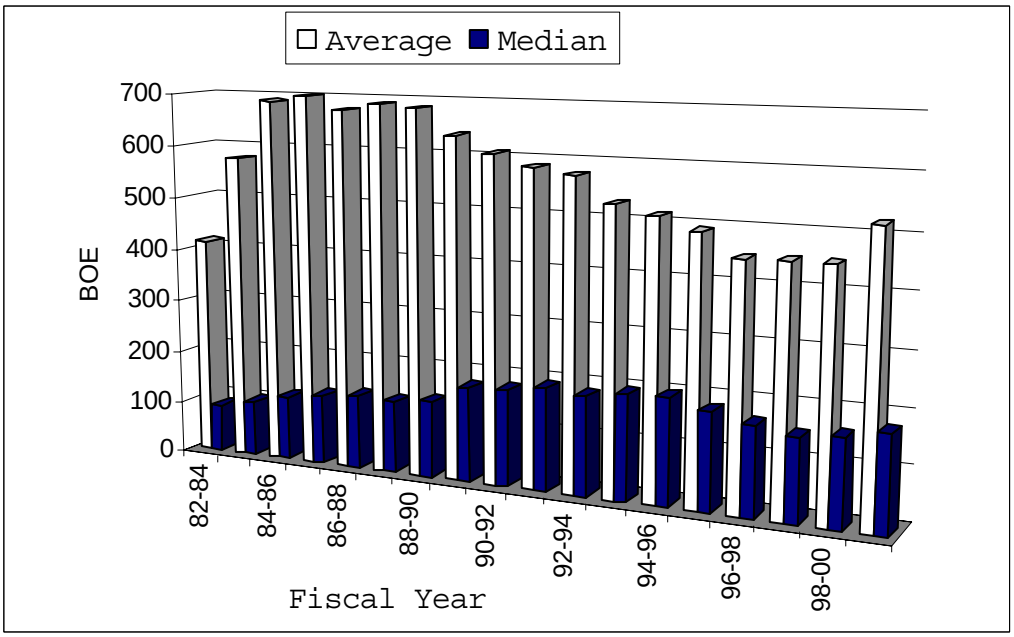


Figure 39. Average and Median Implemented Barrels of Oil Avoided Per Assessment (3 Year Average)

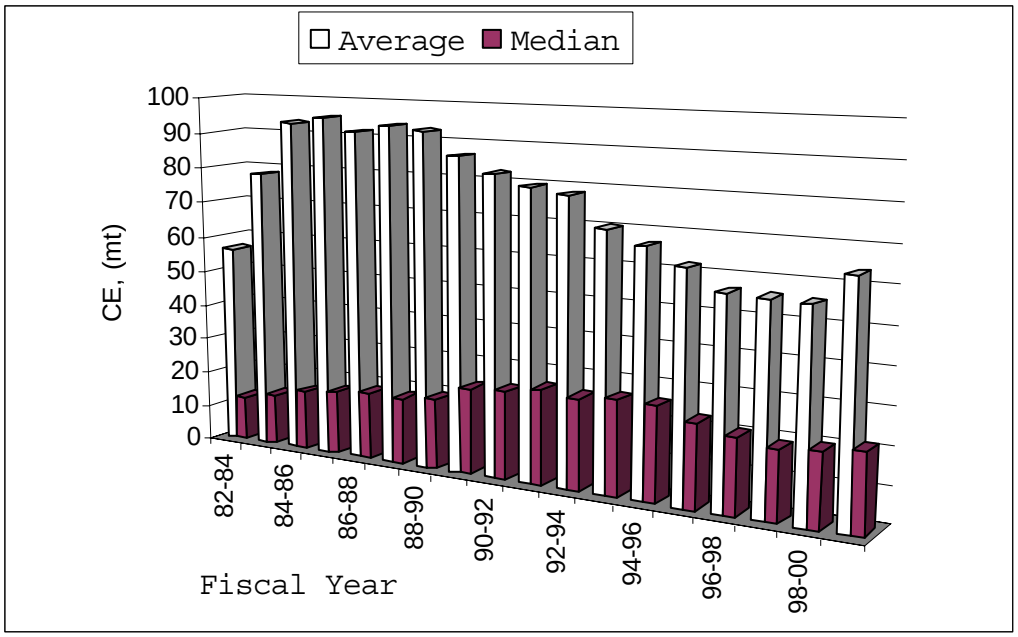


Figure 40. Average and Median Implemented Carbon Avoided Per Assessment (3 Year Average)

In some cases, immediate implementation of a measure was not recommended due to financial restrictions, time constraints, or other considerations. Starting in FY92 these recommendations (called incremental) were flagged to prevent skewing the program database. Table 20 and Figures 41 through 45 show the average first year energy and dollars conserved per assessment. A comparison with Table 18 shows the effect that incremental recommendations represent.

Fiscal Year	Implemented Energy Conservation						Implemented Cost Savings ($)			
	Site (KWH)	Source Electric (MMBtu)	Site Fuels (MMBtu)	(MMBtu)	(B.O.E.)	(C.E., mt)	Energy	Waste	Productivity	Total
1982	52,447	538	1,220	1,758	299	41	7,269	N/A	N/A	7,269
1983	52,192	535	1,487	2,022	344	47	9,118	N/A	N/A	9,118
1984	117,055	1,200	2,250	3,449	587	80	18,480	N/A	N/A	18,480
1985	157,339	1,613	2,522	4,135	703	96	19,038	N/A	N/A	19,038
1986	203,853	2,089	2,336	4,426	753	102	22,375	N/A	N/A	22,375
1987	184,326	1,889	1,923	3,813	648	88	18,107	N/A	N/A	18,107
1988	157,039	1,609	2,160	3,770	641	87	15,804	N/A	N/A	15,804
1989	249,538	2,558	2,051	4,608	784	107	22,000	N/A	N/A	22,000
1990	197,185	2,021	1,709	3,730	634	86	18,252	N/A	N/A	18,252
1991	200,971	2,060	1,054	3,114	530	72	18,594	N/A	N/A	18,594
1992	238,923	2,298	1,393	3,691	628	85	18,406	N/A	N/A	18,406
1993	139,680	1,432	1,330	2,762	470	64	13,558	28	2,805	16,392
1994	154,228	1,581	936	2,516	428	58	12,944	2,193	1,979	17,116
1995	154,639	1,585	731	2,316	394	50	12,195	5,329	2,942	20,467
1996	177,845	1,823	657	2,479	422	54	12,937	8,071	7,287	28,295
1997	138,923	1,424	822	2,246	382	48	11,592	7,660	35,608	54,859
1998	130,166	1,334	583	1,917	326	40	9,811	6,776	41,276	57,863
1999	140,691	1,515	1,339	2,854	485	61	10,640	7,905	35,833	54,379
2000	142,247	1,460	923	2,383	405	49	12,226	4,389	25,487	42,102
2001	227,647	2,333	1,684	4,017	683	83	23,052	2,843	32,710	58,606

Table 20. Average First Year Implemented Savings by Fiscal Year

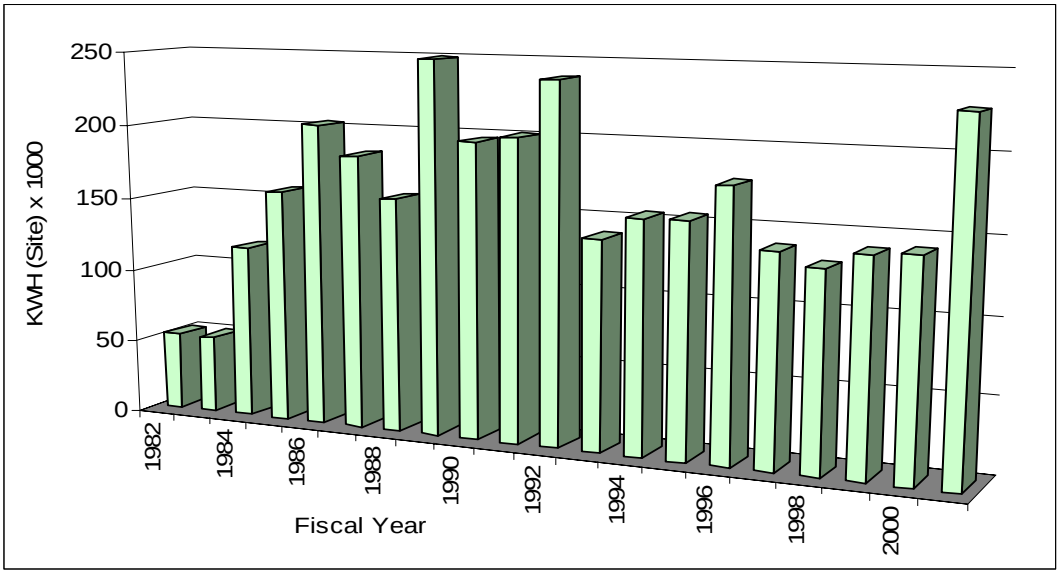


Figure 41. Average First Year Implemented Electric Consumption Conserved by Fiscal Year

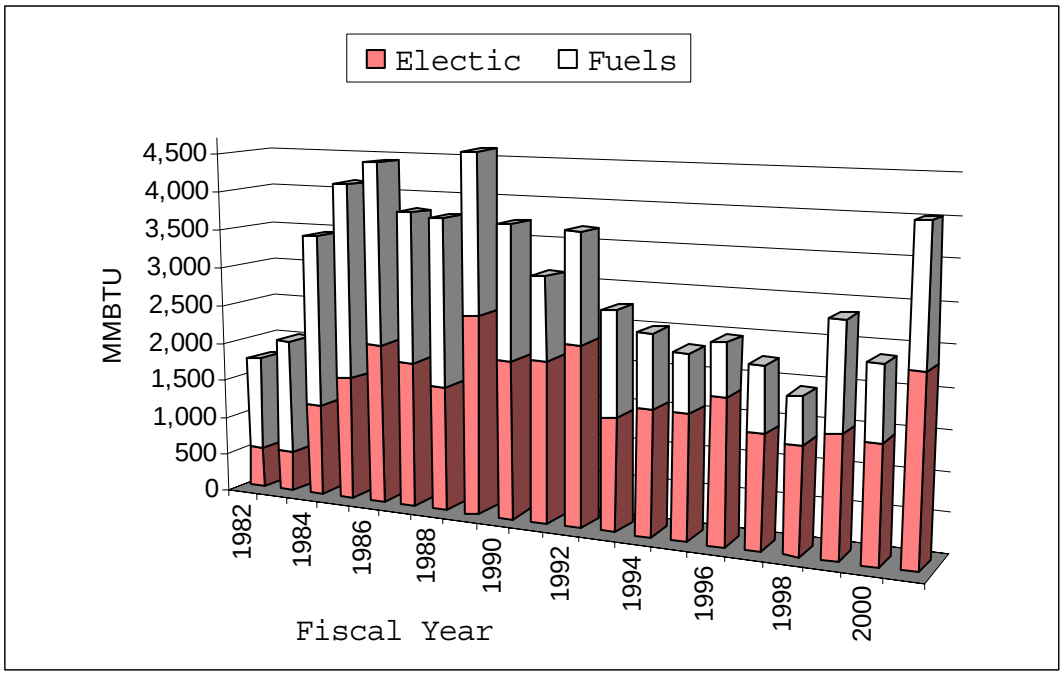


Figure 42. Average First Year Implemented Energy Conserved by Fiscal Year

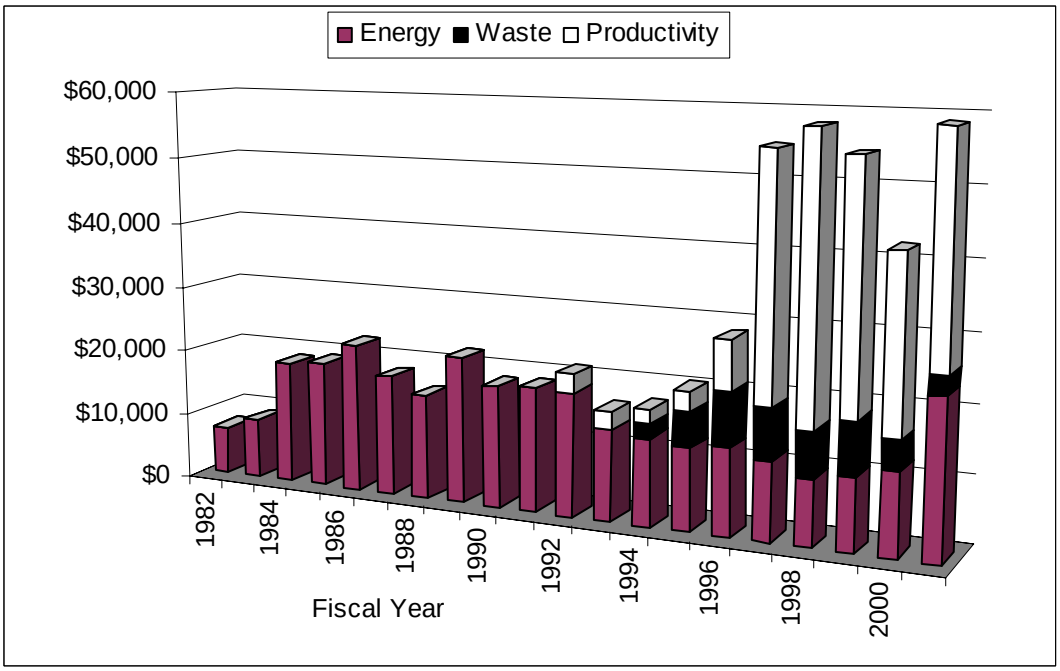


Figure 43. Average First Year Implemented Cost Savings by Fiscal Year

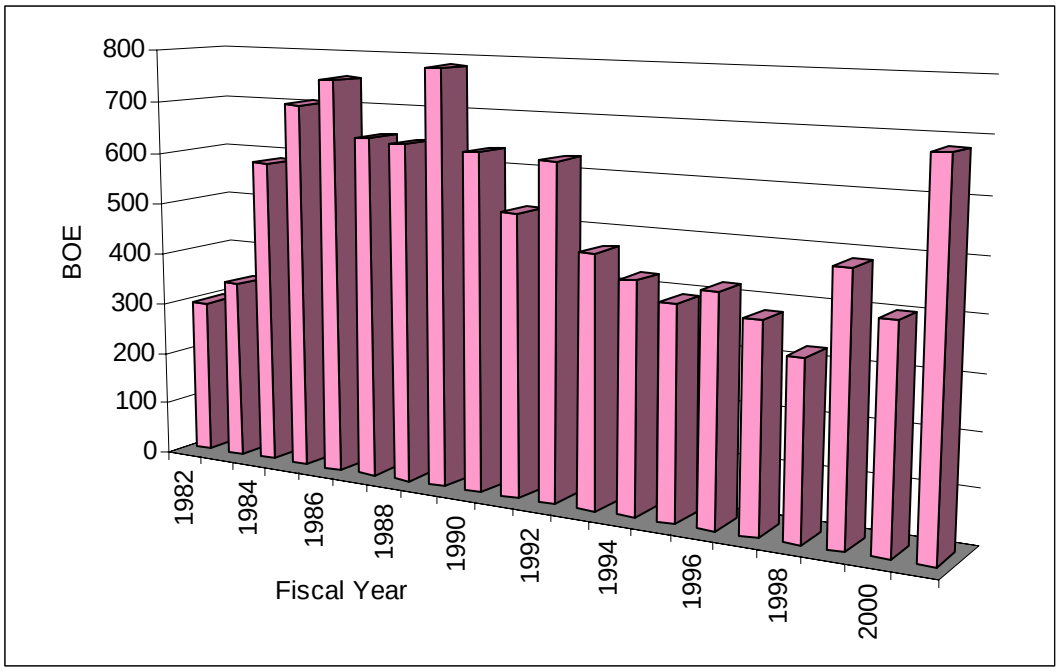


Figure 44. Average First Year Implemented Barrels of Oil Avoided by Fiscal Year

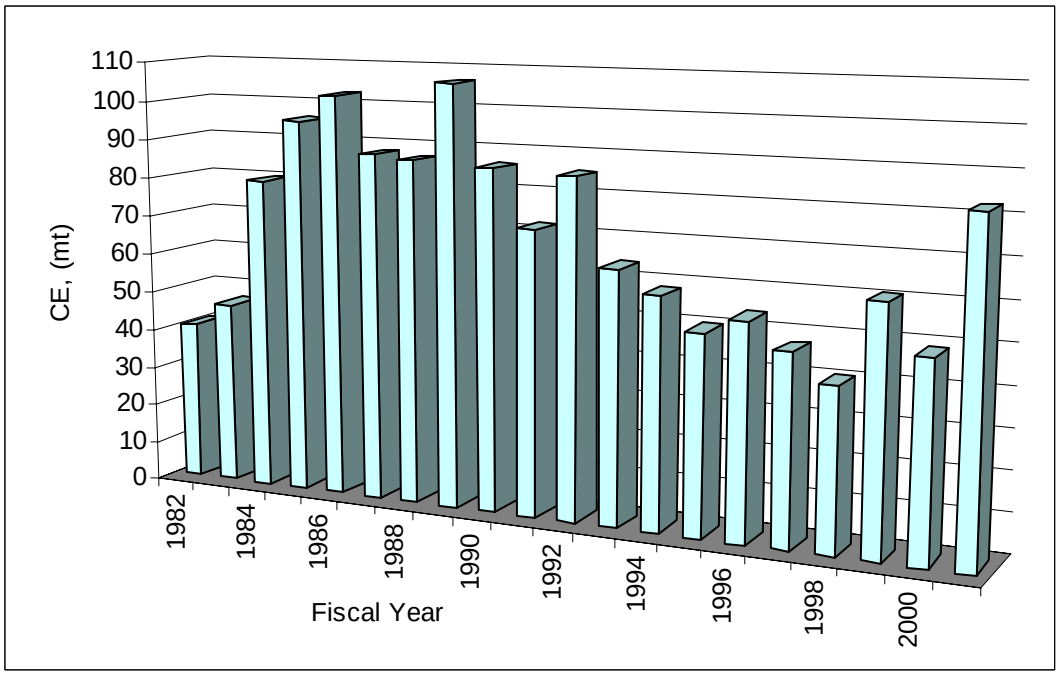


Figure 45. Average First Year Implemented Carbon Avoided by Fiscal Year

ii. Implemented Savings by Industry Type

Energy conservation and cost savings resulting from implemented recommendations by industry type is shown in Table 21 and Figures 46-50. The greatest amount of energy conserved was in SIC 28 (Chemical and Allied Products); the largest in cost savings was SIC 34 (Fabricated Metal Products). There were also single recommendations not shown on table 21 for SIC 10 (Metal Mining) and SIC 12 (Coal Mining) .

		Implemented Energy Conservation						Implemented Cost Savings ($)			
SIC Code	Industry Description	Site (KWH)	Source Electric (MMBtu)	Site Fuels (MMBtu)	Total (MMBtu)	(B.O.E.)	(C.E., mt)	Energy	Waste	Productivity	Total
20	Foods	3,379,604	34,639	38,615	73,254	12,458	1,506	304,408	97,247	1,213,857	1,615,512
22	Textile Mills	1,561,186	16,003	40,583	56,586	9,623	1,163	291,549	235	8,200	299,984
23	Apparel	1,666,234	17,079	5,897	22,976	3,907	472	144,965	69,515	91,008	305,488
24	Wood Prod.	11,422,020	117,077	24,602	141,679	24,095	2,913	776,198	90,480	1,936,445	2,803,123
25	Furniture	1,609,601	16,499	9,988	26,487	4,505	545	155,952	1,694	307,582	465,228
26	Paper Prod.	12,469,319	127,813	122,784	250,597	42,619	5,152	1,222,035	65,101	1,360,990	2,648,126
27	Printing	1,636,972	16,790	1,700	18,490	3,145	380	148,510	35,953	232,222	416,685
28	Chemical Prod.	13,274,160	136,061	306,638	442,699	75,289	9,102	2,063,006	93,741	616,898	2,773,645
29	Petroleum	506,760	5,194	100,704	105,898	18,010	2,177	531,233	55,440	108,490	695,163
30	Rubber & Plast.	16,344,084	167,523	12,939	180,462	30,691	3,710	1,354,371	180,968	1,103,021	2,638,360
31	Leather Prod.	127,073	1,302	0	1,302	221	27	22,235	0	0	22,235
32	Stone & Glass	9,662,365	99,039	65,667	164,706	28,011	3,386	610,754	30,680	155,150	796,584
33	Primary Metal	12,393,102	127,028	49,001	176,029	29,937	3,619	1,051,129	147,423	1,953,179	3,151,731
34	Fab. Metal	23,296,692	238,794	37,300	276,094	46,955	5,676	1,654,193	179,823	6,428,913	8,262,929
35	Ind. Machinery	19,279,169	197,614	60,514	258,128	43,899	5,307	1,702,165	212,183	2,648,238	4,562,586
36	Electronics	4,109,586	42,123	10,100	52,223	8,881	1,074	285,029	3,885	1,133,480	1,422,394
37	Trans. Equip.	8,605,238	88,186	98,699	186,885	31,783	3,842	1,377,077	80,313	2,032,549	3,489,939
38	Instruments	6,030,852	61,816	151	61,967	10,539	1,274	242,788	228,411	289,870	761,069
39	Misc. Manuf.	1,138,147	11,667	822	12,489	2,124	257	110,411	450	32,558	143,419
Totals		**148,512,164**	**1,522,247**	**986,704**	**2,508,951**	**426,692**	**51,584**	**14,048,008**	**1,573,542**	**21,652,650**	**37,274,200**

Table 21. Implemented Energy and Cost Savings by Industry Type

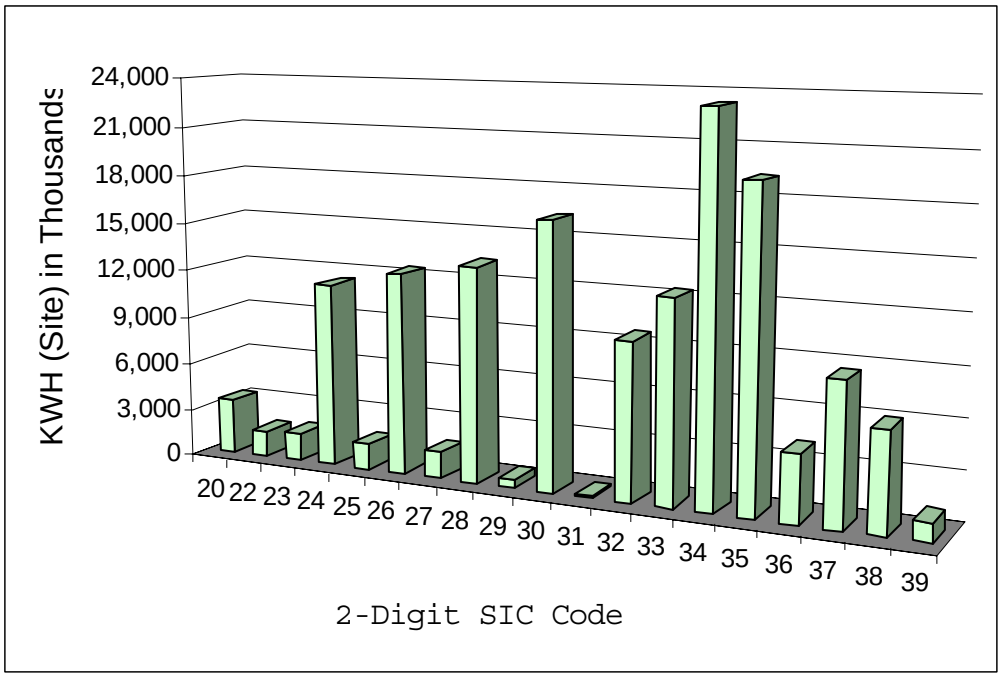


Figure 46. Implemented Electric Consumption by Industry Type

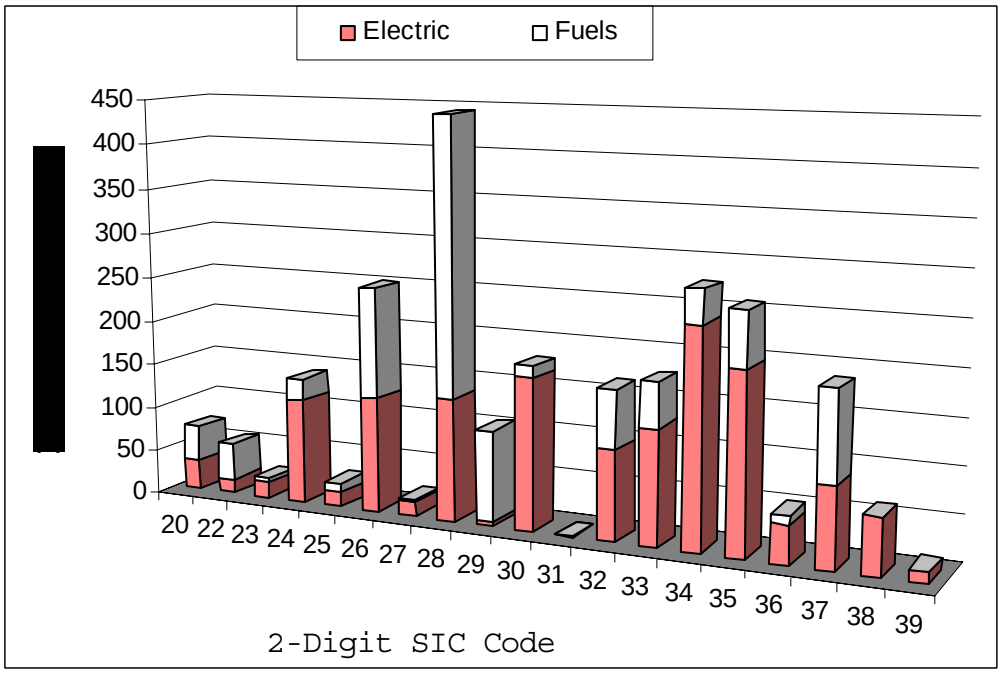


Figure 47. Implemented Energy Conserved by Industry Type

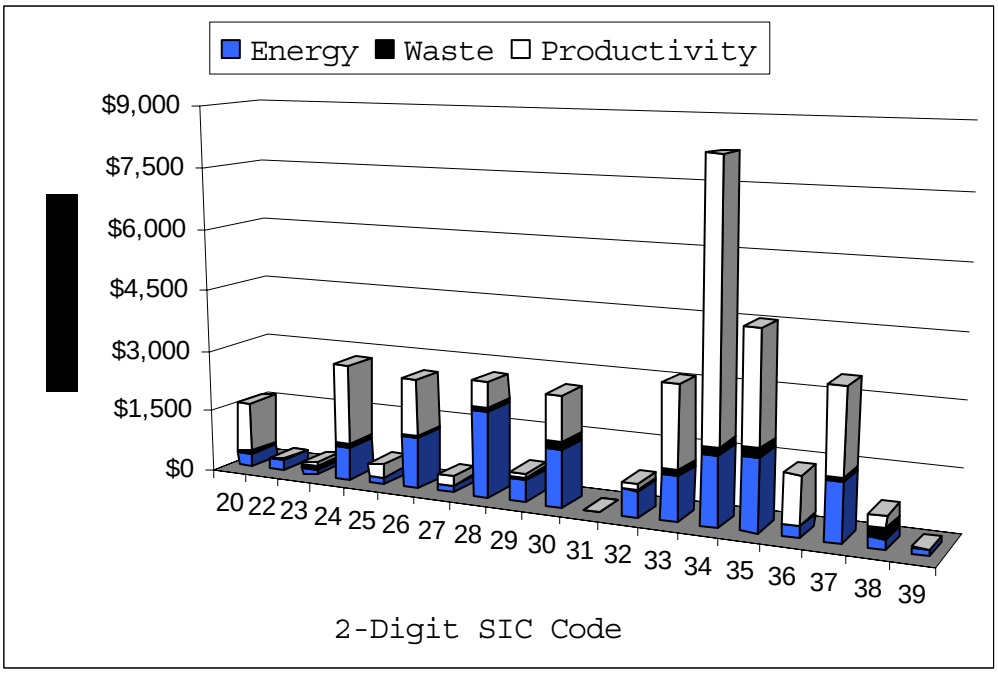


Figure 48. Implemented Cost Savings by Industry Type

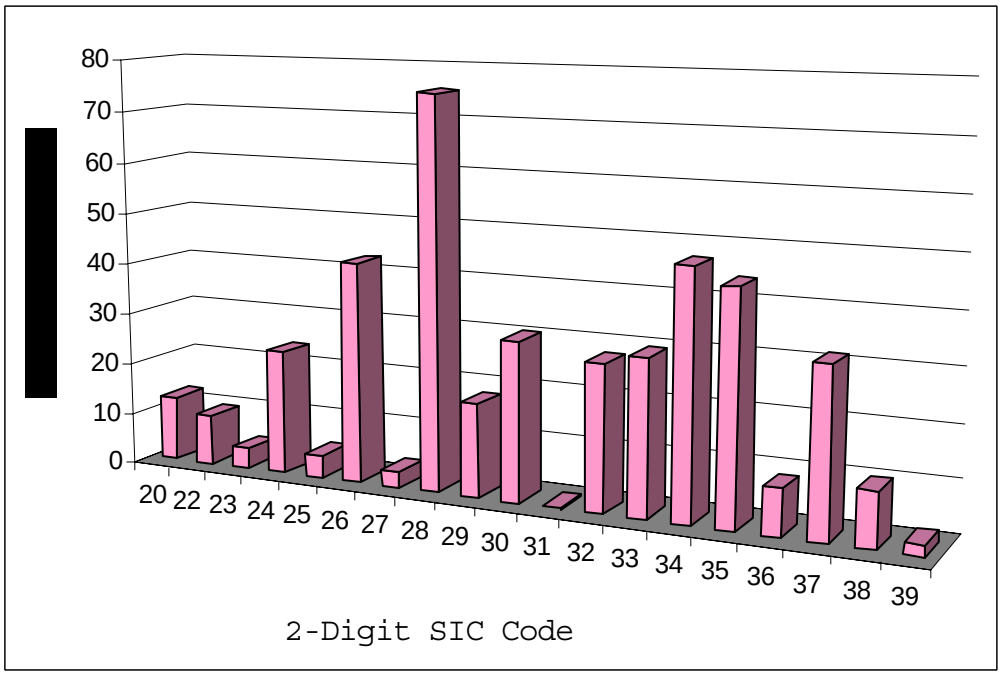


Figure 49. Implemented Barrels of Oil Avoided by Industry Type

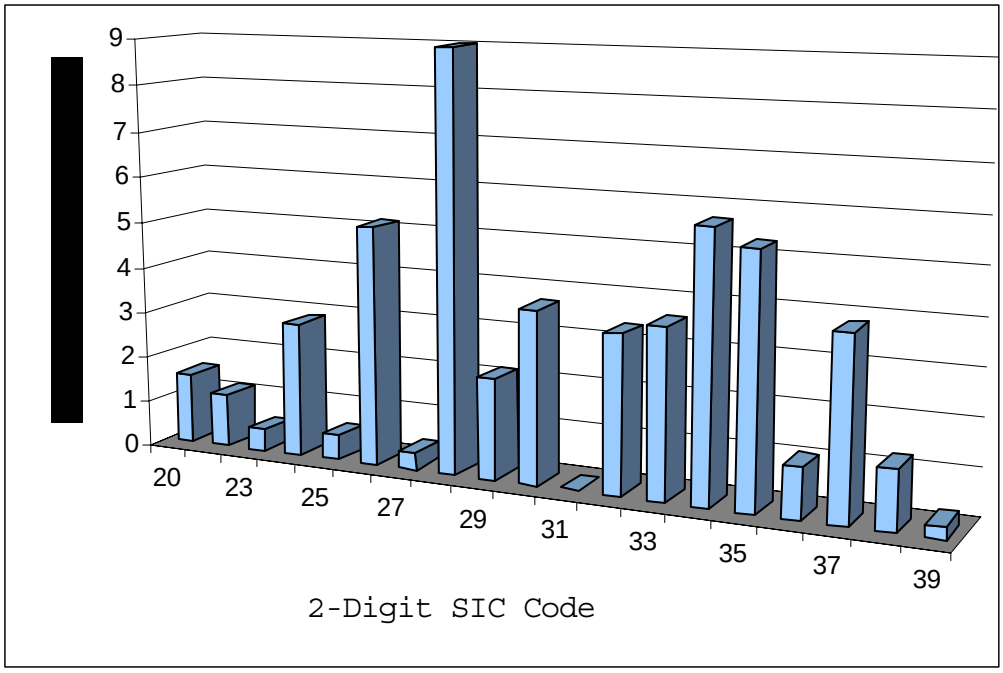


Figure 50. Implemented Carbon Avoided by Industry Type

Table 22 and Figures 51-54 show the average implemented energy and cost savings by industry type per assessment.

SIC Code	Industry Description	Implemented Energy Conservation (thousands)						Implemented Cost Savings (thousands $)			
		Site (KWH)	Source Electric (MMBtu)	Site Fuels (MMBtu)	Total (MMBtu)	(B.O.E.)	(C.E., mt)	Energy	Waste	Productivity	Total
20	Foods	96,560	990	1,103	2,093	356	43	8,697	2,778	34,682	46,157
22	Textile Mills	130,099	1,334	3,382	4,716	802	97	24,296	20	683	24,999
23	Apparel	185,137	1,898	655	2,553	434	52	16,107	7,724	10,112	33,943
24	Wood Prod.	326,343	3,345	703	4,048	688	83	22,177	2,585	55,327	80,089
25	Furniture	146,327	1,500	908	2,408	410	50	14,177	154	27,962	42,293
26	Paper Prod.	415,644	4,260	4,093	8,353	1,421	172	40,735	2,170	45,366	88,271
27	Printing	102,311	1,049	106	1,156	197	24	9,282	2,247	14,514	26,043
28	Chemical Prod.	368,727	3,779	8,518	12,297	2,091	253	57,306	2,604	17,136	77,046
29	Petroleum	126,690	1,299	25,176	26,475	4,502	544	132,808	13,860	27,123	173,791
30	Rubber & Plast.	302,668	3,102	240	3,342	568	69	25,081	3,351	20,426	48,859
31	Leather Prod.	127,073	1,302	0	1,302	221	27	22,235	0	0	22,235
32	Stone & Glass	603,898	6,190	4,104	10,294	1,751	212	38,172	1,918	9,697	49,787
33	Primary Metal	193,642	1,985	766	2,750	468	57	16,424	2,303	30,518	49,246
34	Fab. Metal	264,735	2,714	424	3,137	534	65	18,798	2,043	73,056	93,897
35	Ind. Machinery	287,749	2,949	903	3,853	655	79	25,405	3,167	39,526	68,098
36	Electronics	152,207	1,560	374	1,934	329	40	10,557	144	41,981	52,681
37	Trans. Equip.	391,147	4,008	4,486	8,495	1,445	175	62,594	3,651	92,389	158,634
38	Instruments	430,775	4,415	11	4,426	753	91	17,342	16,315	20,705	54,362
39	Misc. Manuf.	126,461	1,296	91	1,388	236	29	12,268	50	3,618	15,935
Average		**270,022**	**2,768**	**1,794**	**4,562**	**776**	**94**	**25,542**	**2,861**	**39,368**	**67,771**

Table 22. Average Implemented Energy and Cost Savings by Industry Type

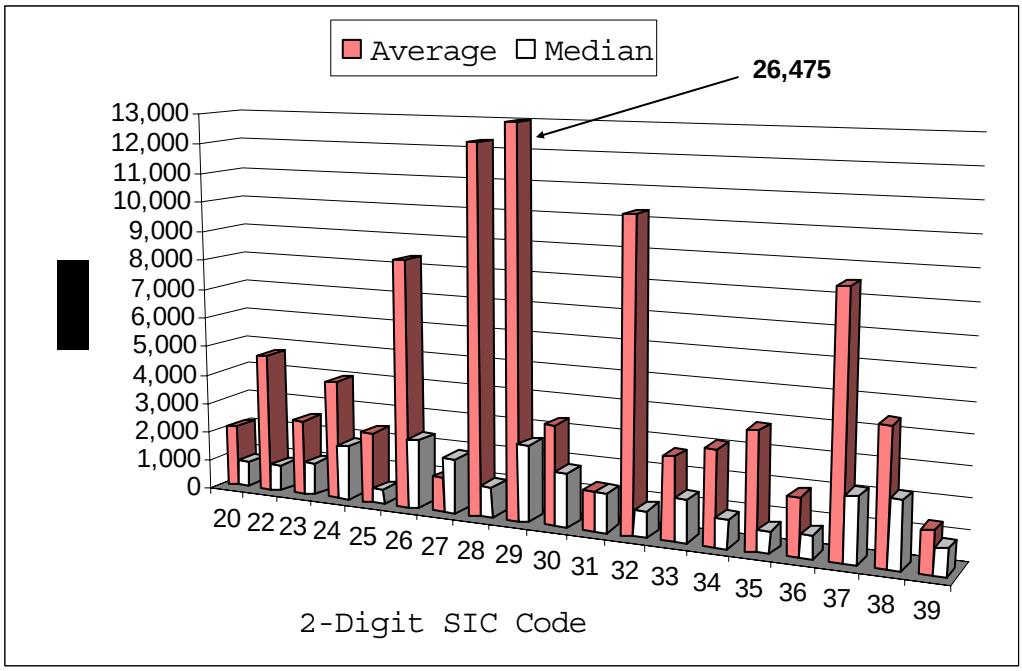


Figure 51. Average and Median Implemented Electric Consumption by Industry Type

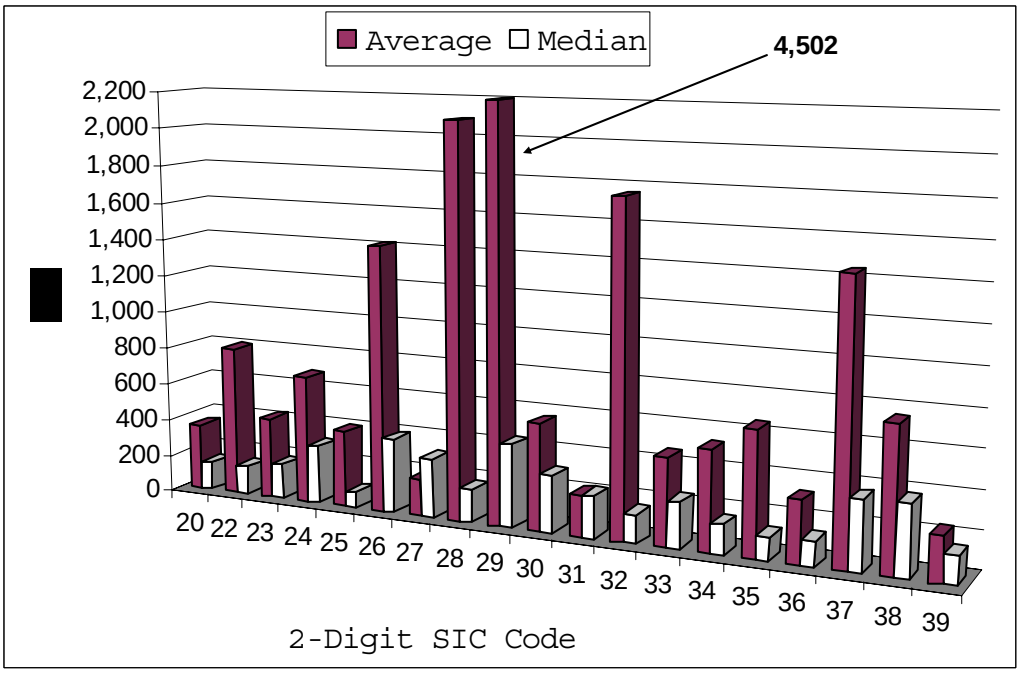


Figure 52. Average and Median Implemented Barrels of Oil Avoided by Industry Type

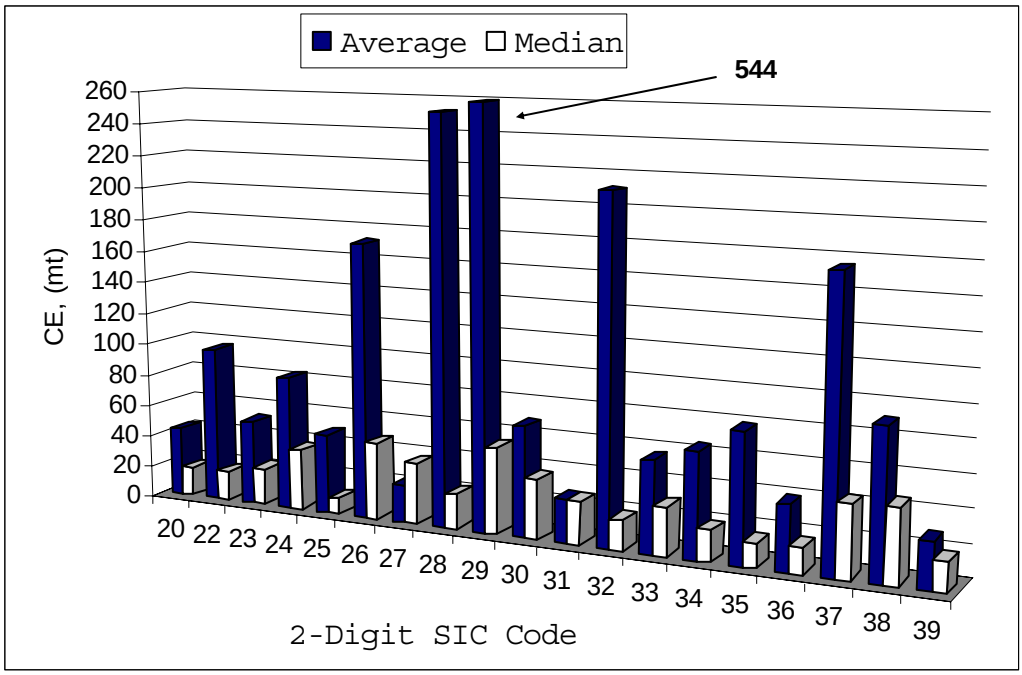


Figure 53. Average and Median Implemented Carbon Avoided by Industry Type

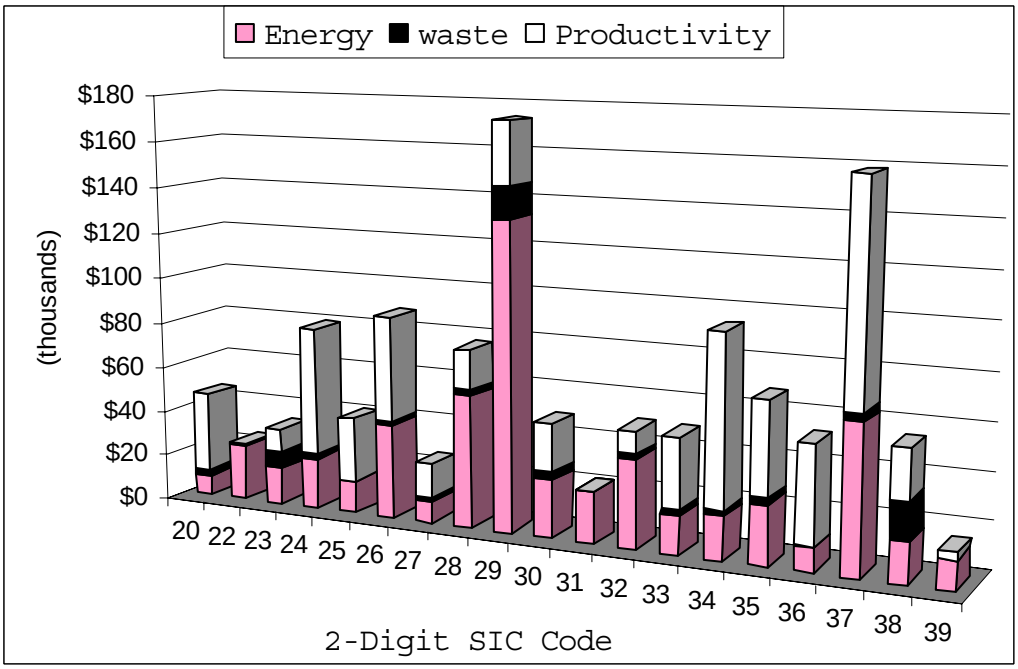


Figure 54. Average Implemented Cost Savings by Industry Type

iii. Implemented Savings by Resource Stream

Table 23 and Figures 55-56 reflect implemented energy and cost savings broken down by energy stream.

Energy Stream	Implemented Energy Conservation (MMBTU)	Implemented Energy Cost Savings ($)
Electricity		
Demand	392,925 KW-months/yr	2,674,341
Fees		439,398
Consumption - Site	148,809,164 KWH	
Consumption - Source	1,525,291	6,264,585
Natural Gas	801,365	4,151,769
L. P. G.	-525	-5,841
Fuel Oil #1	1,430	26,474
Fuel Oil #2	2,746	18,949
Fuel Oil #4	-1,629	-5,025
Fuel Oil #6	94,734	341,560
Coal	86,039	148,595
Wood	2,854	3,643
Other Gas	0	0
Other Energy	0	0
Energy Totals	**2,512,305**	**14,058,448**
Waste	n/a	1,573,542
Productivity	n/a	21,652,650
Program Totals	**2,512,305**	**37,284,640**

Table 23. Implemented Energy and Cost Savings by Resource Stream

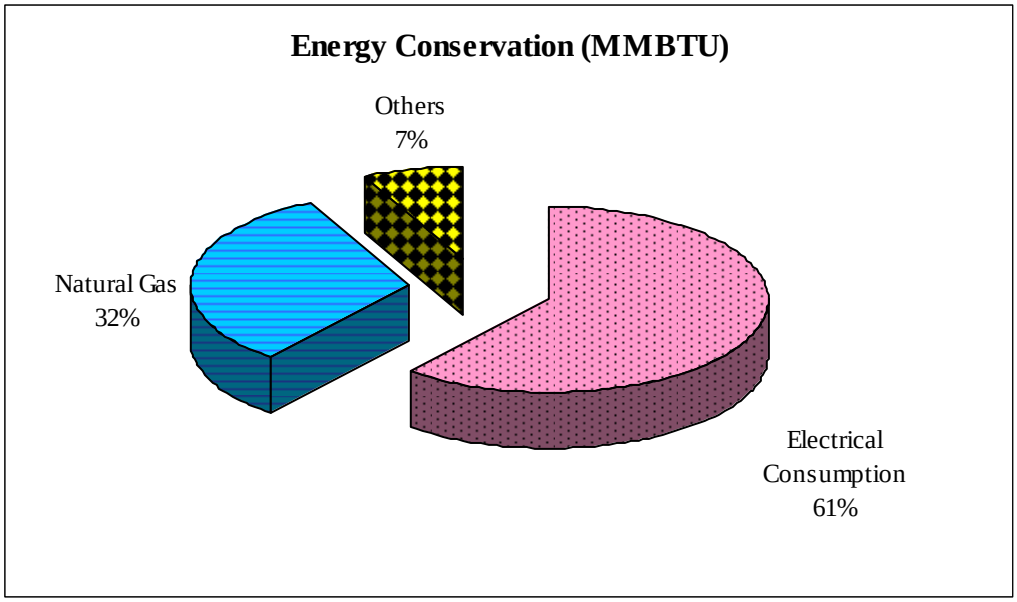


Figure 55. Composition of Implemented Energy Conserved by Energy Stream

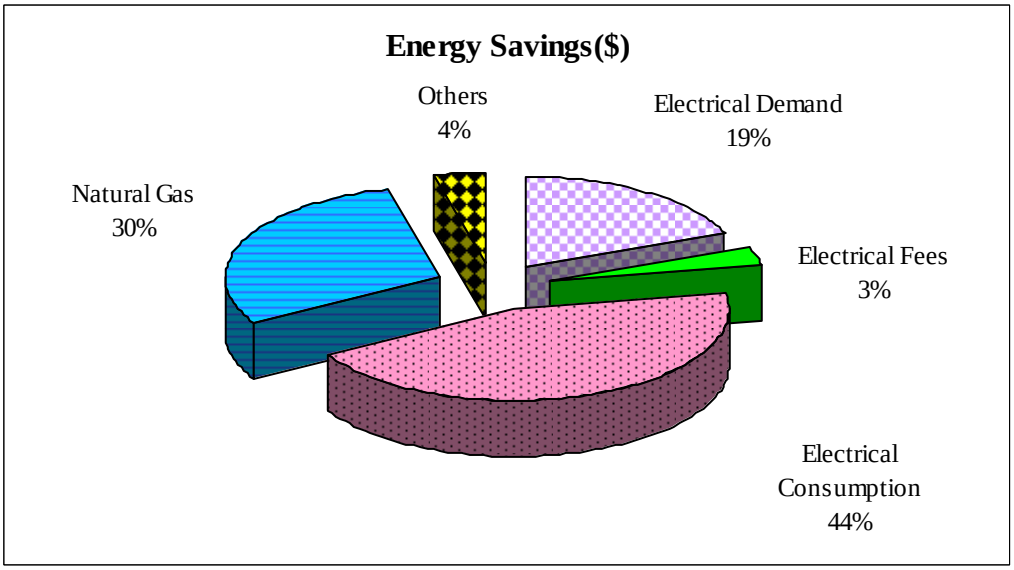


Figure 56. Composition of Implemented Energy Cost Savings by Energy Stream

The breakdown of non-energy savings by resource stream type is shown in Table 24, and Figure 57. The total implemented cost savings by resource stream are shown in Figure 58.

Stream Type	Total Implemented Non-Energy Cost Savings ($)
Primary Product	6,814,246
Byproduct Production	116,540
Resource Costs	
Personnel Changes	6,024,044
Administrative Costs	6,608,001
Primary Raw Material	773,043
Ancillary Material Cost	578,796
Water Consumption	46,296
One-time Revenue or Avoided Cost	691,684
Waste Reduction	
Water Disposal	366,544
Other Liquid (non-haz)	197,241
Other Liquid (haz)	103,377
Solid Waste (non-haz)	901,188
Solid Waste (haz)	5,192
Gaseous Waste (haz)	0
Non-Energy Total	**23,226,192**

Table 24. Total Implemented Non-Energy Cost Savings

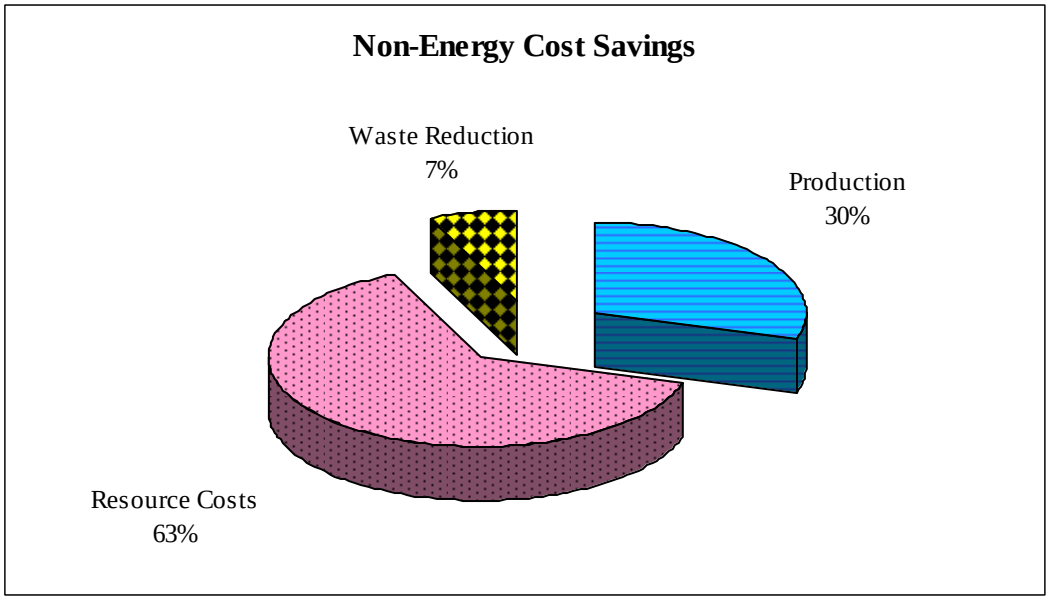


Figure 57. Composition of Non-Energy Implemented Savings

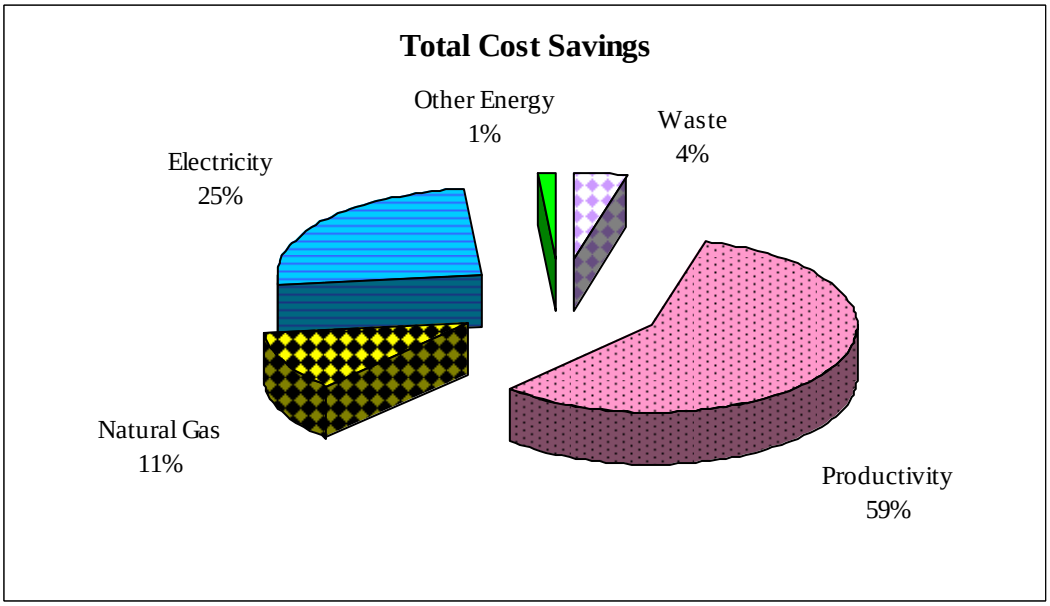


Figure 58. Composition of Total Implemented Cost Savings

iv. Implemented Savings by Recommendation Type

Finally, the number of implemented recommendations by type for Fiscal Year 2001 is shown in Table 25 and Figure 59.

2-Digit ARC Code	Category Description	No. of Implemented Recommendations	No. of Recommendations with client followups	% of Implemented Recommendations
2.1	Combustion Systems	68	179	38.0%
2.2	Thermal Systems	212	500	42.4%
2.3	Electrical Power	74	213	34.7%
2.4	Motor Systems	600	1150	52.2%
2.5	Industrial Design	7	10	70.0%
2.6	Operations	99	161	61.5%
2.7	Buildings and Grounds	446	1049	42.5%
2.8	Ancillary Costs	47	89	52.8%
2.9	Alternate Energy Use	0	1	0.0%
3.1	Operations	14	36	38.9%
3.2	Equipment	3	17	17.6%
3.3	Post Generation Treatment / Minimization	6	26	23.1%
3.4	Water Use	37	93	39.8%
3.5	Recycling	71	168	42.3%
3.6	Waste Disposal	30	102	29.4%
3.7	Maintenance	7	23	30.4%
3.8	Raw Materials	8	21	38.1%
4.1	Manufacturing Enhancements	48	111	43.2%
4.2	Purchasing	1	16	6.3%
4.3	Inventory	13	33	39.4%
4.4	Labor Optimization	66	188	35.1%
4.5	Space Utilization	20	56	35.7%
4.6	Reduction of Downtime	37	91	40.7%
4.7	Management Practices	7	10	70.0%
4.8	Other Administrative Savings	21	34	61.8%
	Total	**1942**	**4377**	**44.4%**

Table 25. Number of Implemented Recommendations by Recommendation Type

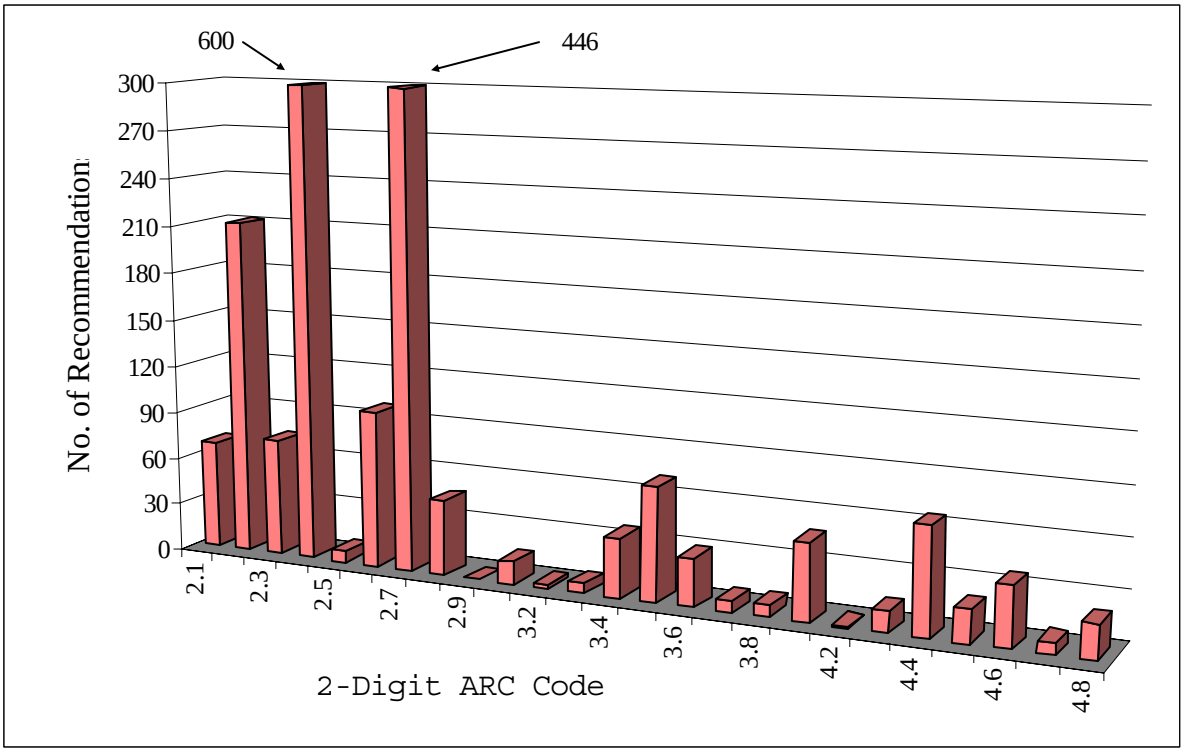


Figure 59. Number of Implemented Recommendations by Recommendation Type

2.1	Combustion Systems.	3.1	Operations	4.1	Manufacturing
2.2	Thermal Systems	3.2	Equipment	4.2	Purchasing
2.3	Electrical Power	3.3	Post Generation Treatment	4.3	Inventory
2.4	Motor Systems	3.4	Water Use	4.4	Labor Optimization
2.5	Industrial Design	3.5	Recycling	4.5	Space Utilization
2.6	Operations	3.6	Waste Disposal	4.6	Downtime
2.7	Building / Grounds	3.7	Maintenance	4.7	Mgt. Practices
2.8	Ancillary Costs	3.8	Raw Materials	4.8	Administrative Savings
2.9	Alternate Energy				

The history of the Centers, the directors' experience, and the student participation is shown in Table 26. The IAC program boasts an experienced and stable group of directors, with a total of all most 150 years of experience in the program and an average of just under 6 years. The 6 years experience includes 8 new centers. Excluding the new centers the average experience of the directors is 8 years.

Industrial Assessment Center	Entered Program	FY2001 Directors	Years as Director	2001 Assessments Completed	# of Students per 2001 Assessment
Arizona State University	FY1990	Dr.Patrick E. Phelan	5	25	4.4
Bradley University	FY1994	Dr. Paul Metha	8	22	4.0
Colorado State University	FY1984	Dr.Harry W. Edwards	5	20	4.2
Georgia Tech. Research Institute	FY1982	Dr. Samuel Sheldon	1	18	2.6
Iowa State University	FY1991	Dr.Gregory M. Maxwell	3	22	5.0
Lehigh University	FY2001	Dr. Sudhakar Neti	1	25	1.4
Loyola Marymount University	FY2001	Dr. Bohdan W. Oppenheim	1	22	3.7
Mississippi State University	FY1994	Dr. B. K. Hodge	8	23	4.4
North Carolina State University	FY1993	Dr. James Leach	8	22	3.0
Oklahoma State Univ.	FY1981	Dr. William Kolarik	3	23	3.7
Oregon State University	FY1987	Dr. George M. Wheeler	15	20	4.8
San Diego State University	FY1991	Dr. Asfaw Beyene	5	24	2.7
San Francisco State Univ.	FY1993	Dr. Admad Ganji	9	22	4.5
Syracuse University	FY2001	Dr. Frederick Caranti	1	25	3.8
Texas A&M - College Station	FY1987	Dr. Warren M. Heffington	15	21	5.9
University of Dayton	FY1976	Dr. Kelly Kissock	4	25	3.5
University of Florida	FY1991	Dr. Diane Schaub	2	24	4.5
University of Illionis at Chicago	FY2001	Dr. William Worek	1	24	5.8
Univ. of Louisiana at Layafayette	FY2001	Dr. Theodore Kozman	1	25	4.1
University of Massachusetts	FY1984	Dr. Lawrence Ambs	18	23	2.5
University of Miami	FY2001	Dr. Shihab Asfour	1	25	3.3
Univ. of Michigan - Ann Arbor	FY1994	Dr. Arvind Atreya	8	22	2.5
University Texas at Arlington	FY2001	Dr. Kendall Harris	1	20	3.7
University of Utah	FY2001	Dr. Gary Sanquist	1	18	4.9
Univ. of Wisconsin - Milwaukee	FY1987	Dr. Umesh Saxena	15	24	2.0
West Virginia University	FY1993	Dr. Ralph Plummer	9	24	3.1

Table 26. History of Centers

Appendix I.

Assumptions Used in Carbon Equivalent Calculations

1.) Carbon Avoided was calculated for three sources; natural gas, electricity, and other (fuel oil)
2.) These sources were calculated separately by percentage for Recommended Savings and for Implemented Savings.
3.) Efficiencies for on site fossil fuel savings (natural gas, fuel oil) are inherent in the reported values.
4.) Carbon Avoided for Electricity saved was calculated using average US generation values.
5.) Electric generation site to source MMBtu's relationship is:

3412 MMBtu's site = 10,250 Source MMBtu's

This is a Fossil Fuel generation efficiency of 33.29%

6.) For purposes of this report those values were:

Coal	80.0 %
Natural Gas	15.0 %
Fuel Oil	5.0 %
Fossil Fuel Total	100%

Carbon Equivalents

CE_{coal}: 56.669 lb. of Carbon per MMBtu

CE_{oil}: 43.439 lb. of Carbon per MMBtu

CE_{gas}: 32.414 lb. of Carbon per MMBtu

$CE_{electricity}$: 119.8 lb. of Carbon per MMBtu

FY2001 Implemented Average 45.4 lb. of Carbon per MMBtu