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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 twenty-two in Fiscal Year 1993. In Fiscal Year 1994 eight new universities were added to the program bringing the total to thirty centers. The new centers are Mississippi State University, Old Dominion University, the University of Louisville, the University of Michigan, Bradley University, the University of Nevada (Reno), South Dakota State University and Texas A&M (Kingsville). These centers were brought in as energy only centers and given a reduced load of 15 assessments, while experienced centers conducted 30. The centers conducted 776 assessments for small to medium sized manufacturers in FY94 through funding provided by the Office of Industrial Technologies (OIT) of the U.S. Department of Energy.

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. This group consisted of Colorado State University, the University of Massachusetts, Oregon State University, the University of Tennessee, Texas A&M University, and the University of Wisconsin. For this first year, the six IACs each conducted a minimum of ten combination, or industrial, assessments. For FY94, the number of Industrial Assessments actually amounted to 61.

The remaining experienced EADCs were trained in August of 1994 to bring them into the IAC program with the start of Fiscal Year 1995. This training was conducted at the University of Tennessee by the Center Director, Dr. Richard Jendrucko, with assistance from George Smelcer from the Waste Reduction Assistance Program at the University of Tennessee, and Dr. Harry Edwards of Colorado State University. An exception was made to include the University of Louisville into the IAC program in FY95 due to their previous involvement in a similar program which had been funded by the Environmental Protection Agency. Training scheduling projects entry of all centers into the IAC program by the start of the FY96 year.

Introduction (continued)

EADC/IAC assessments consist 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 employment was under 500 persons at the site, sales were less than $75 million, annual energy bills totaled under $1.75 million, and no professional staff were on hand to do the analyses. The resulting report produced for the manufacturer includes information about the plant's energy use, processes and other information.

In addition, several assessment recommendations are written up with sufficient detail to provide anticipated energy or waste cost savings, as well as implementation costs and simple paybacks. Within one year the staff of each center conducts a survey of the manufacturers to determine which recommended conservation measures were adopted.

For the second 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 maintains 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. Program statistics analysis, and graphics were generated by the database managers at Rutgers University. Section III., Standard Financial Calculations, was produced by the University City Science Center. Field management reports were contributed by each respective management organization.

II. Program Statistics

A. General

In Fiscal Year 1994, 776 assessments were performed bringing the program total to 5,152 assessments from inception. As only fifteen assessments were performed in FY81, the data shown in this report dates back to 1982, the second year for which data was available. The number of assessments in this data set is 5,137. Unless otherwise noted, Figures are for FY94. 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
Total	5,137	61

Table 1. Assessments Performed by Fiscal Year

The total amount of recommended energy conservation measures in FY94 was approximately 3,500,000 Million British Thermal Units (MMBTU) with a dollar value of over $35.5 million. The oil consumption that would be avoided was 600,000 barrels, measured in barrels of oil equivalent (BOE), and the carbon avoided was 81,000 metric tons, measured in carbon equivalent (CE).[1] Non-energy recommendations, such as administrative cost savings and waste reduction savings, amounted to $6.9 million. The resultant total recommended savings were $42.4 million.

[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.

The FY94 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 1,260,000 MMBTU, with a dollar value of almost $12.2 million. This equates to 216,000 barrels of oil and 29,100 metric tons of carbon avoided. The implemented non-energy measures resulted in a savings of $3.1 million. This brings the total implemented savings in FY94 to over $15 million.

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 FY94 is shown in the following Table by state.

STATE	Total No. of Assessments Performed in Each State	EADC/IAC	No. of Assessments Performed by Each EADC/IAC	Percent of the Total No. of Assessments Performed in Each State
Alabama	3	Georgia Institute of Tech.	2	67%
		University of Tennessee	1	33%
Arkansas	28	U. of Arkansas - Little Rock	28	100%
Arizona	30	Arizona State University	30	100%
California	61	University of Nevada	1	2%
		San Diego State University	30	49%
		San Francisco State U.	30	49%
Colorado	28	Colorado State University	28	100%
Connecticut	9	U. of Massachusetts	9	100%
Florida	28	University of Florida	28	100%
Georgia	30	Georgia Institute of Tech.	28	93%
		University of Florida	2	7%
Iowa	26	Iowa State University	26	100%
Illinois	40	Bradley University	15	37%
		U. of Missouri - Rolla	3	8%
		U. of Wisconsin - Milwaukee	22	55%
Indiana	30	Notre Dame University	23	77%
		University of Dayton	1	3%
		University of Louisville	6	20%
Kansas	17	University of Kansas	13	76%
		Oklahoma State University	4	24%
Kentucky	15	University of Tennessee	4	27%
		University of Dayton	2	13%
		University of Louisville	9	60%

Table 2. Geographic Distribution of Assessments by State

STATE	Total No. of Assessments Performed in Each State	EADC/IAC	No. of Assessments Performed by Each EADC/IAC	Percent of the Total No. of Assessments Performed in Each State
Massachusetts	16	U. of Massachusetts	16	100%
Maine	30	University of Maine	30	100%
Michigan	22	Notre Dame University	7	32%
		University of Michigan	15	68%
Minnesota	14	Iowa State University	3	21%
		South Dakota State U.	11	79%
Missouri	33	University of Kansas	6	18%
		U. of Missouri - Rolla	27	82%
Mississippi	15	Mississippi State U.	15	100%
North Carolina	32	North Carolina State U.	30	94%
		University of Tennessee	2	6%
Nebraska	13	Colorado State University	2	15%
		Iowa State University	1	8%
		University of Kansas	10	77%
N. Hampshire	3	U.of Massachusetts	3	100%
New Jersey	26	Hofstra University	26	100%
Nevada	14	University of Nevada	14	100%
Ohio	31	University of Dayton	26	84%
		West Virginia University	5	16%
Oklahoma	26	Oklahoma State University	26	100%
Oregon	26	Oregon State University	26	100%
Pennsylvania	14	Hofstra University	4	29%
		West Virginia University	10	71%
Rhode Island	1	U. of Massachusetts	1	100%
South Carolina	2	University of Tennessee	2	100%
South Dakota	4	South Dakota State U.	4	100%
Tennessee	20	University of Tennessee	20	100%
Texas	45	Texas A&M - College Station	30	67%
		Texas A&M - Kingsville	15	33%
Virginia	20	Old Dominion University	15	75%
		University of Tennessee	1	5%
		West Virginia University	4	20%
Vermont	1	University of Massachusetts	1	100%
Washington	4	Oregon State University	4	100%
Wisconsin	8	U. of Wisconsin - Milwaukee	8	100%
West Virginia	11	West Virginia University	11	100%

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

The following Table shows the state breakdown of assessments performed by each center.

EADC/IAC	Total No. of Assessments Performed by Each EADC/IAC	STATE	No. of Assessments Performed in Each State	Percent of Assessments Performed by Each EADC/IAC in a State
Arizona State University	30	Arizona	30	100%
Bradley University	15	Illinois	15	100%
Colorado State University	30	Colorado	28	93%
		Nebraska	2	7%
Georgia Institute of Tech.	30	Alabama	2	7%
		Georgia	28	93%
Hofstra University	30	New Jersey	26	87%
		Pennsylvania	4	13%
Iowa State University	30	Iowa	26	87%
		Minnesota	3	10%
		Nebraska	1	3%
Mississippi State University	15	Mississippi	15	100%
North Carolina State U.	30	North Carolina	30	100%
Notre Dame University	30	Indiana	23	77%
		Michigan	7	23%
Oklahoma State University	30	Kansas	4	13%
		Oklahoma	26	87%
Old Dominion University	15	Virginia	15	100%
Oregon State University	30	Oregon	26	87%
		Washington	4	13%
San Diego State University	30	California	30	100%
San Francisco State University	30	California	30	100%
South Dakota State University	15	Minnesota	11	73%
		South Dakota	4	27%
Texas A&M - College Station	30	Texas	30	100%
Texas A&M - Kingsville	15	Texas	15	100%
U. of Arkansas - Little Rock	28	Arkansas	28	100%
University of Dayton	29	Indiana	1	3%
		Kentucky	2	7%
		Ohio	26	90%
University of Florida	30	Florida	28	93%
		Georgia	2	7%
University of Kansas	29	Kansas	13	45%
		Missouri	6	21%
		Nebraska	10	34%
University of Louisville	15	Kentucky	9	60%
		Indiana	6	40%

Table 3. Geographic Distribution of Assessments by Center

EADC/IAC	Total No. of Assessments Performed by Each EADC/IAC	STATE	No. of Assessments Performed in Each State	Percent of Assessments Performed by Each EADC/IAC in a State
University of Maine	30	Maine	30	100%
University of Massachusetts	30	Connecticut	9	30%
		Massachusetts	16	54%
		New Hampshire	3	10%
		Rhode Island	1	3%
		Vermont	1	3%
University of Michigan	15	Michigan	15	100%
University of Missouri - Rolla	30	Illinois	3	10%
		Missouri	27	90%
University of Nevada - Reno	15	California	1	7%
		Nevada	14	93%
University of Tennessee	30	Alabama	1	3%
		Kentucky	4	13%
		North Carolina	2	7%
		South Carolina	2	7%
		Tennessee	20	67%
		Virginia	1	3%
U. of Wisconsin - Milwaukee	30	Illinois	22	73%
		Wisconsin	8	27%
West Virginia University	30	Ohio	5	17%
		Pennsylvania	10	33%
		Virginia	4	13%
		West Virginia	11	37%

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

The EADC/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. Note that no assessments were performed in SIC 21 (Tobacco Products) in FY94.

2-digit SIC Code	Industry	No. of Assessments Performed
20	Food and Kindred Products	97
22	Textile Mill Products	20
23	Apparel and Other Textile Products	15
24	Lumber and Wood Products	32
25	Furniture and Fixtures	17
26	Paper and Allied Products	57
27	Printing and Publishing	37
28	Chemicals and Allied Products	34
29	Petroleum and Coal Products	10
30	Rubber and Misc. Plastics Products	85
31	Leather and Leather Products	8
32	Stone, Clay, and Glass Products	25
33	Primary Metal Industries	54
34	Fabricated Metal Products	81
35	Industrial Machinery and Equipment	89
36	Electronic and Other Electric Equipment	53
37	Transportation Equipment	31
38	Instruments and Related Products	21
39	Miscellaneous Manufacturing Industries	10
Total		776

Table 4. Number of Assessments Performed by Industry Type

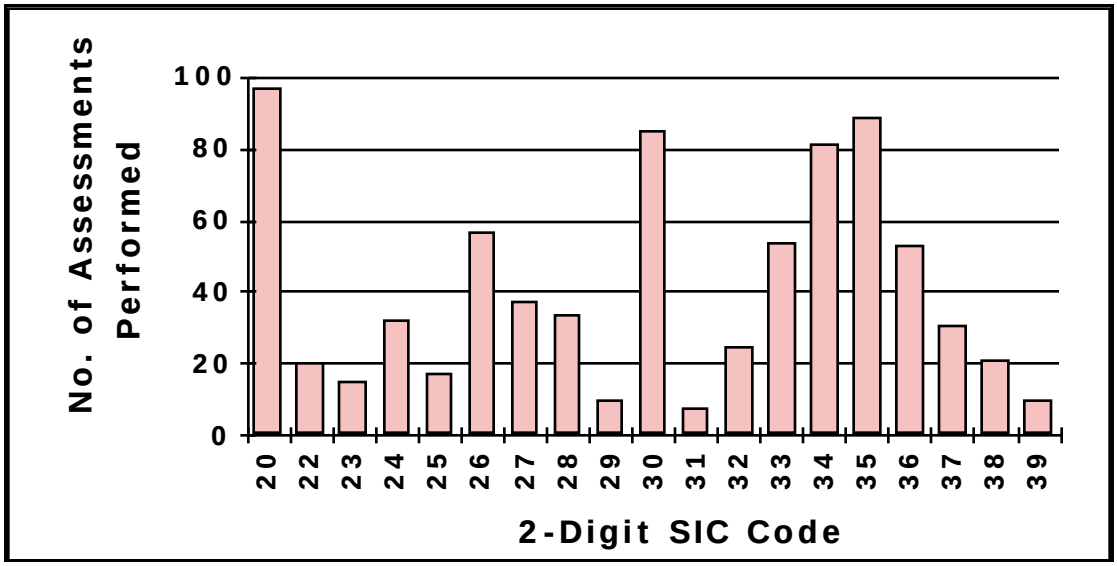

Figure 1. Plants Served in FY94 by Industry Type

Assessments are available for small to medium size plants which 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 FY94, the total energy usage of the clients was 52 million MMBTU, costing $341 million. There was an average of 176 employees at each location. The companies had a total sales of almost $22 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	19,438,338	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

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

Figure 2 shows the average sales Figures for the EADC/IAC clients over the years since the program's inception.

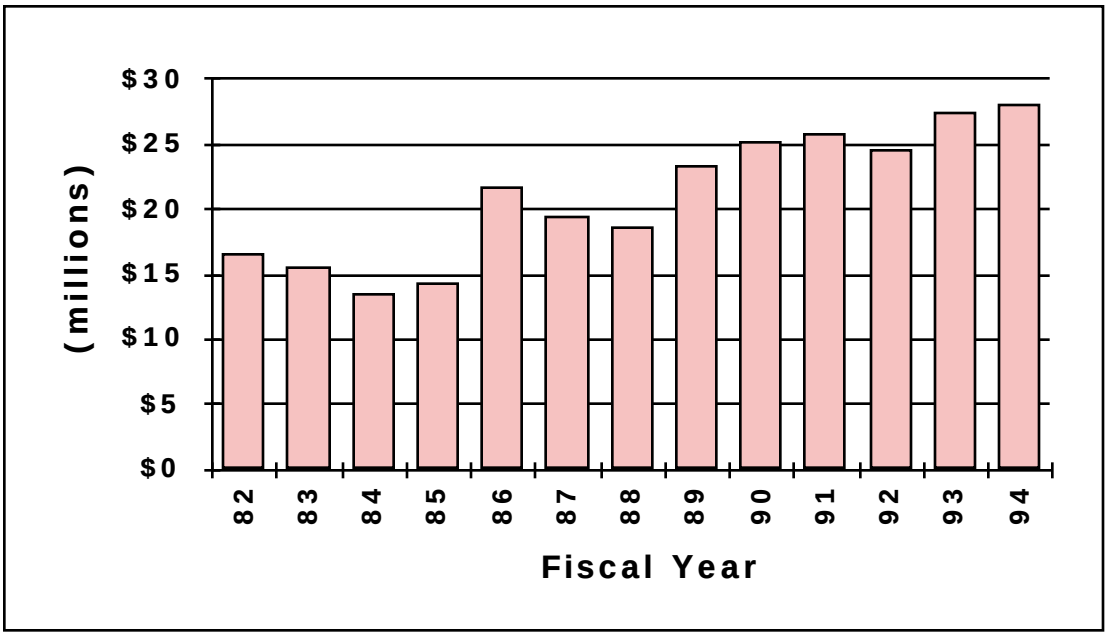

Figure 2. Average Client Sales by Fiscal Year

The average plant served in FY94 had purchased energy use of 67,000 MMBTU with an associated cost of $439,000. Electricity cost the typical client $16.53/ MMBTU and natural gas cost $3.50/ MMBTU. The average energy use and associated costs are shown in Figures 3 and 4.

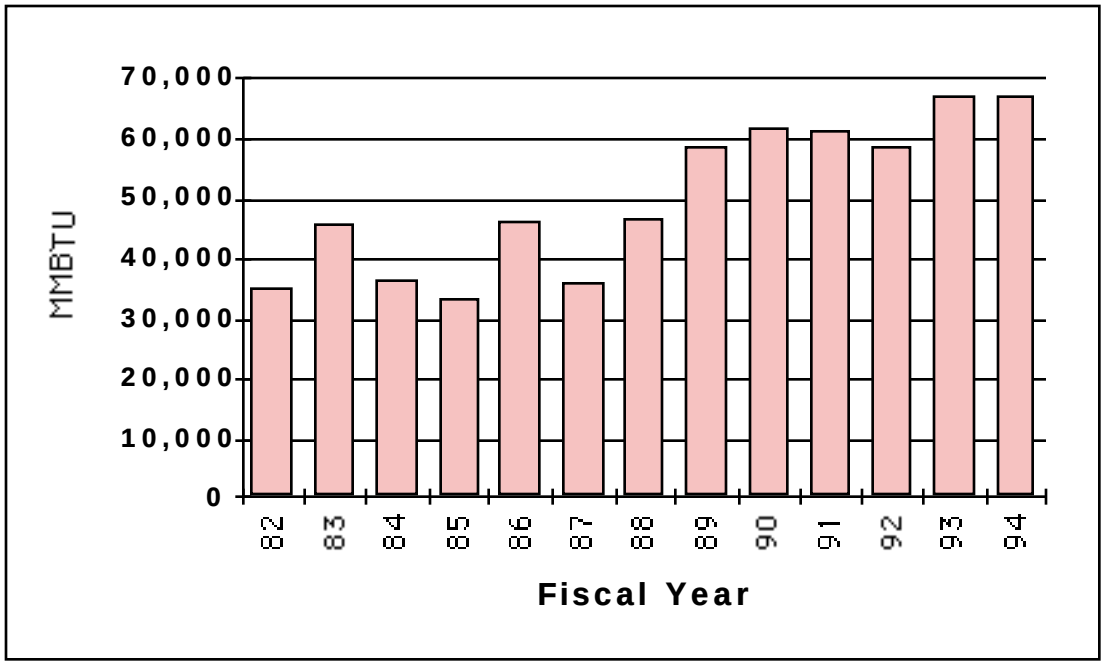

Figure 3. Average Client Energy Usage by Fiscal Year

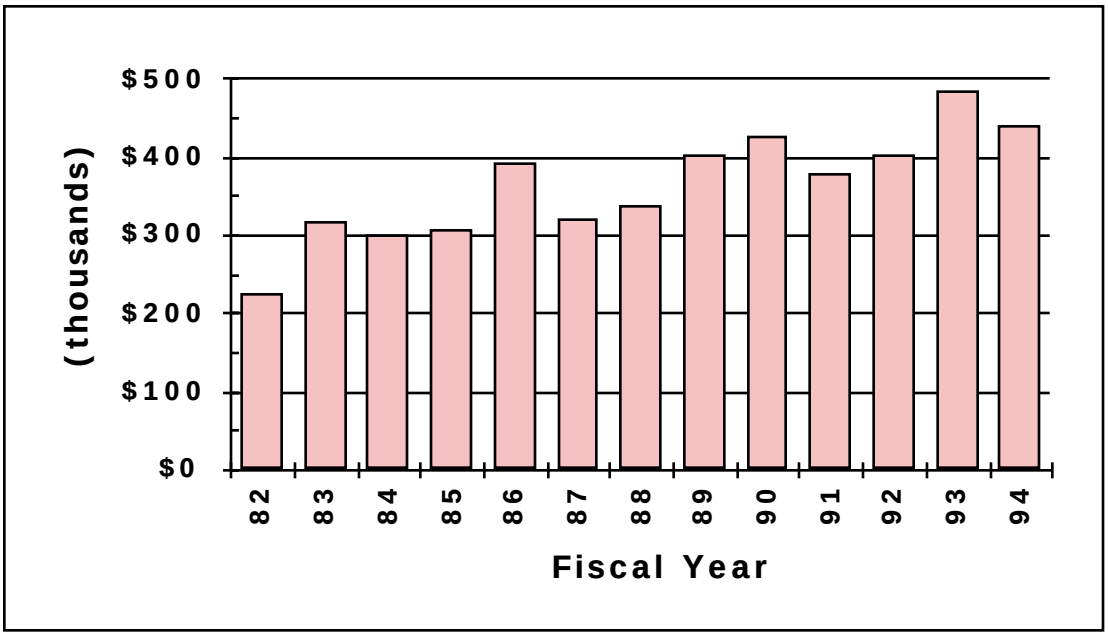

Figure 4. Average Client Energy Costs by Fiscal Year

The program database breaks energy use into eleven specific streams and one category for "other" energy. Energy use other than electricity and natural gas increased from 16% in FY93 to 23% in FY94, however the cost as a percentage did not increase. 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	14,375,769	237,702,366
Natural Gas	25,528,848	89,322,552
L. P. G.	285,334	1,256,815
Fuel Oil #1	1,950	12,197
Fuel Oil #2	403,535	1,392,005
Fuel Oil #4	189,591	768,200
Fuel Oil #6	1,416,501	3,716,502
Coal	898,001	1,680,725
Wood	3,765,115	2,500,038
Paper	0	0
Other Gas	2,698	17,544
Other Energy	5,125,338	2,595,480
Totals	51,992,679	340,964,424

Table 6. Energy Use and Cost by Energy Streams

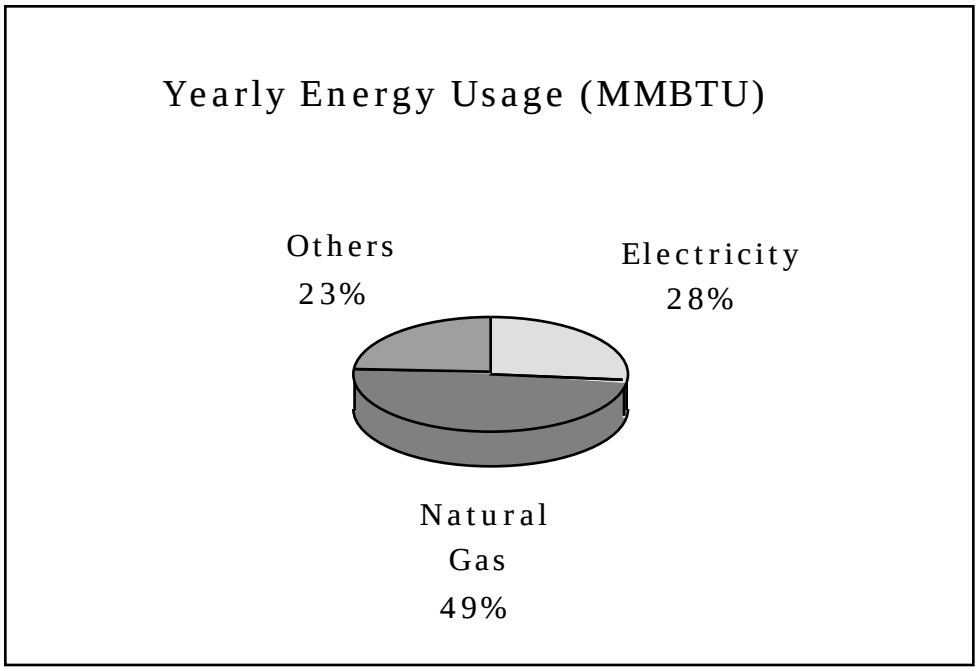

Figure 5. Energy Use of Plants Served in FY94 by Energy Stream

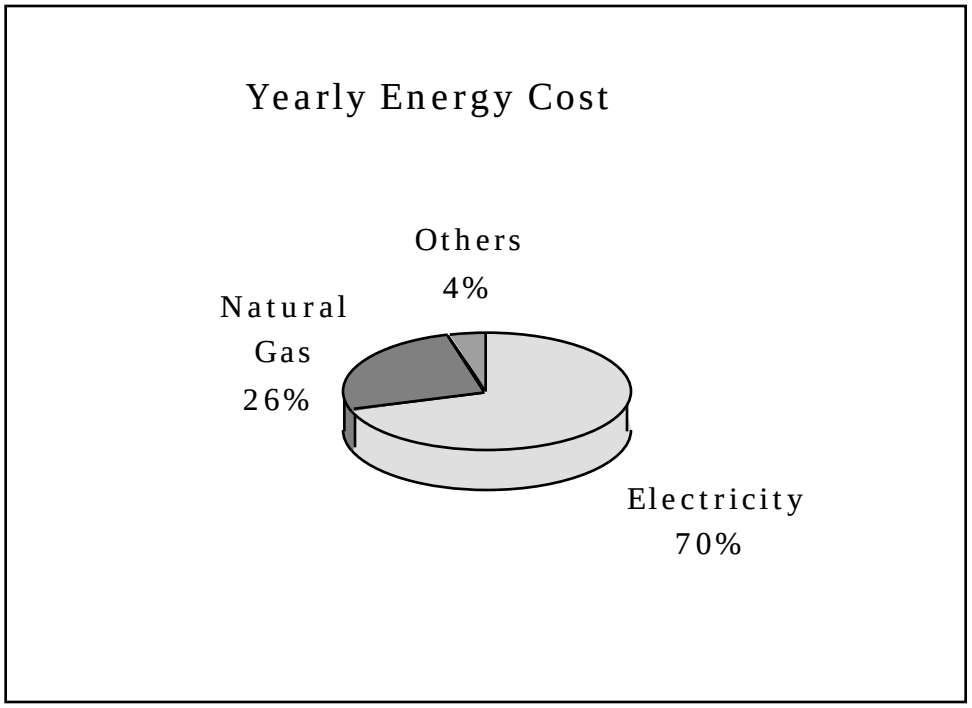

Figure 6. Energy Costs of Plants Served in FY94 by Energy Stream

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 FY94 and previous years. Due to the anticipated growth of the program into Industrial Assessments in FY94, 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	Non-Energy	Total
82	1,106,843	190,016	25,600	6,699,741	n/a	6,699,741
83	1,520,973	261,111	35,179	8,712,422	n/a	8,712,422
84	1,278,278	219,447	29,566	8,979,598	n/a	8,979,598
85	2,186,558	375,375	50,573	13,917,967	n/a	13,917,967
86	1,663,618	285,600	38,478	13,640,445	n/a	13,640,445
87	1,101,577	189,112	25,479	10,751,519	n/a	10,751,519
88	1,503,026	258,030	34,764	13,603,630	n/a	13,603,630
89	1,780,449	305,656	41,180	13,081,589	n/a	13,081,589
90	1,568,225	269,223	36,272	14,028,351	n/a	14,028,351
91	1,290,537	221,551	29,849	17,373,265	n/a	17,373,265
92	2,035,676	349,472	47,084	21,804,001	n/a	21,804,001
93	2,429,267	417,042	56,187	27,042,250	2,596,381	29,638,631
94	3,497,670	600,458	80,898	35,542,867	6,870,839	42,413,706

Table 7. Recommended Conservation Figures by Fiscal Year

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

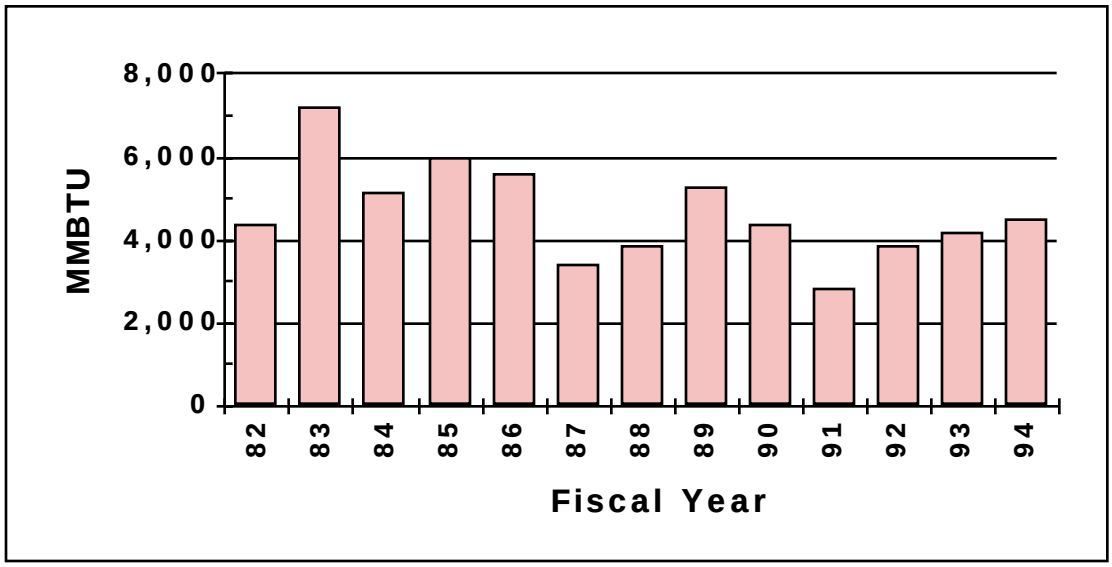

Figure 7. Average Recommended Energy Conserved by Fiscal Year

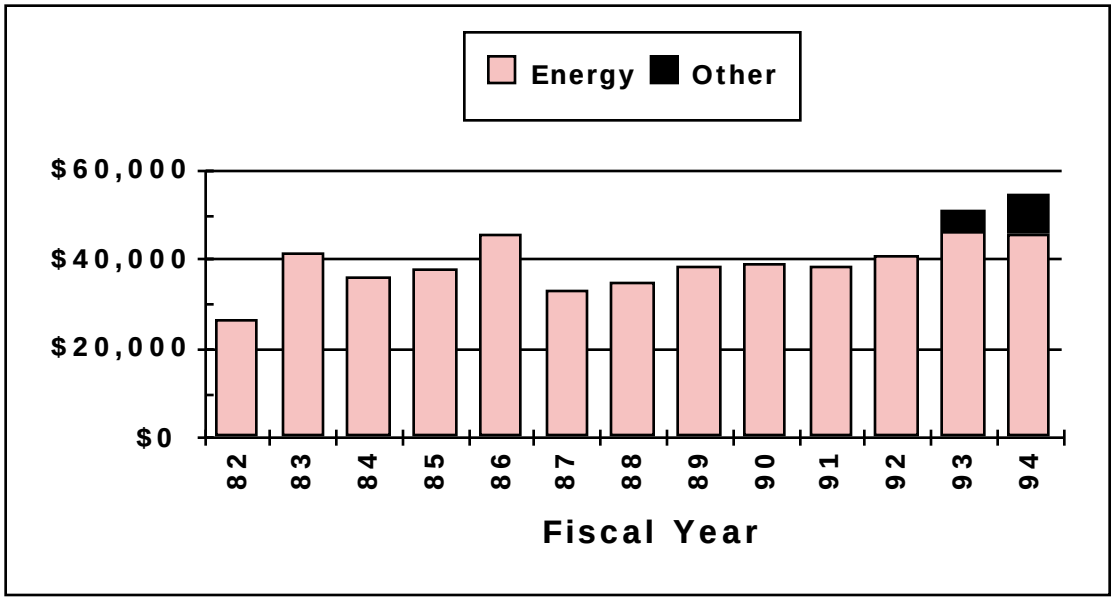

Figure 8. Average Recommended Cost Savings by Fiscal Year

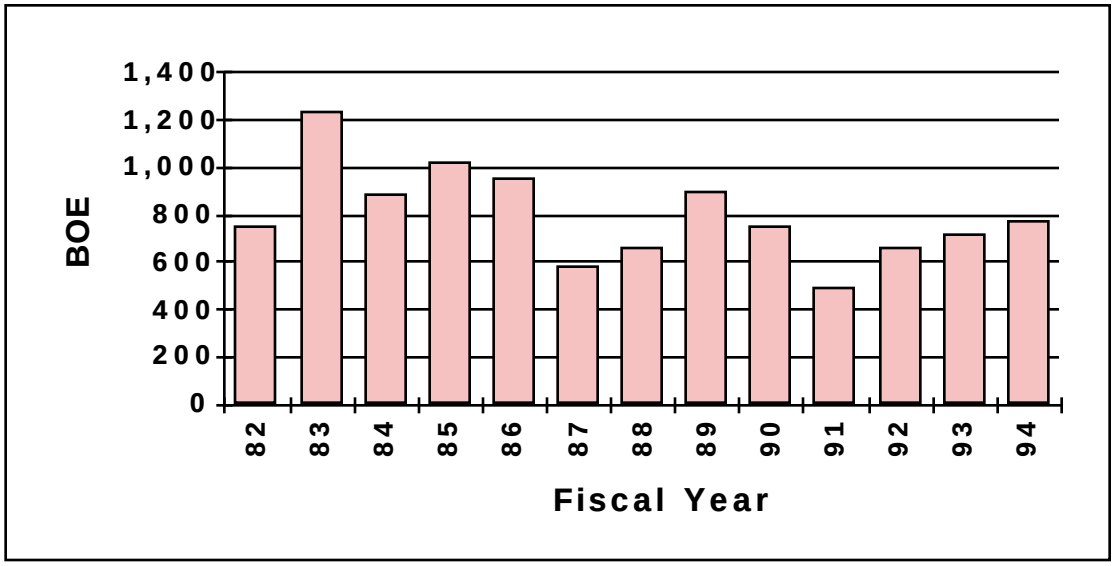

Figure 9. Average Recommended Barrels of Oil Avoided by Fiscal Year

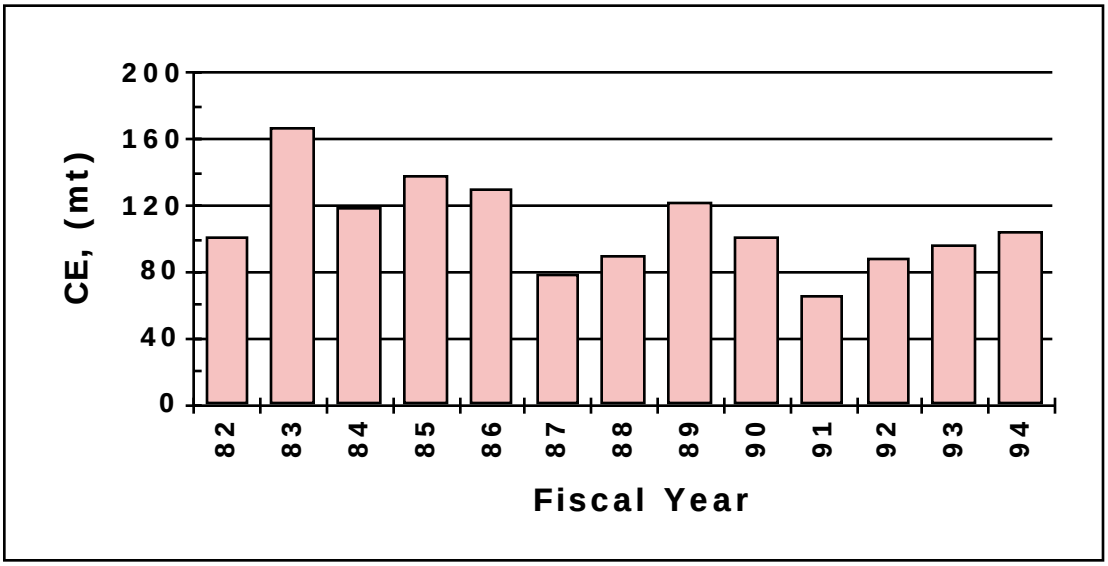

Figure 10. Average Recommended Carbon Avoided by Fiscal Year

Fiscal Year	Recommended Energy Conservation			Recommended Cost Savings ($)		
	(MMBtu)	(B.O.E.)	(C.E., mt)	Energy	Non-Energy	Total
82	4,375	751	101	26,481	N/A	26,481
83	7,208	1,237	167	41,291	N/A	41,291
84	5,154	885	119	36,208	N/A	36,208
85	5,942	1,020	137	37,821	N/A	37,821
86	5,583	958	129	45,773	N/A	45,773
87	3,400	584	79	33,184	N/A	33,184
88	3,874	665	90	35,061	N/A	35,061
89	5,237	899	121	38,475	N/A	38,475
90	4,356	748	101	38,968	N/A	38,968
91	2,836	487	66	38,183	N/A	38,183
92	3,834	658	89	41,062	N/A	41,062
93	4,153	713	96	46,226	4,438	50,664
94	4,507	774	104	45,803	8,854	54,657

Table 8. Average Recommended Energy Conservation and Cost Savings by Fiscal Year

Figures 11 and 12 indicate recommended energy and dollars conserved per assessment on a three year average basis:

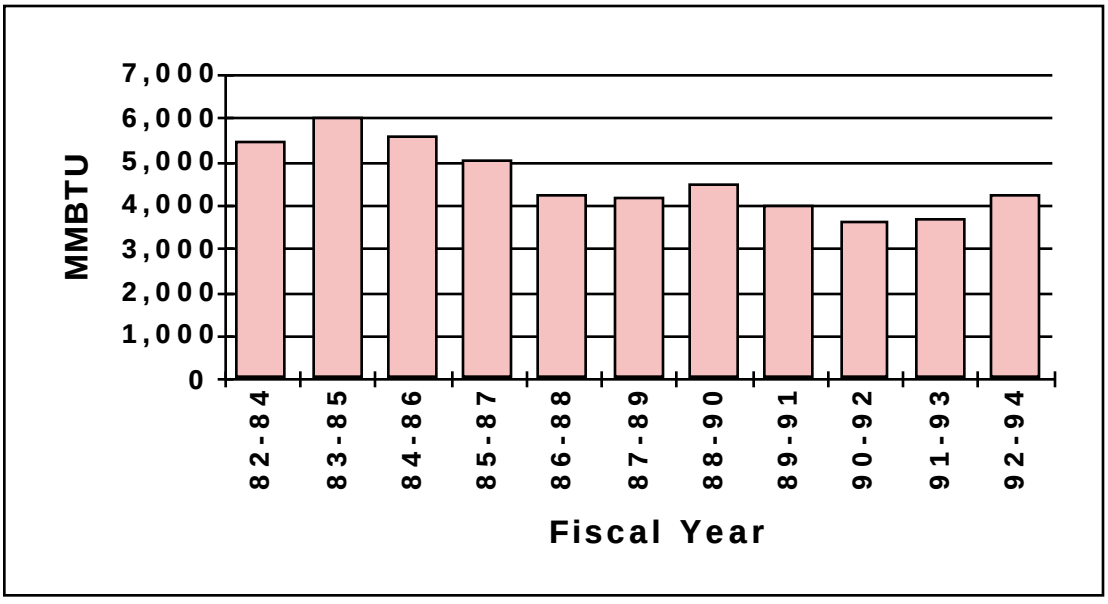

Figure 11. Average Energy Conserved Per Assessment (3 Year Average)

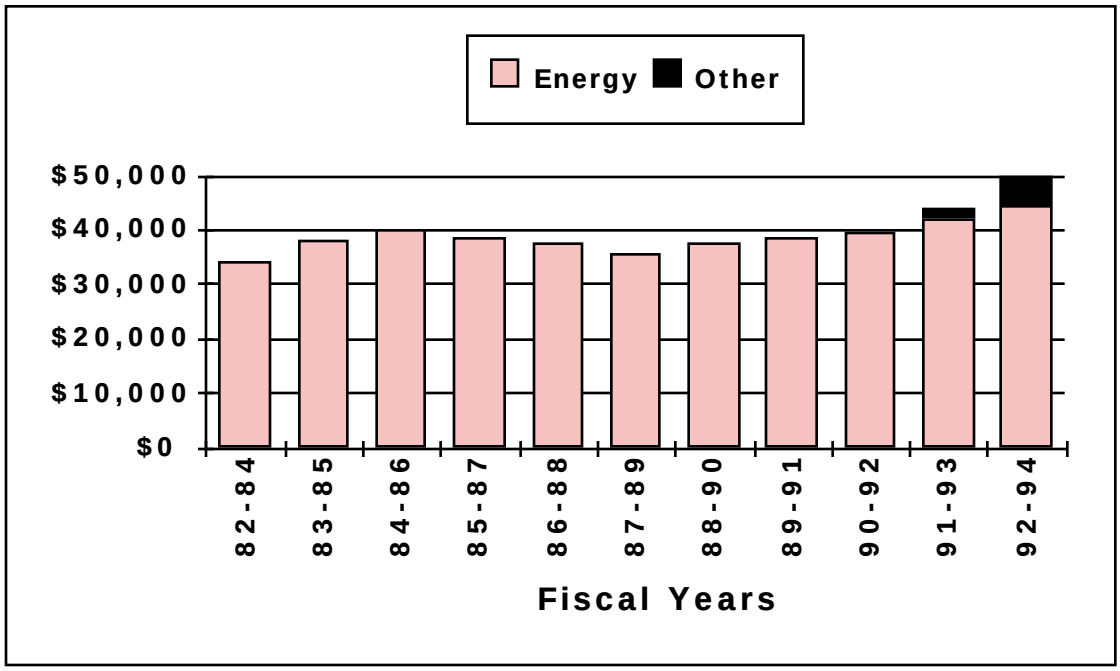

Figure 12. Recommended Cost Savings Per Assessment (3 Year Average)

The three year average of recommended barrels of oil saved and carbon avoided is indicated in Figures 13 and 14.

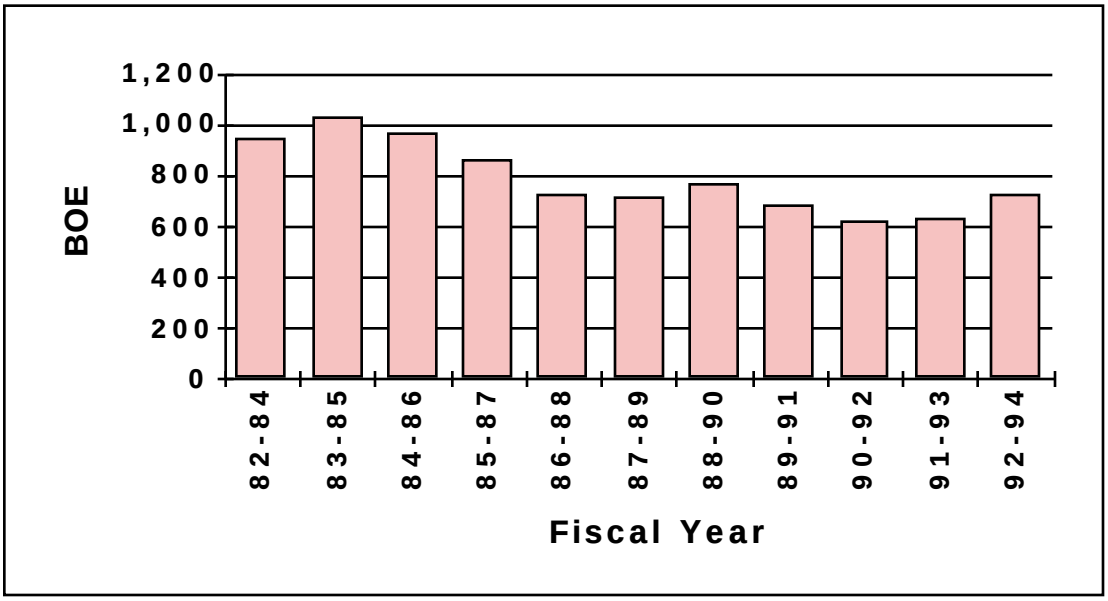

Figure 13. Recommended Barrels of Oil Avoided Per Assessment (3 Year Average)

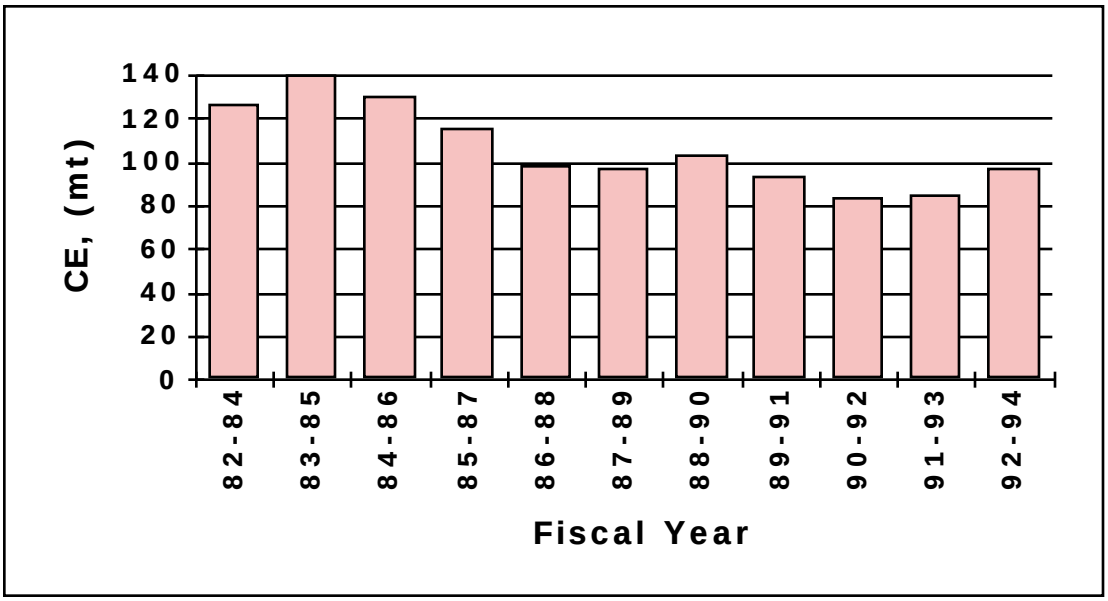

Figure 14. Recommended Carbon Avoided Per Assessment (3 Year Average)

In some cases, immediate implementation of a measure is not recommended due to financial restrictions, time constraints, or other considerations. Starting in FY93 these recommendations (called incremental) were flagged to prevent skewing the program database. Table 9 and Figures 15 through 18 show the average first year recommended energy and dollars conserved per assessment. A comparison with Table 8 shows that incremental recommendations represent less than 10% of all recommendations.

Fiscal Year	Recommended Energy Conservation			Recommended Cost Savings ($)		
	(MMBtu)	(B.O.E.)	(C.E., mt)	Energy	Non-Energy	Total
82	4,375	751	101	26,481	N/A	26,481
83	7,208	1,237	167	41,291	N/A	41,291
84	5,154	885	119	36,208	N/A	36,208
85	5,942	1,020	137	37,821	N/A	37,821
86	5,583	958	129	45,773	N/A	45,773
87	3,400	584	79	33,184	N/A	33,184
88	3,874	665	90	35,061	N/A	35,061
89	5,237	899	121	38,475	N/A	38,475
90	4,356	748	101	38,968	N/A	38,968
91	2,836	487	66	38,183	N/A	38,183
92	3,769	647	87	40,265	N/A	40,265
93	3,945	677	91	42,863	4,438	47,301
94	4,281	735	99	42,392	8,854	51,246

Table 9. Average First Year Recommended Conservation and Cost Savings by Fiscal Year

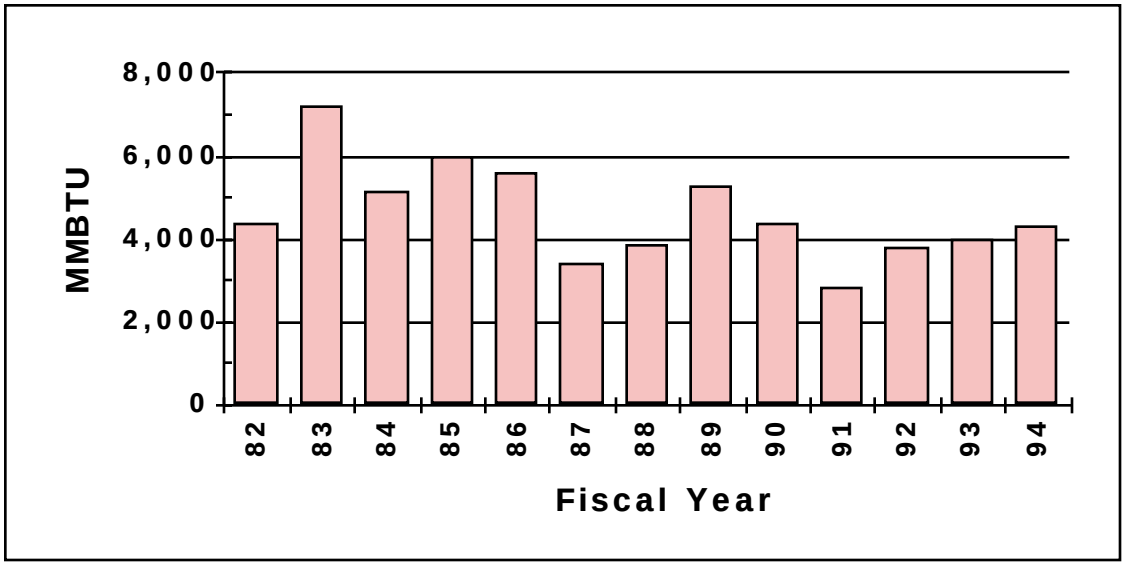

Figure 15. Average First Year Recommended Energy Conserved by Fiscal Year

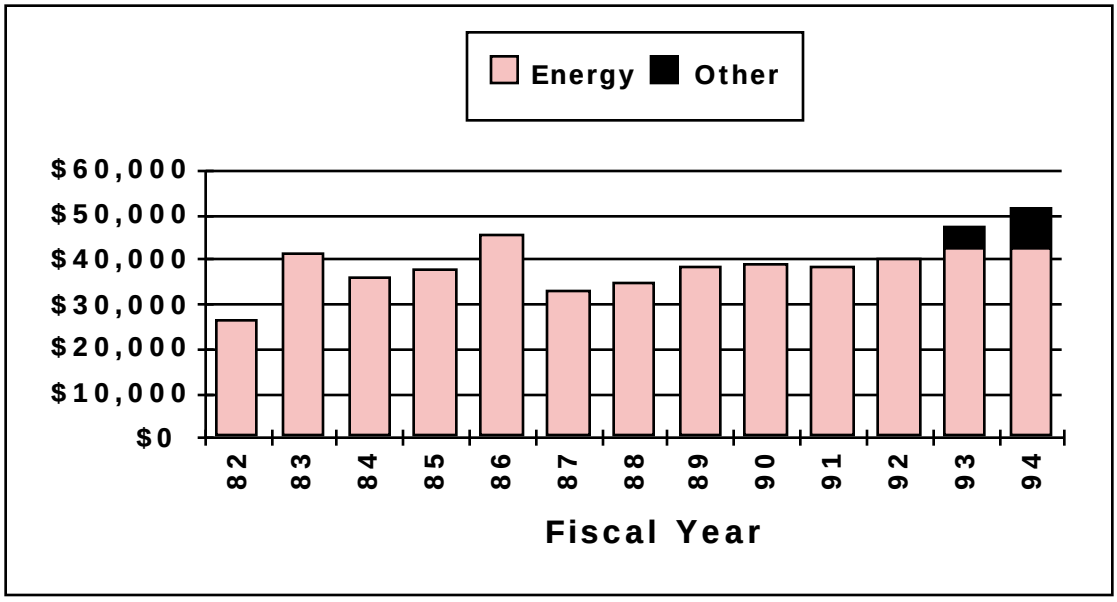

Figure 16. Average First Year Recommended Cost Savings by Fiscal Year

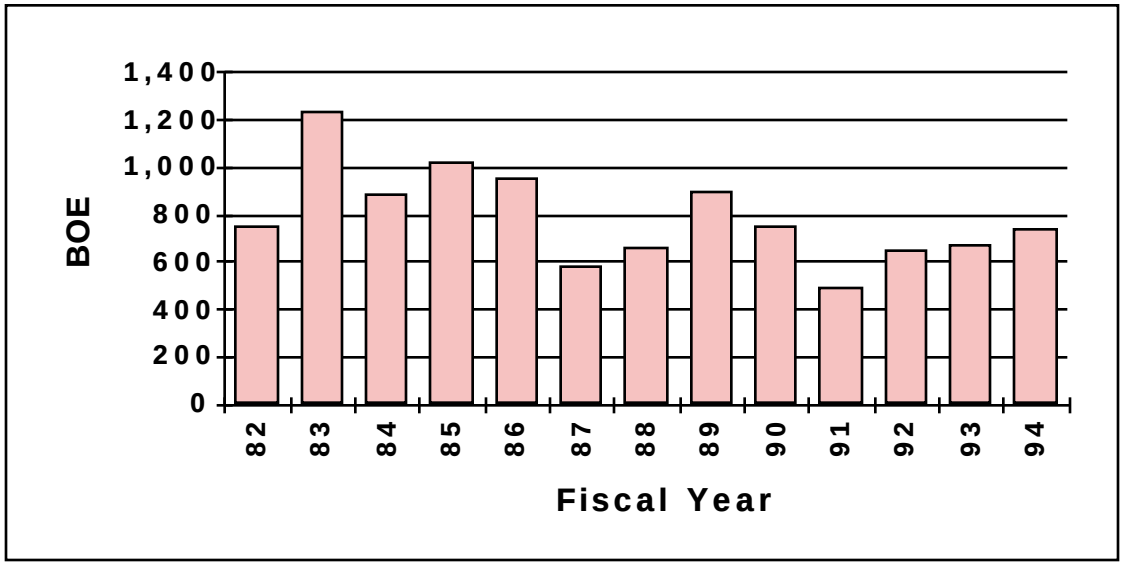

Figure 17. Average First Year Recommended Barrels of Oil Avoided by Fiscal Year

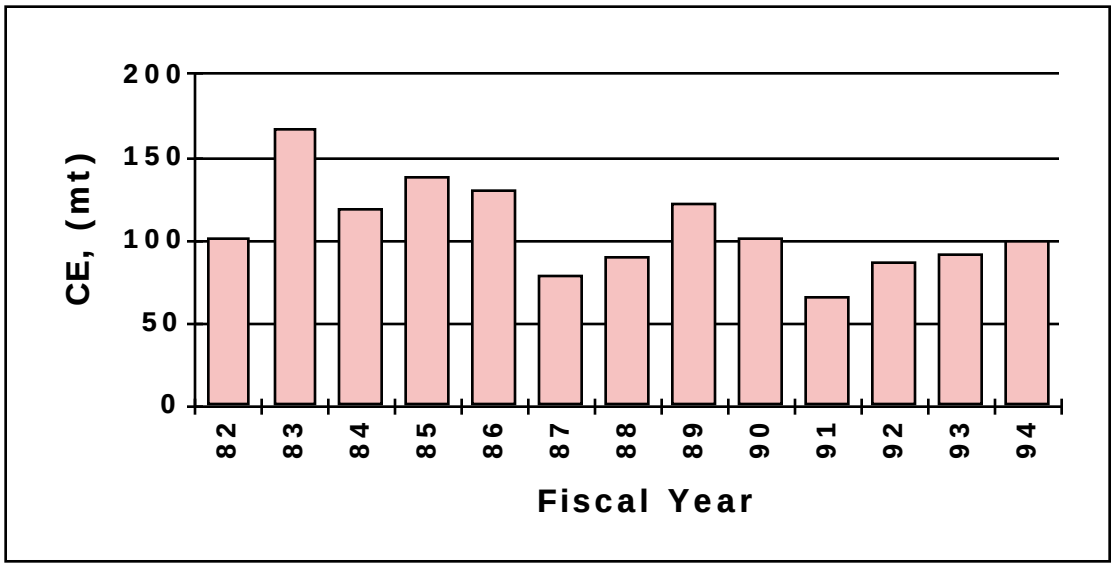

Figure 18. Average First Year Recommended Carbon Avoided by Fiscal Year

ii. Recommended Conservation by Industry Type

Energy conservation recommended by industry type in Fiscal Year 1994 is shown in Table 10 and Figures 19 through 22. The largest amount of recommended energy conserved by a substantial margin occurred during SIC 26 (Paper and Allied Products) assessments. The largest recommended cost savings was in SIC 20 (Food and kindred Products). Both these values replace SIC 32 (Stone, Clay, and Glass Products) as the leader in FY93. The lowest recommended cost savings was SIC 31 (Leather Products); however, the margin was not substantially lower than some other industry types.

SIC Code	Industry Description	Recommended Energy Conservation			Recommended Cost Savings ($)		
		(MMBtu)	(B.O.E.)	(C.E., mt)	Energy	Non-Energy	Total
20	Foods	411,667	70,672	9,522	4,760,453	504,995	5,265,448
22	Textile Mills	76,004	13,048	1,758	1,075,894	-35,418	1,040,476
23	Apparel	62,075	10,657	1,436	365,050	4,280	369,330
24	Wood Prod.	231,545	39,750	5,355	2,112,671	246,239	2,358,910
25	Furniture	139,823	24,004	3,234	998,319	1,323,048	2,321,367
26	Paper Prod.	671,360	115,255	15,528	3,801,181	532,702	4,333,883
27	Printing	-14,232	-2,443	-329	1,281,371	185,317	1,466,688
28	Chemical Prod.	67,255	11,546	1,556	1,343,590	284,004	1,627,594
29	Petroleum	191,814	32,929	4,437	1,765,723	-889	1,764,834
30	Rubber & Plast.	285,411	48,998	6,601	3,648,871	720,186	4,369,057
31	Leather Prod.	12,852	2,206	297	124,331	18,224	142,555
32	Stone & Glass	423,709	72,740	9,800	3,353,298	214,885	3,568,183
33	Primary Metal	324,923	55,781	7,515	2,235,366	660,718	2,896,084
34	Fab. Metal	223,565	38,380	5,171	2,437,682	799,244	3,236,926
35	Ind. Machinery	132,985	22,830	3,076	2,154,216	492,932	2,647,148
36	Electronics	133,699	22,953	3,092	2,066,823	378,679	2,445,502
37	Trans. Equip.	54,147	9,296	1,252	1,030,075	481,235	1,511,310
38	Instruments	52,698	9,047	1,219	811,017	46,918	857,935
39	Misc. Manuf.	16,370	2,810	379	176,936	13,540	190,476
Totals		3,497,670	600,458	80,898	35,542,867	6,870,839	42,413,706

Table 10. Recommended Cost and Energy Savings by Industry Type

The negative energy conservation values in SIC 27 are due primarily to one co-generation recommendation. This project was estimated to increase on-site energy consumption by over 71,000 MMBTU with an estimated annual savings potential of over $300,000.

Negative non-energy conserved in SIC 22 is also due to a co-generation recommendation. In this case, the estimated maintenance and operations cost exceeded all other conservation values in this category for SIC 22. Neither project was implemented.

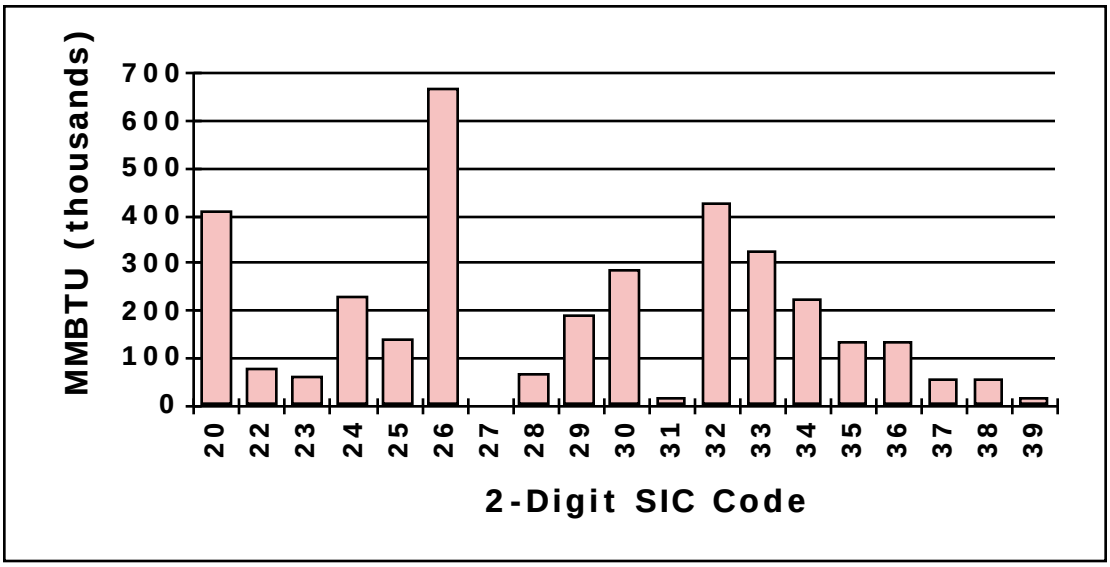

Figure 19. Recommended Energy Conserved by Industry Type

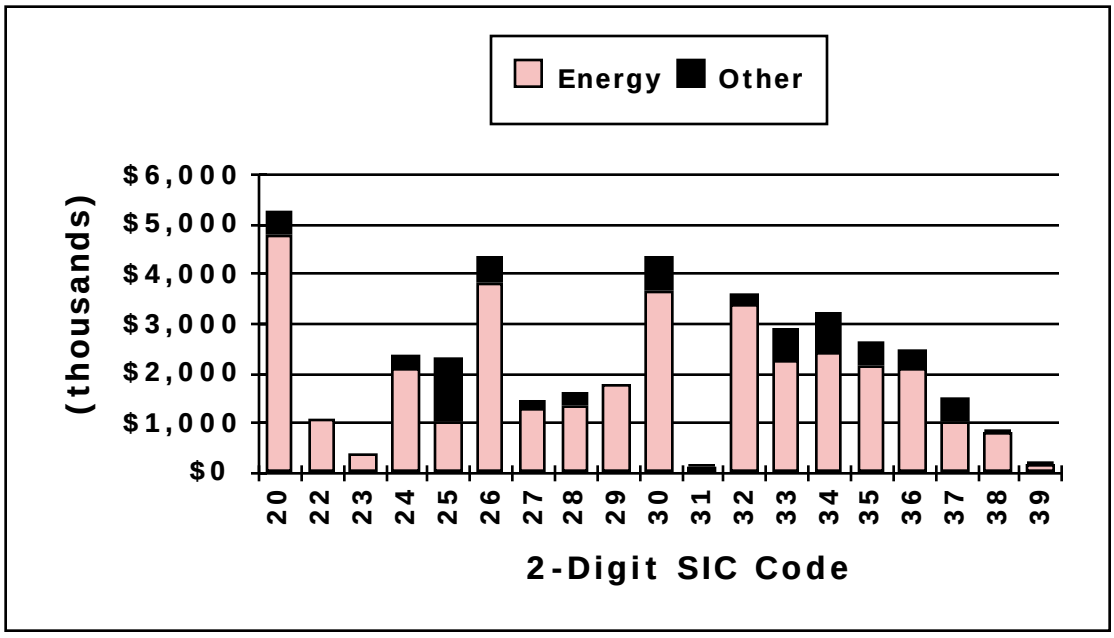

Figure 20. Recommended Cost Savings by Industry Type

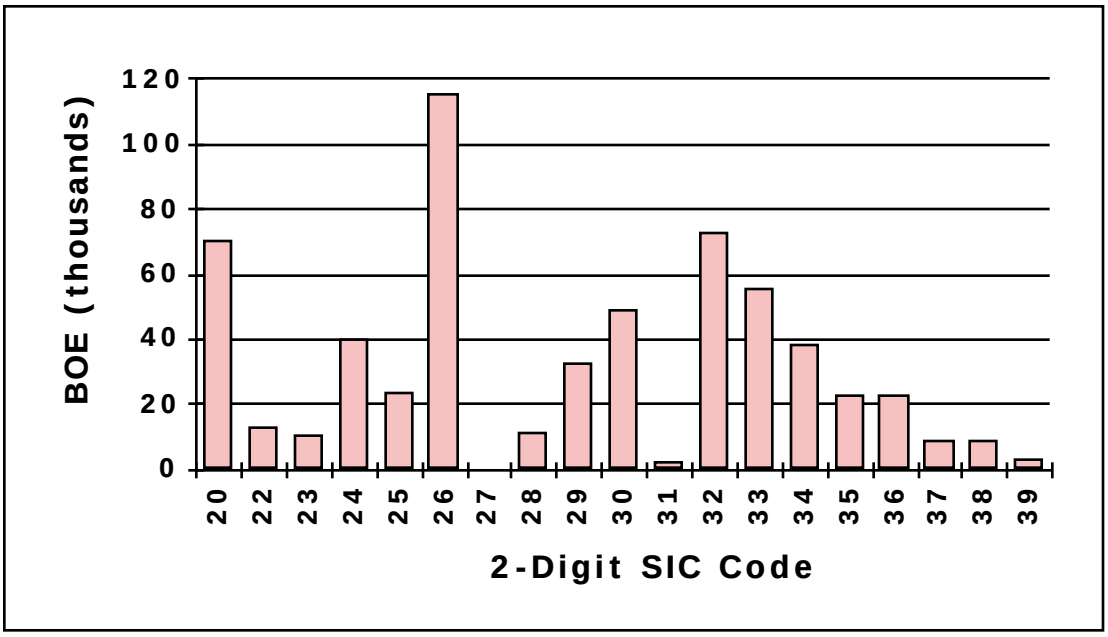

Figure 21. Recommended Barrels of Oil Avoided by Industry Type

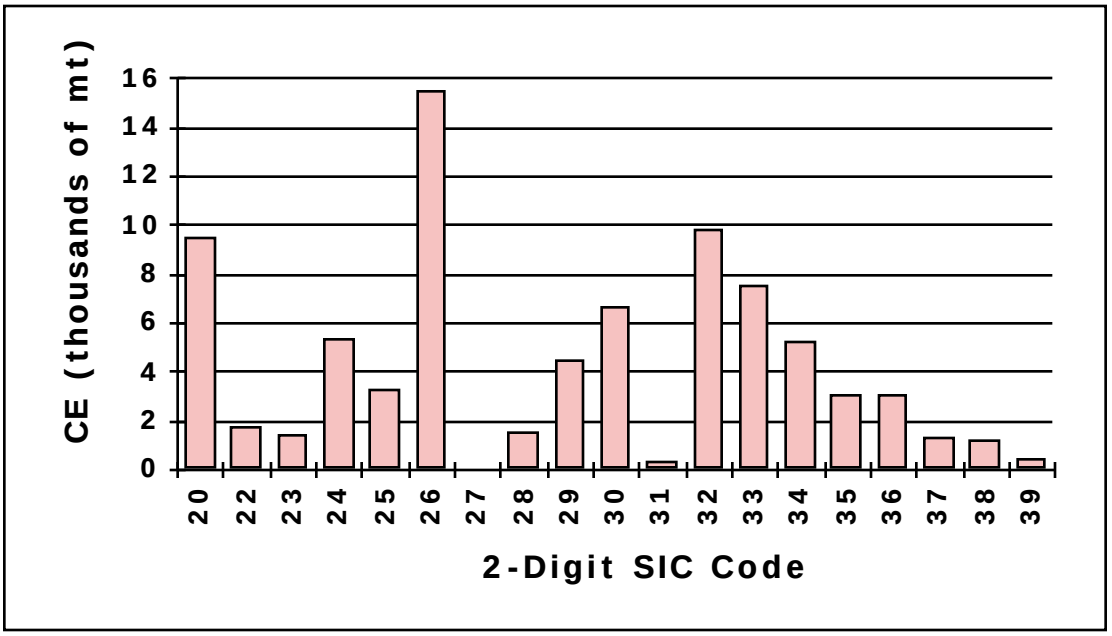

Figure 22. Recommended Carbon Avoided by Industry Type

Average recommendation Figures per assessment are shown in Table 11, and Figures 23 through 26.

SIC Code	Industry Description	Recommended Energy Conservation (MMBtu)	(B.O.E.)	(C.E., mt)	Recommended Cost Savings ($) Energy	Non-Energy	Total
20	Foods	4,244	729	98	49,077	5,206	54,283
22	Textile Mills	3,800	652	88	53,795	-1,771	52,024
23	Apparel	4,138	710	96	24,337	285	24,622
24	Wood Prod.	7,236	1,242	167	66,021	7,695	73,716
25	Furniture	8,225	1,412	190	58,725	77,826	136,551
26	Paper Prod.	11,778	2,022	272	66,687	9,346	76,033
27	Printing	-385	-66	-9	34,632	5,009	39,640
28	Chemical Prod.	1,978	340	46	39,517	8,353	47,870
29	Petroleum	19,181	3,293	444	176,572	-89	176,483
30	Rubber & Plast.	3,358	576	78	42,928	8,473	51,401
31	Leather Prod.	1,607	276	37	15,541	2,278	17,819
32	Stone & Glass	16,948	2,910	392	134,132	8,595	142,727
33	Primary Metal	6,017	1,033	139	41,396	12,236	53,631
34	Fab. Metal	2,760	474	64	30,095	9,867	39,962
35	Ind. Machinery	1,494	257	35	24,205	5,539	29,743
36	Electronics	2,523	433	58	38,997	7,145	46,142
37	Trans. Equip.	1,747	300	40	33,228	15,524	48,752
38	Instruments	2,509	431	58	38,620	2,234	40,854
39	Misc. Manuf.	1,637	281	38	17,694	1,354	19,048
Average		4,507	774	104	45,803	8,854	54,657

Table 11. Average Recommended Conservation and Cost Savings by Industry Type

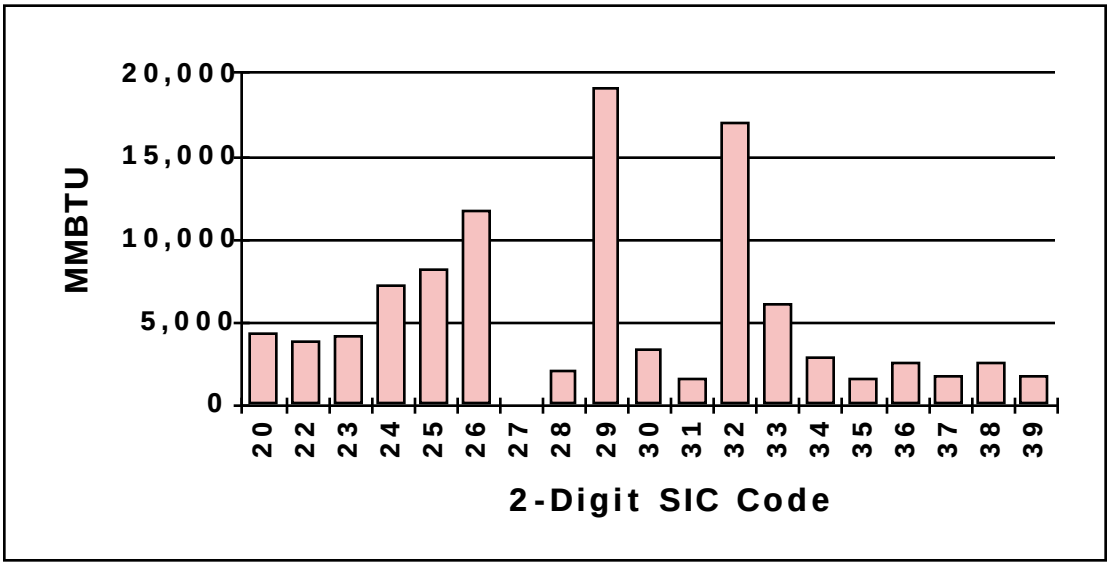

Figure 23. Average Recommended Energy Saved by Industry Type

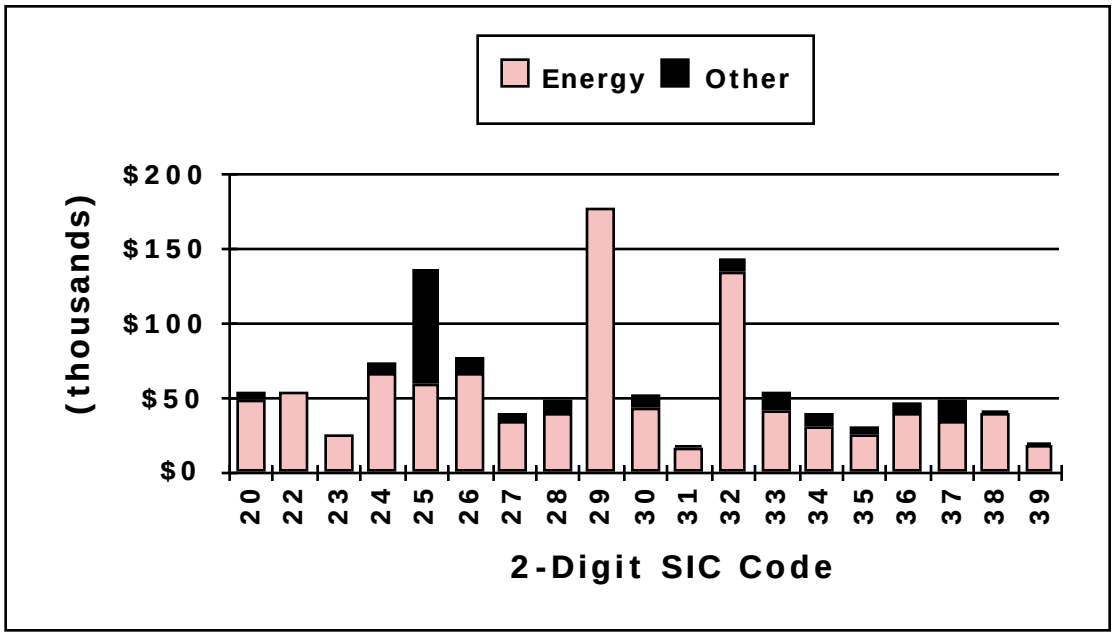

Figure 24. Average Recommended Cost Savings by Industry Type

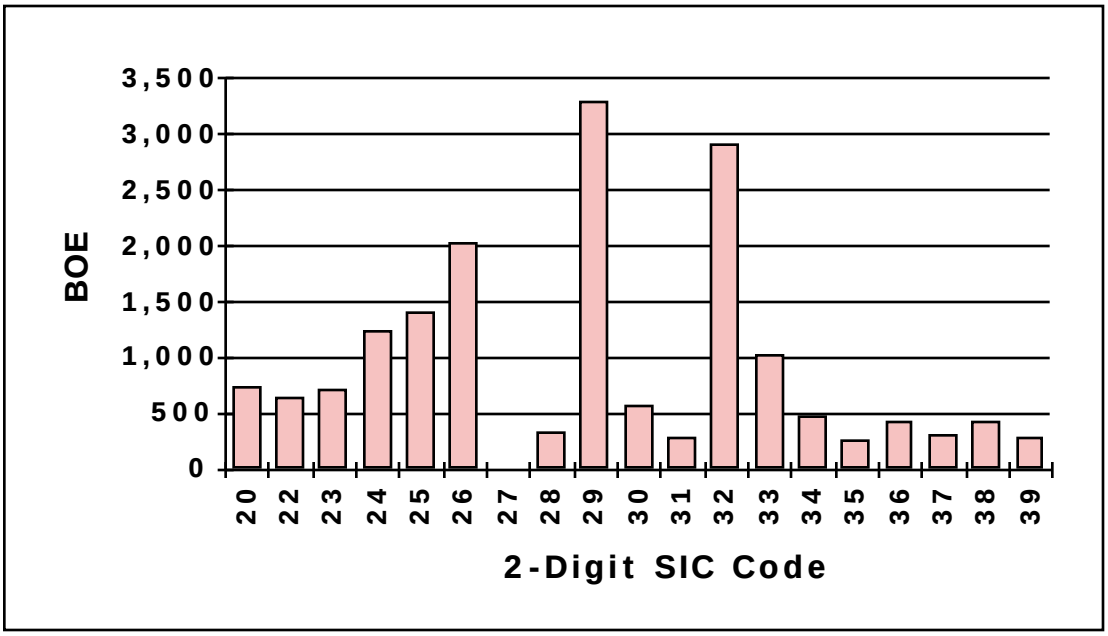

Figure 25. Average Recommended Barrels of Oil Saved by Industry Type

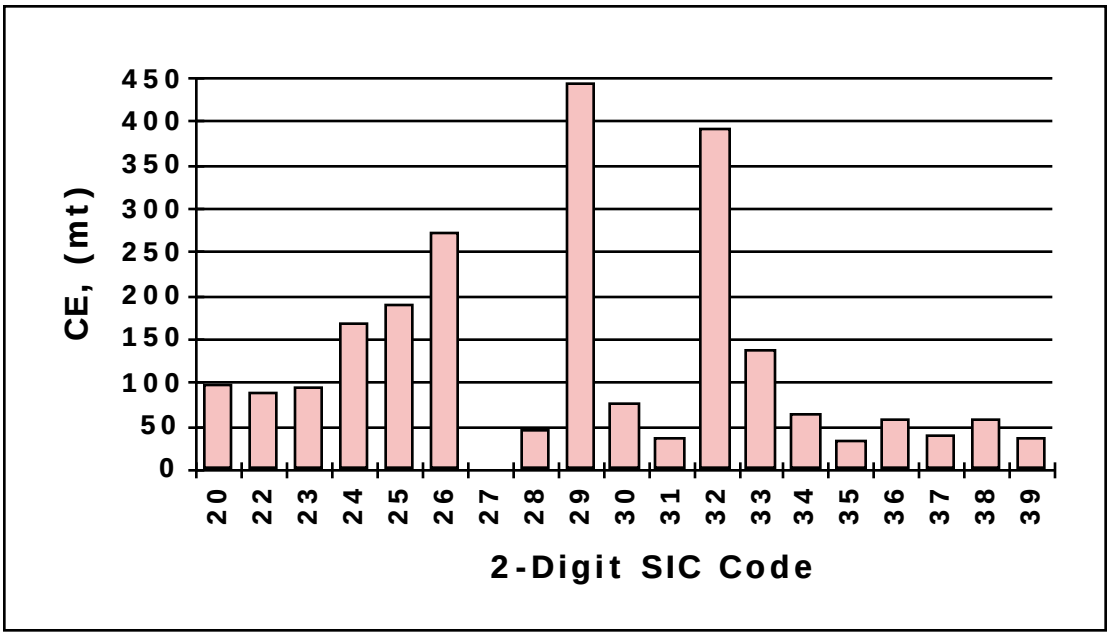

Figure 26. Average Recommended Carbon Avoided by Industry Type

iii. Recommended Conservation 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". Again, starting in FY93, non-energy savings were separately tracked. The amount of energy savings recommended in FY94 was almost 3.5 million MMBTUs, with a dollar amount of over $35 Million. This data is shown in Table 12, with the percentages by energy type in Figures 27 and 28. 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 savings).

Energy Stream	Recommended Energy Conservation (MMBTU)	Recommended Energy Cost Savings ($)
Electricity	1,725,625	29,669,150
Natural Gas	1,391,450	4,820,218
L. P. G.	7,670	30,000
Fuel Oil #2	-63,937	-264,281
Fuel Oil #4	16,218	73,208
Fuel Oil #6	203,269	520,173
Coal	150,229	301,226
Wood	-23,803	17,052
Other Gas	16,975	86,635
Other Energy	73,974	289,486
Energy Totals	3,497,670	35,542,867
Non-Energy	n/a	6,870,839
Program Totals	3,497,670	42,413,706

Table 12. Recommended Conservation and Cost Savings by Resource Stream

The negative savings for wood resulted from a co-generation recommendation that suggested burning waste wood as a fuel. This resulted in a negative energy savings, and no cost associated with the fuel (wood).

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

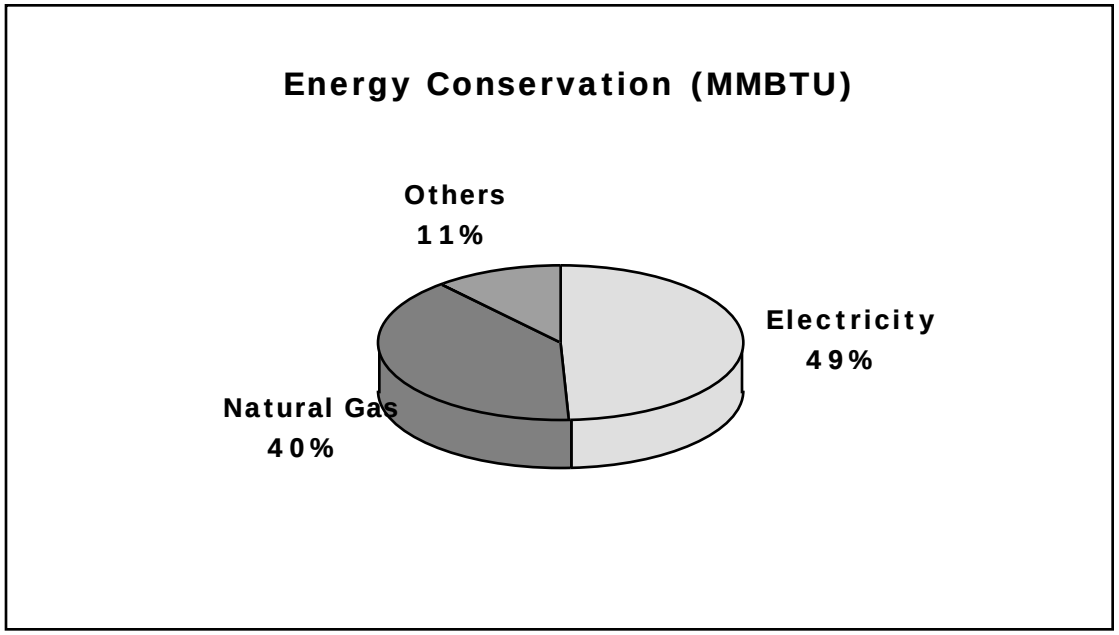

Figure 27. Composition of Recommended Energy Conserved by Energy Stream

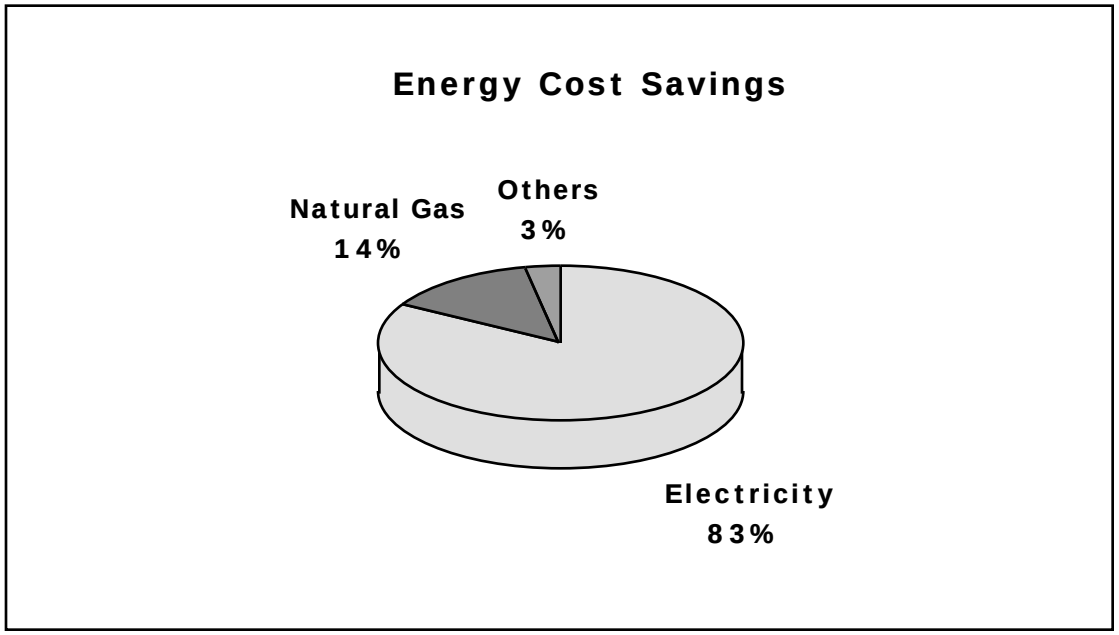

Figure 28. Composition of Recommended Cost Savings by Energy Stream

The database is broken into four resource stream types: energy, waste reduction, resource costs, and production. Table 13 shows the recommended cost savings grouped by non-energy resource type. Figure 29 shows the composition of the recommended non-energy cost savings.

Resource Type	Total Recommended Non-Energy Cost Savings ($)
Production	
Primary Product	368,965
Resource Costs	
Personnel Changes	95,777
Administrative Costs	1,856,809
Primary Raw Material	245,118
Ancillary Material Cost	44,829
Water Consumption	125,244
Waste Reduction	
Water Disposal	705,004
Other Liquid (non-haz)	98,289
Other Liquid (haz)	583,067
Solid Waste (non-haz)	2,225,670
Solid Waste (haz)	218,937
Gaseous Waste (haz)	303,130
Total:	**6,870,839**

Table 13. Recommended Non-Energy Cost Savings by Resource Type

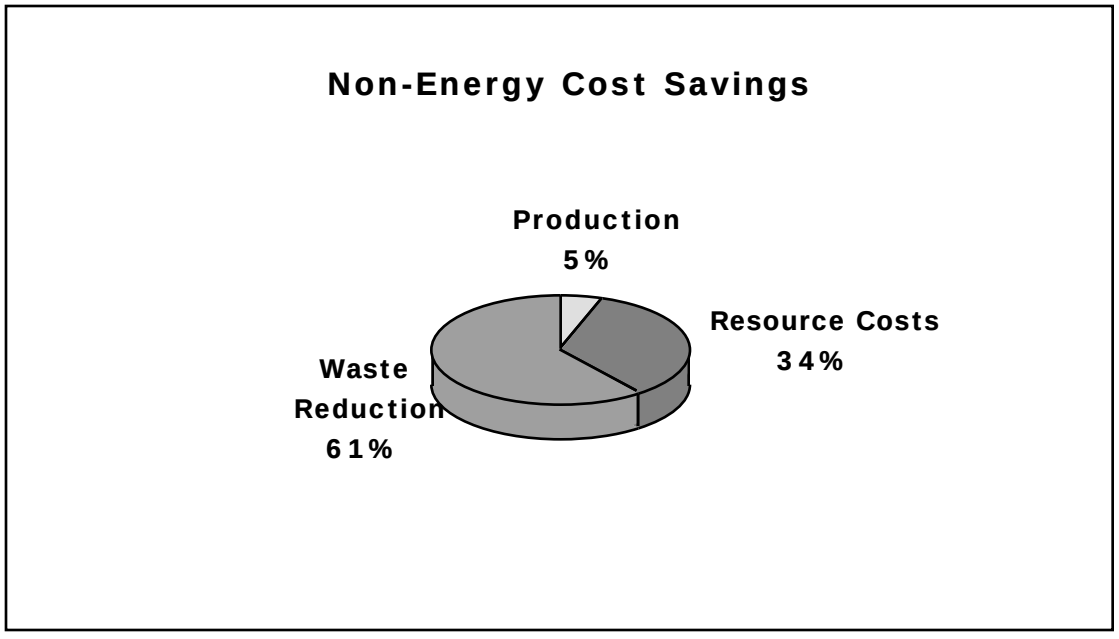

Figure 29. Recommended Non-Energy Cost Savings

Figure 30 indicates the composition of the total recommendations by resource stream for FY94.

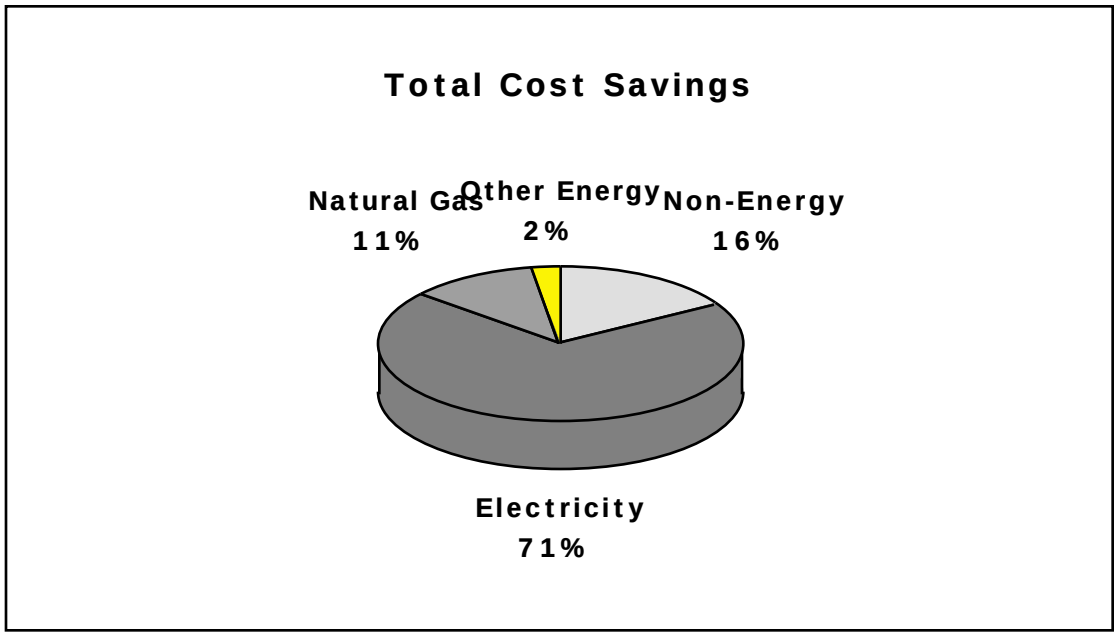

Figure 30. Recommended Cost Savings by Resource Stream

iv. Recommended Conservation by Recommendation Type

Energy conservation recommendations are categorized by use of a detailed expert system known as Assessment Recommendation Codes (ARC). There are more than 300 coded recommendations broken into nine major 2-digit categories for energy. Starting with FY94, we introduced the single digit categories 3 (waste minimization and pollution prevention) and 4 (productivity enhancements). There are almost 250 recommendations in these categories. Table 14 shows the category description and number of recommendations by assessment recommendation (AR) type. Figure 31 shows the frequency of the recommendations.

2-Digit ARC Code	Category Description	No. of Recommendations
2.1	Combustion Systems	337
2.2	Thermal Systems	703
2.3	Electrical Power	271
2.4	Motor Systems	1778
2.5	Industrial Design	18
2.6	Operations	225
2.7	Buildings and Grounds	1849
2.8	Ancillary Costs	107
2.9	Alternate Energy Use	2
3.x	Waste Minimization / P2*	175
4.x	Productivity Enhancement	9
	Total	5474

Table 14. Recommendations by Recommendation Type

* P2 is an abbreviation for Pollution Prevention

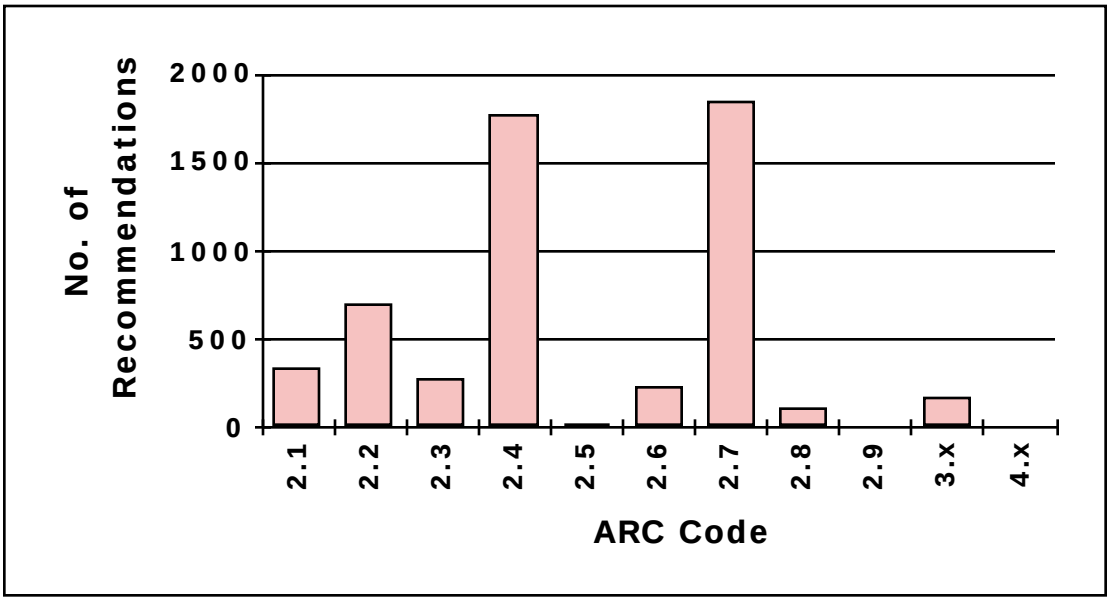

Figure 31. Number of Recommendations by Recommendation Type

D. Implementation Results

i. General

The EADC program has historically enjoyed a high rate of implementation of recommendations. The results of the 1994 program year showed an implementation rate of over 47%. This rate represents the ratio of the number of recommendations that are adopted, as reported by the clients, to the number of recommendations made by the centers. The implementation rate as defined as the amount of energy (MMBTU) saved compared to the amount recommended was 36%, and as cost ($) saved to recommended was 36%. Tables 15 and 16; and Figures 32 through 59 are all related to implementation results.

Fiscal Year	No. of Recommendations	No. of Recommendations Implemented
82	1,152	317
83	1,150	352
84	1,746	1,050
85	2,377	1,400
86	1,998	1,254
87	2,175	1,404
88	2,629	1,581
89	2,380	1,402
90	2,417	1,395
91	3,091	1,766
92	3,777	1,828
93	4,130	2,052
94	5,474	2,586
Totals	34,496	18,387

Table 15. No. of Recommendations and Implemented Recommendations by Fiscal Year

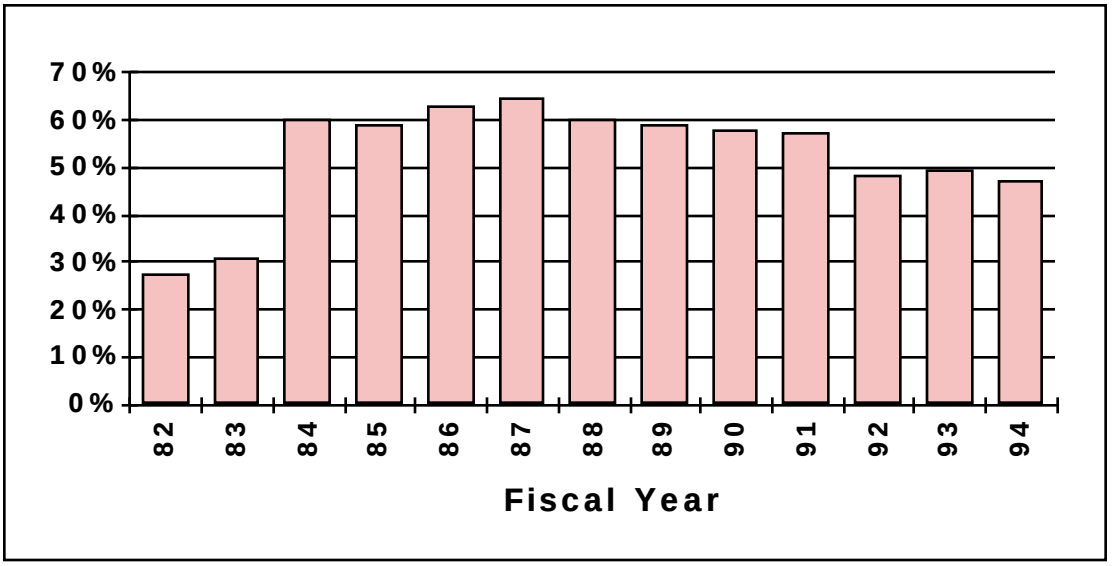

Figure 32. Percent of Recommendations Implemented by Fiscal Year

Fiscal Year	Implemented Energy Conservation			Implemented Cost Savings ($)		
	(MMBtu)	(B.O.E.)	(C.E., mt)	Energy	Non-Energy	Total
82	354,008	60,774	8,188	1,839,122	N/A	1,839,122
83	351,431	60,332	8,128	1,923,834	N/A	1,923,834
84	655,636	112,556	15,164	4,591,834	N/A	4,591,834
85	1,125,751	193,262	26,038	7,007,105	N/A	7,007,105
86	904,243	155,235	20,914	6,677,381	N/A	6,677,381
87	827,032	141,980	19,129	5,866,384	N/A	5,866,384
88	1,047,382	179,808	24,225	6,149,840	N/A	6,149,840
89	995,477	170,897	23,025	7,509,294	N/A	7,509,294
90	859,421	147,540	19,878	6,628,891	N/A	6,628,891
91	791,924	135,953	18,317	8,464,119	N/A	8,464,119
92	1,174,662	201,659	27,169	10,185,850	N/A	10,185,850
93	1,153,099	197,957	26,670	9,363,870	1,607,717	10,971,587
94	1,259,651	216,249	29,135	12,169,824	3,121,562	15,291,386

Table 16. Implemented Savings by Fiscal Year

Figure 33 and Table 17 show a comparison of the simple payback of the measures recommended to the simple payback of the measures that were implemented. In FY94, the directors used over 275 different recommendations. The average number of recommendations was over seven, and 83 recommendations were used only once. A review of Table 14 and Figure 31 further illustrate the fact that most recommendations were process oriented.

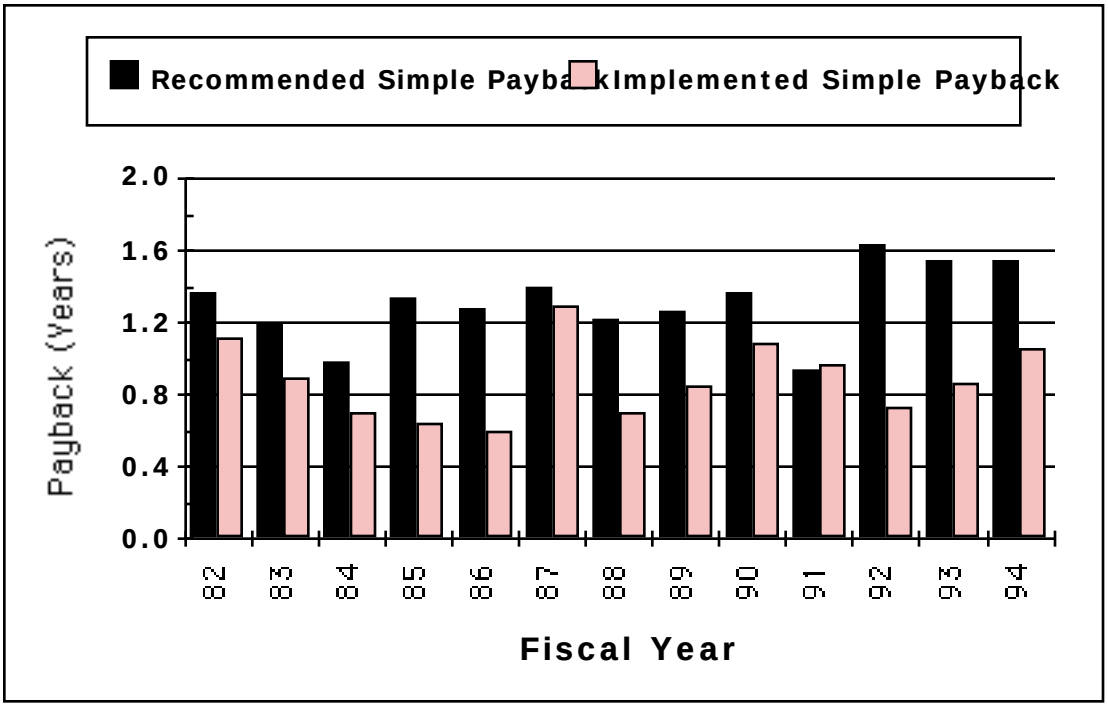

Figure 33. Recommended vs. Implemented Simple Payback

Fiscal Year	Recommended Quantities			Implemented Quantities		
	Cost Savings ($)	Implement. Cost ($)	Simple Payback Period (years)	Cost Savings ($)	Implement. Cost ($)	Simple Payback Period (years)
82	6,699,741	9,158,809	1.4	1,839,122	2,047,222	1.1
83	8,712,422	10,384,859	1.2	1,923,834	1,708,454	0.9
84	8,979,598	8,847,072	1.0	4,591,834	3,222,790	0.7
85	13,917,967	18,494,810	1.3	7,007,105	4,513,755	0.6
86	13,640,445	17,456,672	1.3	6,677,381	3,976,805	0.6
87	10,751,519	15,046,708	1.4	5,866,384	7,609,706	1.3
88	13,603,630	16,479,255	1.2	6,149,840	4,339,946	0.7
89	13,081,589	16,474,805	1.3	7,509,294	6,320,629	0.8
90	14,028,351	19,113,257	1.4	6,628,891	7,158,361	1.1
91	17,373,265	16,297,082	0.9	8,464,119	8,155,209	1.0
92	21,804,001	35,496,798	1.6	10,185,850	7,374,841	0.7
93	29,640,859	45,521,405	1.5	10,973,815	9,447,658	0.9
94	42,413,706	65,574,847	1.5	15,291,386	16,995,184	1.1
Totals	214,647,093	294,346,379	1.4	93,108,855	82,870,560	0.9

Table 17. Recommended and Implemented Simple Payback

Assuming that the useful life of any one implemented energy conservation measure is not indefinite, Table 18 and Figures 34 through 37 show the cumulative effect of these measures if each remained in place over a ten year time frame.

Fiscal Year	Implemented Energy Conservation			Implemented Cost Savings ($)		
	(MMBtu) x1000	(B.O.E.) x1000	(C.E., mt) x1000	Energy x1000	Non-Energy x1000	Total x1000
82	354	61	8	1,839	N/A	1,839
82-83	705	121	16	3,763	N/A	3,763
82-84	1,361	234	31	8,355	N/A	8,355
82-85	2,487	427	58	15,362	N/A	15,362
82-86	3,391	582	78	22,039	N/A	22,039
82-87	4,218	724	98	27,906	N/A	27,906
82-88	5,265	904	122	34,056	N/A	34,056
82-89	6,261	1,075	145	41,565	N/A	41,565
82-90	7,120	1,222	165	48,194	N/A	48,194
82-91	7,912	1,358	183	56,658	N/A	56,658
83-92	8,733	1,499	202	65,005	N/A	65,005
84-93	9,535	1,637	221	72,445	1,608	74,052
85-94	10,139	1,741	234	80,023	4,729	84,752
Totals	67,482	11,585	1,561	477,207	6,337	483,554

Table 18. Ten Year Cumulative Conservation and Cost Savings

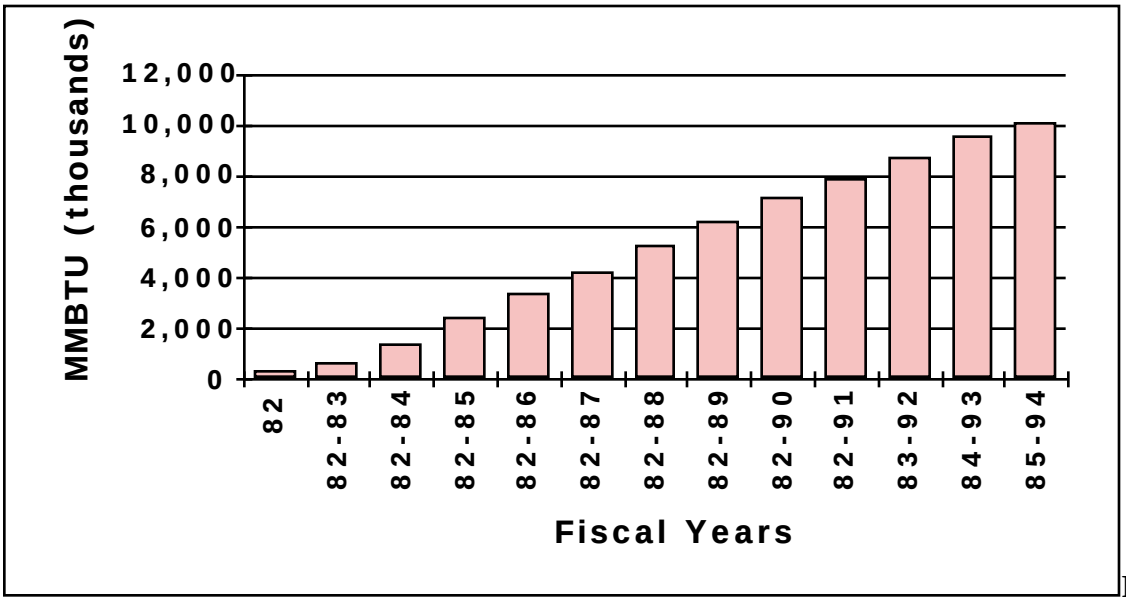

Figure 34. Ten Year Cumulative Energy Savings

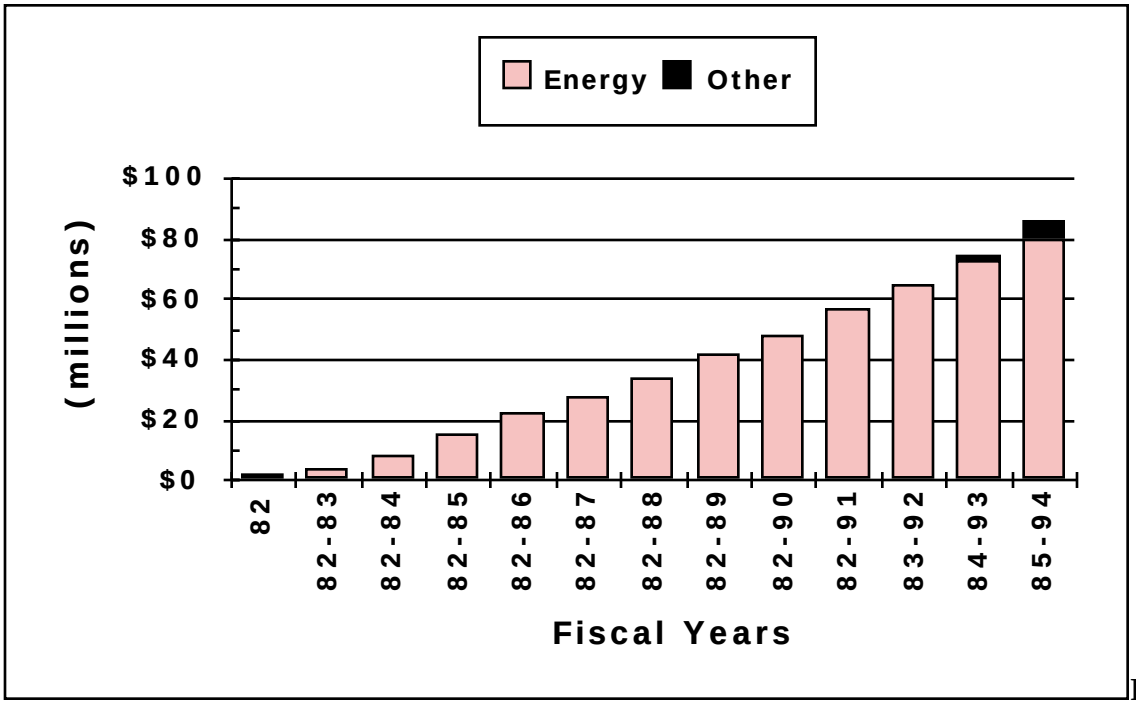

Figure 35. Ten Year Cumulative Cost Savings

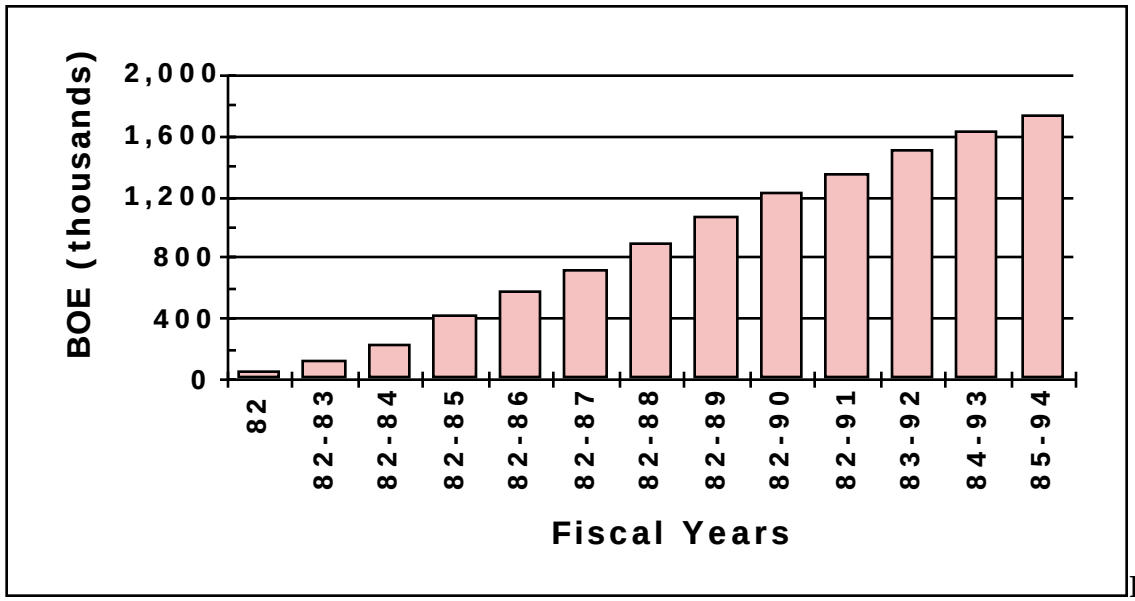

Figure 36. Ten Year Cumulative Barrels of Oil Avoided

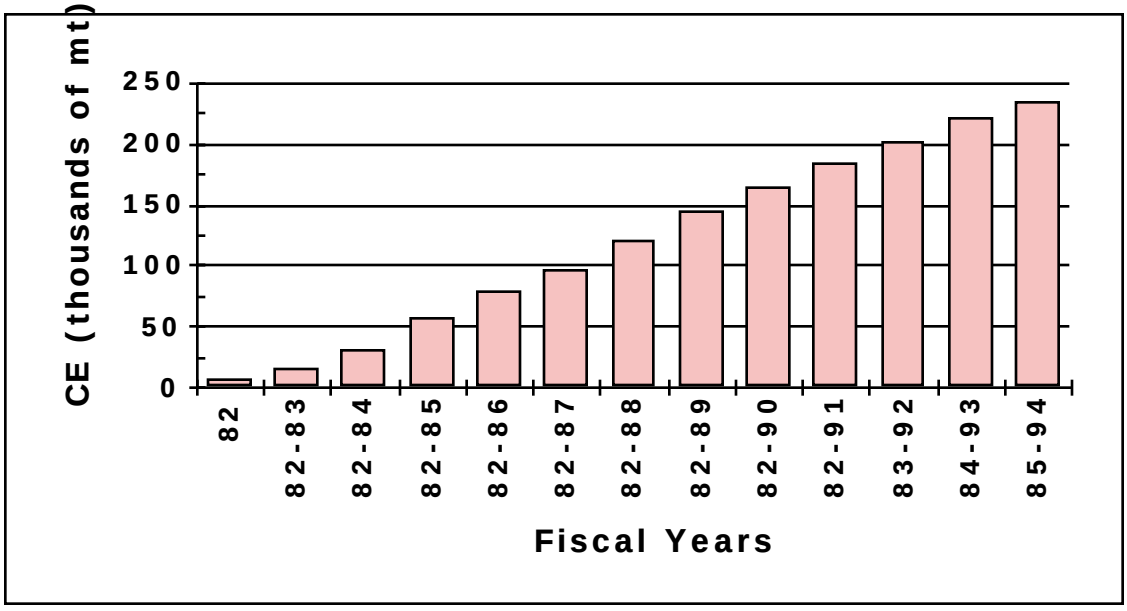

Figure 37. Ten Year Cumulative Carbon Avoided

Similar to the charts in the previous section showing recommended savings, the average energy saved due to the implementation of recommended measures is shown per assessment for FY94 and as a three year average. This can be seen in Table 19 and Figures 38 through 45.

Fiscal Year	Implemented Energy Conservation			Implemented Cost Savings ($)		
	(MMBtu)	(B.O.E.)	(C.E., mt)	Energy	Non-Energy	Total
82	1,399	240	32	7,269	N/A	7,269
83	1,666	286	39	9,118	N/A	9,118
84	2,644	454	61	18,515	N/A	18,515
85	3,059	525	71	19,041	N/A	19,041
86	3,034	521	70	22,407	N/A	22,407
87	2,553	438	59	18,106	N/A	18,106
88	2,699	463	62	15,850	N/A	15,850
89	2,928	503	68	22,086	N/A	22,086
90	2,387	410	55	18,414	N/A	18,414
91	1,740	299	40	18,602	N/A	18,602
92	2,212	380	51	19,182	N/A	19,182
93	1,971	338	46	16,007	2,748	18,755
94	1,623	279	38	15,683	4,023	19,705

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

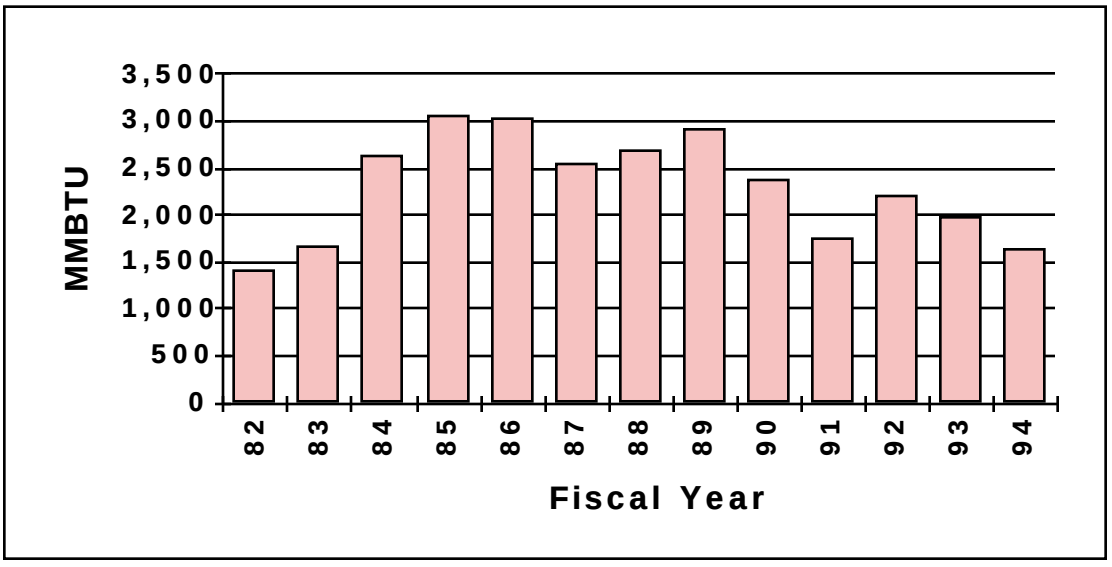

Figure 38. Average Implemented Conservation by Fiscal Year

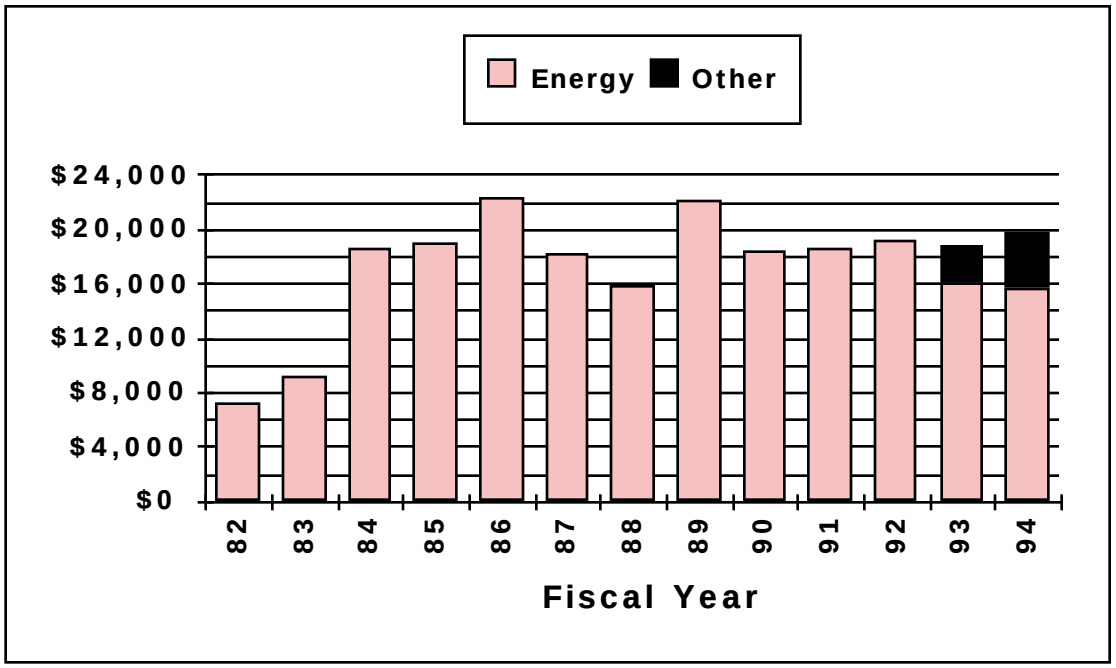

Figure 39. Average Implemented Cost Savings by Fiscal Year

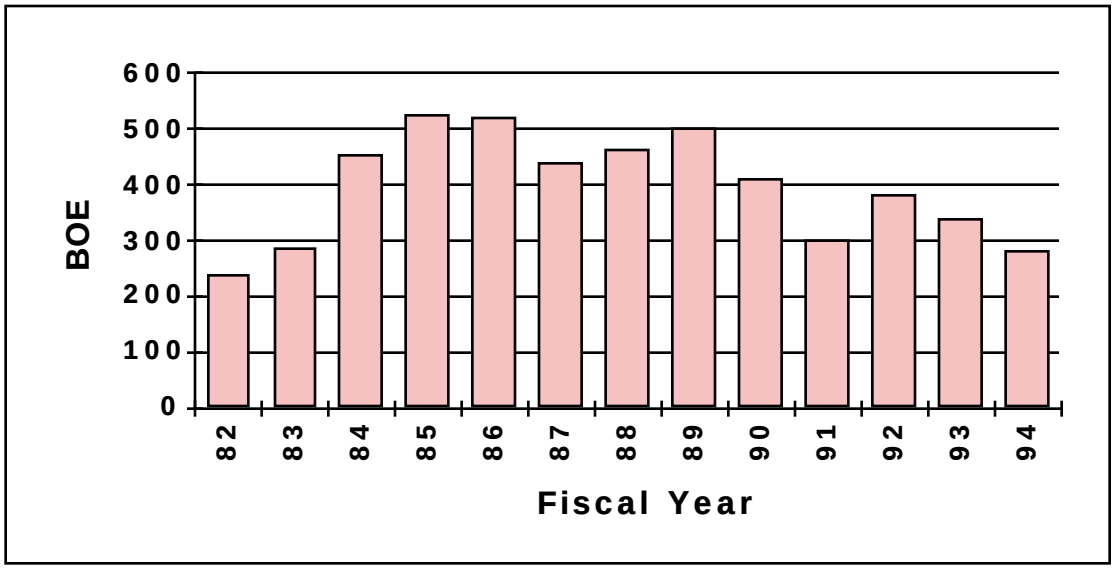

Figure 40. Average Implemented Barrels of Oil Avoided by Fiscal Year

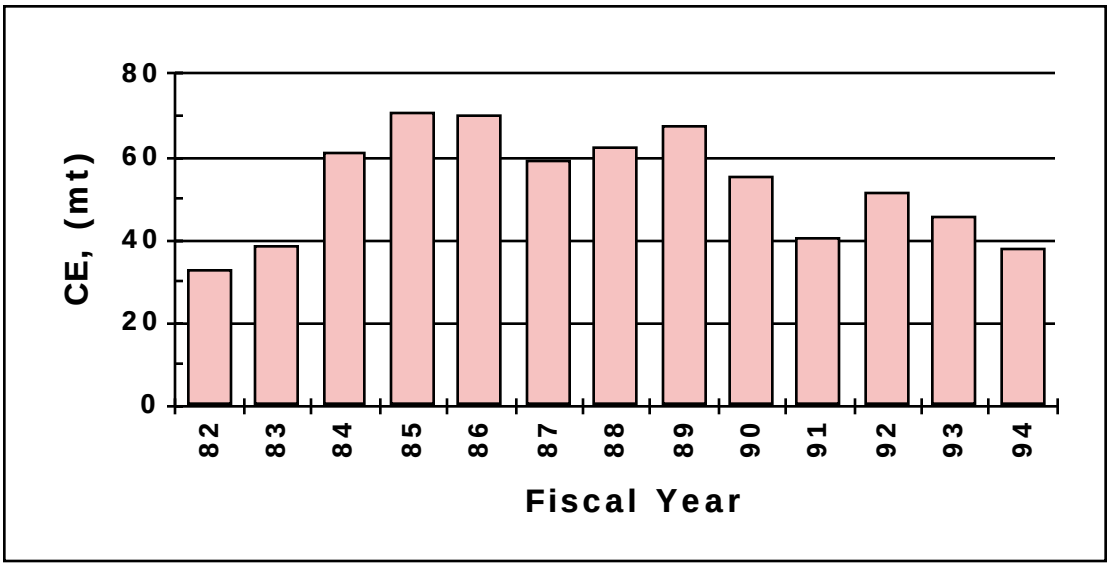

Figure 41. Average Implemented Carbon Avoided by Fiscal Year

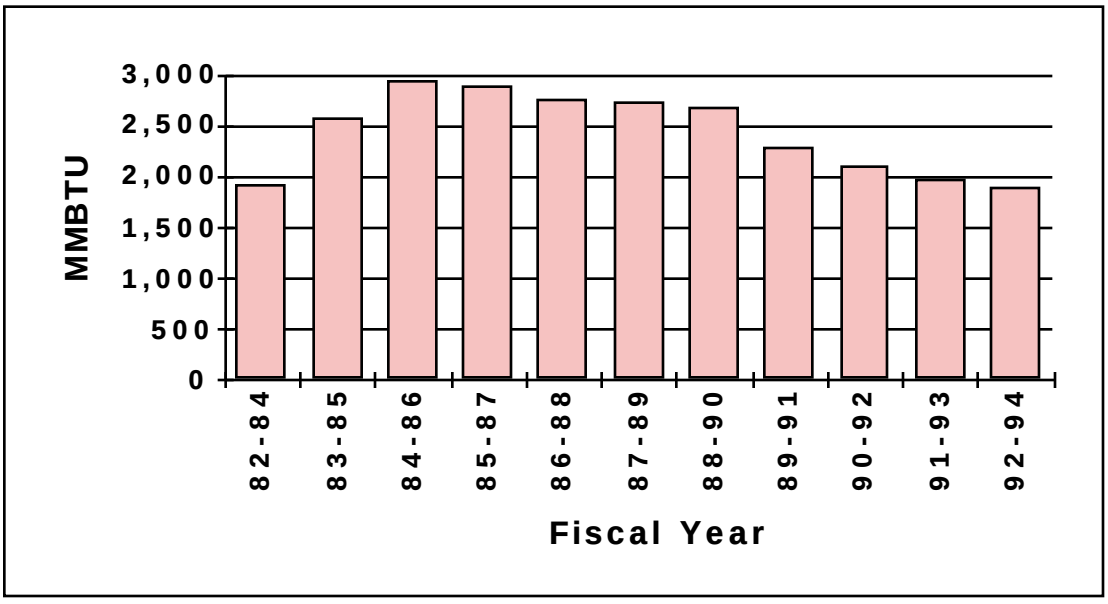

Figure 42. Implemented Energy Conserved Per Assessment (3 Year Average)

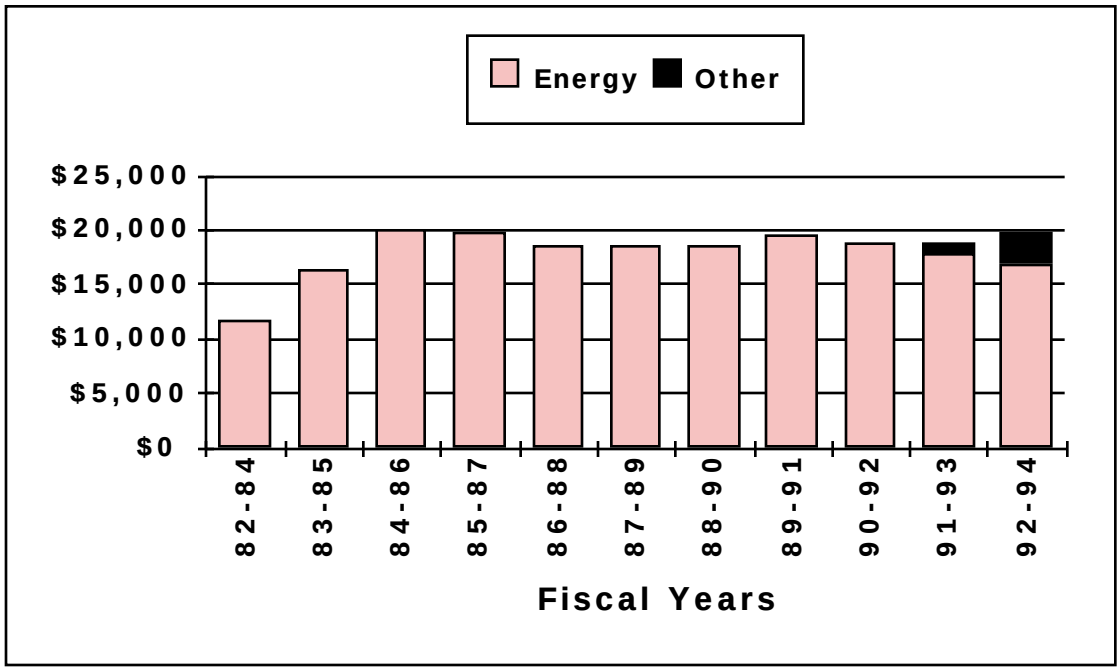

Figure 43. Average Implemented Cost Savings Per Assessment (3 Year Average)

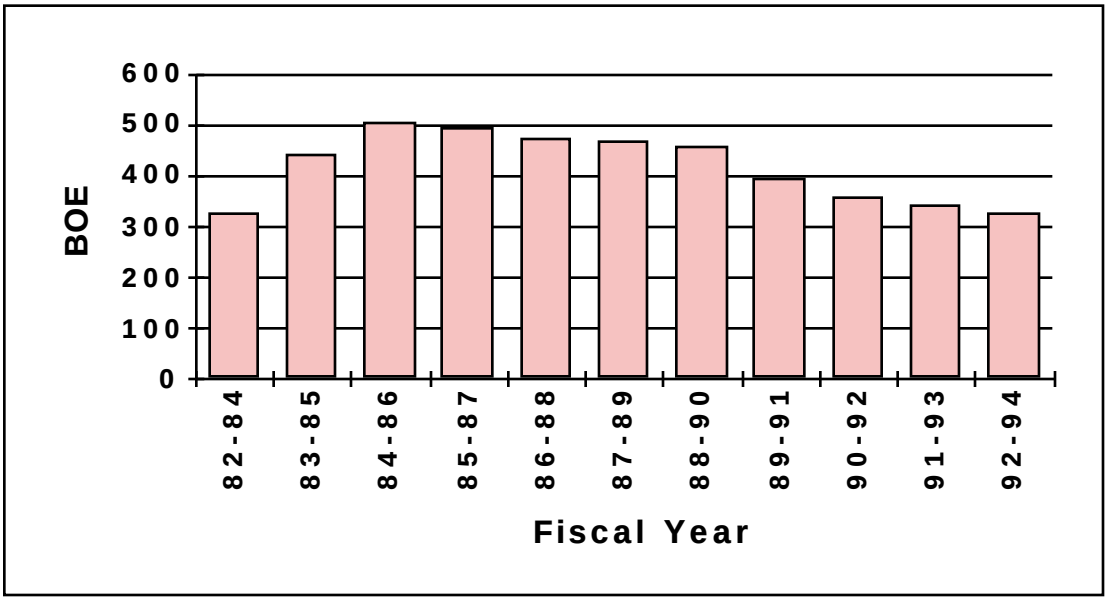

Figure 44. Average Implemented Barrels of Oil Avoided Per Assessment (3 Year Average)

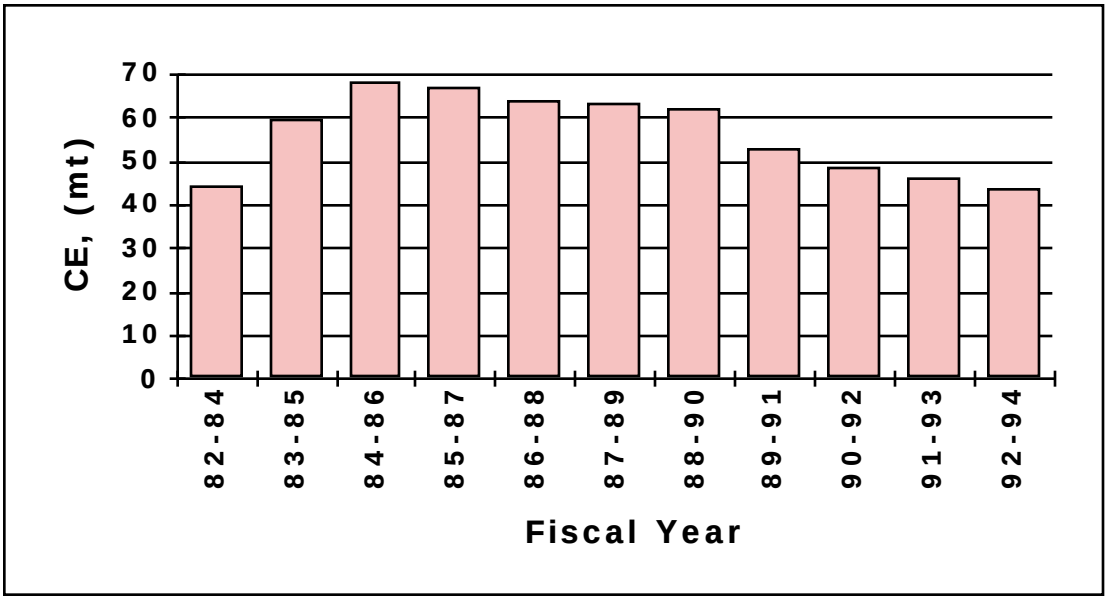

Figure 45. Average Implemented Carbon Avoided Per Assessment (3 Year Average)

ii. Implemented Conservation by Industry Type

Energy conservation and cost savings resulting from implemented recommendations by industry type is shown on Figures 46 through 49. The greatest amount of energy conserved was in SIC 26 (paper products). In cost the largest savings was in SIC 20 (food and kindred products) followed closely by SIC 30 (rubber and plastics) and SIC 26.

SIC Code	Industry Description	Implemented Energy Conservation (MMBtu)	(B.O.E.)	(C.E., mt)	Implemented Cost Savings ($) Energy	Non-Energy	Total
20	Foods	156,404	26,850	3,618	1,560,713	388,135	1,948,848
22	Textile Mills	20,479	3,516	474	171,868	0	171,868
23	Apparel	56,358	9,675	1,304	277,393	2,301	279,694
24	Wood Prod.	100,206	17,203	2,318	581,826	203,675	785,501
25	Furniture	18,935	3,251	438	201,358	107,306	308,664
26	Paper Prod.	296,776	50,949	6,864	1,690,533	191,328	1,881,861
27	Printing	21,118	3,625	488	422,126	9,535	431,661
28	Chemical Prod.	29,146	5,004	674	282,970	280,426	563,396
29	Petroleum	34,589	5,938	800	234,214	0	234,214
30	Rubber & Plast.	129,051	22,155	2,985	1,693,649	250,923	1,944,572
31	Leather Prod.	2,840	488	66	28,679	18,224	46,903
32	Stone & Glass	20,259	3,478	469	369,047	166,860	535,907
33	Primary Metal	100,613	17,273	2,327	744,396	154,029	898,425
34	Fab. Metal	93,560	16,062	2,164	1,078,482	436,419	1,514,901
35	Ind. Machinery	65,228	11,198	1,509	989,272	154,503	1,143,775
36	Electronics	46,760	8,027	1,082	747,511	259,492	1,007,003
37	Trans. Equip.	34,506	5,924	798	484,960	488,318	973,278
38	Instruments	24,506	4,207	567	505,619	10,088	515,707
39	Misc. Manuf.	8,317	1,428	192	105,208	0	105,208
Totals		1,259,651	216,249	29,135	12,169,824	3,121,562	15,291,386

Table 20. Implemented Energy and Cost Savings by Industry Type

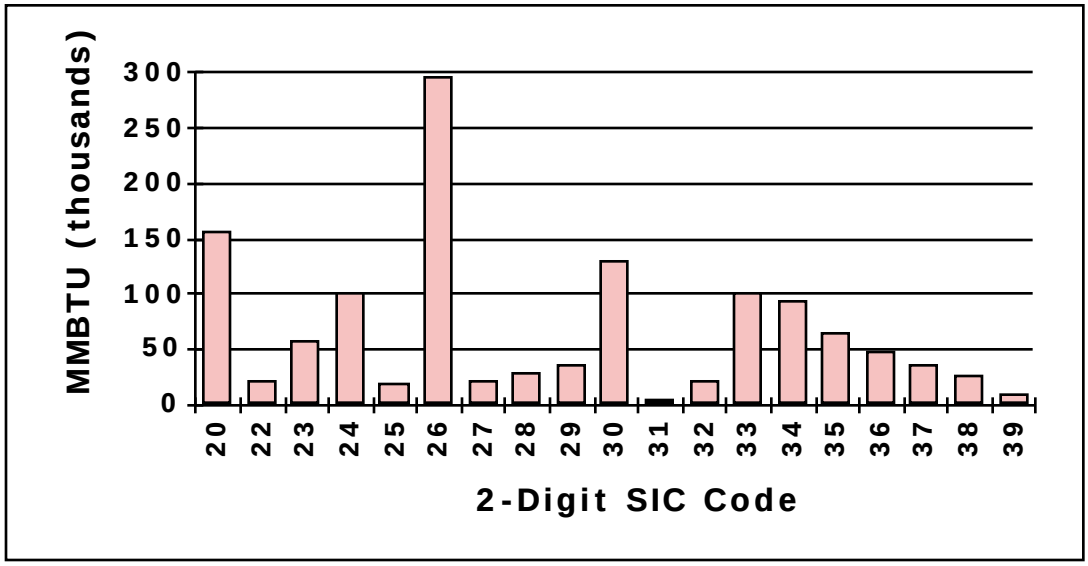

Figure 46. Implemented Energy Conserved by Industry Type

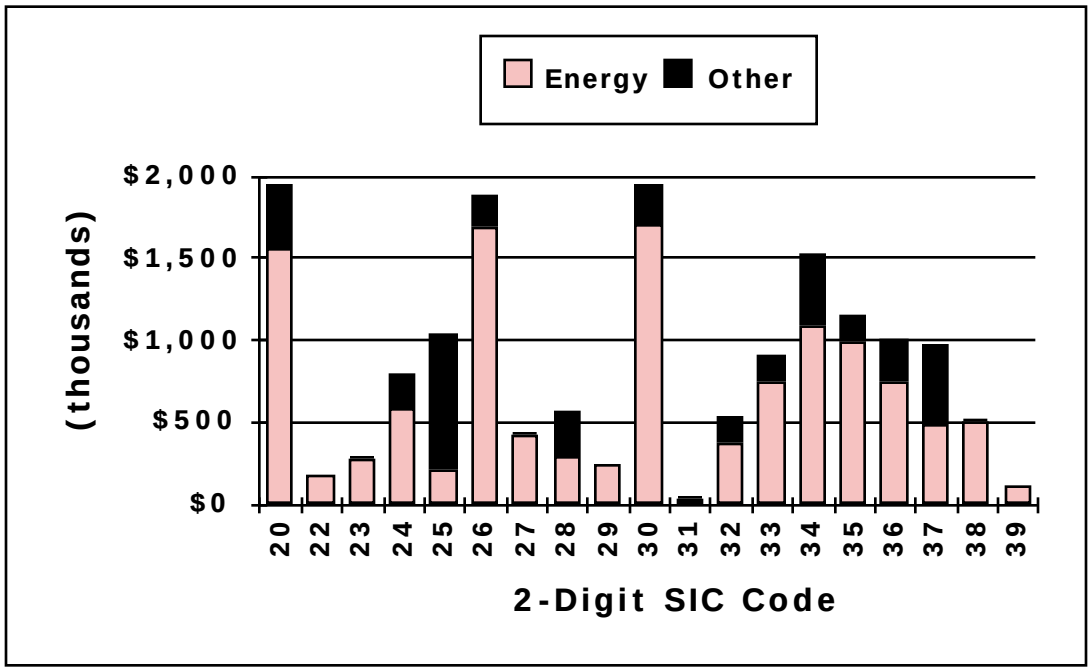

Figure 47. Implemented Cost Savings by Industry Type

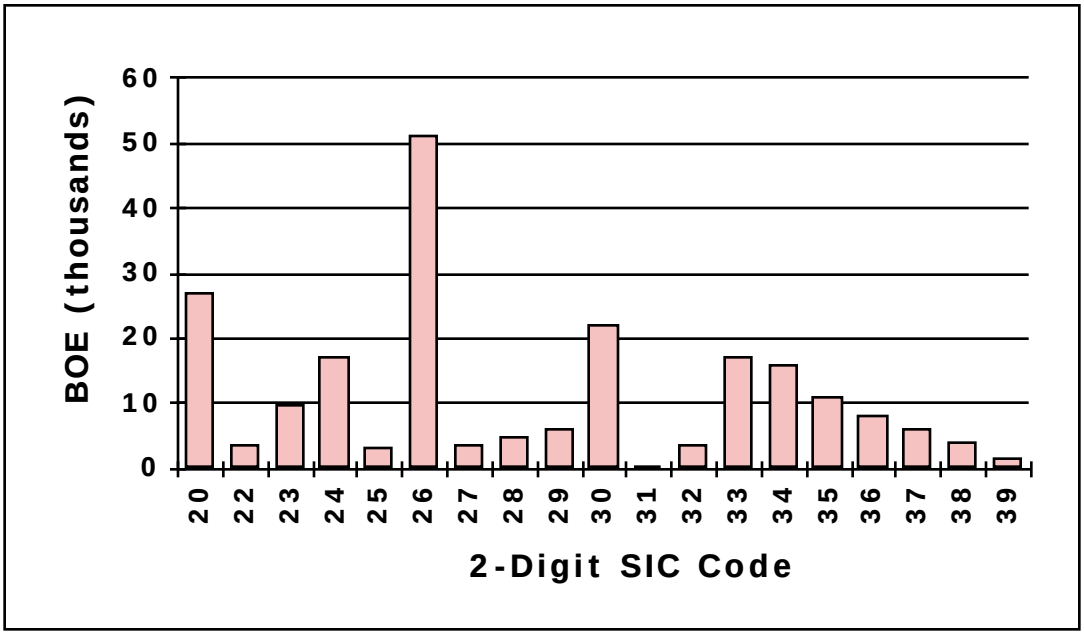

Figure 48. Implemented Barrels of Oil Avoided by Industry Type

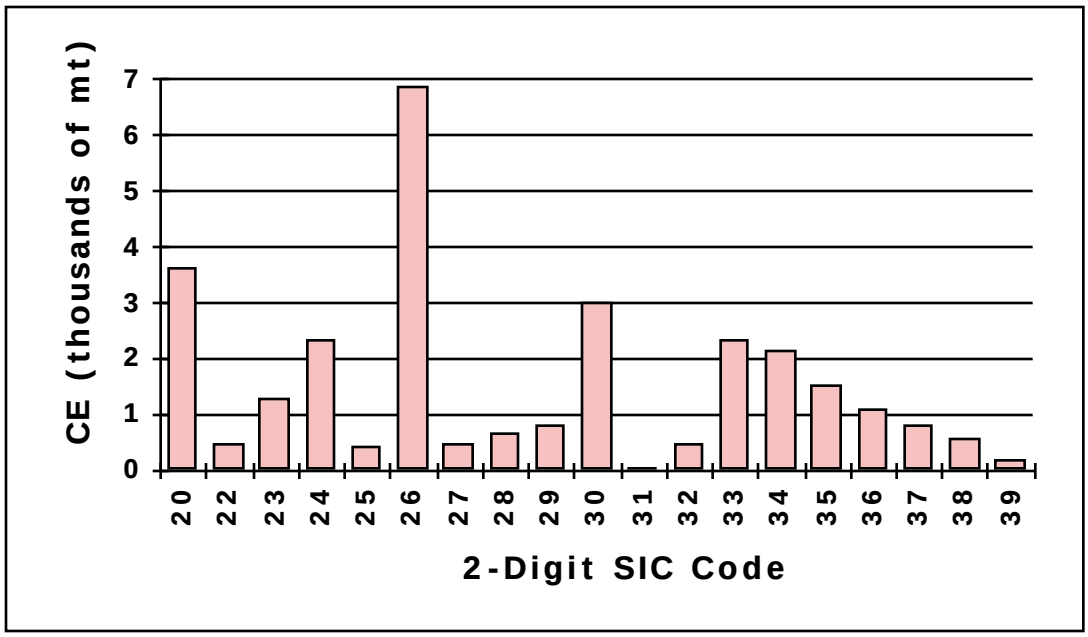

Figure 49. Implemented Carbon Avoided by Industry Type

Table 21 and Figures 50 - 53 show the average implemented energy and cost savings by industry type per assessment.

SIC Code	Industry Description	Implemented Energy Conservation (MMBtu)	(B.O.E.)	(C.E., mt)	Implemented Cost Savings ($) Energy	Non-Energy	Total
20	Foods	1,612	277	37	16,090	4,001	20,091
22	Textile Mills	1,024	176	24	8,593	0	8,593
23	Apparel	3,757	645	87	18,493	153	18,646
24	Wood Prod.	3,131	538	72	18,182	6,365	24,547
25	Furniture	1,114	191	26	11,845	6,312	18,157
26	Paper Prod.	5,207	894	120	29,658	3,357	33,015
27	Printing	571	98	13	11,409	258	11,667
28	Chemical Prod.	857	147	20	8,323	8,248	16,570
29	Petroleum	3,459	594	80	23,421	0	23,421
30	Rubber & Plast.	1,518	261	35	19,925	2,952	22,877
31	Leather Prod.	355	61	8	3,585	2,278	5,863
32	Stone & Glass	810	139	19	14,762	6,674	21,436
33	Primary Metal	1,863	320	43	13,785	2,852	16,638
34	Fab. Metal	1,155	198	27	13,315	5,388	18,702
35	Ind. Machinery	733	126	17	11,115	1,736	12,851
36	Electronics	882	151	20	14,104	4,896	19,000
37	Trans. Equip.	1,113	191	26	15,644	15,752	31,396
38	Instruments	1,167	200	27	24,077	480	24,557
39	Misc. Manuf.	832	143	19	10,521	0	10,521
Average		1,623	279	38	15,683	4,023	19,705

Table 21. Average Implemented Energy and Cost Savings by Industry Type

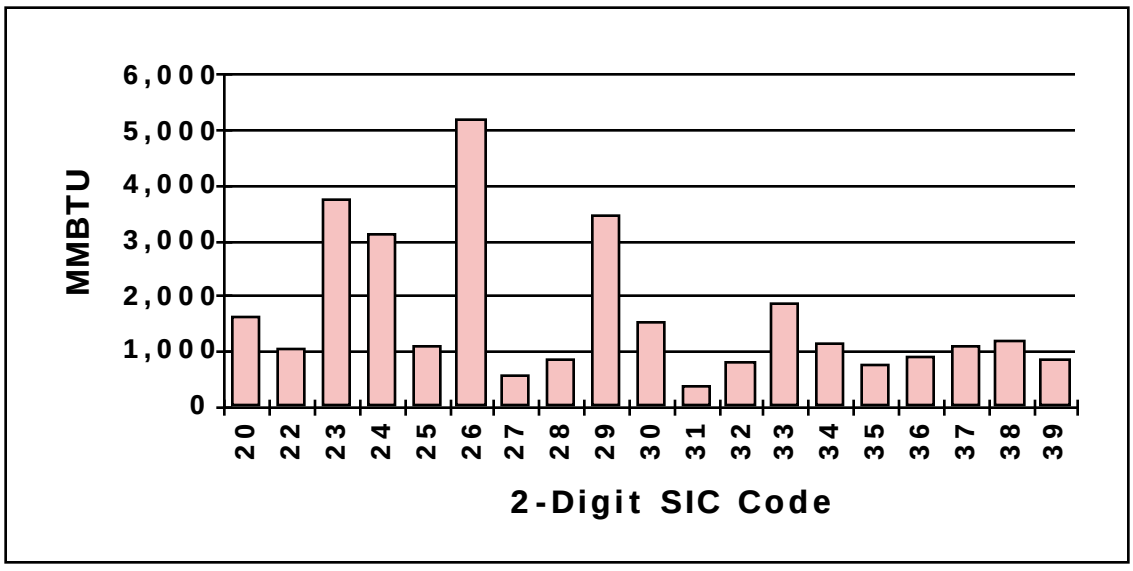

Figure 50. Average Implemented Energy Savings by Industry Type

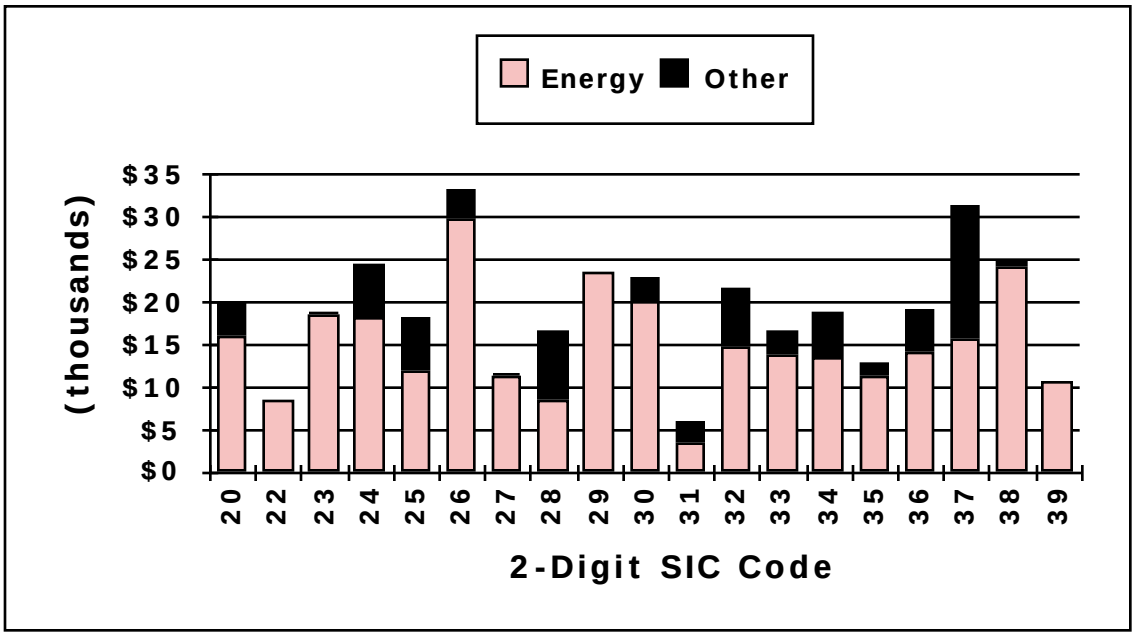

Figure 51. Average Implemented Cost Savings by Industry Type

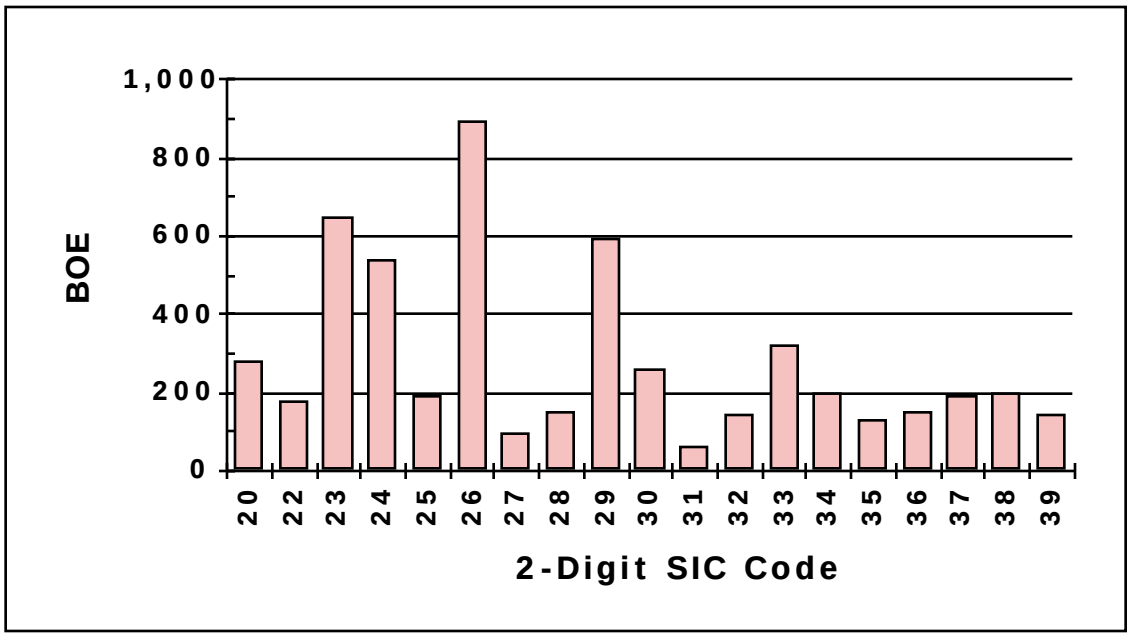

Figure 52. Average Implemented Barrels of Oil Avoided by Industry Type

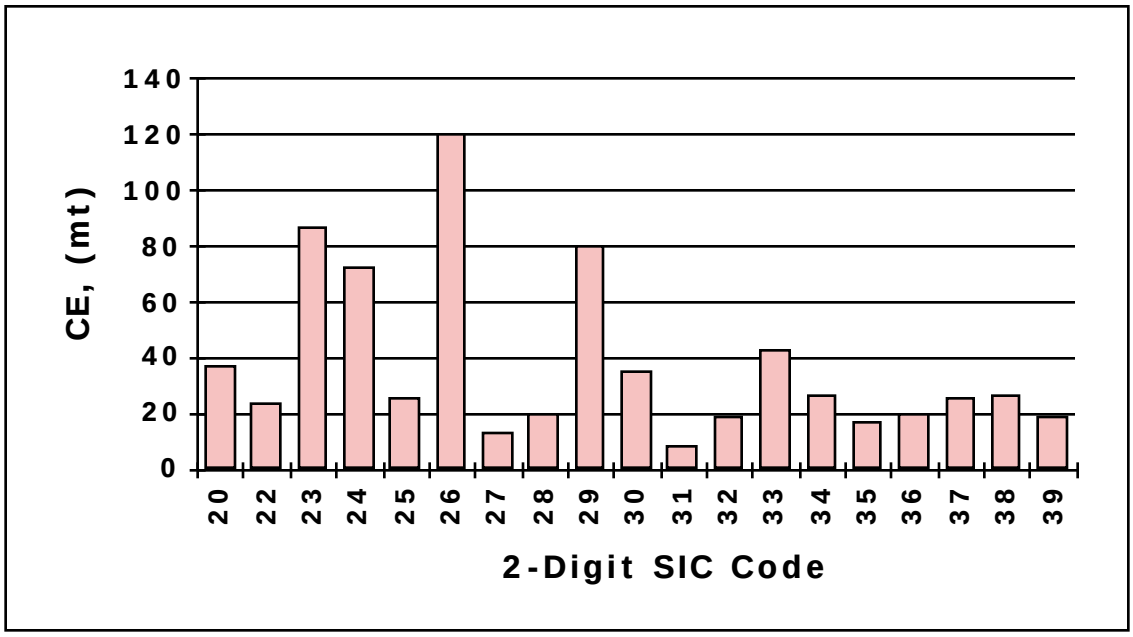

Figure 53. Average Implemented Carbon Avoided by Industry Type

iii. Implemented Conservation by Resource Stream

Table 22, and Figures 54 and 55 reflect implemented energy and cost savings broken down by energy stream. A large percentage of the fuel switching and electricity generating recommendations were not implemented, explaining why the recommended energy and cost saved for #2 fuel oil was negative (see Table 11), yet the implemented values shown here are positive.

Energy Stream	Implemented Energy Conservation (MMBTU)	Implemented Energy Cost Savings ($)
Electricity	526,435	9,796,961
Natural Gas	503,888	1,754,272
L. P. G.	2,342	12,313
Fuel Oil #2	4,711	29,554
Fuel Oil #4	1,494	4,676
Fuel Oil #6	193,142	493,949
Coal	2,339	9,080
Wood	22,449	38,037
Other Gas	41	358
Other Energy	2,810	30,624
Energy Totals	1,259,651	12,169,824
Non-Energy	n/a	3,121,562
Program Totals	1,259,651	15,291,386

Table 22. Implemented Energy and Cost Savings by Resource Stream

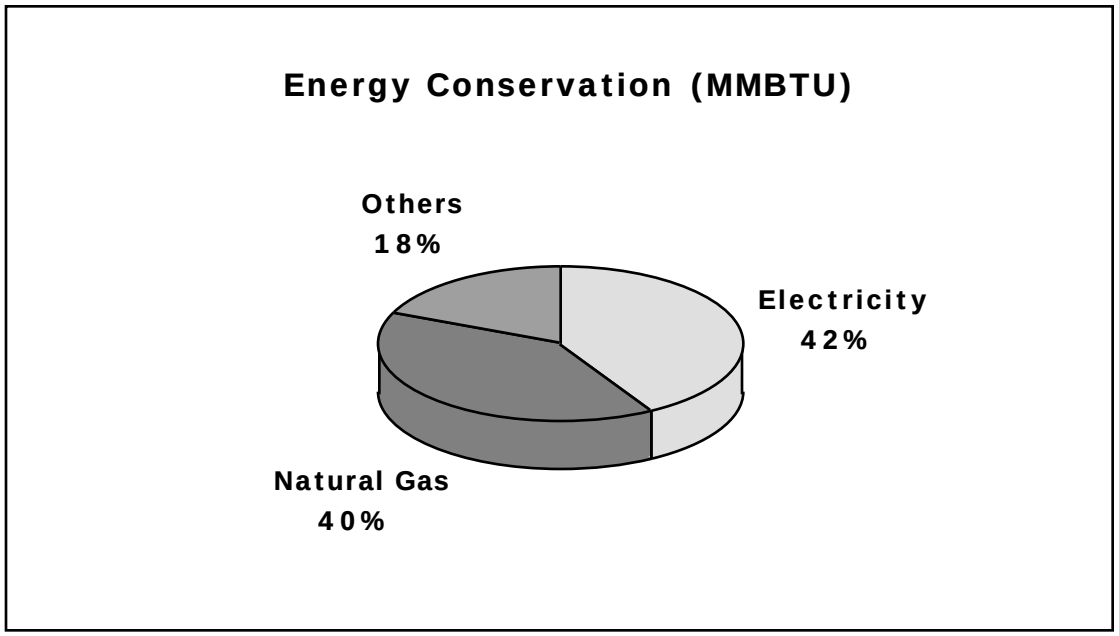

Figure 54. Composition of Implemented Energy Conserved by Energy Stream

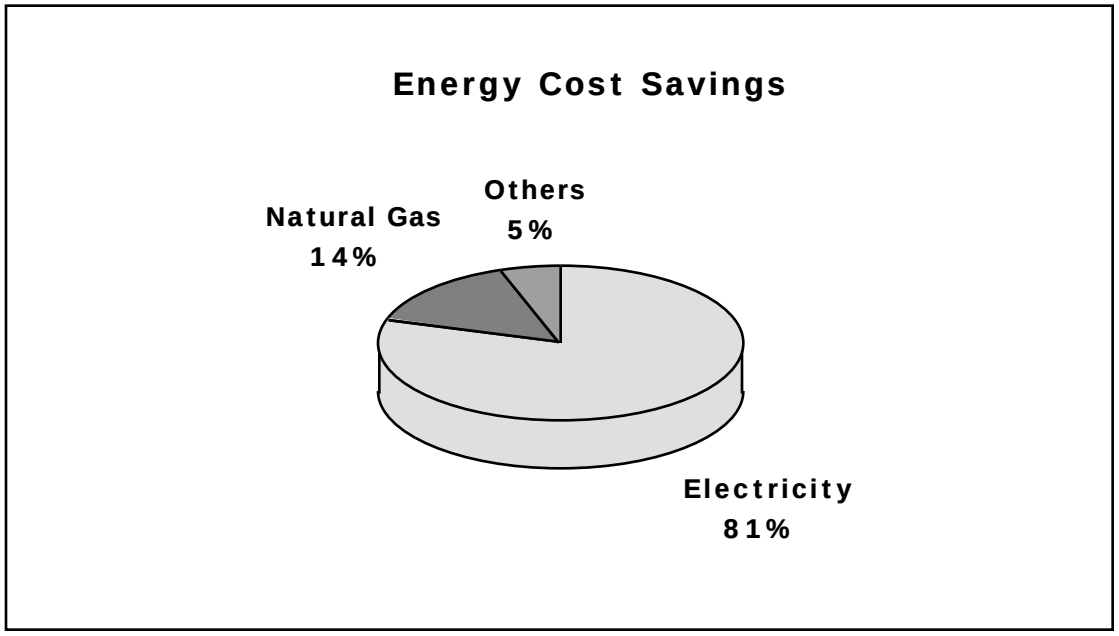

Figure 55. Composition of Implemented Energy Cost Savings by Energy Stream

The breakdown of non-energy savings by resource stream type is shown in Table 23, and Figure 56. The total implemented cost savings by resource stream is shown in Figure 57.

Stream Type	Total Implemented Non-Energy Cost Savings ($)
Production	
Primary Product	15,000
Resource Costs	
Personnel Changes	3,051
Administrative Costs	1,251,072
Primary Raw Material	123,913
Ancillary Material Cost	10,250
Water Consumption	29,620
Waste Reduction	
Water Disposal	548,639
Other Liquid (non-haz)	51,185
Other Liquid (haz)	37,708
Solid Waste (non-haz)	633,061
Solid Waste (haz)	171,243
Gaseous Waste (haz)	246,820
Non-Energy Total	3,121,562

Table 23. Total Implemented Non-Energy Cost Savings

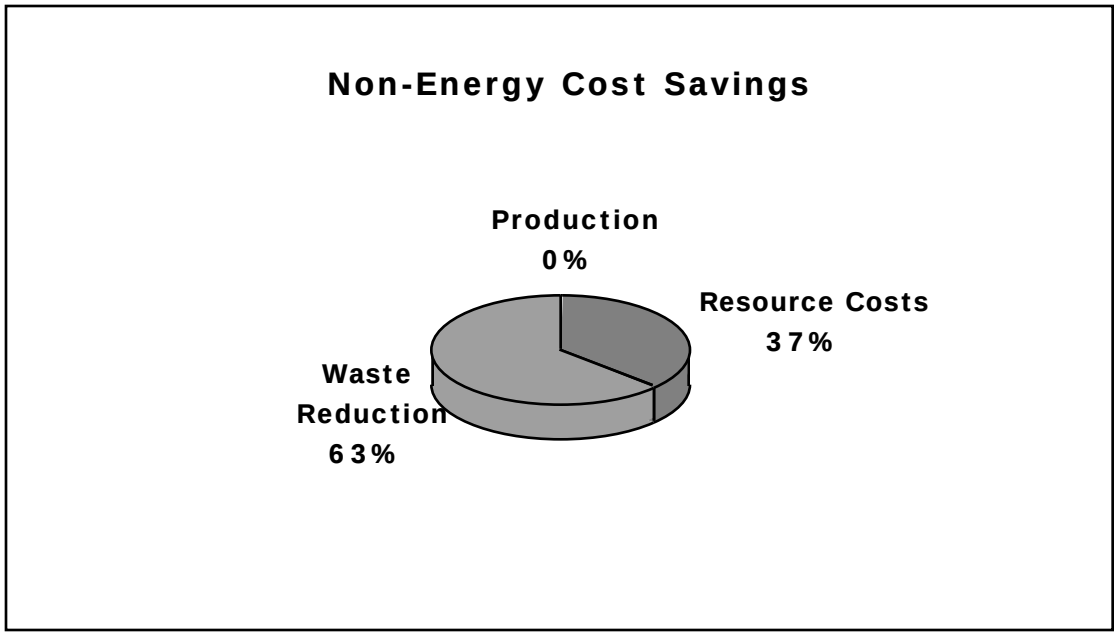

Figure 56. Composition of Non-Energy Implemented Savings

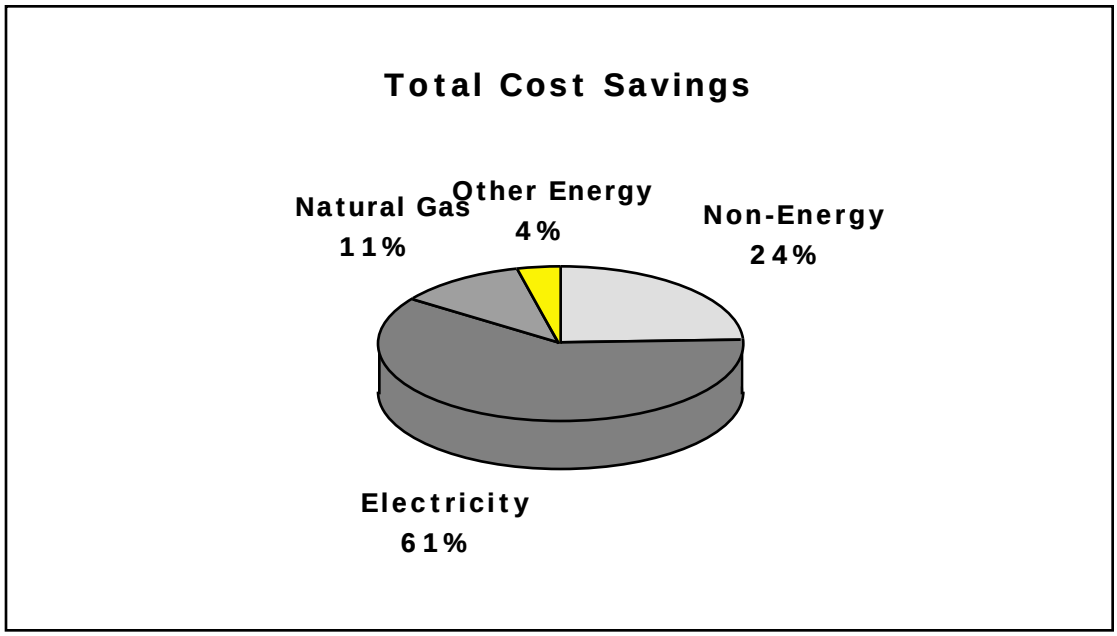

Figure 57. Composition of Total Implemented Cost Savings_

iv. Implemented Conservation by Recommendation Type

Finally, the number of implemented recommendations by recommendation type for Fiscal Year 1994 is shown in Tables 24 & 25; and Figures 58 & 59.

2-Digit ARC Code	Category Description	No. of Implemented Recommendations
2.1	Combustion Systems	127
2.2	Thermal Systems	243
2.3	Electrical Power	106
2.4	Motor Systems	970
2.5	Industrial Design	8
2.6	Operations	114
2.7	Buildings and Grounds	898
2.8	Ancillary Costs	50
2.9	Alternate Energy Use	0
3.x	Waste Minimization / P2	66
4.x	Productivity Enhancement	4
	Total	2586

Table 24. Number of Implemented Recommendations by Recommendation Type

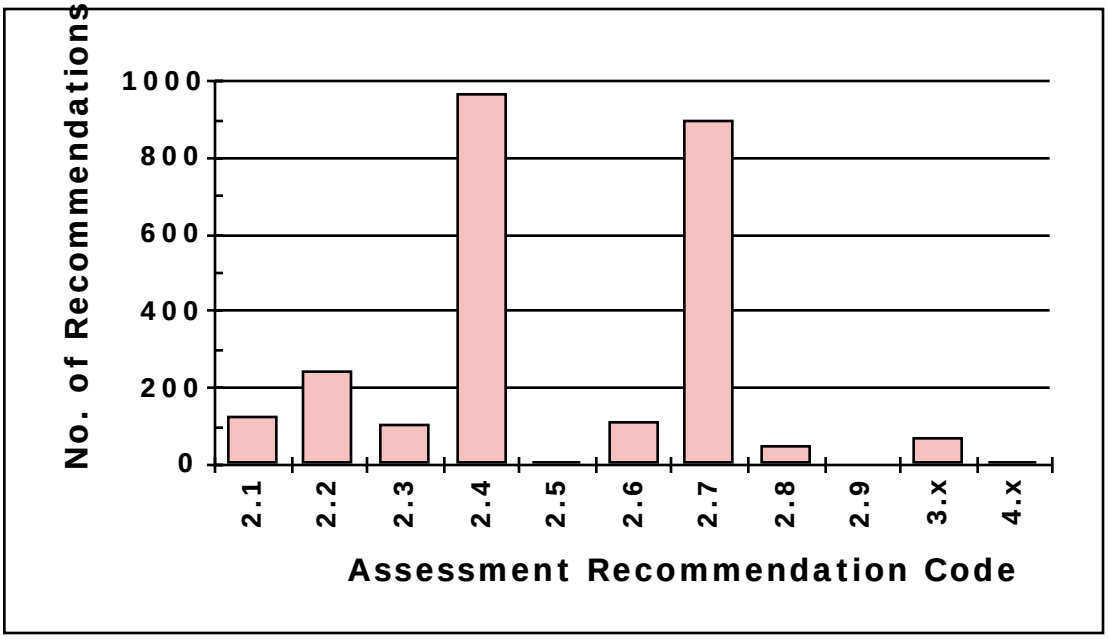

Figure 58. Number of Implemented Recommendations by Recommendation Type

2-Digit ARC Code	Category Description	No. of Implemented Recommendations
3.1	Operations	14
3.2	Equipment	2
3.3	Post Generation Treatment / Minimization	1
3.4	Water Use	15
3.5	Recycling	10
3.6	Waste Disposal	7
3.7	Maintenance	10
3.8	Raw Materials	7
4.1	TQM (Total Quality Management)	4
	Total	70

Table 25. Number of Implemented Non-Energy Recommendations by Recommendation Type

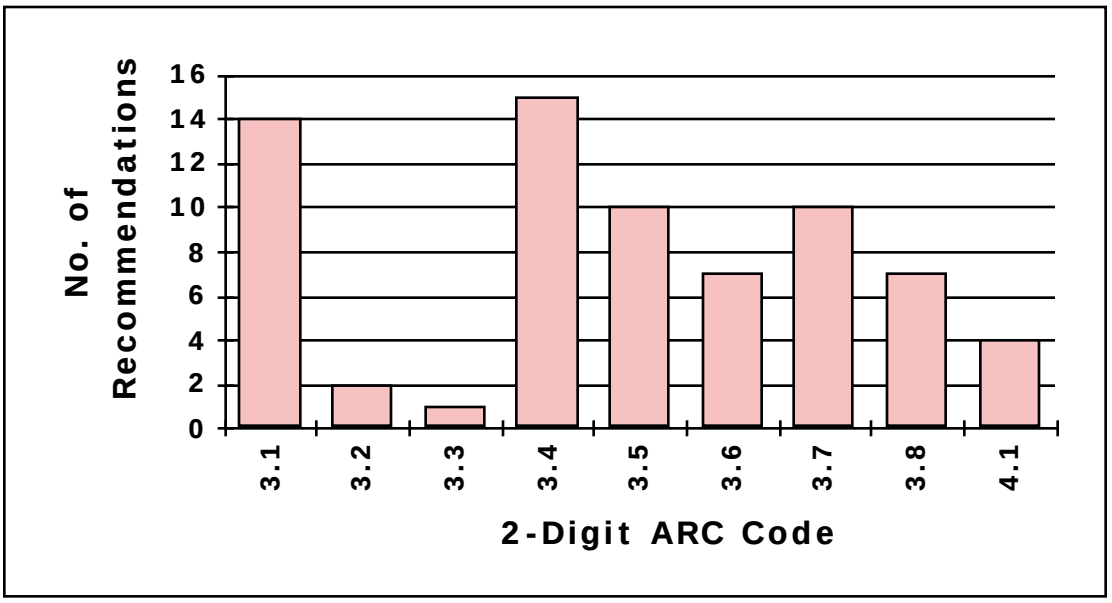

Figure 59. Number of Implemented Non-Energy Recommendations by Recommendation Type

III. Standard Financial CalculationsStandard Financial Calculations, FY94

Standard financial calculations of the EADC/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 FY94.

Standard Financial Calculations of EADC/IAC Results
1993-94

IMPCOST GROWTH	ENSAV GROWTH	BORR RATE	FEDERAL GOVERNMENT			MANUFACTURERS		
%	%	%	IRR	LR_{10}	LR_{15}	IRR	LR_{10}	LR_{15}
3	3	3	43.6	1.97	1.44	316	2.54	2.09
3	3	6	41.9	1.90	1.38	274	2.48	2.03
3	3	9	40.2	1.83	1.31	239	2.41	1.97
3	3	6	41.9	1.90	1.38	274	2.48	2.03
6	3	6	41.6	1.89	1.37	271	2.46	2.02
6	0	6	36.5	1.47	1.03	254	2.11	1.73
6	3	6	41.6	1.89	1.37	271	2.46	2.02
6	6	6	46.7	2.35	1.74	288	2.86	2.34
12	6	6	46.1	2.32	1.71	282	2.83	2.32

Table 26. Standard Financial Calculations of EADC/IAC Results

GLOSSARY

IMPCOST GROWTH = annual growth rate of the cost of implementing EADC/IACs' recommendations.
ENSAV GROWTH = annual growth rate of energy cost savings from implementation of EADC/IACs' recommendations.
BORR RATE = annual borrowing rate for debt service on funds borrowed to implement EADC/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

Field Management for the Eastern EADC/IAC region is 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 EADC/IAC database for the entire program.

The Eastern Region was comprised of eleven experienced centers performing 30 assessments each, and four new centers performing 15 audits each. The addresses and phone numbers of all centers is given in the appendix. The schools and directors participating in the program in FY94 are shown below.

(GT)	Georgia Institute of Technology	Mr. William A. Meffert
(HO)	Hofstra University	Dr. Charles Forsberg
(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.

Center	Date Entered Program	94 Assessments Completed	Director's Years in Program	Student Participation	
				Graduate	Under Grad.
GT	FY82	30	4	0	4
HO	FY92	30	3	2	10
MA	FY84	30	11	4	1
ME	FY93	30	2	0	8
MS	FY94	15	1	2	6
NC	FY93	30	1	5	4
ND	FY91	30	4	0	9
OD	FY94	15	1	1	6
TN	FY76	30	19	2	3
UD	FY76	30	19	1	2
UF	FY91	30	4	6	18
UL	FY94	15	1	0	11
UM	FY94	15	1	7	1
WI	FY87	30	8	3	3
WV	FY93	30	2	9	0

Table 27. History of Eastern Centers

In FY94, a significant shift was initiated by encouraging cooperation between the center directors, energy utilities, state and other government agencies, and manufacturing groups. Two of these outreach activities are outlined below:

- The Director of the Mississippi State Center hosted an on-campus presentation of the program for the Director of the Division of Energy of Mississippi.

- The Directors of the Centers at the University of Tennessee and University of Dayton co-hosted a workshop on Managing Energy Costs in Industrial and Commercial Facilities for clients of Cincinnati Gas and Electric Co.

ii. Analysis of Results From Industrial Assessments

As mentioned in the Introduction, Fiscal Year 1994 marked the first year during which industrial assessments were performed. The data for FY94 allows the first opportunity for comparison between the results of an industrial assessment and those of an energy audit. The recommended and implemented results from *only* the FY94 industrial assessments are presented here. Comparisons between the average industrial assessment and the average energy audit are also made.

General

Six experienced centers performed a total of sixty-one industrial assessments in FY94. Colorado State University, Oregon State University, Texas A&M University, the University of Massachusetts, and the University of Tennessee each performed ten industrial assessments, while the University of Wisconsin-Milwaukee conducted eleven. The distribution of the industrial assessments by industry type is shown in Table 28. No industrial assessments were performed in SIC 21 (Tobacco Products), SIC 22 (Textile Mill Products), SIC 23 (Apparel and Other Textile Products), or SIC 29 (Petroleum and Coal Products).

2-digit SIC Code	Industry	No. of Assessments Performed
20	Food and Kindred Products	2
24	Lumber and Wood Products	3
25	Furniture and Fixtures	2
26	Paper and Allied Products	1
27	Printing and Publishing	7
28	Chemicals and Allied Products	1
30	Rubber and Misc. Plastics Products	4
31	Leather and Leather Products	1
32	Stone, Clay, and Glass Products	2
33	Primary Metal Industries	6
34	Fabricated Metal Products	13
35	Industrial Machinery and Equipment	6
36	Electronic and Other Electric Equipment	7
37	Transportation Equipment	3
38	Instruments and Related Products	2
39	Miscellaneous Manufacturing Industries	1
Total		61

Table 28. Number of Industrial Assessments Performed by Industry Type

Table 29 lists the total number of recommendations and implemented recommendations which resulted from the industrial assessments, grouped by recommendation type. Forty-eight percent of the energy management recommendations were implemented, as compared to thirty-seven percent for the waste minimization and pollution prevention recommendations. The only direct productivity enhancement recommendation was not implemented. Well over 50% of the recommendations were process related.

2-Digit ARC Code	Category Description	No. of Recommendations	No. of Implemented Recommendations
Energy Management			
2.1	Combustion Systems	18	13
2.2	Thermal Systems	51	21
2.3	Electrical Power	28	7
2.4	Motor Systems	117	64
2.5	Industrial Design	3	3
2.6	Operations	24	10
2.7	Buildings and Grounds	113	54
2.8	Ancillary Costs	10	4
2.9	Alternate Energy Use	0	0
Waste Minimization / Pollution Prevention			
3.1	Operations	28	10
3.2	Equipment	4	1
3.3	Post Generation Treatment / Minimization	5	1
3.4	Water Use	9	5
3.5	Recycling	34	10
3.6	Waste Disposal	13	7
3.7	Maintenance	14	9
3.8	Raw Materials	27	7
Direct Productivity Enhancements			
4.1	TQM (Total Quality Management)	1	0
Total		499	226

Table 29. Number of Recommendations by Recommendation Type (Industrial Assessments)

Conservation by Stream Type

Table 30 summarizes the recommended and implemented cost savings totals by resource stream type, and Figure 60 shows each of the implemented values as a percentage of the total implemented cost savings for the industrial assessments.

Table 30. Cost Savings by Stream Type (Industrial Assessments)

Stream Type	Total Recommended Cost Savings ($)	Total Implemented Cost Savings ($)
Non-Energy	4,737,064	1,989,518
Electricity	1,269,327	546,109
Natural Gas	358,116	137,296
Other Energy	11,633	9,792
Program Total	6,376,140	2,682,715

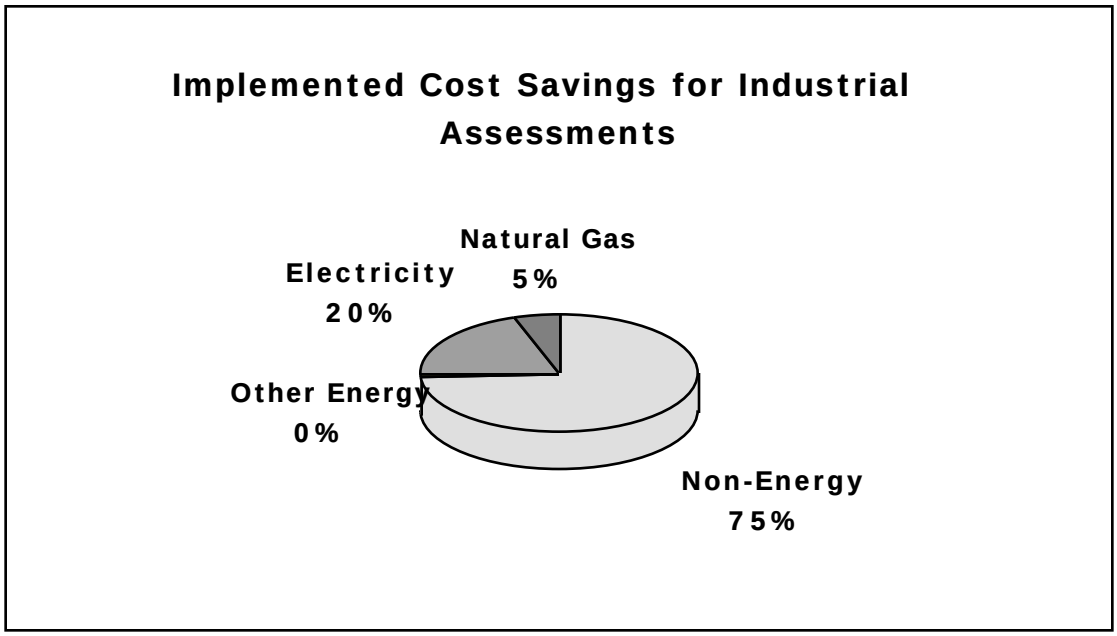

Figure 60. Composition of Total Implemented Cost Savings by Stream Type (Industrial Assessments)

The composition of the implemented cost savings for the energy audits in FY94 was as follows: 9% for non-energy, 73% for electricity, 13% for natural gas, and 5% for other energy sources. Figure 60 shows there was a dramatic increase in implemented non-energy cost savings for industrial assessments. While the implemented non-energy cost savings are only 9% of the total for energy audits, they represent 75% of the total implemented cost savings for industrial assessments

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Comparison of Industrial Assessments to Energy Audits

Table 31 shows recommended and implemented cost savings and energy conservation for energy audits, industrial assessments, and for the combined EADC/IAC program on an average (per assessment) basis for FY94. *Since the industrial assessments represent a relatively small data set in comparison to the energy audit data set, and because the sixty-one industrial assessments summarized here were performed by experienced centers, caution should be used in drawing strong conclusions from this data.*

FY94 Results	Combined (Energy & Industrial)	Energy	Industrial
Recommended Quantities			
Recommended Energy Conservation (MMBTU)	4,507	4,603	3,386
Recommended Energy Cost Savings ($)	45,803	47,418	26,870
Recommended Non-Energy Cost Savings ($)	8,854	2,984	77,657
Recommended Total Cost Savings ($)	54,657	50,402	104,527
Implemented Quantities			
Implemented Energy Conservation (MMBTU)	1,623	1,624	1,616
Implemented Energy Cost Savings ($)	15,683	16,051	11,364
Implemented Non-Energy Cost Savings ($)	4,023	1,583	32,615
Implemented Total Cost Savings ($)	19,705	17,635	43,979

Table 31. Comparison between Average Energy Audits and Industrial Assessments for FY94

The results shown in Table 31 for FY94 are summarized below.

- There was a 26% decrease in recommended energy conservation, but only a 1% decrease in implemented energy conservation per industrial assessment as compared to an average energy audits.

- There was a 43% decrease in recommended energy cost savings, and a 29% decrease in implemented energy cost savings per industrial assessment as compared to an average energy audit.

- The average recommended non-energy cost savings for industrial assessments was 26 times greater than that for energy audits, while the average implemented non-energy cost savings for industrial assessments was more than a factor of 20 greater than that for energy audits.

- The average recommended total cost savings per energy audit was $50,402, compared to $104,527 for the average industrial assessment. *The total recommended cost savings per industrial assessment was more than twice that of an average energy audit.*

- The average implemented total cost savings per energy audit was $18,647, compared to $43,979 for the average industrial assessment. *The total implemented cost savings per industrial assessment was almost 2.5 times greater than that of an average energy audit.*

- The implementation rates for the industrial assessments were as follows:
  45%, based on the number of the total recommendations which were implemented
  48%, based on the amount of the total recommended energy conservation (MMBtu) which was implemented
  42%, based on the amount of the total recommended cost savings which was implemented

There had been concern that the increased concentration on waste reduction and pollution prevention would adversely affect the program performance both from the perspective of the amount of energy saved, and by lowering the implementation rates. While preliminary results reveal an apparent drop in energy dollars saved, investigation shows the average cost for energy resources in the industrial assessments to be considerably lower than those in energy only audits; a factor which might be explained by the geographic locations of the IACs.

The effect of the program expansion indicates that energy conserved as a result of an industrial assessment remained nearly the same as for an energy audit, while the total dollars saved to the client more than doubled. Furthermore, the implementation rates were, on the average, higher than those of the energy only audits.

B. Western Region

Report of the Western Field Manager for FY94

Fifteen universities in the western region of the nation served 389 manufacturing plants during FY94 through an Energy Analysis and Diagnostic Center or an Industrial Assessment Center on the campus. Three IACs were each performing 10 waste-reducing assessments and 20 energy audits (Colorado State, Oregon State, and Texas A&M-College Station). The EADCs were to be trained in waste management and then to begin performing combined energy audits and waste-reducing assessments as IACs.

It would be premature to analyze in detail the waste-reduction work of the three IACs, and there is no direct historical data to help in placing their FY94 assessments in perspective.

There is, however, a large volume of historic energy data to use in evaluating the results of EADCs' energy-conserving efforts in FY94. For example, the FY94 western plants were, on average, a little smaller than their FY93 counterparts, as these data show:

Averages	FY93	FY94
Energy Consumed/plant, 10^9 BTU/yr	83.8	58.3
Energy Cost/plant, $/yr	507,000	421,000
Employment/plant	178	169
Sales/plant, $million/yr	31.0	27.3

The mix of their energy sources in quantity and cost has been relatively stable, and so has the percentage of energy cost recommended for savings opportunities.

Possibly the most interesting departure of very recent western region data (FY93 and FY94) from their historic character is the percentage of identified energy cost savings that was reported to be implemented. For FY93 that Figure was 40.3%, and for FY94 it appears to have decreased a little more to 36.8%. Those numbers led us at UCSC to investigate further.

To do that we placed the recommended cost-saving measures into major categories and then tabulated the savings and payback times according to their implementation status. These are the results:

	FY93			FY94		
	IMPLEMENTED		NON-IMPL	IMPLEMENTED		NON-IMPL
DESCRIPTION	PAYBACK (yr)	IMPL. RATE (%)	PAYBACK (yr)	PAYBACK (yr)	IMPL. RATE (%)	PAYBACK (yr)
COMBUSTION	0.49	33.0	0.93	0.48	42.4	0.96
STEAM	0.35	93.8	0.95	0.22	65.1	0.20
UTILITIES & OTHER ENERGY FORMS	0.51	51.0	1.23	0.60	54.9	1.05
SCHEDULING & SHIPPING/HANDLING	0.24	46.7	0.97	0.09	45.9	0.55
PROCESS EQUIPMENT & PROCESS CHANGES	1.33	35.8	1.31	1.48	47.2	1.30
BUILDINGS & GROUNDS	0.75	52.9	1.63	1.24	54.2	1.92
COST SAVINGS UNRELATED TO ENERGY	0.64	36.3	0.21	0.09	54.5	0.50
ALTERNATE SOURCES	0.32	27.9	3.46	1.98	4.6	3.51
TOTAL	0.62	40.3	2.16	1.00	36.8	2.33

Table 32. Comparison of FY93 and FY94 Results

From these results for western region EADCs we offer the following observations:

- Payback times for aggregated implemented measures were 0.62 year for FY93 and 1.00 year for FY94.
- Payback times for aggregated non-implemented measures were 2.16 years for FY93 and 2.33 years for FY94, both of which represent an increase over their values of several years earlier.
- All major categories but steam and process measures consistently showed a shorter payback time for implemented than for non-implemented measures. For the process category, the payback times were about equal for FY93, just as they were for steam measures in FY94.
- The longest payback times are associated with the "alternate source" category of non-implemented measures, just as the lowest implementation rates are.

These measures encompass cogeneration, switching energy sources (such as switching from electricity to natural gas), and using waste as fuel.

This last observation encouraged us to calculate what the cost-saving implementation rates would have been without the "alternate source" category. These are the results:

	Implementation Rates (%)	
	FY93	FY94
With the alternate source category	40.3	36.8
Without the alternate source category	46.7	51.3

The strongest negative influence on cost-saving implementation rate is clearly the poor record of "alternate source" measures, especially cogeneration. In FY93, this implementation rate for cogeneration was 0.9%, and in FY94 it was zero.

The cost-saving implementation rates of 46.7% and 51.3% for the aggregate of all other measures are indeed very attractive.

Appendix I.

EADC/IAC Program Contact List

Appendix II.

EADC/IAC Territory Maps