Savings Generated by the Industrial Assessment Center Program: Fiscal Year 1998

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by

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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 2000 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 FY98, the 30 Centers performed 723 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 consisted of faculty led teams from accredited engineering universities performing a one-day visit 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 $75 million, annual energy bills under $1.75 million, and no professional staff were 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.

For the sixth year, management duties were divided into two regions with Rutgers, The State University of New Jersey providing direction for the Eastern Region and the University City Science Center, Philadelphia, PA continuing in the West. Rutgers University also maintained the database for the entire program.

This report contains sections on general program statistics; assessment recommendations with related implementation results, and field management reports by region. The database managers at Rutgers University generated program statistics analysis and graphics. Section III, Standard Financial Calculations, was produced by the University City Science Center. Field management reports were contributed by each management organization respectively.

II. Program Statistics

A. General

In Fiscal Year 1998, 723 assessments were performed, bringing the program database total to 8,341 assessments since FY81, the first year these records were kept. As only fifteen assessments were performed in FY81, the data shown in this report date back to 1982. The number of assessments in this data set is 8,326. Unless otherwise noted, figures are for FY98. Table 1 shows the number of assessments performed by Fiscal Year.

Fiscal Year	Total No. of Assessments Performed	No. of Industrial Assessments Performed
82	253	n/a
83	211	n/a
84	248	n/a
85	368	n/a
86	298	n/a
87	324	n/a
88	388	n/a
89	340	n/a
90	360	n/a
91	455	n/a
92	531	n/a
93	585	n/a
94	776	61
95	879	237
96	867	867
97	720	720
98	723	723
Total	**8,326**	**2,608**

Table 1. Assessments Performed by Fiscal Year

The total amount of recommended Energy Conservation measures in FY98 was approximately 2,000,000 Million British Thermal Units (MMBTU) with a dollar value of almost $26 million. Waste Reduction and Pollution Prevention cost savings amounted to almost $23 million, and Productivity recommendations were over $88 million. The resultant total recommended savings amounted to $137 million.

The FY98 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 930,000 MMBTU, with a dollar value of over $8.5 million. This equates to 160,000 barrels of oil measured in barrels of oil equivalent (BOE), and almost 30,000 metric tons of carbon avoided measured in carbon equivalent (CE).[1] . The implemented Waste Reduction and Pollution Prevention (P2) measures amounted to $5 million and Productivity measures realized over $35 million. The total amount of money saved by clients as a result of implemented measures was almost $49 million, up from $39 million in FY97. If all implemented energy saving recommendations made over the past 7 years are still in place, the energy savings to the clients would be 7,959,000 MMBTU.

Energy values shown in this report are reported by the centers as *on-site* energy savings. If these values for FY98 take into account energy saved at the source, i.e. electrical power plants, the energy saved is almost 1,815,000 MMBTU, which is equivalent to 311,500 Barrels of Oil.

[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 of approximately 150 miles from the site of the university. The distribution of assessments in FY98 is shown in the following table by state. In FY98, the IACs served manufacturers in 42 states.

STATE	Total No. of Assessments Performed in Each State	Industrial Assessment Center	No. of Audits Performed by Each IAC	Percent of the Total No. of Audits Performed in Each Given State
Alabama	8	Georgia Tech.	2	25%
		Mississippi State University	6	75%
Arizona	25	Arizona State University	25	100%
Arkansas	27	Univ. of Arkansas - Little Rock	25	93%
		Oklahoma State University	2	7%
California	57	University of Nevada	7	12%
		San Diego State University	25	44%
		San Francisco State University	25	44%
Colorado	22	Colorado State University	22	100%
Connecticut	2	University of Massachusetts	2	100%
Florida	25	University of Florida	25	100%
Georgia	22	Georgia Tech.	22	100%
Illinois	39	Bradley University	25	64%
		Univ. of Wisconsin - Milwaukee	14	36%
Indiana	28	Notre Dame University	22	79%
		University of Louisville	6	21%
Iowa	17	Iowa State University	17	100%
Kansas	17	University of Kansas	16	94%
		Oklahoma State University	1	6%
Kentucky	18	University of Louisville	16	89%
		University of Tennessee	2	11%
Maine	17	University of Maine	17	100%
Maryland	3	Old Dominion University	1	33%
		West Virginia University	2	67%
Massachusetts	8	University of Massachusetts	8	100%
Michigan	24	Notre Dame University	3	13%
		University of Michigan	21	88%
Minnesota	24	Iowa State University	4	17%
		South Dakota State University	20	83%
Mississippi	19	Mississippi State University	19	100%
Missouri	32	University of Kansas	7	22%
		University of Missouri - Rolla	25	78%

Table 2. Geographic Distribution of Assessments by State

STATE	Total No. of Assessments Performed in Each State	Industrial Assessment Center	No. of Audits Performed by Each IAC	Percent of the Total No. of Audits Performed in Each Given State
Nebraska	6	Iowa State University	3	50%
		South Dakota State University	1	17%
		University of Kansas	2	33%
Nevada	18	University of Nevada	18	100%
New Hampshire	9	University of Maine	4	44%
		University of Massachusetts	5	56%
New Jersey	9	Hofstra University	9	100%
New Mexico	2	Colorado State University	2	100%
New York	11	Hofstra University	5	45%
		University of Massachusetts	6	55%
North Carolina	28	North Carolina State Univ.	22	79%
		Old Dominion University	2	7%
		University of Tennessee	4	14%
Ohio	34	University of Dayton	25	74%
		University of Michigan	5	15%
		West Virginia University	4	12%
Oklahoma	23	Oklahoma State University	23	100%
Oregon	16	Oregon State University	16	100%
Pennsylvania	19	Hofstra University	11	58%
		West Virginia University	8	42%
Rhode Island	4	University of Massachusetts	4	100%
South Carolina	3	Georgia Tech.	1	33%
		University of Tennessee	2	67%
South Dakota	4	South Dakota State Univ.	4	100%
Tennessee	14	University of Tennessee	14	100%
Texas	25	Texas A&M - College Station	25	100%
Vermont	4	University of Maine	4	100%
Virginia	29	North Carolina State Univ.	3	10%
		Old Dominion University	22	76%
		University of Tennessee	3	10%
		West Virginia University	1	3%
Washington	9	Oregon State University	9	100%
West Virginia	10	West Virginia University	10	100%
Wisconsin	11	Univ. of Wisconsin - Milwaukee	11	100%
Wyoming	1	Colorado State University	1	100%

Table 2. (continued) Geographic Distribution of Assessments by State

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

Industrial Assessment Center	Total No. of Audits Performed by Each IAC	STATE	No. of Assessments Performed in Each State	Percent of Assessments Performed by Each IAC in a State
Arizona State University	25	Arizona	25	100%
Bradley University	25	Illinois	25	100%
Colorado State University	25	Colorado	22	88%
		New Mexico	2	8%
		Wyoming	1	4%
Georgia Tech.	25	Alabama	2	8%
		Georgia	22	88%
		South Carolina	1	4%
Hofstra University	25	New Jersey	9	36%
		New York	5	20%
		Pennsylvania	11	44%
Iowa State University	25	Iowa	17	68%
		Kansas	1	4%
		Minnesota	4	16%
		Nebraska	3	12%
Mississippi State Univ.	25	Alabama	6	24%
		Mississippi	19	76%
North Carolina State Univ.	25	North Carolina	22	88%
		Virginia	3	12%
Notre Dame University	25	Indiana	22	88%
		Michigan	3	12%
Oklahoma State Univ.	25	Arkansas	2	8%
		Oklahoma	23	92%
Old Dominion University	25	Maryland	1	4%
		North Carolina	2	8%
		Virginia	22	88%
Oregon State University	25	Oregon	16	64%
		Washington	9	36%
San Diego State University	25	California	25	100%
San Francisco State Univ.	25	California	25	100%
South Dakota State Univ.	25	Minnesota	20	80%
		Nebraska	1	4%
		South Dakota	4	16%

Table 3. Geographic Distribution of Assessments by Center

Industrial Assessment Center	Total No. of Audits Performed by Each IAC	STATE	No. of Assessments Performed in Each State	Percent of Assessments Performed by Each IAC in a State
Texas A&M - College Station	25	Texas	25	100%
Univ. of Arkansas - Little Rock	25	Arkansas	25	100%
University of Dayton	25	Ohio	25	100%
University of Florida	25	Florida	25	100%
University of Kansas	25	Kansas	16	64%
		Missouri	7	28%
		Nebraska	2	8%
University of Louisville	22	Indiana	6	27%
		Kentucky	16	73%
University of Maine	25	Maine	17	68%
		New Hampshire	4	16%
		Vermont	4	16%
University of Massachusetts	25	Connecticut	2	8%
		Massachusetts	8	32%
		New Hampshire	5	20%
		New York	6	24%
		Road Island	4	16%
Univ. of Michigan - Ann Arbor	26	Michigan	21	81%
		Ohio	5	19%
University of Missouri - Rolla	25	Missouri	25	100%
University of Nevada	25	California	7	28%
		Nevada	18	72%
University of Tennessee	25	Kentucky	2	8%
		North Carolina	4	16%
		South Carolina	2	8%
		Tennessee	14	56%
		Virginia	3	12%
Univ. of Wisconsin - Milwaukee	25	Illinois	14	56%
		Wisconsin	11	44%
West Virginia University	25	Maryland	2	8%
		Ohio	4	16%
		Pennsylvania	8	32%
		Virginia	1	4%
		West Virginia	10	40%

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). Figure 1 shows the distribution of assessments performed in each classification for FY98.

2-digit SIC Code	Industry	No. of Assessments Performed
20	Food and Kindred Products	70
21	Tobacco Products	0
22	Textile Mill Products	23
23	Apparel and Other Textile Products	13
24	Lumber and Wood Products	33
25	Furniture and Fixtures	18
26	Paper and Allied Products	29
27	Printing and Publishing	40
28	Chemicals and Allied Products	21
29	Petroleum and Coal Products	8
30	Rubber and Misc. Plastics Products	96
31	Leather and Leather Products	11
32	Stone, Clay, and Glass Products	48
33	Primary Metal Industries	42
34	Fabricated Metal Products	97
35	Industrial Machinery and Equipment	74
36	Electronic / Other Electric Equipment	38
37	Transportation Equipment	38
38	Instruments and Related Products	12
39	Miscellaneous Manufacturing Industries	12
Total		**723**

Table 4. Number of Assessments Performed by Industry Type

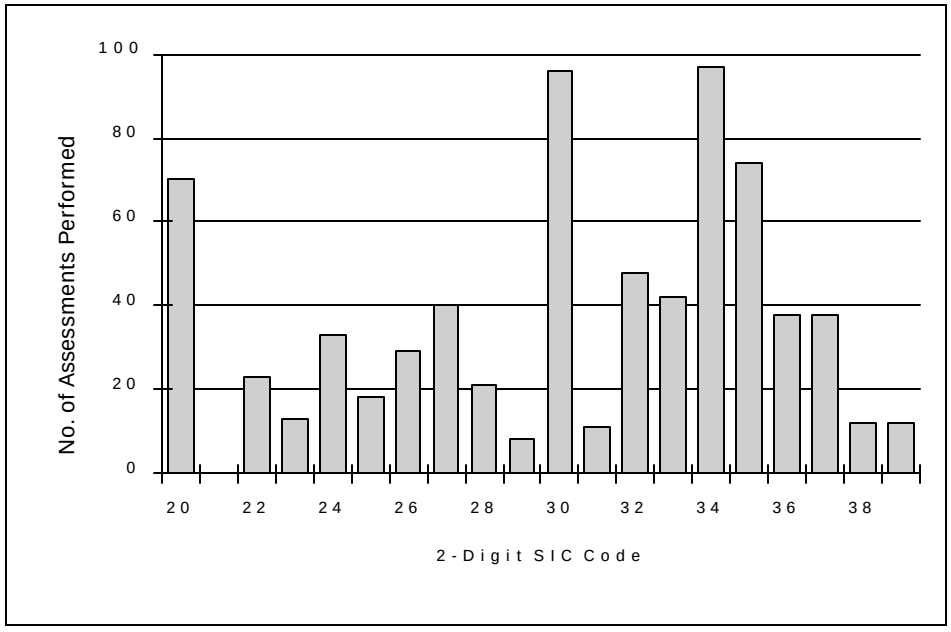

Figure 1. Plants Served in FY98 by Industry Type

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

- Gross sales below $75 million
- A maximum of 500 employees at the site
- Annual energy bills below $1.75 million
- Lack of professional staff to do energy analyses

In FY98, the total energy usage of the clients was 48 million MMBTU, costing $ 348 million. There was an average of 166 employees at each location. The companies had total sales of $ 23 billion. The average sales and energy use of the clients by Fiscal Year is shown in Table 5.

Fiscal Year	Average Yearly Sales($)	Average Yearly Energy Usage (MMBtu)	Average Yearly Energy Cost ($)
82	16,558,654	38,061	231,913
83	15,439,405	46,592	320,200
84	13,543,984	39,796	312,849
85	14,308,457	51,468	329,205
86	21,558,916	61,462	416,228
87	19,438,333	52,135	334,472
88	18,515,013	72,596	361,374
89	23,309,162	67,943	413,965
90	25,126,931	73,933	441,287
91	25,707,204	69,815	382,786
92	24,500,738	106,165	428,295
93	27,333,166	78,372	499,311
94	28,090,421	60,815	437,531
95	29,077,218	52,707	412,759
96	30,609,175	55,932	419,055
97	29,801,416	50,107	386,008
98	31,756,512	66,213	481,024

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 FY82.

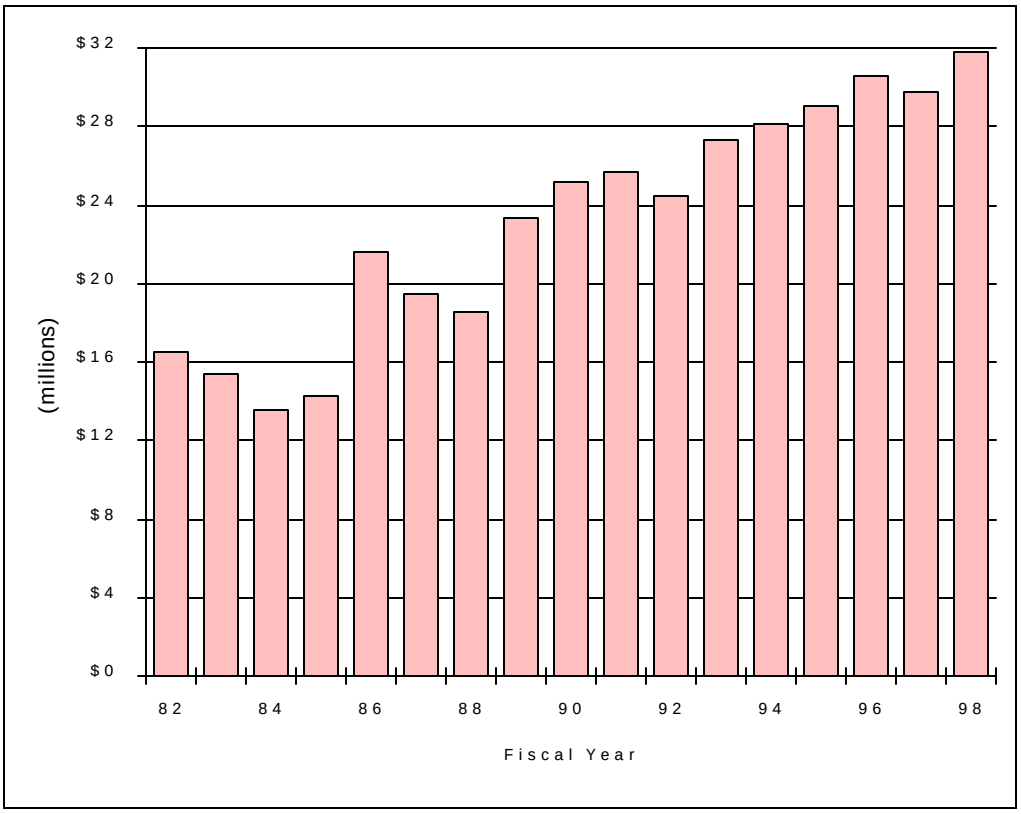

Figure 2. Average Client Sales by Fiscal Year

The average plant served in FY98 had purchased energy use of 66,000 MMBTU with an associated cost of $481,000. Electricity cost the typical client $15.33/ MMBTU and natural gas cost $3.55/ MMBTU. The average energy use and associated costs are shown in Figures 3 and 4.

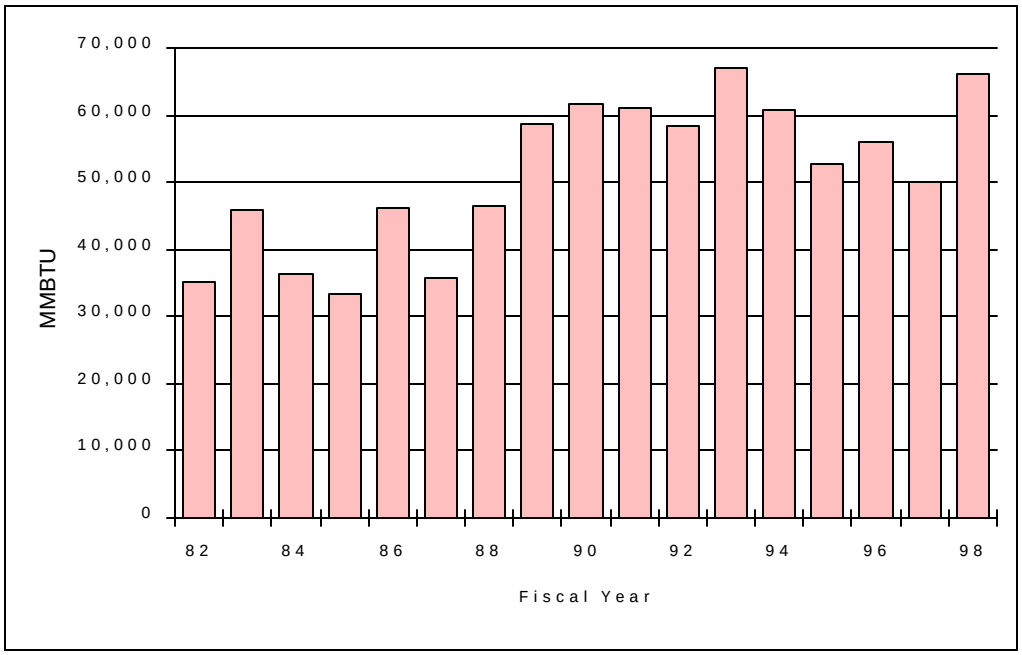

Figure 3. Average Client Energy Usage by Fiscal Year

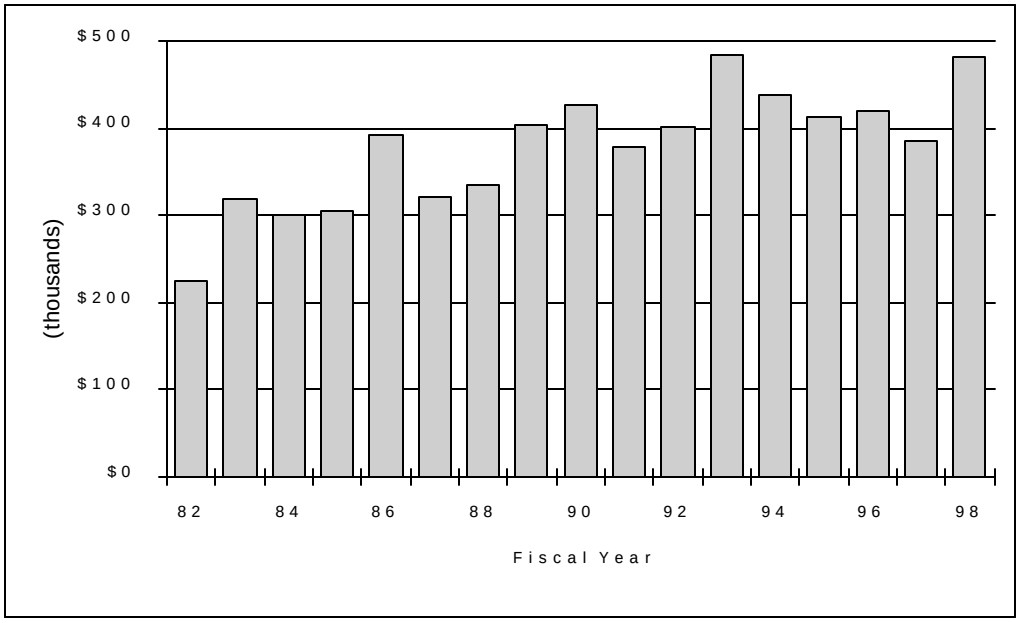

Figure 4. Average Client Energy Costs by Fiscal Year

The program database breaks energy use into eleven specific streams and one category for "other" energy. "Other Energy" in FY98 consisted of such materials as scrap tires and liquid nitrogen for cooling. 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	11,561,522 KW-months/yr	71,850,787
Fees		5,838,764
Consumption	15,582,969	161,254,727
Natural Gas	25,484,662	90,676,277
L. P. G.	255,825	1,628,322
Fuel Oil #1	213,018	946,880
Fuel Oil #2	160,221	818,189
Fuel Oil #4	34,380	139,807
Fuel Oil #6	474,404	1,631,427
Coal	4,033,866	8,437,387
Wood	1,143,752	1,757,229
Paper	0	0
Other Gas	34,082	100,966
Other Energy	454,750	2,698,747
Totals	**47,871,929**	**347,779,509**

Table 6. Energy Use and Cost by Energy Streams

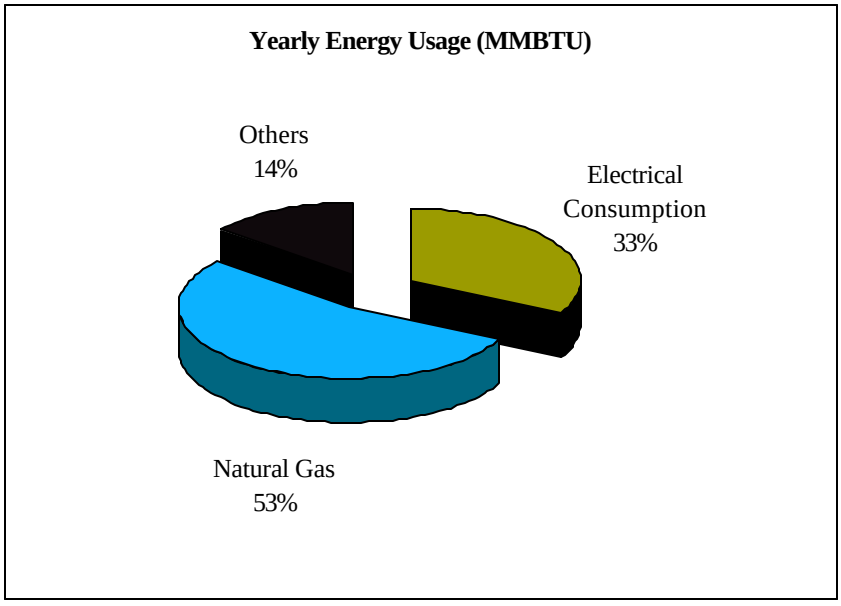

Figure 5. Energy Use of Plants Served in FY98 by Energy Stream

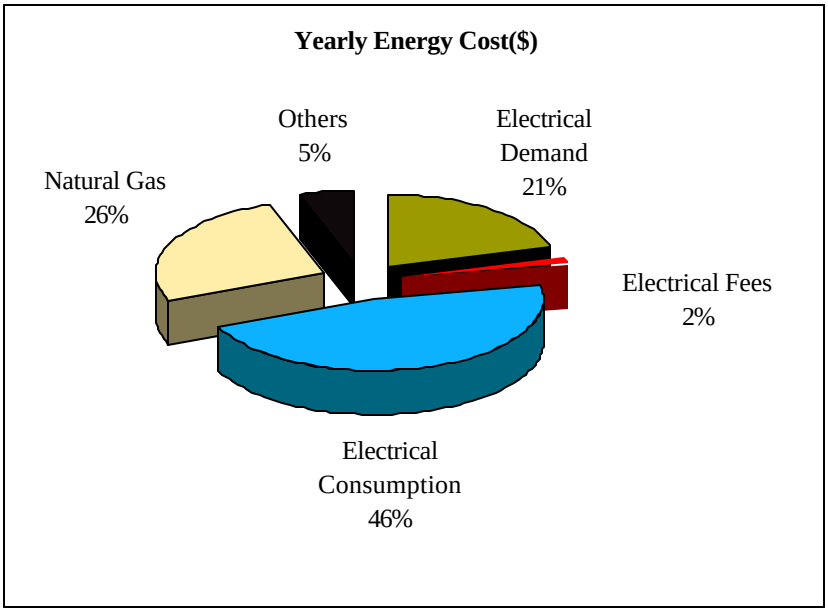

Figure 6. Energy Costs of Plants Served in FY98 by Energy Stream

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 FY98 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 FY93.

Fiscal Year	Recommended Energy Conservation			Recommended Cost Savings ($)			
	(MMBtu)	(B.O.E.)	(C.E., mt)	Energy	Waste	Productivity	Total
82	1,106,749	190,000	25,598	6,699,075	n/a	n/a	6,699,075
83	1,520,973	261,111	35,179	8,712,422	n/a	n/a	8,712,422
84	1,279,588	219,672	29,596	8,970,862	n/a	n/a	8,970,862
85	2,186,556	375,374	50,573	13,917,009	n/a	n/a	13,917,009
86	1,662,854	285,468	38,461	13,670,029	n/a	n/a	13,670,029
87	1,101,527	189,103	25,477	10,742,173	n/a	n/a	10,742,173
88	1,501,641	257,792	34,732	13,585,868	n/a	n/a	13,585,868
89	1,771,766	304,166	40,980	13,052,451	n/a	n/a	13,052,451
90	1,566,269	268,887	36,227	13,970,285	n/a	n/a	13,970,285
91	1,290,331	221,516	29,844	17,369,605	n/a	n/a	17,369,605
92	2,027,666	348,097	46,898	21,749,395	n/a	n/a	21,749,395
93	2,430,789	417,303	56,222	26,253,156	66,793	3,323,992	29,643,941
94	3,522,671	604,750	81,477	34,764,310	3,410,391	3,463,564	41,638,265
95	2,651,229	455,147	75,909	32,918,127	10,459,571	6,741,345	50,119,043
96	1,734,662	297,796	64,592	24,081,673	26,439,503	14,477,738	64,998,914
97	2,568,457	440,937	73,680	23,115,188	15,088,878	104,279,472	142,483,538
98	2,018,075	346,451	80,008	25,797,112	22,596,925	88,073,618	136,467,655

Table 7. Recommended Savings Figures by Fiscal Year

The Figures 7 through 10, and Table 8 show average recommended savings figures per assessment by Fiscal Year.

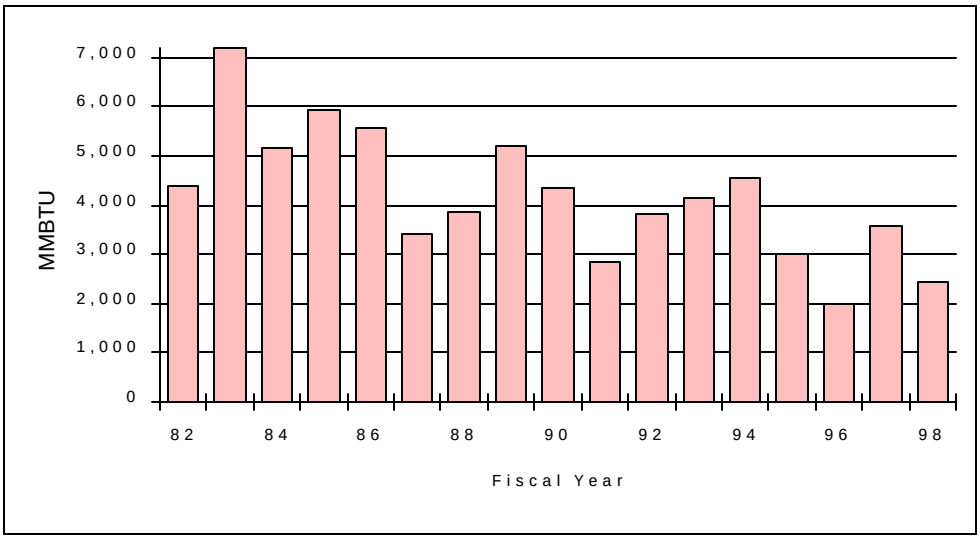

Figure 7. Average Recommended Energy Conserved by Fiscal Year

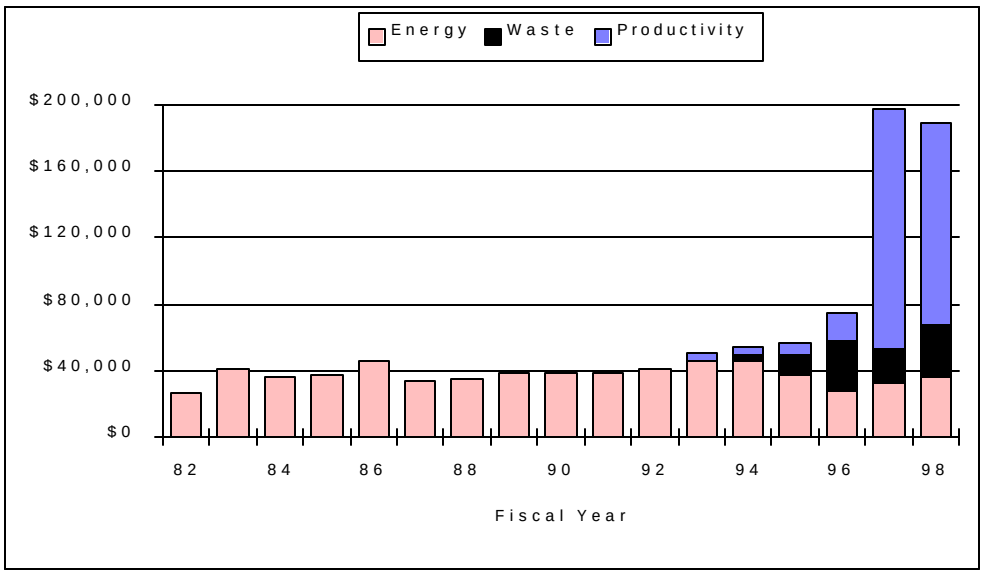

Figure 8. Average Recommended Cost Savings by Fiscal Year

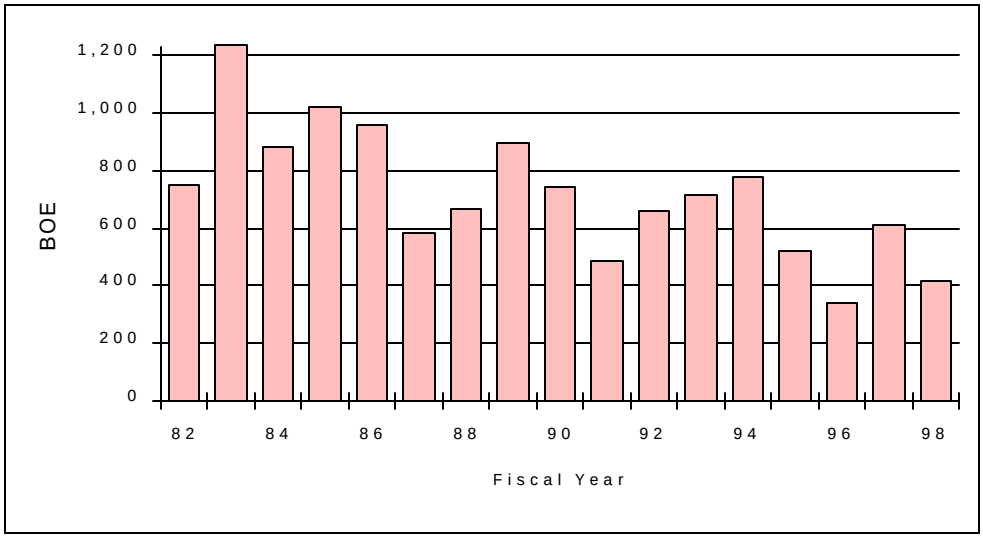

Figure 9. Average Recommended Barrels of Oil Avoided by Fiscal Year

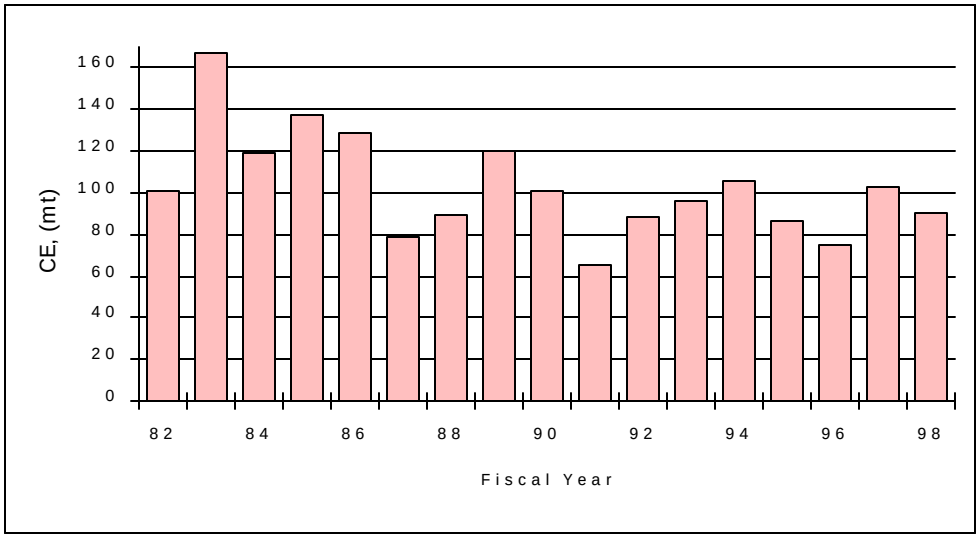

Figure 10. Average Recommended Carbon Avoided by Fiscal Year

Fiscal Year	Recommended Energy Conservation			Recommended Cost Savings ($)			
	(MMBtu)	(B.O.E.)	(C.E., mt)	Energy	Waste	Productivity	Total
82	4,375	751	101	26,479	N/A	N/A	26,479
83	7,208	1,237	167	41,291	N/A	N/A	41,291
84	5,160	886	119	36,173	N/A	N/A	36,173
85	5,942	1,020	137	37,818	N/A	N/A	37,818
86	5,580	958	129	45,873	N/A	N/A	45,873
87	3,400	584	79	33,155	N/A	N/A	33,155
88	3,870	664	90	35,015	N/A	N/A	35,015
89	5,211	895	121	38,390	N/A	N/A	38,390
90	4,351	747	101	38,806	N/A	N/A	38,806
91	2,836	487	66	38,175	N/A	N/A	38,175
92	3,819	656	88	40,959	N/A	N/A	40,959
93	4,155	713	96	44,877	114	5,682	50,673
94	4,540	779	105	44,799	4,395	4,463	53,658
95	3,016	518	86	37,450	11,899	7,669	57,018
96	2,001	343	75	27,776	30,495	16,699	74,970
97	3,567	612	102	32,104	20,957	144,833	197,894
98	2,791	479	111	35,681	31,254	121,817	188,752

Table 8. Average Recommended Energy Conservation and Cost Savings

ii. Recommended Savings by Industry Type

Savings recommended by industry type in Fiscal Year 1998 is shown in Table 9 and Figures 11 through 14. The largest amount of recommended energy conserved occurred during SIC 20 (Food and Kindred Products) assessments replacing SIC 22 (Textile Mills) in FY97. The largest recommended cost savings was in SIC 20 (Food and Kindred Products) for the second year in a row. The lowest recommended cost savings was in SIC 38 (Instruments), and no assessments were performed in SIC 21 (Tobacco Products).

		Recommended Energy Conservation			Recommended Cost Savings ($)			
SIC Code	Industry Description	(MMBtu)	(B.O.E.)	(C.E., mt)	Energy	Waste	Productivity	Total
20	Foods	479,725	82,356	17,959	3,238,021	8,419,923	7,461,034	19,118,978
21	Tobacco Prod.	0	0	0	0	0	0	0
22	Textile Mills	221,365	38,003	8,287	1,281,324	921,853	2,281,115	4,484,292
23	Apparel	36,128	6,202	1,352	514,445	98,477	3,328,550	3,941,472
24	Wood Prod.	168,522	28,931	6,309	1,055,052	525,662	3,321,153	4,901,867
25	Furniture	16,233	2,787	608	241,842	388,343	2,229,940	2,860,125
26	Paper Prod.	86,723	14,888	3,247	829,853	364,625	7,795,645	8,990,123
27	Printing	70,053	12,026	2,622	910,350	285,409	3,309,889	4,505,648
28	Chemical Prod.	210,187	36,084	7,868	2,006,187	521,303	6,896,263	9,423,753
29	Petroleum	24,400	4,189	913	181,679	335,655	1,128,078	1,645,412
30	Rubber & Plast.	200,679	34,451	7,513	2,971,568	2,026,197	9,697,400	14,695,165
31	Leather Prod.	7,859	1,349	294	121,461	296,738	355,831	774,030
32	Stone & Glass	267,062	45,848	9,998	2,394,418	1,583,940	7,130,631	11,108,989
33	Primary Metal	312,193	53,595	11,687	2,151,856	816,703	6,291,932	9,260,491
34	Fab. Metal	202,032	34,684	7,563	2,186,700	1,456,025	7,685,458	11,328,183
35	Ind. Machinery	105,311	18,079	3,942	1,483,802	1,525,015	4,625,887	7,634,704
36	Electronics	-491,650	-84,403	-18,405	2,385,884	339,949	6,279,603	9,005,436
37	Trans. Equip.	76,897	13,201	2,879	992,473	2,511,147	6,106,429	9,610,049
38	Instruments	2,245	385	84	467,487	133,259	773,754	1,374,500
39	Misc. Manuf.	22,111	3,796	828	382,710	46,702	1,375,026	1,804,438
Totals		**2,018,075**	**346,451**	**75,548**	**25,797,112**	**22,596,925**	**88,073,618**	**136,467,655**

Table 9. Recommended Cost and Energy Savings by Industry Type

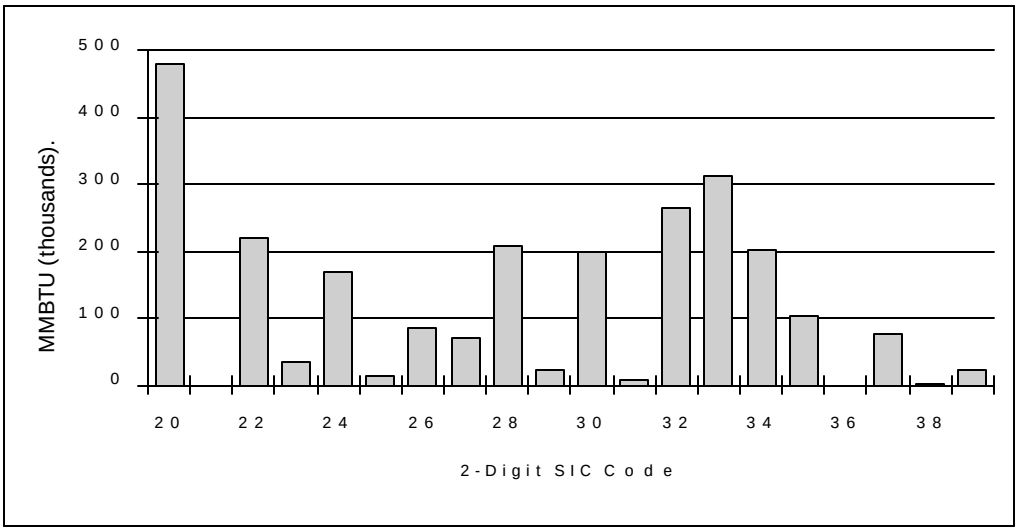

Figure 11. Recommended Energy Conserved by Industry Type

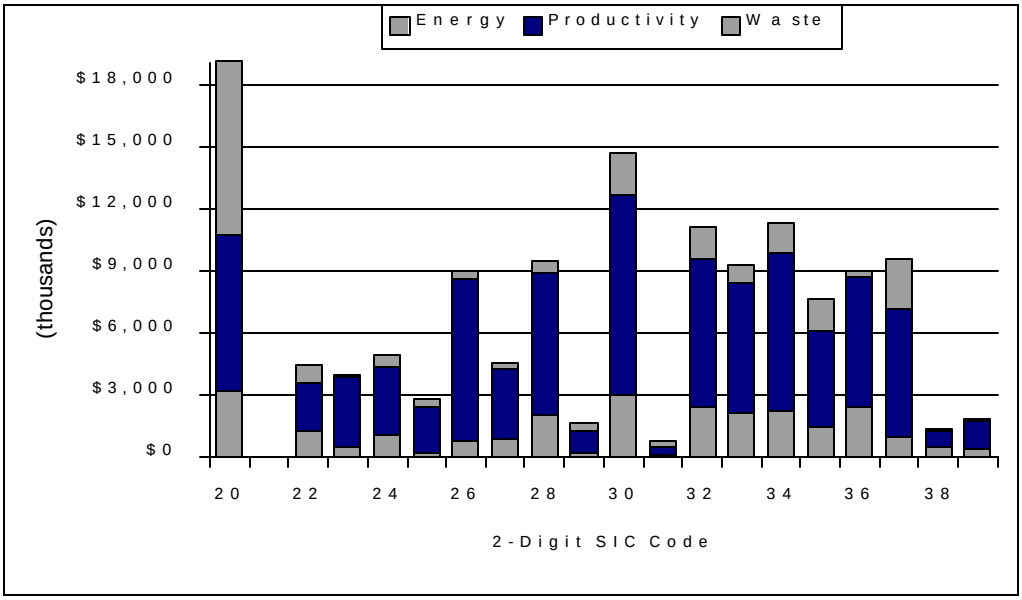

Figure 12. Recommended Cost Savings by Industry Type

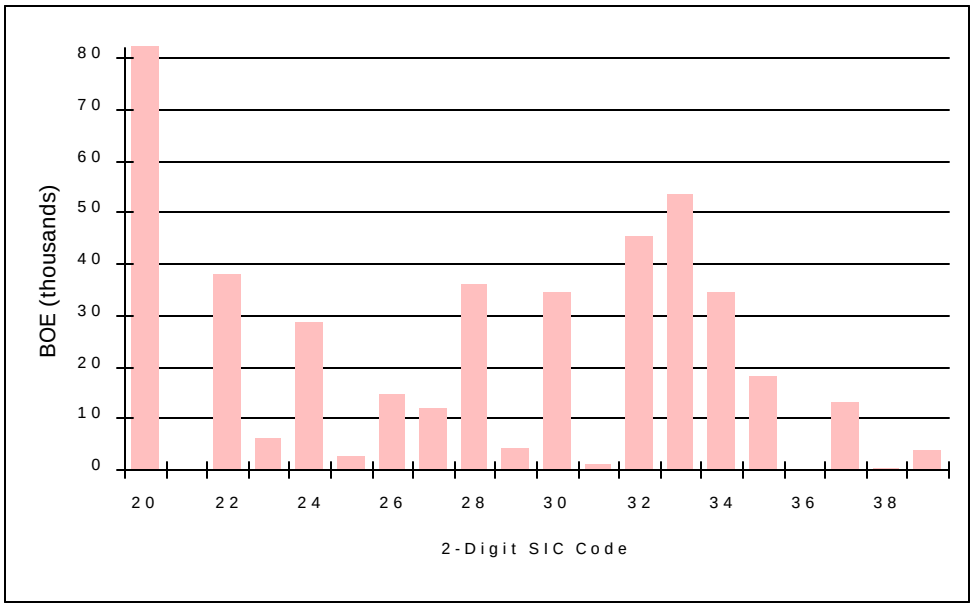

Figure 13. Recommended Barrels of Oil Avoided by Industry Type

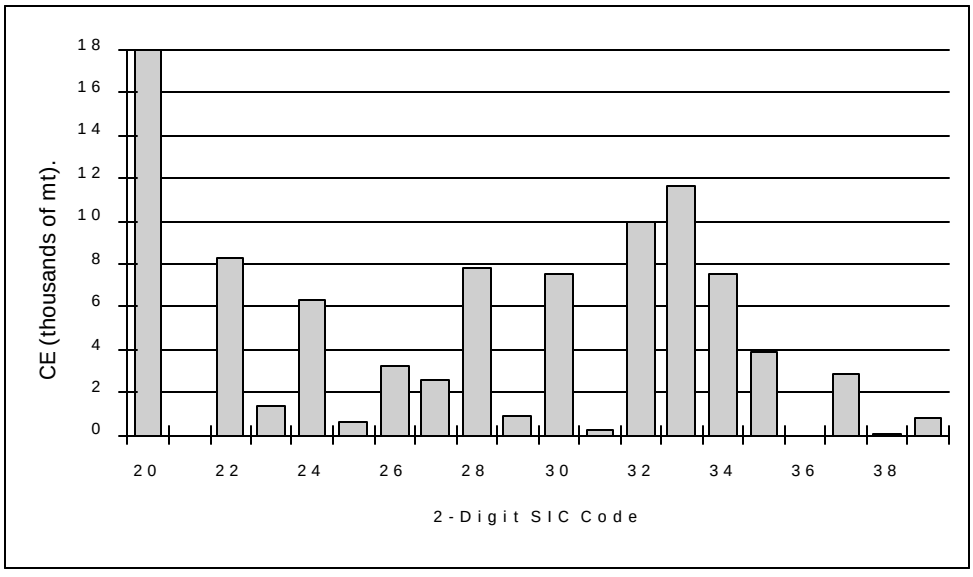

Figure 14. Recommended Carbon Avoided by Industry Type

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 ($)			
		(MMBtu)	(B.O.E.)	(C.E., mt)	Energy	Waste	Productivity	Total
20	Foods	6,853	1,177	257	46,257	120,285	106,586	273,128
21	Tobacco Prod.	0	0	0	0	0	0	0
22	Textile Mills	9,625	1,652	360	55,710	40,081	99,179	194,969
23	Apparel	2,779	477	104	39,573	7,575	256,042	303,190
24	Wood Prod.	5,107	877	191	31,971	15,929	100,641	148,541
25	Furniture	902	155	34	13,436	21,575	123,886	158,896
26	Paper Prod.	2,990	513	112	28,616	12,573	268,815	310,004
27	Printing	1,751	301	66	22,759	7,135	82,747	112,641
28	Chemical Prod.	10,009	1,718	375	95,533	24,824	328,393	448,750
29	Petroleum	3,050	524	114	22,710	41,957	141,010	205,677
30	Rubber & Plast.	2,090	359	78	30,954	21,106	101,015	153,075
31	Leather Prod.	714	123	27	11,042	26,976	32,348	70,366
32	Stone & Glass	5,564	955	208	49,844	32,999	148,555	231,398
33	Primary Metal	7,433	1,276	278	51,235	19,445	149,808	220,488
34	Fab. Metal	2,083	358	78	22,543	15,011	79,232	116,785
35	Ind. Machinery	1,423	244	53	20,051	20,608	62,512	103,172
36	Electronics	-12,938	-2,221	-484	64,370	8,946	165,253	238,569
37	Trans. Equip.	2,024	347	76	26,118	66,083	160,696	252,896
38	Instruments	187	32	7	38,957	11,105	64,480	114,542
39	Misc. Manuf.	1,843	316	69	31,893	3,892	114,586	150,370
Ave.		**2,791**	**479**	**104**	**35,681**	**31,254**	**121,817**	**188,752**

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

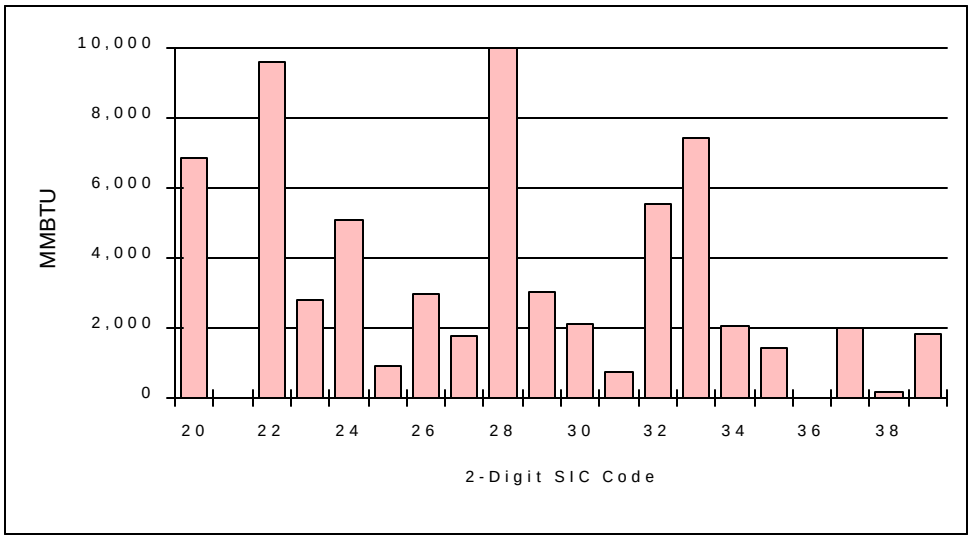

Figure 15. Average Recommended Energy Saved by Industry Type

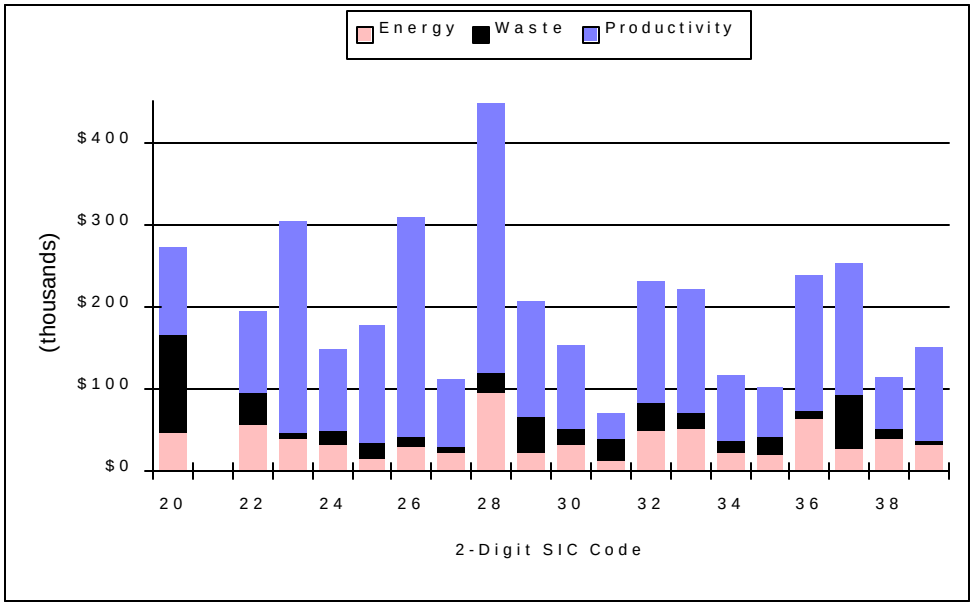

Figure 16. Average Recommended Cost Savings by Industry Type

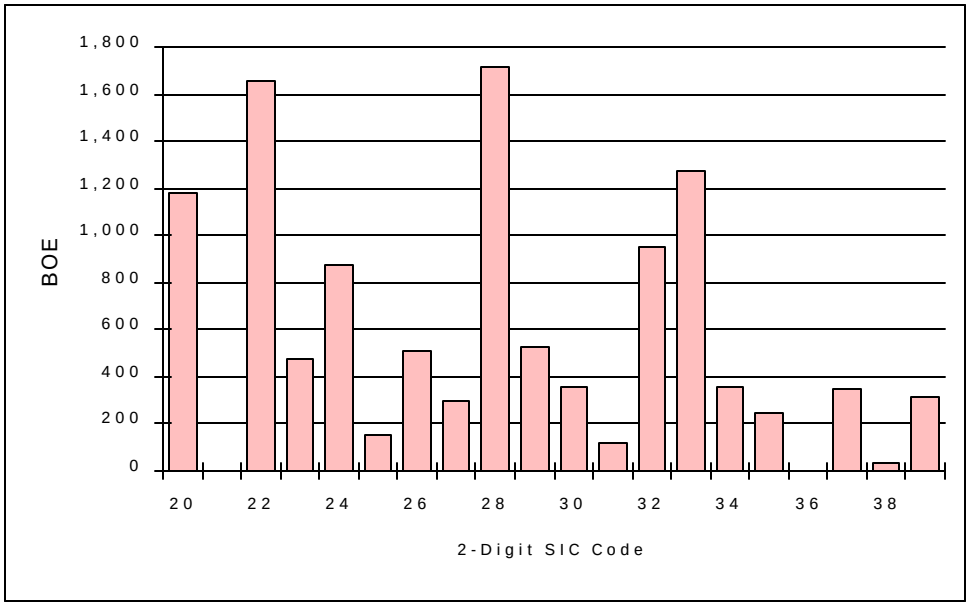

Figure 17. Average Recommended Barrels of Oil Saved by Industry Type

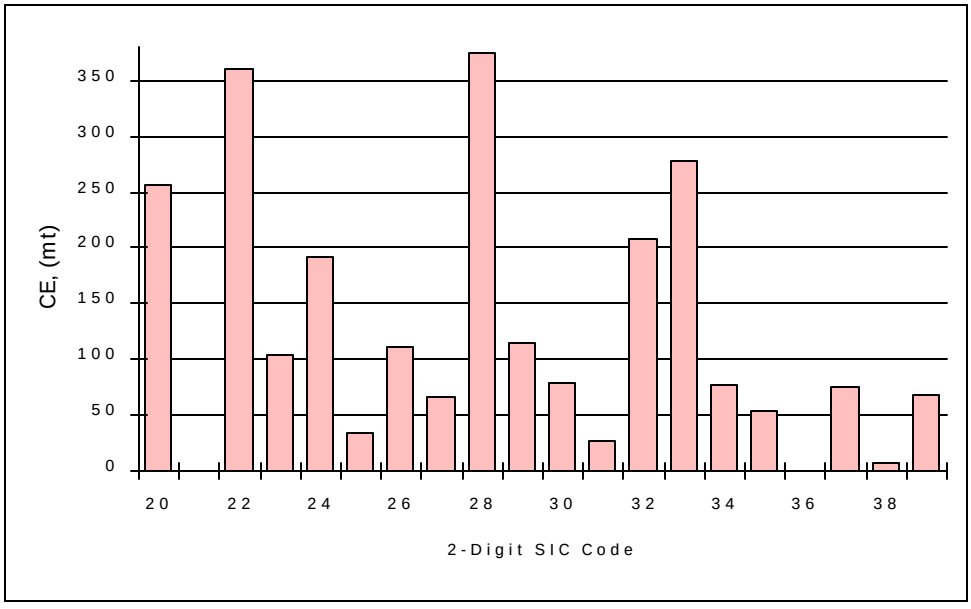

Figure 18. Average Recommended Carbon Avoided by Industry Type

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 FY98 was over 2 million MMBTUs, with a dollar amount of over $25 Million. Including non-energy dollars, the total recommended savings in FY98 amounted to over $136 Million. This data is shown in Table 11, with the percentages by energy type in Figures 19 and 20.

NOTE: Recommendations that involve fuel switching, including Combined Heat and Power result in increased energy consumption (negative energy savings) due to the practice of reporting only on-site energy savings and usage.

Energy Stream	Recommended Energy Conservation (MMBTU)	Recommended Energy Cost Savings ($)
Electricity		
Demand	616,027 KW-months/yr	6,113,921
Fees		706,437
Consumption	1,233,859	13,795,519
Natural Gas	493,001	3,057,469
L. P. G.	17,150	192,801
Fuel Oil #1	3,362	12,360
Fuel Oil #2	14,105	-17,571
Fuel Oil #4	222	789
Fuel Oil #6	93,305	291,866
Coal	402862	1,296,026
Wood	-2,589	3,100
Other Gas	514	21770
Other Energy	-237,716	50,950
Energy Totals	**2,018,075**	**25,525,437**
Waste	n/a	22,596,925
Productivity	n/a	88,406,350
Program Totals	**2,018,075**	**136,528,712**

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.

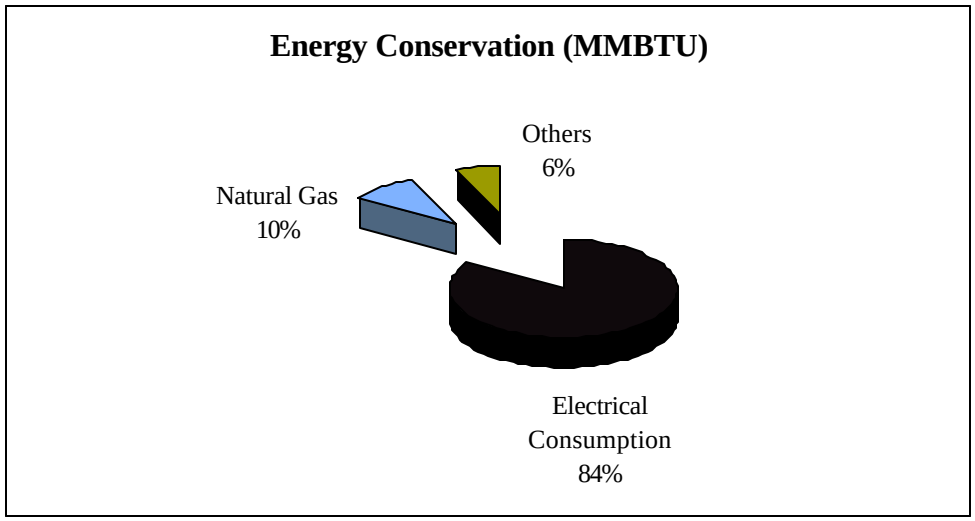

Figure 19. Composition of Recommended Energy Conserved by Energy Stream

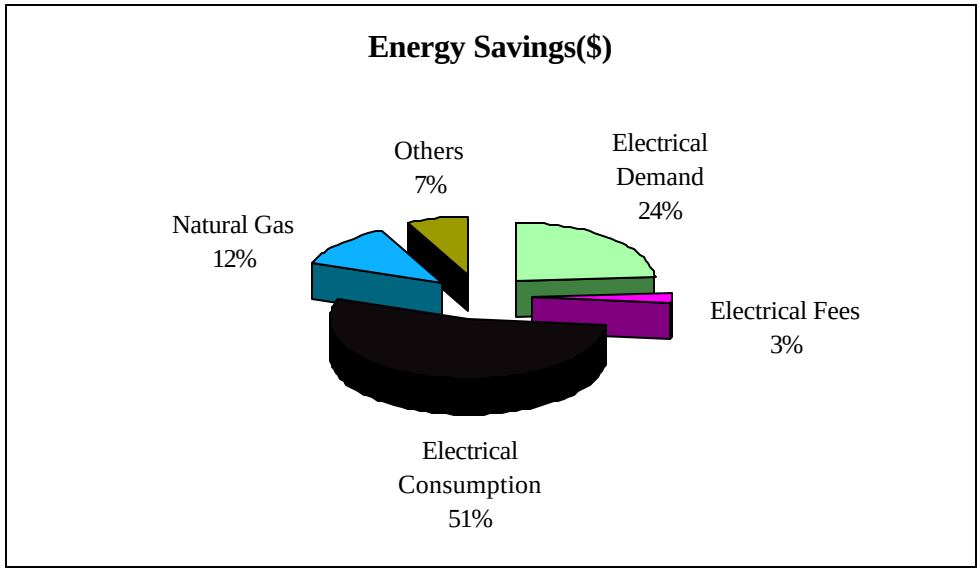

Figure 20. Composition of Recommended Cost Savings by Energy Stream

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 21 shows the composition of the recommended non-energy cost savings.

Stream Type	Total Recommended Non-Energy Cost Savings ($)
Production	
Primary Product	22,878,648
Byproduct Production	1,812,458
Resource Costs	
Personnel Changes	21,881,593
Administrative Costs	25,778,513
Primary Raw Material	6,612,533
Ancillary Material Cost	7,356,589
Water Consumption	1,022,864
One Time Revenue or Avoided Cost	730,420
Waste Reduction	
Water Disposal	8,228,300
Other Liquid (non-haz)	1,870,766
Other Liquid (haz)	919,146
Solid Waste (non-haz)	11,202,981
Solid Waste (haz)	363,004
Gaseous Waste (haz)	12,728
Non-Energy Total	**110,670,543**

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

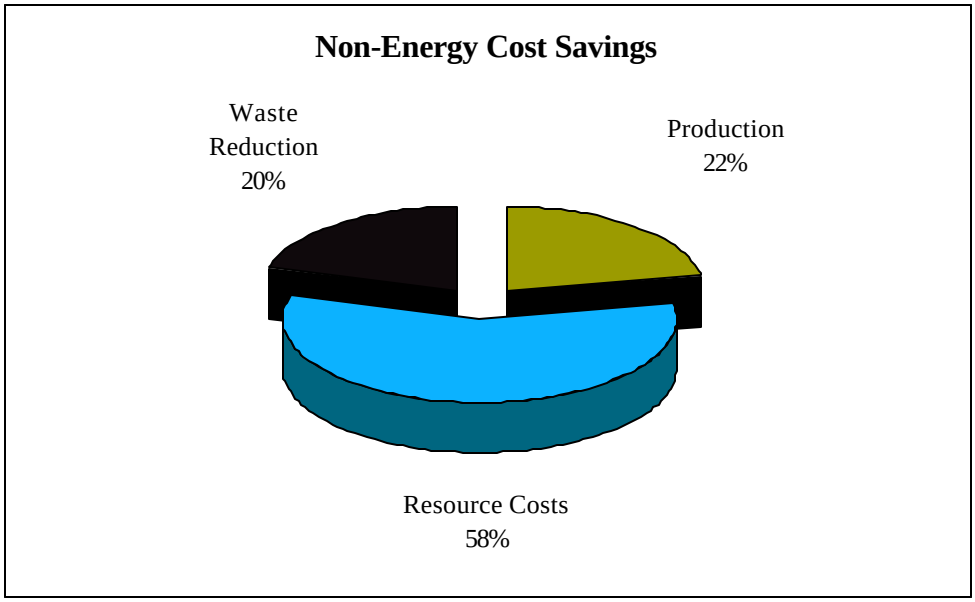

Figure 21. Recommended Non-Energy Cost Savings

Figure 22 indicates the composition of the total recommendations by resource stream for FY98.

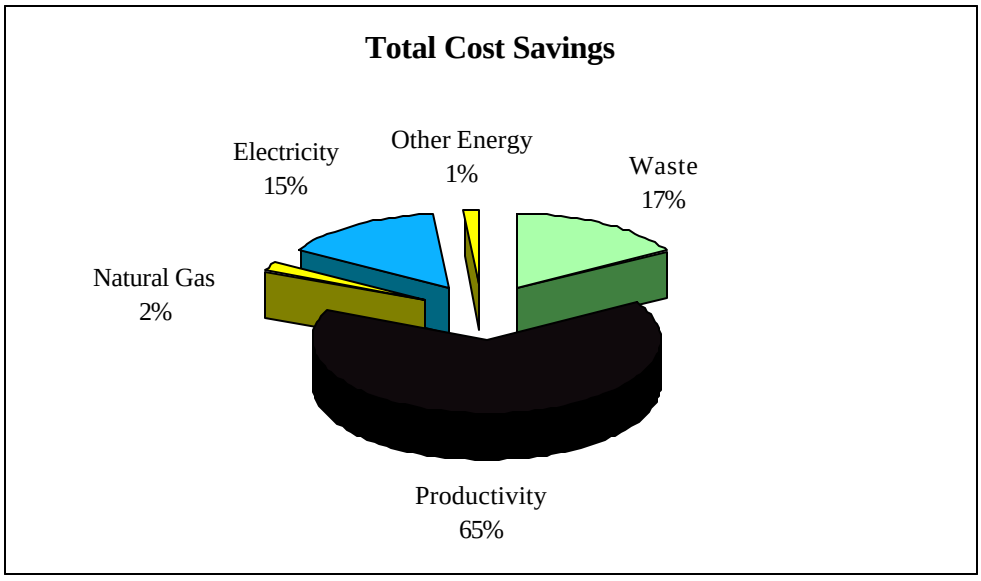

Figure 22. Recommended Cost Savings by Resource Stream

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 300 coded recommendations broken into nine 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 almost 300 different recommendations in these categories. Table 13 shows the category description and number of recommendations by assessment recommendation (AR) type for FY98. Figure 23 shows the frequency of the recommendations. The average number of recommendations was eight, and 108 recommendations were used only once. A review of Table 13 and Figure 23 further illustrate the fact that most recommendations were process oriented.

2-Digit ARC Code	Category Description	No. of Recommendations
2.1	Combustion Systems	233
2.2	Thermal Systems	510
2.3	Electrical Power	193
2.4	Motor Systems	1292
2.5	Industrial Design	12
2.6	Operations	143
2.7	Buildings and Grounds	1255
2.8	Ancillary Costs	181
2.9	Alternate Energy Use	1
3.1	Operations	149
3.2	Equipment	71
3.3	Post Generation Treatment/Minimization	56
3.4	Water Use	211
3.5	Recycling	433
3.6	Waste Disposal	162
3.7	Maintenance	63
3.8	Raw Materials	66
4.1	Manufacturing Enhancements	166
4.2	Purchasing	63
4.3	Inventory	42
4.4	Labor Optimization	214
4.5	Space Utilization	116
4.6	Reduction of Downtime	154
4.7	Management Practices	24
4.8	Other Administrative Savings	62
	Total	**5872**

Table 13. Recommendations by Recommendation Type

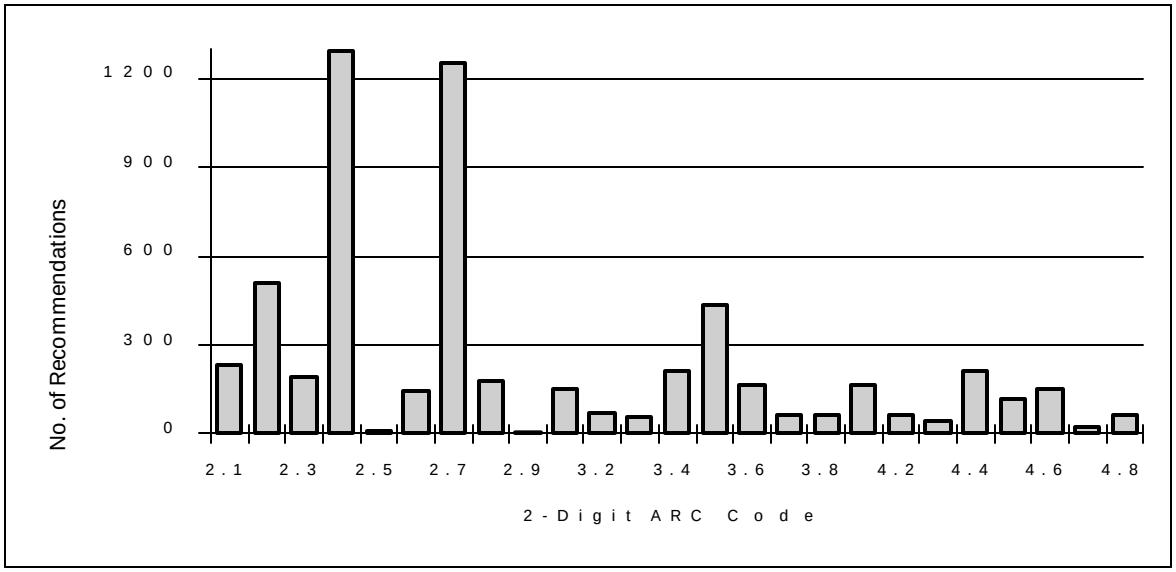

Figure 23. Number of Recommendations by Recommendation Type

D. Implementation Results

i. General

The IAC program has historically enjoyed a high rate of implementation of recommendations. The results of the 1998 program year showed an implementation rate of 50%. 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. This represents a change from annual reports previous to FY97. 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 33%. Tables 14 through 24, and Figures 24 through 54 are all related to implementation results. **Again, it should be pointed out that fuel switching, including CHP is reported as an energy increase, due to the practice of reporting only on-site energy savings and use.**

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
82	1,152	317	28%	N/A	N/A	N/A	N/A	N/A	N/A	1,152	317	28%
83	1,150	352	31%	N/A	N/A	N/A	N/A	N/A	N/A	1,150	352	31%
84	1,746	1,050	60%	N/A	N/A	N/A	N/A	N/A	N/A	1,746	1,050	60%
85	2,377	1,400	59%	N/A	N/A	N/A	N/A	N/A	N/A	2,377	1,400	59%
86	1,998	1,254	63%	N/A	N/A	N/A	N/A	N/A	N/A	1,998	1,254	63%
87	2,175	1,404	65%	N/A	N/A	N/A	N/A	N/A	N/A	2,175	1,404	65%
88	2,629	1,581	60%	N/A	N/A	N/A	N/A	N/A	N/A	2,629	1,581	60%
89	2,380	1,402	59%	N/A	N/A	N/A	N/A	N/A	N/A	2,380	1,402	59%
90	2,417	1,395	58%	N/A	N/A	N/A	N/A	N/A	N/A	2,417	1,395	58%
91	3,091	1,766	57%	N/A	N/A	N/A	N/A	N/A	N/A	3,091	1,766	57%
92	3,749	1,828	49%	N/A	N/A	N/A	N/A	N/A	N/A	3,749	1,828	49%
93	3,963	2,041	52%	29	11	38%	1	0	0%	3,993	2,052	51%
94	5,104	2,516	49%	169	66	39%	8	3	38%	5,281	2,585	49%
95	5,339	2,846	53%	475	203	43%	12	7	58%	5,826	3,056	52%
96	4,912	2,715	55%	1,267	573	45%	59	33	56%	6,238	3,321	53%
97	3,532	1,866	53%	1,304	537	41%	678	328	48%	5,514	2,731	50%
98	3,624	1,889	52%	1,155	503	44%	791	381	48%	5,570	2,773	50%
Totals	**51,338**	**27,622**	**54%**	**4,399**	**1,893**	**43%**	**1,549**	**752**	**49%**	**57,286**	**30,267**	**53%**

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

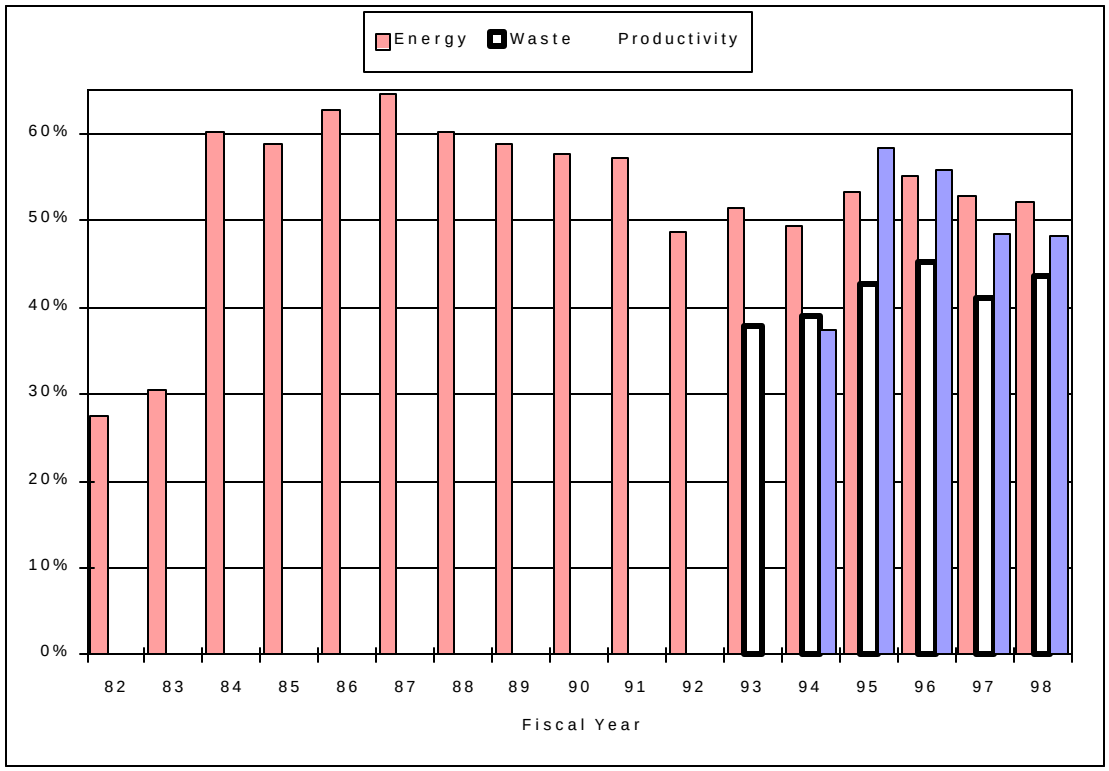

Figure 24. Percent of Recommendations Implemented by Fiscal Year

Fiscal Year	Implemented Energy Conservation			Implemented Cost Savings ($)			
	(MMBtu)	(B.O.E.)	(C.E., mt)	Energy	Waste	Productivity	Total
82	353,998	60,772	8,188	1,839,122	N/A	N/A	1,839,122
83	351,431	60,332	8,128	1,923,834	N/A	N/A	1,923,834
84	656,946	112,780	15,195	4,583,098	N/A	N/A	4,583,098
85	1,125,749	193,262	26,038	7,006,147	N/A	N/A	7,006,147
86	903,479	155,104	20,897	6,667,801	N/A	N/A	6,667,801
87	826,982	141,971	19,127	5,866,646	N/A	N/A	5,866,646
88	1,045,997	179,570	24,193	6,132,078	N/A	N/A	6,132,078
89	986,771	169,403	22,823	7,479,996	N/A	N/A	7,479,996
90	857,465	147,204	19,833	6,570,825	N/A	N/A	6,570,825
91	791,718	135,917	18,312	8,460,459	N/A	N/A	8,460,459
92	1,173,964	201,539	27,153	10,168,974	N/A	N/A	10,168,974
93	1,153,214	197,977	26,673	9,366,098	15,800	1,591,917	10,973,815
94	1,260,138	216,333	29,146	12,163,704	1,688,656	1,432,906	15,285,266
95	1,263,117	216,844	36,165	13,242,626	4,557,805	2,637,179	20,437,610
96	1,213,859	208,388	42,265	13,300,146	7,061,972	6,852,226	27,214,344
97	966,023	165,841	30,470	9,549,476	5,207,156	24,192,763	38,949,395
98	928,175	159,343	29,345	8,618,767	5,373,802	35,104,075	49,096,644

Table 15. Implemented Savings by Fiscal Year

Figure 25 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 FY98, the directors used over 400 different recommendations, of which almost 300 were implemented

Fiscal Year	Recommended Quantities			Implemented Quantities			% of Recommended Cost Savings Implemented
	Cost Savings ($)	Implement. Cost ($)	Simple Payback Period (years)	Cost Savings ($)	Implement. Cost ($)	Simple Payback Period (years)	
82	6,699,075	9,158,809	1.4	1,839,122	2,047,222	1.1	27%
83	8,712,422	10,385,259	1.2	1,923,834	1,708,454	0.9	22%
84	8,970,862	8,847,422	1.0	4,583,098	3,222,790	0.7	51%
85	13,917,009	18,538,810	1.3	7,006,147	4,517,755	0.6	50%
86	13,670,029	17,469,216	1.3	6,667,801	3,984,805	0.6	49%
87	10,742,173	15,057,528	1.4	5,866,646	7,613,376	1.3	55%
88	13,585,868	16,533,416	1.2	6,132,078	4,392,033	0.7	45%
89	13,052,451	16,496,742	1.3	7,479,996	6,338,466	0.8	57%
90	13,970,285	19,176,962	1.4	6,570,825	7,191,266	1.1	47%
91	17,369,605	16,303,282	0.9	8,460,459	8,155,209	1.0	49%
92	22,441,561	35,954,528	1.6	10,168,974	16,777,959	1.6	45%
93	29,643,941	45,521,405	1.5	10,973,815	9,447,658	0.9	37%
94	41,638,265	65,574,847	1.6	15,285,266	16,990,827	1.1	37%
95	50,119,043	72,855,526	1.5	20,437,610	23,834,919	1.2	41%
96	64,998,914	71,511,907	1.1	27,214,344	29,659,638	1.1	42%
97	142,483,538	100,564,895	0.7	38,949,395	26,314,346	0.7	27%
98	136,467,655	143,787,752	1.1	49,096,644	39,049,904	0.8	36%
Totals	**608,482,696**	**683,738,306**	**1.1**	**228,656,054**	**211,246,627**	**0.9**	**38%**

Table 16. Recommended and Implemented Simple Payback

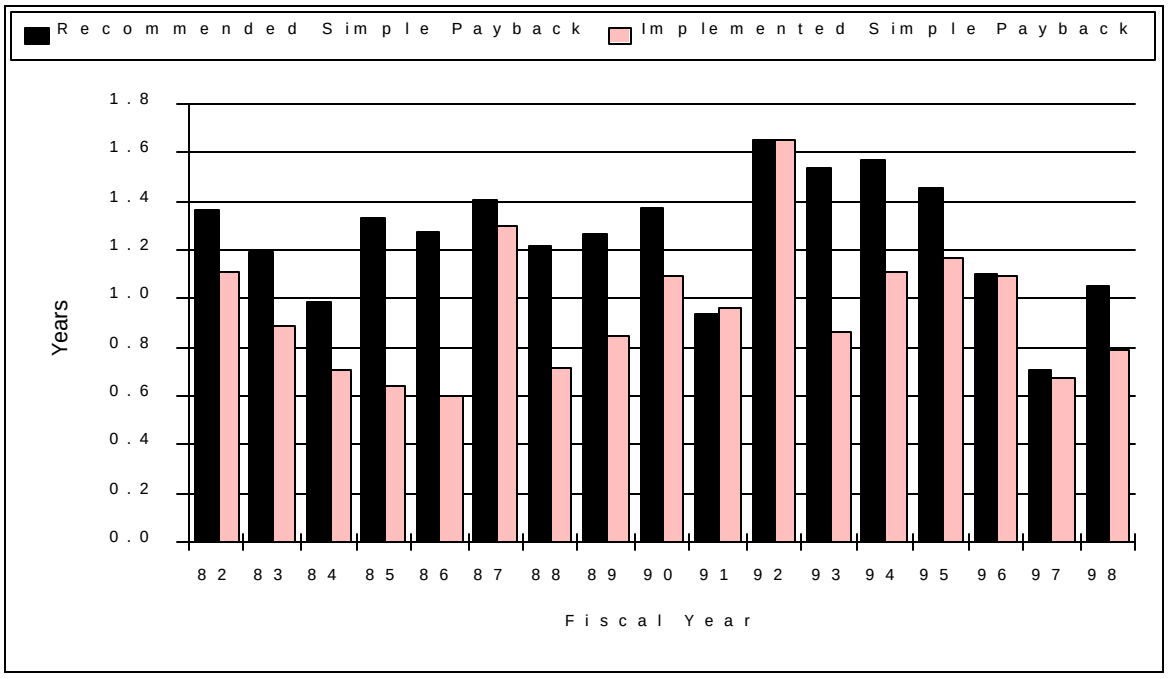

Figure 25. Recommended vs. Implemented Simple Payback

Assuming that the useful life of any one implemented energy conservation measure is not indefinite, Table 17 and Figures 26 through 29 show the cumulative effect of these measures if each remained in place over a seven-year time frame.

Fiscal Year	Implemented Energy Conservation (thousands)			Implemented Cost Savings ($) (thousands)			
	(MMBtu)	(B.O.E.)	(C.E., mt)	Energy	Waste	Productivity	Total
82-88	5,265	904	122	34,019	N/A	N/A	34,019
83-89	5,897	1,012	136	39,660	N/A	N/A	39,660
84-90	6,403	1,099	148	44,307	N/A	N/A	44,307
85-91	6,538	1,122	151	48,184	N/A	N/A	48,184
86-92	6,586	1,131	152	51,347	N/A	N/A	51,347
87-93	6,836	1,174	158	54,045	16	1,592	55,653
88-94	7,269	1,248	168	60,342	1,704	3,025	65,071
89-95	7,486	1,285	214	67,453	6,262	5,662	79,377
90-96	7,713	1,324	269	73,273	13,324	12,514	99,111
91-97	7,822	1,343	247	76,251	18,531	36,707	131,490
92-98	7,958	1,366	252	76,410	23,905	71,811	172,126

Table 17. Seven Year Cumulative Conservation and Cost Savings

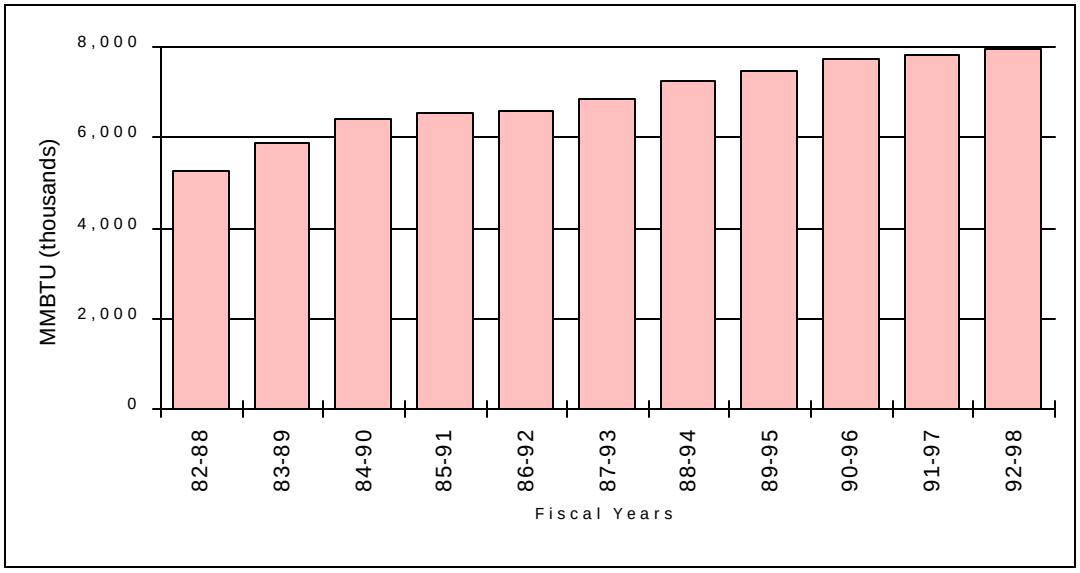

Figure 26. Seven Year Cumulative Energy Savings

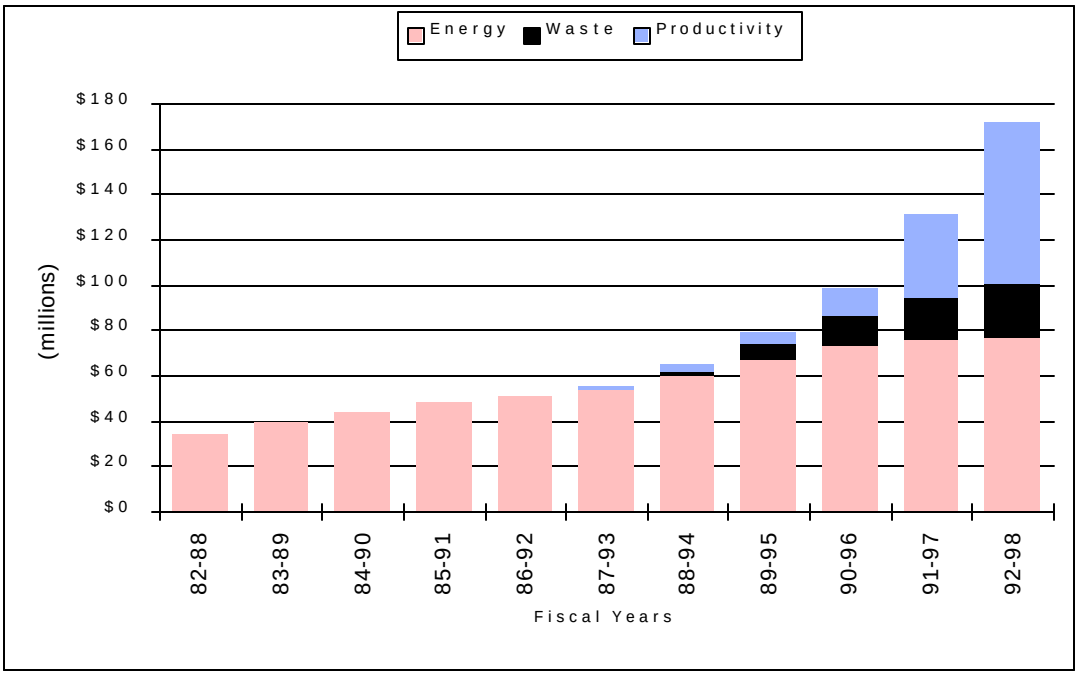

Figure 27. Seven Year Cumulative Cost Savings

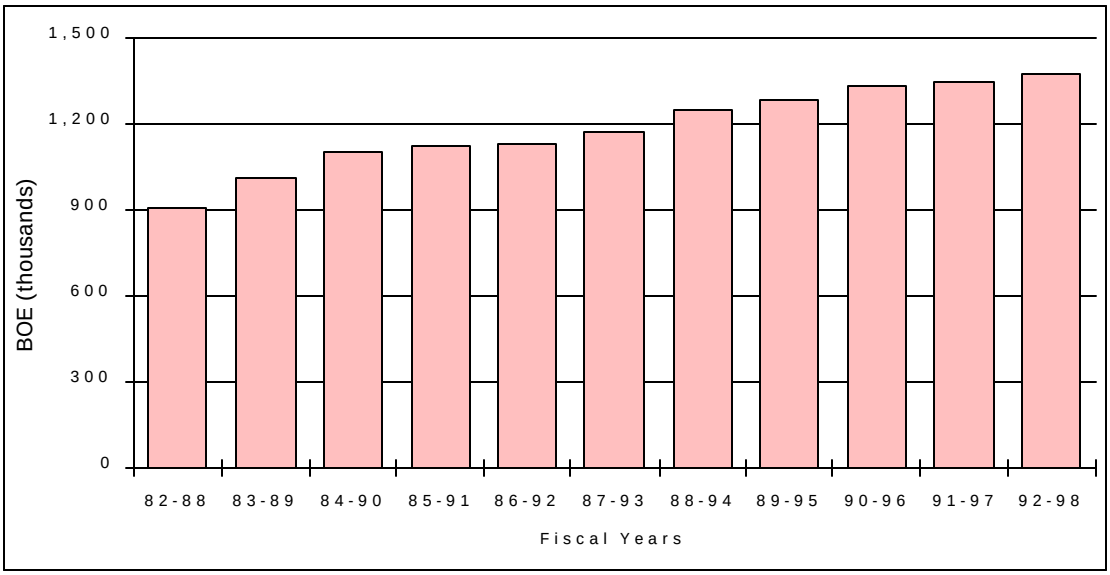

Figure 28. Seven Year Cumulative Barrels of Oil Avoided

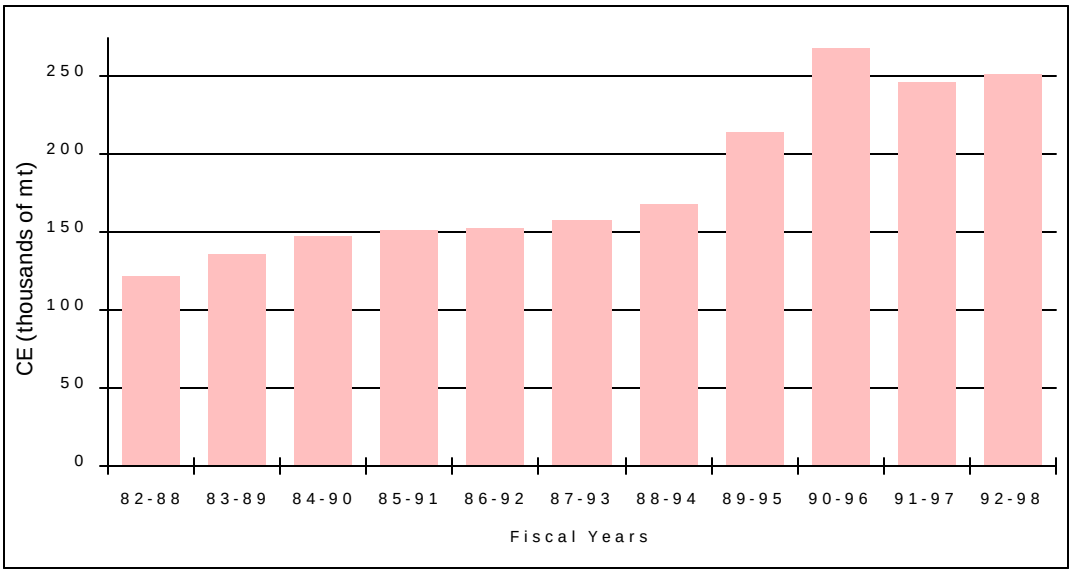

Figure 29. Seven Year Cumulative Carbon Avoided

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 FY98 and as a three year average. This can be seen in Table 18-19 and Figures 30-37.

Fiscal Year	Implemented Energy Conservation			Implemented Cost Savings ($)			
	(MMBtu)	(B.O.E.)	(C.E., mt)	Energy	Waste	Productivity	Total
82	1,399	240	32	7,269	N/A	N/A	7,269
83	1,666	286	39	9,118	N/A	N/A	9,118
84	2,649	455	61	18,480	N/A	N/A	18,480
85	3,059	525	71	19,038	N/A	N/A	19,038
86	3,032	520	70	22,375	N/A	N/A	22,375
87	2,552	438	59	18,107	N/A	N/A	18,107
88	2,696	463	62	15,804	N/A	N/A	15,804
89	2,902	498	67	22,000	N/A	N/A	22,000
90	2,382	409	55	18,252	N/A	N/A	18,252
91	1,740	299	40	18,594	N/A	N/A	18,594
92	2,228	382	52	19,296	N/A	N/A	19,296
93	2,037	350	47	16,548	28	2,813	19,388
94	1,685	289	39	16,262	2,258	1,916	20,435
95	1,488	255	43	15,598	5,368	3,106	24,073
96	1,435	246	50	15,721	8,347	8,100	32,168
97	1,464	251	46	14,469	7,890	36,656	59,014
98	1,353	232	43	12,564	7,834	51,172	71,569

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
82	814	140	19	5,039
83	894	153	21	7,985
84	1,017	175	24	10,071
85	882	151	20	10,005
86	1,109	190	26	11,881
87	970	167	22	9,890
88	810	139	19	9,058
89	1,075	185	25	10,605
90	1,088	187	25	16,522
91	1,086	186	25	17,344
92	676	116	16	9,495
93	612	105	14	10,315
94	646	111	15	9,811
95	897	154	26	9,095
96	559	96	19	8,550
97	490	84	15	7,449
98	466	80	15	7,098

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

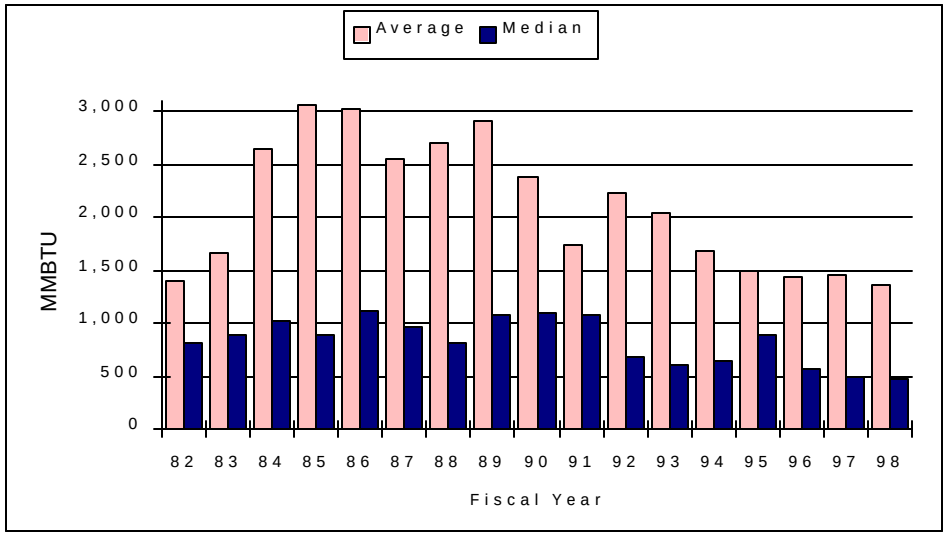

Figure 30. Average and Median Implemented Conservation by Fiscal Year

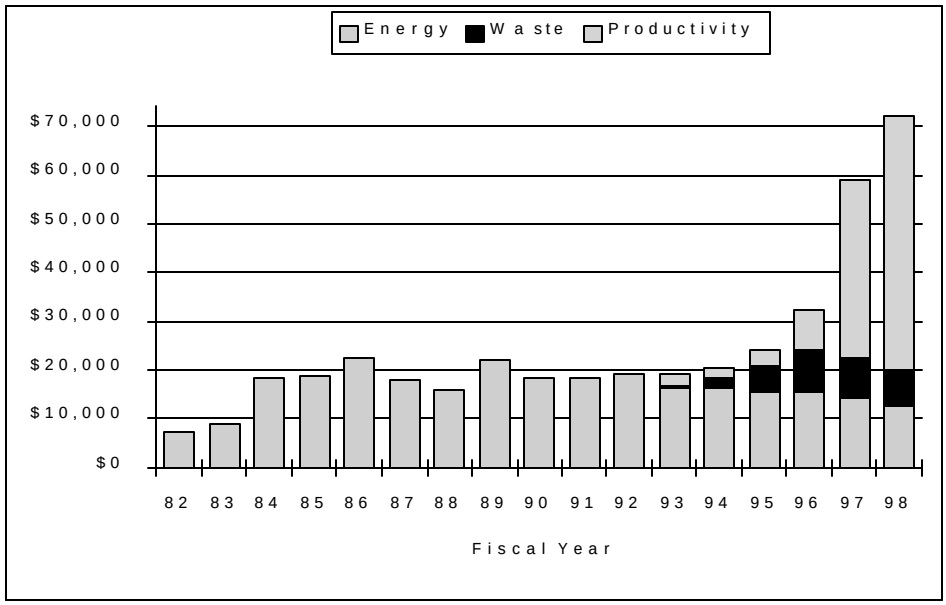

Figure 31. Average Implemented Cost Savings by Fiscal Year

Due to the low distribution of data, the values of median dollars approach zero, and therefore are not shown in Figure 31.

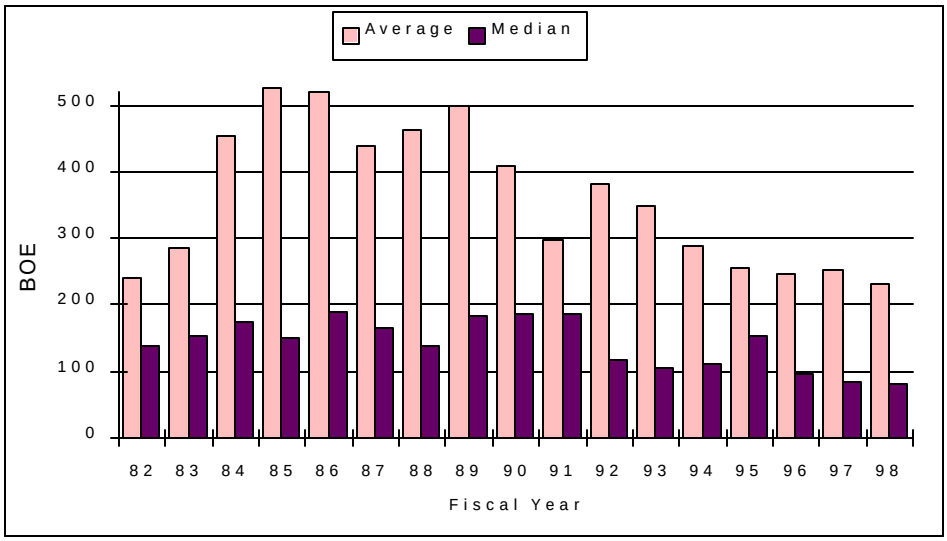

Figure 32. Average Implemented Barrels of Oil Avoided by Fiscal Year

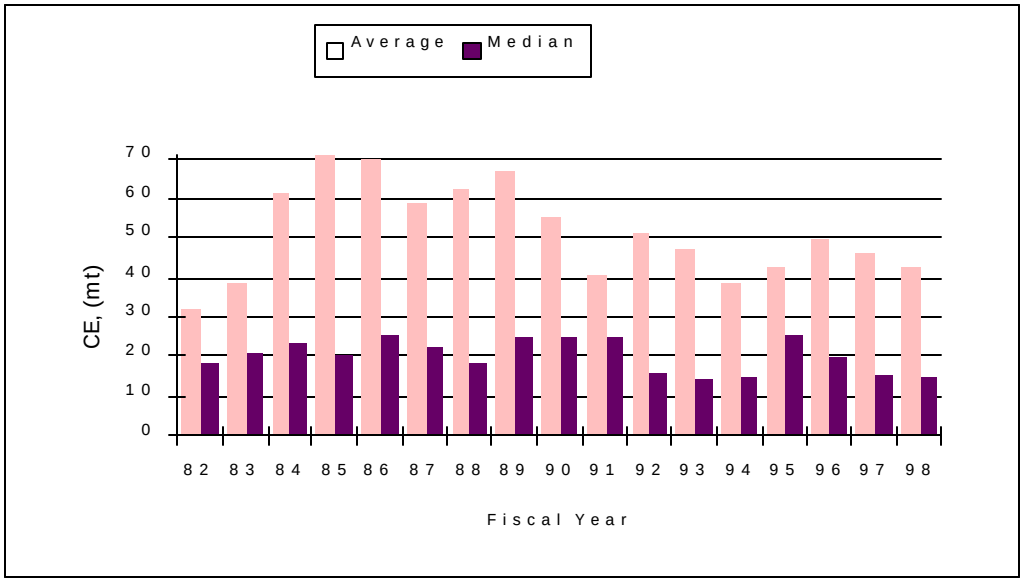

Figure 33. Average Implemented Carbon Avoided by Fiscal Year

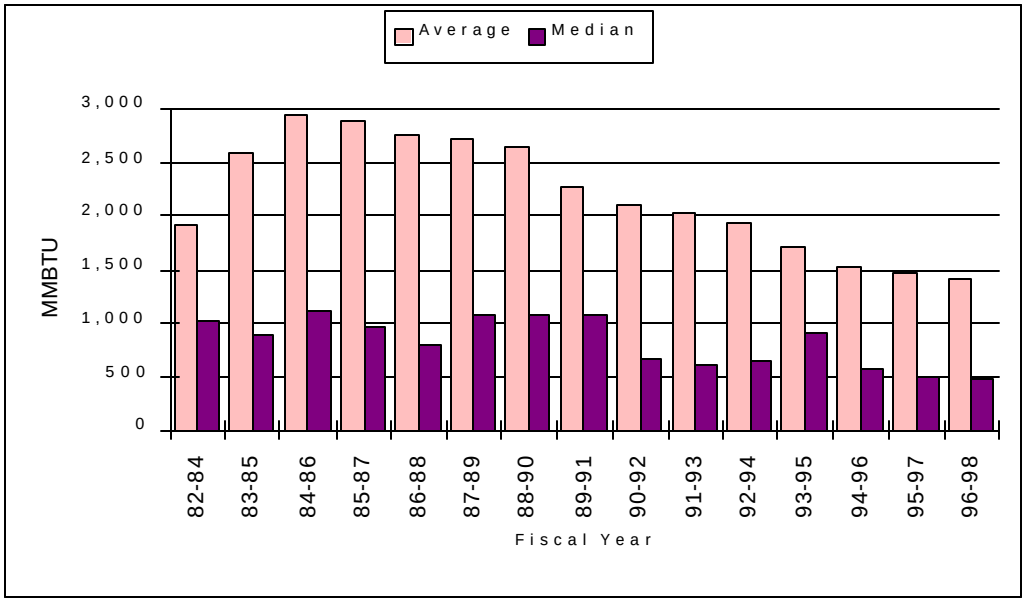

Figure 34. Average and Median Implemented Energy Conserved Per Assessment (3 Year Average)

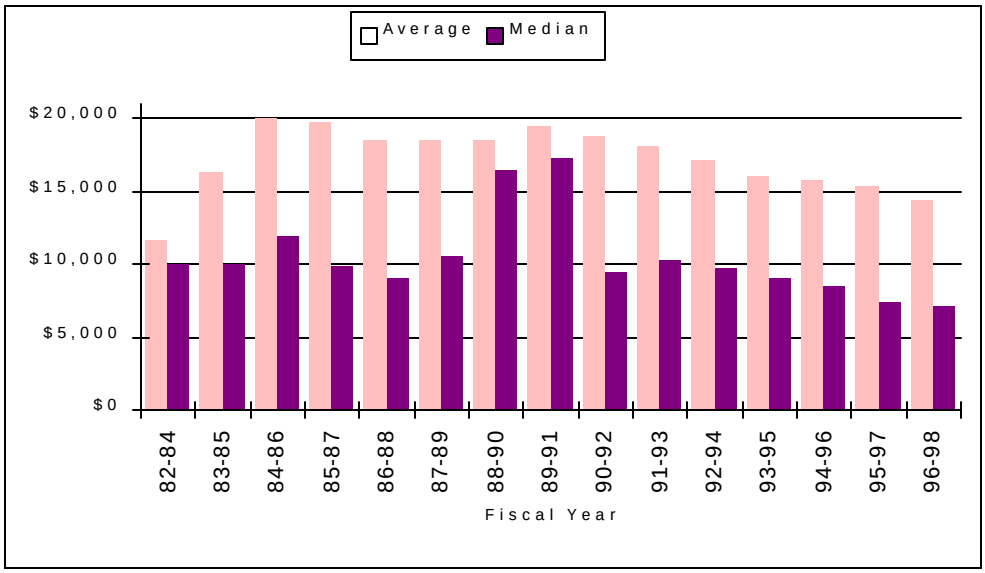

Figure 35. Average and Median Implemented Energy Cost Savings Per Assessment (3 Year Average)

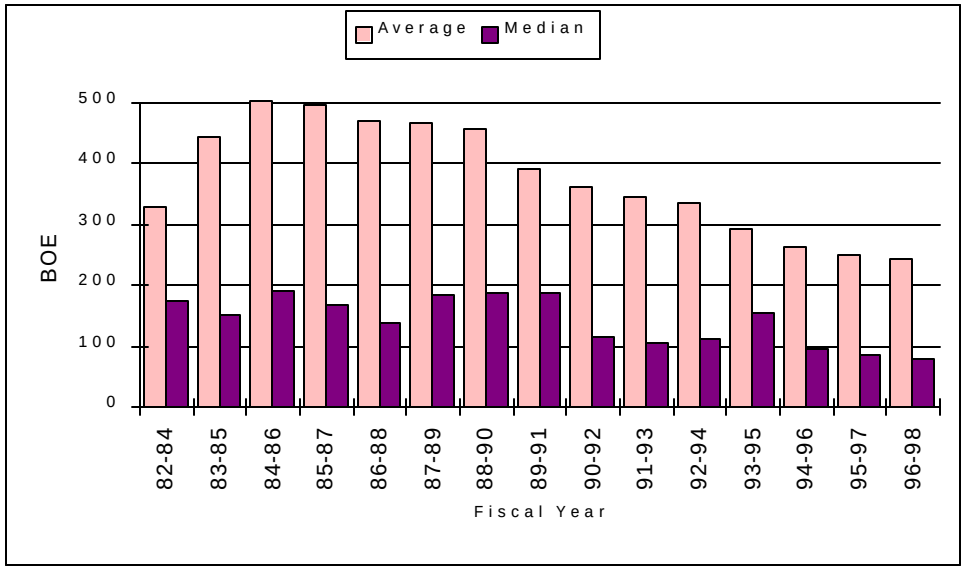

Figure 36. Average and Median Implemented Barrels of Oil Avoided Per Assessment (3 Year Average)

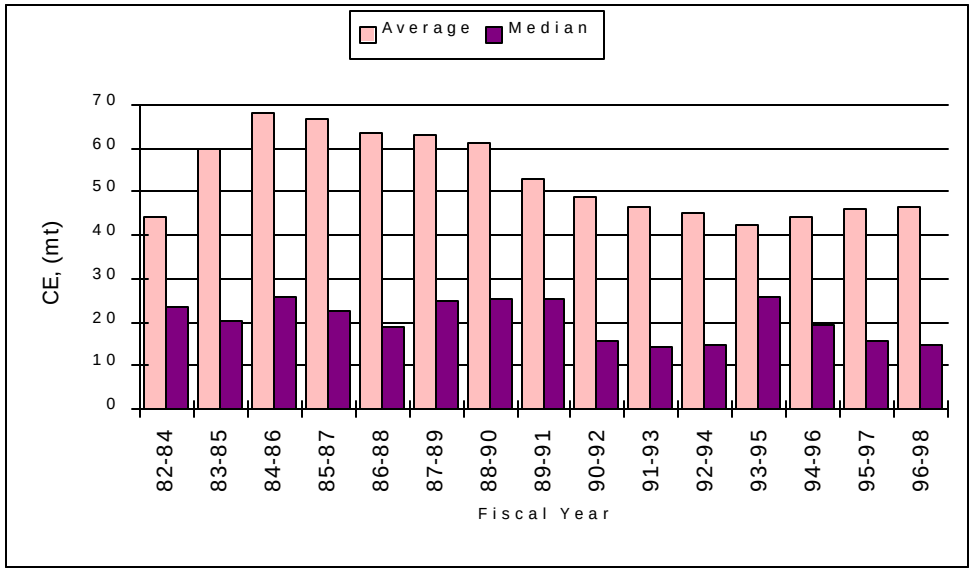

Figure 37. Average and Median Implemented Carbon Avoided Per Assessment (3 Year Average)

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 38 through 41 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 ($)			
	(MMBtu)	(B.O.E.)	(C.E., mt)	Energy	Waste	Productivity	Total
82	1,399	240	32	7,269	N/A	N/A	7,269
83	1,666	286	39	9,118	N/A	N/A	9,118
84	2,649	455	61	18,480	N/A	N/A	18,480
85	3,059	525	71	19,038	N/A	N/A	19,038
86	3,032	520	70	22,375	N/A	N/A	22,375
87	2,552	438	59	18,107	N/A	N/A	18,107
88	2,696	463	62	15,804	N/A	N/A	15,804
89	2,902	498	67	22,000	N/A	N/A	22,000
90	2,382	409	55	18,252	N/A	N/A	18,252
91	1,740	299	40	18,594	N/A	N/A	18,594
92	2,158	382	52	18,406	N/A	N/A	18,406
93	1,807	350	47	13,558	28	2,805	16,392
94	1,461	289	39	13,019	2,193	1,904	17,116
95	1,259	255	43	12,195	5,329	2,942	20,467
96	1,263	247	50	12,962	8,071	7,266	28,299
97	1,309	251	46	12,165	7,660	35,035	54,859
98	1,233	232	43	10,742	7,586	48,683	67,011

Table 20. Average First Year Implemented Savings by Fiscal Year

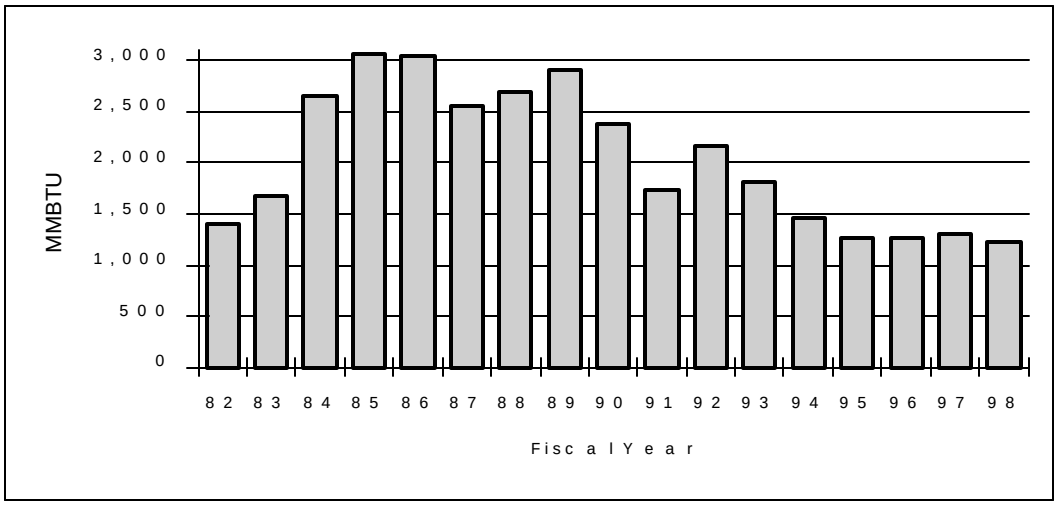

Figure 38. Average First Year Implemented Energy Conserved by Fiscal Year

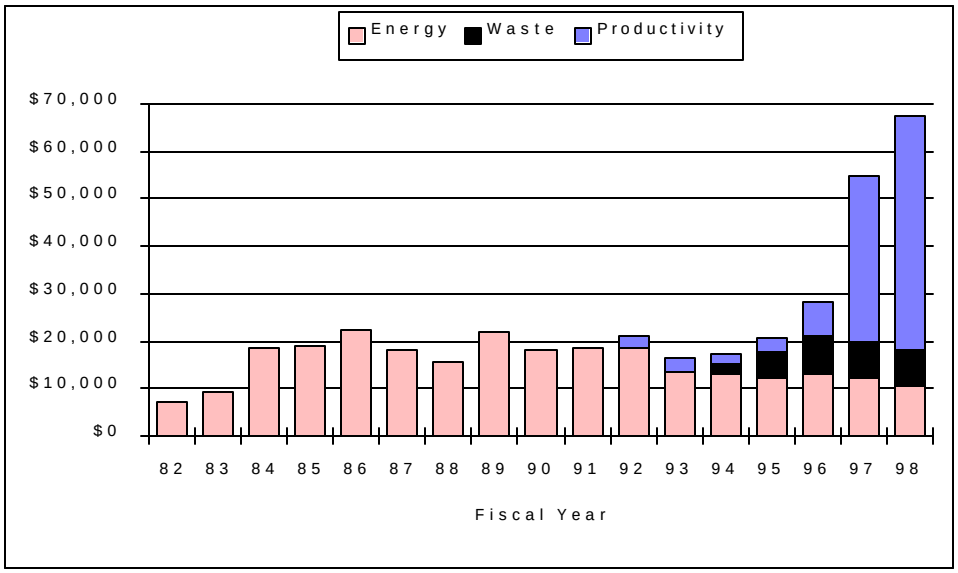

Figure 39. Average First Year Implemented Cost Savings by Fiscal Year

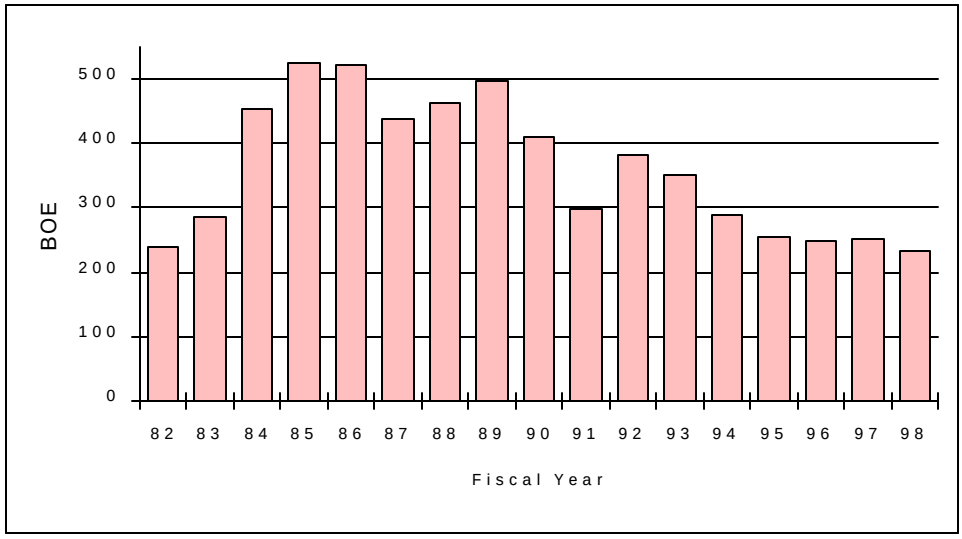

Figure 40. Average First Year Implemented Barrels of Oil Avoided by Fiscal Year

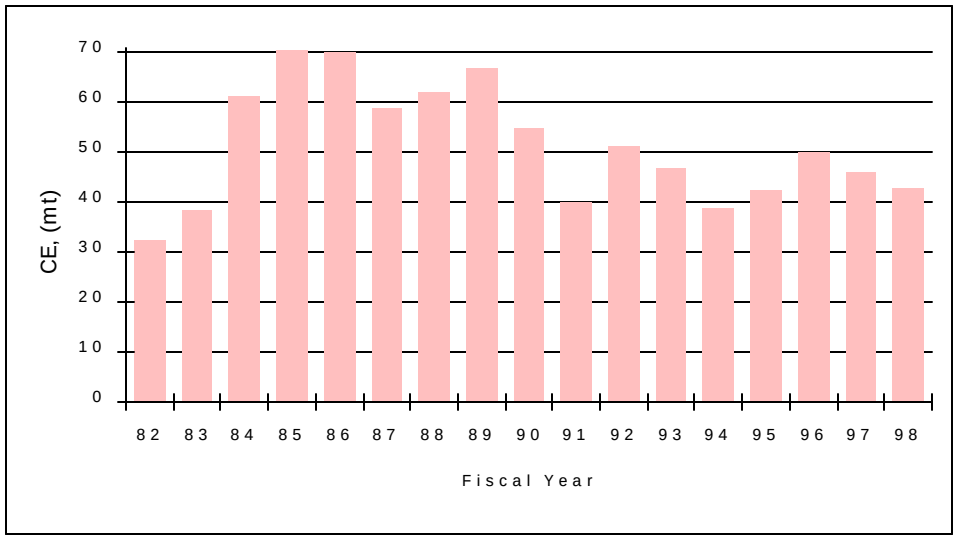

Figure 41. Average First Year Implemented Carbon Avoided by Fiscal Year

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 42-45. The greatest amount of energy conserved and in cost savings was in SIC 30 (Rubber and Plastic products).

SIC Code	Industry Description	Implemented Energy Conservation			Implemented Cost Savings ($)			
		(MMBtu)	(B.O.E.)	(C.E., mt)	Energy	Waste	Productivity	Total
20	Foods	97,127	16,674	3,074	1,087,678	430,451	3,288,743	4,806,872
21	Tobacco Prod.	0	0	0	0	0	0	0
22	Textile Mills	62,801	10,781	1,988	385,450	78,817	1,197,664	1,661,931
23	Apparel	28,770	4,939	911	126,386	82,097	2,182,395	2,390,878
24	Wood Prod.	27,172	4,665	860	369,169	202,179	1,980,069	2,551,417
25	Furniture	9,444	1,621	299	158,619	30,883	1,733,767	1,923,269
26	Paper Prod.	37,237	6,393	1,179	275,348	209,299	1,053,518	1,538,165
27	Printing	26,032	4,469	824	254,345	133,801	601,600	989,746
28	Chemical Prod.	109,033	18,718	3,451	549,698	196,672	1,998,260	2,744,630
29	Petroleum	6,568	1,128	208	63,407	43,967	523,645	631,019
30	Rubber & Plast.	115,456	19,821	3,655	1,176,783	431,566	5,643,055	7,251,404
31	Leather Prod.	3,294	565	104	70,392	68,066	219,634	358,092
32	Stone & Glass	84,378	14,485	2,671	549,837	231,467	1,662,208	2,443,512
33	Primary Metal	89,468	15,359	2,832	659,756	558,713	3,018,222	4,236,691
34	Fab. Metal	71,038	12,195	2,249	910,002	478,623	3,081,407	4,470,032
35	Ind. Machinery	33,129	5,687	1,049	667,750	1,003,763	1,990,700	3,662,213
36	Electronics	75,967	13,042	2,405	608,985	116,800	2,031,362	2,757,147
37	Trans. Equip.	38,262	6,569	1,211	470,094	1,022,442	2,594,303	4,086,839
38	Instruments	6,083	1,044	193	127,603	40,014	150,111	317,728
39	Misc. Manuf.	6,916	1,187	219	106,187	14,182	153,412	273,781
Totals		**928,175**	**159,343**	**29,380**	**8,617,489**	**5,373,802**	**35,104,075**	**49,095,366**

Table 21. Implemented Energy and Cost Savings by Industry Type

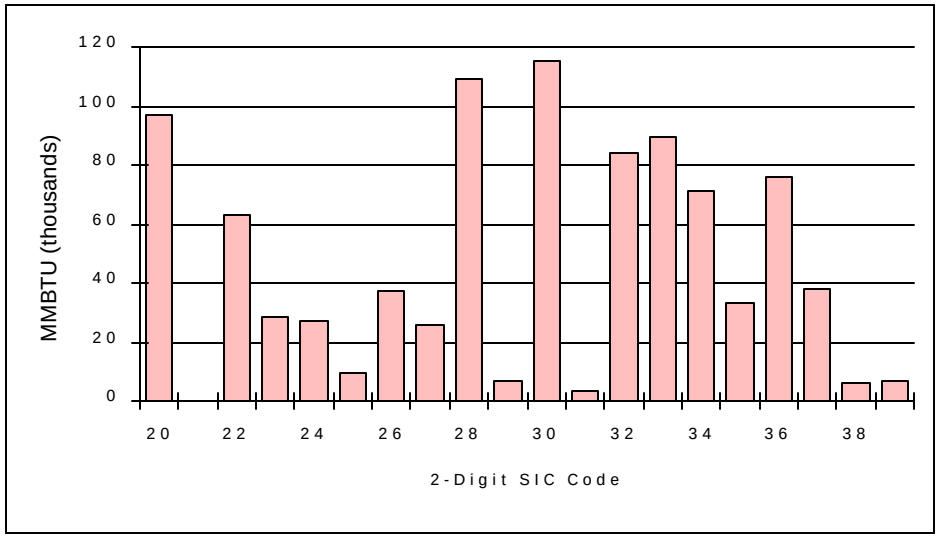

Figure 42. Implemented Energy Conserved by Industry Type

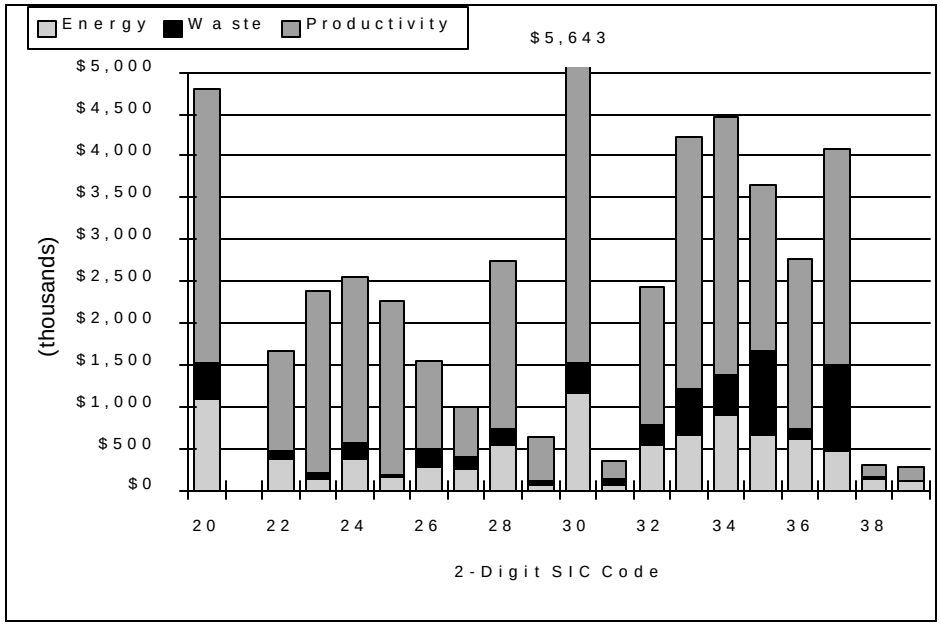

Figure 43. Implemented Cost Savings by Industry Type

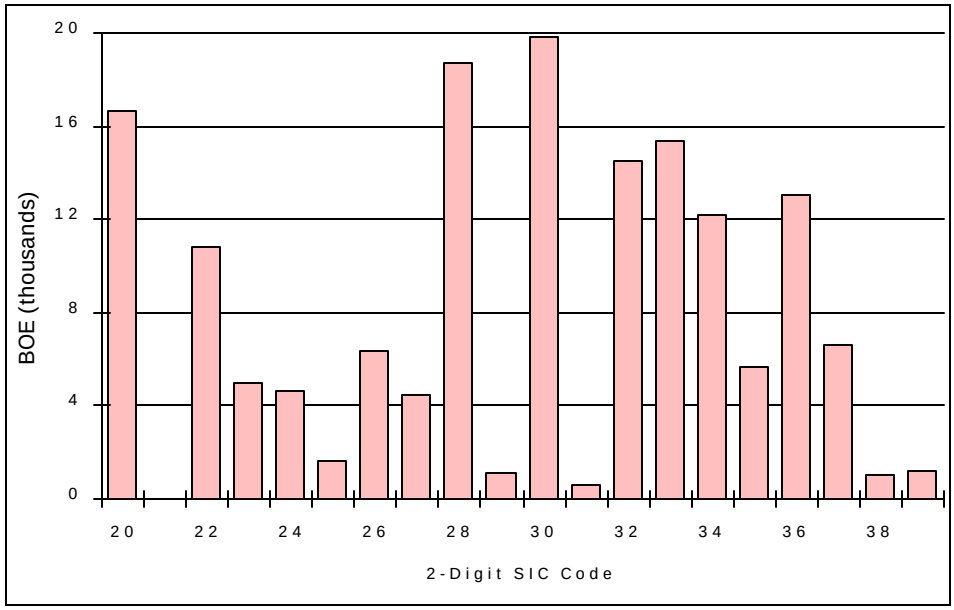

Figure 44. Implemented Barrels of Oil Avoided by Industry Type

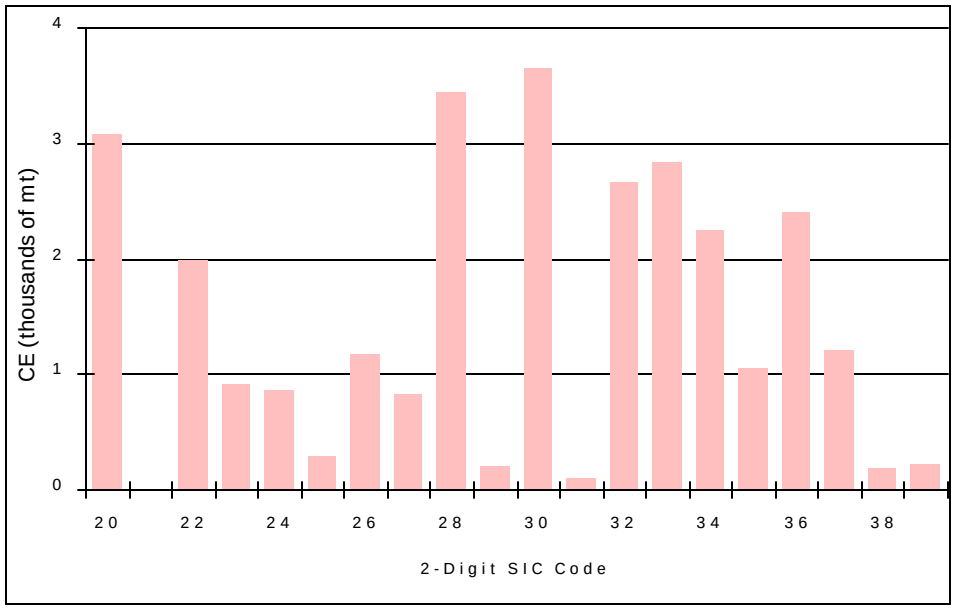

Figure 45. Implemented Carbon Avoided by Industry Type

Table 22 and Figures 46-49 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 $)			
		(MMBtu)	(B.O.E.)	(C.E., mt)	Energy	Waste	Productivity	Total
20	Foods	1,494	257	47	16,734	6,622	50,596	73,952
21	Tobacco Products	0	0	0	0	0	0	0
22	Textile Mills	2,991	513	95	18,355	3,753	57,032	79,140
23	Apparel	2,213	380	70	9,722	6,315	167,877	183,914
24	Wood Prod.	877	150	28	11,909	6,522	63,873	82,304
25	Furniture	525	90	17	8,812	1,716	96,320	106,848
26	Paper Prod.	1,489	256	47	11,014	8,372	42,141	61,527
27	Printing	685	118	22	6,693	3,521	15,832	26,046
28	Chemical Prod.	5,192	891	164	26,176	9,365	95,155	130,697
29	Petroleum	938	161	30	9,058	6,281	74,806	90,146
30	Rubber & Plast.	1,241	213	39	12,667	4,640	60,678	77,985
31	Leather Prod.	366	63	12	7,821	7,563	24,404	39,788
32	Stone & Glass	1,834	315	58	11,953	5,032	36,135	53,120
33	Primary Metal	2,237	384	71	16,494	13,968	75,456	105,917
34	Fab. Metal	789	136	25	10,111	5,318	34,238	49,667
35	Ind. Machinery	460	79	15	9,274	13,941	27,649	50,864
36	Electronics	2,110	362	67	16,916	3,244	56,427	76,587
37	Trans. Equip.	1,007	173	32	12,371	26,906	68,271	107,548
38	Instruments	553	95	18	11,600	3,638	13,646	28,884
39	Misc. Manuf.	576	99	18	8,849	1,182	12,784	22,815
Average		**1,353**	**232**	**43**	**12,562**	**7,722**	**51,654**	**71,939**

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

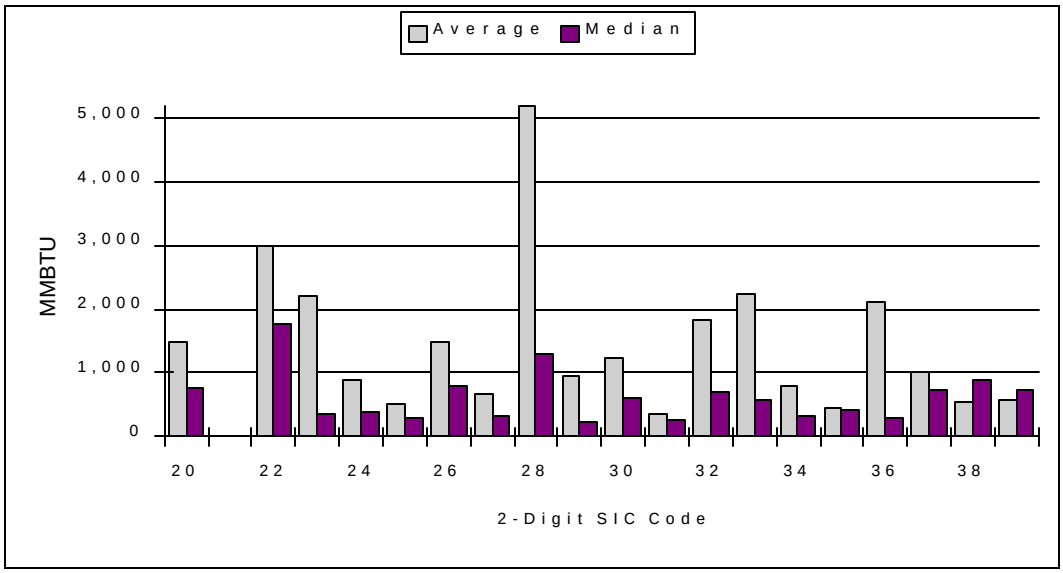

Figure 46. Average and Median Implemented Energy Savings by Industry Type

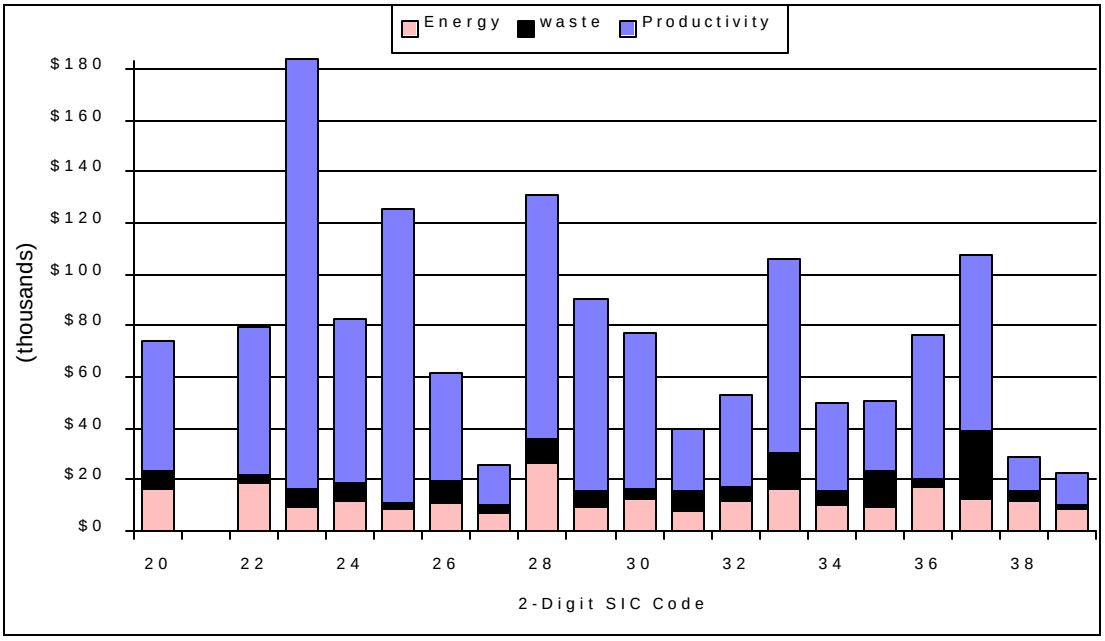

Figure 47. Average Implemented Cost Savings by Industry Type

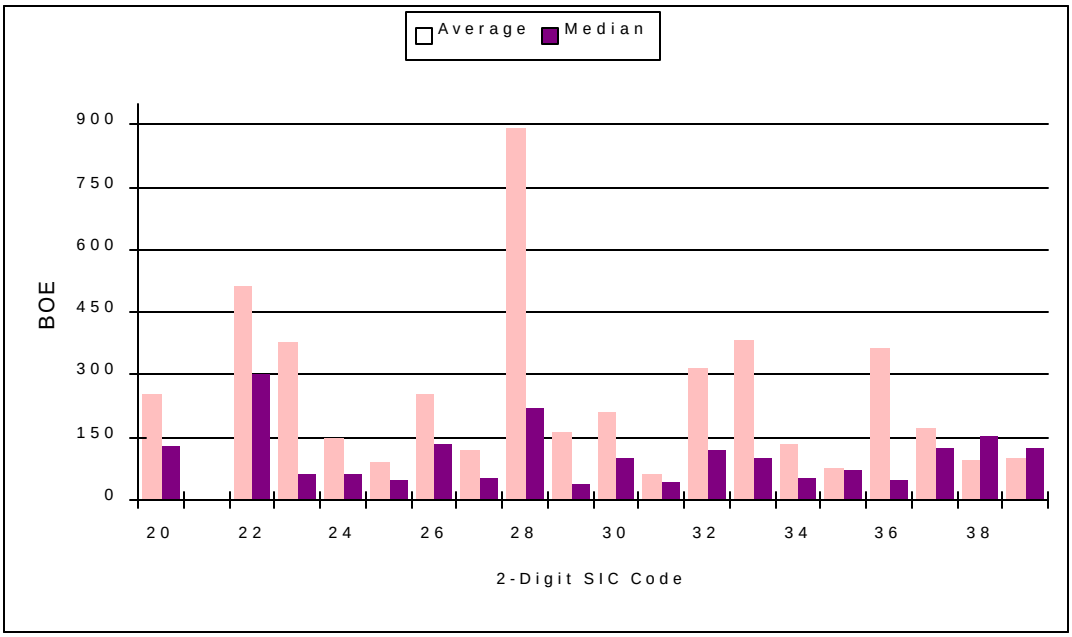

Figure 48. Average and Median Implemented Barrels of Oil Avoided by Industry Type

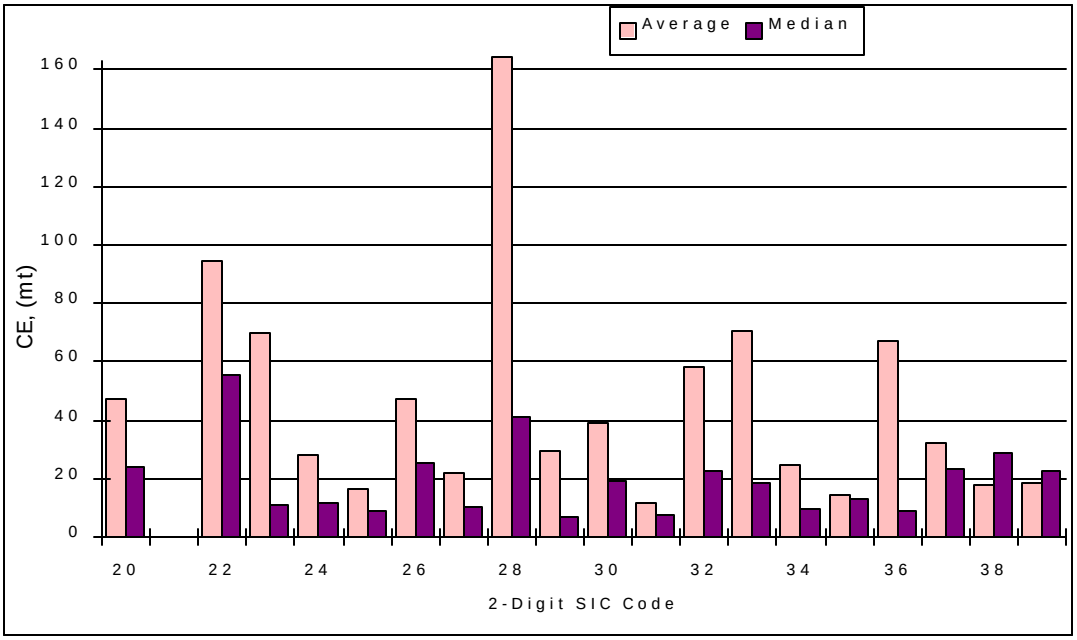

Figure 49. Average and Median Implemented Carbon Avoided by Industry Type

iii. Implemented Savings by Resource Stream

Table 23, and Figures 50-51 reflect implemented energy and cost savings broken down by energy stream.

Energy Stream	Implemented Energy Conservation (MMBTU)	Implemented Energy Cost Savings ($)
Electricity		
Demand	199,610 KW-months/yr	1,875,223
Fees		247,732
Consumption	389,122	4,504,084
Natural Gas	477,470	1,722,451
L. P. G.	8,817	57,584
Fuel Oil #1	0	0
Fuel Oil #2	12,879	40,000
Fuel Oil #4	222	789
Fuel Oil #6	36,115	113,007
Coal	1,176	2,250
Wood	-4,372	-1,593
Other Gas	344	2,278
Other Energy	6,402	54,962
Energy Totals	**928,175**	**8,618,767**
Non-Energy	n/a	40,477,877
Program Totals	**928,175**	**49,096,644**

Table 23. Implemented Energy and Cost Savings by Resource Stream

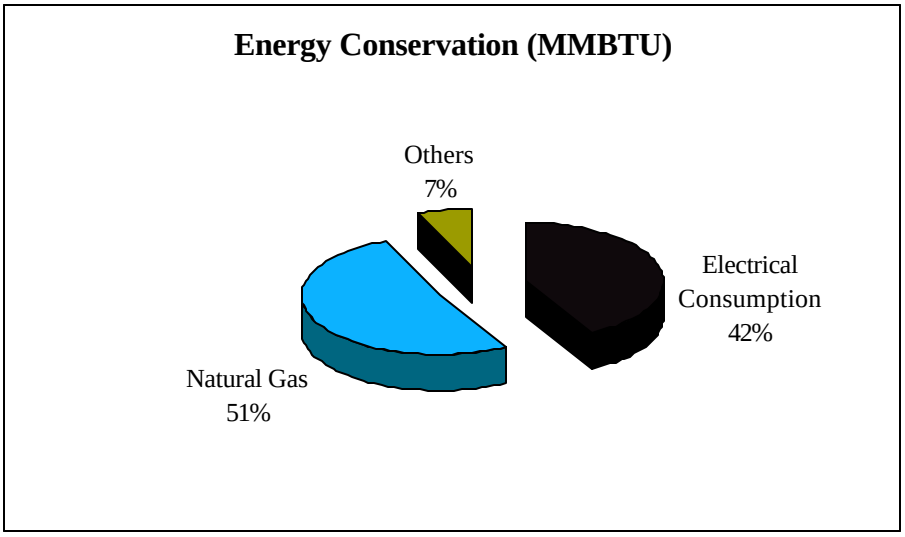

Figure 50. Composition of Implemented Energy Conserved by Energy Stream

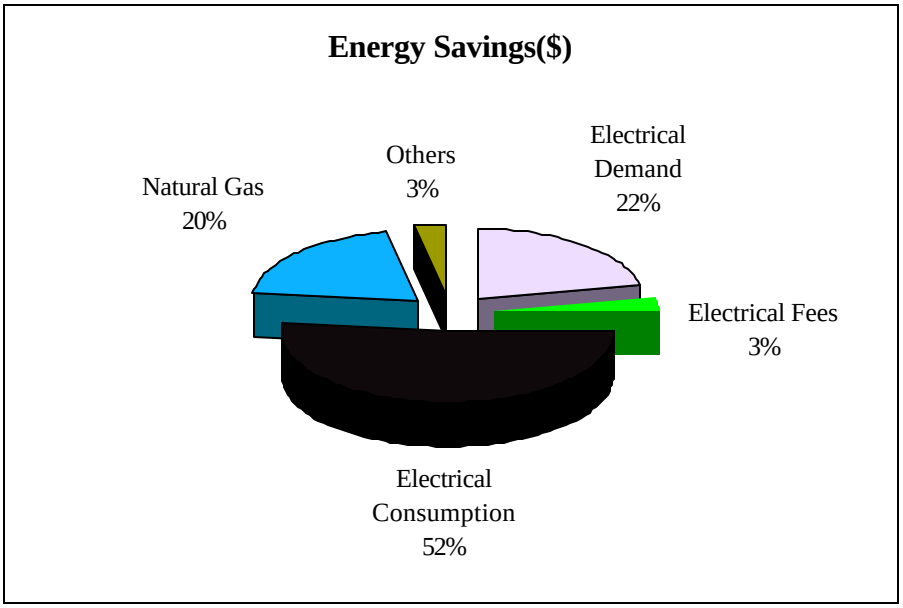

Figure 51. Composition of Implemented Energy Cost Savings by Energy Stream

The breakdown of non-energy savings by resource stream type is shown in Table 24, and Figure 52. The total implemented cost savings by resource stream are shown in Figure 53.

Stream Type	Total Implemented Non-Energy Cost Savings ($)
Primary Product	11,615,774
Byproduct Production	1,052,198
Resource Costs	
Personnel Changes	10,141,382
Administrative Costs	8,960,150
Primary Raw Material	1,669,185
Ancillary Material Cost	1,139,020
Water Consumption	362,854
One-time Revenue or Avoided Cost	163,512
Waste Reduction	
Water Disposal	1,033,733
Other Liquid (non-haz)	938,349
Other Liquid (haz)	301,018
Solid Waste (non-haz)	3,013,242
Solid Waste (haz)	86,950
Gaseous Waste (haz)	510
Non-Energy Total	**40,477,877**

Table 24. Total Implemented Non-Energy Cost Savings

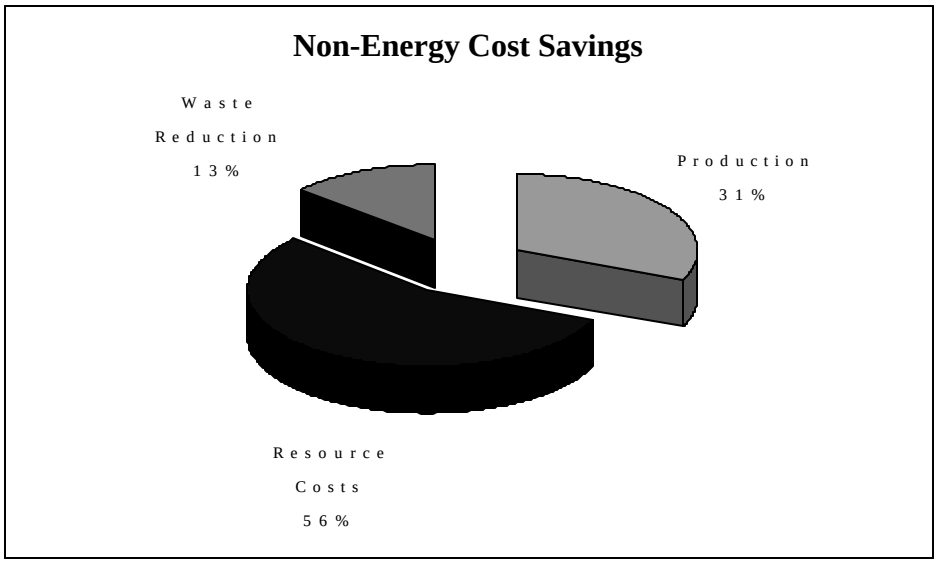

Figure 52. Composition of Non-Energy Implemented Savings

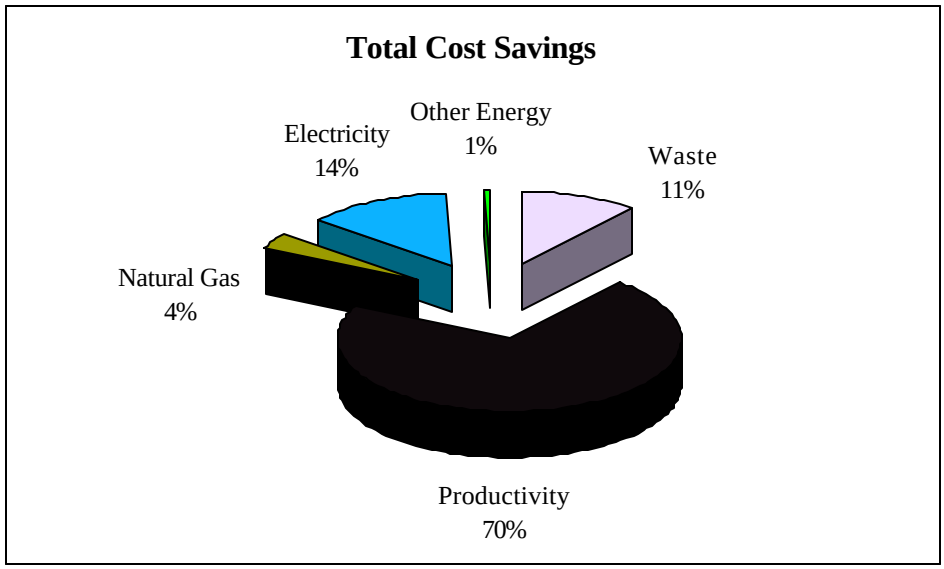

Figure 53. Composition of Total Implemented Cost Savings

iv. Implemented Savings by Recommendation Type

Finally, the number of implemented recommendations by type for Fiscal Year 1998 is shown in Table 25 and Figure 54.

2-Digit ARC Code	Category Description	No. of Implemented Recommendations
ENERGY MANAGEMENT		
2.1	Combustion Systems	96
2.2	Thermal Systems	206
2.3	Electrical Power	77
2.4	Motor Systems	760
2.5	Industrial Design	7
2.6	Operations	83
2.7	Buildings and Grounds	563
2.8	Ancillary Costs	97
2.9	Alternate Energy Use	0
WASTE MINIMIZATION/POLLUTION PREVENTION		
3.1	Operations	73
3.2	Equipment	24
3.3	Post Generation Treatment / Minimization	14
3.4	Water Use	83
3.5	Recycling	205
3.6	Waste Disposal	64
3.7	Maintenance	25
3.8	Raw Materials	16
DIRECT PRODUCTIVITY ENHANCEMENTS		
4.1	Manufacturing Enhancements	68
4.2	Purchasing	22
4.3	Inventory	22
4.4	Labor Optimization	95
4.5	Space Utilization	58
4.6	Reduction of Downtime	70
4.7	Management Practices	12
4.8	Other Administrative Savings	35
	Total	**2775**

Table 25. Number of Implemented Recommendations by Recommendation Type

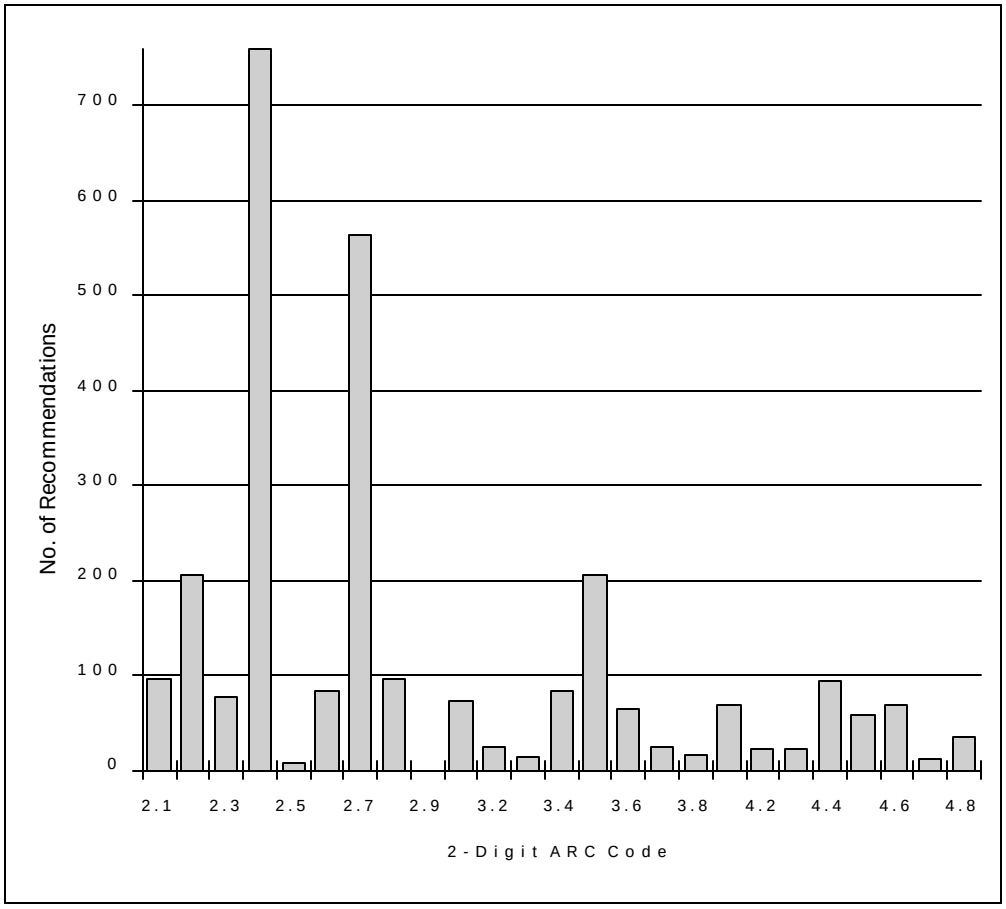

Figure 54. Number of Implemented Recommendations by Recommendation Type

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				

III. Standard Financial Calculations
Standard Financial Calculations, FY98

Standard financial calculations of the IAC program results have been made by ITEM staff on the basis of data obtained from the IAC database maintained by Rutgers University. These calculations show financial returns to the federal government and to manufacturers from their investments in generating and implementing energy-conserving and cost-saving recommendations.

Results are summarized in Table 26 for a variety of parameters: growth rate of implementation costs, growth rate of cost savings, and borrowing rate.

These results were calculated according to standard financial methods, which specify IRR as the rate of return at which the sum of discounted future cash flows (until all loans have been amortized) equals the initial investment, or the rate at which net present value is zero. Mathematically, IRR is expressed by this equation:

$$0 = CF_0 + \{CF_1/(1 + i)\} + \{CF_2/(1 + i)^2\} + \ldots + \{CF_n/(1 + i)^n\}$$

in which CF = cash flow

$CF_{subscript}$ = the year in which the cash flow occurs

i = IRR

A similar net present value method was used to calculate leverage ratios or profitability indices. For the same series of annual cash flows (until all loans have been amortized) based upon actual implementation, a rate (for example, 10%) is assumed in order to discount these future cash flows to the initial period of the investment. The leverage ratio for manufacturers is the ratio of the sum of discounted future cash flows to the sum of all capital investments made to implement the assessment recommendations. For the federal government, the leverage ratio is the ratio of the sum of discounted future cash flows to the program support provided by the federal government for FY98.

These leverage ratios (or profitability indices) show that, at a 10% discount rate, the federal government will realize $4.04 to $5.65 for every federal dollar spent on the program in FY98. Similarly, manufacturers will, as a group, receive $3.73 to $4.92 for every dollar invested in implementing cost-saving measures.

Standard Financial Calculations of IAC Results

IMPCOST GROWTH	ENSAV GROWTH	BORR RATE	FEDERAL GOVERNMENT			MANUFACTURERS		
%	%	%	IRR	LR_{10}	LR_{15}	IRR	LR_{10}	LR_{15}
3	3	3	82.9	4.91	3.90	770	4.37	3.6
3	3	6	80.7	4.82	3.83	675	4.31	3.57
3	3	9	78.6	4.74	3.75	597	4.25	3.52
3	3	6	80.7	4.82	3.83	675	4.31	3.57
6	3	6	80.3	4.80	3.81	670	4.29	3.55
6	0	6	74.0	4.04	3.20	640	3.73	3.10
6	3	6	80.3	4.80	3.81	670	4.29	3.55
6	6	6	86.6	5.65	4.49	701	4.92	4.06
12	6	6	85.8	5.60	4.45	691	4.88	4.03

Table 26. Standard Financial Calculations of IAC Results

GLOSSARY

IMPCOST GROWTH = annual growth rate of the cost of implementing IACs' recommendations.

ENSAV GROWTH = annual growth rate of energy cost savings from implementation of IACs' recommendations.

BORR RATE = annual borrowing rate for debt service on funds borrowed to implement IACs' recommendations.

IRR = internal rate of return

LR_{10}, LR_{15} = leverage ratio for five-year cash flows discounted at 10 or 15% to the initial time period and compared to the program investment by the government and the capital investment by the manufacturers.

IV. Regional Reports

A. Eastern Region

i Major Activities and Highlights of the Eastern Region

In Fiscal Year 1998, Field Management for the Eastern IAC region was the responsibility of the Office of Industrial Productivity and Energy Assessment (OIPEA) at Rutgers, The State University of New Jersey. OIPEA is an office of the department of Mechanical and Aerospace Engineering at Rutgers. In addition to the field management responsibilities, in FY93, Rutgers was tasked with the responsibility of maintaining the IAC database for the entire program.

In FY98, the Eastern Region was comprised of fifteen experienced Centers performing 25 assessments, with the exception of the University of Louisville which performed 22, and three case studies, bringing the total number of assessments performed in the east to 372. The addresses and phone numbers of all Centers is given in the appendix. The schools and directors participating in the program in FY98 are shown below.

(GT)	Georgia Institute of Technology	Mr. William A. Meffert
(HO)	Hofstra University	Dr. Richard Jensen
(MA)	University of Massachusetts	Dr. Lawrence A. Ambs
(ME)	University of Maine	Mr. Scott C. Dunning
(MS)	Mississippi State University	Dr. B. K. Hodge
(NC)	North Carolina State University	Dr. James Leach
(ND)	University of Notre Dame	Dr. John W. Lucey
(OD)	Old Dominion University	Dr. Sidney Roberts
(TN)	University of Tennessee	Dr. Richard J. Jendrucko
(UD)	University of Dayton	Dr. Kelly Kisock
(UF)	University of Florida	Dr. Barney L. Capehart
(UL)	University of Louisville	Dr. Geoffery Cobourn
(UM)	University of Michigan	Dr. Arvind Atreya
(WI)	University of Wisconsin	Dr. Umesh Saxena
(WV)	University of West Virginia	Dr. Ralph Plummer

The history of the Centers, the directors' experience, and the student participation is shown in Table 27. The eastern region boasts an experienced and stable group of directors, with a total of over 100 years of experience in the program and an average of over 7 years. In FY98, Dr. Kelly Kissock took over the leadership of the University of Dayton from Dr. Henry Chuang, who had personally completed over 500 assessments. Also in FY98, Dr. Geoffery Cobourn assumed the directorship of the University of Louisville.

Centers	Date Entered Program	FY98 Assessments Completed	Director's Years in Program	Student Participation	
				Graduate	Under Grad.
GT	FY82	25	8	1	4
HO	FY92	25	3	2	8
MA	FY84	25	15	10	0
ME	FY93	25	6	0	10
MS	FY94	25	5	10	1
NC	FY93	25	5	3	2
ND	FY91	25	8	1	16
OD	FY94	25	5	1	13
TN	FY76	25	23	1	8
UD	FY76	25	1	4	2
UF	FY91	25	8	6	22
UL	FY94	22	1	0	27
UM	FY94	25	5	6	12
WI	FY87	25	12	1	4
WV	FY93	25	6	13	1

Table 27. History of Eastern Centers

Other activities that occurred during the fiscal year included:

- The OIPEA staff conducted a training session at Rutgers University to representatives of the Ministry of Energy from Ghana . This was part of an on-going program to help develop an IAC style Center in Ghana.

- Dr. Muller was a speaker at the International Network for Energy Demand and Efficiency in Utrecht, the Netherlands. The focus of the meeting was to discuss technical issues surrounding voluntary agreement to global warming initiatives. Dr. Muller and Mr. Barnish also visited he motor system workshop at the University of Nottingham, UK.

- Mr. Kasten was an invited speaker at the Pollution Prevention Roundtable held in Cincinnati, Oh in April. At this meeting he introduced the IAC concept of Pollution Prevention by Energy Efficiency (P2/E2).

- In his continuing effort to introduce anarchy and undermine the social fabric of society, Timothy Barnish was sneaking around seeking other employment that would allow him to build his empire and laugh in the faces of the poor suffering souls left behind.

- Awards were granted to the centers at the University of Massachusetts to study the potential of retrofitting die casting equipment with Adjustable Speed Drives, and The University of Tennessee to create a tool for assessing the feasibility of various methods of waste water treatment.

ii. IAC Alumni Newsletter

Rutgers produced the first *IAC Alumni Newsletter*. Features included the introduction of the term "Industrial Assessment Center, Dr. Henry Chuang's 500th assessment, OIT Launches Technology Access Partnerships, and introduces the strategy of "Industries of the Future". This letter is included in the appendix.

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B. Western Region

i. Major Activities and Highlights

During FY 98, the Industrial Technology and Energy Management division (ITEM) of the University City Science Center provided field management for the western region where 14 centers served a total of 350 manufacturers. The western region IACs are listed below, along with the IAC director and student participation during FY 98. The addresses and phone numbers of the western region directors are given in the Appendix.

					Student Participation	
IAC	FY 98 Director	Date Entered Program	FY 98 Plants	Years Director in Program	Graduate	Under-graduate
Arizona State University	Patrick E. Phelan	FY 90	25	2	2	5
Univ. of Arkansas-Little Rock	Mamdouh Bakr	FY 93	25	3	0	14
Bradley University	D. Paul Mehta	FY 94	25	5	8	8
Colorado State University	Harry W. Edwards	FY 84	25	2	5	16
Iowa State University	Richard Rusk	FY 91	25	2	2	20
University of Kansas	Jerry D. Swearingen	FY 81	25	3	1	8
University of Missouri-Rolla	Burns Hegler	FY 90	25	9	1	14
University of Nevada-Reno	Yunus A. Cengel	FY 94	25	2	2	12
Oklahoma State University	Wayne C. Turner	FY 81	25	10	8	23
Oregon State University	George M. Wheeler	FY 87	25	12	4	17
San Diego State University	Asfaw Beyene	FY 91	25	2	5	12
San Francisco State University	Ahmad Ganji	FY 93	25	6	3	13
South Dakota State University	Kurt Bassett	FY 94	25	5	3	4
Texas A&M University	Warren M. Heffington	FY 87	25	12	7	15

The western region IACs performed a total of 40 extended assessment days during the program period. The additional time at the plant sites permitted the IACs to obtain additional data to support specific assessment recommendations.

In addition to carrying out the responsibilities associated with the performance of those assessments, the following activities were undertaken.

Special project proposals (16 from western region IACs and 6 from eastern region IACs) were reviewed. Awards were made to Arizona State University and Bradley University in the west. Arizona State began work on a project to conduct field studies of advanced water treatment technologies. Bradley's special project involved implementation of heat recovery devices.

ITEM prepared brief case histories of the results of IAC assessments for DOE. A total of 11 were completed during FY 98.

Plans were made to add Prairie View A&M University to the IAC program during FY 99. Western region IACs recommended 2,942 measures with potential cost savings of \$69.5 x 10^6/yr during FY98. Manufacturers implemented 1,418 measures (51% of those recommended with known results) resulting in cost savings of \$24.5 x 10^6/yr.

Energy conservation measures accounted for 22% of the total implemented cost savings, while the waste minimization and productivity enhancement measures accounted for remaining cost savings at 14% and 64%, respectively. The best implementation rate of 54% was achieved from energy conservation, followed by productivity enhancement and waste minimization at 49% and 44%, respectively, based on recommended measures with known results.

When comparing the average cost savings per AR among the different categories of measures, it is expected that the productivity enhancement measures should be the largest followed by waste minimization and energy conservation. In FY 98 the average cost savings per AR for an implemented energy conservation AR was about \$5,600/yr, whereas for waste minimization it was about \$12,600/yr, and for productivity enhancement it was about \$77,400/yr.

The average implemented cost savings of $69,900/yr/plant in FY98 was 23% greater than last year with the same percentage of ARs implemented as shown below:

	FY98	FY97	FY96	FY95
Implemented Cost Savings				
$/yr/plant	69,900	56,700	35,600	23,900
Implementation				
Rate, % ARs Implemented	51	51	58	57

Although this year resulted in the largest amount of implemented cost savings per plant, there was still about $42 x 10^6/yr or an average of about $121,000/yr/plant of non-implemented cost savings potential identified by the IACs in FY98. About 26% of the non-implemented savings was in energy conservation category, 28% in waste minimization, and 46% in productivity enhancement.

Reasons for non-implementation were grouped into 4 major categories: plant-internal, financial, IAC-fault, and other. The plant-internal category includes reasons such as process, facility, or personnel changes which served as obstacles to implementation. Financial includes unsuitable ROI, too much up-front cost, or inadequate cash flow. The IAC-fault category reflects instances where the plant had a problem with the credibility, practicality, or nature of the IACs' recommendations. The "Other" category is used for non-specific reasons. Non-implemented cost savings measure percentages for the major categories are summarized below:

Category of Reason	**% of Non-Implemented Cost Saving Measures**
Plant-internal	43%
Financial	16%
IAC-fault	30%
Other	11%
Total Non-Implementation	100%

Note that about 60% of non-implemented cost saving measures were attributed to plant-internal and financial factors while 30% are due to the fault of the IAC. As a whole, the recommendations which manufacturers viewed as poor quality ARs only represents 15% of the recommended cost saving measures as shown in Figure 55.

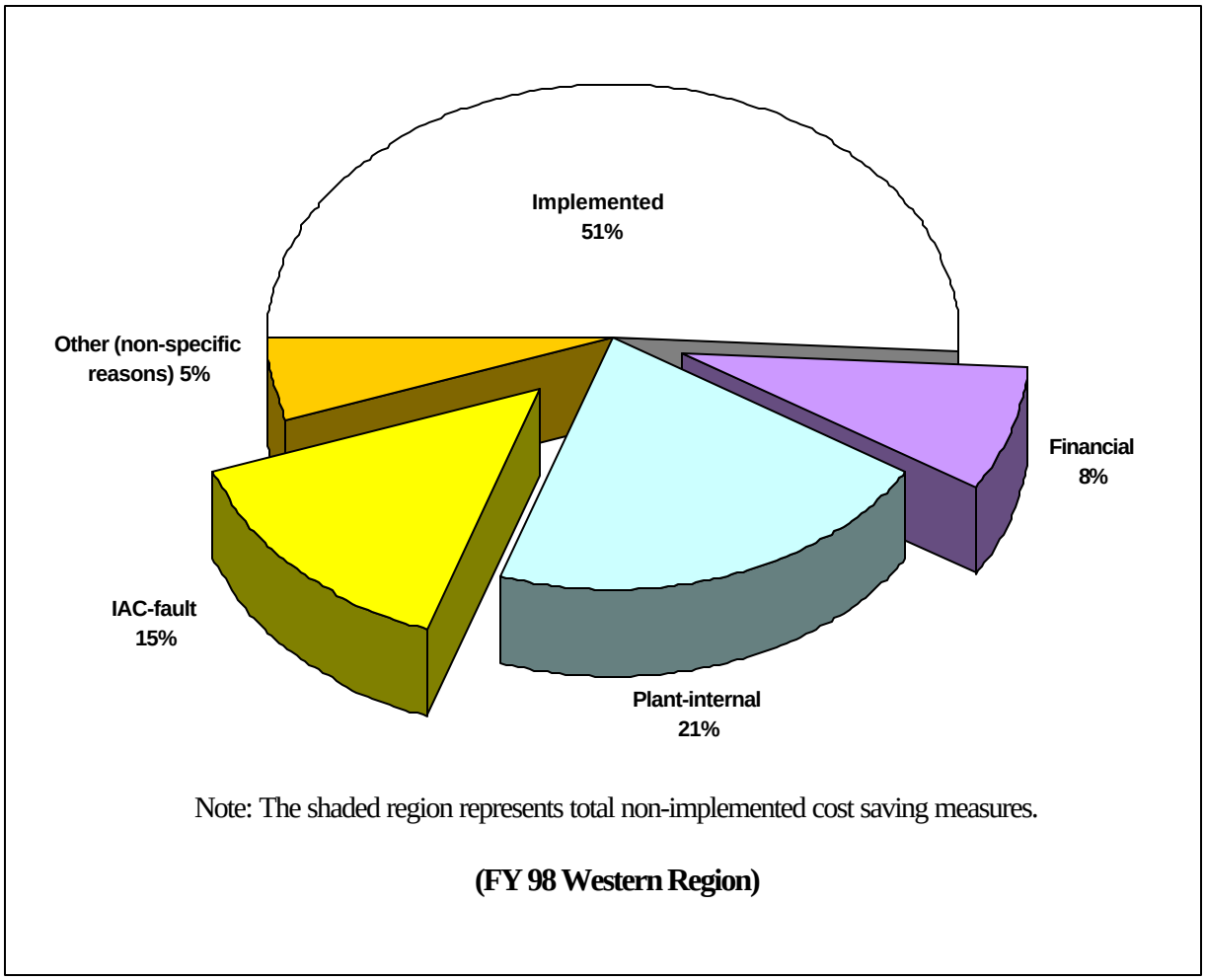

Figure 55. Breakdown of Total Recommended Cost Saving Measures

Appendix I.

1.1. 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 for 1998 (Energy Information Agency)
5.) For purposes of this report those values were:

Coal	81.167 %
Natural Gas	13.886 %
Fuel Oil	4.947 %
Fossil Fuel Total	100%

Fossil Fuel Generation (69.326%)
Average Fossil Fuel Generation Efficiency (0.30472)
Non-fossil Fuel Generation (30.674%)

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

FY98 Implemented Average 69.769 lb. of Carbon per MMBtu

Appendix II.

1.2. IAC Program Contact List

Appendix III

1.3. IAC Territory Maps

Appendix IV

1.4. IAC Newsletter

Volume1, Number 1