Savings Generated by the Industrial Assessment Center Program: Fiscal Year 1997

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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 FY97, the 30 Centers performed 720 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. This report reflects the first year implementing this change.

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 fifth 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 1997, 720 assessments were performed, bringing the program database total to 7,618 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 7,603. Unless otherwise noted, figures are for FY97. 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
Total	**7,603**	**1,885**

Table 1. Assessments Performed by Fiscal Year

The total amount of recommended Energy Conservation measures in FY97 was approximately 2,500,000 Million British Thermal Units (MMBTU) with a dollar value of almost $23 million. Waste Reduction and Pollution Prevention cost savings amounted to $15 million, and Productivity recommendations were over $104 million. The resultant total recommended savings were $142 million.

The FY97 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 950,000 MMBTU, with a dollar value of almost $9 million. This equates to 165,000 barrels of oil measured in barrels of oil equivalent (BOE), and 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 $22 million. The total amount of money saved by clients as a result of implemented measures was almost $37 million, up from $27 million in FY96.

[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 FY97 is shown in the following table by state. In FY97, the IACs served manufacturers in 39 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
Alabama	3	Georgia Tech.	1	33%
		Mississippi State University	2	67%
Arizona	20	Arizona State University	20	100%
Arkansas	26	Univ. of Arkansas - Little Rock	24	92%
		Oklahoma State University	2	8%
California	59	University of Nevada	9	15%
		San Diego State University	25	42%
		San Francisco State University	25	42%
Colorado	25	Colorado State University	25	100%
Connecticut	4	University of Massachusetts	4	100%
Florida	25	University of Florida	25	100%
Georgia	22	Georgia Tech.	22	100%
Illinois	36	Bradley University	25	69%
		Univ. of Wisconsin - Milwaukee	11	31%
Indiana	19	Notre Dame University	14	74%
		University of Louisville	5	26%
Iowa	16	Iowa State University	16	100%
Kansas	10	University of Kansas	8	80%
		Oklahoma State University	2	20%
Kentucky	14	University of Louisville	10	71%
		University of Tennessee	4	29%
Maine	25	University of Maine	25	100%
Maryland	1	Old Dominion University	1	100%
Massachusetts	13	University of Massachusetts	13	100%
Michigan	33	Notre Dame University	10	30%
		University of Michigan	23	70%
Minnesota	28	Iowa State University	5	18%
		South Dakota State University	23	82%
Mississippi	23	Mississippi State University	23	100%
	31	University of Kansas	6	19%
Missouri		University of Missouri - Rolla	25	81%
Nebraska	5	Iowa State University	4	80%
		University of Kansas	1	20%

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
Nevada	11	University of Nevada	11	100%
New Jersey	5	Hofstra University	5	100%
New York	19	Hofstra University	16	84%
		University of Massachusetts	3	16%
North Carolina	28	North Carolina State Univ.	21	75%
		Old Dominion University	1	4%
		University of Tennessee	6	21%
North Dakota	1	South Dakota State Univ.	1	100%
Ohio	34	Notre Dame University	1	3%
		University of Dayton	25	74%
		University of Michigan	2	6%
		West Virginia University	6	18%
Oklahoma	21	Oklahoma State University	21	100%
Oregon	18	Oregon State University	18	100%
Pennsylvania	20	Hofstra University	4	20%
		West Virginia University	16	80%
Rhode Island	5	University of Massachusetts	5	100%
South Carolina	4	Georgia Tech.	2	50%
		North Carolina State Univ.	1	25%
		University of Tennessee	1	25%
South Dakota	1	South Dakota State Univ.	1	100%
Tennessee	13	Univ. of Arkansas - Little Rock	1	8%
		University of Tennessee	12	92%
Texas	50	Texas A&M - College Station	25	50%
		Texas A&M - Kingsville	25	50%
Virginia	28	North Carolina State Univ.	3	11%
		Old Dominion University	23	82%
		University of Tennessee	2	7%
Washington	7	Oregon State University	7	100%
West Virginia	3	West Virginia University	3	100%
Wisconsin	14	Univ. of Wisconsin - Milwaukee	14	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	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	20	Arizona	20	100%
Bradley University	25	Illinois	25	100%
Colorado State University	25	Colorado	25	100%
Georgia Tech.	25	Alabama	1	4%
		Georgia	22	88%
		South Carolina	2	8%
Hofstra University	25	New Jersey	5	20%
		New York	16	64%
		Pennsylvania	4	16%
Iowa State University	25	Iowa	16	64%
		Minnesota	5	20%
		Nebraska	4	16%
Mississippi State Univ.	25	Alabama	2	8%
		Mississippi	23	92%
North Carolina State Univ.	25	North Carolina	21	84%
		South Carolina	1	4%
		Virginia	3	12%
Notre Dame University	25	Indiana	14	56%
		Michigan	10	40%
		Ohio	1	4%
Oklahoma State Univ.	25	Arkansas	2	8%
		Kansas	2	8%
		Oklahoma	21	84%
Old Dominion University	25	Maryland	1	4%
		North Carolina	1	4%
		Virginia	23	92%
Oregon State University	25	Oregon	18	72%
		Washington	7	28%
San Diego State University	25	California	25	100%
San Francisco State Univ.	25	California	25	100%
South Dakota State Univ.	25	Minnesota	23	92%
		North Dakota	1	4%
		South Dakota	1	4%
Texas A&M - College Station	25	Texas	25	100%
Texas A&M - Kingsville	25	Texas	25	100%
Univ. of Arkansas - Little Rock	25	Arkansas	24	96%
		Tennessee	1	4%
University of Dayton	25	Ohio	25	100%
University of Florida	25	Florida	25	100%

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
University of Kansas	15	Kansas	8	53%
		Missouri	6	40%
		Nebraska	1	7%
University of Louisville	15	Indiana	5	33%
		Kentucky	10	67%
University of Maine	25	Maine	25	100%
University of Massachusetts	25	Connecticut	4	16%
		Massachusetts	13	52%
		Rhode Island	5	20%
		New York	3	12%
Univ. of Michigan - Ann Arbor	25	Michigan	23	92%
		Ohio	2	8%
University of Missouri - Rolla	25	Missouri	25	100%
University of Nevada	20	California	9	45%
		Nevada	11	55%
University of Tennessee	25	Kentucky	4	16%
		North Carolina	6	24%
		South Carolina	1	4%
		Tennessee	12	48%
		Virginia	2	8%
Univ. of Wisconsin - Milwaukee	25	Illinois	11	44%
		Wisconsin	14	56%
West Virginia University	25	Ohio	6	24%
		Pennsylvania	16	64%
		West Virginia	3	12%

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 FY97.

2-digit SIC Code	Industry	No. of Assessments Performed
20	Food and Kindred Products	83
21	Tobacco Products	1
22	Textile Mill Products	27
23	Apparel and Other Textile Products	15
24	Lumber and Wood Products	27
25	Furniture and Fixtures	23
26	Paper and Allied Products	46
27	Printing and Publishing	40
28	Chemicals and Allied Products	22
29	Petroleum and Coal Products	4
30	Rubber and Misc. Plastics Products	85
31	Leather and Leather Products	11
32	Stone, Clay, and Glass Products	17
33	Primary Metal Industries	33
34	Fabricated Metal Products	95
35	Industrial Machinery and Equipment	84
36	Electronic and Other Electric Equip.	38
37	Transportation Equipment	35
38	Instruments and Related Products	17
39	Miscellaneous Manufacturing Industries	17
Total		**720**

Table 4. Number of Assessments Performed by Industry Type

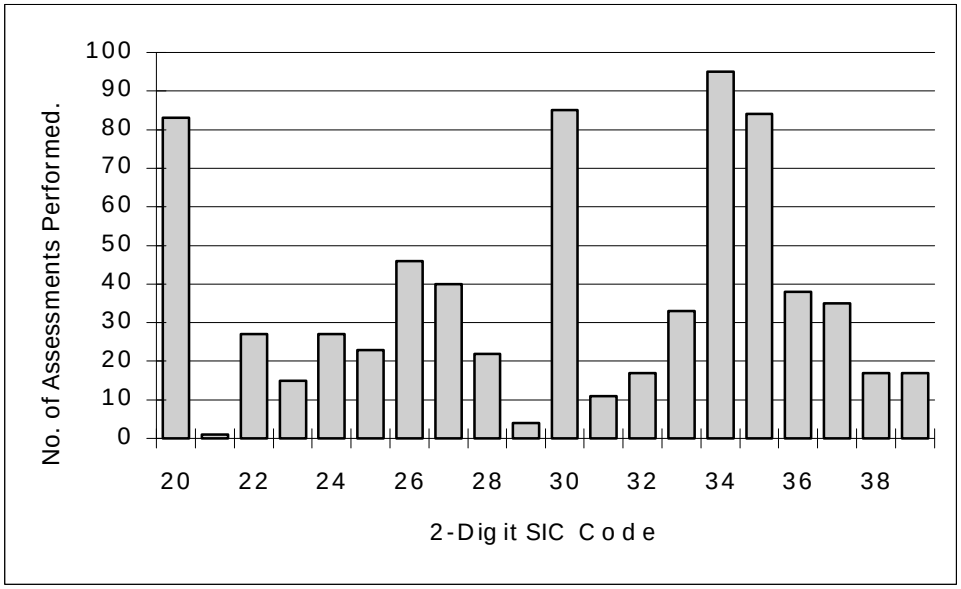


Figure 1. Plants Served in FY97 by Industry Type

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 FY97, the total energy usage of the clients was 36 million MMBTU, costing $ 277.6 million. There was an average of 166 employees at each location. The companies had total sales of $ 21.4 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	35,125	225,200
83	15,439,405	45,728	318,029
84	13,543,984	36,316	300,904
85	14,308,457	33,412	306,279
86	21,558,916	46,070	392,983
87	19,438,333	35,746	320,926
88	18,515,013	46,430	335,448
89	23,309,162	58,563	403,367
90	25,126,931	61,704	426,906
91	25,707,204	61,067	378,334
92	24,500,738	58,423	402,468
93	27,333,166	66,972	483,247
94	28,090,421	67,001	439,387
95	29,077,218	52,707	412,759
96	30,609,175	55,932	419,055
97	29,801,416	50,038	385,605

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.

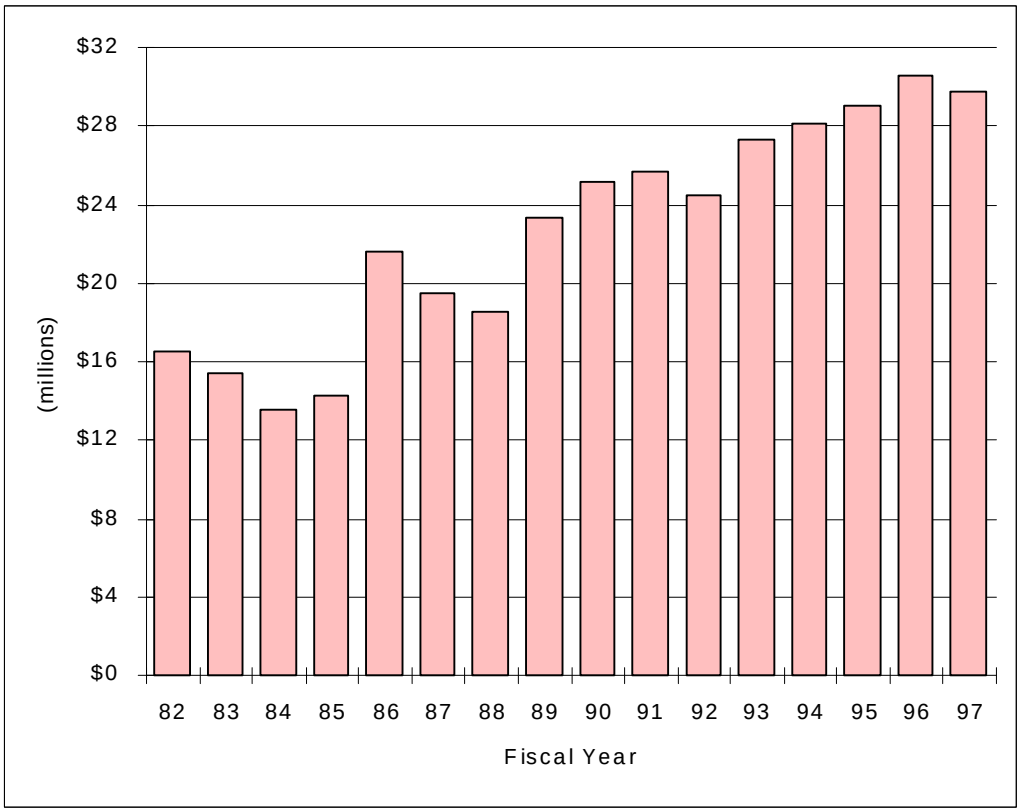


Figure 2. Average Client Sales by Fiscal Year

The average plant served in FY97 had purchased energy use of 50,000 MMBTU with an associated cost of $385,600. Electricity cost the typical client $16.22/ MMBTU and natural gas cost $3.44/ MMBTU. The average energy use and associated costs are shown in Figures 3 and 4.

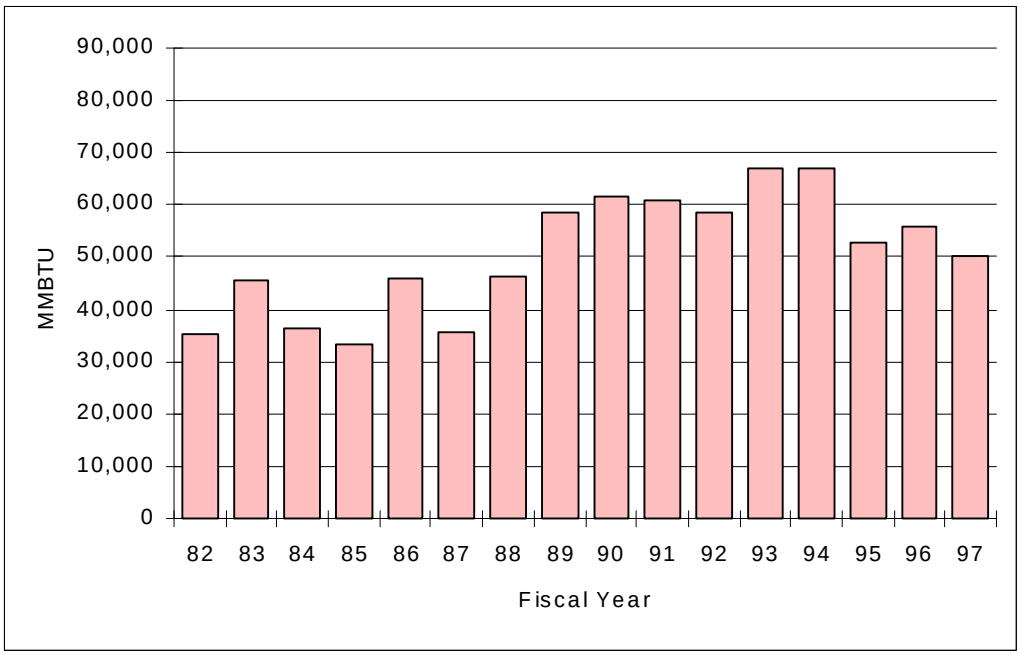


Figure 3. Average Client Energy Usage by Fiscal Year

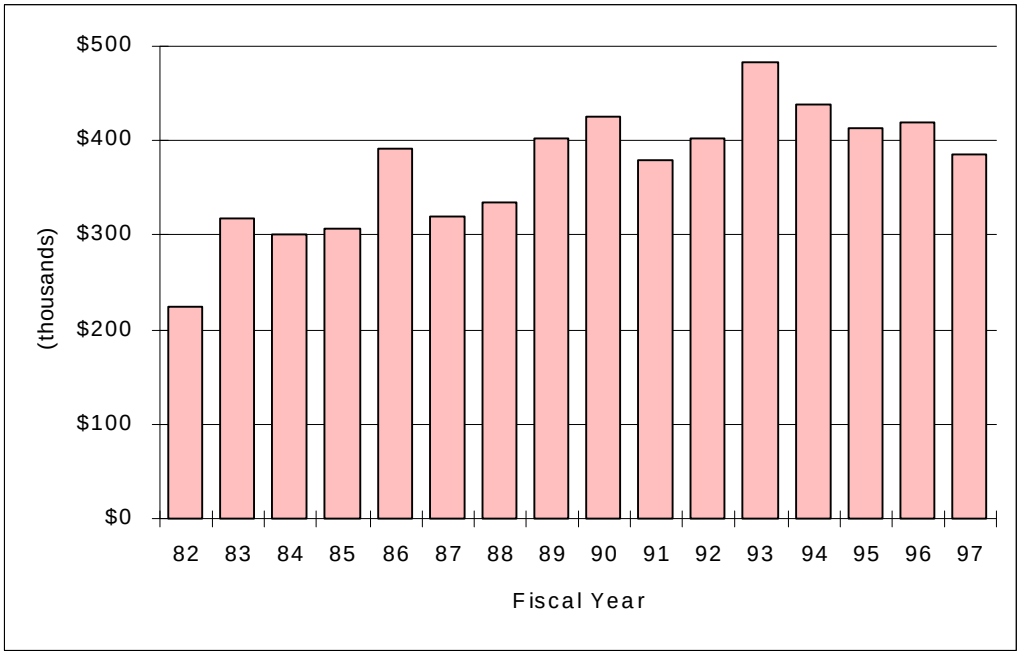


Figure 4. Average Client Energy Costs by Fiscal Year

The program database breaks energy use into eleven specific streams and one category for "other" energy. “Other Energy” in FY97 consisted mainly of 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	9,179,820 KW-months/yr	63,157,641
Fees		6,185,485
Consumption	12,147,398	127,744,256
Natural Gas	19,788,742	68,080,388
L. P. G.	504,349	3,521,145
Fuel Oil #1	833	6,612
Fuel Oil #2	255,135	1,390,418
Fuel Oil #4	92,423	387,471
Fuel Oil #6	1,016,823	3,267,968
Coal	1,125,839	2,159,121
Wood	902,817	600,501
Paper	0	0
Other Gas	1,065	12,256
Other Energy	192,150	1,122,331
Totals	**36,027,574**	**277,635,593**

Table 6. Energy Use and Cost by Energy Streams

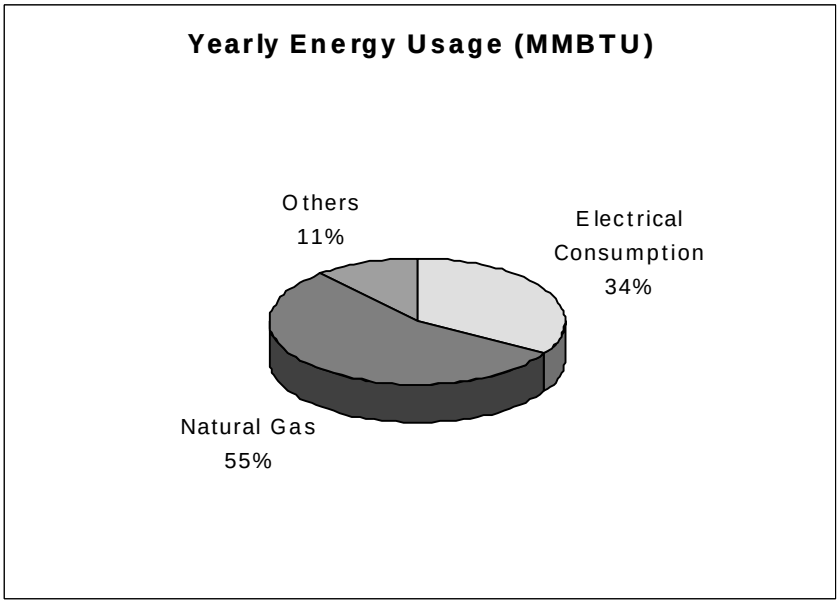


Figure 5. Energy Use of Plants Served in FY97 by Energy Stream

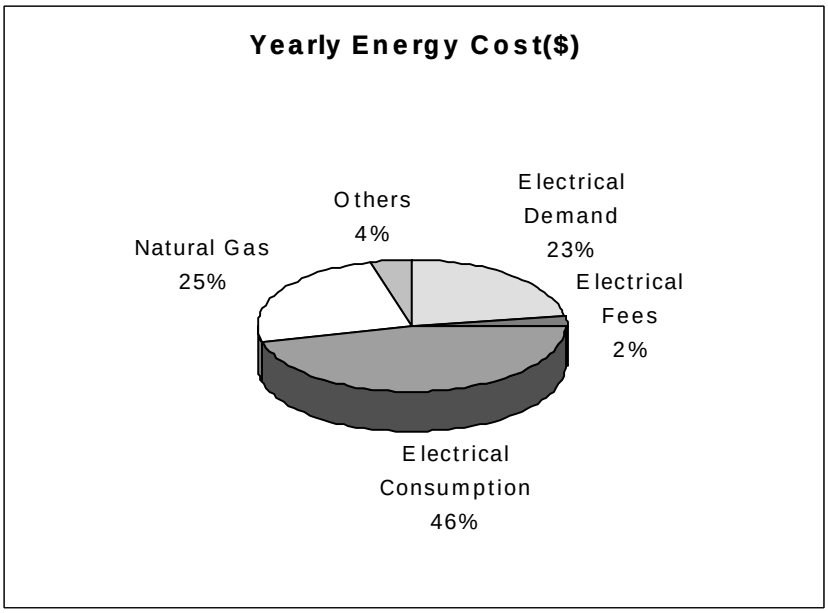


Figure 6. Energy Costs of Plants Served in FY97 by Energy Stream

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 FY97 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	2,034,978	349,352	47,068	21,787,125	n/a	n/a	21,787,125
93	2,429,382	417,061	56,190	27,044,478	66,793	2,529,588	29,640,859
94	3,533,187	606,556	81,720	35,354,074	3,410,391	2,921,786	41,686,251
95	2,651,229	455,147	75,909	32,918,127	10,459,571	6,741,345	50,119,043
96	1,734,662	299,080	64,592	24,081,673	26,439,503	14,477,738	64,998,914
97	2,567,991	442,757	73,666	22,888,743	15,110,923	104,235,242	142,234,908
Totals	27,371,692	4,700,287	672,145	261,875,256	55,487,181	130,905,699	471,156,879

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.

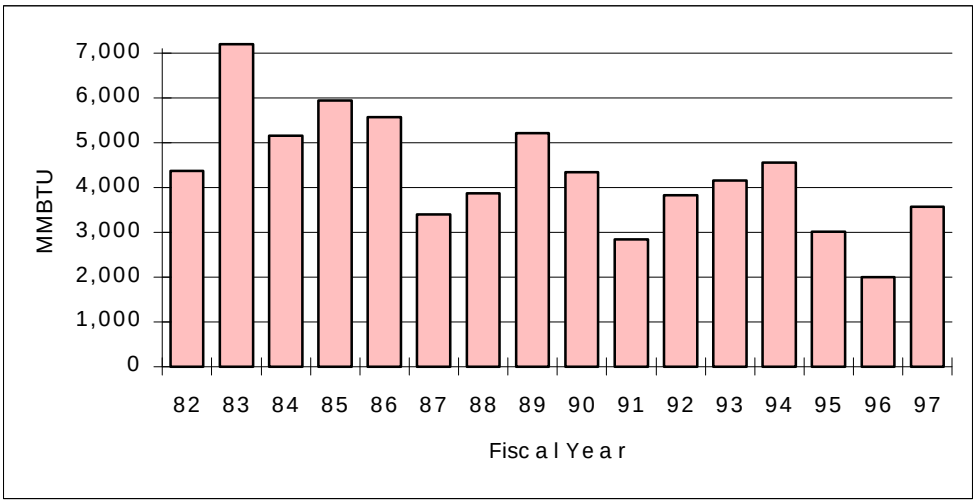


Figure 7. Average Recommended Energy Conserved by Fiscal Year

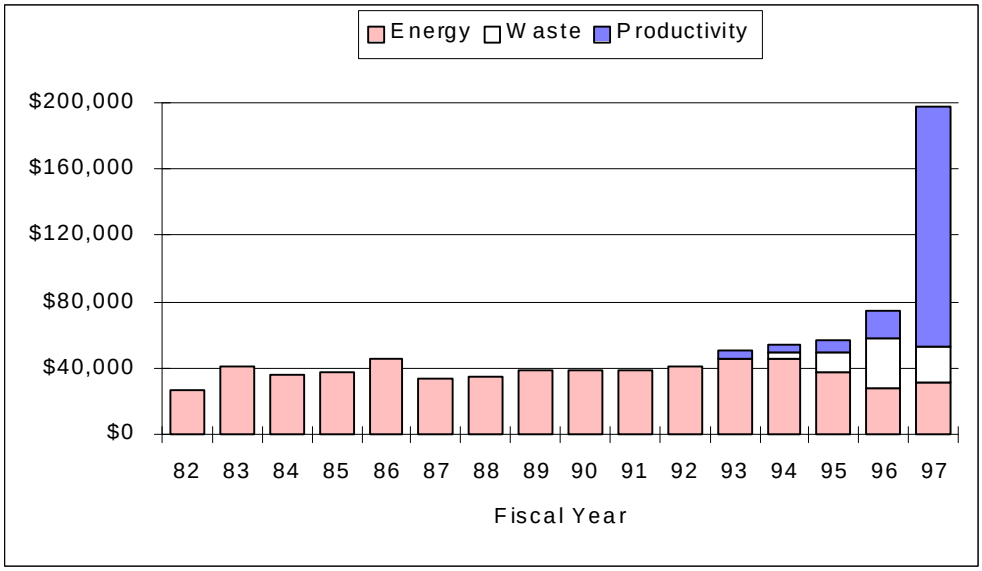


Figure 8. Average Recommended Cost Savings by Fiscal Year

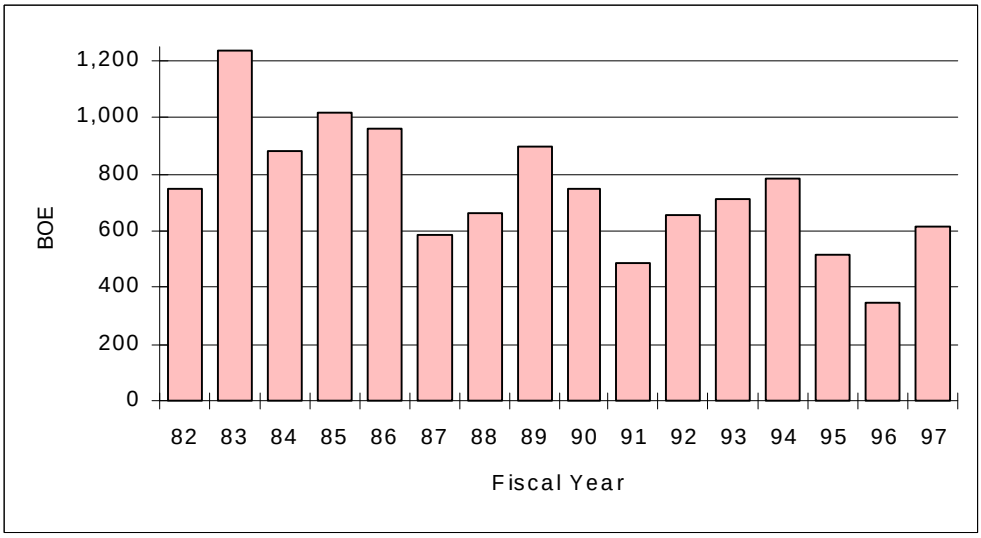


Figure 9. Average Recommended Barrels of Oil Avoided by Fiscal Year

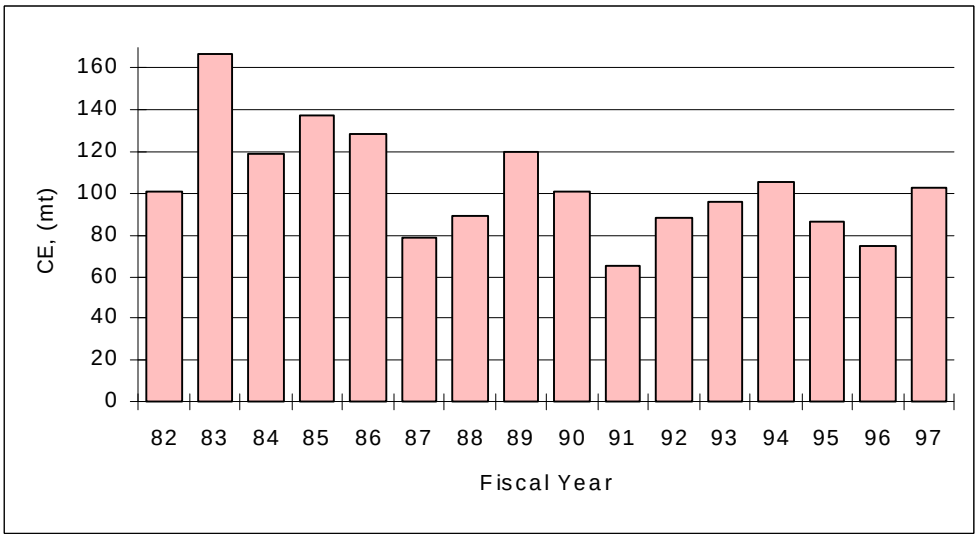


Figure 10. Average Recommended Carbon Avoided by Fiscal Year

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	3,832	658	89	41,030	N/A	N/A	41,030
93	4,153	713	96	46,230	114	4,324	50,668
94	4,553	782	105	45,559	4,395	3,765	53,719
95	3,016	518	86	37,450	11,899	7,669	57,018
96	2,001	345	75	27,776	30,495	16,699	74,970
97	3,567	615	102	31,790	20,987	144,771	197,548

Table 8. Average Recommended Energy Conservation and Cost Savings

ii. Recommended Savings by Industry Type

Savings recommended by industry type in Fiscal Year 1997 is shown in Table 9 and Figures 11 through 14. The largest amount of recommended energy conserved occurred during SIC 22 (Textile Mills) assessments replacing SIC 33 (Primary Metals) in FY96. The largest recommended cost savings was in SIC 30 (Rubber and Plastic Products) replacing SIC 20 (Food and Kindred Products). The lowest recommended cost savings was in SIC 21 (Tobacco Products), where only one assessment was performed.

SIC Code	Industry Description	Recommended Energy Conservation			Recommended Cost Savings ($)			
		(MMBtu)	(B.O.E.)	(C.E., mt)	Energy	Waste	Productivity	Total
20	Foods	379,226	65,384	10,879	2,140,330	2,767,629	14,291,585	19,199,544
21	Tobacco Prod.	35,485	6,118	1,018	133,530	9,154	278,893	421,577
22	Textile Mills	500,882	86,359	14,368	2,212,246	761,639	6,279,571	9,253,456
23	Apparel	10,382	1,790	298	131,107	157,045	1,934,257	2,222,409
24	Wood Prod.	80,838	13,938	2,319	582,404	297,403	3,151,639	4,031,446
25	Furniture	50,997	8,793	1,463	414,634	561,775	1,446,329	2,422,738
26	Paper Prod.	189,340	32,645	5,431	1,524,329	2,039,828	5,086,182	8,650,339
27	Printing	51,155	8,820	1,467	707,047	721,975	3,138,414	4,567,436
28	Chemical Prod.	44,665	7,701	1,281	490,280	633,564	3,309,500	4,433,344
29	Petroleum	34,466	5,942	989	162,699	49,536	276,600	488,835
30	Rubber & Plast.	362,248	62,457	10,392	4,125,761	1,789,821	14,196,831	20,112,413
31	Leather Prod.	12,939	2,231	371	159,003	206,649	1,780,507	2,146,159
32	Stone & Glass	83,864	14,459	2,406	398,916	170,840	2,275,769	2,845,525
33	Primary Metal	145,888	25,153	4,185	2,830,160	789,420	14,500,261	18,119,841
34	Fab. Metal	158,252	27,285	4,540	1,820,595	1,262,029	10,057,971	13,140,595
35	Ind. Machinery	155,596	26,827	4,463	1,763,641	1,203,477	5,111,366	8,078,484
36	Electronics	117,247	20,215	3,363	1,644,100	448,330	7,806,429	9,898,859
37	Trans. Equip.	90,763	15,649	2,604	995,273	840,520	5,067,904	6,903,697
38	Instruments	22,752	3,923	653	250,929	143,887	2,794,393	3,189,209
39	Misc. Manuf.	41,006	7,070	1,176	401,759	256,402	1,450,841	2,109,002
Totals		**2,567,991**	**442,757**	**73,666**	**22,888,743**	**15,110,923**	**104,235,242**	**142,234,908**

Table 9. Recommended Cost and Energy Savings by Industry Type

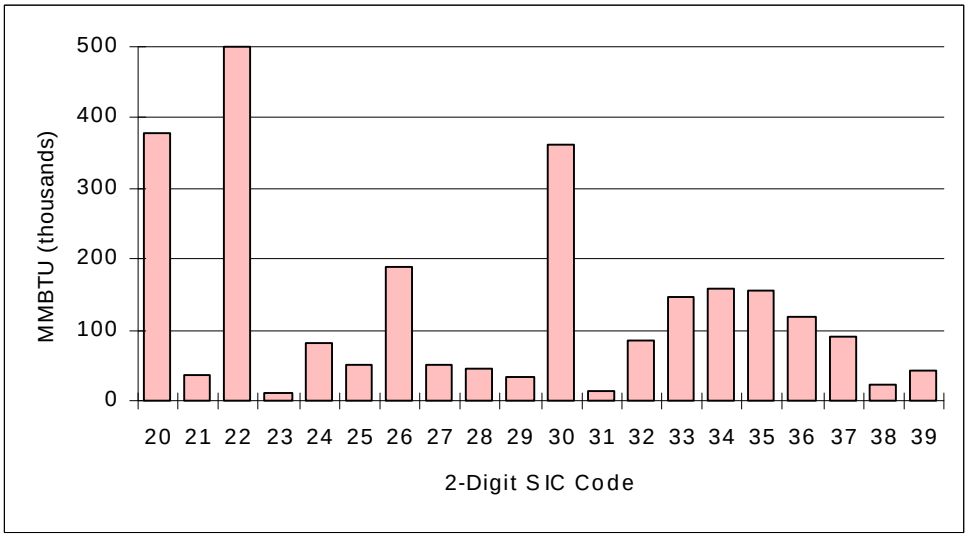


Figure 11. Recommended Energy Conserved by Industry Type

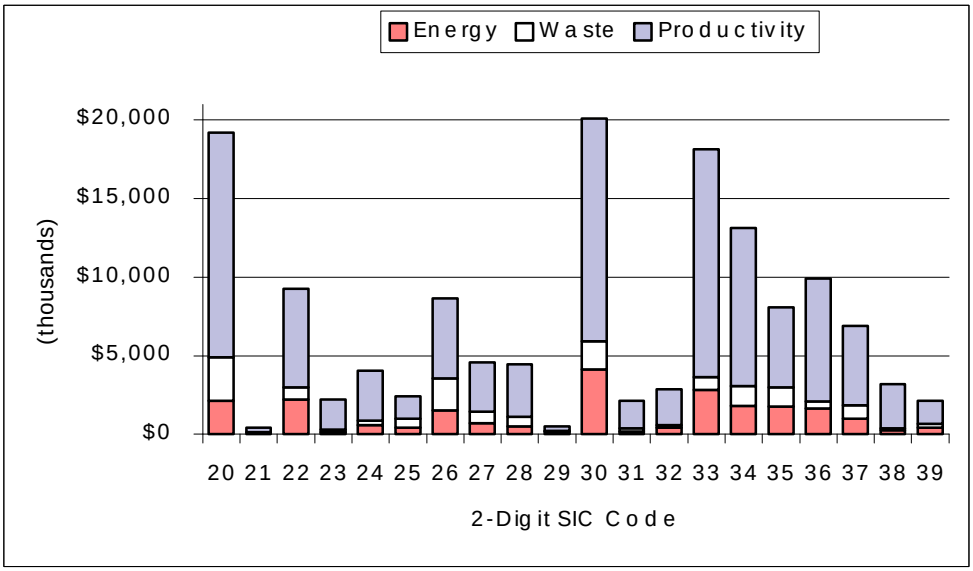


Figure 12. Recommended Cost Savings by Industry Type

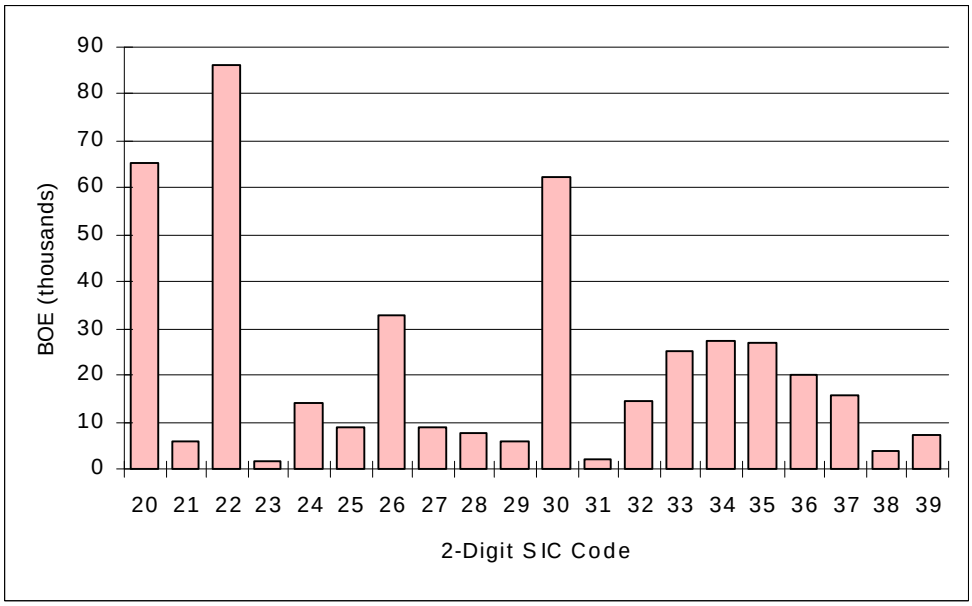


Figure 13. Recommended Barrels of Oil Avoided by Industry Type

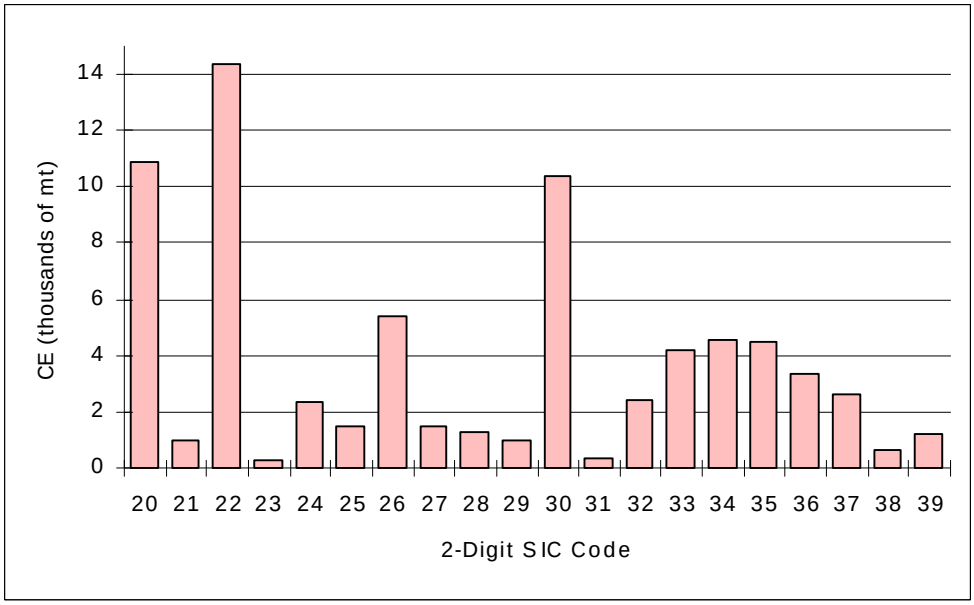


Figure 14. Recommended Carbon Avoided by Industry Type

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	4,569	788	131	25,787	33,345	172,188	231,320
21	Tobacco Prod.	35,485	6,118	1,018	133,530	9,154	278,893	421,577
22	Textile Mills	18,551	3,198	532	81,935	28,209	232,577	342,721
23	Apparel	692	119	20	8,740	10,470	128,950	148,161
24	Wood Prod.	2,994	516	86	21,571	11,015	116,727	149,313
25	Furniture	2,217	382	64	18,028	24,425	62,884	105,336
26	Paper Prod.	4,116	710	118	33,138	44,344	110,569	188,051
27	Printing	1,279	220	37	17,676	18,049	78,460	114,186
28	Chemical Prod.	2,030	350	58	22,285	28,798	150,432	201,516
29	Petroleum	8,617	1,486	247	40,675	12,384	69,150	122,209
30	Rubber & Plast.	4,262	735	122	48,538	21,057	167,022	236,617
31	Leather Prod.	1,176	203	34	14,455	18,786	161,864	195,105
32	Stone & Glass	4,933	851	142	23,466	10,049	133,869	167,384
33	Primary Metal	4,421	762	127	85,762	23,922	439,402	549,086
34	Fab. Metal	1,666	287	48	19,164	13,285	105,873	138,322
35	Ind. Machinery	1,852	319	53	20,996	14,327	60,850	96,172
36	Electronics	3,085	532	89	43,266	11,798	205,432	260,496
37	Trans. Equip.	2,593	447	74	28,436	24,015	144,797	197,248
38	Instruments	1,338	231	38	14,761	8,464	164,376	187,601
39	Misc. Manuf.	2,412	416	69	23,633	15,082	85,344	124,059
Ave.		**3,567**	**615**	**102**	**31,790**	**20,987**	**144,771**	**197,548**

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

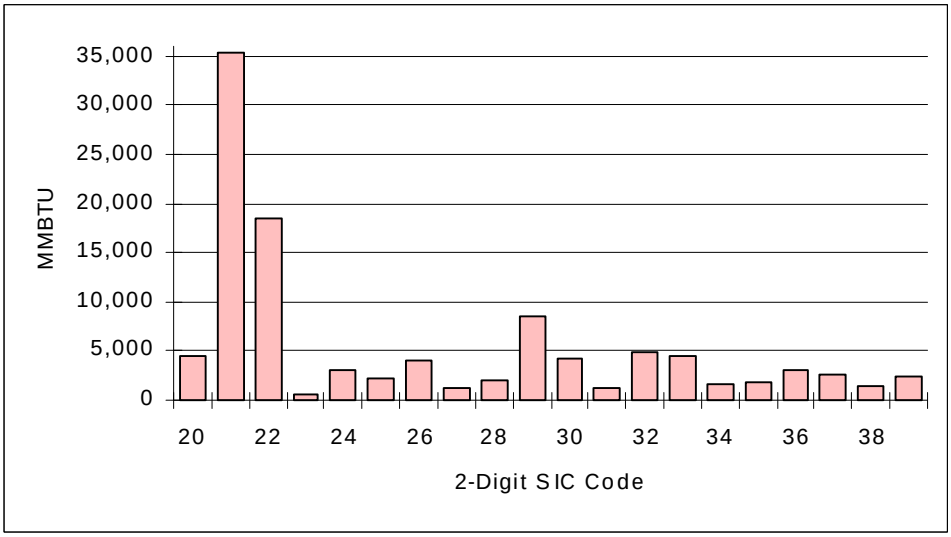


Figure 15. Average Recommended Energy Saved by Industry Type

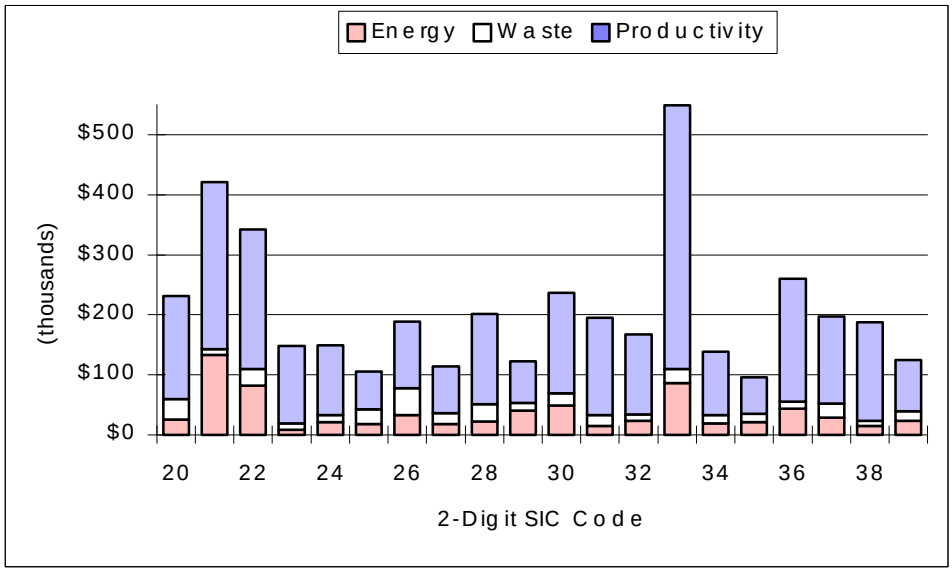


Figure 16. Average Recommended Cost Savings by Industry Type

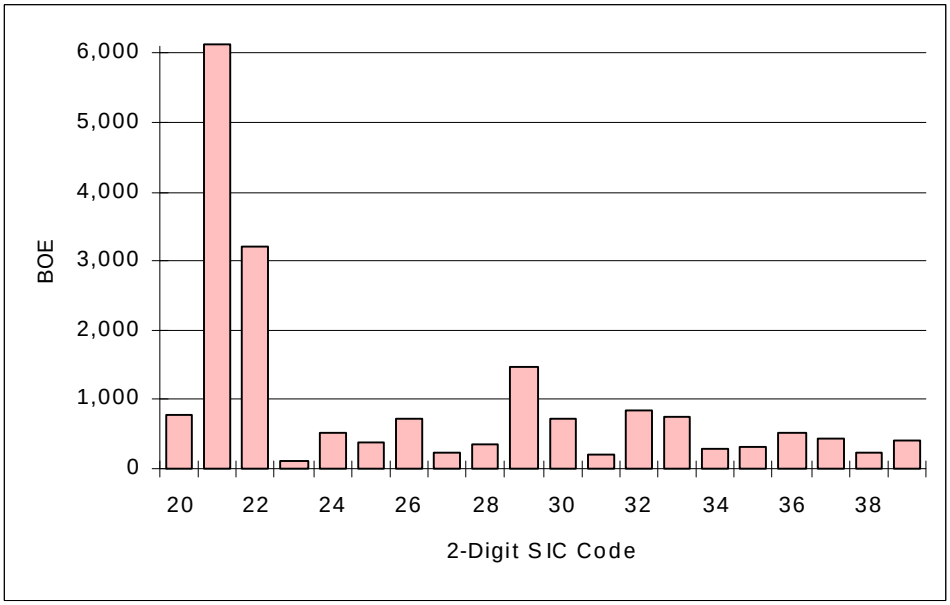


Figure 17. Average Recommended Barrels of Oil Saved by Industry Type

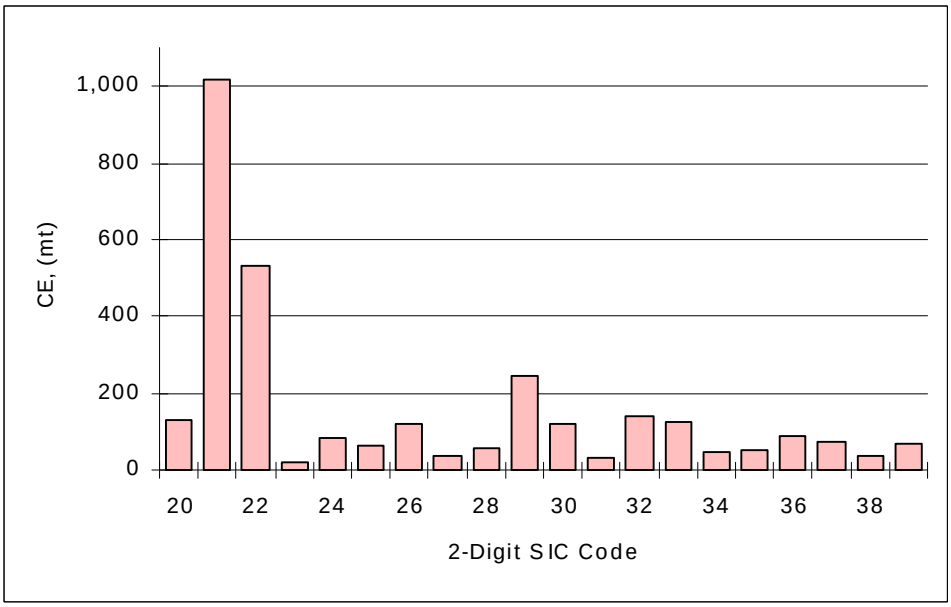


Figure 18. Average Recommended Carbon Avoided by Industry Type

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 FY97 was over 2.5 million MMBTUs, with a dollar amount of almost $23 Million. Including non-energy dollars, the total recommended savings in FY97 amounted to over $142 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).

Energy Stream	Recommended Energy Conservation (MMBTU)	Recommended Energy Cost Savings ($)
Electricity		
Demand	467,131 KW-months/yr	4,728,441
Fees		554,059
Consumption	874,561	11,496,623
Natural Gas	1,445,419	5,335,591
L. P. G.	5,775	19,527
Fuel Oil #2	10,937	63,904
Fuel Oil #4	12,759	51,463
Fuel Oil #6	180,005	580,153
Coal	7,940	14,472
Wood	24,910	21,546
Other Gas	1791	-505
Other Energy	3,894	23,469
Energy Totals	**2,567,991**	**22,888,743**
Waste	n/a	15,110,923
Productivity	n/a	104,235,242
Program Totals	**2,567,991**	**142,234,908**

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.

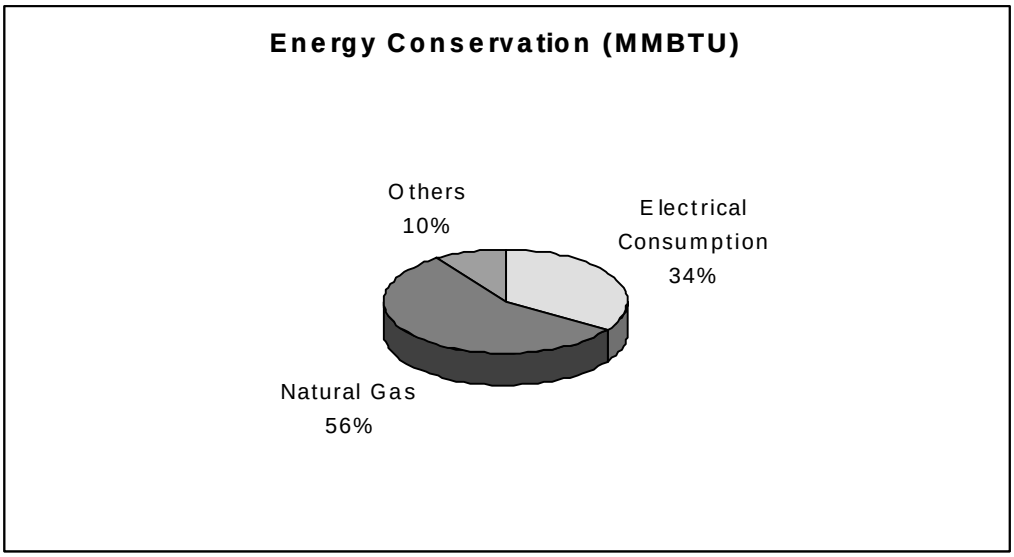


Figure 19. Composition of Recommended Energy Conserved by Energy Stream

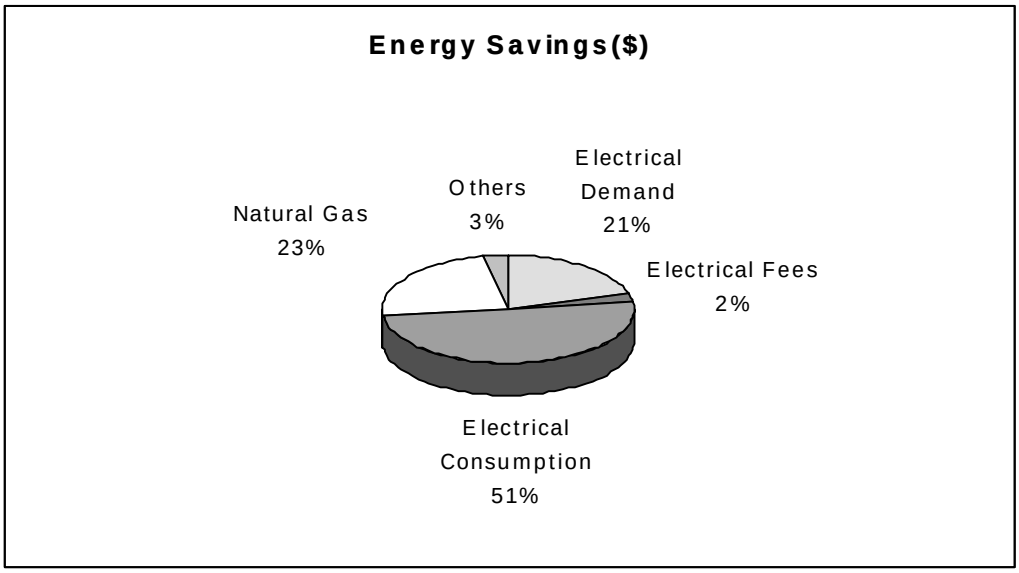


Figure 20. Composition of Recommended Cost Savings by Energy Stream

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	51,940,783
Byproduct Production	2,634,515
Resource Costs	
Personnel Changes	14,509,687
Administrative Costs	18,080,014
Primary Raw Material	10,605,666
Ancillary Material Cost	5,999,933
Water Consumption	464,644
Waste Reduction	
Water Disposal	3,403,356
Other Liquid (non-haz)	1,126,372
Other Liquid (haz)	1,695,319
Solid Waste (non-haz)	8,306,076
Solid Waste (haz)	499,170
Gaseous Waste (haz)	80,630
Non-Energy Total	**119,346,165**

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

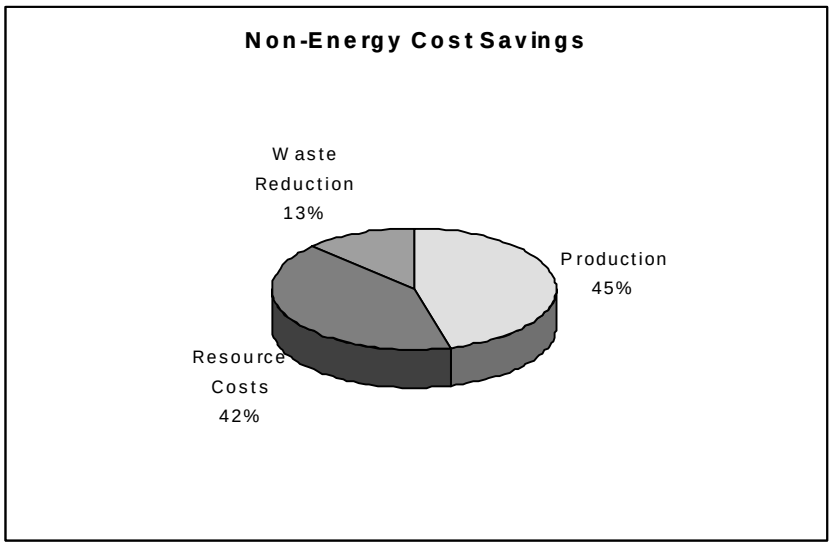


Figure 21. Recommended Non-Energy Cost Savings

Figure 22 indicates the composition of the total recommendations by resource stream for FY97.

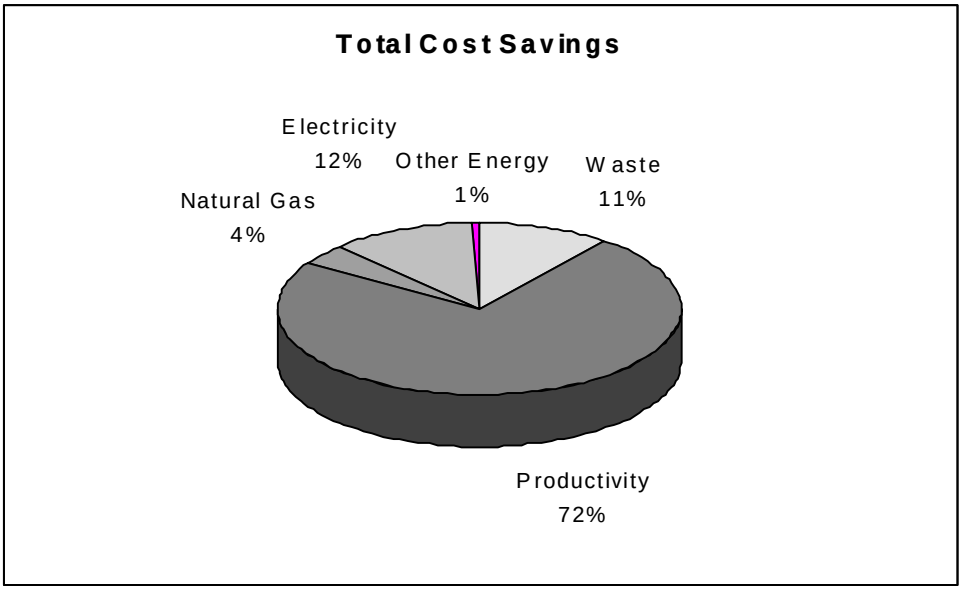


Figure 22. Recommended Cost Savings by Resource Stream

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 FY97. Figure 23 shows the frequency of the recommendations.. The average number of recommendations was seven, and 110 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	224
2.2	Thermal Systems	457
2.3	Electrical Power	181
2.4	Motor Systems	1360
2.5	Industrial Design	13
2.6	Operations	123
2.7	Buildings and Grounds	1351
2.8	Ancillary Costs	134
2.9	Alternate Energy Use	0
3.1	Operations	163
3.2	Equipment	74
3.3	Post Generation Treatment/Minimization	66
3.4	Water Use	268
3.5	Recycling	496
3.6	Waste Disposal	174
3.7	Maintenance	80
3.8	Raw Materials	95
4.1	Manufacturing Enhancements	114
4.2	Purchasing	45
4.3	Inventory	55
4.4	Labor Optimization	221
4.5	Space Utilization	120
4.6	Reduction of Downtime	123
4.7	Management Practices	28
4.8	Other Administrative Savings	32
	Total	**5997**

Table 13. Recommendations by Recommendation Type

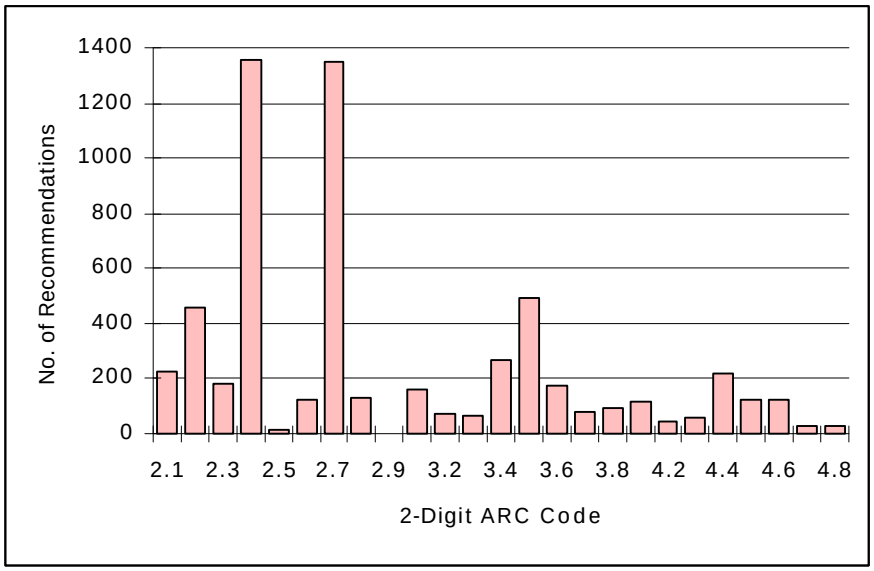


Figure 23. Number of Recommendations by Recommendation Type

D. Implementation Results

i. General

The IAC program has historically enjoyed a high rate of implementation of recommendations. The results of the 1997 program year showed an implementation rate of almost 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 previous annual reports. The implementation rate as defined as the amount of energy (MMBTU) saved compared to the amount recommended was 37%, and as energy cost ($) saved to recommended was 40%. Tables 14 through 24, and Figures 24 through 54 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
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	3,777	1,828	48%	n/a	n/a	n/a	n/a	n/a	n/a	3,749	1,828	48%
93	3,962	2,041	52%	30	11	37%	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	1,852	52%	1,303	534	41%	680	323	48%	5,515	2,709	49%
Totals	**47,741**	**25,719**	**54%**	**3,244**	**1,387**	**43%**	**760**	**366**	**48%**	**51,717**	**27,472**	**53%**

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

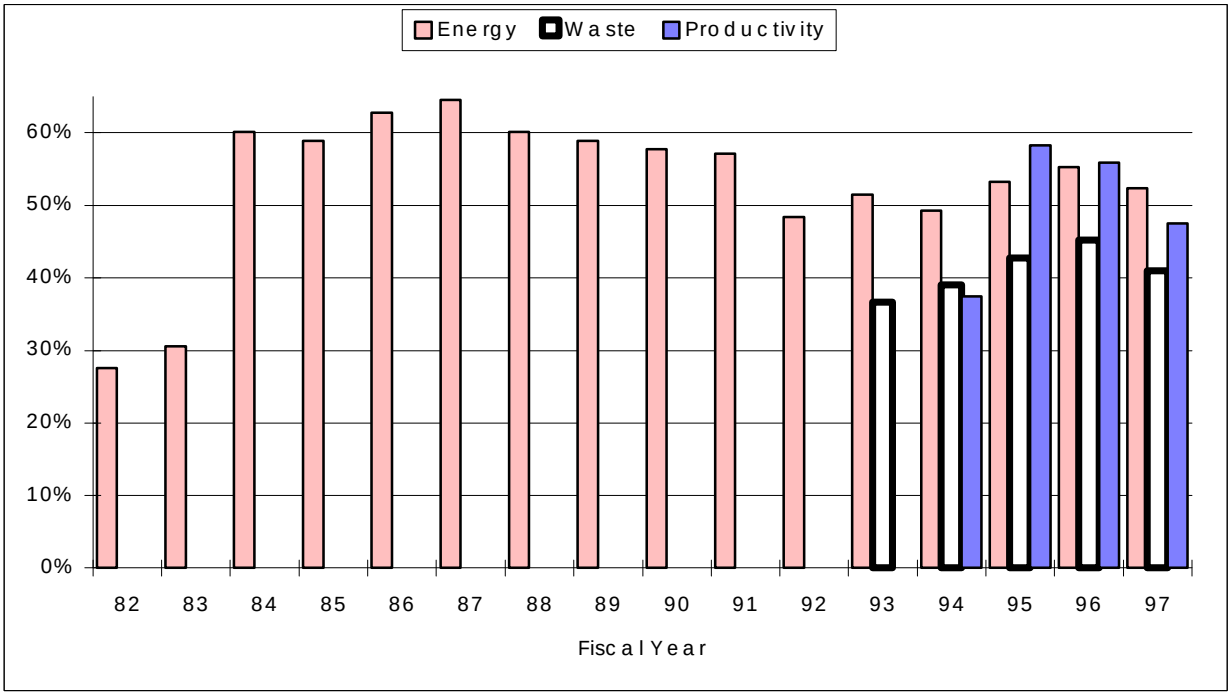


Figure 24. Percent of Recommendations Implemented by Fiscal Year

Fiscal Year	(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	209,286	42,265	13,300,146	7,061,972	6,852,226	27,214,344
97	960,214	165,554	30,287	9,290,838	5,198,095	22,454,004	36,942,937

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 FY97, 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	21,787,125	35,954,528	1.7	10,168,974	16,777,959	1.6	47%
93	29,640,859	45,521,405	1.5	10,973,815	9,447,658	0.9	37%
94	41,686,251	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	142,234,908	101,788,476	0.7	36,942,937	27,007,653	0.7	26%
Totals	**471,156,879**	**541,174,135**	**1.1**	**177,552,952**	**172,890,030**	**1.0**	**38%**

Table 16. Recommended and Implemented Simple Payback

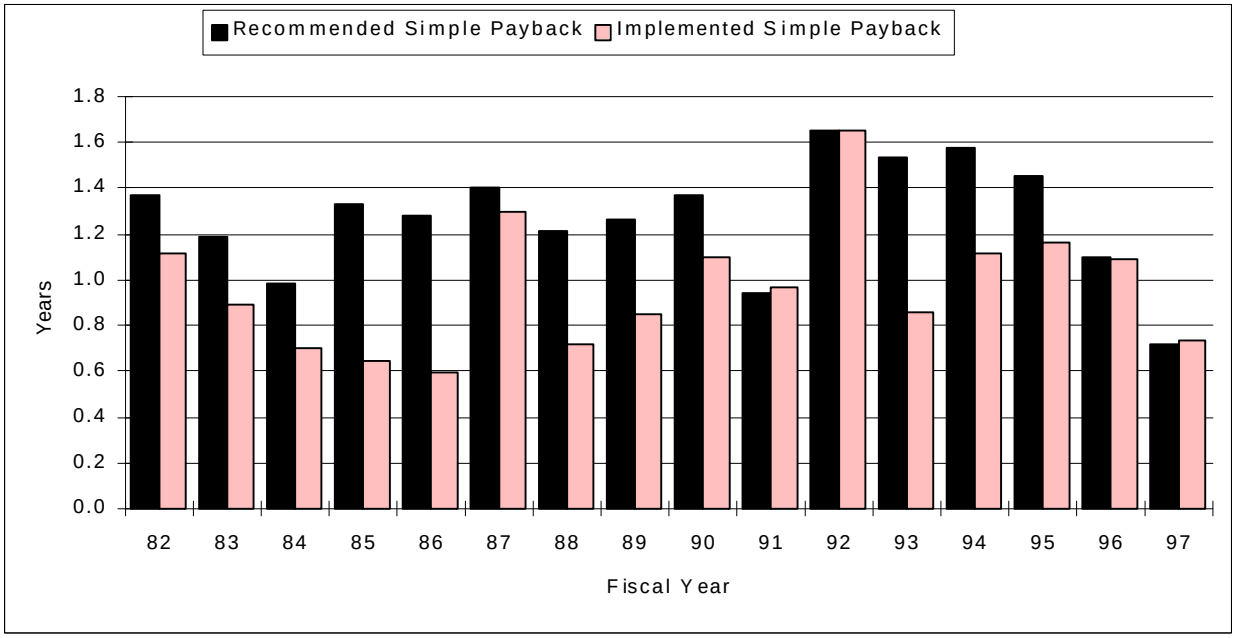


Figure 25. Recommended vs. Implemented Simple Payback

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			Implemented Cost Savings ($)			
	(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	1,330	269	73,273	13,324	12,514	99,111
91-97	7,816	1,348	247	75,993	18,522	34,968	129,483

Table 17. Seven Year Cumulative Conservation and Cost Savings

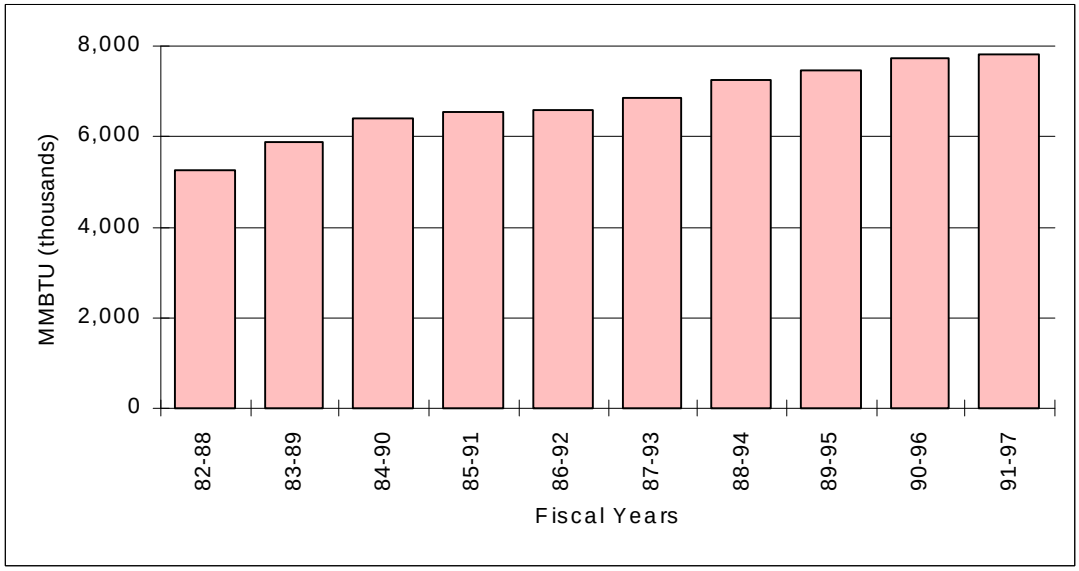


Figure 26. Seven Year Cumulative Energy Savings

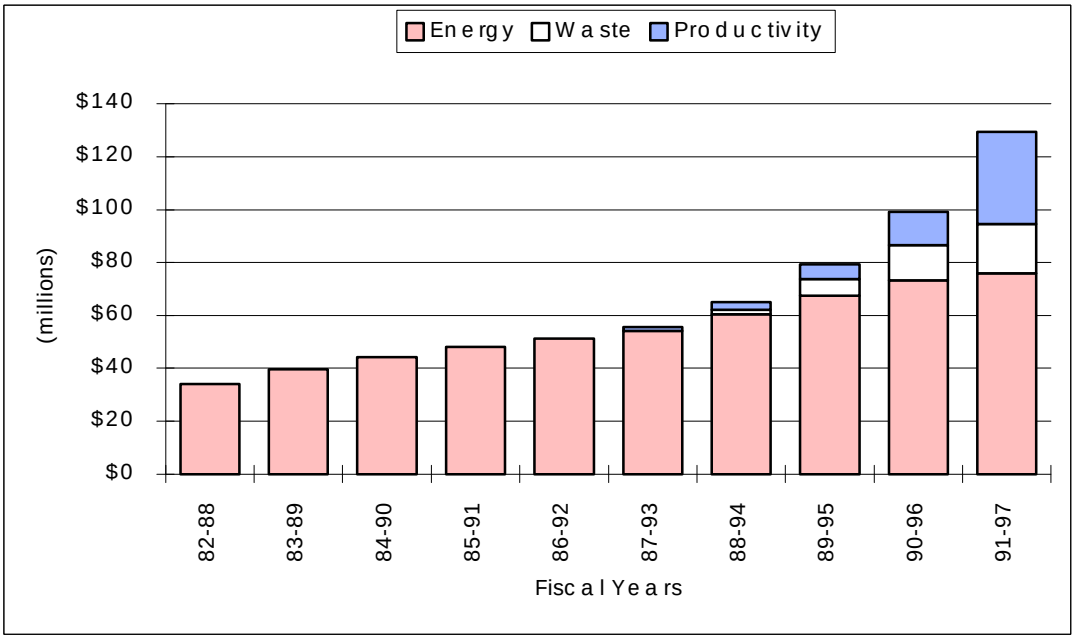


Figure 27. Seven Year Cumulative Cost Savings

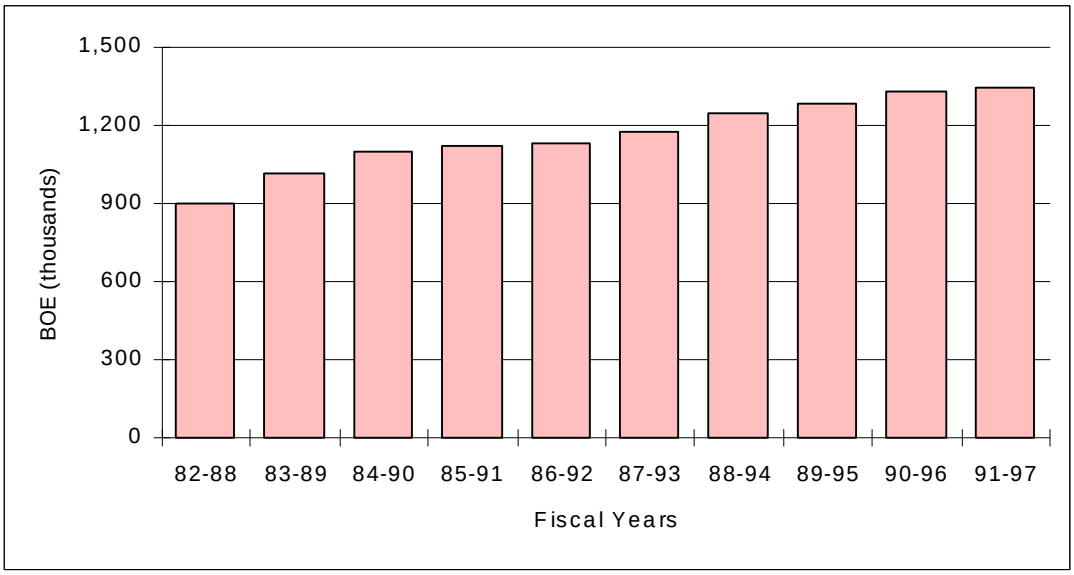


Figure 28. Seven Year Cumulative Barrels of Oil Avoided

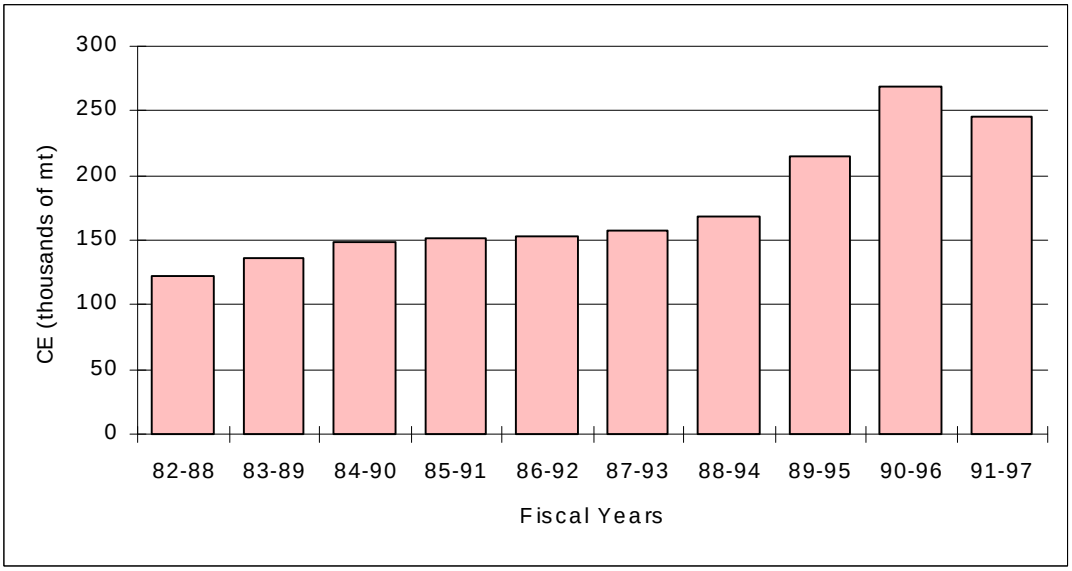


Figure 29. Seven Year Cumulative Carbon Avoided

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 FY97 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	247	50	15,721	8,347	8,100	32,168
97	1,455	251	46	14,077	7,876	34,021	48,098

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	1,427	245	33	12,005
83	1,931	332	45	16,527
84	1,992	342	46	17,020
85	950	163	22	12,263
86	1,985	341	46	22,327
87	1,678	288	39	18,569
88	1,520	261	35	17,515
89	2,095	360	48	21,931
90	1,842	316	43	21,026
91	1,175	202	27	18,125
92	574	99	13	9,048
93	487	84	11	8,786
94	540	93	12	8,288
95	484	83	14	7,580
96	468	81	16	7,616
97	341	59	11	6,277

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

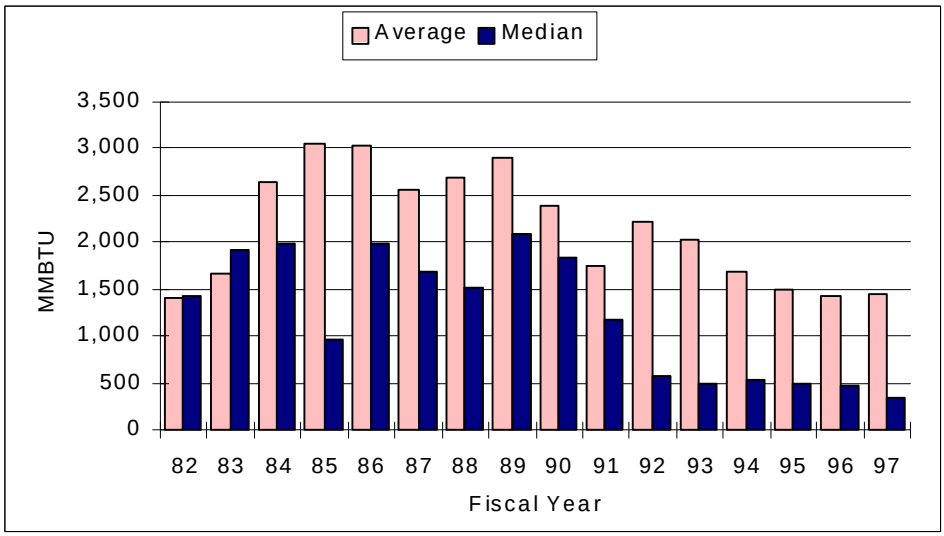


Figure 30. Average and Median Implemented Conservation by Fiscal Year

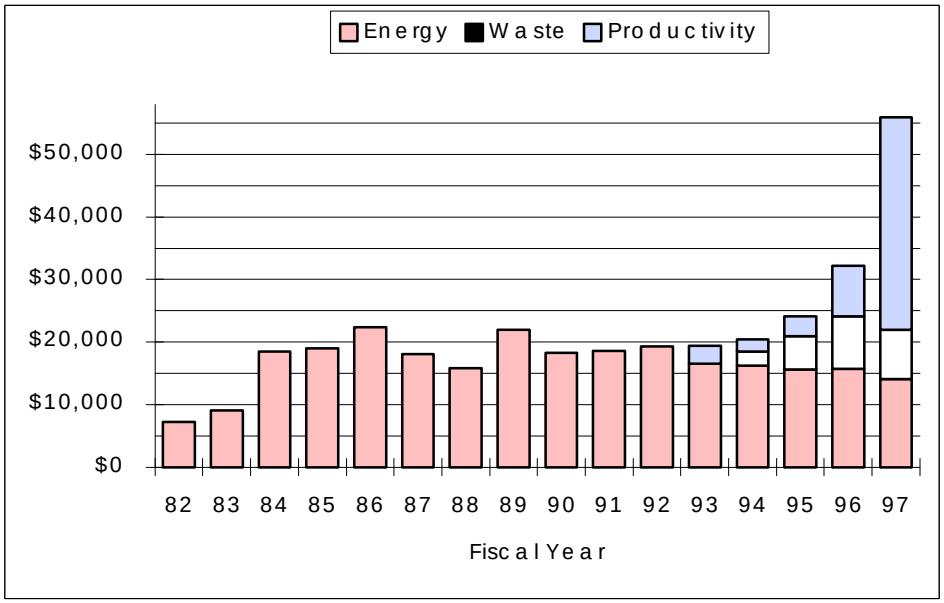


Figure 31. Average Implemented Cost Savings by Fiscal Year

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

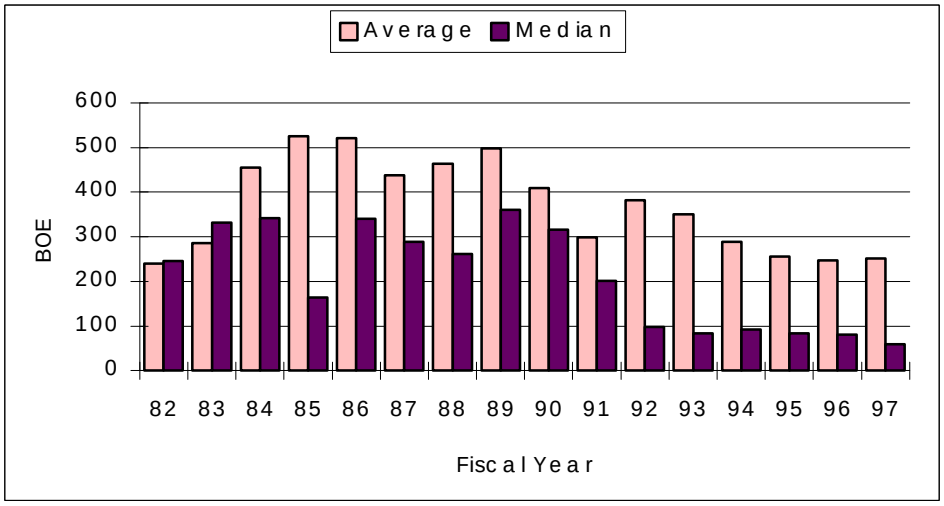


Figure 32. Average Implemented Barrels of Oil Avoided by Fiscal Year

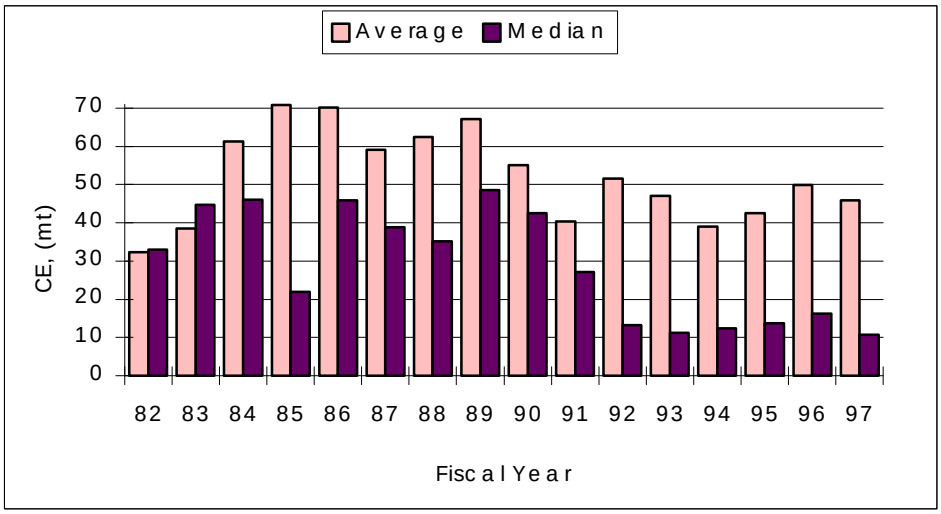


Figure 33. Average Implemented Carbon Avoided by Fiscal Year

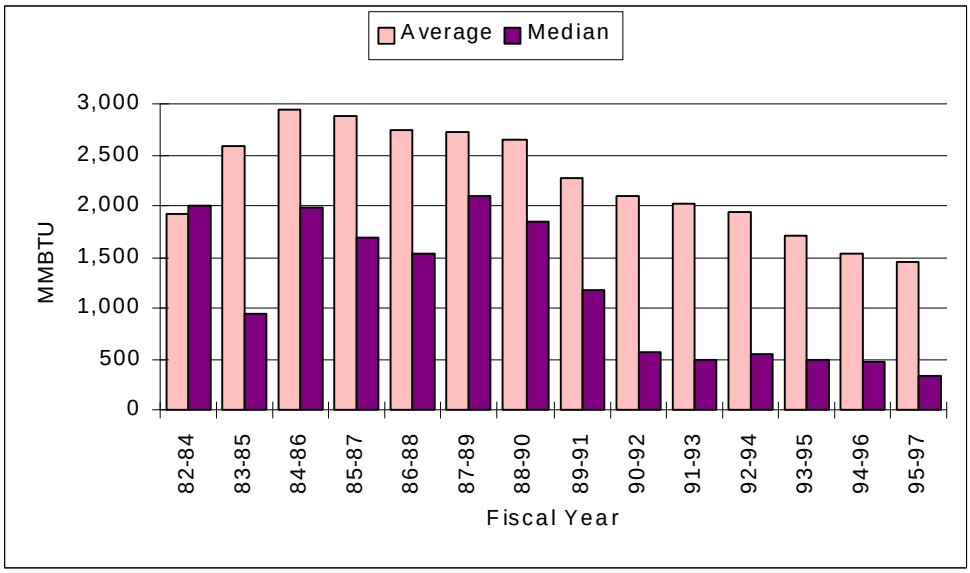


Figure 34. Average and Median Implemented Energy Conserved Per Assessment (3 Year Average)

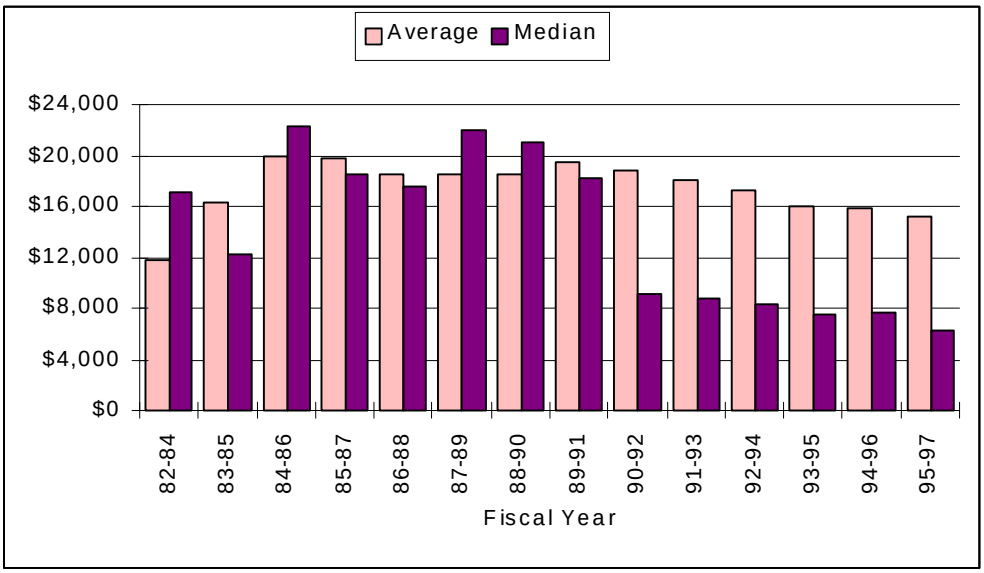


Figure 35. Average and Median Implemented Energy Cost Savings Per Assessment (3 Year Average)

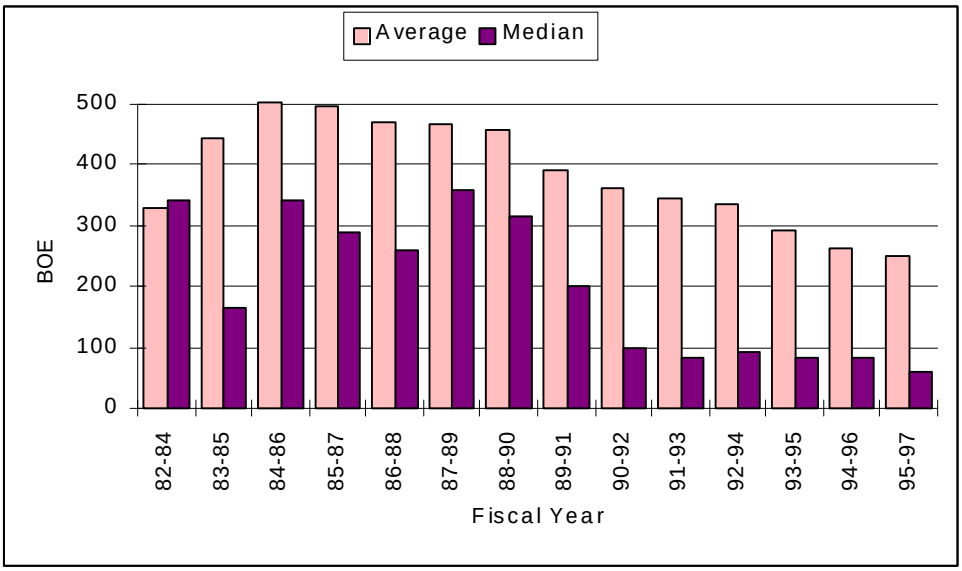


Figure 36. Average and Median Implemented Barrels of Oil Avoided Per Assessment (3 Year Average)

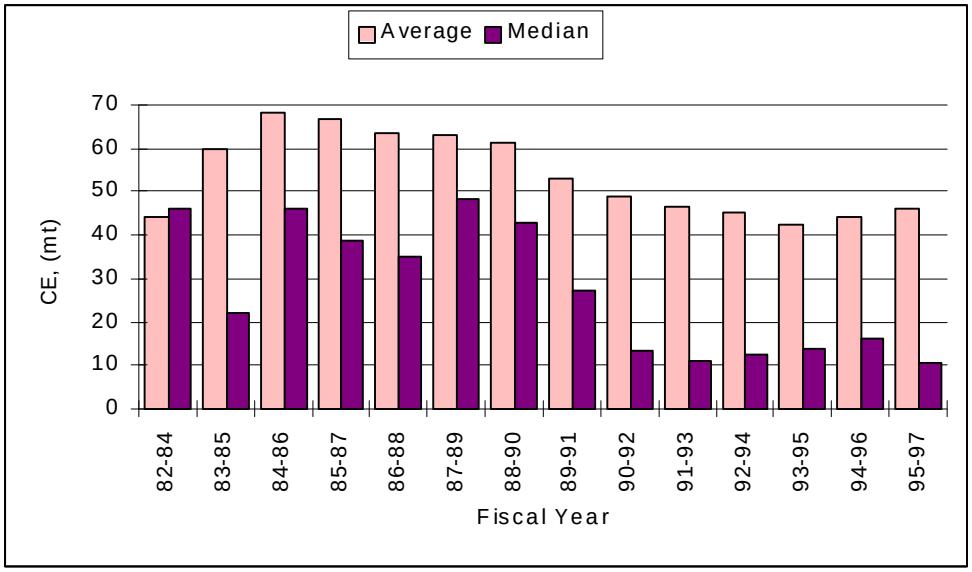


Figure 37. Average and Median Implemented Carbon Avoided Per Assessment (3 Year Average)

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	2,228	382	52	19,296	n/a	n/a	19,296
93	2,041	350	47	16,577	28	2,818	19,423
94	1,687	290	39	16,283	2,261	1,918	20,462
95	1,488	255	43	15,598	5,368	3,106	24,073
96	1,440	248	50	15,777	8,377	8,128	32,283
97	1,455	251	46	14,077	7,876	34,021	55,974

Table 20. Average First Year Implemented Savings by Fiscal Year

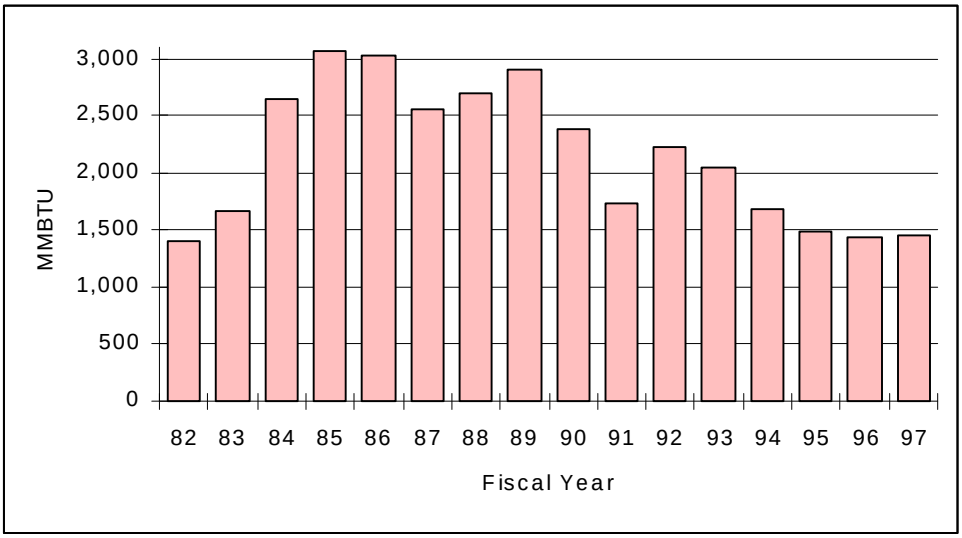


Figure 38. Average First Year Implemented Energy Conserved by Fiscal Year

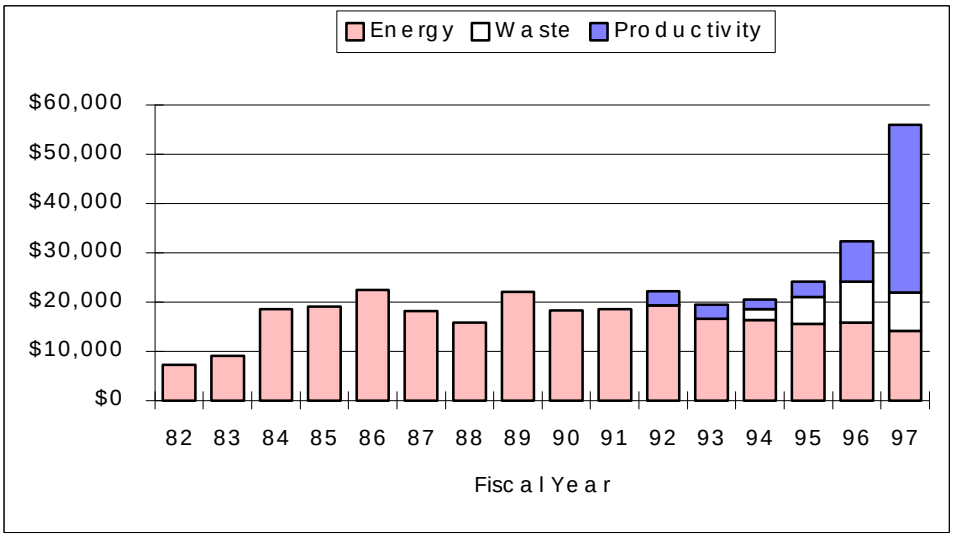


Figure 39. Average First Year Implemented Cost Savings by Fiscal Year

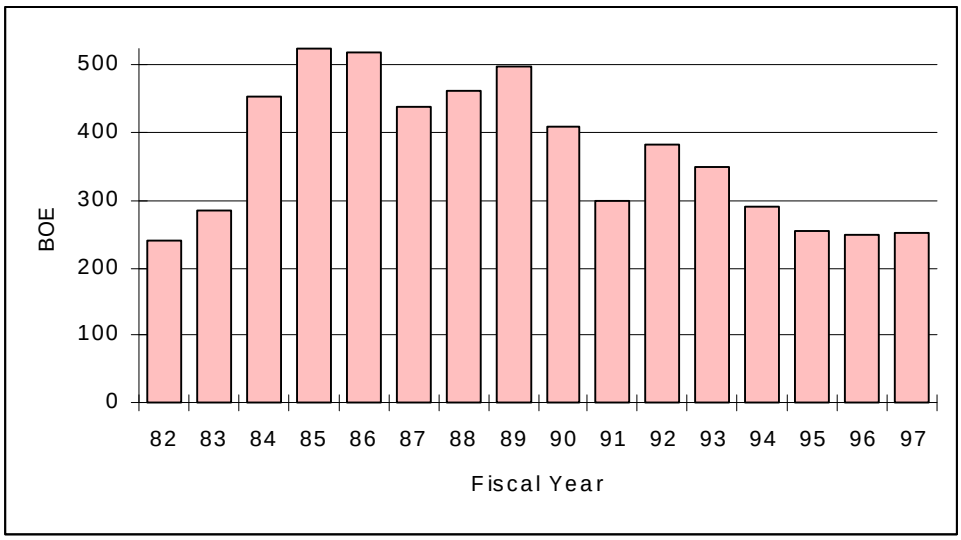


Figure 40. Average First Year Implemented Barrels of Oil Avoided by Fiscal Year

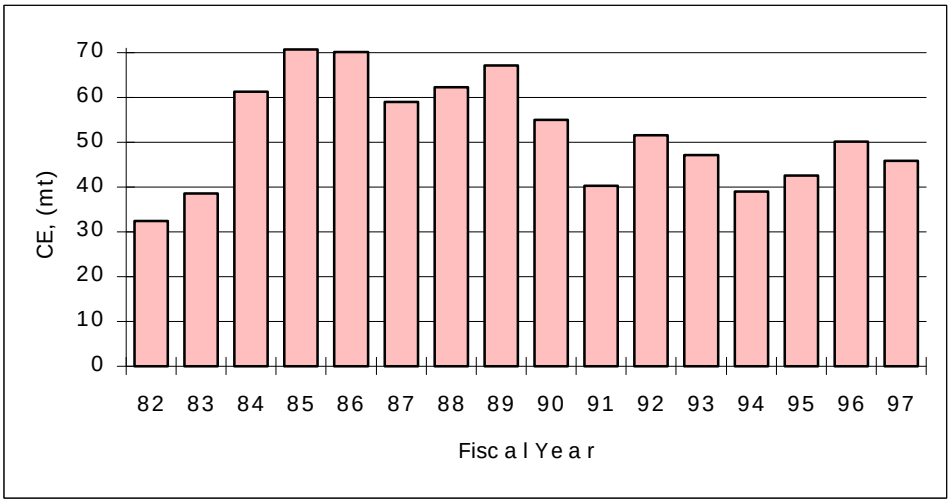


Figure 41. Average First Year Implemented Carbon Avoided by Fiscal Year

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 was in SIC 20 (food and kindred products); the largest in cost savings was SIC 30 (Rubber and Plastic Products).

		Implemented Energy Conservation			Implemented Cost Savings ($)			
SIC Code	Industry Description	(MMBtu)	(B.O.E.)	(C.E., mt)	Energy	Waste	Productivity	Total
20	Foods	185,587	31,998	5,854	876,607	1,214,072	3,058,964	3,935,571
21	Tobacco Prod.	30,061	5,183	948	108,210	9,154	6,003	114,213
22	Textile Mills	114,561	19,752	3,613	531,220	332,992	306,328	837,548
23	Apparel	2,603	449	82	30,726	7,800	157,434	188,160
24	Wood Prod.	13,026	2,246	411	127,938	151,403	1,067,267	1,195,205
25	Furniture	17,855	3,078	563	202,845	211,520	345,033	547,878
26	Paper Prod.	120,934	20,851	3,815	791,794	316,699	2,348,061	3,139,855
27	Printing	12,534	2,161	395	227,876	291,484	395,499	623,375
28	Chemical Prod.	15,832	2,730	499	210,788	65,960	1,303,335	1,514,123
29	Petroleum	10,847	1,870	342	50,000	60,836	27,680	77,680
30	Rubber & Plast.	103,024	17,763	3,250	1,621,438	626,305	2,805,474	4,426,912
31	Leather Prod.	4,966	856	157	84,356	120,603	280,588	364,944
32	Stone & Glass	18,809	3,243	593	125,593	30,344	233,773	359,366
33	Primary Metal	93,022	16,038	2,934	1,406,023	289,589	1,206,059	2,612,082
34	Fab. Metal	49,906	8,604	1,574	729,604	396,147	2,052,801	2,782,405
35	Ind. Machinery	78,544	13,542	2,477	978,996	659,043	1,920,135	2,899,131
36	Electronics	17,486	3,015	552	453,656	83,933	1,459,775	1,913,431
37	Trans. Equip.	49,327	8,505	1,556	516,795	261,366	2,725,701	3,242,496
38	Instruments	11,757	2,027	371	96,978	21,170	423,725	520,703
39	Misc. Manuf.	9,533	1,644	301	119,395	47,675	330,369	449,764
Totals		**960,214**	**165,554**	**30,287**	**9,290,838**	**5,198,095**	**22,454,004**	**36,942,937**

Table 21. Implemented Energy and Cost Savings by Industry Type

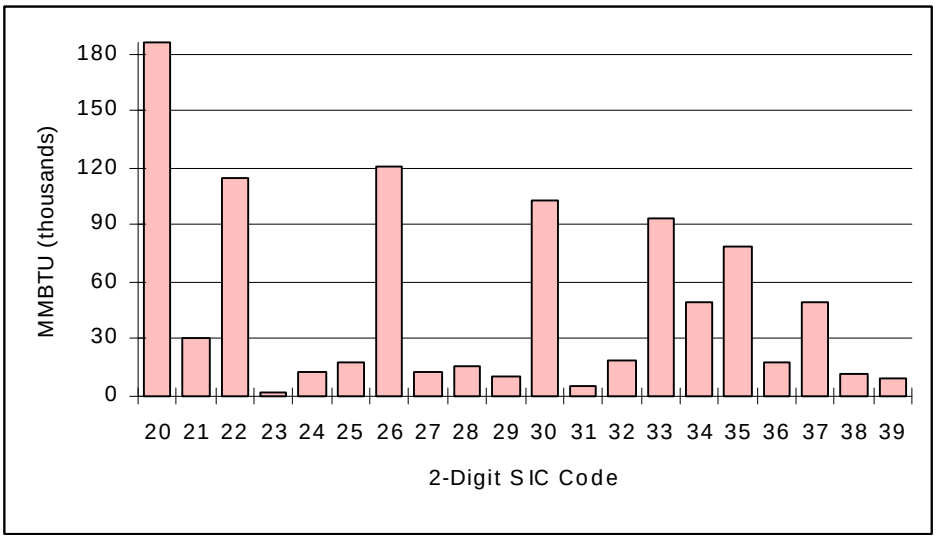


Figure 42. Implemented Energy Conserved by Industry Type

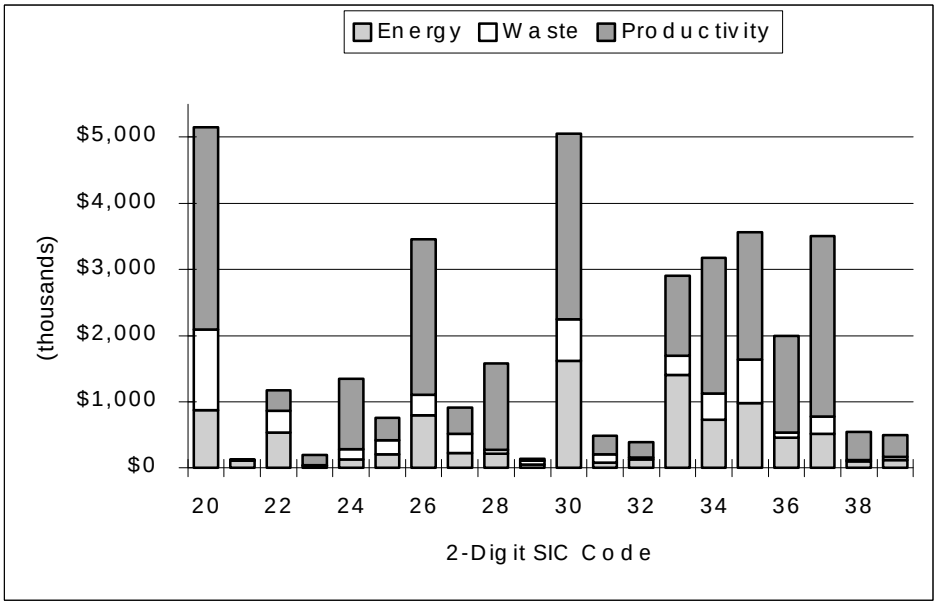


Figure 43. Implemented Cost Savings by Industry Type

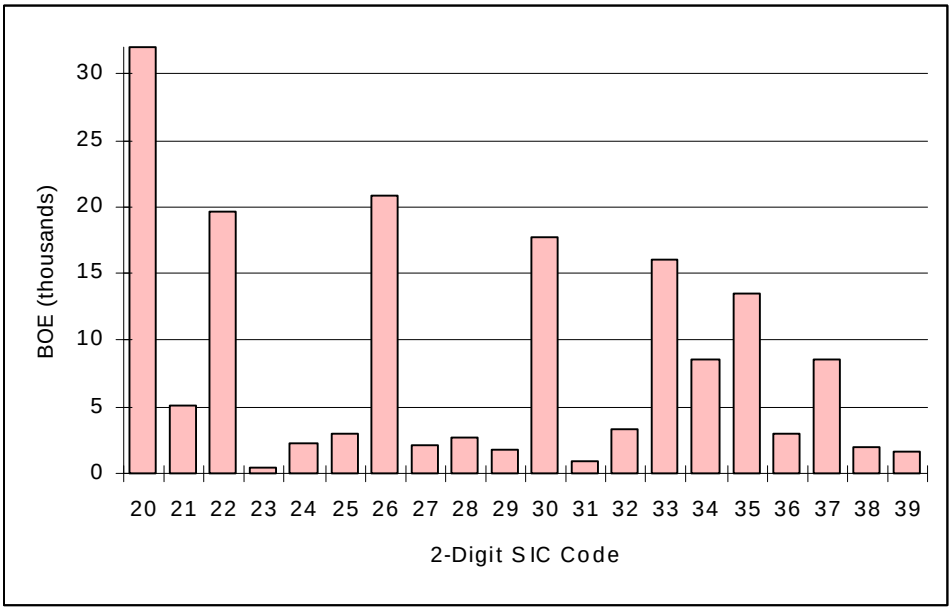


Figure 44. Implemented Barrels of Oil Avoided by Industry Type

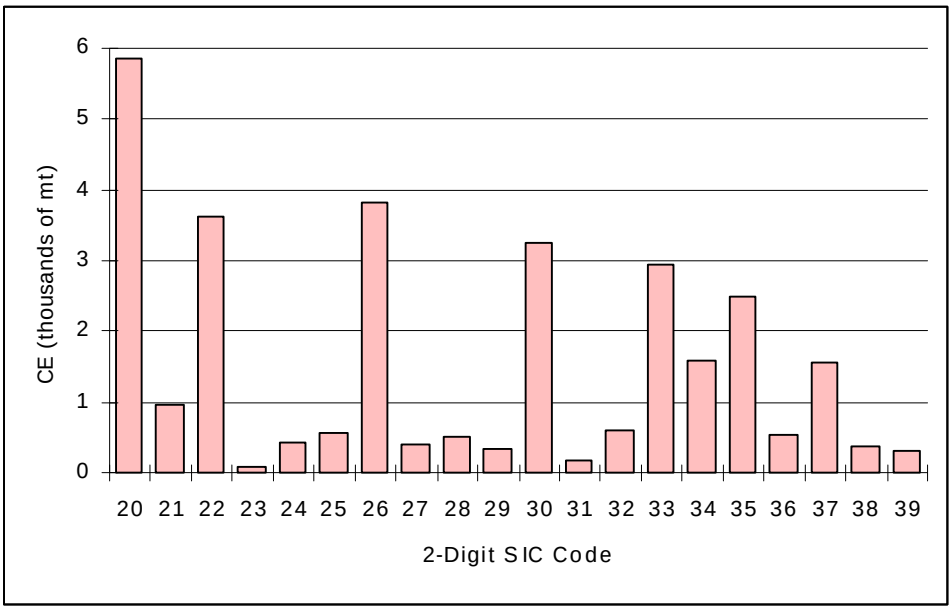


Figure 45. Implemented Carbon Avoided by Industry Type

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			Implemented Cost Savings ($)			
		(MMBtu)	(B.O.E.)	(C.E., mt)	Energy	Waste	Productivity	Total
20	Foods	2,578	444	81	12,175	16,862	42,486	71,523
21	Tobacco Products	30,061	5,183	948	108,210	9,154	6,003	123,367
22	Textile Mills	4,981	859	157	23,097	14,478	13,319	50,893
23	Apparel	237	41	7	2,793	709	14,312	17,815
24	Wood Prod.	501	86	16	4,921	5,823	41,049	51,793
25	Furniture	812	140	26	9,220	9,615	15,683	34,518
26	Paper Prod.	2,950	509	93	19,312	7,724	57,270	84,306
27	Printing	330	57	10	5,997	7,671	10,408	24,075
28	Chemical Prod.	720	124	23	9,581	2,998	59,243	71,822
29	Petroleum	2,712	468	86	12,500	15,209	6,920	34,629
30	Rubber & Plast.	1,288	222	41	20,268	7,829	35,068	63,165
31	Leather Prod.	451	78	14	7,669	10,964	25,508	44,141
32	Stone & Glass	1,106	191	35	7,388	1,785	13,751	22,924
33	Primary Metal	3,001	517	95	45,356	9,342	38,905	93,602
34	Fab. Metal	574	99	18	8,386	4,553	23,595	36,535
35	Ind. Machinery	1,007	174	32	12,551	8,449	24,617	45,618
36	Electronics	546	94	17	14,177	2,623	45,618	62,418
37	Trans. Equip.	1,541	266	49	16,150	8,168	85,178	109,496
38	Instruments	784	135	25	6,465	1,411	28,248	36,125
39	Misc. Manuf.	561	97	18	7,023	2,804	19,433	29,261
Average		**1,455**	**251**	**46**	**14,077**	**7,876**	**34,021**	**55,974**

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

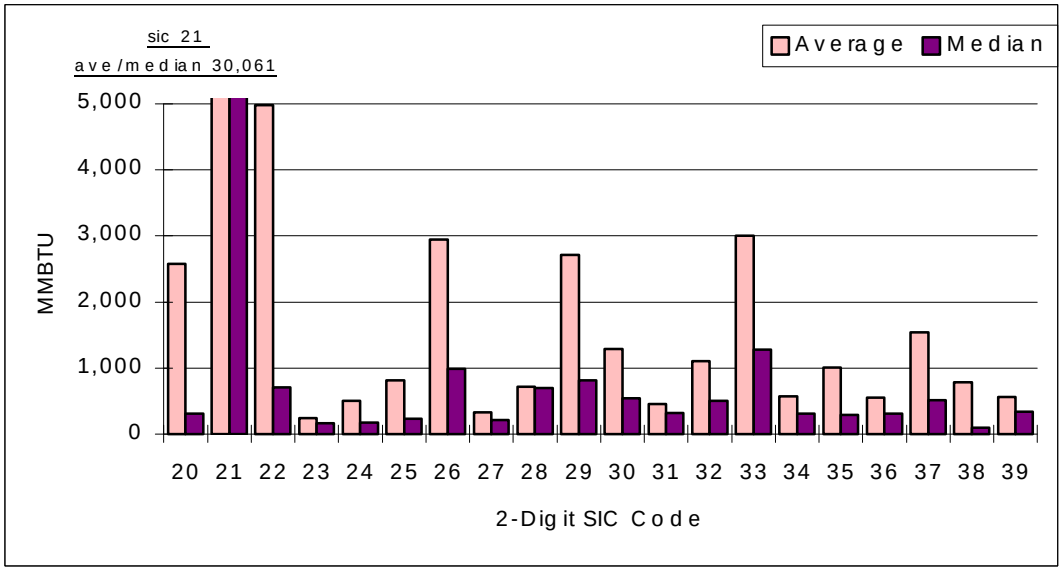


Figure 46. Average and Median Implemented Energy Savings by Industry Type

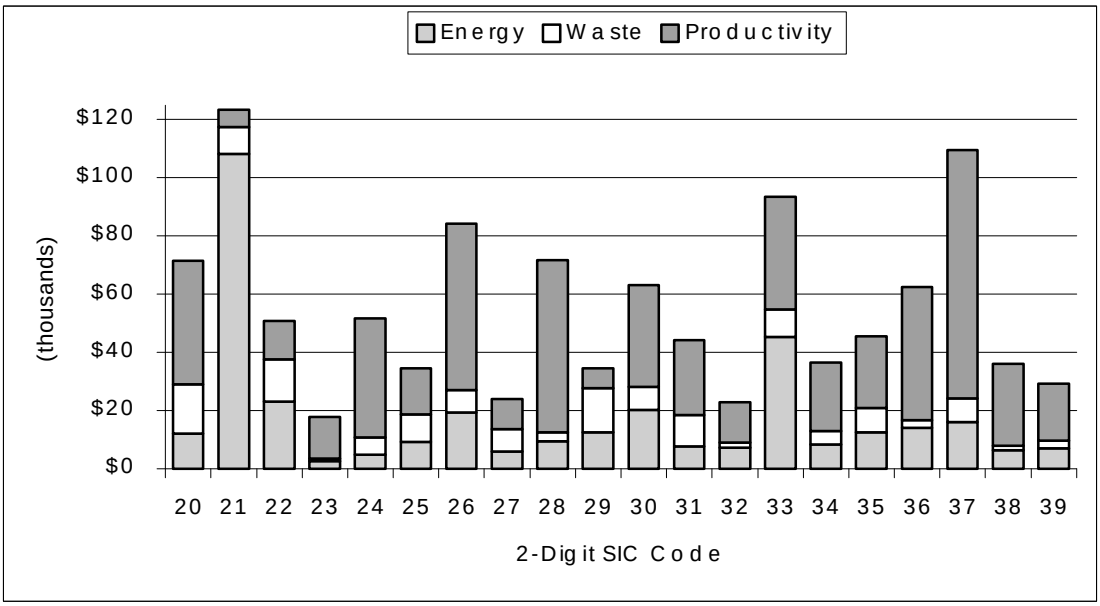


Figure 47. Average Implemented Cost Savings by Industry Type

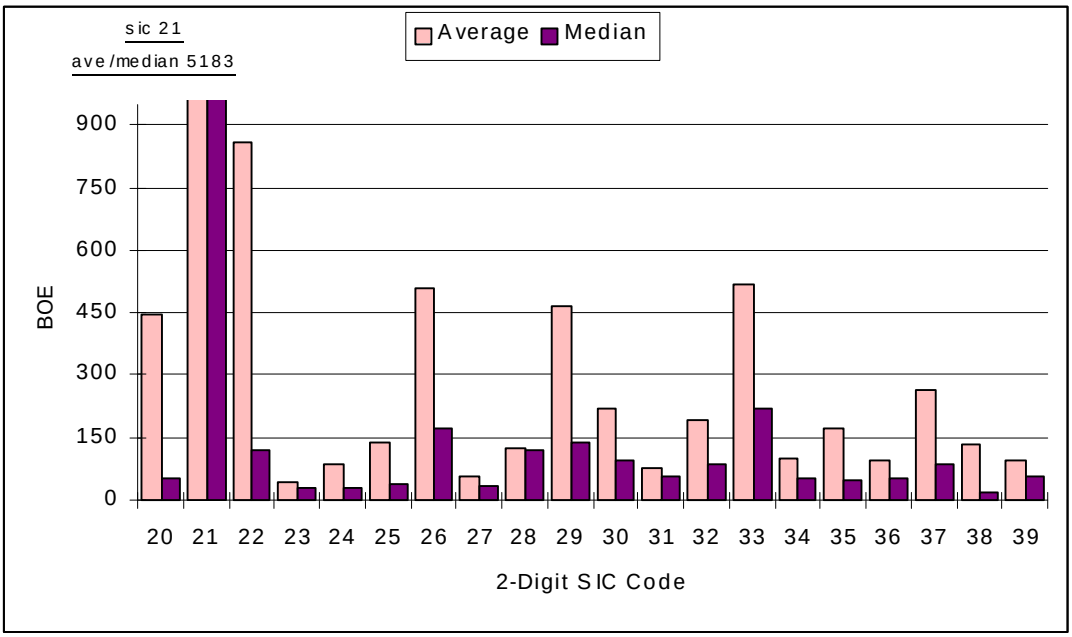


Figure 48. Average and Median Implemented Barrels of Oil Avoided by Industry Type

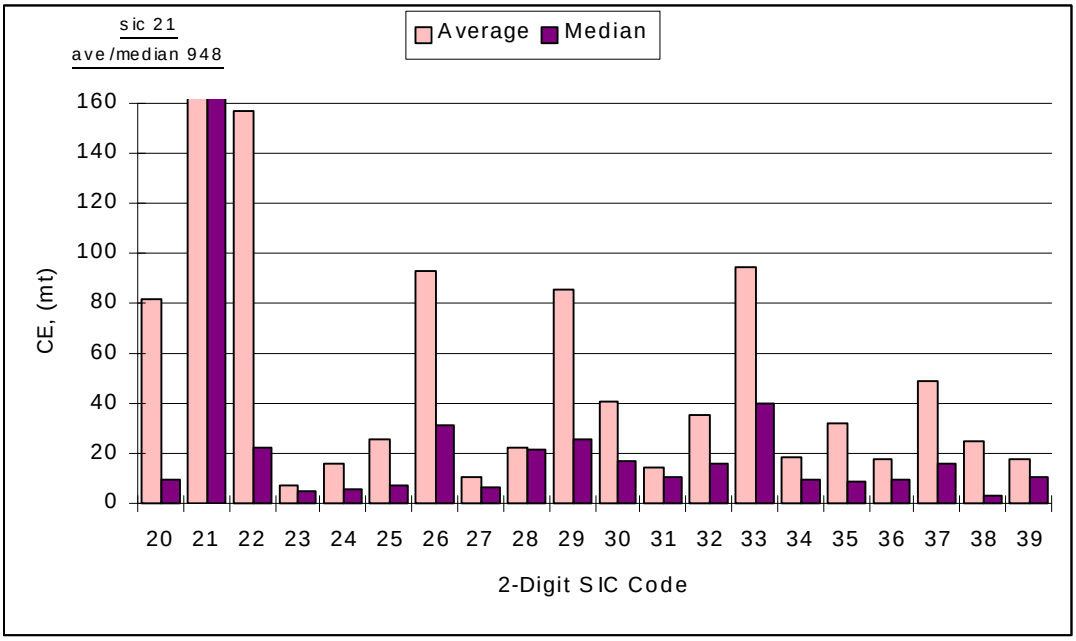


Figure 49. Average and Median Implemented Carbon Avoided by Industry Type

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	221,023 KW-months/yr	2,159,636
Fees		257,335
Consumption	392,793	4,998,856
Natural Gas	447,817	1,496,165
L. P. G.	5,917	28,359
Fuel Oil #1	0	0
Fuel Oil #2	-232	-349
Fuel Oil #4	225	965
Fuel Oil #6	109,114	350,344
Coal	0	0
Wood	4,580	4,527
Other Gas	0	-5,000
Energy Totals	**960,214**	**9,290,838**
Non-Energy	n/a	49,345,933
Program Totals	**960,214**	**58,636,771**

Table 23. Implemented Energy and Cost Savings by Resource Stream

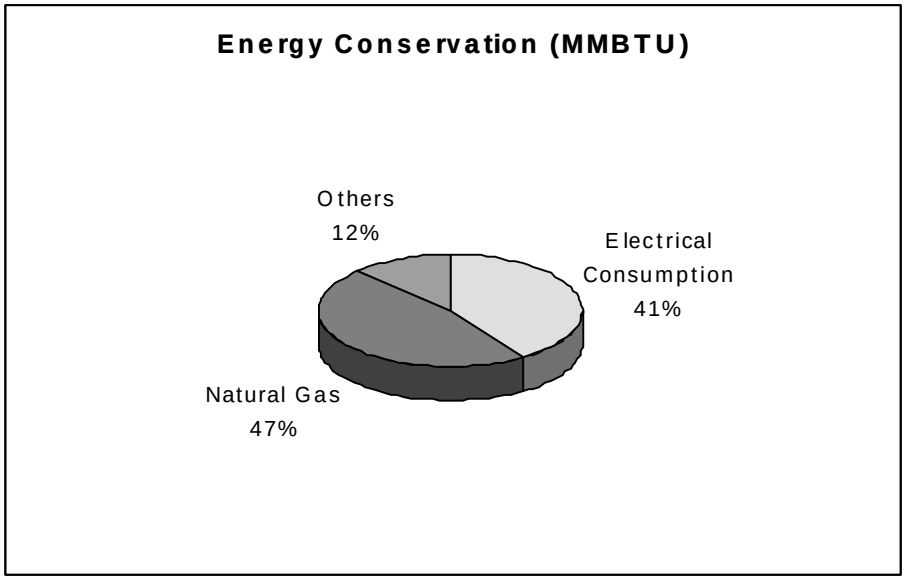


Figure 50. Composition of Implemented Energy Conserved by Energy Stream

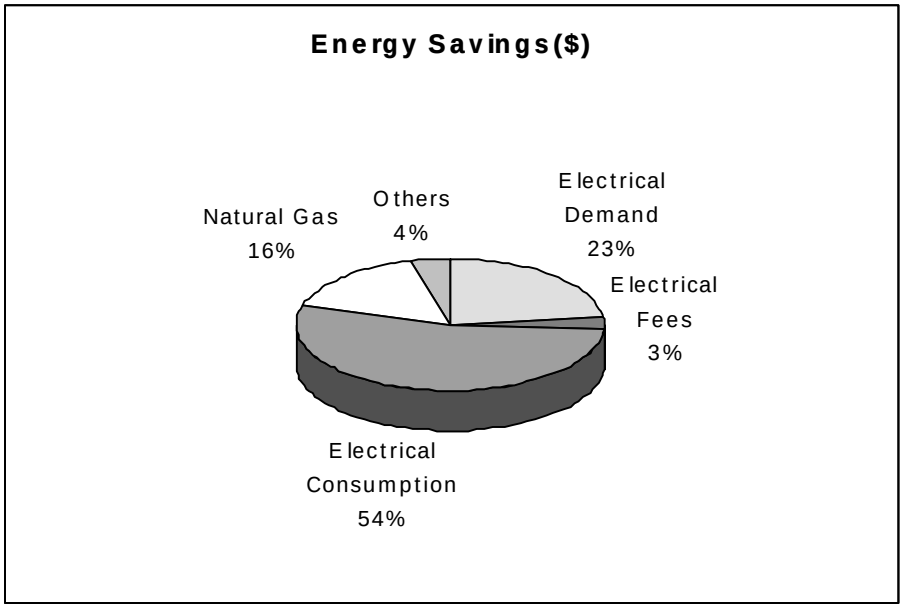


Figure 51. Composition of Implemented Energy Cost Savings by Energy Stream

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	7,400,497
Byproduct Production	1,366,915
Resource Costs	
Personnel Changes	4,846,759
Administrative Costs	5,529,461
Primary Raw Material	1,416,200
Ancillary Material Cost	1,770,961
Water Consumption	123,211
Waste Reduction	
Water Disposal	742,978
Other Liquid (non-haz)	500,517
Other Liquid (haz)	854,432
Solid Waste (non-haz)	2,989,361
Solid Waste (haz)	110,328
Gaseous Waste (haz)	479
Non-Energy Total	**27,652,099**

Table 24. Total Implemented Non-Energy Cost Savings

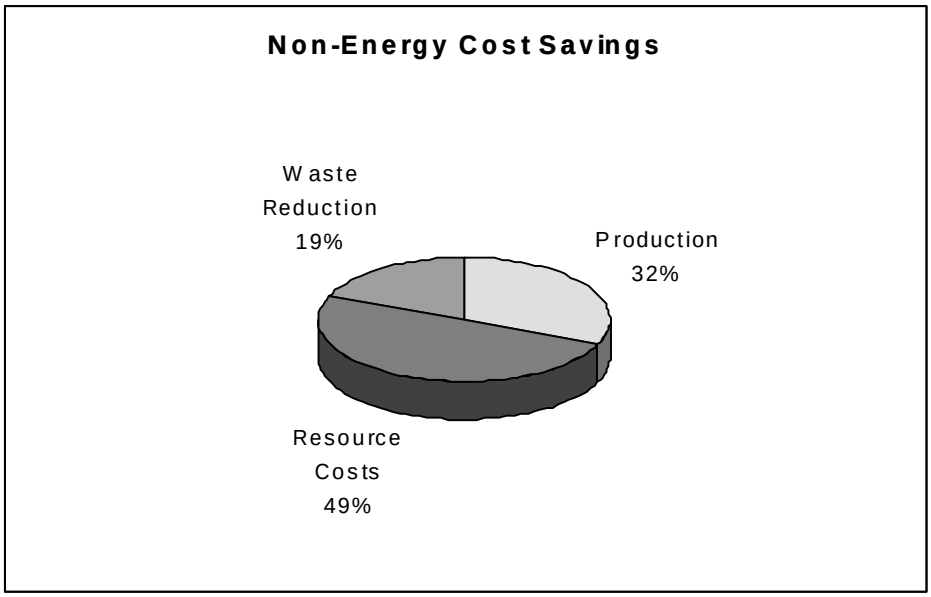


Figure 52. Composition of Non-Energy Implemented Savings

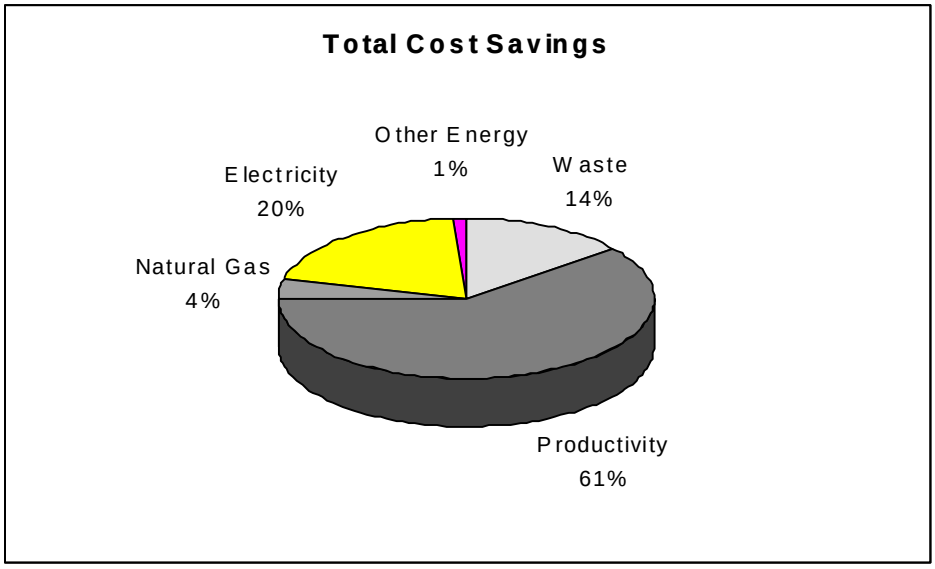


Figure 53. Composition of Total Implemented Cost Savings

iv. Implemented Savings by Recommendation Type

Finally, the number of implemented recommendations by type for Fiscal Year 1997 is shown in Table 25 and Figure 54.

2-Digit ARC Code	Category Description	No. of Imp'd Recs	No. of Recs	% of Imp'd Recs
2.1	Combustion Systems	101	210	48.1%
2.2	Thermal Systems	182	417	43.6%
2.3	Electrical Power	63	167	37.7%
2.4	Motor Systems	793	1268	62.5%
2.5	Industrial Design	4	13	30.8%
2.6	Operations	55	107	51.4%
2.7	Buildings and Grounds	594	1228	48.4%
2.8	Ancillary Costs	61	122	50.0%
2.9	Alternate Energy Use	0	0	n/a
3.1	Operations	59	157	37.6%
3.2	Equipment	32	71	45.1%
3.3	Post Generation Treatment / Minimization	18	61	29.5%
3.4	Water Use	106	248	42.7%
3.5	Recycling	200	431	46.4%
3.6	Waste Disposal	54	166	32.5%
3.7	Maintenance	36	77	46.8%
3.8	Raw Materials	30	93	32.3%
4.1	Manufacturing Enhancements	39	100	39.0%
4.2	Purchasing	16	43	37.2%
4.3	Inventory	21	50	42.0%
4.4	Labor Optimization	97	201	48.3%
4.5	Space Utilization	54	114	47.4%
4.6	Reduction of Downtime	55	113	48.7%
4.7	Management Practices	21	28	75.0%
4.8	Other Administrative Savings	19	29	65.5%
	Total	**2710**	**5514**	**49.1%**

Table 25. Number of Implemented Recommendations by Recommendation Type

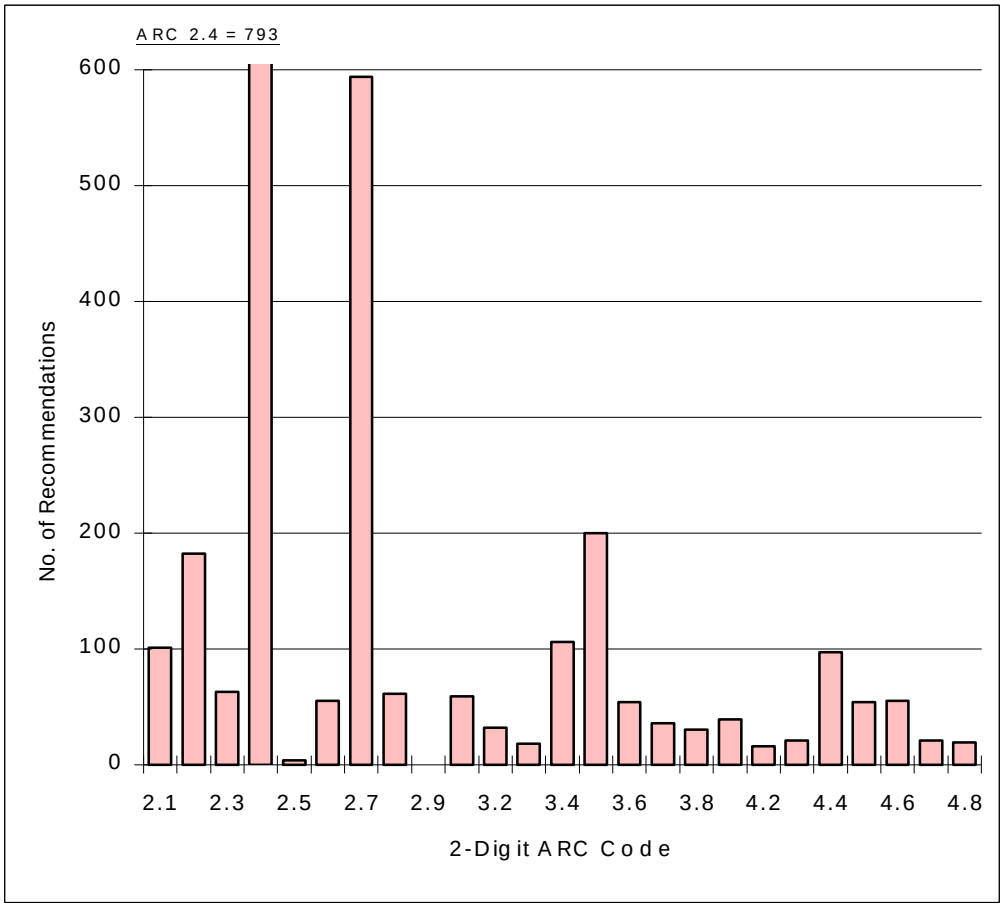


Figure 54. Number of Implemented Recommendations by Recommendation Type

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, FY97

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:

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

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 FY97.

These leverage ratios (or profitability indices) show that, at a 10% discount rate, the federal government will realize $4.19 to $5.82 for every federal dollar spent on the program in FY97. Similarly, manufacturers will, as a group, receive $4.07 to $5.36 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	83.3	5.06	4.02	712	4.76	3.94
3	3	6	81.3	4.98	3.95	627	4.70	3.89
3	3	9	79.3	4.90	3.88	557	4.63	3.83
3	3	6	81.3	4.98	3.95	627	4.70	3.89
6	3	6	80.9	4.96	3.93	623	4.68	3.87
6	0	6	74.7	4.19	3.31	594	4.07	3.38
6	3	6	80.9	4.96	3.93	623	4.68	3.87
6	6	6	87.1	5.82	4.63	651	5.36	4.42
12	6	6	86.3	5.78	4.59	643	5.32	4.39

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

Major Activities and Highlights of the Eastern Region

In Fiscal Year 1997, 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 FY97, the Eastern Region was comprised of fifteen experienced Centers performing 30 assessments, with the exception of the University of Louisville which performed 15, bringing the total number of assessments performed in the east to 365. The addresses and phone numbers of all Centers is given in the appendix. The schools and directors participating in the program in FY97 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. Henry N. Chuang
(UF)	University of Florida	Dr. Barney L. Capehart
(UL)	University of Louisville	Dr. James Watters
(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 an average of 8 years in the program. Dr. Henry Chuang became the first director to personally conduct 500 assessments.

Centers	Date Entered Program	96 Assessments Completed	Director's Years in Program	Student Participation	
				Graduate	Under Grad.
GT	FY82	30	7	0	6
HO	FY92	15	2	0	7
MA	FY84	30	14	6	1
ME	FY93	30	5	0	12
MS	FY94	30	4	0	12
NC	FY93	30	4	5	4
ND	FY91	30	7	1	15
OD	FY94	30	4	3	11
TN	FY76	30	22	1	4
UD	FY76	30	22	0	5
UF	FY91	30	7	6	21
UL	FY94	30	4	10	9
UM	FY94	30	4	4	4
WI	FY87	30	11	2	4
WV	FY93	30	5	11	11

Table 27. History of Eastern Centers

Other activities that occurred during the fiscal year included:

- Rutgers participated in the 2nd Industrial Energy Efficiency Symposium and Exposition held in February, hosted in Washington, DC. Database products and demonstrations were available in the “Electronic Café”.

- The OIPEA assessment team in conjunction with the IAC at the University of Louisville conducted an assessment at BTR Metals in Russselville, KY at the request of the DoE. The assessment was conducted over 2 days in May, and was used both as a demonstration of multi-day assessments, and as a cooperative venture with the cast metals team of the *Industries of the Future* program.

- Rutgers University promoted and represented the IAC at the ACEEE Summer Study in Saratoga Springs, NY. Two papers on IAC related topics were submitted and presented; ***Motor Maintenance: a Survey of Techniques and Results*** authored by T. Barnish, M.R. Muller, and D. Kasten, and ***Experiences in Integrating Productivity, Pollution Prevention, and Energy Conservation*** by Kasten, Muller, and Barnish.

- In the continuing effort to introduce more financial tools and opportunities to IACs and their clients, Timothy Barnish attended the Financial Workshop held in Chicago, IL in September.

- In an effort to get more substantive case studies, the centers in the east each identified one significant client that was willing to have their story publicized. From this information, OIPEA produced 15 case studies with client names for use in advancing the program goals. These studies are included in the appendix of this report.

- Awards were granted to the centers at the University of Massachusetts to study multi-day assessments, and to Mississippi State to study energy savings in baghouse operations.

B. Western Region

I. Major Activities and Highlights

During FY97 the ITEM division of University City Science Center provided field management for the western region where 15 centers served a total of 355 manufacturers. Twelve of the western region IACs each completed 25 industrial assessments, while the other 3 centers performed a total of 55. The centers are listed below, along with the directors and the number of industrial assessments completed.

IAC	FY97 Director	Assessments Completed
Arizona State University	Dr. Byard Wood/Dr. Patrick Phelan	20
University of Arkansas at Little Rock	Dr. Mamdouh Bakr	25
Bradley University	Dr. Paul Mehta	25
Colorado State University	Dr. Harry W. Edwards	25
Iowa State University	Mr. Richard Rusk	25
University of Kansas	Dr. Jerry D. Swearingen	15
University of Missouri-Rolla	Dr. Burns E. Hegler	25
University of Nevada-Reno	Dr. Yunus A. Cengel	20
Oklahoma State University	Dr. Wayne C. Turner`	25
Oregon State University	Dr. George M. Wheeler	25
San Diego State University	Dr. Asfaw Beyene	25
San Francisco State University	Dr. Ahmad Ganji	25
South Dakota State University	Dr. Kurt Bassett	25
Texas A&M University (College Station)	Dr. Warren M. Heffington	25
Texas A&M University-Kingsville	Dr. Yousri Elkassabgi	25

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

- Drs. Wheeler and Medina provided on-site assistance to the Mexican Industrial Energy Centers.
- ITEM participated in the 2nd Industrial Energy Efficiency Symposium and Exposition held February 24 through 27, 1997.
- Awards were made to the San Francisco State University and Texas A&M IACs to conduct special projects. San Francisco State's project involved the evaluation of power washers and verification of ECOs, WMOs, and PIOs. Texas A&M's project involved a plant electrical demand analysis. Work continued through FY98.

- II. Analysis of Results

Fifteen western region IACs served 355 manufacturing plants in FY97 across a wide range of industries as illustrated in Figure 55. The distribution of industry types for the total

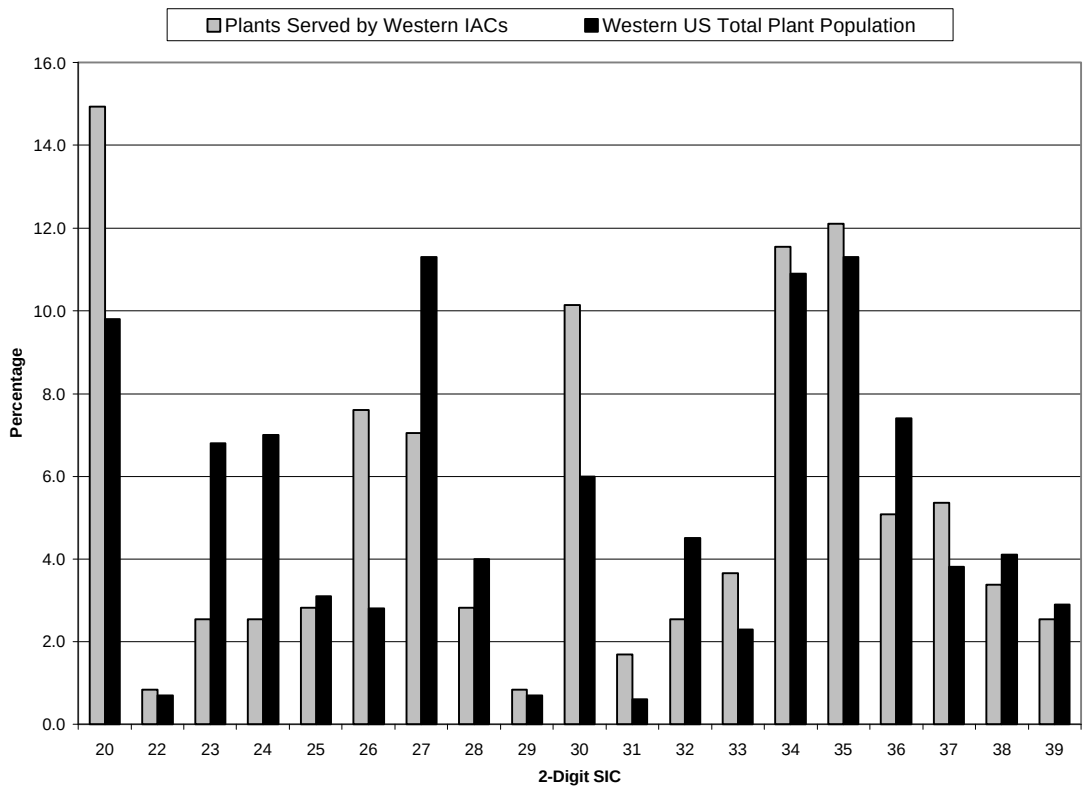


Figure 55. SIC Distribution of Assessments (FY 97 Western Region)

population of small and medium-size plants in the western U.S. is shown for reference. Characteristics of the average plant served in FY97 are provided below, along with comparable figures for FY96.

	FY 97	FY96
Sales, MM $/yr	31	28
Employees	173	158
Energy consumption, 10^9 BTU/yr	43	52
Energy cost, 10^3 $/yr	331	377
Energy mix, BTU%		
Electricity	38	32
Natural Gas	60	64
Other Fuels	2	14

IACs recommended 3,054 measures with cost savings of \$67.6 x 10^6/yr during FY97. Manufacturers implemented 1,569 measures (51% of those recommended) resulting in cost savings of \$20.1 x 10^6/yr. Reported implementation costs for all implemented measures were \$17.8 x 10^6 for an overall simple payback of 0.9 years.

Table 27 provides information on the implemented cost savings contributions and paybacks for the various types of assessment recommendations. Energy management measures accounted for 30% of the total implemented cost savings, with a 54% implementation of recommended measures and an average payback of 1.1 years. Motor systems, buildings and grounds, and thermal systems comprised the top three types of measures and 78% of the energy management cost savings. The waste minimization/pollution prevention category made up 33% of the total implemented cost savings at a 44% implementation rate based on measures recommended and a 1.0 year average payback period. Operations, equipment, and recycling were the top three types of measures accounting for 72% of the implemented cost savings in the waste minimization/pollution prevention category. The productivity enhancement category comprised 37% of the total implemented cost savings and yielded a 0.6 year average payback. The top three contributors to implemented productivity enhancement cost savings were labor optimization, manufacturing enhancements, and space utilization, accounting for 74% of this category.

It is interesting to note from the data in Table 27 the differences in the average cost savings per AR among the different categories of measures. In FY97 the average cost savings per AR for an implemented energy management AR was about \$5,800/yr, whereas for waste minimization/pollution prevention it was about \$20,100/yr, and for productivity enhancement it was about \$37,300/yr.

Average implemented cost savings of \$56,700/yr/plant in FY97 were significantly greater than the two previous years, despite a somewhat lower percentage of ARs implemented as shown below:

	FY 97	FY96	FY95
Implemented Cost Savings			
\$/yr/plant	56,700	35,600	23,900
Implementation			
Rate, % ARs Implemented	51	58	57

The addition of waste minimization in FY96 and productivity enhancements in FY97 contributed significantly to growth in implemented savings in those years.

However, there was still about $47 x 10^6/yr or an average of about $133,800/yr/plant of non-implemented cost savings potential identified by the IACs in FY97. Information on non-implemented cost savings is provided in Table 28. About 10% of the non-implemented savings was in the energy management category, 17% in waste minimization, and 73% in productivity enhancement. Buildings and grounds and motor systems were the two types of energy management measures with the greatest amount of cost savings not implemented. Equipment, operations, and recycling measures accounted for the most non-implemented cost savings in the waste minimization and pollution prevention category. Manufacturing enhancements, reduction of downtime, and labor optimization were the leading types of productivity enhancements not implemented. Note that very significant waste minimization and productivity enhancement type measures were not implemented, despite very attractive estimated payback times.

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 includes non-specific reasons or instances where the plant could not be contacted. Non-implemented cost saving measure percentages for the major categories are summarized below:

Category of Reason	% of Non-Implemented Cost Saving Measures
Plant-internal	42%
Financial	10%
IAC-fault	22%
Other	26%
Total Non-Implementation	100%

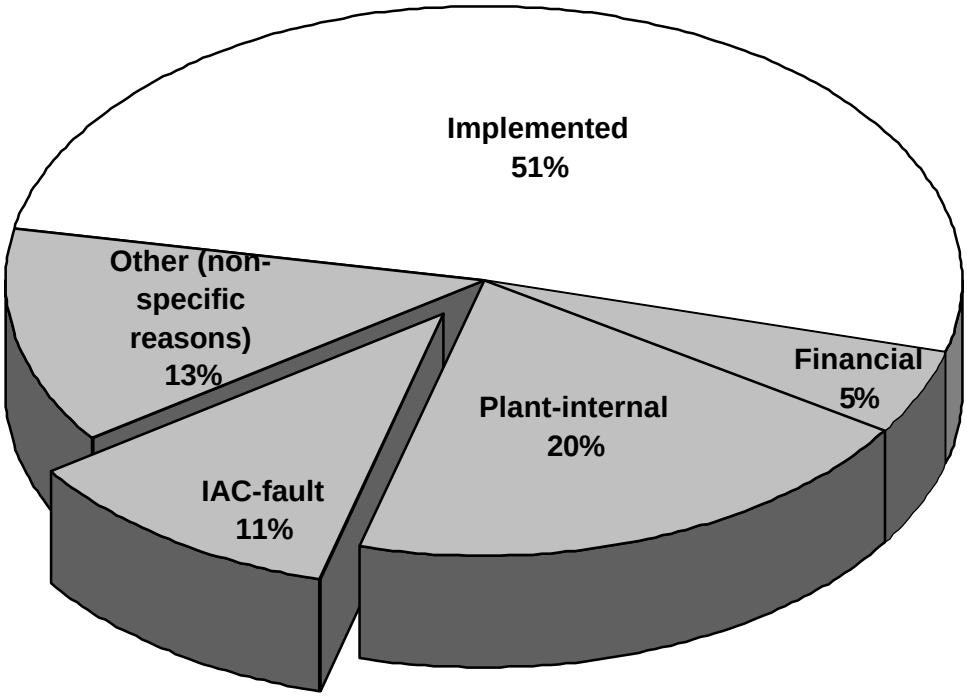
Note that about three-fourths of the non-implemented cost saving measures with specifically identified reasons are attributed to plant-internal and financial factors and less than one-fourth are the fault of the IAC. But keep in mind that 51% of the recommended cost saving measures were implemented. Figure 56 provides a breakdown of total recommended cost saving measures which illustrates that manufacturers had problems with the quality of ARs representing only about 11% of the total recommended cost saving measures.

	Implemented Cost Savings ($/year)	Number of ARs Implemented	Payback Time (years)	AR Implementation Rate
Energy Management				
Motor Systems	2,914,371	472	0.9	66.4%
Buildings and Grounds	1,186,208	350	1.9	47.7%
Thermal Systems	651,930	91	1.9	49.2%
Combustion Systems	477,551	43	0.5	45.3%
Ancillary Costs	355,468	23	0.2	52.3%
Electrical Power	337,557	32	0.9	39.5%
Operations	104,678	27	0.3	50.9%
Industrial Design	27,336	1	0.1	33.3%
Total	**6,055,099**	**1039**	**1.1**	**54.5%**
Waste Minimization/Pollution Prevention				
Operations	1,949,316	37	0.3	44.6%
Recycling	1,752,728	125	2.5	43.1%
Equipment	1,059,403	19	0.5	46.3%
Water Use	735,206	62	0.8	51.2%
Raw Materials	442,973	21	0.1	36.8%
Maintenance	310,935	22	0.1	45.8%
Waste Disposal	241,154	33	0.9	40.2%
Post Generation Treatment/Minimization	143,709	11	1.0	40.7%
Total	**6,635,424**	**330**	**1.0**	**44.1%**
Productivity Enhancement				
Labor Optimization	3,108,719	58	0.5	45.7%
Manufacturing Enhancements	1,474,168	25	0.6	42.4%
Space Utilization	968,999	38	0.9	52.8%
Management Practices	662,525	20	0.6	76.9%
Reduction of Downtime	880,027	36	0.5	54.5%
Inventory	309,270	8	0.8	40.0%
Purchasing	24,953	6	0.6	33.3%
Other Administrative Savings	24,248	9	0.1	75.0%
Total	**7,452,909**	**200**	**0.6**	**50.0%**
GRAND TOTAL	**20,143,432**	**1,569**	**0.9**	**51.4%**

Table 28. Ranking by Annual Cost Savings of Implemented Assessment Recommendation Types (FY 97 Western Region)

	Non-Implemented Cost Savings ($/year)	Number of ARs Not Implemented	Payback Time (years)	Percent of Total Recommended ARs
Energy Management				
Buildings and Grounds	1,337,003	384	1.1	52.3%
Motor Systems	1,120,236	238	1.2	33.5%
Combustion Systems	1,005,371	52	0.7	54.7%
Thermal Systems	638,459	94	1.6	50.8%
Electrical Power	270,379	49	0.8	60.5%
Ancillary Costs	252,054	21	0.7	47.7%
Industrial Design	143,900	2	0.8	66.7%
Operations	119,434	26	0.2	49.0%
Total	**4,886,836**	**866**	**1.1**	**45.5%**
Waste Minimization/Pollution Prevention				
Equipment	2,283,099	22	1.4	53.6%
Operations	2,254,363	46	0.8	55.4%
Recycling	1,794,925	165	0.8	56.9%
Water Use	715,118	59	0.9	48.8%
Waste Disposal	303,648	49	1.6	59.7%
Raw Materials	297,978	36	0.7	3.2%
Maintenance	288,367	26	0.6	54.2%
Post Generation Treatment/Minimization	235,750	16	1.4	59.2%
Total	**8,173,248**	**419**	**1.0**	**55.9%**
Productivity Enhancement				
Manufacturing Enhancements	11,150,429	34	0.3	57.6%
Reduction of Downtime	9,912,374	30	0.3	45.5%
Labor Optimization	6,670,445	69	0.6	54.3%
Space Utilization	3,096,557	34	0.5	47.2%
Inventory	3,052,006	12	1.5	60.0%
Purchasing	385,771	12	0.4	66.7%
Management Practices	145,118	6	0.5	23.1%
Other Administrative Savings	15,380	3	0.0	25.0%
Total	**34,428,080**	**200**	**0.5**	**50.0%**
GRAND TOTAL	**47,488,164**	**1485**	**0.6**	**48.6%**

Table 29. Ranking by Annual Cost Savings of Non-Implemented Assessment Recommendation Types (FY 97 Western Region)



Note: shaded region represents total non-implemented cost saving measures.

Figure 56. Breakdown of Total Recommended Cost Saving Measurres

(FY 97 Western Region)

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 for 1997 (Energy Information Agency)
5.) For purposes of this report those values were:

Coal	83.185 %
Natural Gas	13.197 %
Fuel Oil	3.618 %
Fossil Fuel Total	100%

Fossil Fuel Generation (68.828%)
Average Fossil Fuel Generation Efficiency (0.30433)
Non-fossil Fuel Generation (31.172%)

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

FY97 Implemented Average 69.6 lb. of Carbon per MMBtu

Appendix II.

IAC Program Contact List

Appendix III

IAC Territory Maps

Appendix IV

Eastern Region Case Studies