TABLE OF CONTENTS

I. INTRODUCTION **1**

II. PROGRAM STATISTICS **3**

A. General **3**

B. Client Profile **5**

C. Assessment Recommendations **14**

i. General 14

ii. Recommended Savings by Industry Type 22

iii. Recommended Savings by Resource Stream 28

iv. Recommended Savings by Recommendation Type 31

D. Implementation Results **33**

i. General 33

ii. Implemented Savings by Industry Type 44

iii. Implemented Savings by Resource Stream 50

iv. Implemented Savings by Recommendation Type 54

III. STANDARD FINANCIAL CALCULATIONS, FY96 **56**

IV. REGIONAL REPORTS **58**

A. Eastern Region **58**

i. Major Activities and Highlights of the Eastern Region 58

ii. FY96 OIPEA Activities 60

B. Western Region **61**

i. Major Activities and Highlights 61

ii. Analysis of Results 63

Appendix I Assumptions Used in Carbon Equivilant Calculations

Appendix II IAC Program Contact List

Appendix III IAC Territory Maps

LIST OF TABLES

TABLE 1. ASSESSMENTS PERFORMED BY FISCAL YEAR 3
TABLE 2. GEOGRAPHIC DISTRIBUTION OF ASSESSMENTS BY STATE 5
TABLE 3. GEOGRAPHIC DISTRIBUTION OF ASSESSMENTS BY CENTER 7
TABLE 4. NUMBER OF ASSESSMENTS PERFORMED BY INDUSTRY TYPE 9
TABLE 5. AVERAGE CLIENT SALES AND ENERGY USE BY FISCAL YEAR 10
TABLE 6. ENERGY USE AND COST BY ENERGY STREAMS 12
TABLE 7. RECOMMENDED SAVINGS FIGURES BY FISCAL YEAR 14
TABLE 8. AVERAGE RECOMMENDED ENERGY CONSERVATION AND COST SAVINGS 17
TABLE 9. AVE. FIRST YEAR RECOMMENDED SAVINGS BY FISCAL YEAR 19
TABLE 10. RECOMMENDED COST AND ENERGY SAVINGS BY INDUSTRY TYPE 22
TABLE 11. AVE. RECOMMENDED CONSERVATION AND COST SAVINGS BY INDUSTRY TYPE 25
TABLE 12. RECOMMENDED CONSERVATION AND COST SAVINGS BY RESOURCE STREAM 28
TABLE 13. RECOMMENDED NON-ENERGY COST SAVINGS BY RESOURCE TYPE 30
TABLE 14. RECOMMENDATIONS BY RECOMMENDATION TYPE 32
TABLE 15. NO. OF RECOMMENDATIONS AND IMPLEMENTED RECOMMENDATIONS BY FY 33
TABLE 16. IMPLEMENTED SAVINGS BY FISCAL YEAR 34
TABLE 17. RECOMMENDED AND IMPLEMENTED SIMPLE PAYBACK 35
TABLE 18. SEVEN YEAR CUMULATIVE CONSERVATION AND COST SAVINGS 36
TABLE 19. AVERAGE IMPLEMENTED ENERGY AND COST SAVINGS BY FISCAL YEAR 39
TABLE 20. IMPLEMENTED ENERGY AND COST SAVINGS BY INDUSTRY TYPE 44
TABLE 21. AVERAGE IMPLEMENTED ENERGY AND COST SAVINGS BY INDUSTRY TYPE 47
TABLE 22. IMPLEMENTED ENERGY AND COST SAVINGS BY RESOURCE STREAM 50
TABLE 23. TOTAL IMPLEMENTED NON-ENERGY COST SAVINGS 52
TABLE 24. NUMBER OF IMPLEMENTED RECOMMENDATIONS BY RECOMMENDATION TYPE 54
TABLE 25. STANDARD FINANCIAL CALCULATIONS OF IAC/EADC RESULTS 57
TABLE 26. HISTORY OF EASTERN CENTERS 59
TABLE 27. RANKING BY ANNUAL COST SAVINGS OF IMPLEMENTED ASSESSMENT RECOMMENDATION TYPES (FY 96 WESTERN REGION) 65
TABLE 28. RANKING BY ANNUAL COST SAVINGS OF NON-IMPLEMENTED ASSESSMENT RECOMMENDATION TYPES (FY 96 WESTERN REGION) 66

LIST OF FIGURES

FIGURE 1. PLANTS SERVED IN FY96 BY INDUSTRY TYPE 9
FIGURE 2. AVERAGE CLIENT SALES BY FISCAL YEAR 11
FIGURE 3. AVERAGE CLIENT ENERGY USAGE BY FISCAL YEAR 11
FIGURE 4. AVERAGE CLIENT ENERGY COSTS BY FISCAL YEAR 12
FIGURE 5. ENERGY USE OF PLANTS SERVED IN FY96 BY ENERGY STREAM 13
FIGURE 6. ENERGY COSTS OF PLANTS SERVED IN FY96 BY ENERGY STREAM 13
FIGURE 7. AVERAGE RECOMMENDED ENERGY CONSERVED BY FISCAL YEAR 15
FIGURE 8. AVERAGE RECOMMENDED COST SAVINGS BY FISCAL YEAR 15
FIGURE 9. AVERAGE RECOMMENDED BARRELS OF OIL AVOIDED BY FISCAL YEAR 16
FIGURE 10. AVERAGE RECOMMENDED CARBON AVOIDED BY FISCAL YEAR 16
FIGURE 11. RECOMMENDED ENERGY CONSERVED PER ASSESSMENT (3 YEAR AVERAGE) 17
FIGURE 12. RECOMMENDED COST SAVINGS PER ASSESSMENT (3 YEAR AVERAGE) 18
FIGURE 13. RECOMMENDED BARRELS OF OIL AVOIDED PER ASSESSMENT (3 YEAR AVE.) 18
FIGURE 14. RECOMMENDED CARBON AVOIDED PER ASSESSMENT (3 YEAR AVERAGE) 19
FIGURE 15. AVERAGE FIRST YEAR RECOMMENDED ENERGY CONSERVED BY FISCAL YEAR 20
FIGURE 16. AVERAGE FIRST YEAR RECOMMENDED COST SAVINGS BY FISCAL YEAR 20
FIGURE 17. AVERAGE FIRST YEAR RECOMMENDED BARRELS OF OIL AVOIDED BY FY 21
FIGURE 18. AVERAGE FIRST YEAR RECOMMENDED CARBON AVOIDED BY FISCAL YEAR 21
FIGURE 19. RECOMMENDED ENERGY CONSERVED BY INDUSTRY TYPE 23
FIGURE 20. RECOMMENDED COST SAVINGS BY INDUSTRY TYPE 23
FIGURE 21. RECOMMENDED BARRELS OF OIL AVOIDED BY INDUSTRY TYPE 24
FIGURE 22. RECOMMENDED CARBON AVOIDED BY INDUSTRY TYPE 24
FIGURE 23. AVERAGE RECOMMENDED ENERGY SAVED BY INDUSTRY TYPE 25
FIGURE 24. AVERAGE RECOMMENDED COST SAVINGS BY INDUSTRY TYPE 26
FIGURE 25. AVERAGE RECOMMENDED BARRELS OF OIL SAVED BY INDUSTRY TYPE 26
FIGURE 26. AVERAGE RECOMMENDED CARBON AVOIDED BY INDUSTRY TYPE 27
FIGURE 27. COMPOSITION OF RECOMMENDED ENERGY CONSERVED BY ENERGY STREAM 29
FIGURE 28. COMPOSITION OF RECOMMENDED COST SAVINGS BY ENERGY STREAM 29
FIGURE 29. RECOMMENDED NON-ENERGY COST SAVINGS 30
FIGURE 30. RECOMMENDED COST SAVINGS BY RESOURCE STREAM 31
FIGURE 31. NUMBER OF RECOMMENDATIONS BY RECOMMENDATION TYPE 32
FIGURE 32. PERCENT OF RECOMMENDATIONS IMPLEMENTED BY FISCAL YEAR 34
FIGURE 33. RECOMMENDED VS. IMPLEMENTED SIMPLE PAYBACK 35
FIGURE 34. SEVEN YEAR CUMULATIVE ENERGY SAVINGS 36
FIGURE 35. SEVEN YEAR CUMULATIVE COST SAVINGS 37
FIGURE 36. SEVEN YEAR CUMULATIVE BARRELS OF OIL AVOIDED 37

LIST OF FIGURES (Continued)

FIGURE 37. SEVEN YEAR CUMULATIVE CARBON AVOIDED 38
FIGURE 38. AVERAGE IMPLEMENTED CONSERVATION BY FISCAL YEAR 39
FIGURE 39. AVERAGE IMPLEMENTED COST SAVINGS BY FISCAL YEAR 40
FIGURE 40. AVERAGE IMPLEMENTED BARRELS OF OIL AVOIDED BY FISCAL YEAR 40
FIGURE 41. AVERAGE IMPLEMENTED CARBON AVOIDED BY FISCAL YEAR 41
FIGURE 42. IMPLEMENTED ENERGY CONSERVED PER ASSESSMENT (3 YEAR AVERAGE) 41
FIGURE 43. AVERAGE IMPLEMENTED COST SAVINGS PER ASSESSMENT (3 YEAR AVERAGE) 42
FIGURE 44. AVE. IMPLEMENTED BARRELS OF OIL AVOIDED PER ASSESSMENT (3 YEAR AVE.) 42
FIGURE 45. AVERAGE IMPLEMENTED CARBON AVOIDED PER ASSESSMENT (3 YEAR AVE.) 43
FIGURE 46. IMPLEMENTED ENERGY CONSERVED BY INDUSTRY TYPE 45
FIGURE 47. IMPLEMENTED COST SAVINGS BY INDUSTRY TYPE 45
FIGURE 48. IMPLEMENTED BARRELS OF OIL AVOIDED BY INDUSTRY TYPE 46
FIGURE 49. IMPLEMENTED CARBON AVOIDED BY INDUSTRY TYPE 46
FIGURE 50. AVERAGE IMPLEMENTED ENERGY SAVINGS BY INDUSTRY TYPE 47
FIGURE 51. AVERAGE IMPLEMENTED COST SAVINGS BY INDUSTRY TYPE 48
FIGURE 52. AVERAGE IMPLEMENTED BARRELS OF OIL AVOIDED BY INDUSTRY TYPE 48
FIGURE 53. AVERAGE IMPLEMENTED CARBON AVOIDED BY INDUSTRY TYPE 49
FIGURE 54. COMPOSITION OF IMPLEMENTED ENERGY CONSERVED BY ENERGY STREAM 51
FIGURE 55. COMPOSITION OF IMPLEMENTED ENERGY COST SAVINGS BY ENERGY STREAM 51
FIGURE 56. COMPOSITION OF NON-ENERGY IMPLEMENTED SAVINGS 52
FIGURE 57. COMPOSITION OF TOTAL IMPLEMENTED COST SAVINGS 53
FIGURE 58. NUMBER OF IMPLEMENTED RECOMMENDATIONS BY RECOMMENDATION TYPE 55
FIGURE 59. SIC DISTRIBUTION OF ASSESSMENTS (FY96 WESTERN REGION) 63
FIGURE 60. BREAKDOWN OF TOTAL RECOMMENDED COST SAVINGS (FY 96 W. REGION) 68

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.

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 Analysis and Diagnostic Center” (EADC) was retired in favor of Industrial Assessment Center. The 30 Centers performed 867 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, the 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. This report reflects the results of the first year implementing these changes.

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 totaled under $1.75 million, and no professional staff were on hand to do the analyses. 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 or waste 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 fourth 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. 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 management organization respectively.

II. Program Statistics

A. General

In Fiscal Year 1996, 867 assessments were performed bringing the program database total to 6,898 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 6,883. Unless otherwise noted, figures are for FY96. 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
Total	6,883	1,165

Table 1. Assessments Performed by Fiscal Year

The total amount of recommended energy conservation measures in FY96 was approximately 1,700,000 Million British Thermal Units (MMBTU) with a dollar value of almost $24 million. If adopted, the oil consumption that would have been avoided was 290,000 barrels, measured in barrels of oil equivalent (BOE), and the carbon avoided was 63,000 metric tons, measured in carbon equivalent (CE).[1] Non-energy recommendations, such as administrative cost savings and waste reduction savings, amounted to $53 million, up from $17 million in FY95. The resultant total recommended savings were $77 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 FY96 implementation survey conducted by the Centers revealed the amount of energy saved by manufacturers through implementation of recommendations contained in reports resulting from assessments. As reported by the clients, the value was over 1,200,000 MMBTU, with a dollar value of over $13 million. This equates to 208,000 barrels of oil and 42,000 metric tons of carbon avoided. The implemented non-energy measures resulted in a savings of $13.9 million. This brings the total implemented savings in FY96 to over $27 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 FY96 is shown in the following table by state.

STATE	Total No. of Assessments Performed in Each State	Industrial Assessment Center	No. of Assessments Performed by Each IAC	Percent of Total No. of Assessments Performed in Each State
Alabama	7	Georgia Tech.	4	57%
		Mississippi State	3	43%
Arizona	30	Arizona State University	30	100%
Arkansas	29	U. of Arkansas - Little Rock	28	97%
		Oklahoma State University	1	3%
California	74	University of Nevada	14	19%
		San Diego State University	30	41%
		San Francisco State	30	41%
Colorado	23	Colorado State University	23	100%
Connecticut	4	U. of Massachusetts	4	100%
Florida	28	University of Florida	28	100%
Georgia	27	Georgia Tech.	25	93%
		University of Florida	2	7%
Illinois	42	Bradley University	30	71%
		U. of Wisconsin - Milwaukee	12	29%
Indiana	38	Notre Dame University	23	61%
		University of Dayton	1	3%
		University of Louisville	14	37%
Iowa	27	Iowa State University	27	100%
Kansas	11	University of Kansas	9	82%
		Oklahoma State University	2	18%
Kentucky	20	University of Dayton	1	5%
		University of Louisville	16	80%
		University of Tennessee	3	15%
Maine	30	University of Maine	30	100%
Maryland	2	West Virginia University	2	100%
Massachusetts	19	U. of Massachusetts	19	100%
Michigan	37	Notre Dame University	7	19%
		University of Michigan	30	81%
Minnesota	27	Iowa State University	1	4%
		South Dakota State	26	96%
Mississippi	27	Mississippi State	27	100%

Table 2. Geographic Distribution of Assessments by State

STATE	Total No. of Assessments Performed in Each State	Industrial Assessment Center	No. of Assessments Performed by Each IAC	Percent of Total No. of Assessments Performed in Each State
Missouri	34	University of Kansas	4	12%
		U. of Missouri - Rolla	30	88%
Nebraska	10	Colorado State University	6	60%
		Iowa State University	2	20%
		University of Kansas	2	20%
Nevada	16	University of Nevada	16	100%
New Hampshire	7	U. of Massachusetts	7	100%
New Jersey	5	Hofstra University	5	100%
New York	10	Hofstra University	10	100%
North Carolina	30	North Carolina State	23	77%
		Old Dominion University	3	10%
		University of Tennessee	4	13%
North Dakota	2	South Dakota State	2	100%
Ohio	35	University of Dayton	28	80%
		West Virginia University	7	20%
Oklahoma	27	Oklahoma State University	27	100%
Oregon	17	Oregon State University	17	100%
Pennsylvania	14	West Virginia University	14	100%
South Carolina	13	Georgia Tech.	1	8%
		North Carolina State	7	54%
		University of Tennessee	5	38%
South Dakota	2	South Dakota State	2	100%
Tennessee	19	U. of Arkansas - Little Rock	1	5%
		University of Tennessee	18	95%
Texas	59	Texas A&M - College Sta.	30	51%
		Texas A&M - Kingsville	29	49%
Virginia	28	Old Dominion University	27	96%
		West Virginia University	1	4%
Washington	12	Oregon State University	12	100%
West Virginia	6	West Virginia University	6	100%
Wisconsin	18	U. of Wisconsin - Milwaukee	18	100%
Wyoming	1	Colorado State University	1	100%

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

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

Industrial Assessment Center	No. of Assess. Performed by Each IAC	State	No. of Assess. Performed in Each State	Percent of Assessments Performed by Each IAC in a State
Arizona State University	30	Arizona	30	100%
Bradley University	30	Illinois	30	100%
Colorado State University	30	Colorado	23	77%
		Nebraska	6	20%
		Wyoming	1	3%
Georgia Tech.	30	Alabama	4	13%
		Georgia	25	83%
		South Carolina	1	3%
Hofstra University	15	New Jersey	5	33%
		New York	10	67%
Iowa State University	30	Iowa	27	90%
		Minnesota	1	3%
		Nebraska	2	7%
Mississippi State	30	Alabama	3	10%
		Mississippi	27	90%
North Carolina State University	30	North Carolina	23	77%
		South Carolina	7	23%
Notre Dame University	30	Indiana	23	77%
		Michigan	7	23%
Oklahoma State	30	Arkansas	1	3%
		Kansas	2	7%
		Oklahoma	27	90%
Old Dominion University	30	North Carolina	3	10%
		Virginia	27	90%
Oregon State University	29	Oregon	17	59%
		Washington	12	41%
San Diego State University	30	California	30	100%
San Francisco State University	30	California	30	100%
South Dakota State University	30	Minnesota	26	87%
		North Dakota	2	7%
		South Dakota	2	7%
Texas A&M - College Station	30	Texas	30	100%
Texas A&M - Kingsville	29	Texas	29	100%

Table 3. Geographic Distribution of Assessments by Center

Industrial Assessment Center	No. of Assess. Performed by Each IAC	State	No. of Assess. Performed in Each State	Percent of Assessments Performed by Each IAC in a State
U. of Arkansas - Little Rock	29	Arkansas	28	97%
		Tennessee	1	3%
University of Dayton	30	Indiana	1	3%
		Kentucky	1	3%
		Ohio	28	93%
University of Florida	30	Florida	28	93%
		Georgia	2	7%
University of Kansas	15	Kansas	9	60%
		Missouri	4	27%
		Nebraska	2	13%
University of Louisville	30	Indiana	14	47%
		Kentucky	16	53%
University of Maine	30	Maine	30	100%
University of Massachusetts	30	Connecticut	4	13%
		Massachusetts	19	63%
		New Hampshire	7	23%
U. of Michigan - Ann Arbor	30	Michigan	30	100%
University of Missouri - Rolla	30	Missouri	30	100%
University of Nevada	30	California	14	47%
		Nevada	16	53%
University of Tennessee	30	Kentucky	3	10%
		North Carolina	4	13%
		South Carolina	5	17%
		Tennessee	18	60%
U. of Wisconsin - Milwaukee	30	Illinois	12	40%
		Wisconsin	18	60%
West Virginia University	30	Maryland	2	7%
		Ohio	7	23%
		Pennsylvania	14	47%
		Virginia	1	3%
		West Virginia	6	20%

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

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 FY96.

2-digit SIC Code	Industry	No. of Assessments Performed
20	Food and Kindred Products	127
21	Tobacco Products	1
22	Textile Mill Products	28
23	Apparel and Other Textile Products	24
24	Lumber and Wood Products	37
25	Furniture and Fixtures	19
26	Paper and Allied Products	38
27	Printing and Publishing	44
28	Chemicals and Allied Products	36
29	Petroleum and Coal Products	2
30	Rubber and Misc. Plastics Products	85
31	Leather and Leather Products	7
32	Stone, Clay, and Glass Products	35
33	Primary Metal Industries	52
34	Fabricated Metal Products	121
35	Industrial Machinery and Equipment	76
36	Electronic and Other Electric Equipment	52
37	Transportation Equipment	56
38	Instruments and Related Products	17
39	Miscellaneous Manufacturing Industries	10
Total		867

Table 4. Number of Assessments Performed by Industry Type

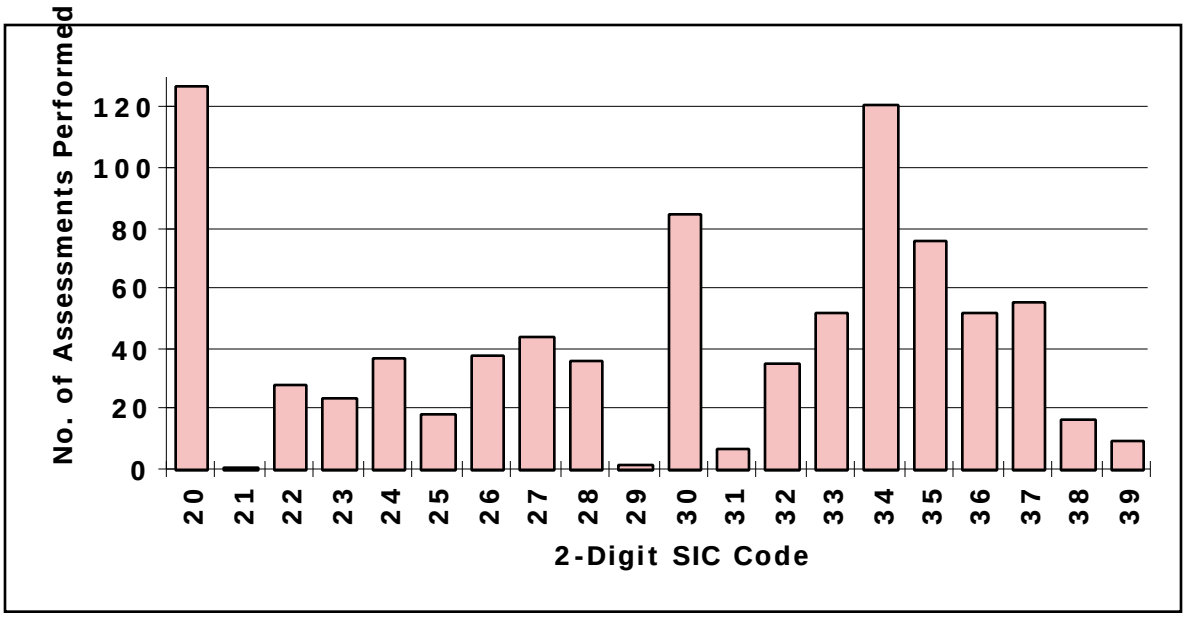


Figure 1. Plants Served in FY96 by Industry Type

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

- Annual 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 FY96, the total energy usage of the clients was 48.5 million MMBTU, costing $363 million. There was an average of 167 employees at each location. The companies had a total sales of $26.5 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

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

Figure 2 shows the average sales figures for the IAC clients over the years since FY82.

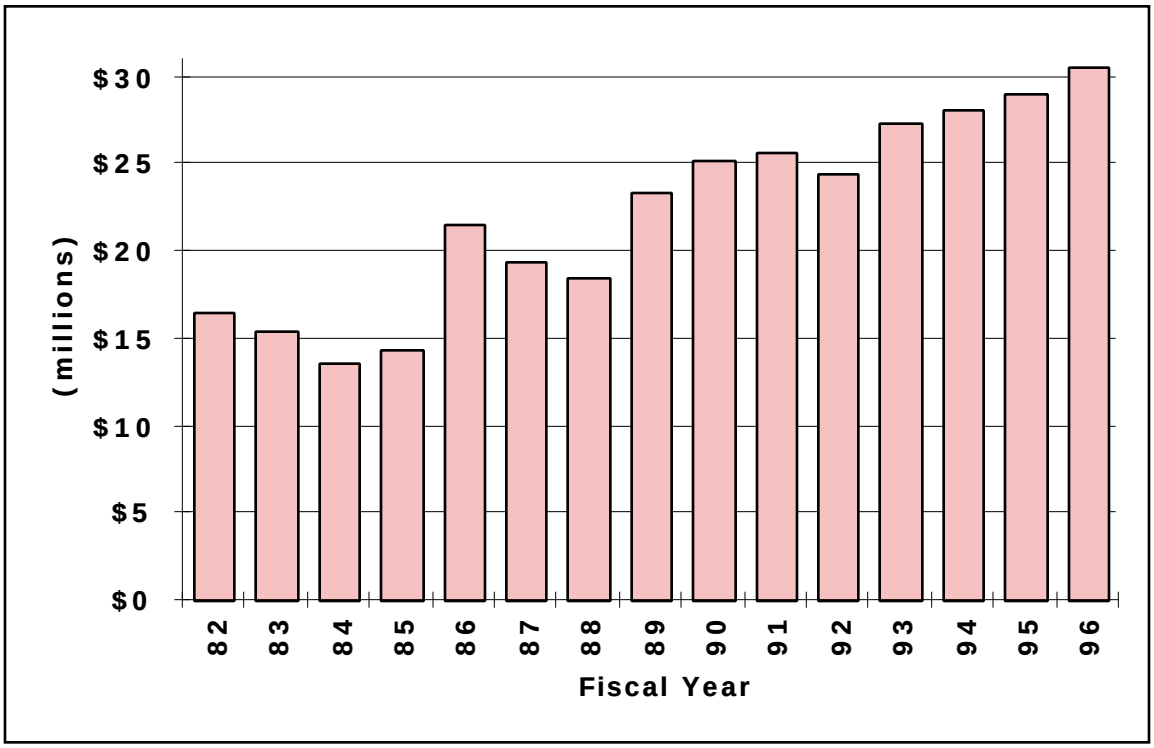


Figure 2. Average Client Sales by Fiscal Year

The average plant served in FY96 had purchased energy use of 56,000 MMBTU with an associated cost of $419,000. Electricity cost the typical client $16.64/ MMBTU and natural gas cost $2.92/ MMBTU. The average energy use and associated costs are shown in Figures 3 and 4.

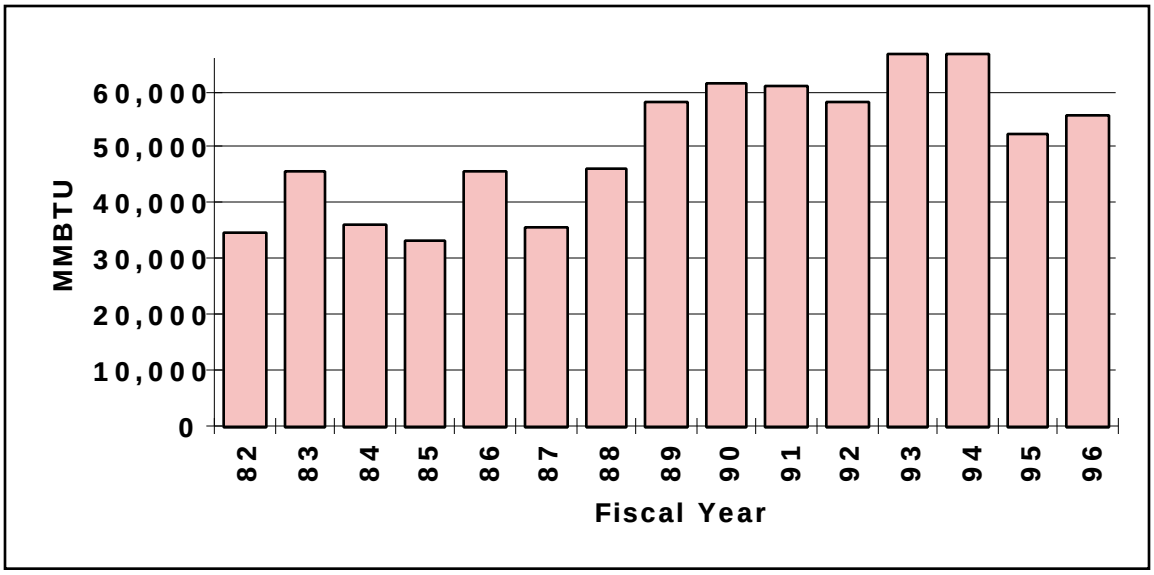


Figure 3. Average Client Energy Usage by Fiscal Year

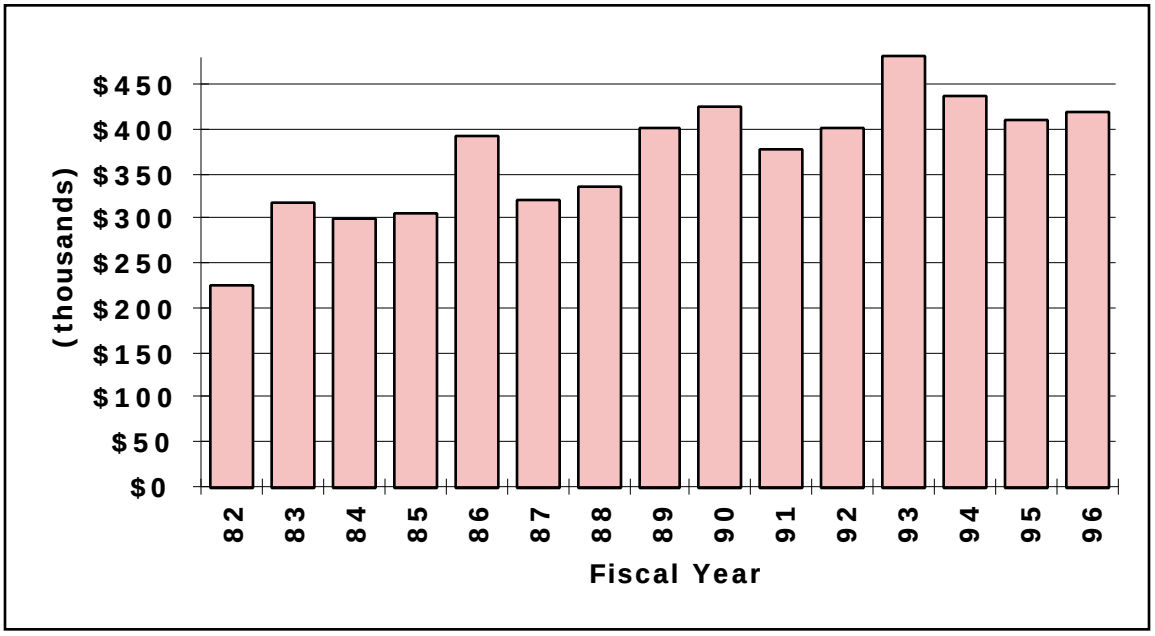


Figure 4. Average Client Energy Costs by Fiscal Year

The program database breaks energy use into eleven specific streams and one category for "other" energy. “Other Energy” in FY96 consisted mainly of coke and tar pitch. The breakdown of the different energy streams is shown in Table 6, and Figures 5 and 6.

Energy Stream	Energy Usage	Total Cost ($)
Electricity		
Demand	{10,379,279 KW-months/yr}	81,191,833
Fees		10,767,914
Consumption	16,340,001	179,943,901
Natural Gas	25,707,063	74,994,701
L. P. G.	317,594	1,797,523
Fuel Oil #1	0	0
Fuel Oil #2	410,250	1,858,023
Fuel Oil #4	75,984	323,456
Fuel Oil #6	2,589,716	7,537,354
Coal	663,286	839,302
Wood	1,121,190	323,160
Paper	0	0
Other Gas	0	0
Other Energy	1,268,314	3,754,893
Totals	(MMBTU) 48,493,398	363,332,060

Table 6. Energy Use and Cost by Energy Streams

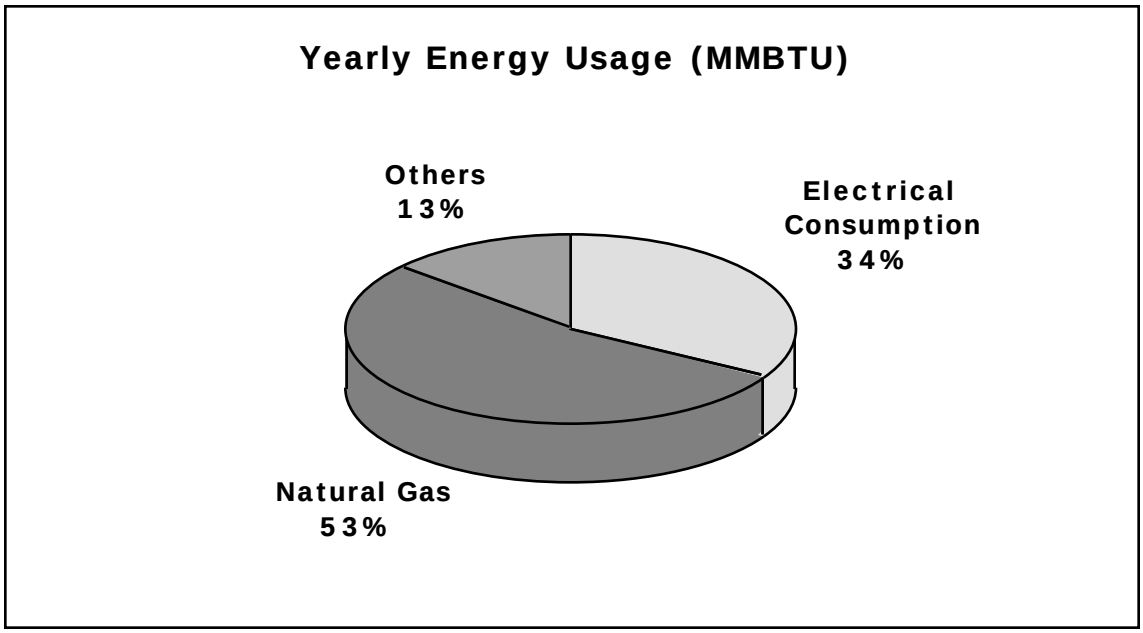


Figure 5. Energy Use of Plants Served in FY96 by Energy Stream

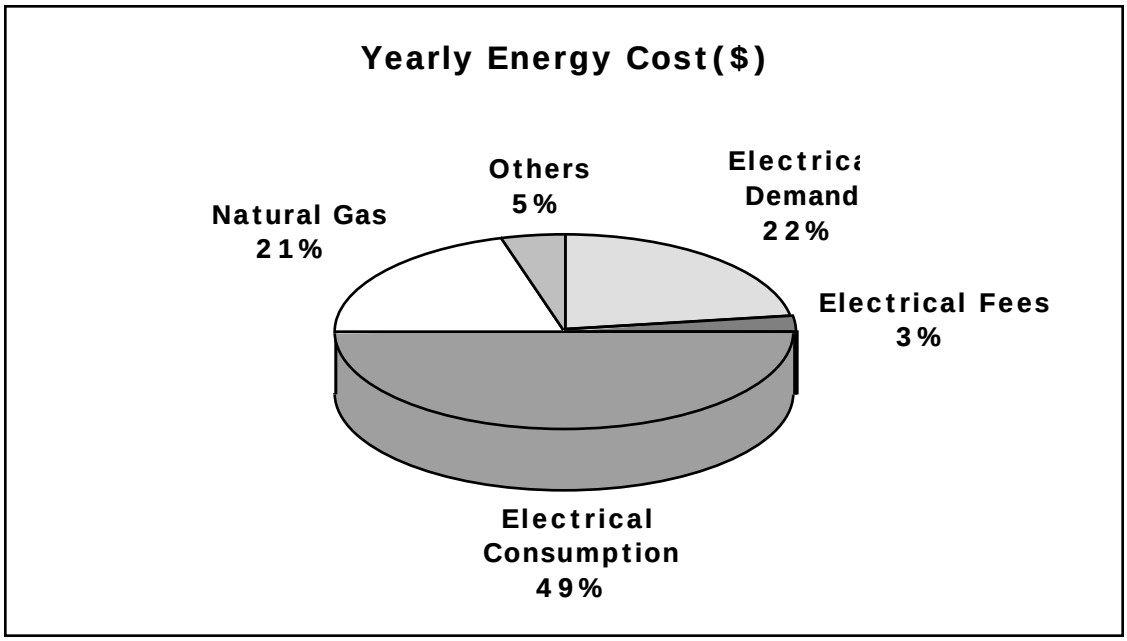


Figure 6. Energy Costs of Plants Served in FY96 by Energy Stream

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 FY96 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	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
95	2,651,229	455,147	75,909	32,922,715	17,196,328	50,119,043
96	1,699,106	291,692	63,268	23,929,888	53,317,091	77,246,979

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.

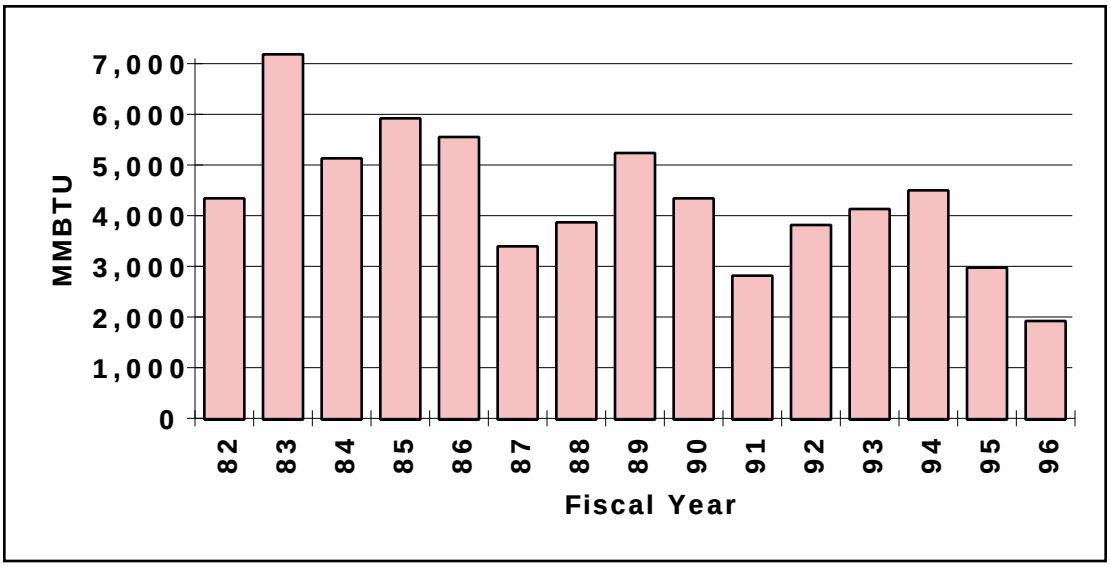


Figure 7. Average Recommended Energy Conserved by Fiscal Year

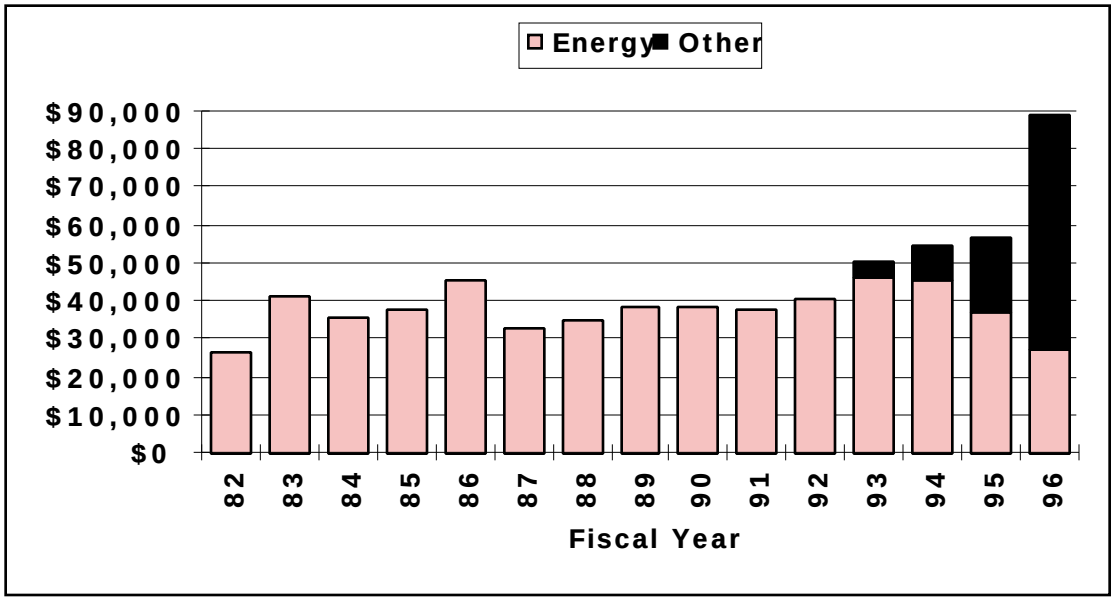


Figure 8. Average Recommended Cost Savings by Fiscal Year

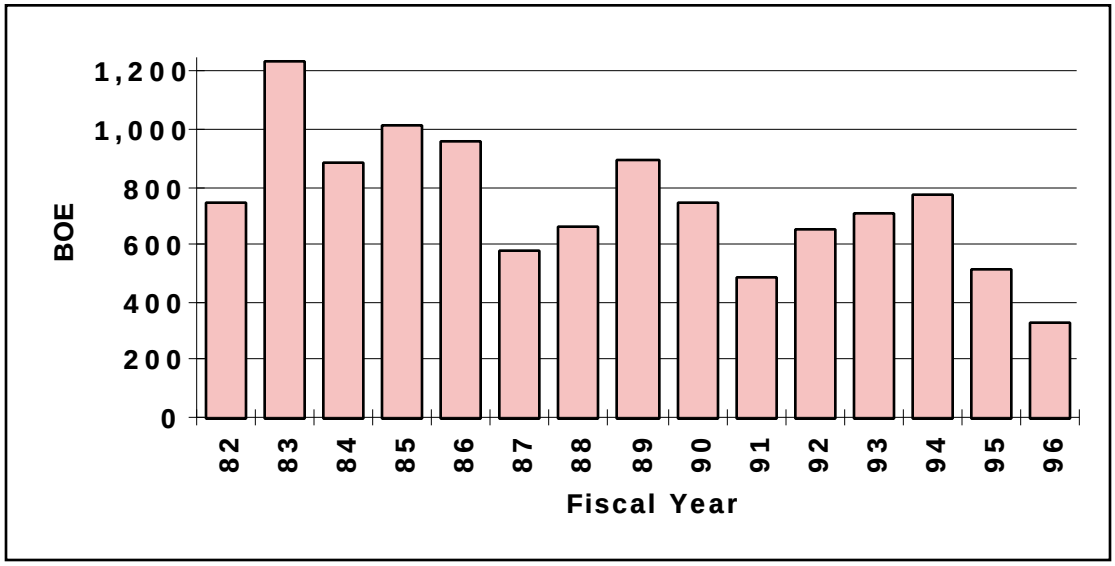


Figure 9. Average Recommended Barrels of Oil Avoided by Fiscal Year

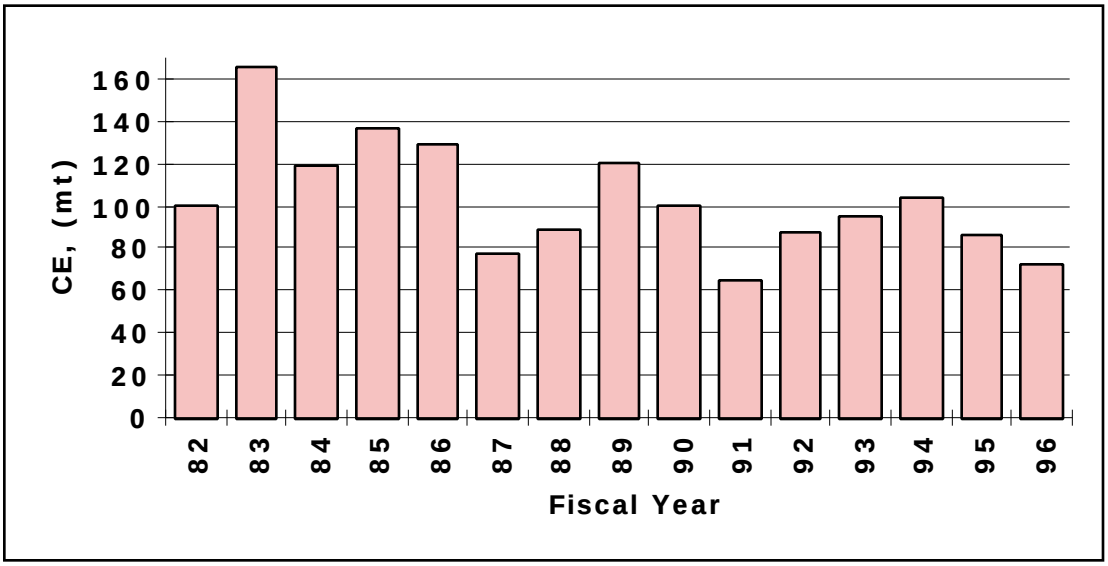


Figure 10. Average Recommended Carbon Avoided by Fiscal Year

Fiscal Year	Recommended Energy Conservation			Recommended Cost Savings ($)		
	(MMBtu)	(B.O.E.)	(C.E., mt)	Energy	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
95	3,016	518	86	37,455	19,564	57,018
96	1,960	336	73	27,601	61,496	89,097

Table 8. Average Recommended Energy Conservation and Cost Savings

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

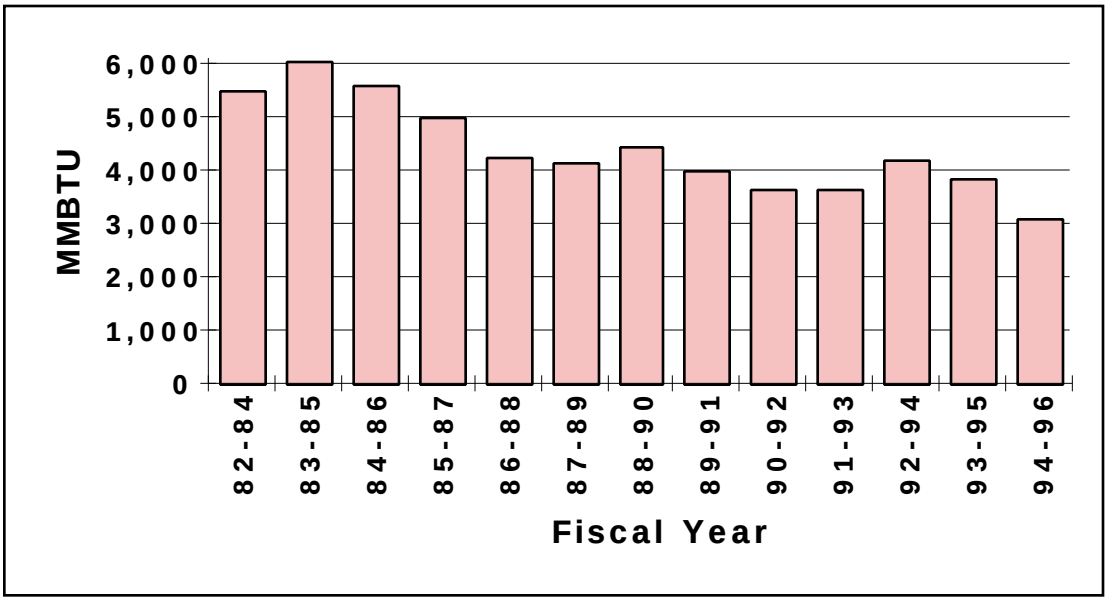


Figure 11. Recommended Energy Conserved Per Assessment (3 Year Average)

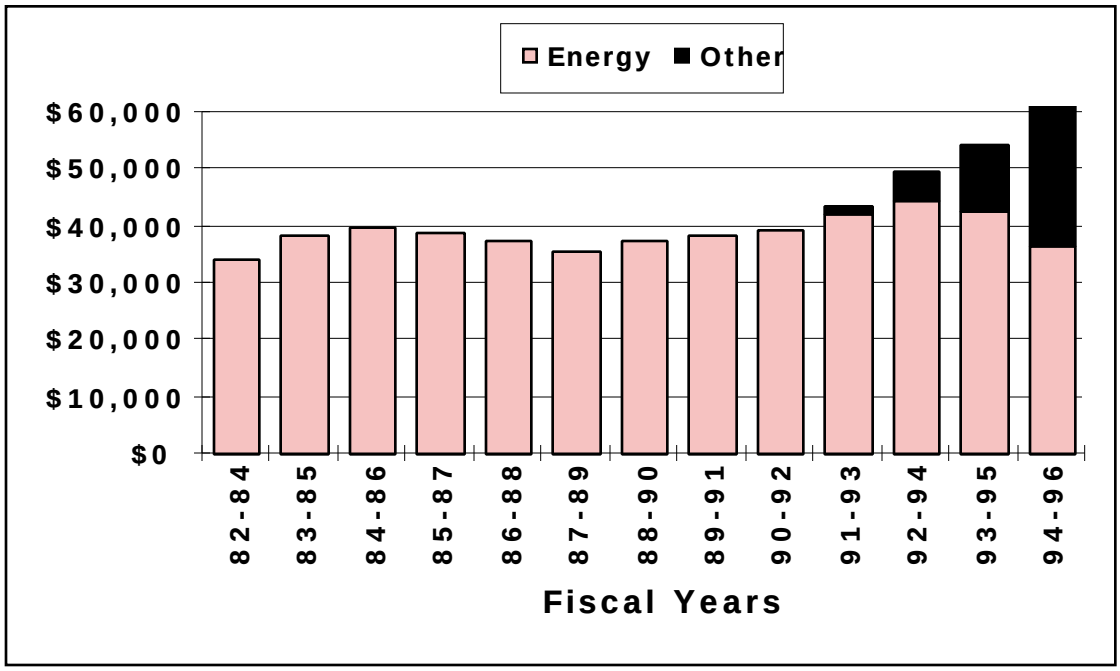


Figure 12. Recommended Cost Savings Per Assessment (3 Year Average)

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

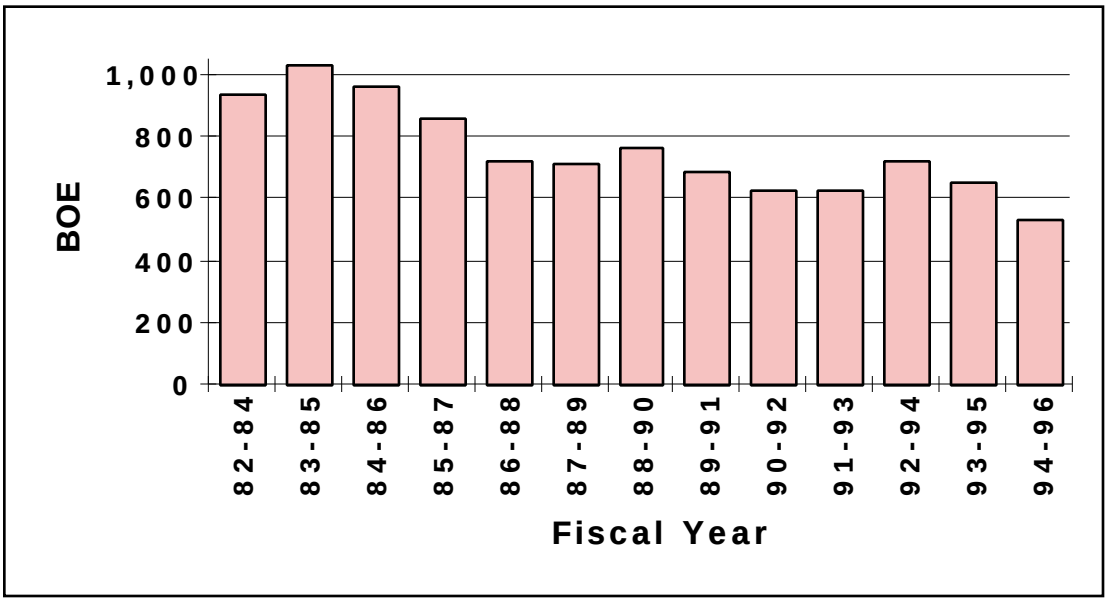


Figure 13. Recommended Barrels of Oil Avoided Per Assessment (3 Year Average)

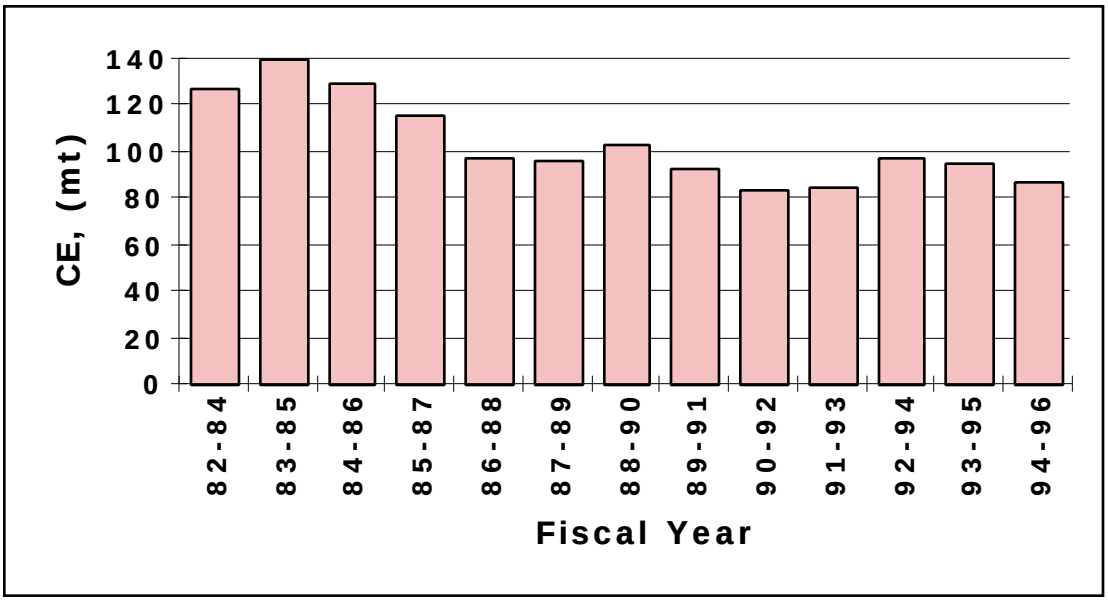


Figure 14. Recommended Carbon Avoided Per Assessment (3 Year Average)

In some cases, immediate implementation of a measure 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 9 and Figures 15 through 18 show the average first year recommended energy and dollars conserved per assessment. A comparison with Table 8 shows the effect that incremental recommendations represent.

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
95	2,787	478	80	33,960	19,307	53,267
96	1,788	307	67	24,974	60,670	85,644

Table 9. Ave. First Year Recommended Savings by Fiscal Year

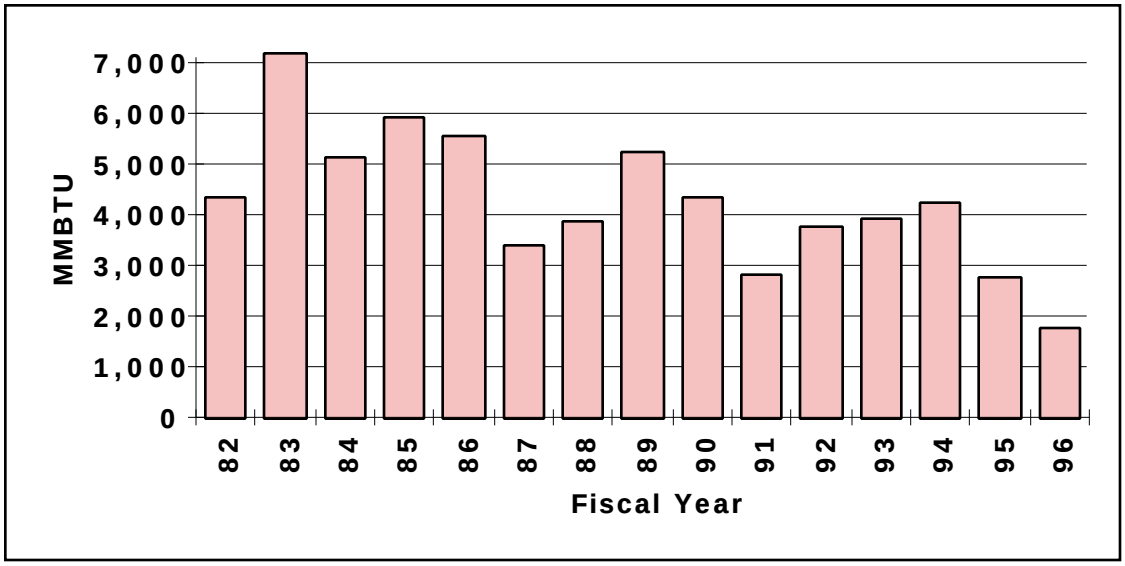


Figure 15. Average First Year Recommended Energy Conserved by Fiscal Year

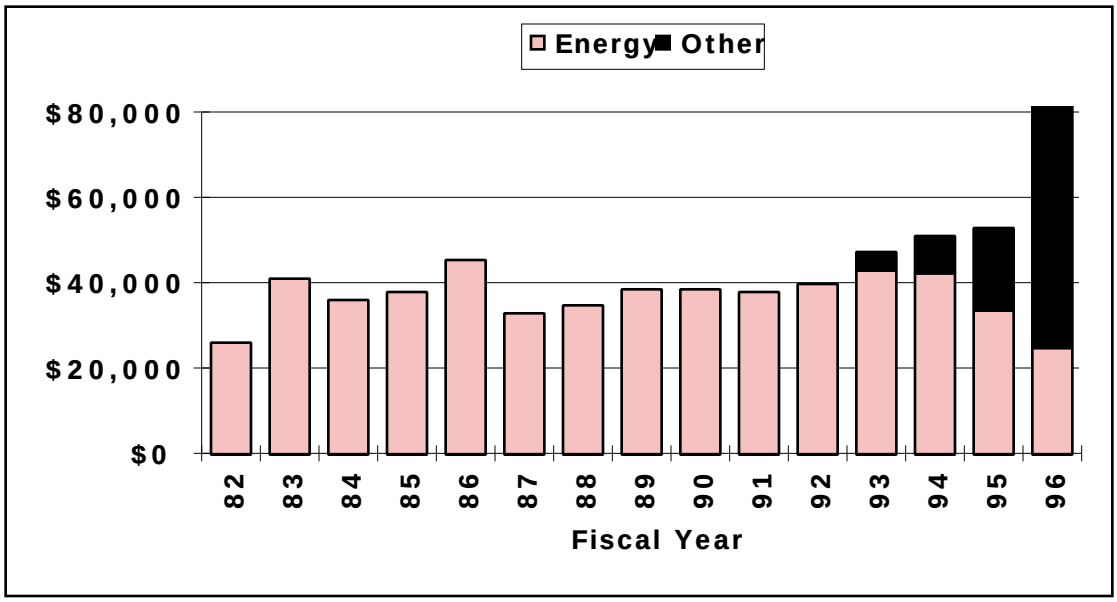


Figure 16. Average First Year Recommended Cost Savings by Fiscal Year

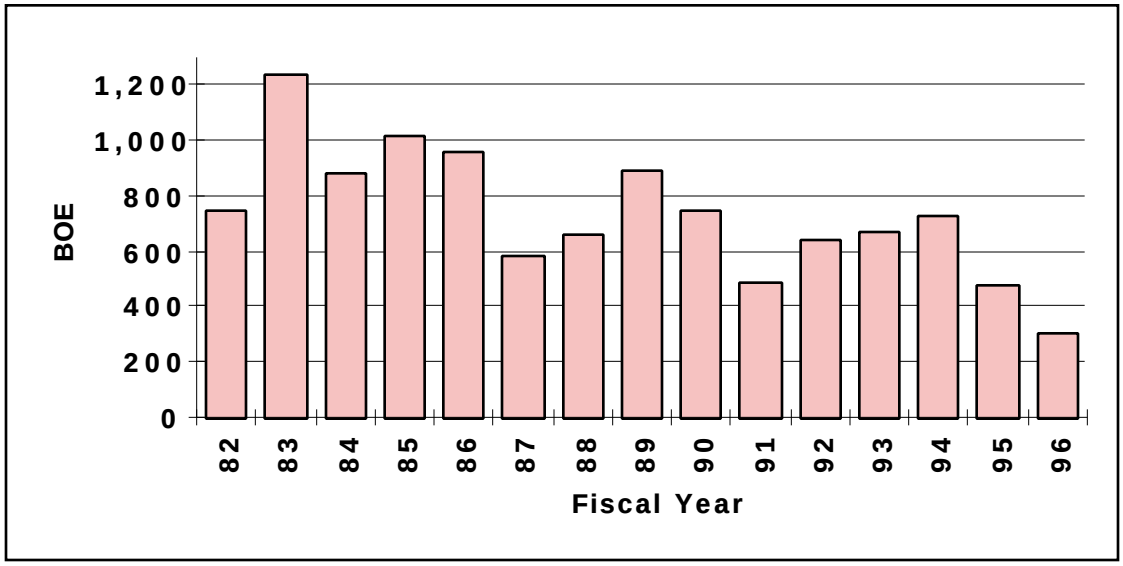


Figure 17. Average First Year Recommended Barrels of Oil Avoided by Fiscal Year

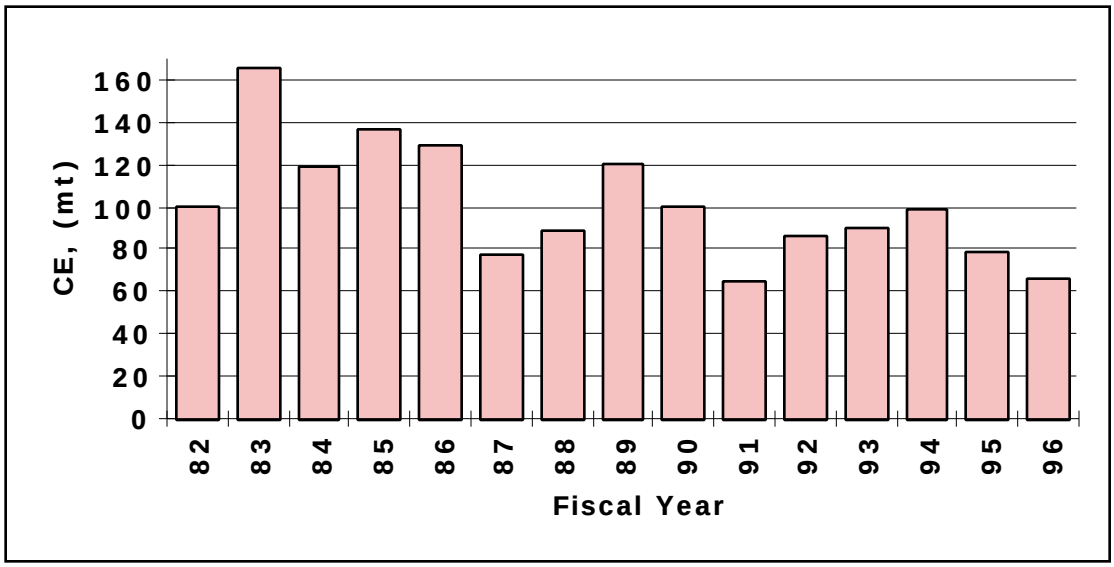


Figure 18. Average First Year Recommended Carbon Avoided by Fiscal Year

ii. Recommended Savings by Industry Type

Savings recommended by industry type in Fiscal Year 1996 is shown in Table 10 and Figures 19 through 22. The largest amount of recommended energy conserved occurred during SIC 22 (Textile Mills) assessments replacing SIC 33 (Primary Metals) in FY95. The largest recommended cost savings was again in SIC 20 (Food and Kindred Products). The lowest recommended cost savings was in SIC 21 (Tobacco Products), where only one assessment was performed.

Industry Description	Recommended Energy Conservation			Recommended Cost Savings ($)		
	(MMBtu)	(B.O.E.)	(C.E., mt)	Energy	Non-Energy	Total
20 Foods	-318,399	-54,661	-11,856	2,362,609	25,489,475	27,852,084
21 Tobacco Prod.	6,871	1,180	256	21,645	32,427	54,072
22 Textile Mills	301,977	51,842	11,244	1,876,513	1,622,769	3,499,282
23 Apparel	33,811	5,804	1,259	639,413	556,750	1,196,163
24 Wood Prod.	51,959	8,920	1,935	1,297,340	1,310,072	2,607,412
25 Furniture	10,344	1,776	385	183,938	1,116,003	1,299,941
26 Paper Prod.	128,755	22,104	4,794	1,441,242	4,696,896	6,138,138
27 Printing	72,579	12,460	2,703	924,321	1,563,444	2,487,765
28 Chemical Prod.	172,522	29,618	6,424	1,053,362	1,311,283	2,364,645
29 Petroleum	6,756	1,160	252	29,188	42,710	71,898
30 Rubber & Plast.	206,767	35,496	7,699	3,089,099	3,651,860	6,740,959
31 Leather Prod.	6,051	1,039	225	198,420	141,013	339,433
32 Stone & Glass	212,448	36,472	7,911	1,848,472	873,366	2,721,838
33 Primary Metal	245,050	42,069	9,125	1,681,178	1,068,641	2,749,819
34 Fab. Metal	173,587	29,800	6,464	2,382,885	2,392,859	4,775,744
35 Ind. Machinery	107,320	18,424	3,996	1,423,695	1,235,238	2,658,933
36 Electronics	144,889	24,874	5,395	1,660,961	2,983,469	4,644,430
37 Trans. Equip.	87,545	15,029	3,260	1,095,333	2,853,405	3,948,738
38 Instruments	33,665	5,779	1,254	518,739	242,213	760,952
39 Misc. Manuf.	14,609	2,508	544	201,535	133,198	334,733
	1,699,106	291,692	63,268	23,929,888	53,317,091	77,246,979

Table 10. Recommended Cost and Energy Savings by Industry Type

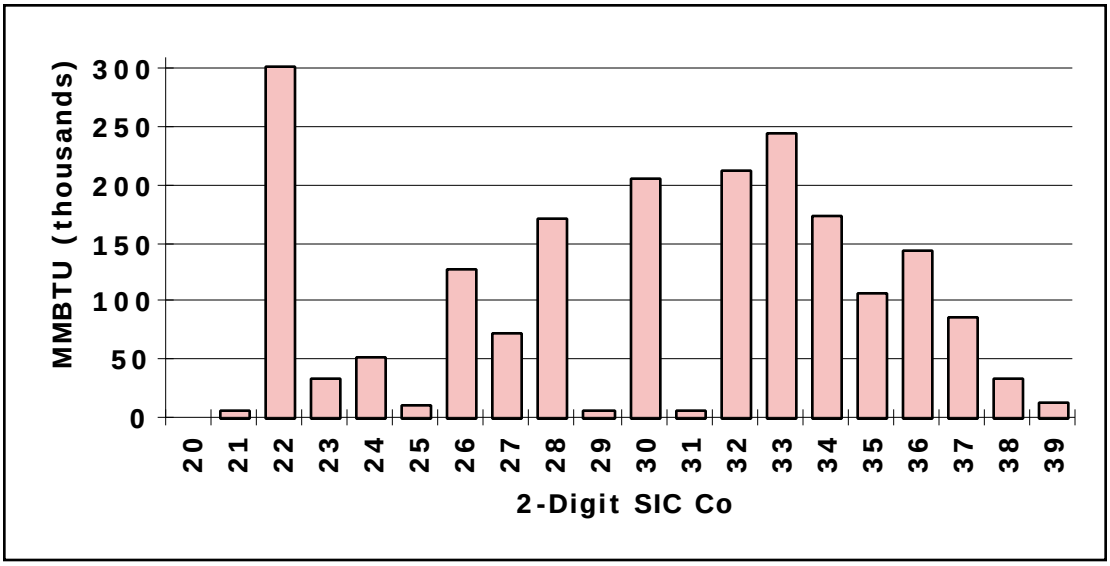


Figure 19. Recommended Energy Conserved by Industry Type

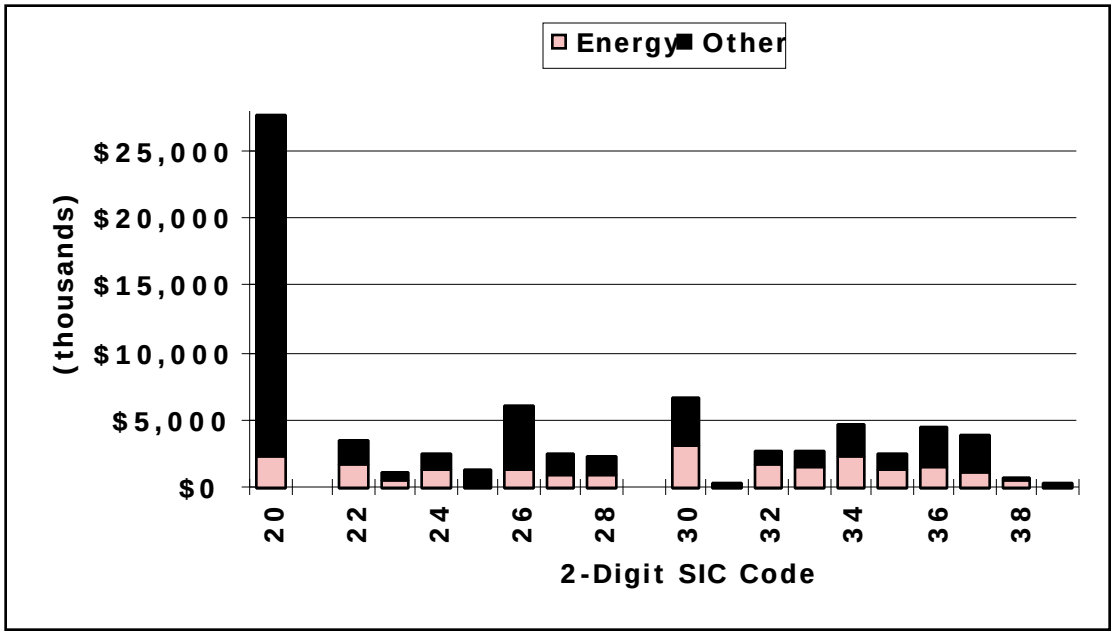


Figure 20. Recommended Cost Savings by Industry Type

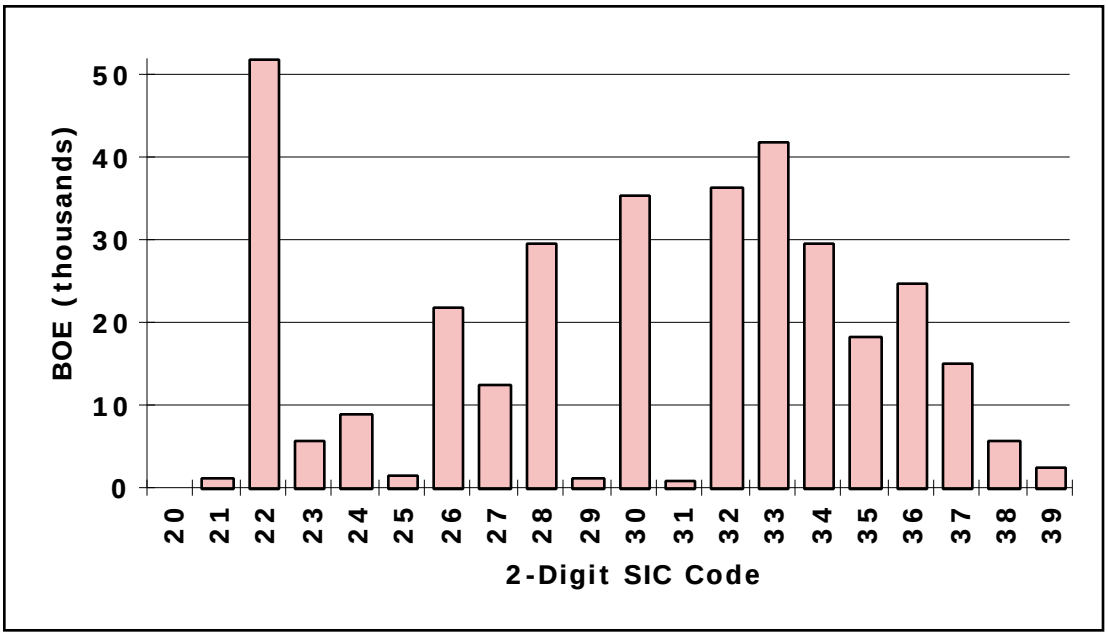


Figure 21. Recommended Barrels of Oil Avoided by Industry Type

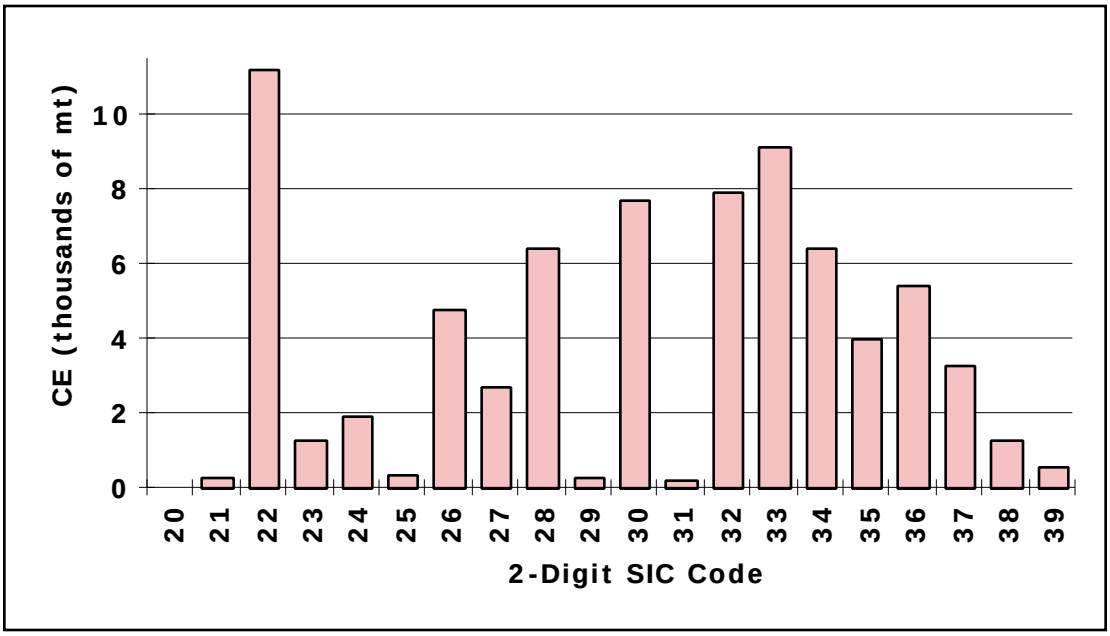


Figure 22. Recommended Carbon Avoided by Industry Type

Average recommended 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	-2,507	-430	-93	18,603	200,705	219,308
21	Tobacco Prod.	6,871	1,180	256	21,645	32,427	54,072
22	Textile Mills	10,785	1,851	402	67,018	57,956	124,974
23	Apparel	1,409	242	52	26,642	23,198	49,840
24	Wood Prod.	1,404	241	52	35,063	35,407	70,471
25	Furniture	544	93	20	9,681	58,737	68,418
26	Paper Prod.	3,388	582	126	37,927	123,603	161,530
27	Printing	1,650	283	61	21,007	35,533	56,540
28	Chemical Prod.	4,792	823	178	29,260	36,425	65,685
29	Petroleum	3,378	580	126	14,594	21,355	35,949
30	Rubber & Plast.	2,438	418	91	36,342	42,963	79,305
31	Leather Prod.	864	148	32	28,346	20,145	48,490
32	Stone & Glass	6,070	1,042	226	52,813	24,953	77,767
33	Primary Metal	4,718	809	175	32,330	20,551	52,881
34	Fab. Metal	1,435	246	53	19,693	19,776	39,469
35	Ind. Machinery	1,412	242	53	18,733	16,253	34,986
36	Electronics	2,786	478	104	31,942	57,374	89,316
37	Trans. Equip.	1,563	268	58	19,560	50,954	70,513
38	Instruments	1,980	340	74	30,514	14,248	44,762
39	Misc. Manuf.	1,461	251	54	20,154	13,320	33,473
Average		1,960	336	73	27,601	61,496	89,097

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

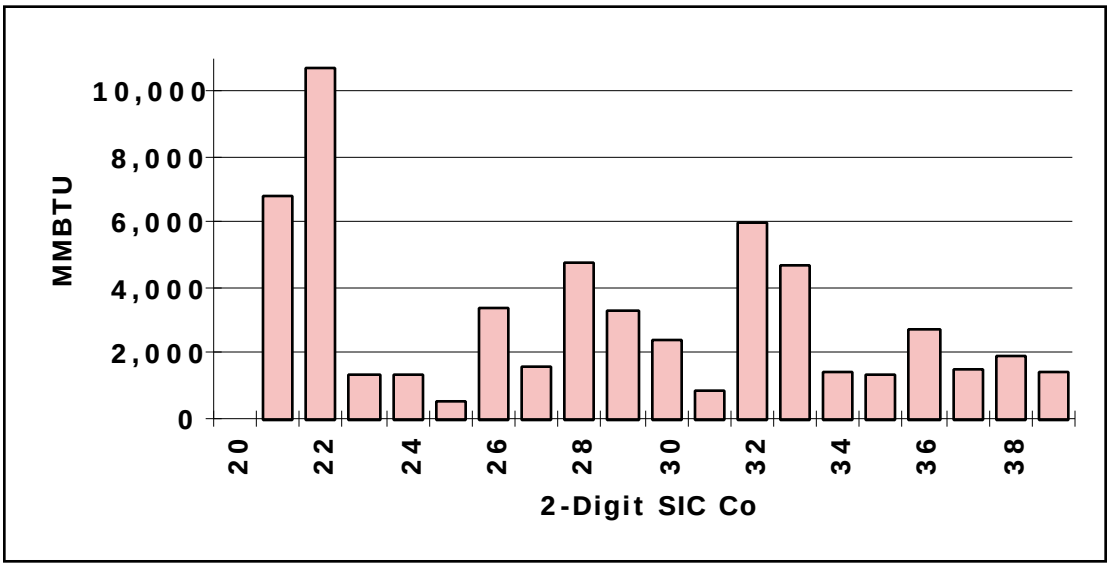


Figure 23. Average Recommended Energy Saved by Industry Type

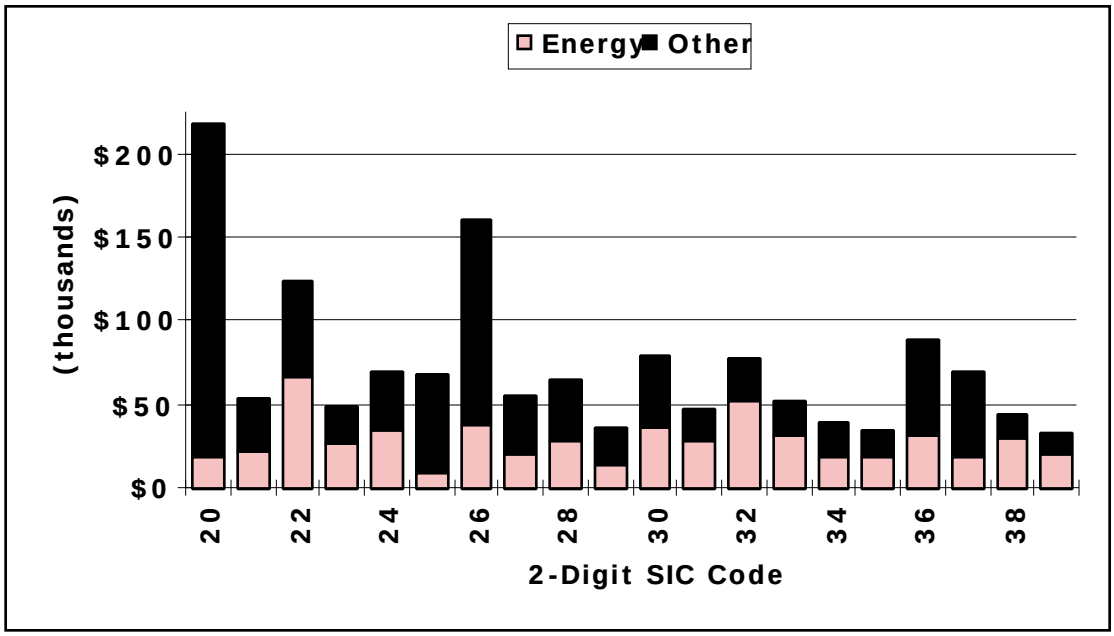


Figure 24. Average Recommended Cost Savings by Industry Type

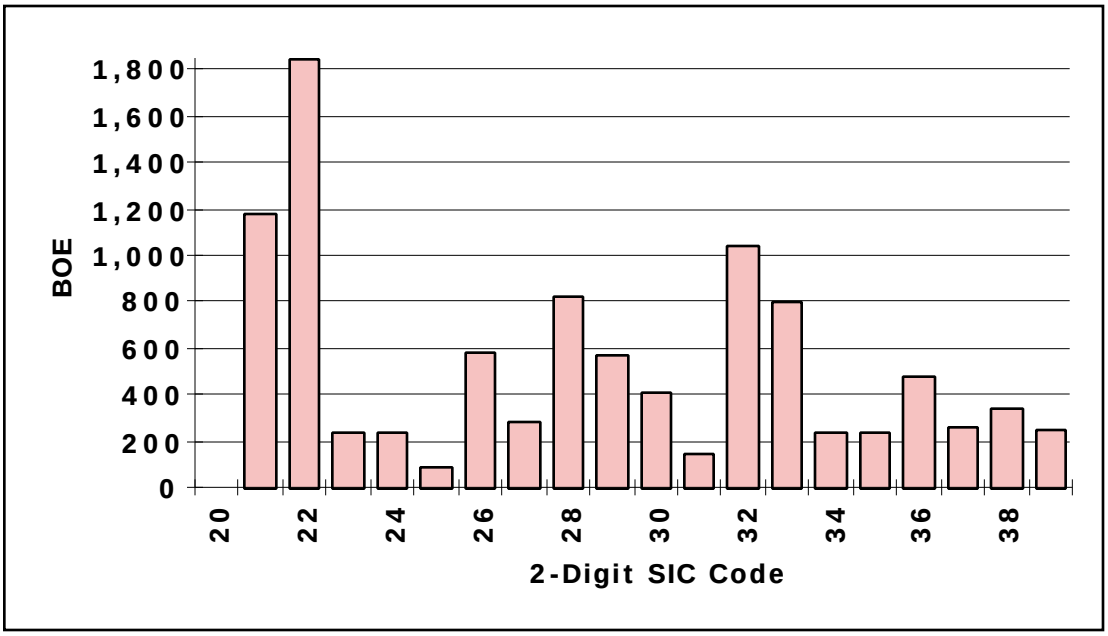


Figure 25. Average Recommended Barrels of Oil Saved by Industry Type

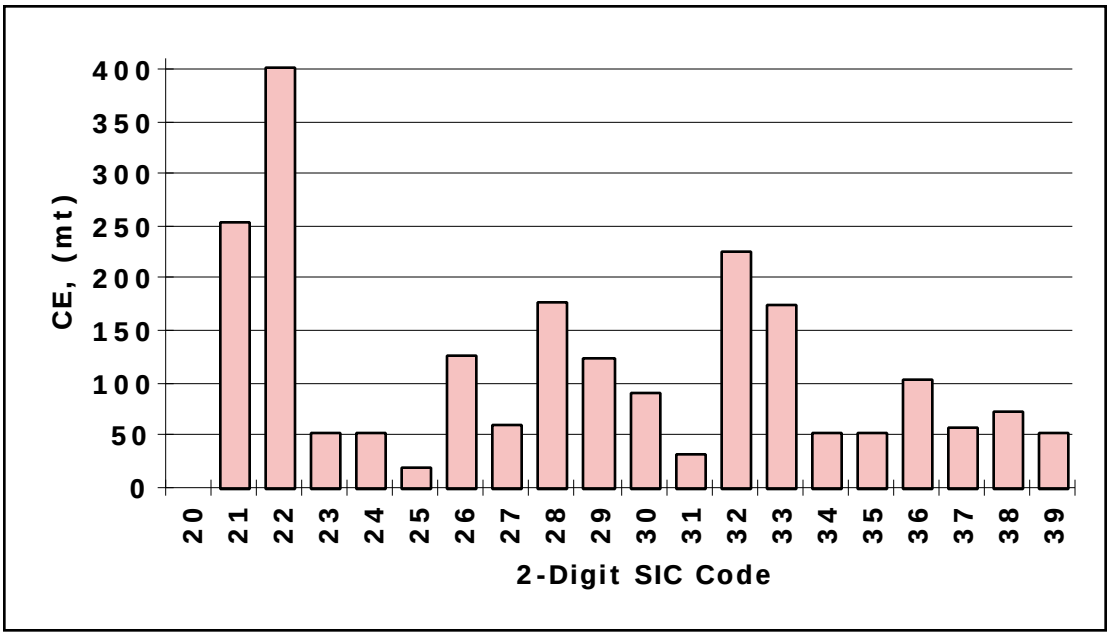


Figure 26. Average Recommended Carbon Avoided by Industry Type

iii. Recommended Savings by Resource Stream

Energy recommendations are broken into 12 different fuel types: Electricity (demand, fees, consumption), 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 FY96 was almost 1.7 million MMBTUs, with a dollar amount of almost $24 Million. Including non-energy dollars, the total recommended savings in FY96 amounted to over $77 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 energy savings).

Energy Stream	Recommended Energy Conservation (MMBTU)	Recommended Energy Cost Savings ($)
Electricity		
Demand	712,364 KW-months/yr	6,453,329
Fees		700,751
Consumption	1,042,787	13,618,821
Natural Gas	816,912	2,508,646
L. P. G.	-3,467	27,830
Fuel Oil #1	-95	-955
Fuel Oil #2	18,339	98,430
Fuel Oil #4	3,071	13,090
Fuel Oil #6	152,504	420,749
Coal	290	435
Wood	-355,272	-28,935
Other Energy	24,037	117,697
Energy Totals	**1,699,106**	**23,929,888**
Non-Energy	n/a	53,317,091
Program Totals	**1,699,106**	**77,246,979**

Table 12. 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.

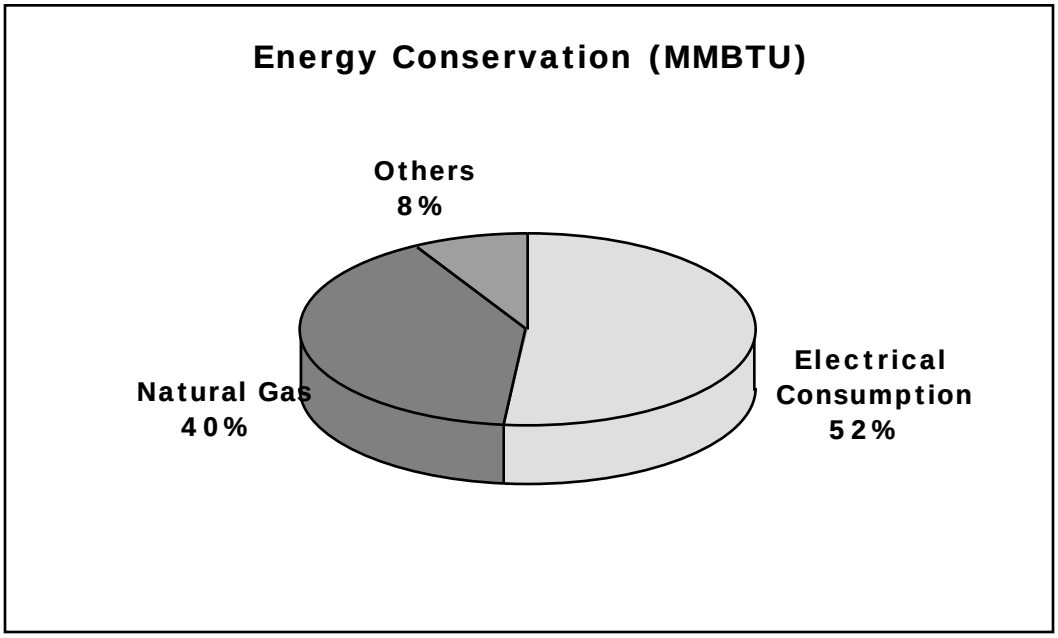


Figure 27. Composition of Recommended Energy Conserved by Energy Stream

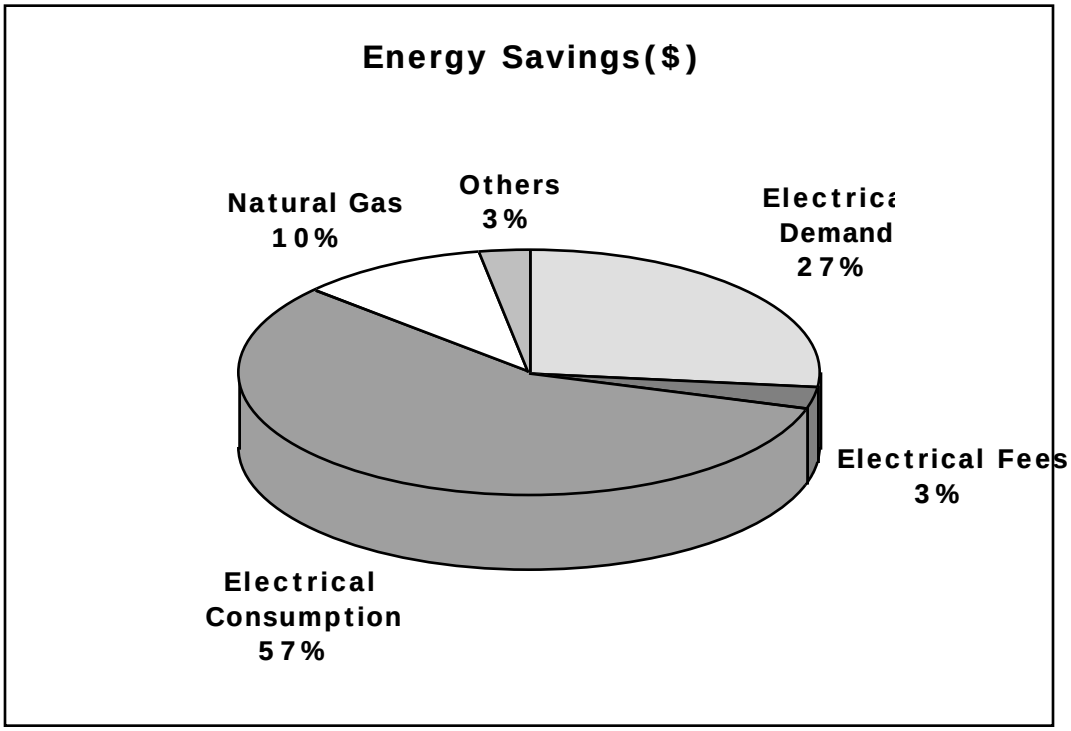


Figure 28. Composition of Recommended Cost Savings by Energy Stream

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.

Stream Type	Total Recommended Non-Energy Cost Savings ($)
Production	
Primary Product	11,612,003
By-product Production	2,892,852
Resource Costs	
Personnel Changes	67,445
Administrative Costs	7,410,746
Primary Raw Material	3,826,571
Ancillary Material Cost	624,686
Water Consumption	443,285
Waste Reduction	
Water Disposal	3,319,055
Other Liquid (non-haz)	1,372,091
Other Liquid (haz)	2,019,936
Solid Waste (non-haz)	11,082,573
Solid Waste (haz)	332,957
Gaseous Waste (haz)	8,312,891
Non-Energy Total	**53,317,091**

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

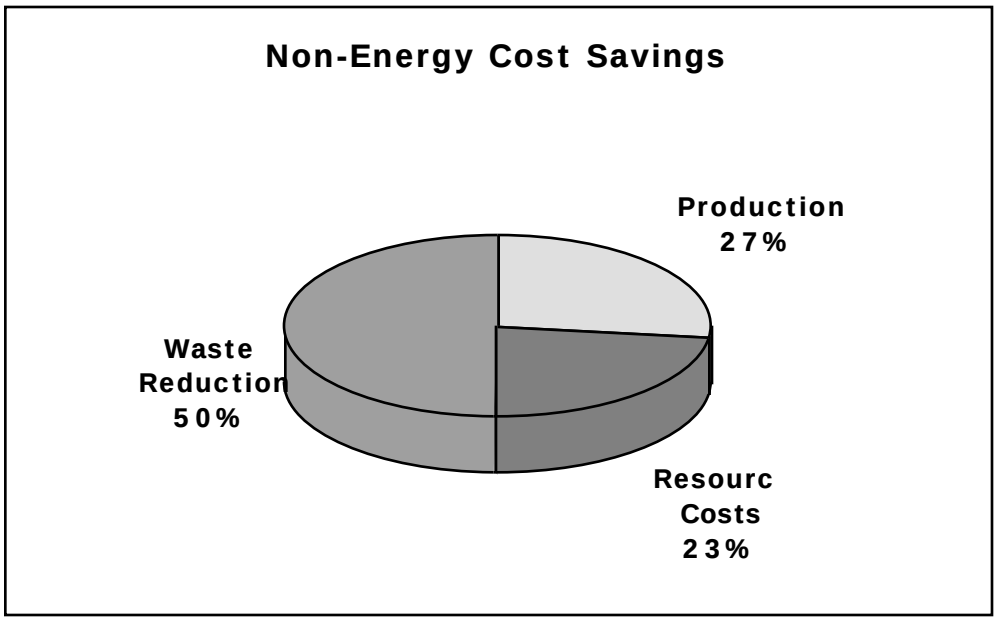


Figure 29. Recommended Non-Energy Cost Savings

Figure 30 indicates the composition of the total recommendations by resource stream for FY96.

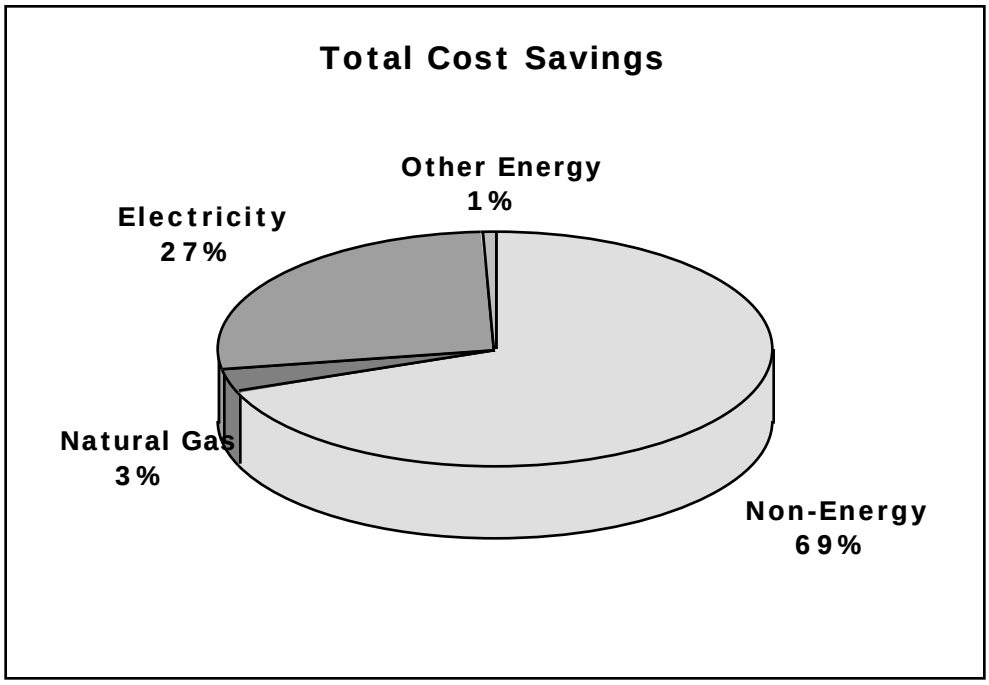


Figure 30. Recommended Cost Savings by Resource Stream

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 250 different recommendations in these categories. Table 14 shows the category description and number of recommendations by assessment recommendation (AR) type for FY96. Figure 31 shows the frequency of the recommendations.

2-Digit ARC Code	Category Description	No. of Recommendations
2.1	Combustion Systems	281
2.2	Thermal Systems	561
2.3	Electrical Power	225
2.4	Motor Systems	1936
2.5	Industrial Design	8
2.6	Operations	153
2.7	Buildings and Grounds	1741
2.8	Ancillary Costs	143
2.9	Alternate Energy Use	1
3.1	Operations	159
3.2	Equipment	72
3.3	Post Generation Treatment/Minimization	50
3.4	Water Use	293
3.5	Recycling	418
3.6	Waste Disposal	133
3.7	Maintenance	72
3.8	Raw Materials	98
4.x	Productivity Enhancement	61
	Total	6405

Table 14. Recommendations by Recommendation Type

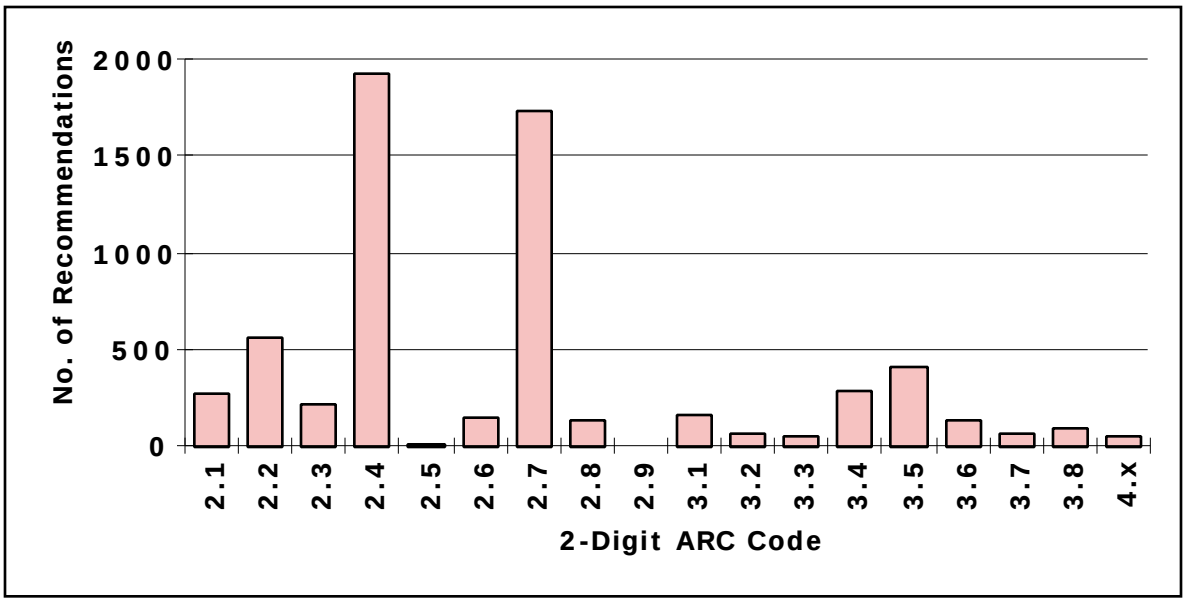


Figure 31. Number of Recommendations by Recommendation Type

D. Implementation Results

i. General

The IAC/EADC program has historically enjoyed a high rate of implementation of recommendations. The results of the 1996 program year showed an implementation rate of over 50%. 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 71%, and as cost ($) saved to recommended was 35%. Tables 15 & 16, and Figures 32 through 59 are all related to implementation results.

Fiscal Year	No. of Recommendations	No. of Recommendations Implemented	% of Recommendations Implemented
82	1,152	317	28%
83	1,150	352	31%
84	1,746	1,050	60%
85	2,377	1,400	59%
86	1,998	1,254	63%
87	2,175	1,404	65%
88	2,629	1,581	60%
89	2,380	1,402	59%
90	2,417	1,395	58%
91	3,091	1,766	57%
92	3,777	1,828	48%
93	4,130	2,052	50%
94	5,474	2,586	47%
95	6,055	3,041	50%
96	6,405	3,301	52%
Totals	46,956	24,729	53%

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

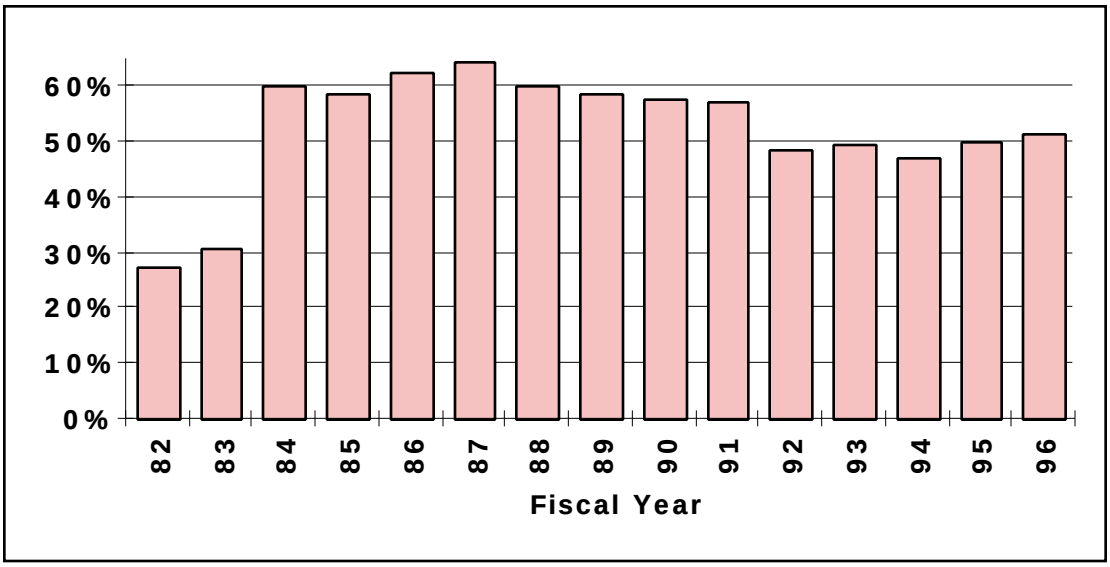


Figure 32. Percent of Recommendations Implemented by Fiscal Year

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
95	1,245,394	213,802	35,658	13,132,652	6,775,750	19,908,402
96	1,211,850	208,043	42,195	13,264,595	13,875,861	27,140,456

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 FY96, the directors used over 372 different recommendations. The average number of recommendations was seven, and 107 recommendations were used only once. A review of Table 14 and Figure 31 further illustrate the fact that most recommendations were process oriented.

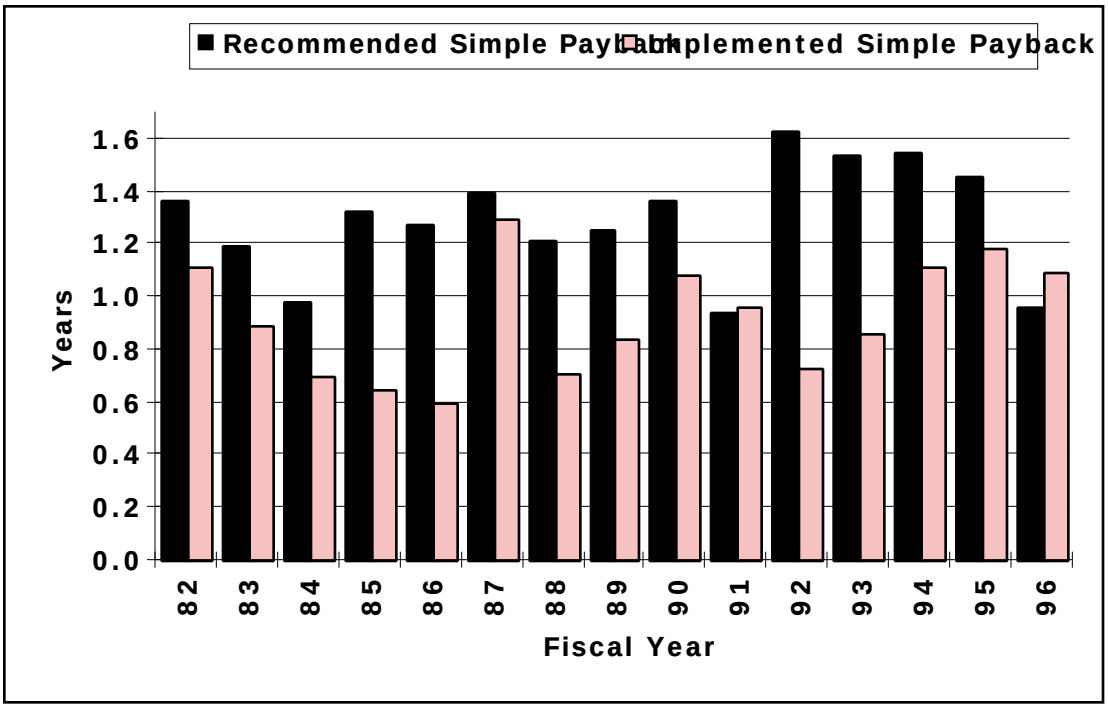


Figure 33. Recommended vs. Implemented Simple Payback

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
95	50,119,043	72,855,526	1.5	19,908,402	23,640,685	1.2
96	77,246,979	74,511,907	1.0	27,140,456	29,534,720	1.1
Totals	342,013,115	441,713,812	1.3	140,157,713	136,045,965	1.0

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 seven year time frame.

Fiscal Year	Implemented Energy Conservation			Implemented Cost Savings ($)		
	(MMBtu)	(B.O.E.)	(C.E., mt)	Energy	Non-Energy	Total
82-87	4,218	724	98	27,906	N/A	27,906
82-88	5,265	904	122	34,056	N/A	34,056
83-89	5,907	1,014	137	39,726	N/A	39,726
84-90	6,415	1,101	148	44,431	N/A	44,431
85-91	6,551	1,125	152	48,303	N/A	48,303
86-92	6,600	1,133	153	51,482	N/A	51,482
87-93	6,849	1,176	158	54,168	1,608	55,776
88-94	7,282	1,250	168	60,472	4,729	65,201
89-95	7,480	1,284	214	67,455	11,505	78,960
90-96	7,696	1,321	268	73,210	25,381	98,591

Table 18. Seven Year Cumulative Conservation and Cost Savings

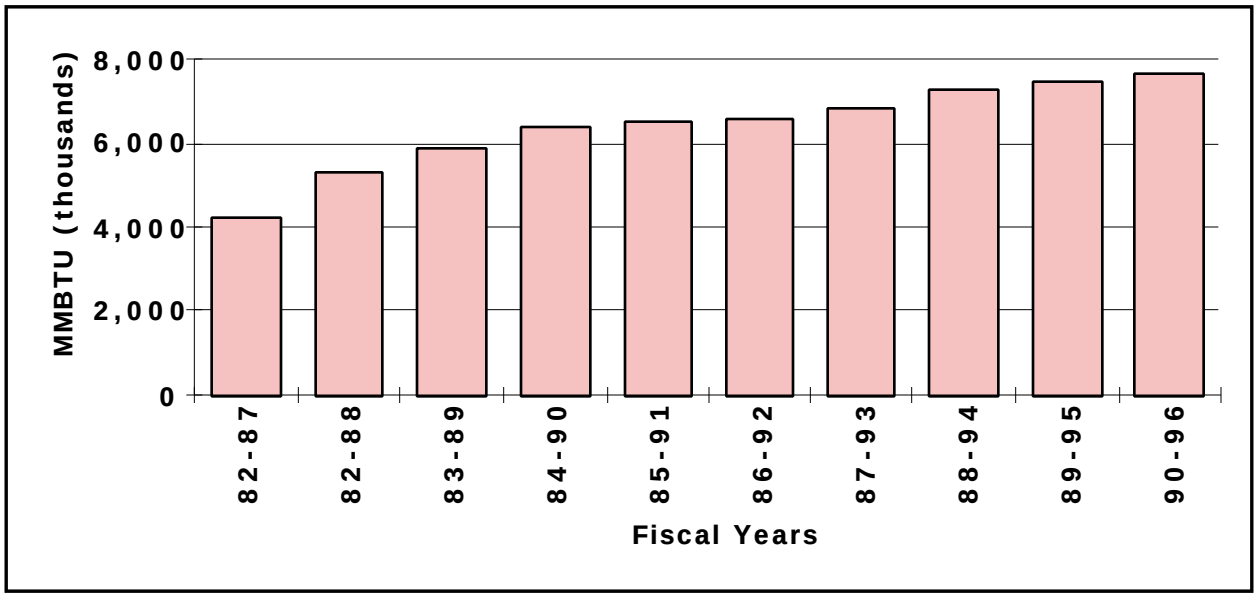


Figure 34. Seven Year Cumulative Energy Savings

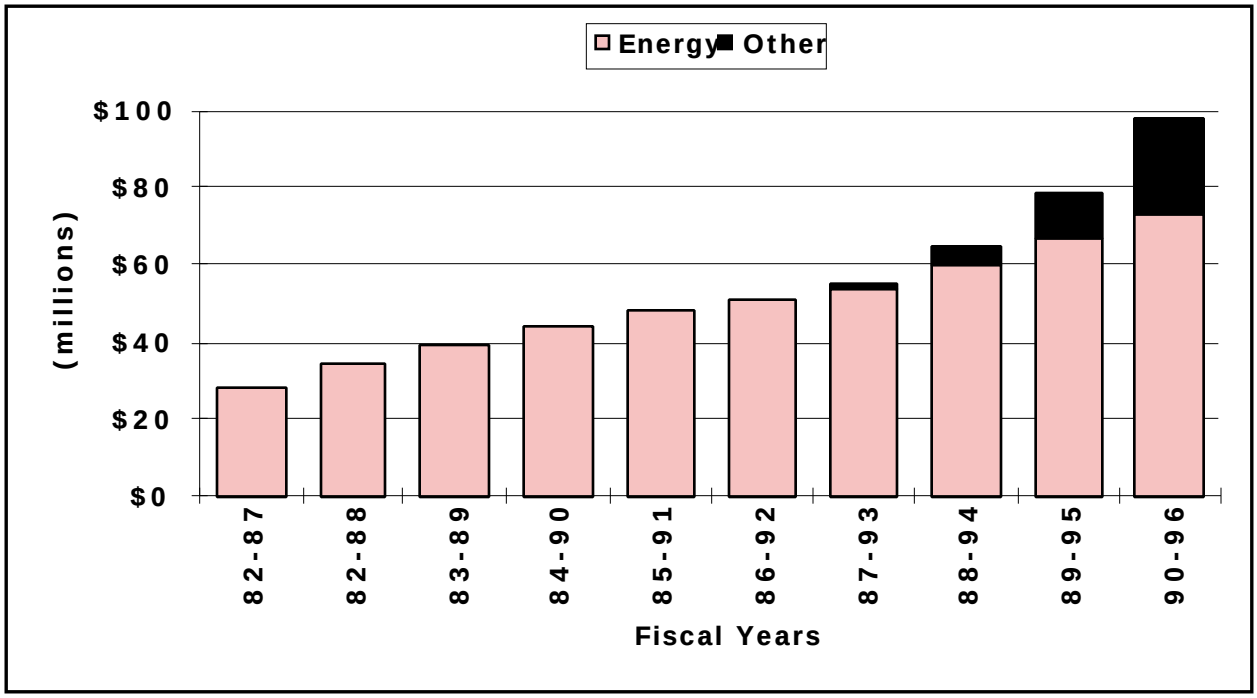


Figure 35. Seven Year Cumulative Cost Savings

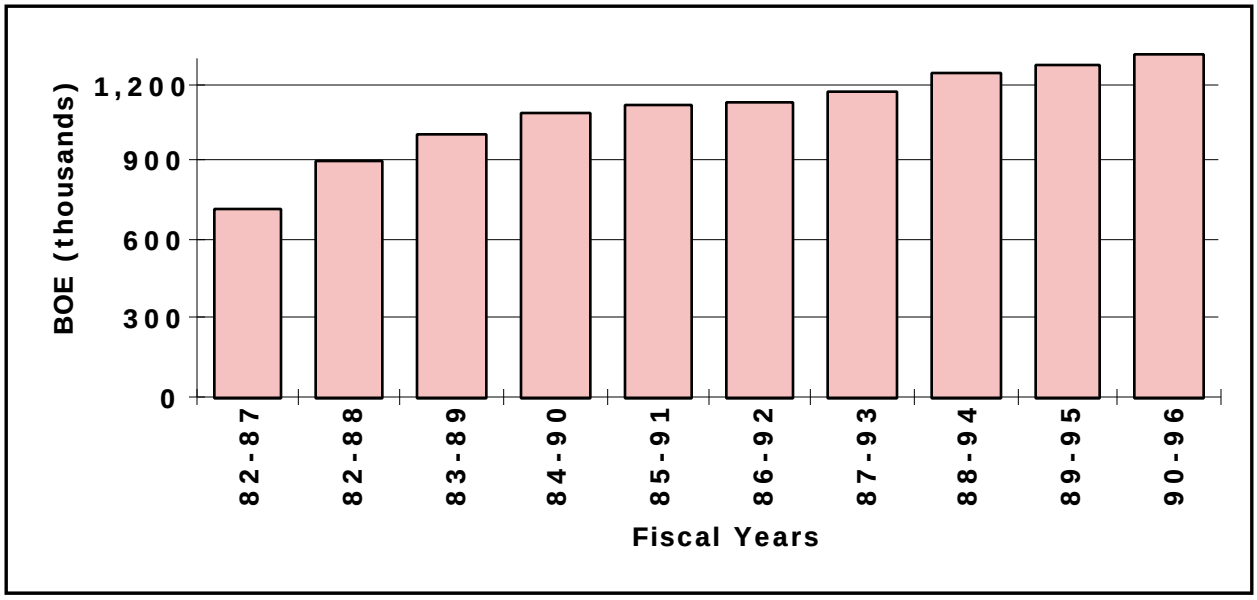


Figure 36. Seven Year Cumulative Barrels of Oil Avoided

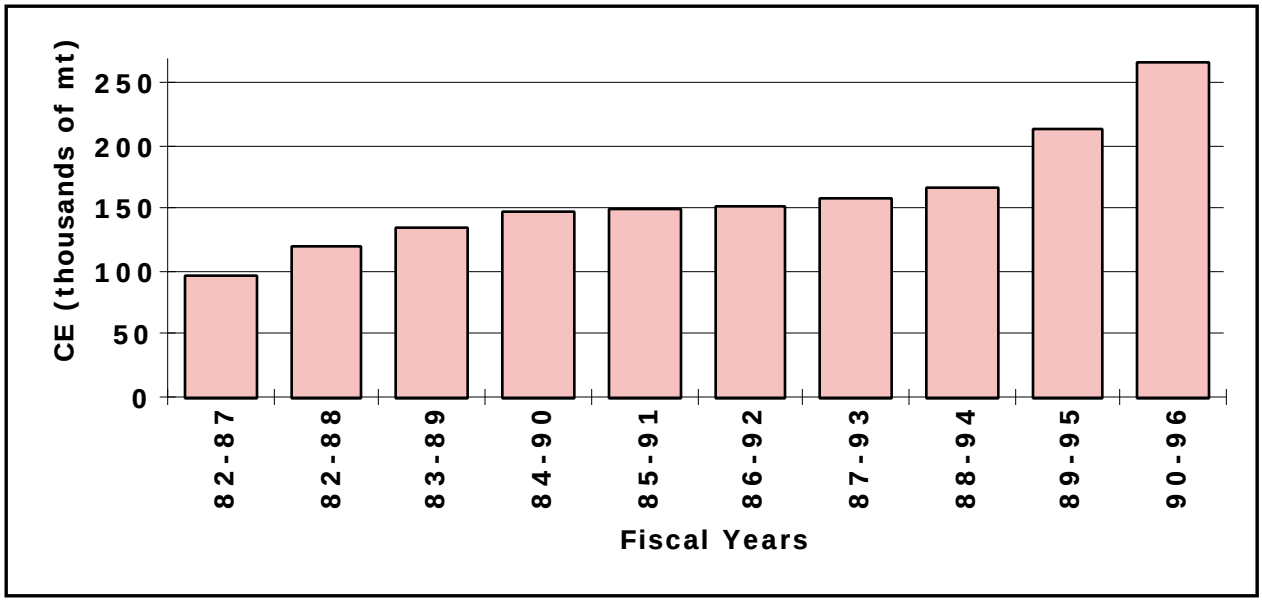


Figure 37. Seven Year Cumulative Carbon Avoided

Similar to the charts in the previous section showing recommended savings, the average energy and cost saved due to the implementation of recommended measures is shown per assessment for FY96 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
95	1,417	243	41	14,940	7,708	22,649
96	1,398	240	49	15,299	16,004	31,304

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

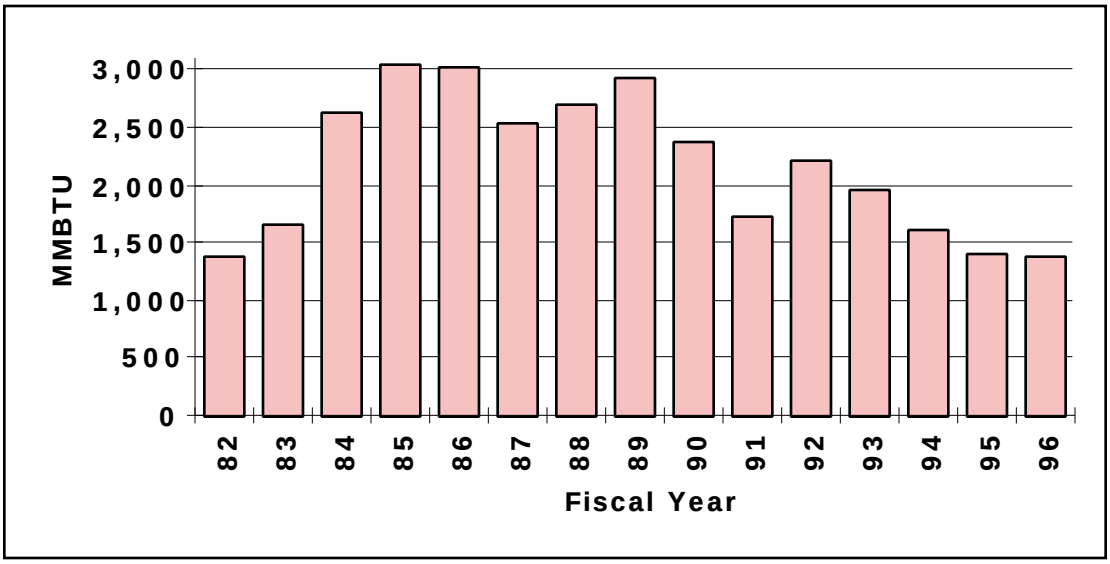


Figure 38. Average Implemented Conservation by Fiscal Year

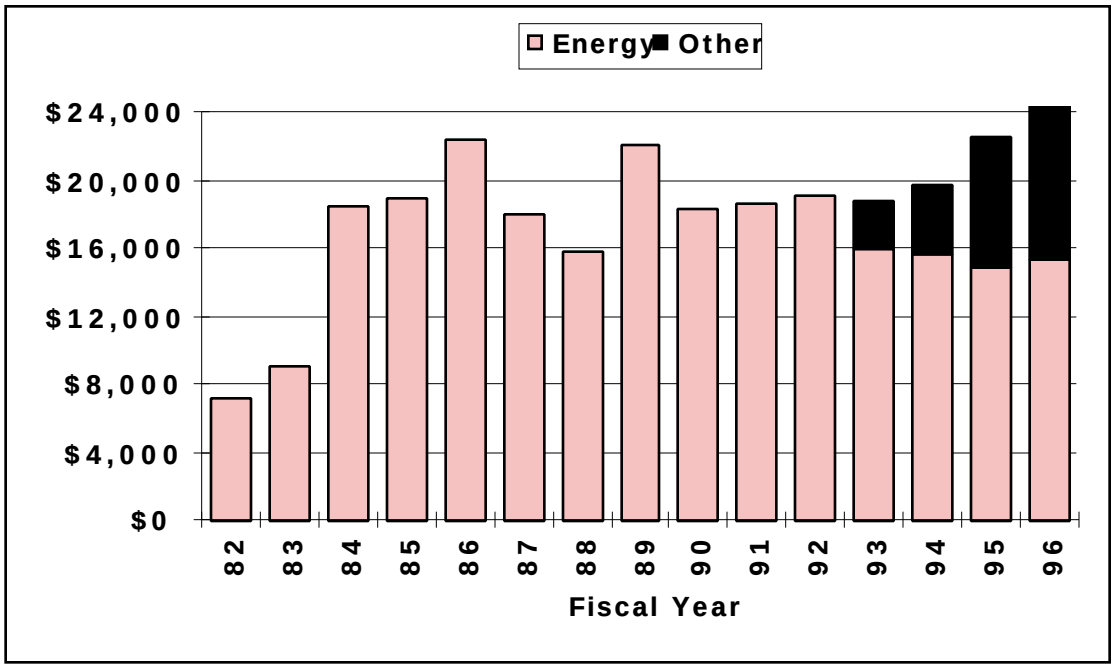


Figure 39. Average Implemented Cost Savings by Fiscal Year

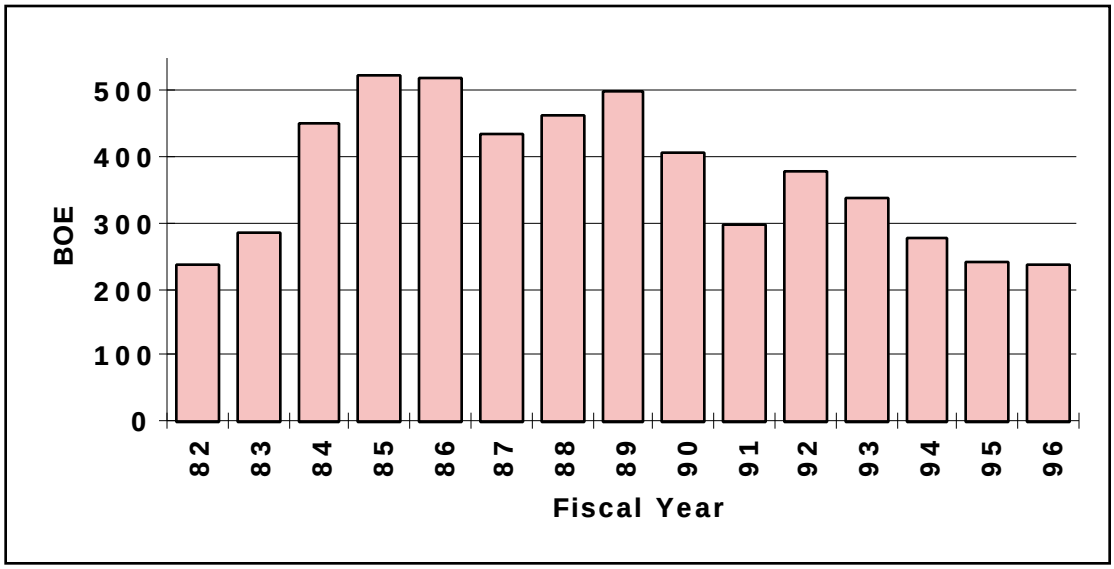


Figure 40. Average Implemented Barrels of Oil Avoided by Fiscal Year

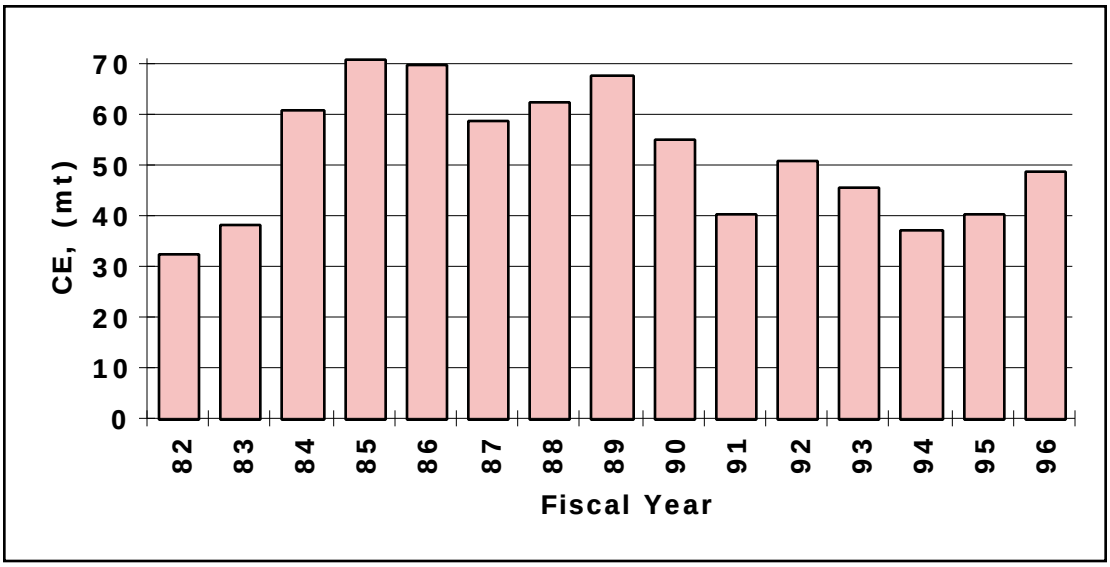


Figure 41. Average Implemented Carbon Avoided by Fiscal Year

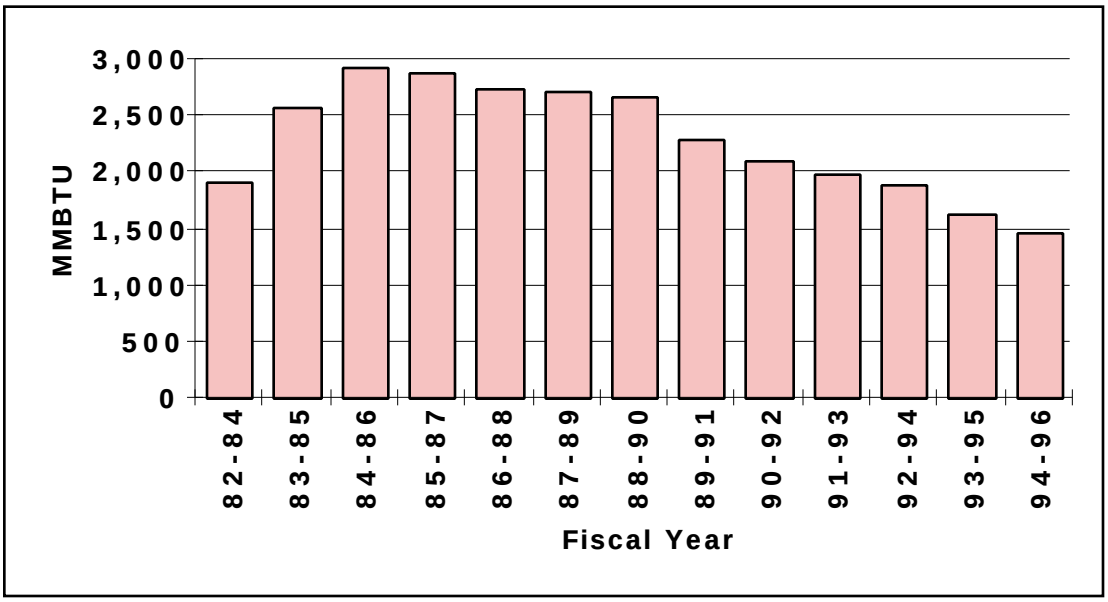


Figure 42. Implemented Energy Conserved Per Assessment (3 Year Average)

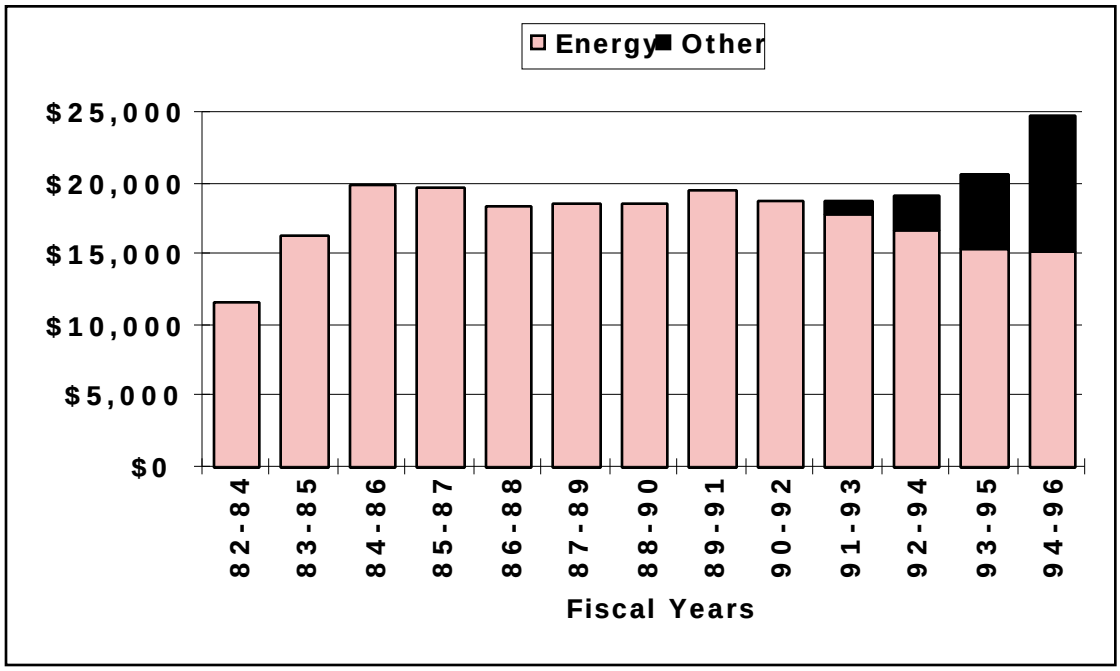


Figure 43. Average Implemented Cost Savings Per Assessment (3 Year Average)

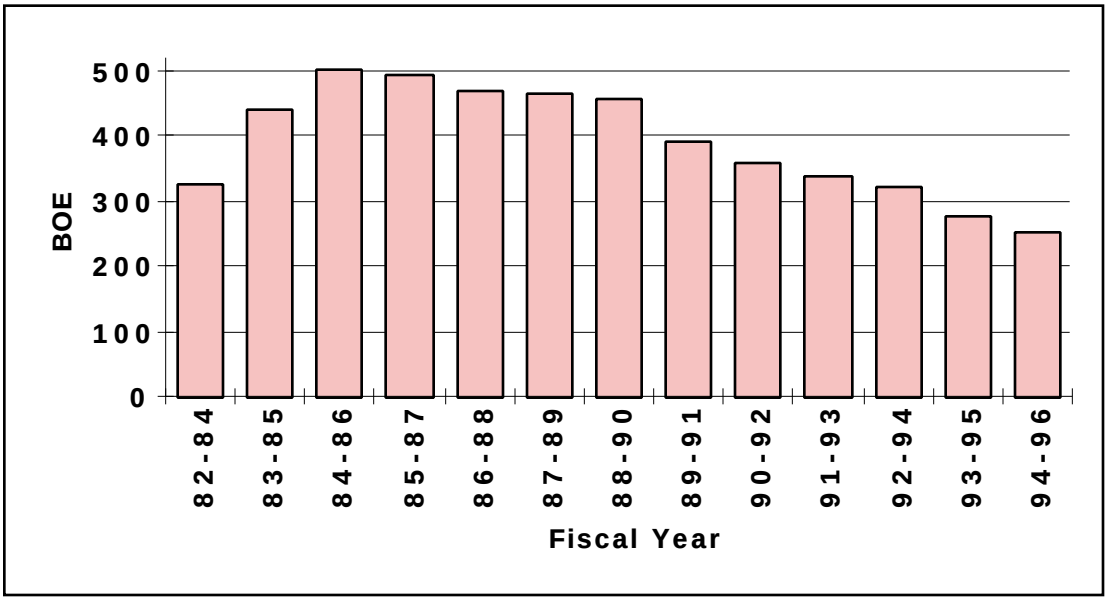


Figure 44. Average Implemented Barrels of Oil Avoided Per Assessment (3 Year Average)

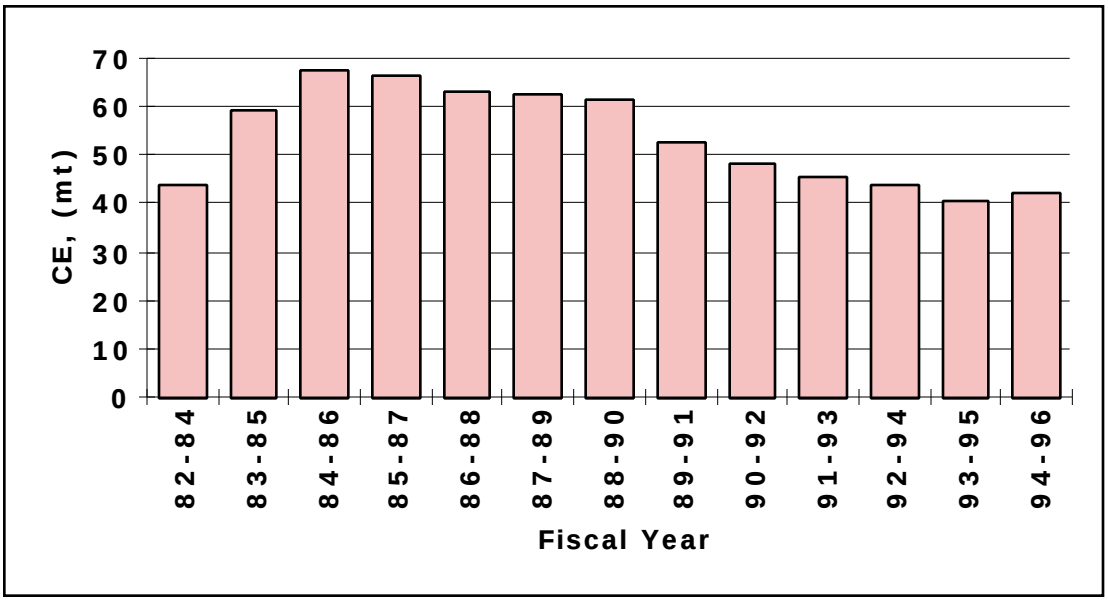


Figure 45. Average Implemented Carbon Avoided Per Assessment (3 Year Average)

ii. Implemented Savings by Industry Type

Energy conservation and cost savings resulting from implemented recommendations by industry type is shown in Table 20, and on Figures 46 through 49. The greatest amount of energy conserved was in SIC 30 (Rubber and Plastic); the largest in cost savings was SIC 20 (food and kindred products).

SIC Code	Industry Description	Implemented Energy Conservation			Implemented Cost Savings ($)		
		(MMBtu)	(B.O.E.)	(C.E., mt)	Energy	Non-Energy	Total
20	Foods	182,368	31,308	6,350	2,079,646	3,825,973	5,905,619
21	Tobacco Prod.	6,331	1,087	220	16,145	0	16,145
22	Textile Mills	60,547	10,394	2,108	696,698	309,169	1,005,867
23	Apparel	12,485	2,143	435	241,121	53,054	294,175
24	Wood Prod.	37,256	6,396	1,297	619,879	697,963	1,317,842
25	Furniture	5,638	968	196	118,758	938,677	1,057,435
26	Paper Prod.	55,496	9,527	1,932	567,967	748,657	1,316,624
27	Printing	45,580	7,825	1,587	594,872	846,106	1,440,978
28	Chemical Prod	115,136	19,766	4,009	590,873	456,880	1,047,753
29	Petroleum	7,077	1,215	246	32,862	26,900	59,762
30	Rubber & Plast.	198,606	34,095	6,915	1,587,758	1,116,651	2,704,409
31	Leather Prod.	8,138	1,397	283	161,794	120,723	282,517
32	Stone & Glass	121,762	20,903	4,240	1,433,475	-21,550	1,411,925
33	Primary Metal	59,936	10,289	2,087	696,437	215,574	912,011
34	Fab. Metal	79,306	13,615	2,761	1,280,812	1,182,114	2,462,926
35	Ind. Machinery	45,805	7,864	1,595	647,700	589,668	1,237,368
36	Electronics	94,914	16,294	3,305	854,099	1,458,894	2,312,993
37	Trans. Equip.	46,859	8,044	1,632	614,089	1,050,341	1,664,430
38	Instruments	20,026	3,438	697	310,813	146,404	457,217
39	Misc. Manuf.	8,584	1,474	299	118,797	113,663	232,460
Totals		1,211,850	208,043	42,195	13,264,595	13,875,861	27,140,456

Table 20. Implemented Energy and Cost Savings by Industry Type

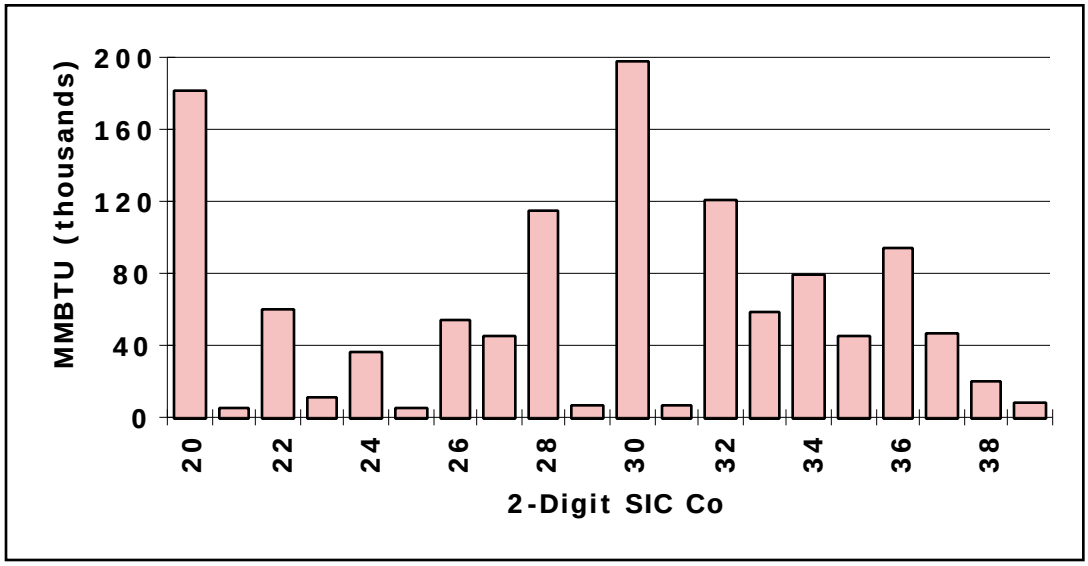


Figure 46. Implemented Energy Conserved by Industry Type

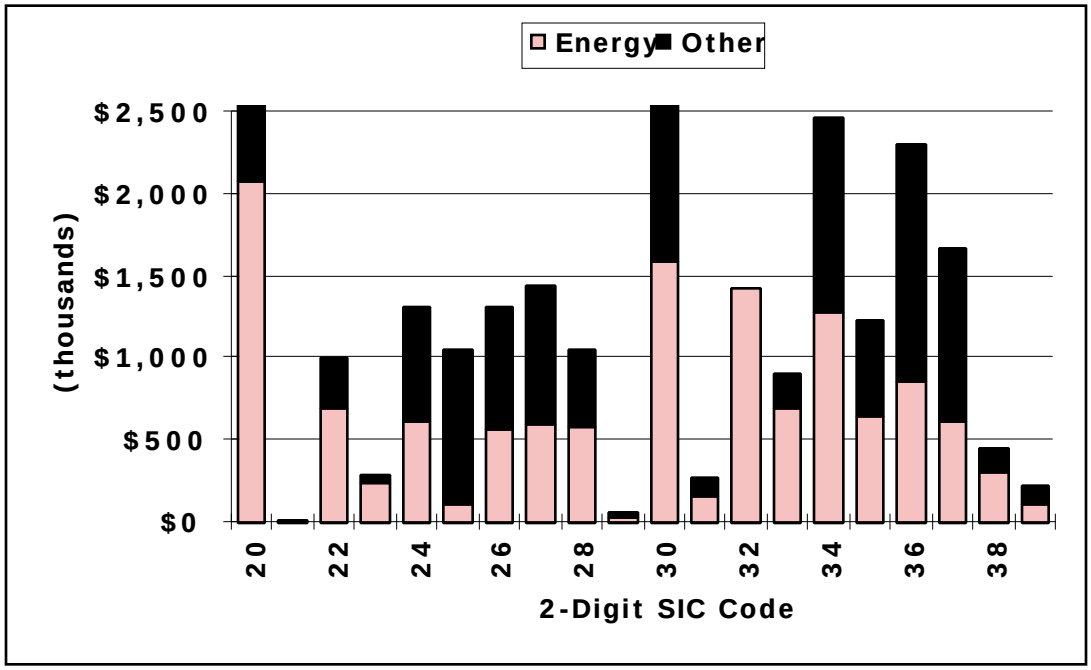


Figure 47. Implemented Cost Savings by Industry Type

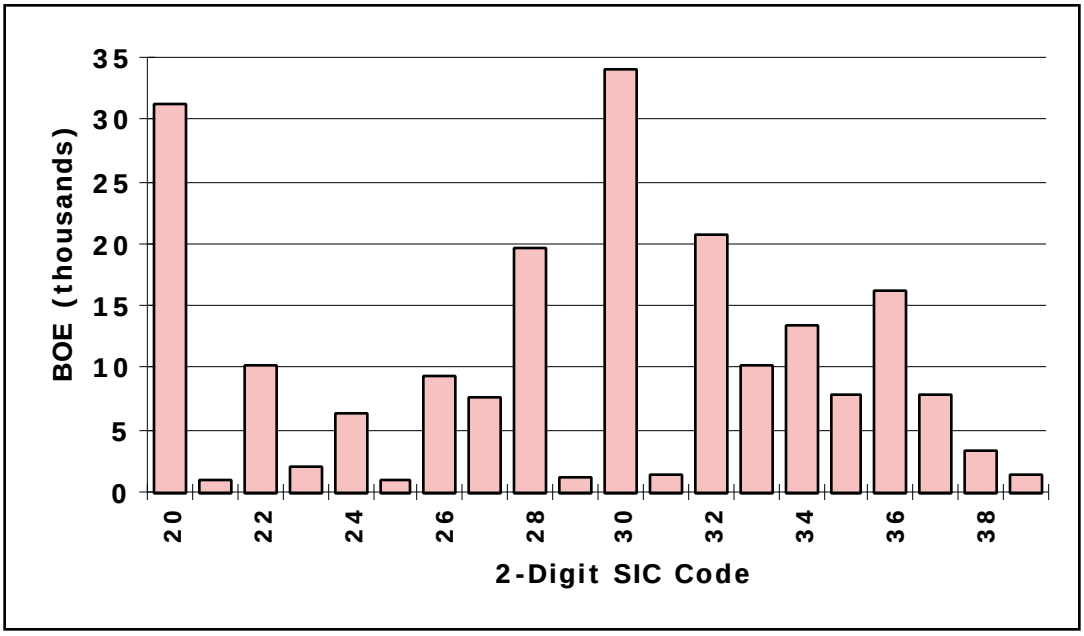


Figure 48. Implemented Barrels of Oil Avoided by Industry Type

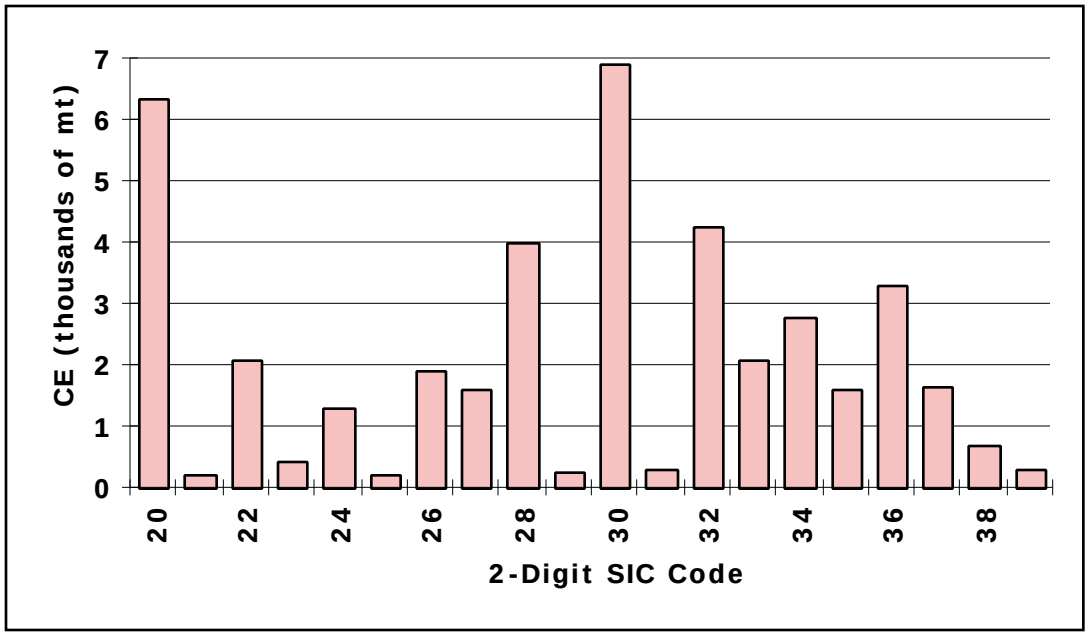


Figure 49. Implemented Carbon Avoided by Industry Type

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			Implemented Cost Savings ($)		
		(MMBtu)	(B.O.E.)	(C.E., mt)	Energy	Non-Energy	Total
20	Foods	1,436	247	50	16,375	30,126	46,501
21	Tobacco Prod.	6,331	1,087	220	16,145	0	16,145
22	Textile Mills	2,162	371	75	24,882	11,042	35,924
23	Apparel	520	89	18	10,047	2,211	12,258
24	Wood Prod.	1,007	173	35	16,753	18,864	35,617
25	Furniture	297	51	10	6,250	49,404	55,654
26	Paper Prod.	1,460	251	51	14,947	19,702	34,649
27	Printing	1,036	178	36	13,520	19,230	32,750
28	Chemical Prod.	3,198	549	111	16,413	12,691	29,104
29	Petroleum	3,539	608	123	16,431	13,450	29,881
30	Rubber & Plast.	2,337	401	81	18,680	13,137	31,817
31	Leather Prod.	1,163	200	40	23,113	17,246	40,359
32	Stone & Glass	3,479	597	121	40,956	-616	40,340
33	Primary Metal	1,153	198	40	13,393	4,146	17,539
34	Fab. Metal	655	112	23	10,585	9,770	20,355
35	Ind. Machinery	603	104	21	8,522	7,759	16,281
36	Electronics	1,825	313	64	16,425	28,056	44,481
37	Trans. Equip.	837	144	29	10,966	18,756	29,722
38	Instruments	1,178	202	41	18,283	8,612	26,895
39	Misc. Manuf.	858	147	30	11,880	11,366	23,246
Average		1,398	240	49	15,299	16,004	31,303

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

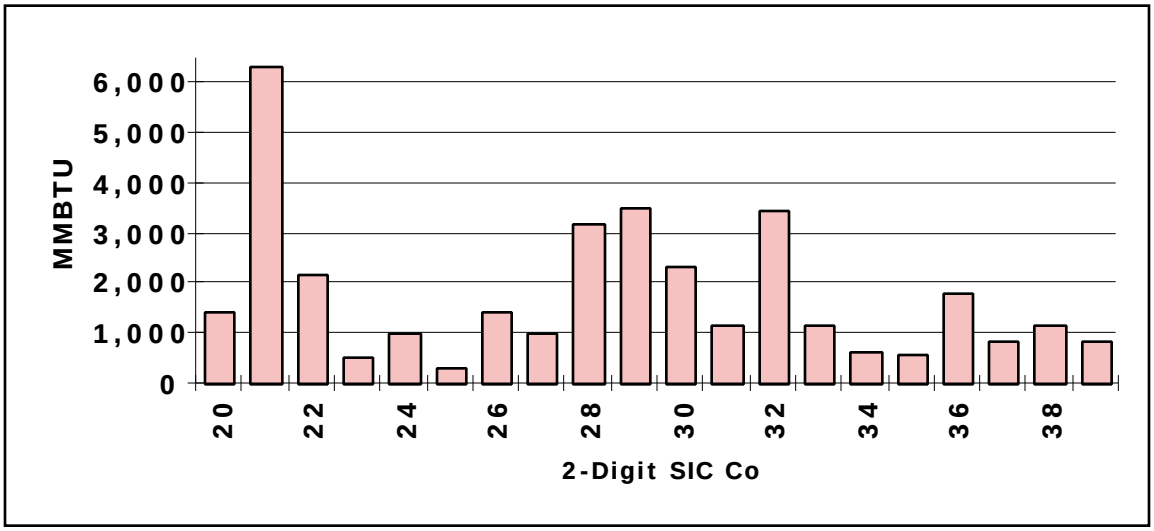


Figure 50. Average Implemented Energy Savings by Industry Type

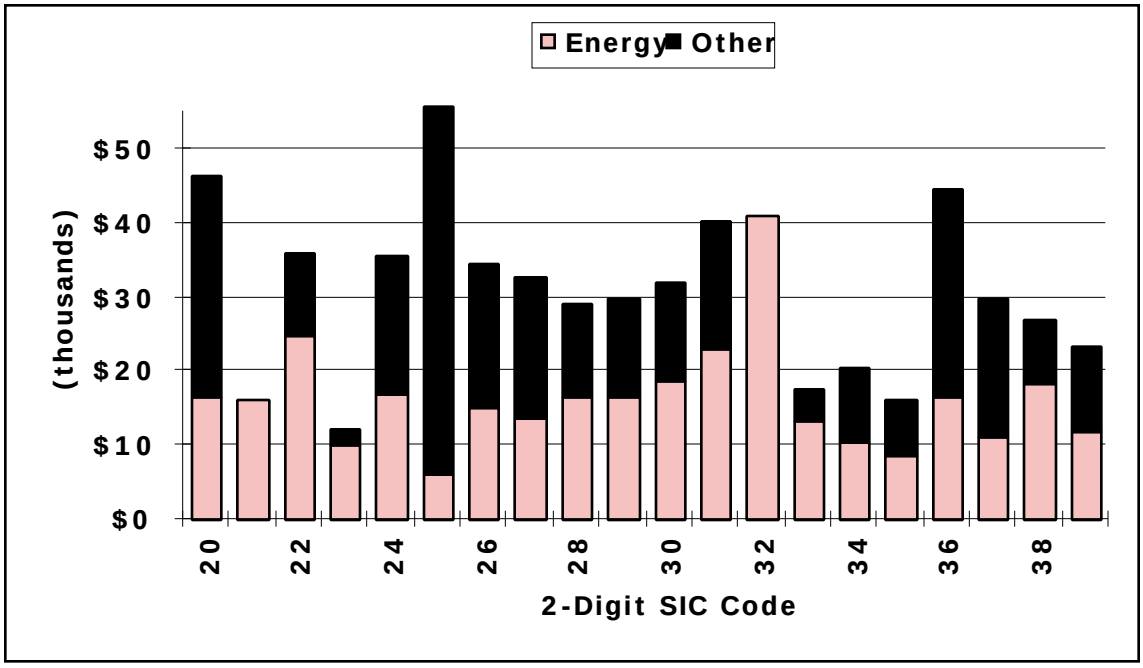


Figure 51. Average Implemented Cost Savings by Industry Type

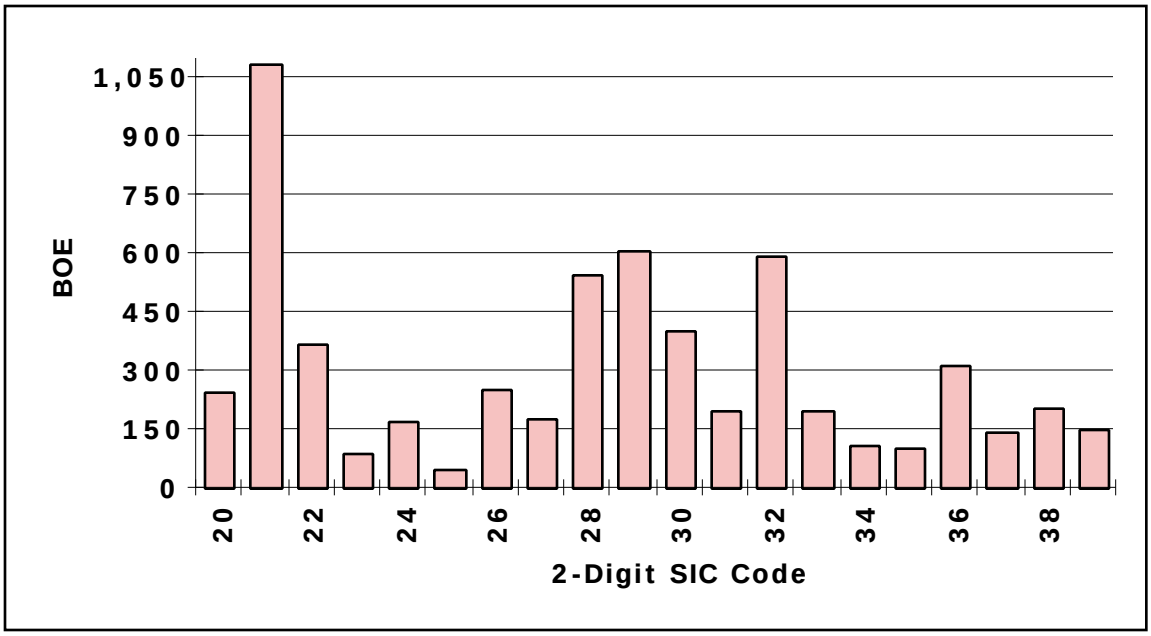


Figure 52. Average Implemented Barrels of Oil Avoided by Industry Type

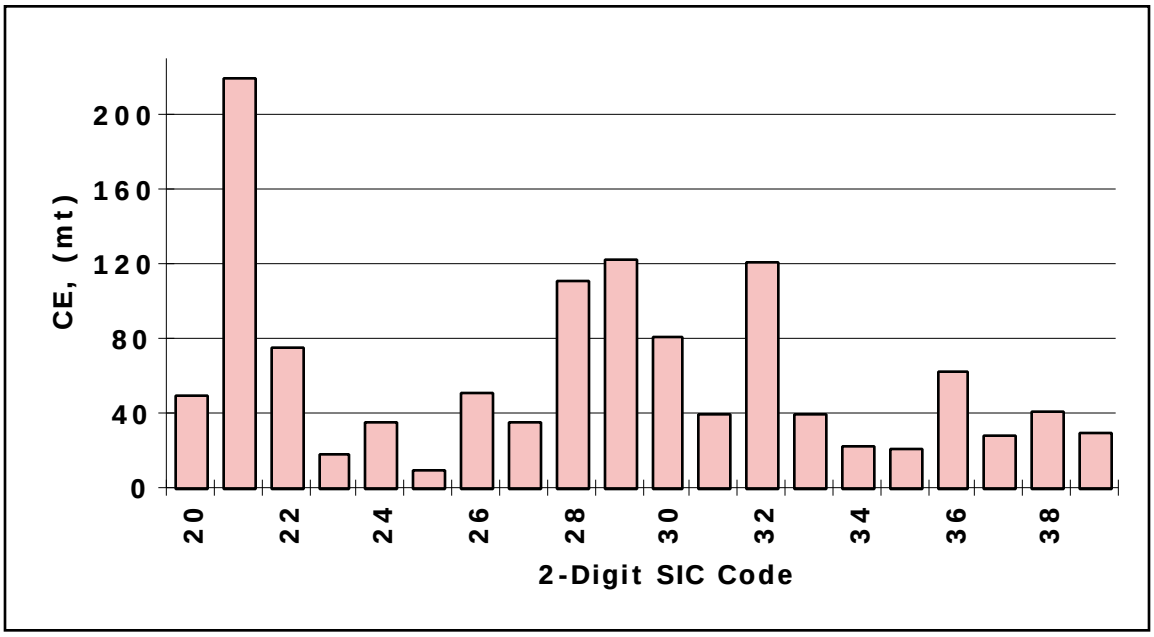


Figure 53. Average Implemented Carbon Avoided by Industry Type

iii. Implemented Savings by Resource Stream

Table 22, and Figures 54 and 55 reflect implemented energy and cost savings broken down by energy stream.

Energy Stream	Implemented Energy Conservation (MMBTU)	Implemented Energy Cost Savings ($)
Electricity		
Demand	409,097 KW-months/yr	3,703,178
Fees		233,297
Consumption	647,068	7,402,039
Natural Gas	540,344	1,846,948
L. P. G.	-25,090	-98,309
Fuel Oil #1	-96	-955
Fuel Oil #2	9,487	43,249
Fuel Oil #4	579	2,405
Fuel Oil #6	18,371	51,668
Coal	127	166
Wood	5,522	11,363
Other Energy	15,538	69,546
Energy Totals	1,211,850	13,264,595
Non-Energy	n/a	13,875,861
Program Totals	1,211,850	27,140,456

Table 22. Implemented Energy and Cost Savings by Resource Stream

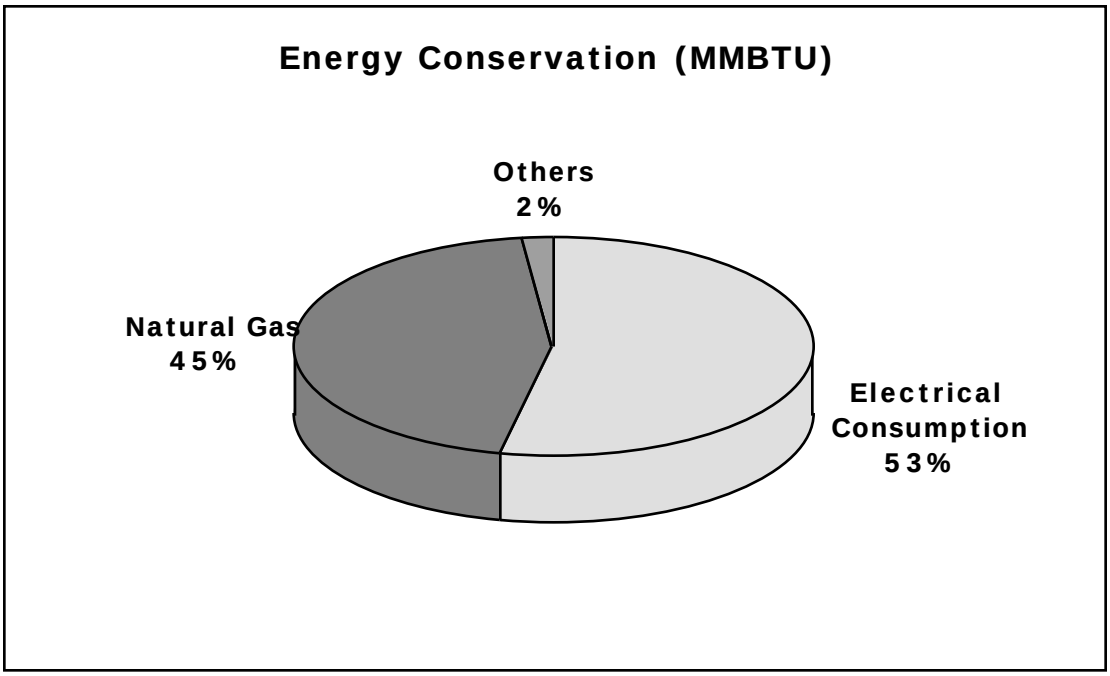


Figure 54. Composition of Implemented Energy Conserved by Energy Stream

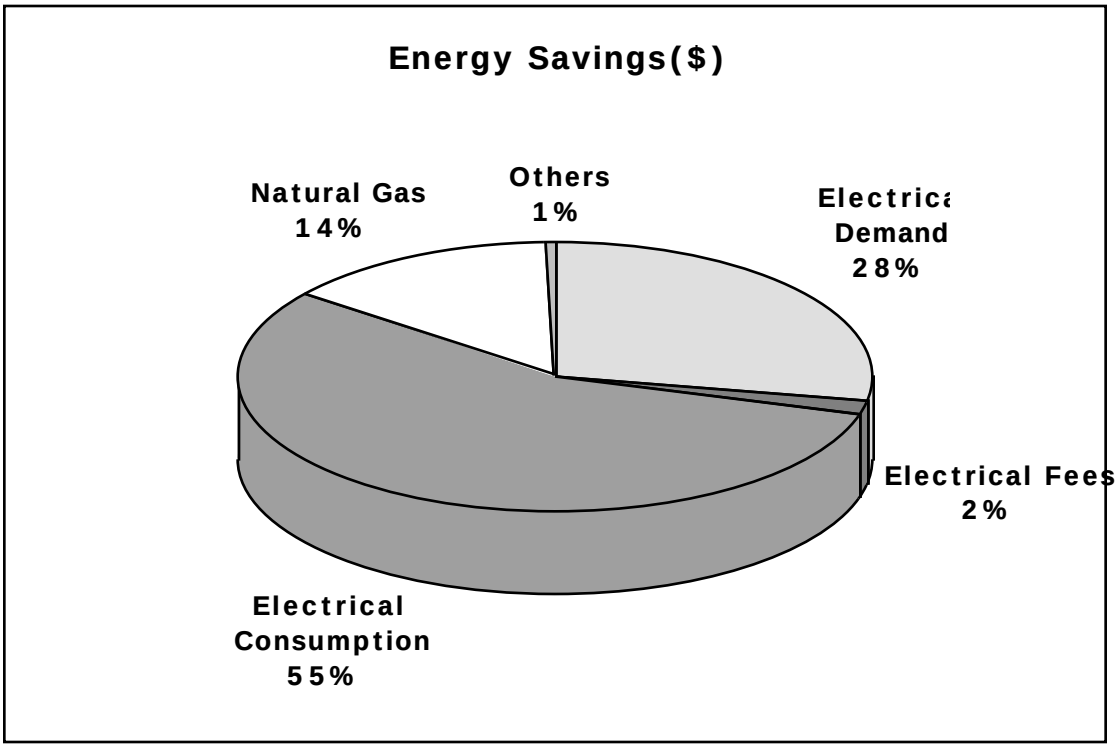


Figure 55. Composition of Implemented Energy Cost Savings by Energy Stream

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	1,164,261
By-product Production	188,731
Resource Costs	
Personnel Changes	823,207
Administrative Costs	953,562
Primary Raw Material	2,101,521
Ancillary Material Cost	1,499,885
Water Consumption	120,709
Waste Reduction	
Water Disposal	1,370,861
Other Liquid (non-haz)	321,543
Other Liquid (haz)	1,075,294
Solid Waste (non-haz)	4,042,345
Solid Waste (haz)	143,319
Gaseous Waste (haz)	70,623
Non-Energy Total	**13,875,861**

Table 23. Total Implemented Non-Energy Cost Savings

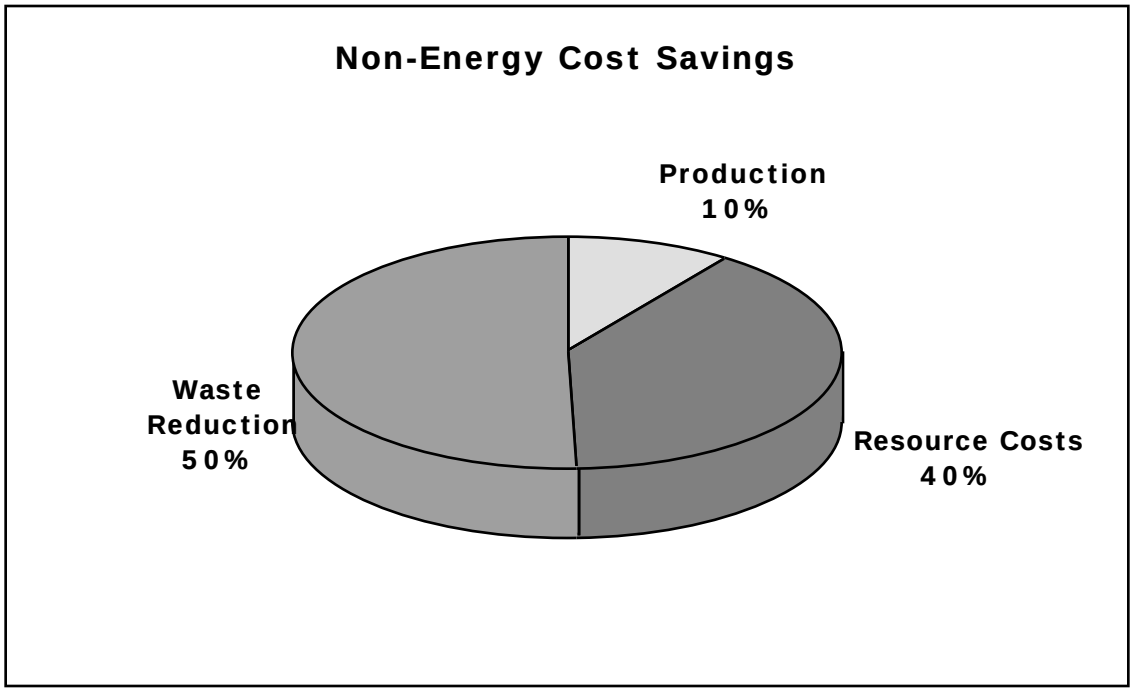


Figure 56. Composition of Non-Energy Implemented Savings

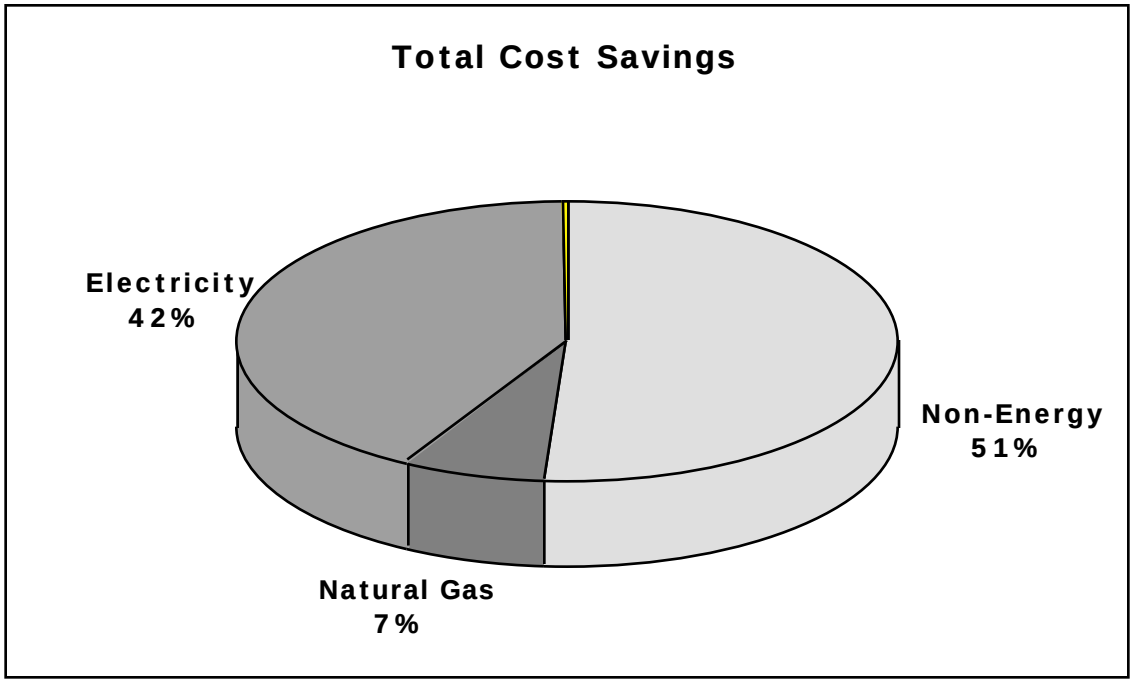


Figure 57. Composition of Total Implemented Cost Savings

iv. Implemented Savings by Recommendation Type

Finally, the number of implemented recommendations by type for Fiscal Year 1996 is shown in Table 24 and Figure 58.

2-Digit ARC Code	Category Description	No. of Implemented Recommendations
Energy		
2.1	Combustion Systems	121
2.2	Thermal Systems	257
2.3	Electrical Power	96
2.4	Motor Systems	1201
2.5	Industrial Design	1
2.6	Operations	87
2.7	Buildings and Grounds	860
2.8	Ancillary Costs	76
2.9	Alternate Energy Use	1
Waste		
3.1	Operations	76
3.2	Equipment	32
3.3	Post Generation Treatment / Minimization	23
3.4	Water Use	139
3.5	Recycling	177
3.6	Waste Disposal	52
3.7	Maintenance	33
3.8	Raw Materials	37
Productivity		
4.x	Productivity Enhancement	32
	Total	3301

Table 24. Number of Implemented Recommendations by Recommendation Type

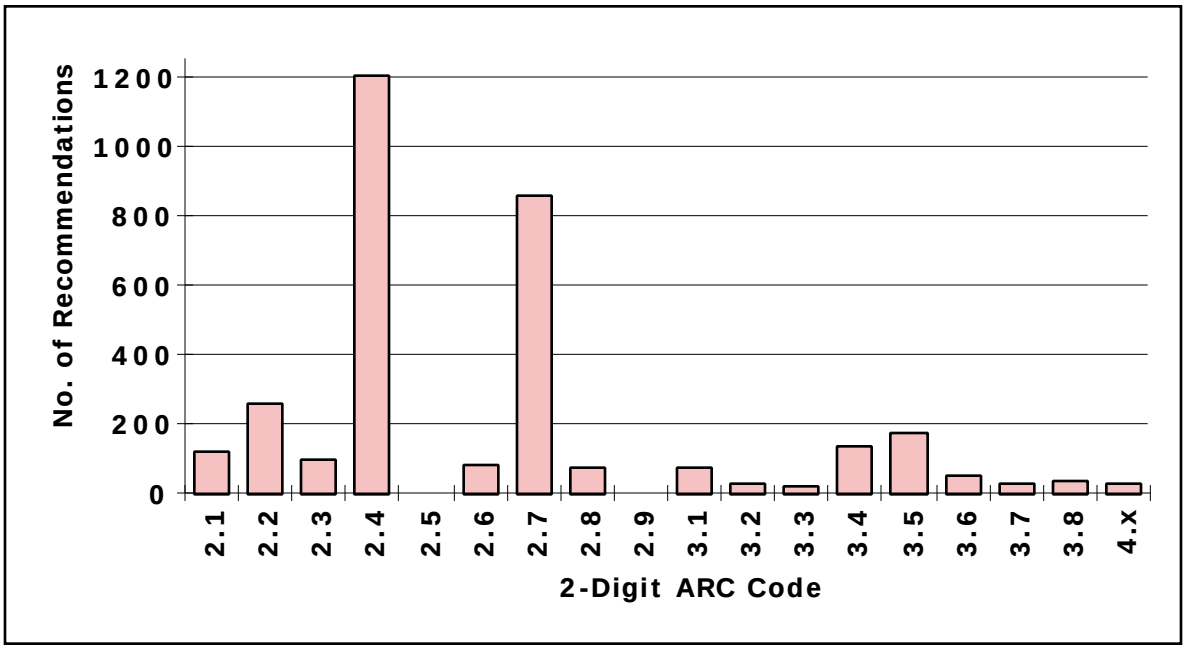


Figure 58. Number of Implemented Recommendations by Recommendation Type

Energy	
2.1	Combustion Systems
2.2	Thermal Systems
2.3	Electrical Power
2.4	Motor Systems
2.5	Industrial Design
2.6	Operations
2.7	Buildings and Grounds
2.8	Ancillary Costs
2.9	Alternate Energy Use
Waste	
3.1	Operations
3.2	Equipment
3.3	Post Generation Treatment / Minimization
3.4	Water Use
3.5	Recycling
3.6	Waste Disposal
3.7	Maintenance
3.8	Raw Materials
Productivity	
4.x	Productivity Enhancement

III. Standard Financial Calculations, FY96

Standard financial calculations of the IAC/EADC 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 25 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 FY96.

These leverage ratios (or profitability indices) show that, at a 10% discount rate, the federal government will realize $2.21 to $3.40 for every federal dollar spent on the program in FY96. Similarly, manufacturers will, as a group, receive $2.08 to $2.86 for every dollar invested in implementing cost-saving measures.

Standard Financial Calculations of IAC/EADC Results

IMPCOST GROWTH	ENSAV GROWTH	BORR RATE	FEDERAL GOVERNMENT			MANUFACTURERS		
%	%	%	IRR	LR_{10}	LR_{15}	IRR	LR_{10}	LR_{15}
3	3	3	52.2	2.89	2.18	321	2.53	2.07
3	3	6	50.2	2.80	2.10	278	2.47	2.01
3	3	9	48.3	2.70	2.01	243	2.41	1.96
3	3	6	50.2	2.80	2.10	278	2.47	2.01
6	3	6	49.8	2.77	2.07	273	2.45	2.00
6	0	6	44.2	2.21	1.62	254	2.08	1.70
6	3	6	49.8	2.77	2.07	273	2.45	2.00
6	6	6	55.3	3.40	2.58	292	2.86	2.33
12	6	6	54.4	3.35	2.53	283	2.82	2.29

Table 25. Standard Financial Calculations of IAC/EADC Results

GLOSSARY

IMPCOST GROWTH	=	annual growth rate of the cost of implementing IAC/EADCs' recommendations.
ENSAV GROWTH	=	annual growth rate of energy cost savings from implementation of IAC/EADCs' recommendations.
BORR RATE	=	annual borrowing rate for debt service on funds borrowed to implement IAC/EADCs' recommendations.
IRR	=	internal rate of return
LR_{10}, LR_{15}	=	leverage ratio for five-year cash flows discounted at 10 or 15% to the initial time period and compared to the program investment by the government and the capital investment by the manufacturers.

IV. Regional Reports

A. Eastern Region

i. Major Activities and Highlights of the Eastern Region

In Fiscal Year 1996, 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 FY96, the Eastern Region was comprised of fourteen experienced Centers performing 30 assessments. The directorship of Hofstra was handed over from Dr. Charles Forsberg to Dr. William Jensen, and the number of required assessments was reduced to 15 in order for Dr. Jensen to familiarize himself with the rigors of the program. The addresses and phone numbers of all Centers is given in the appendix. The schools and directors participating in the program in FY96 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 26.

Centers	Date Entered Program	96 Assessments Completed	Director's Years in Program	Student Participation	
				Graduate	Under Grad.
GT	FY82	30	6	0	4
HO	FY92	15	1	0	7
MA	FY84	30	13	11	1
ME	FY93	30	4	1	15
MS	FY94	30	3	3	10
NC	FY93	30	3	5	8
ND	FY91	30	6	2	26
OD	FY94	30	3	3	7
TN	FY76	30	21	1	6
UD	FY76	30	21	1	4
UF	FY91	30	6	8	24
UL	FY94	30	3	1	13
UM	FY94	30	3	4	5
WI	FY87	30	10	1	6
WV	FY93	30	4	11	1

Table 26. History of Eastern Centers

ii. FY96 OIPEA Activities

Productivity Training

Recommendations involving energy and/or waste almost always effect productivity issues in the modern manufacturing plant. In some cases, such as assembly plants, other concerns (such as layout, or defect reduction) were deemed more important than energy/waste reduction.

For these reasons it was determined that recognizing basic productivity related concerns was crucial to the credibility of the program. The Office of Industrial Productivity and Energy Assessment at Rutgers was asked to develop a productivity training program to be conducted at the FY96 Directors Meeting in August, 1996, held in Baltimore, MD. In conjunction with this training session, Rutgers produced a training manual, "Industrial Productivity Training Manual" which was distributed to the centers at the training session, as well as published and made universally available on the OIPEA web site at :

oipea-www.rutgers.edu

The center directors, as well as some assistant directors were trained in the application of basic productivity opportunity tools and techniques. The program was expanded to include productivity assessments starting with the 1997 fiscal year, starting October, 1996.

Showcase Assessment

At the request of the Department of Energy, and in conjunction with the "Industries of the Future" program the Office of Industrial Productivity and Energy Assessment performed an assessment at a major glass container manufacturer in the east. On May 20 and 21, 1996 the OIPEA team conducted the assessment, and approximately two months later the report was delivered to the company.

As a result of this visit, over $130,000 in energy savings were recommended. A one time savings of over $11,000 selling scrap glass, and a $16,000 savings in water use reduction was identified. Finally, the team suggested changes in productivity methods that, if implemented, would realize an annual savings of over $3.5 million.

B. Western Region

i. Major Activities and Highlights

During FY96 the ITEM division of University City Science Center provided field management for the western region where 15 centers served a total of 432 manufacturers. Eleven of the western region IACs completed thirty industrial assessments, while the other 5 centers performed a total of 102. The centers are listed below, along with the directors and the number of industrial assessments completed.

IAC	FY96 Director	Assessments Completed
Arizona State University	Dr. Byard Wood	30
University of Arkansas at Little Rock	Mr. Burton Henderson/ Dr. Mamdouh Bakr	29
Bradley University	Dr. Paul Mehta	30
Colorado State University	Dr. C. Byron Winn	30
Iowa State University	Dr. Howard N. Shapiro	30
University of Kansas	Dr. Jerry D. Swearingen	15
University of Missouri-Rolla	Dr. Burns E. Hegler	30
University of Nevada-Reno	Dr. Robert Turner	30
Oklahoma State University	Dr. Wayne C. Turner`	30
Oregon State University	Dr. George M. Wheeler	29
San Diego State University	Dr. Halil M. Guven/ Dr. Asfaw Beyene	30
San Francisco State University	Dr. Ahmad Ganji	30
South Dakota State University	Dr. Kurt Bassett	30
Texas A&M University (College Station)	Dr. Warren M. Heffington	30
Texas A&M University-Kingsville	Dr. Yousri Elkassabgi	29
		432

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

- ITEM reviewed proposals to develop collaborative projects between State offices and IACs in response to State Energy Program Notice 96-1, and reported evaluation scores to C. J. Glaser.
- ITEM staff designed and managed a brief study tour to provide information on the EADC/IAC program to a delegation of seven representatives of the Republic of Ghana. The group visited Texas A&M University and the University of Arkansas at Little Rock to observe IAC operations and participate in industrial assessments. The study tour was funded by the World Bank.
- A team was selected (Dr. Greg Wheeler at Oregon State University and Dr. Mario Medina at Texas A&M University-Kingsville) to provide on-site technical assistance to two Mexican universities performing industrial assessments in Mexican plants.
- A series of 20 case studies of results from industrial assessments was completed in response to a request from DOE and the U.S. EPA. Each case study describes results from at least three plants in a particular 2-, 3-, or 4-digit SIC code.

ii. Analysis of Results

Fifteen western region IACs served 432 manufacturing plants in FY96 across a wide range of industries as illustrated in Figure 59. The distribution of industry types for the total population of small and medium-size plants in the western U.S. is shown for reference.

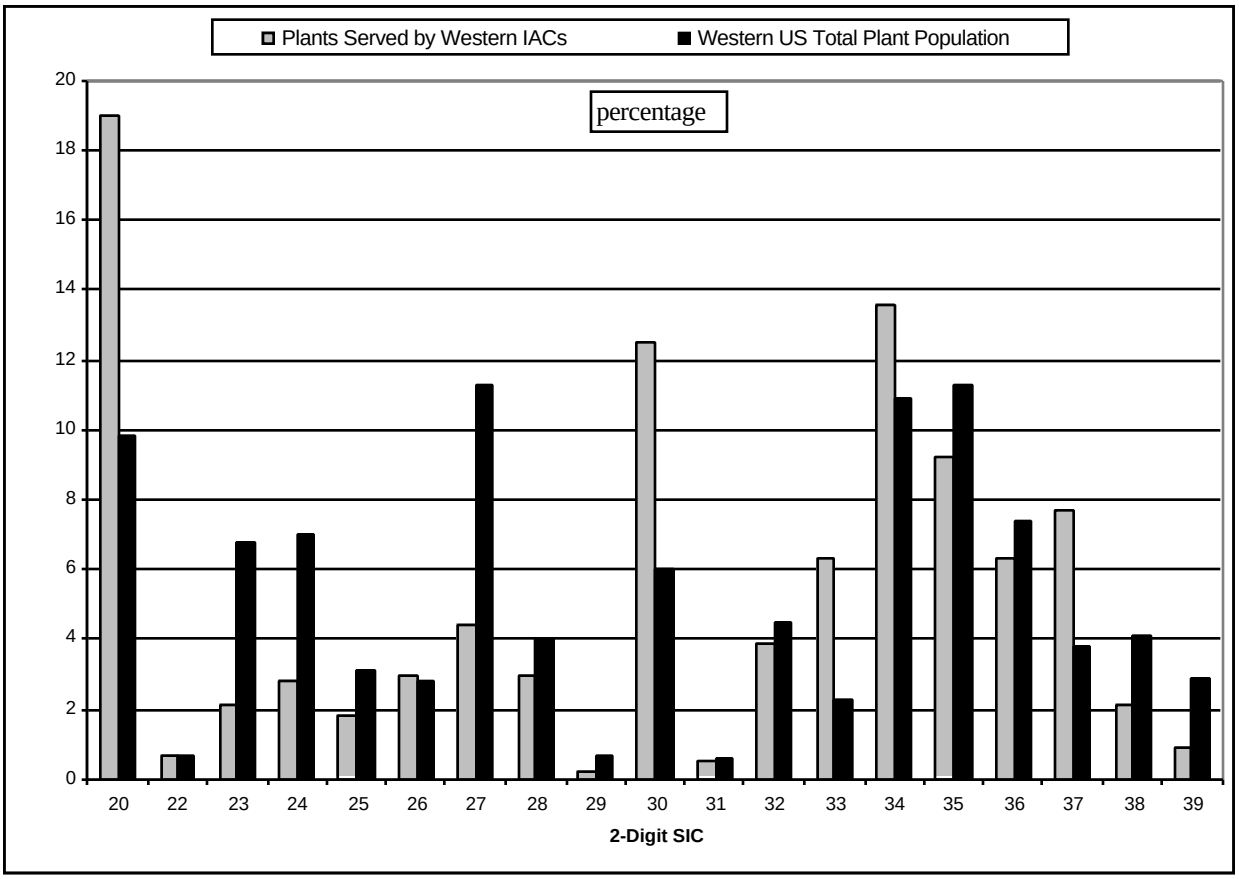


Figure 59. SIC Distribution of Assessments (FY96 Western Region)

Characteristics of the average plant served in FY96 are provided below, along with comparable figures for FY95.

	FY 96	FY95
Sales, MM $/yr	28	29
Employees	158	172
Energy consumption, 10^9BTU/yr	52	53
Energy cost, 10^3 $/yr	377	387
Energy mix, BTU%		
Electricity	32	33
Natural Gas	64	59
Other Fuels	14	18

IACs recommended cost savings of about \$26 x 10^6/yr at 432 plants served during FY96, or an average of about \$60,500/yr/plant. Manufacturers reported total implemented cost savings of \$15.4 x 10^6/yr or an average of about \$35,600/yr/plant, resulting in an overall implementation rate of 59% based on cost savings. Reported implementation costs for all implemented measures were \$18.6 x 10^6 for an overall simple payback of 1.2 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 54% of the total implemented cost savings, with a 62% implementation rate, and an average payback of 1.6 years. Motor systems, buildings and grounds, and electrical power comprised the top three types of measures and 77% of the energy management cost savings. The waste minimization/pollution prevention category made up 41% of the total implemented cost savings at a 58% implementation rate and a 0.8 year average payback period. Operations, recycling, and equipment were the top three types of measures accounting for 66% of the waste minimization/pollution prevention category. The productivity enhancement category comprised only 5% of the total implemented cost savings.

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 FY96 the average cost savings per AR for an implemented energy management AR was about \$5,400/yr, whereas for waste minimization/pollution prevention it was about \$18,600/yr, and for productivity enhancement it was about \$46,200/yr.

Average implemented cost savings of \$35,600/yr/plant and an overall cost savings implementation rate of 59% in FY96 were significantly greater than the two previous years, as shown below:

	FY 96	FY 95	FY 94
Implemented Cost Savings \$/yr/plant	35,600	23,900	21,200
Implementation Rate, %	59	48	39

Despite an improved rate of implementation there was still nearly \$11 x 10^6/yr or an average of about \$24,800/yr/plant of non-implemented cost savings potential identified by the IACs in FY96. Information on non-implemented cost savings is provided in Table 28. About 46% of the non-implemented savings was in the energy management category, 42% in waste minimization, and the remainder in productivity enhancement. Building and Grounds and Motor Systems were the top two types of measures with cost savings not implemented

	Implemented Cost Savings ($/year)	Number of ARs Implemented	Payback Time (years)	Implementation Rate
Energy Management				
Motor Systems	3,225,503	703	1.6	73.0%
Buildings and Grounds	1,757,927	520	1.3	57.1%
Electrical Power	1,374,806	34	2.9	66.6%
Combustion Systems	1,115,771	132	0.8	59.8%
Thermal Systems	427,465	58	0.7	40.4%
Operations	243,922	55	0.9	80.8%
Ancillary Costs	142,211	23	0.2	32.9%
Total	**8,287,605**	**1,525**	**1.6**	**62.6%**
Waste Minimization/Pollution Prevention				
Operations	2,090,094	41	0.6	76.3%
Recycling	1,122,976	108	0.4	41.7%
Equipment	1,032,110	21	0.3	76.0%
Water Use	709,385	77	1.6	45.2%
Waste Disposal	565,394	26	2.1	77.3%
Raw Materials	317,273	26	0.8	36.3%
Post Generation Treatment/Minimization	304,981	14	1.7	52.6%
Maintenance	200,307	28	0.1	58.6%
Total	**6,342,520**	**341**	**0.8**	**58.3%**
Productivity Enhancement				
Manufacturing Enhancements	262,640	2	0.2	37.6%
Inventory	225,789	2	1.0	29.8%
Purchasing	96,633	4	0.3	38.6%
Labor Optimization	80,184	3	1.8	100%
Reduction of Downtime	42,386	3	1.2	100%
Space Utilization	29,180	1	0.0	30.1%
Other Administrative Savings	2,570	1	0.1	100%
Total	**739,382**	**16**	**0.7**	**38.4%**
GRAND TOTAL	**15,369,507**	**1,882**	**1.2**	**59.0%**

Table 27. Ranking by Annual Cost Savings of Implemented Assessment Recommendation Types (FY 96 Western Region)

	Non-Implemented Cost Savings ($/year)	Number of ARs Not Implemented	Payback Time (years)	Percent of Total Recommended
Energy Management				
Buildings and Grounds	1,323,274	400	1.3	42.9%
Motor Systems	1,195,116	369	1.3	27.0%
Combustion Systems	750,997	126	1.3	40.2%
Electrical Power	689,568	48	5.8	33.4%
Thermal Systems	629,479	57	2.1	59.6%
Ancillary Costs	304,197	22	0.8	68.1%
Operations	58,029	25	2.5	19.2%
Industrial Design	14,034	3	0.6	100%
Total	**4,964,694**	**1,050**	**2.0**	**37.5%**
Waste Minimization/Pollution Prevention				
Recycling	1,567,231	108	0.4	58.3%
Water Use	860,618	66	1.7	54.8%
Operations	649,542	23	0.2	23.7%
Raw Materials	555,897	37	0.6	63.7%
Equipment	325,990	17	0.2	24.0%
Post Generation Treatment/Minimization	275,025	13	0.9	47.4%
Waste Disposal	166,301	24	2.1	22.7%
Maintenance	141,301	17	0.6	41.4%
Total	**4,541,905**	**305**	**0.7**	**41.7%**
Productivity Enhancement				
Inventory	530,800	2	0.4	70.2%
Manufacturing Enhancements	435,660	1	0.0	62.4%
Purchasing	153,420	4	0.1	61.4%
Space Utilization	67,684	1	0.1	69.9%
Labor Optimization		1		
Total	**1,187,564**	**9**	**0.2**	**63.1%**
GRAND TOTAL	**10,694,163**	**1,364**	**1.3**	**41.1%**

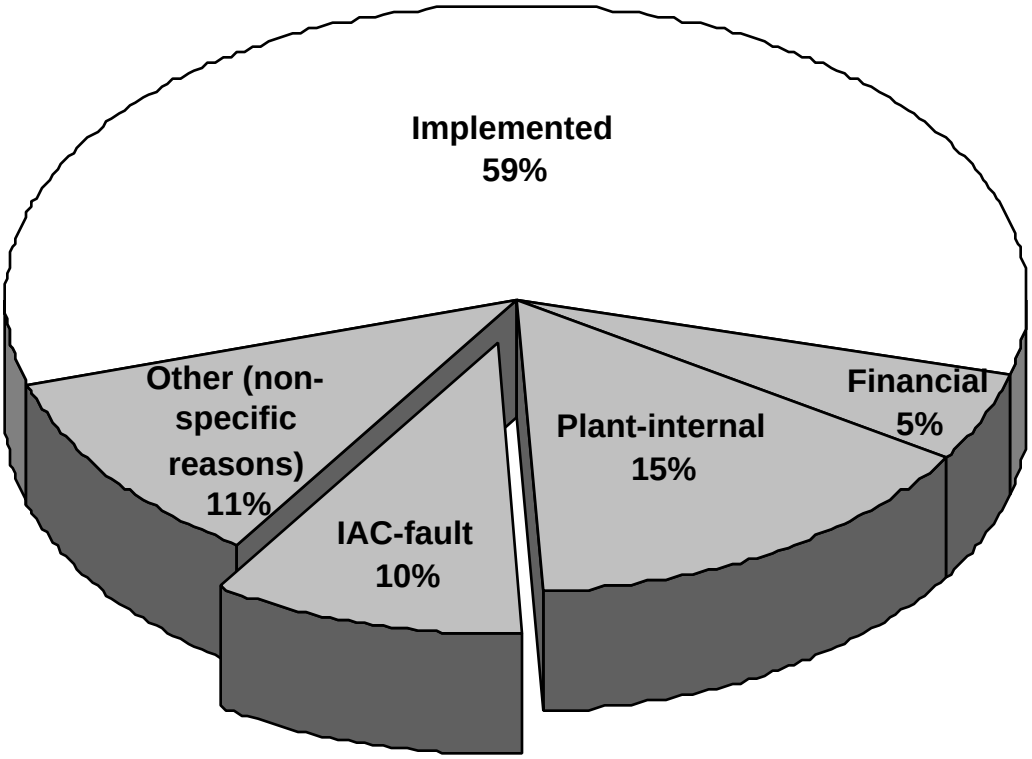
Table 28. Ranking by Annual Cost Savings of Non-Implemented Assessment Recommendation Types (FY 96 Western Region)

Recycling and water use measures had the most non-implemented cost savings in the waste minimization and pollution prevention category. Inventory management and manufacturing enhancements 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 savings percentages for the major categories are summarized below:

Category of Reason	% of Non-Implemented Cost Savings (%)
Plant-internal	37%
Financial	11%
IAC-fault	24%
Other	28%
Total Non-Implementation	100%

Note that about two-thirds of the non-implemented cost savings with specifically identified reasons are attributed to plant-internal and financial factors and only one-third are the fault of the IAC. But keep in mind that 59% of the recommended cost savings was implemented. Figure 60 provides a breakdown of total recommended cost savings which illustrates that manufacturers had problems with the quality of ARs representing only about 10% of the total recommended cost savings.



Note: shaded region represents total non-implemented cost savings.

Figure 60. Breakdown of Total Recommended Cost Savings (FY 96 Western Region)