Table of Contents

I. Introduction 1

II. Program Statistics.....3

A. General.....3

B. Client Profile.....4

C. Assessment Recommendations.....13

i. General.....13

ii. Recommended Savings by Industry Type.....21

iii. Recommended Savings by Resource Stream 27

iv. Recommended Savings by Recommendation Type.....30

D. Implementation Results.....32

i. General.....32

ii. Implemented Savings by Industry Type.....43

iii. Implemented Savings by Resource Stream.....49

iv. Implemented Savings by Recommendation Type 53

III. Standard Financial Calculations.....55

IV. Regional Reports.....57

A. Eastern Region 57

i. Major Activities and Highlights of the Eastern Region.....57

ii. Analysis of Results From Industrial Assessments.....59

B. Western Region 63

Appendix

I. IAC/EADC Program Contact List

II. IAC/EADC Territory Maps

List of Tables

Table 1. Assessments Performed by Fiscal Year 3
Table 2. Geographic Distribution of Assessments by State.....4
Table 3. Geographic Distribution of Assessments by Center.....6
Table 4. Number of Assessments Performed by Industry Type.....8
Table 5. Ave. Client Sales and Energy Use by Fiscal Year.....9
Table 6. Energy Use and Cost by Energy Streams.....11
Table 7. Recommended Savings Figures by Fiscal Year 13
Table 8. Ave. Recommended Energy Conservation and Cost Savings by FY.....16
Table 9. Ave. First Year Recommended Conservation and Cost Savings by FY 18
Table 10. Recommended Cost and Energy Savings by Industry Type.....21
Table 11. Ave. Recommended Conservation and Cost Savings by Industry Type 24
Table 12. Recommended Conservation and Cost Savings by Resource Stream.....27
Table 13. Recommended Non-Energy Cost Savings by Resource Type.....29
Table 14. Recommendations by Recommendation Type.....31
Table 15. No. of Recommendations and Implemented Recommendations by FY 32
Table 16. Implemented Savings by Fiscal Year 33
Table 17. Recommended and Implemented Simple Payback 34
Table 18. Ten Year Cumulative Conservation and Cost Savings.....35
Table 19. Ave. Implemented Energy and Cost Savings by Fiscal Year 38
Table 20. Implemented Energy and Cost Savings by Industry Type 43
Table 21. Ave. Implemented Energy and Cost Savings by Industry Type.....46
Table 22. Implemented Energy and Cost Savings by Resource Stream.....49
Table 23. Total Implemented Non-Energy Cost Savings.....51
Table 24. No. of Implemented Recommendations by Rec. Type 53
Table 25. Standard Financial Calculations of IAC/EADC Results 56
Table 26. History of Eastern Centers.....58
Table 27. No. of Industrial Assessments Performed by Industry Type.....59
Table 28. No. of Recommendations by Rec. Type (Industrial Assessments) 60
Table 29. Cost Savings by Stream Type (Industrial Assessments) 61
Table 30. Comparison Between Ave. Energy and Industrial Assessments 62
Table 31. FY94 and FY95 Paybacks and Implementation Rates.....66
Table 32. Recommended and Implemented Savings for FY94 and FY95..... 68

List of Figures

Figure 1. Plants Served in FY95 by Industry Type.....8
Figure 2. Ave. Client Sales by FY.....10
Figure 3. Ave. Client Energy Usage by FY 10
Figure 4. Ave. Client Energy Costs by FY.....11
Figure 5. Energy Use of Plants Served in FY95 by Energy Stream.....12
Figure 6. Energy Costs of Plants Served in FY95 by Energy Stream.....12
Figure 7. Ave. Recommended Energy Conserved by FY.....14
Figure 8. Ave. Recommended Cost Savings by FY.....14
Figure 9. Ave. Recommended Barrels of Oil Avoided by FY.....15
Figure 10. Ave. Recommended Carbon Avoided by FY.....15
Figure 11. Ave. Energy Conserved Per Assessment (3 Yr Ave.).....16
Figure 12. Recommended Cost Savings Per Assessment (3 Yr Ave.).....17
Figure 13. Recommended Barrels of Oil Avoided Per Assessment (3 Yr Ave.).....17
Figure 14. Recommended Carbon Avoided Per Assessment (3 Yr Ave.).....18
Figure 15. Ave. First Year Recommended Energy Conserved by FY 19
Figure 16. Ave. First Year Recommended Cost Savings by FY 19
Figure 17. Ave. First Year Recommended Barrels of Oil Avoided by FY.....20
Figure 18. Ave. First Year Recommended Carbon Avoided by FY.....20
Figure 19. Recommended Energy Conserved by Industry Type 22
Figure 20. Recommended Cost Savings by Industry Type 22
Figure 21. Recommended Barrels of Oil Avoided by Industry Type.....23
Figure 22. Recommended Carbon Avoided by Industry Type.....23
Figure 23. Ave. Recommended Energy Saved by Industry Type 24
Figure 24. Ave. Recommended Cost Savings by Industry Type.....25
Figure 25. Ave. Recommended Barrels of Oil Saved by Industry Type.....25
Figure 26. Ave. Recommended Carbon Avoided by Industry Type 26
Figure 27. Composition of Recommended Energy Conserved by Energy Stream.....28
Figure 28. Composition of Recommended Cost Savings by Energy Stream 28
Figure 29. Recommended Non-Energy Cost Savings.....29
Figure 30. Recommended Cost Savings by Resource Stream.....30
Figure 31. No. of Recommendations by Recommendation Type 31
Figure 32. Percent of Recommendations Implemented by FY.....33
Figure 33. Recommended vs. Implemented Simple Payback.....34
Figure 34. Ten Year Cumulative Energy Savings.....35

List of Figures (continued)

Figure 35. Ten Year Cumulative Cost Savings 36
Figure 36. Ten Year Cumulative Barrels of Oil Avoided 36
Figure 37. Ten Year Cumulative Carbon Avoided.....37
Figure 38. Ave. Implemented Conservation by FY.....38
Figure 39. Ave. Implemented Cost Savings by FY.....39
Figure 40. Ave. Implemented Barrels of Oil Avoided by FY 39
Figure 41. Ave. Implemented Carbon Avoided by FY.....40
Figure 42. Implemented Energy Conserved Per Assessment (3 Year Ave.).....40
Figure 43. Ave. Implemented Cost Savings Per Assessment (3 Year Ave.).....41
Figure 44. Ave. Implemented Barrels of Oil Avoided Per Assessment (3 Year Ave.)...41
Figure 45. Ave. Implemented Carbon Avoided Per Assessment (3 Year Ave.).....42
Figure 46. Implemented Energy Conserved by Industry Type 44
Figure 47. Implemented Cost Savings by Industry Type.....44
Figure 48. Implemented Barrels of Oil Avoided by Industry Type.....45
Figure 49. Implemented Carbon Avoided by Industry Type.....45
Figure 50. Ave. Implemented Energy Savings by Industry Type.....46
Figure 51. Ave. Implemented Cost Savings by Industry Type.....47
Figure 52. Ave. Implemented Barrels of Oil Avoided by Industry Type.....47
Figure 53. Ave. Implemented Carbon Avoided by Industry Type 48
Figure 54. Composition of Implemented Energy Conserved by Energy Stream 50
Figure 55. Composition of Implemented Energy Cost Savings by Energy Stream 50
Figure 56. Composition of Non-Energy Implemented Savings 51
Figure 57. Composition of Total Implemented Cost Savings.....52
Figure 58. No. of Implemented Recommendations by Rec. Type 54
Figure 59. Composition of Implemented Cost Savings by Stream Type
(Industrial Assessments) 61

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 Centers conducted assessments 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. 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. Due to changes in directors at Arizona State University and the University of Kansas, their entry into the IAC program was delayed one year, until FY96. This brought the number of Centers performing industrial assessments in FY95 to 21. The 30 Centers performed 879 assessments of which 237 were "industrial assessments", including recommendations for both energy conservation and waste reduction/pollution prevention.

IAC/EADC 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, 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, 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.

Introduction (continued)

For the third 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 1995, 879 assessments were performed bringing the program database total to 6,031 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 6,016. Unless otherwise noted, figures are for FY95. 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
Total	6,016	298

Table 1. Assessments Performed by Fiscal Year

The total amount of recommended energy conservation measures in FY95 was approximately 2,650,000 Million British Thermal Units (MMBTU) with a dollar value of almost $33 million. If adopted, the oil consumption that would have been avoided was 450,000 barrels, measured in barrels of oil equivalent (BOE), and the carbon avoided was 76,000 metric tons, measured in carbon equivalent (CE).[1] Non-energy recommendations, such as administrative cost savings and waste reduction savings, amounted to $17 million, up from $6.9 million in FY94. The resultant total recommended savings were $50 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 FY95 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 1,250,000 MMBTU, with a dollar value of almost $13 million. This equates to 214,000 barrels of oil and 35,600 metric tons of carbon avoided. The implemented non-energy measures resulted in a savings of $6.7 million. This brings the total implemented savings in FY95 to almost $20 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 FY95 is shown in the following table by state.

STATE	Total No. of Assessments Performed in Each State	IAC/EADC	No. of Assessments Performed by Each IAC/EADC	Percent of the Total No. of Assessments Performed in Each State
Alabama	3	Georgia Tech Mississippi State	2 1	67% 33%
Arkansas	23	University of Arkansas - Little Rock	23	100%
Arizona	30	Arizona State University	30	100%
California	70	University of Nevada San Diego State University San Francisco State U.	10 30 30	14% 43% 43%
Colorado	29	Colorado State University	29	100%
Connecticut	18	Hofstra University U. of Massachusetts	3 15	17% 83%
Delaware	1	Old Dominion University	1	100%
Florida	27	University of Florida	27	100%
Georgia	30	Georgia Tech University of Florida	27 3	90% 10%
Iowa	27	Iowa State University South Dakota State U.	25 2	93% 7%
Idaho	1	Oregon State University	1	100%
Illinois	56	Bradley University U. of Missouri - Rolla University of Wisconsin - Milwaukee	30 3 23	54% 5% 41%
Indiana	25	Notre Dame University University of Louisville	21 4	84% 16%

Table 2. Geographic Distribution of Assessments by State

Kansas	8	University of Kansas	7	88%
		Oklahoma State University	1	12%
Kentucky	30	University of Tennessee	2	7%
		University of Dayton	2	7%
		University of Louisville	26	86%
Louisiana	7	U. of Arkansas - Little Rock	7	100%
Massachusetts	10	U. of Massachusetts	10	100%
Maryland	5	West Virginia University	5	100%
Maine	30	University of Maine	30	100%
Michigan	39	Notre Dame University	9	23%
		University of Michigan	30	77%
Minnesota	18	Iowa State University	3	17%
		South Dakota State U.	15	83%
Missouri	27	U.of Missouri - Rolla	27	100%
Mississippi	29	Mississippi State U.	29	100%
N. Carolina	33	North Carolina State	26	79%
		Old Dominion University	4	12%
		University of Tennessee	3	9%
Nebraska	3	Colorado State University	1	33%
		Iowa State University	2	67%
N. Hampshire	3	U. of Massachusetts	3	100%
New Jersey	3	Hofstra University	3	100%
Nevada	20	University of Nevada	20	100%
New York	24	Hofstra University	24	100%
Ohio	35	University of Dayton	28	80%
		West Virginia University	7	20%
Oklahoma	29	Oklahoma State University	29	100%
Oregon	16	Oregon State University	16	100%
Pennsylvania	12	West Virginia University	12	100%
South Carolina	7	Georgia Tech	1	14%
		North Carolina State U.	2	29%
		University of Tennessee	4	57%
South Dakota	13	South Dakota State U.	13	100%
Tennessee	19	U. of Arkansas - Little Rock	1	5%
		University of Tennessee	18	95%
Texas	61	Texas A&M - College Station	30	49%
		Texas A&M - Kingsville	30	49%
		U. of Arkansas - Little Rock	1	2%
Virginia	30	North Carolina State	2	7%
		Old Dominion University	25	83%
		University of Tennessee	3	10%
Vermont	2	U. of Massachusetts	2	100%
Washington	13	Oregon State University	13	100%
Wisconsin	7	University of Wisconsin - Milwaukee	7	100%
West Virginia	6	West Virginia University	6	100%

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

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

IAC/EADC	Total No. of Assessments Performed by Each IAC/EADC	STATE	No. of Assessments Performed in Each State	Percent of Assessments Performed by Each IAC/EADC in a State
Arizona State U.	30	Arizona	30	100%
Bradley University	30	Illinois	30	100%
Colorado State U.	30	Colorado	29	97%
		Nebraska	1	3%
Georgia Tech	30	Alabama	2	7%
		Georgia	27	90%
		S. Carolina	1	3%
Hofstra University	30	Connecticut	3	10%
		New Jersey	3	10%
		New York	24	80%
Iowa State University	30	Iowa	25	83%
		Minnesota	3	10%
		Nebraska	2	7%
Mississippi State U.	30	Alabama	1	3%
		Mississippi	29	97%
North Carolina State U.	30	N. Carolina	26	86%
		S. Carolina	2	7%
		Virginia	2	7%
Notre Dame University	30	Indiana	21	70%
		Michigan	9	30%
Oklahoma State U.	30	Kansas	1	3%
		Oklahoma	29	97%
Old Dominion U.	30	Delaware	1	3%
		N. Carolina	4	14%
		Virginia	25	83%
Oregon State U.	30	Idaho	1	4%
		Oregon	16	53%
		Washington	13	43%
San Diego State U.	30	California	30	100%
San Francisco State U.	30	California	30	100%
South Dakota State U.	30	Iowa	2	7%
		Minnesota	15	50%
		S. Dakota	13	43%
Texas A&M - College Station	30	Texas	30	100%
Texas A&M - Kingsville	30	Texas	30	100%

Table 3. Geographic Distribution of Assessments by Center

U. of Arkansas - Little Rock	32	Arkansas	23	72%
		Louisiana	7	22%
		Tennessee	1	3%
		Texas	1	3%
University of Dayton	30	Kentucky	2	7%
		Ohio	28	93%
University of Florida	30	Florida	27	90%
		Georgia	3	10%
University of Kansas	7	Kansas	7	100%
University of Louisville	30	Indiana	4	13%
		Kentucky	26	87%
University of Maine	30	Maine	30	100%
U. of Massachusetts	30	Connecticut	15	50%
		Massachusetts	10	33%
		N. Hampshire	3	10%
		Vermont	2	7%
University of Michigan	30	Michigan	30	100%
U. of Missouri - Rolla	30	Illinois	3	10%
		Missouri	27	90%
University of Nevada	30	California	10	33%
		Nevada	20	67%
University of Tennessee	30	Kentucky	2	7%
		N. Carolina	3	10%
		S. Carolina	4	13%
		Tennessee	18	60%
		Virginia	3	10%
University of Wisconsin - Milwaukee	30	Illinois	23	77%
		Wisconsin	7	23
West Virginia University	30	Maryland	5	17%
		Ohio	7	23%
		Pennsylvania	12	40%
		W. Virginia	6	20%

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

The IAC/EADC 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 FY95.

2-digit SIC Code	Industry	No. of Assessments Performed
20	Food and Kindred Products	103
21	Tobacco Products	1
22	Textile Mill Products	27
23	Apparel and Other Textile Products	21
24	Lumber and Wood Products	37
25	Furniture and Fixtures	24
26	Paper and Allied Products	48
27	Printing and Publishing	39
28	Chemicals and Allied Products	37
29	Petroleum and Coal Products	5
30	Rubber and Misc. Plastics Products	89
31	Leather and Leather Products	3
32	Stone, Clay, and Glass Products	25
33	Primary Metal Industries	55
34	Fabricated Metal Products	127
35	Industrial Machinery and Equipment	92
36	Electronic and Other Electric Equipment	66
37	Transportation Equipment	46
38	Instruments and Related Products	16
39	Miscellaneous Manufacturing Industries	18
Total		879

Table 4. Number of Assessments Performed by Industry Type

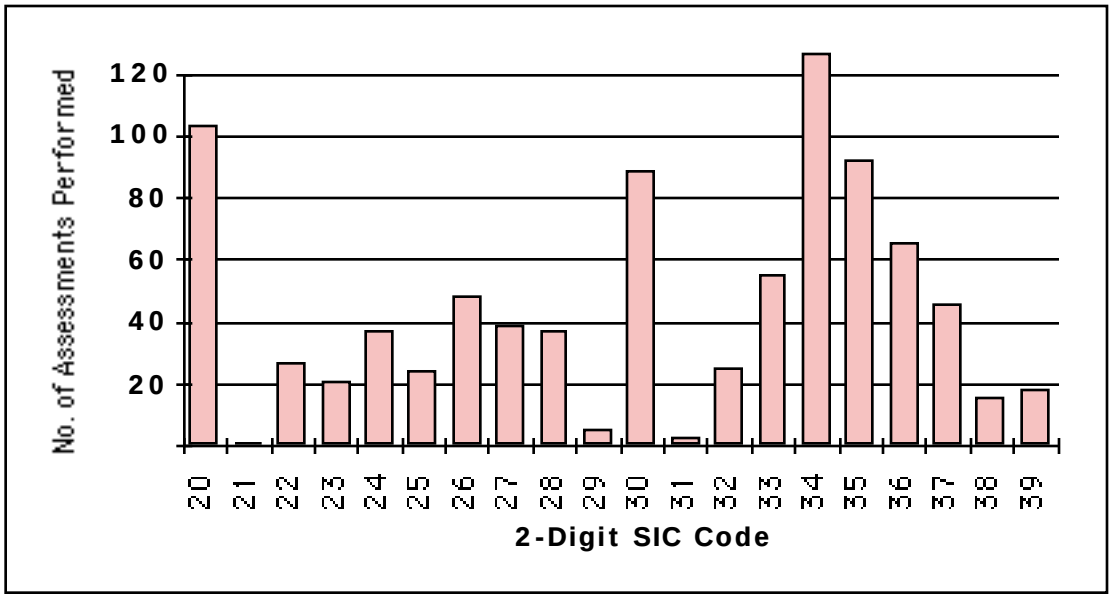

Figure 1. Plants Served in FY95 by Industry Type

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 FY95, the total energy usage of the clients was 46 million MMBTU, costing $363 million. There was an average of 174 employees at each location. The companies had a total sales of over $25 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

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

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

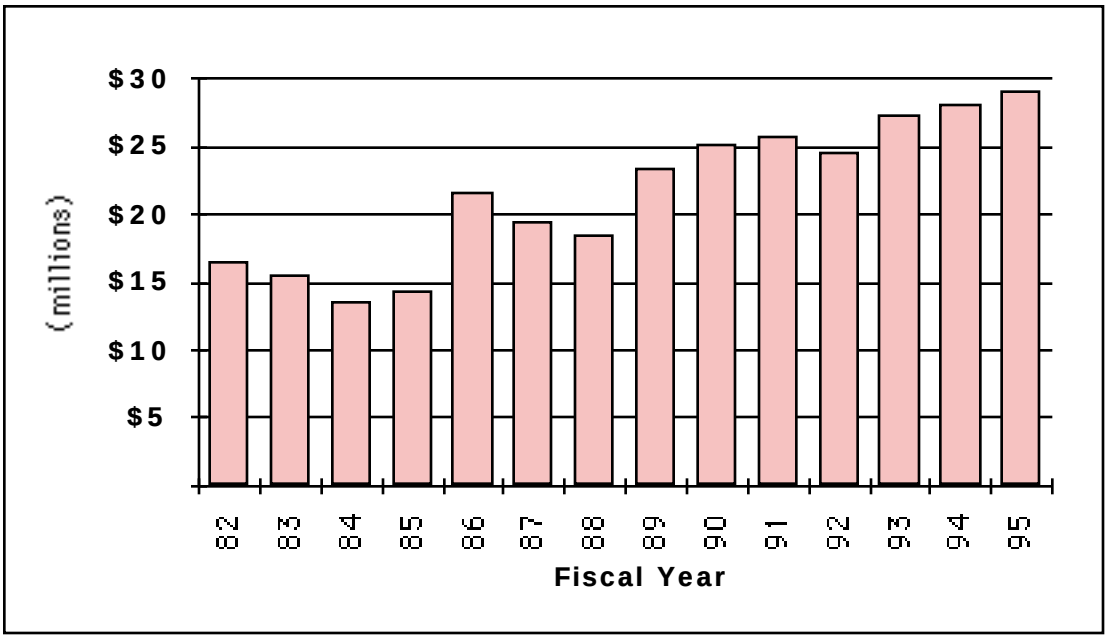

Figure 2. Average Client Sales by Fiscal Year

The average plant served in FY95 had purchased energy use of 53,000 MMBTU with an associated cost of $413,000. Electricity cost the typical client $16.21/ MMBTU and natural gas cost $3.32/ MMBTU. The average energy use and associated costs are shown in Figures 3 and 4.

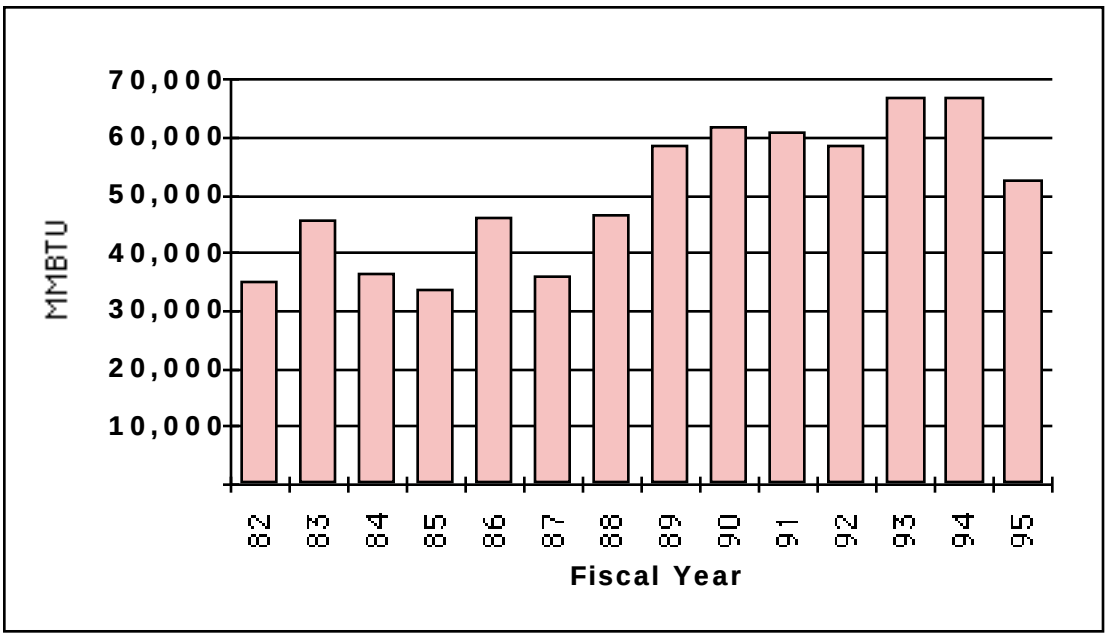

Figure 3. Average Client Energy Usage by Fiscal Year

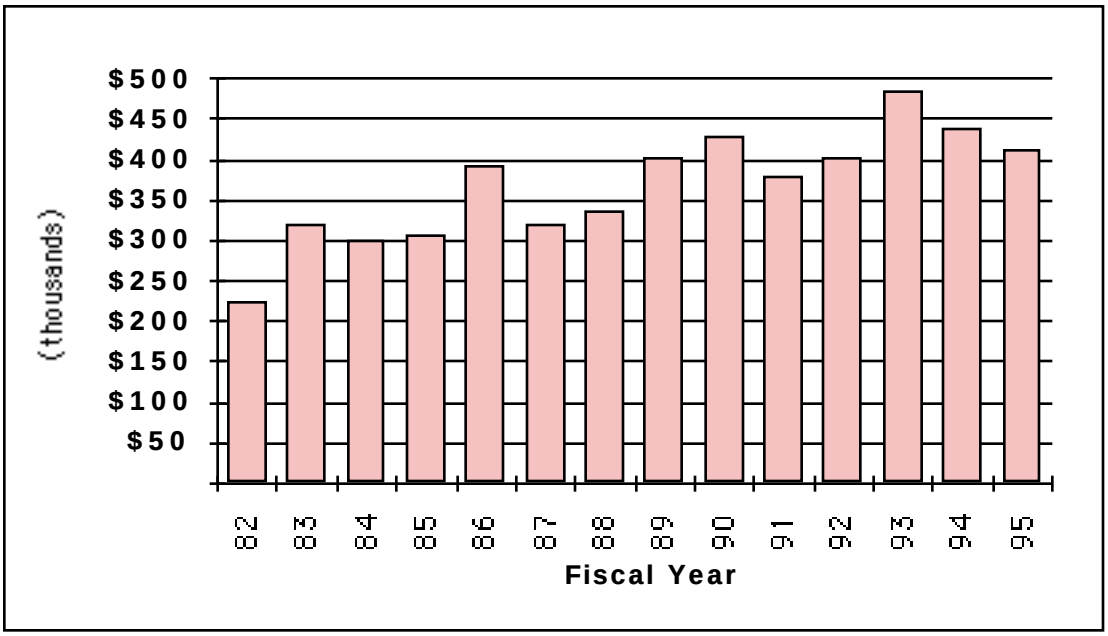

Figure 4. Average Client Energy Costs by Fiscal Year

The program database breaks energy use into eleven specific streams and one category for "other" energy. Energy use and cost other than electricity and natural gas decreased by approximately 50% from last year's values. 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	16,784,227	272,094,190
Natural Gas	24,897,921	82,640,460
L. P. G.	284,789	1,546,105
Fuel Oil #1	5,028	22,614
Fuel Oil #2	426,488	1,664,050
Fuel Oil #4	86,778	217,306
Fuel Oil #6	1,011,695	2,672,187
Coal	0	0
Wood	2,628,106	1,453,317
Paper	0	0
Other Gas	11,745	83,611
Other Energy	192,438	421,547
Totals	46,329,210	362,815,387

Table 6. Energy Use and Cost by Energy Streams

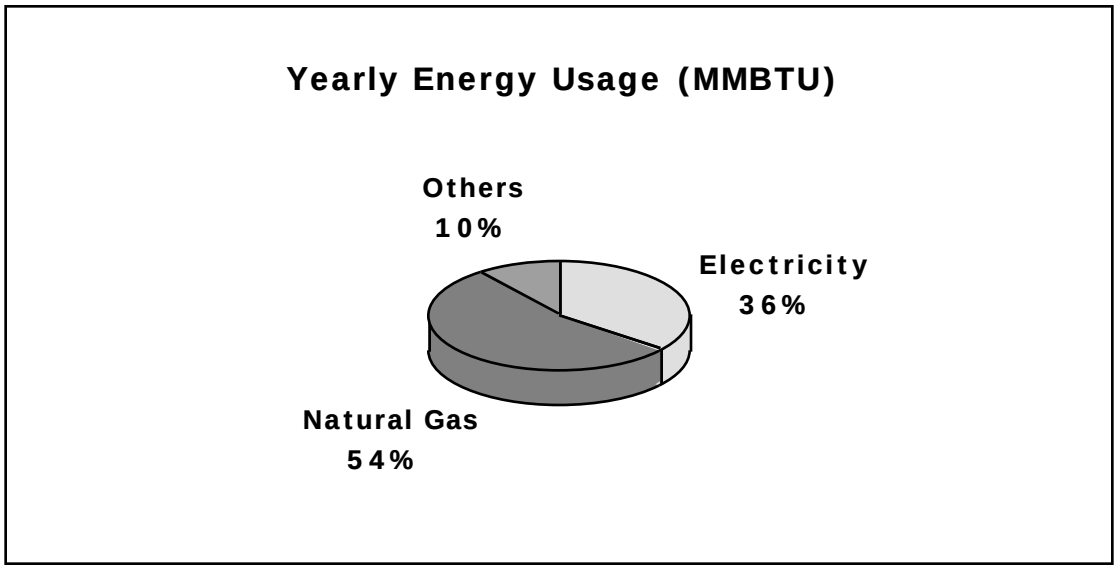

Figure 5. Energy Use of Plants Served in FY95 by Energy Stream

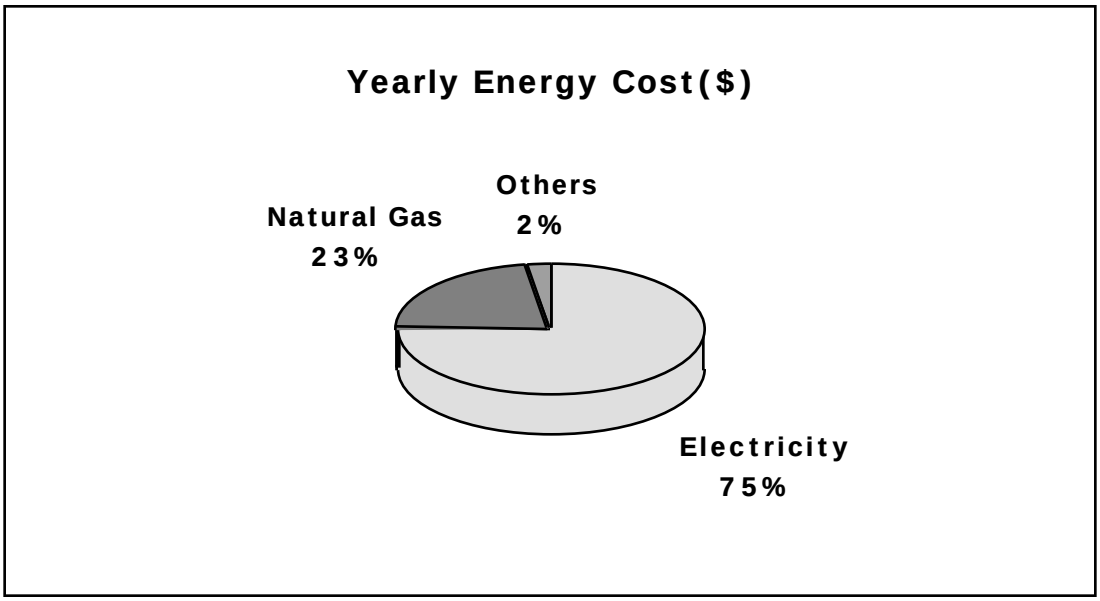

Figure 6. Energy Costs of Plants Served in FY95 by Energy Stream

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 FY95 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

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.

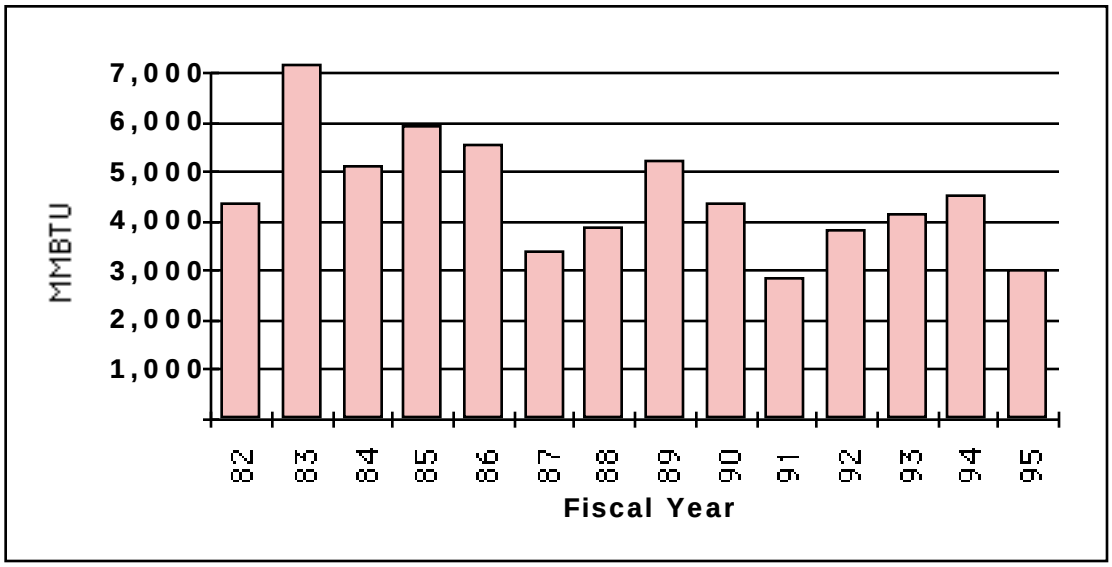

Figure 7. Average Recommended Energy Conserved by Fiscal Year

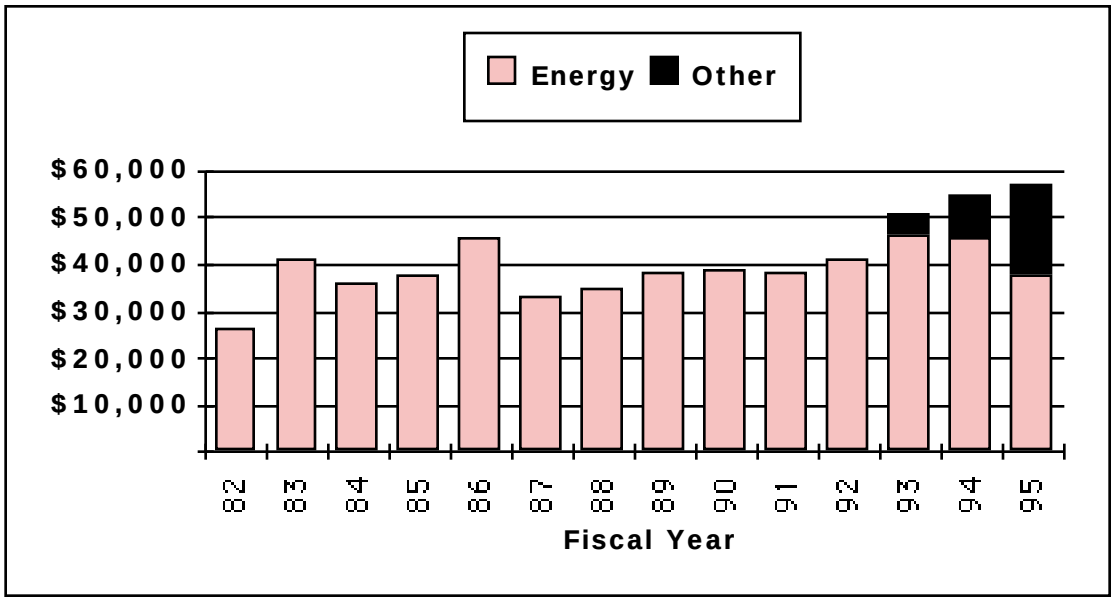

Figure 8. Average Recommended Cost Savings by Fiscal Year

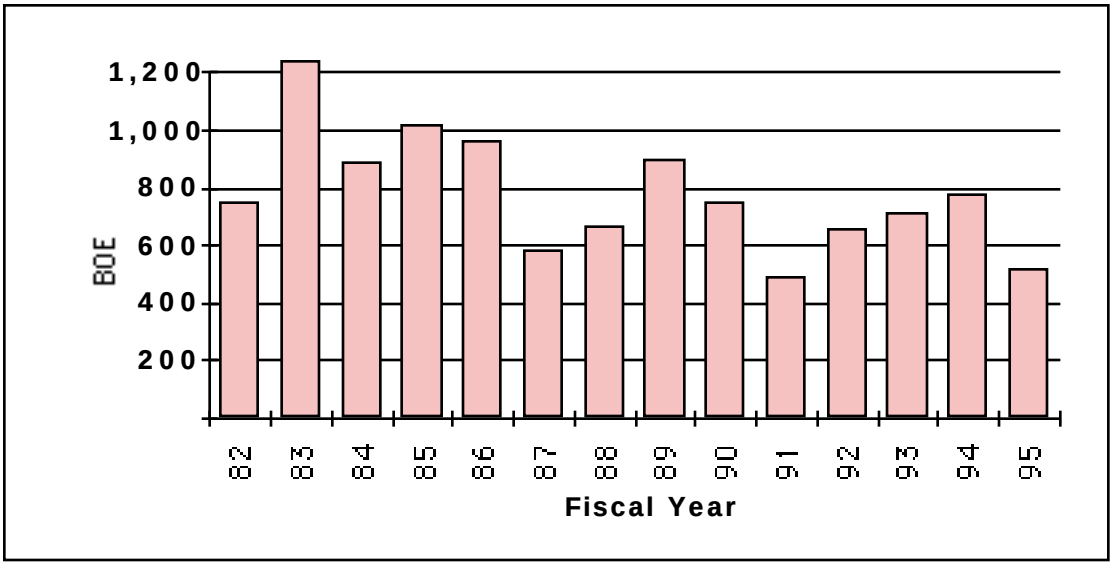

Figure 9. Average Recommended Barrels of Oil Avoided by Fiscal Year

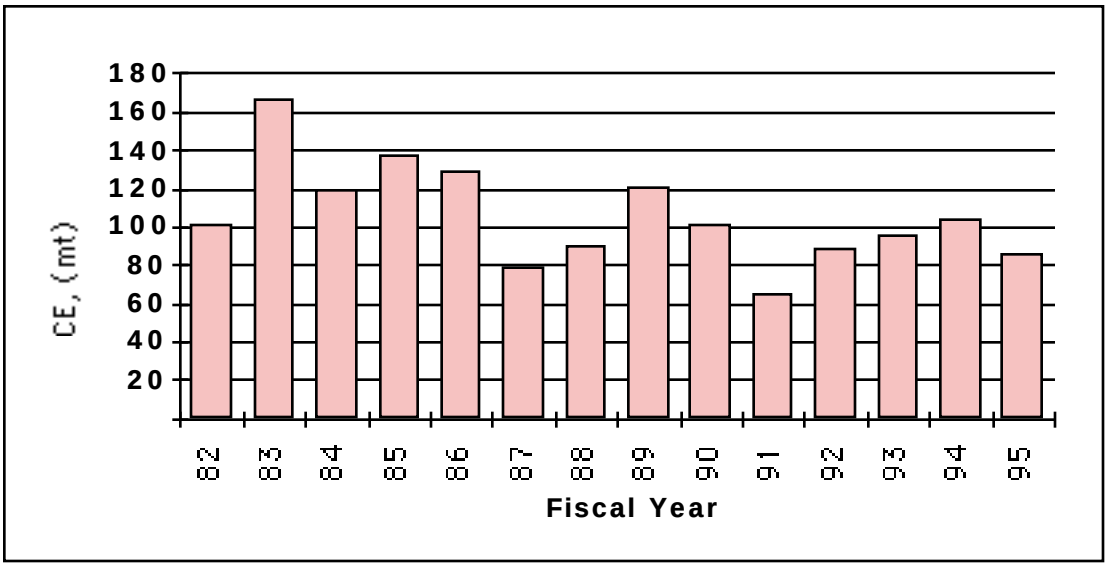

Figure 10. Average Recommended Carbon Avoided by Fiscal Year

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

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

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

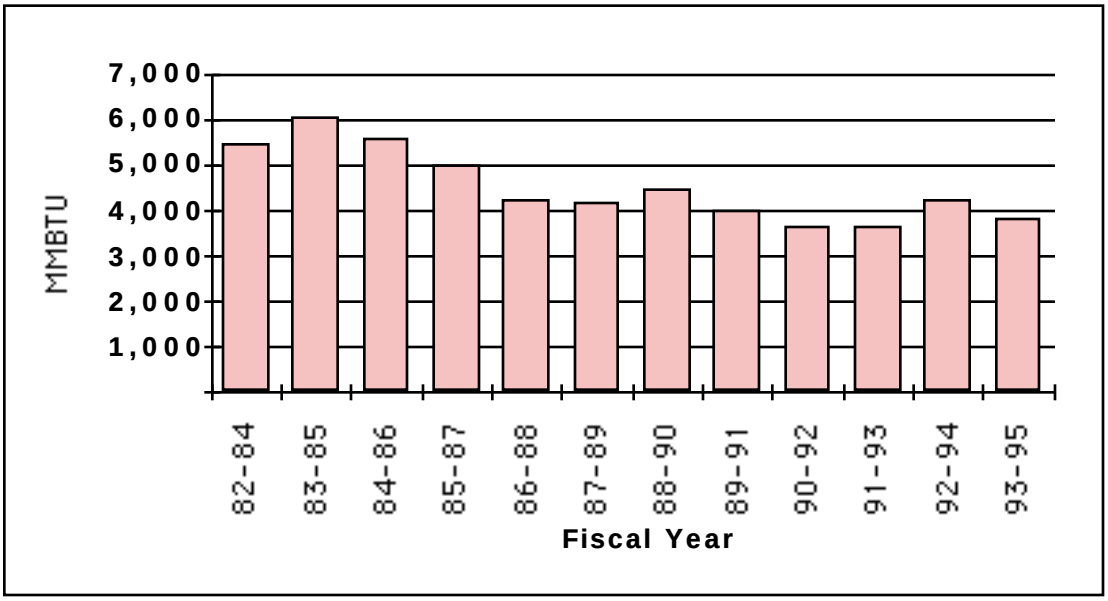

Figure 11. Average Energy Conserved Per Assessment (3 Year Average)

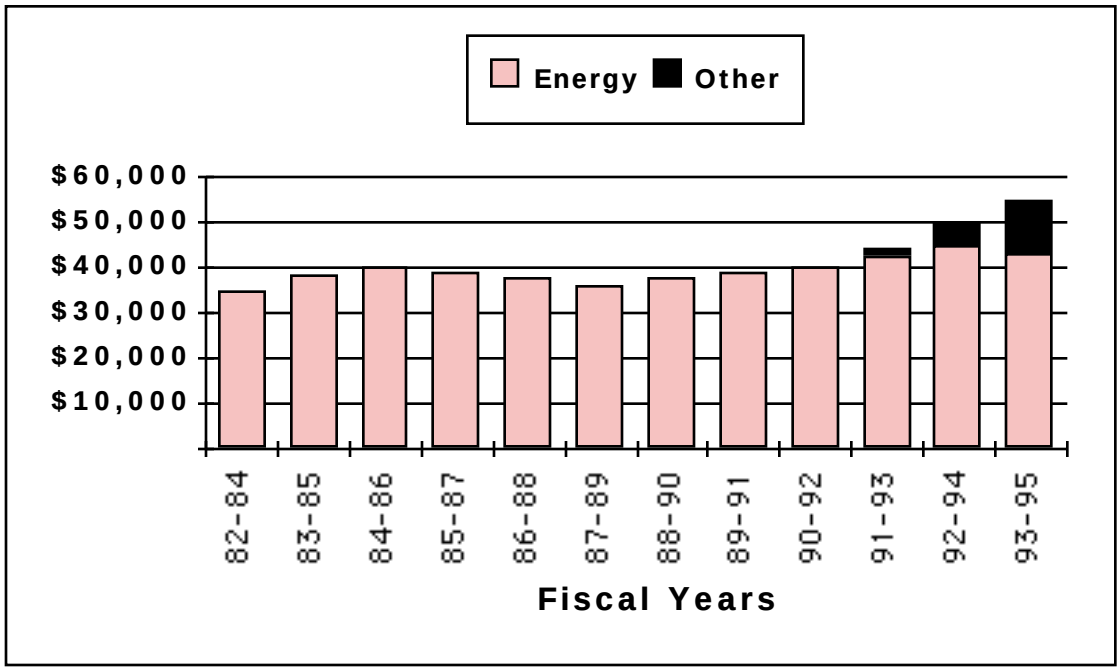

Figure 12. Recommended Cost Savings Per Assessment (3 Year Average)

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

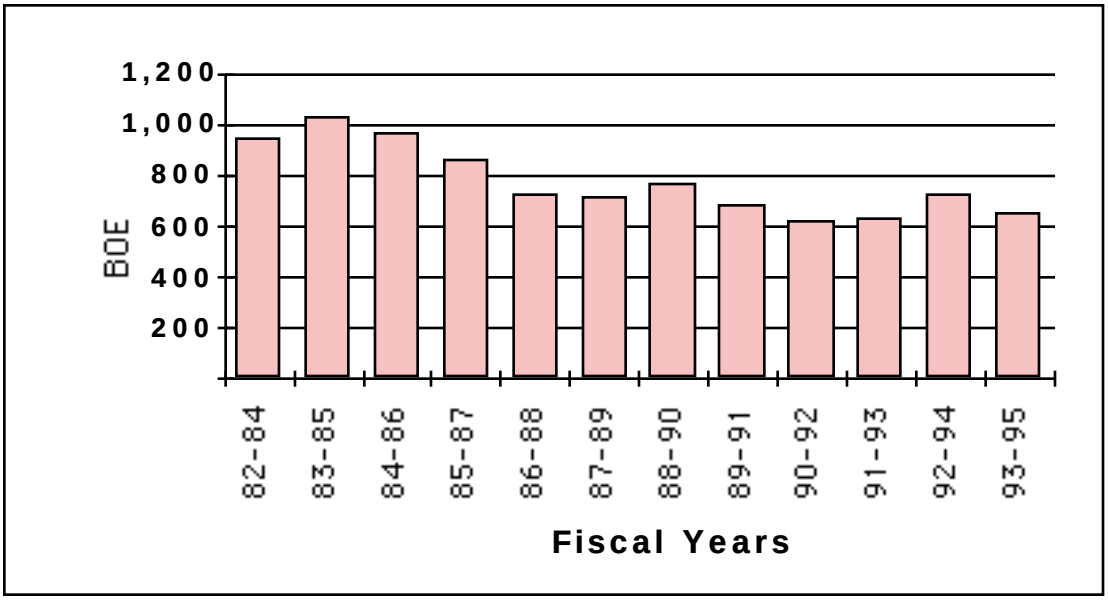

Figure 13. Recommended Barrels of Oil Avoided Per Assessment (3 Year Average)

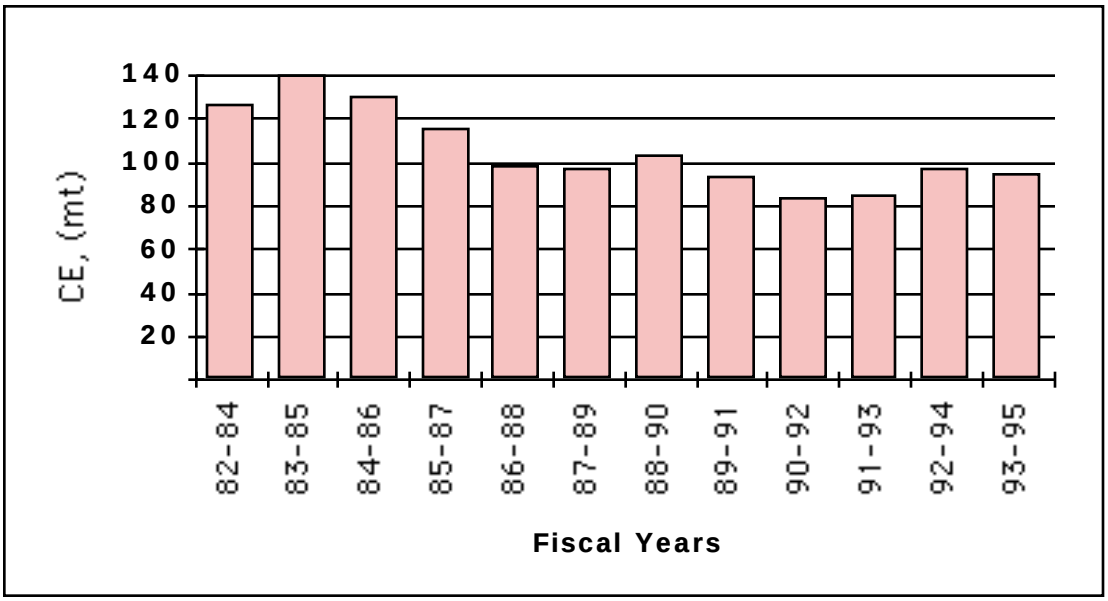

Figure 14. Recommended Carbon Avoided Per Assessment (3 Year Average)

In some cases, immediate implementation of a measure 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 show 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

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

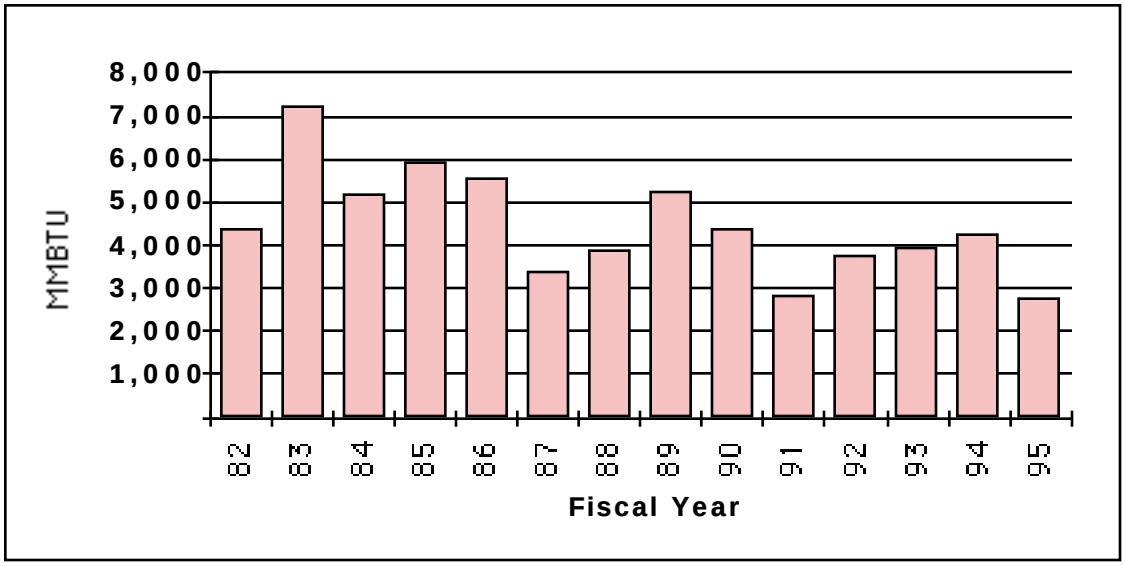

Figure 15. Average First Year Recommended Energy Conserved by Fiscal Year

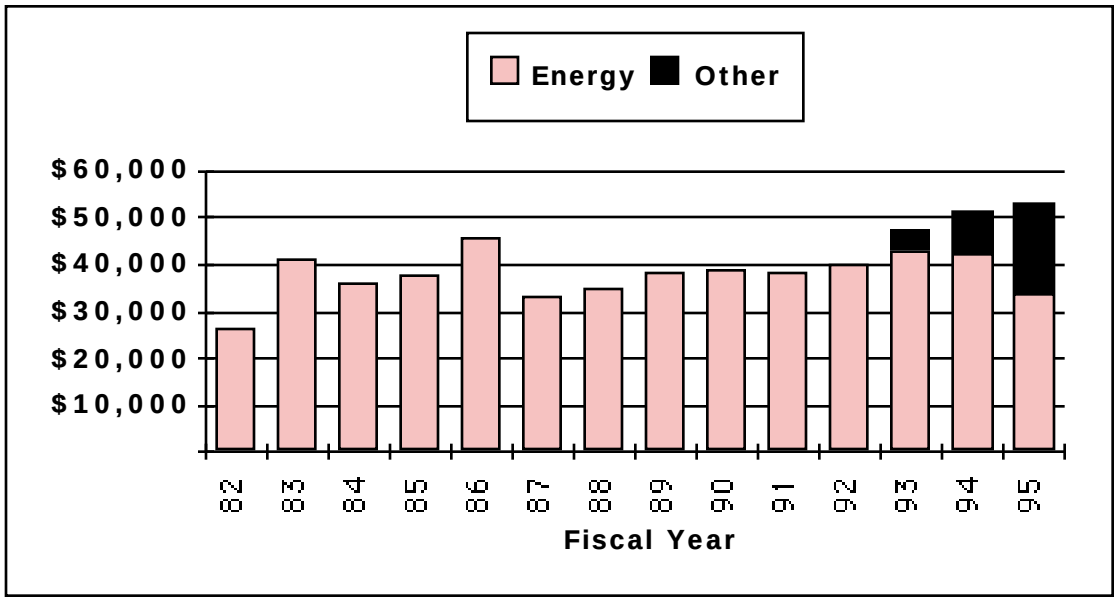

Figure 16. Average First Year Recommended Cost Savings by Fiscal Year

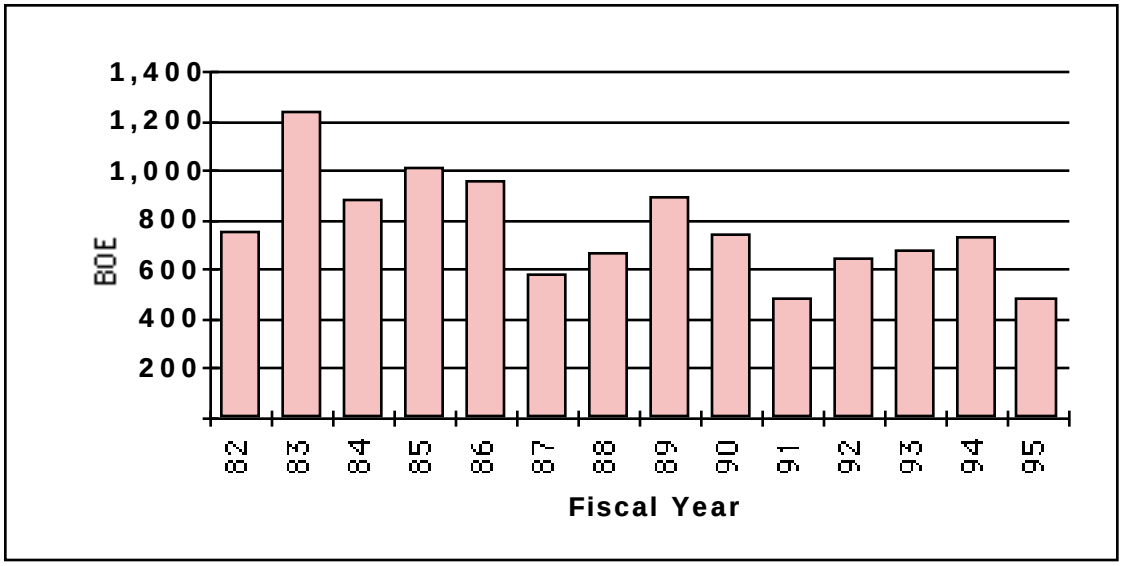

Figure 17. Average First Year Recommended Barrels of Oil Avoided by Fiscal Year

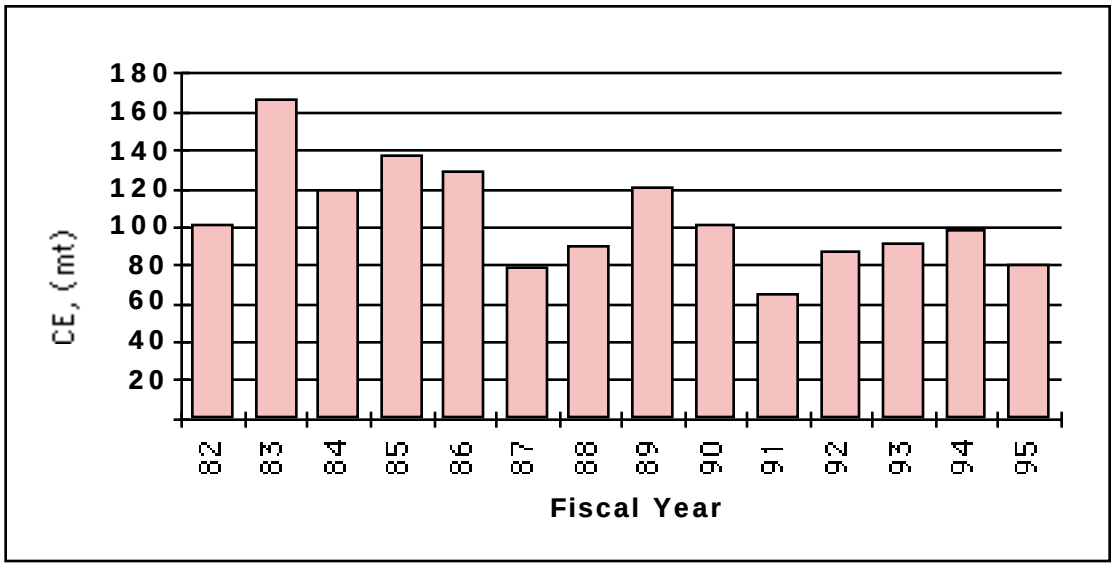

Figure 18. Average First Year Recommended Carbon Avoided by Fiscal Year

ii. Recommended Savings by Industry Type

Savings recommended by industry type in Fiscal Year 1995 is shown in Table 10 and Figures 19 through 22. The largest amount of recommended energy conserved occurred during SIC 33 (Primary Metals) assessments replacing SIC 26 (Paper and Allied Products) in FY94. 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.

		Recommended Energy Conservation			Recommended Cost Savings ($)		
SIC Code	Industry Description	(MMBtu)	(B.O.E.)	(C.E., mt)	Energy	Non-Energy	Total
20	Foods	317,456	54,499	9,089	4,025,382	1,187,969	5,213,351
21	Tobacco Prod.	1,357	233	39	62,822	0	62,822
22	Textile Mills	238,918	41,016	6,841	1,784,758	1,519,756	3,304,514
23	Apparel	34,275	5,884	981	630,414	15,255	645,669
24	Wood Prod.	174,294	29,922	4,990	3,357,161	960,833	4,317,994
25	Furniture	35,235	6,049	1,009	538,014	544,187	1,082,201
26	Paper Prod.	33,789	5,801	967	2,048,303	1,651,981	3,700,284
27	Printing	85,213	14,629	2,440	1,138,185	796,203	1,934,388
28	Chemical Prod.	186,509	32,019	5,340	1,562,147	1,460,525	3,022,672
29	Petroleum	39,238	6,736	1,123	334,796	47,726	382,522
30	Rubber & Plast.	183,182	31,448	5,245	2,964,887	1,273,401	4,238,288
31	Leather Prod.	2,061	354	59	26,648	866	27,514
32	Stone & Glass	206,400	35,433	5,910	1,379,362	821,328	2,200,690
33	Primary Metal	368,017	63,179	10,537	2,313,441	1,885,844	4,199,285
34	Fab. Metal	264,787	45,457	7,581	3,506,339	1,673,984	5,180,323
35	Ind. Machinery	137,202	23,554	3,928	1,800,700	1,042,257	2,842,957
36	Electronics	150,236	25,792	4,301	2,813,548	1,243,997	4,057,545
37	Trans. Equip.	92,915	15,951	2,660	1,610,655	816,365	2,427,020
38	Instruments	56,594	9,716	1,620	624,897	75,734	700,631
39	Misc. Manuf.	43,551	7,477	1,247	400,256	178,117	578,373
Totals		2,651,229	455,147	75,909	32,922,715	17,196,328	50,119,043

Table 10. Recommended Cost and Energy Savings by Industry Type

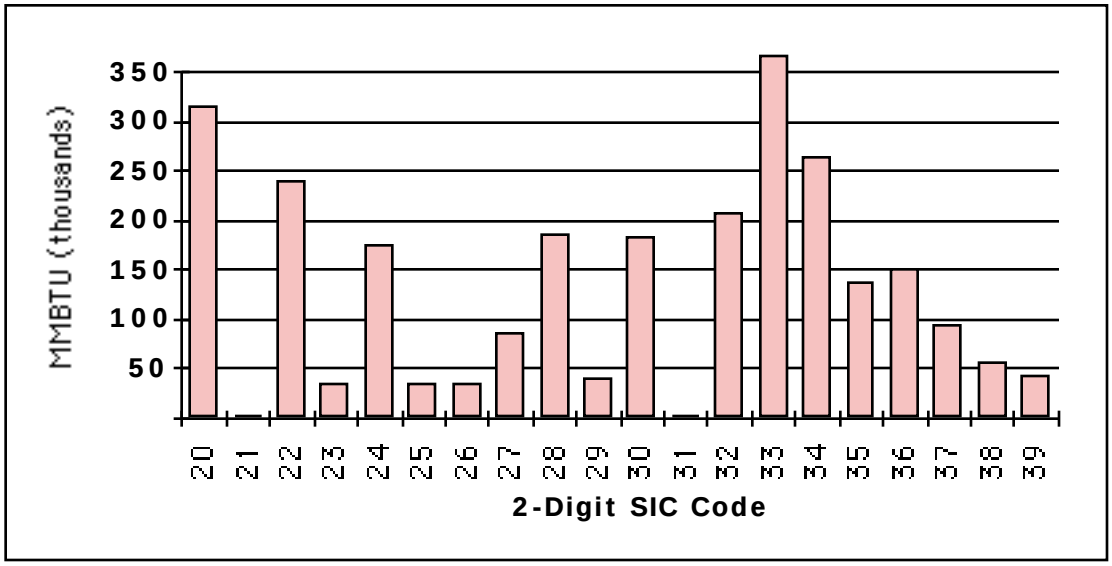

Figure 19. Recommended Energy Conserved by Industry Type

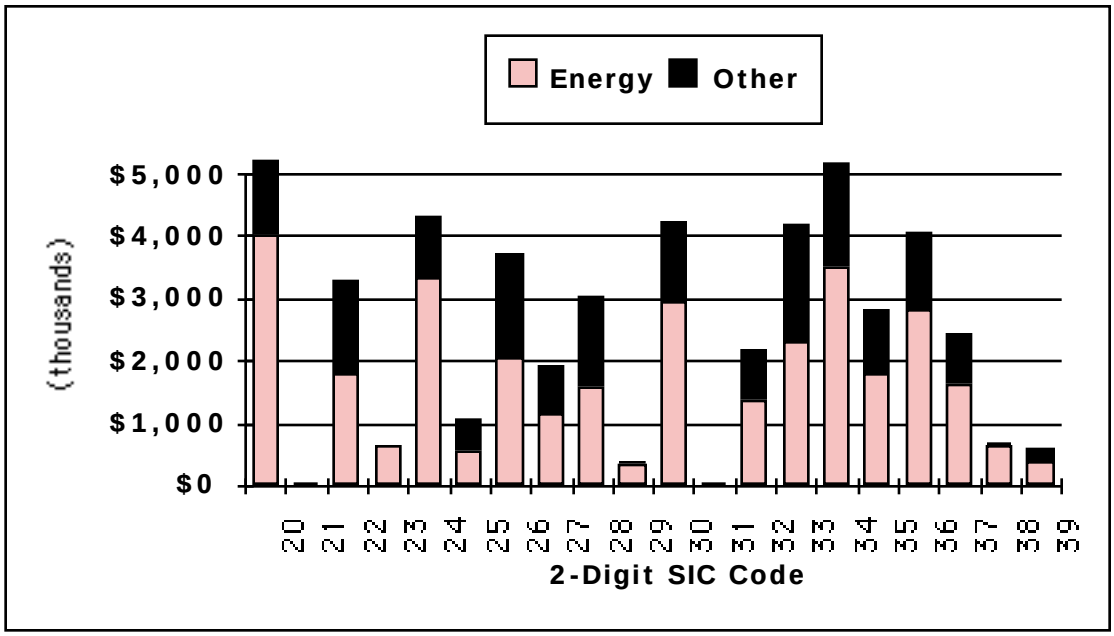

Figure 20. Recommended Cost Savings by Industry Type

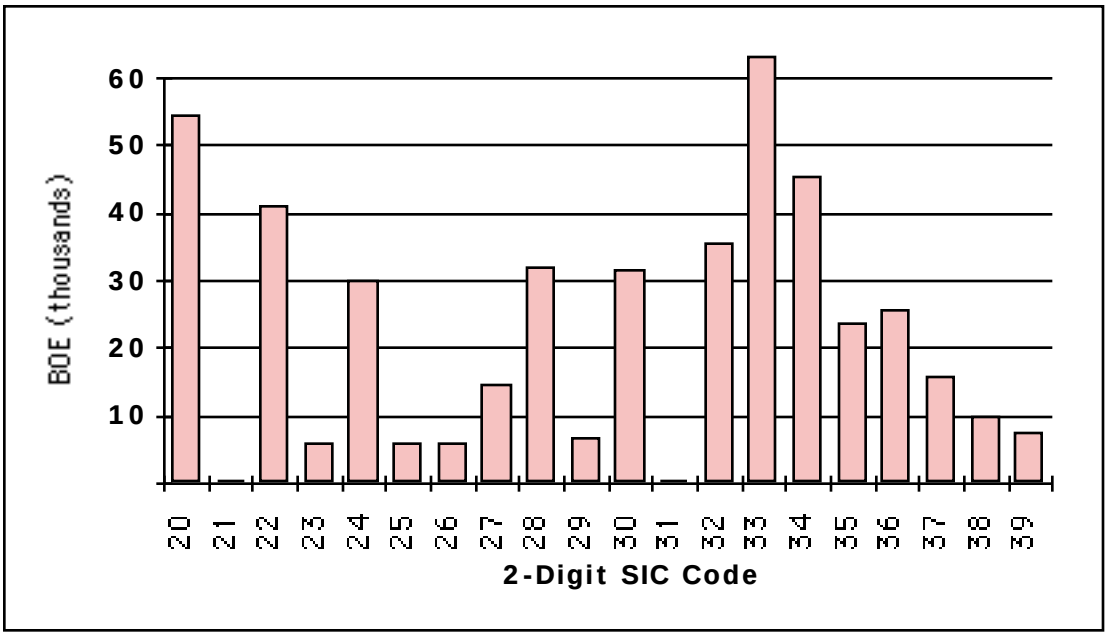

Figure 21. Recommended Barrels of Oil Avoided by Industry Type

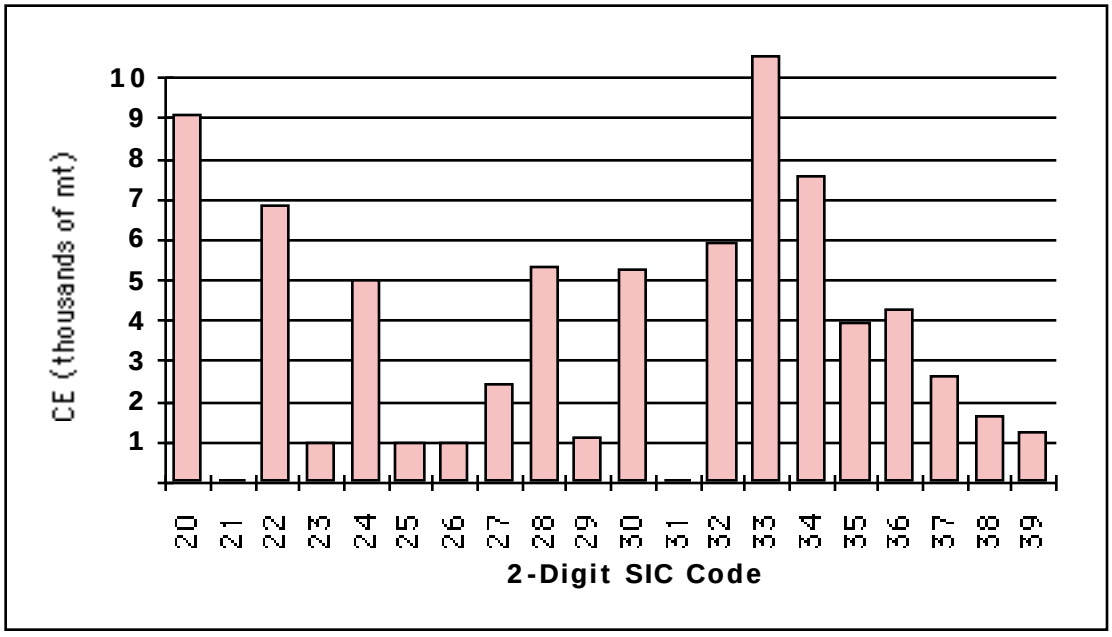

Figure 22. Recommended Carbon Avoided by Industry Type

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	3,082	529	88	39,081	11,534	50,615
21	Tobacco Prod.	1,357	233	39	62,822	0	62,822
22	Textile Mills	8,849	1,519	253	66,102	56,287	122,389
23	Apparel	1,632	280	47	30,020	726	30,746
24	Wood Prod.	4,711	809	135	90,734	25,968	116,703
25	Furniture	1,468	252	42	22,417	22,674	45,092
26	Paper Prod.	704	121	20	42,673	34,416	77,089
27	Printing	2,185	375	63	29,184	20,415	49,600
28	Chemical Prod.	5,041	865	144	42,220	39,474	81,694
29	Petroleum	7,848	1,347	225	66,959	9,545	76,504
30	Rubber & Plast.	2,058	353	59	33,313	14,308	47,621
31	Leather Prod.	687	118	20	8,883	289	9,171
32	Stone & Glass	8,256	1,417	236	55,174	32,853	88,028
33	Primary Metal	6,691	1,149	192	42,063	34,288	76,351
34	Fab. Metal	2,085	358	60	27,609	13,181	40,790
35	Ind. Machinery	1,491	256	43	19,573	11,329	30,902
36	Electronics	2,276	391	65	42,630	18,848	61,478
37	Trans. Equip.	2,020	347	58	35,014	17,747	52,761
38	Instruments	3,537	607	101	39,056	4,733	43,789
39	Misc. Manuf.	2,420	415	69	22,236	9,895	32,132
Average		3,016	518	86	37,455	19,564	57,018

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

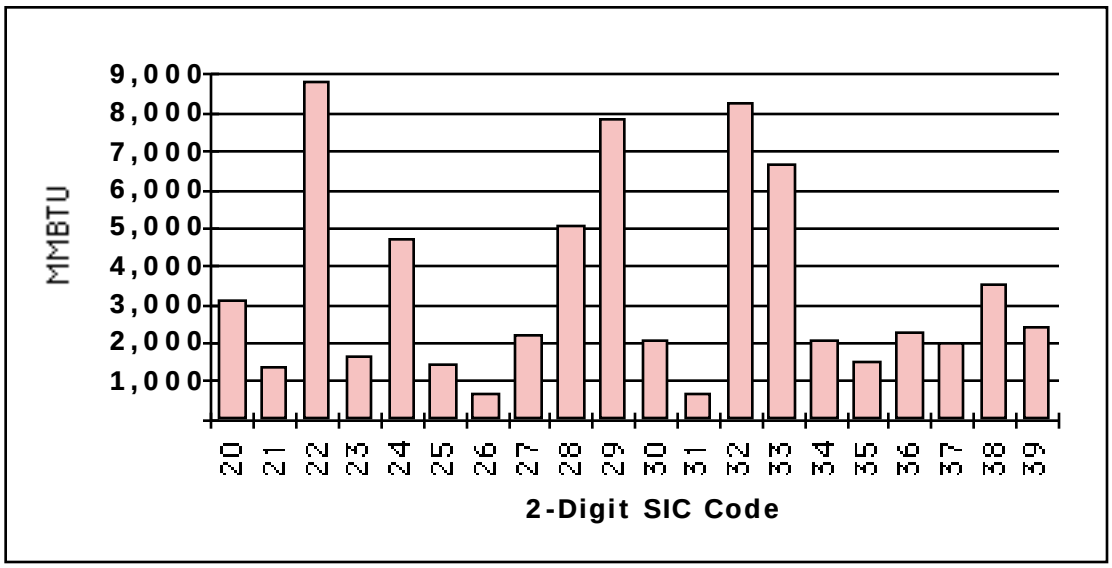

Figure 23. Average Recommended Energy Saved by Industry Type

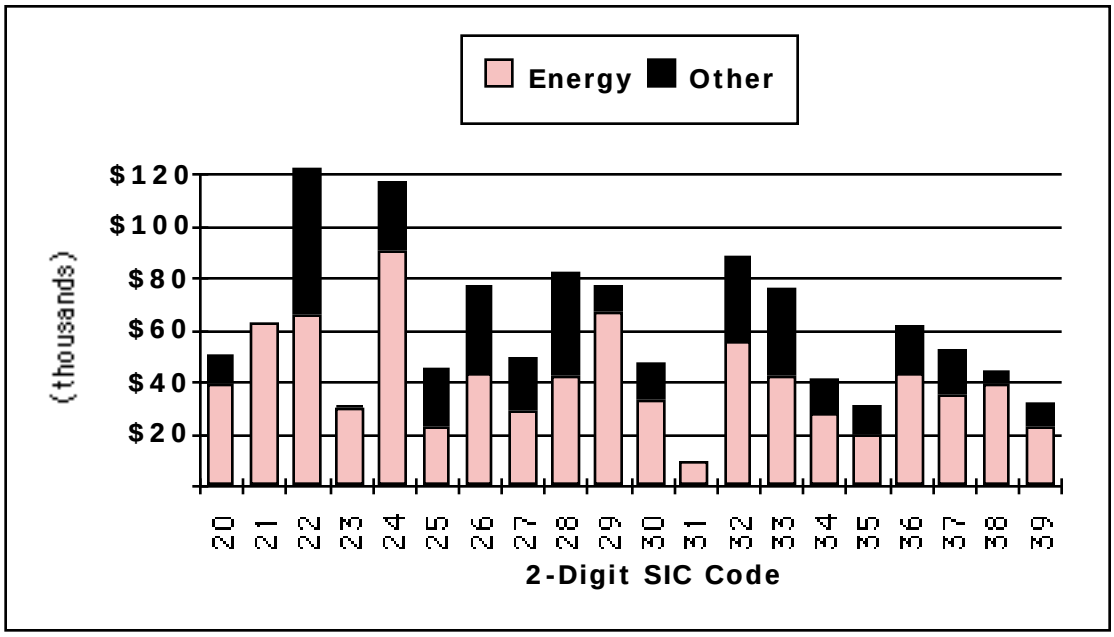

Figure 24. Average Recommended Cost Savings by Industry Type

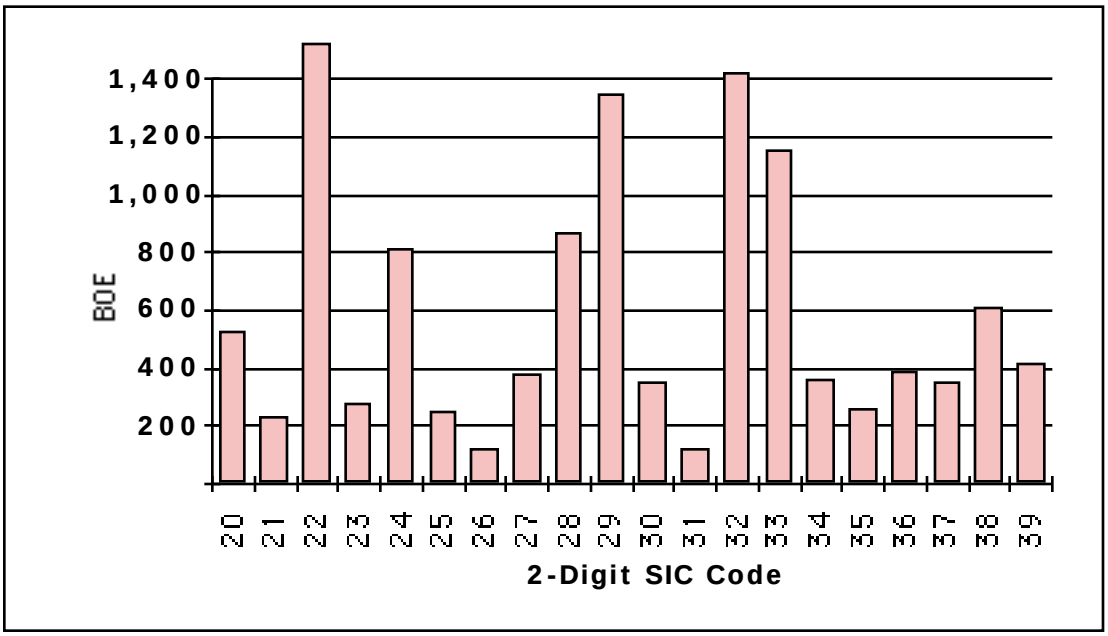

Figure 25. Average Recommended Barrels of Oil Saved by Industry Type

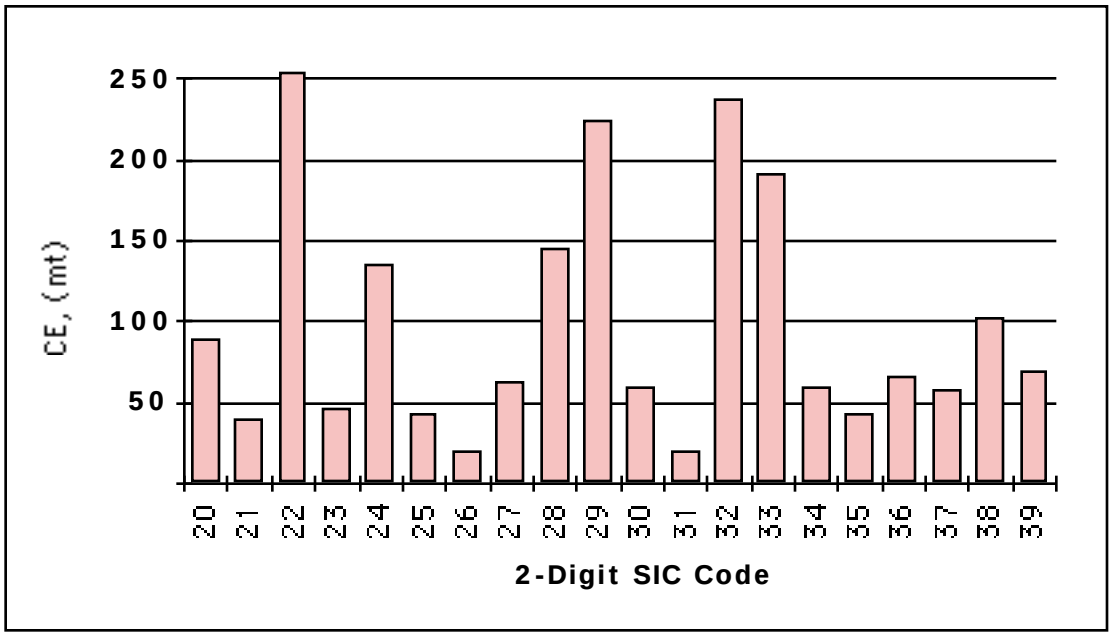

Figure 26. Average Recommended Carbon Avoided by Industry Type

iii. Recommended Savings by Resource Stream

Energy recommendations are broken into 12 different fuel types: Electricity, 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 FY95 was over 2.5 million MMBTUs, with a dollar amount of almost $33 Million. Including non-energy dollars, the total recommended savings in FY95 amounted to over $50 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	1,609,500	29,797,484
Natural Gas	618,495	1,738,845
L. P. G.	16,715	95,518
Fuel Oil #1	506	2,097
Fuel Oil #2	17,024	59,109
Fuel Oil #4	28,031	56,445
Fuel Oil #6	27,990	74,242
Wood	292,496	843,960
Other Gas	37	346
Other Energy	40,435	254,669
Energy Totals	2,651,229	32,922,715
Non-Energy	n/a	17,196,328
Program Totals	2,651,229	50,119,043

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.

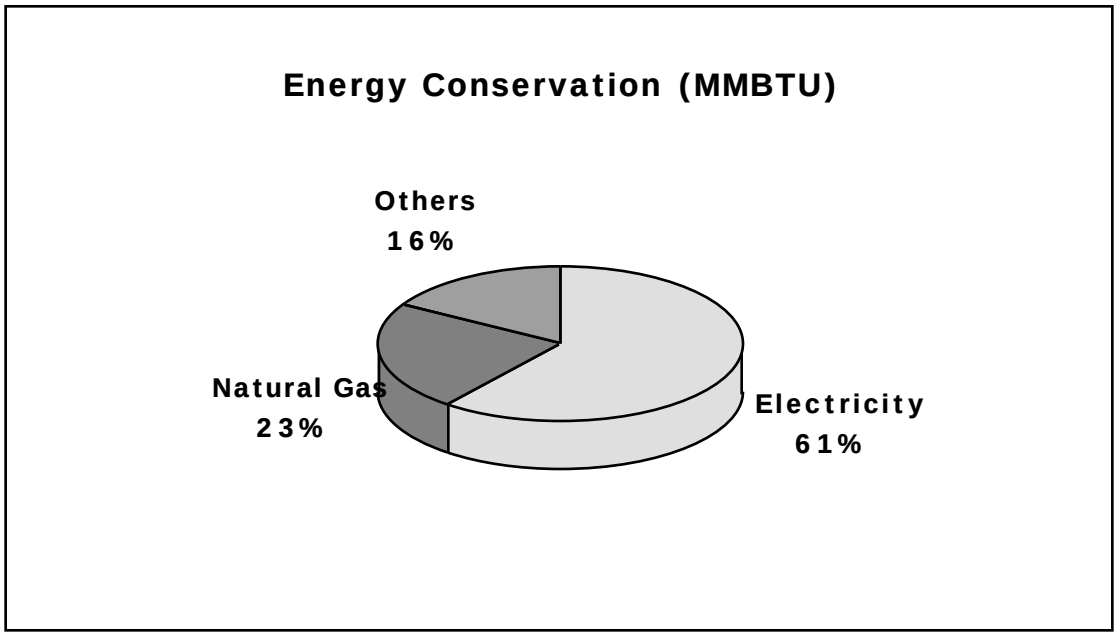

Figure 27. Composition of Recommended Energy Conserved by Energy Stream

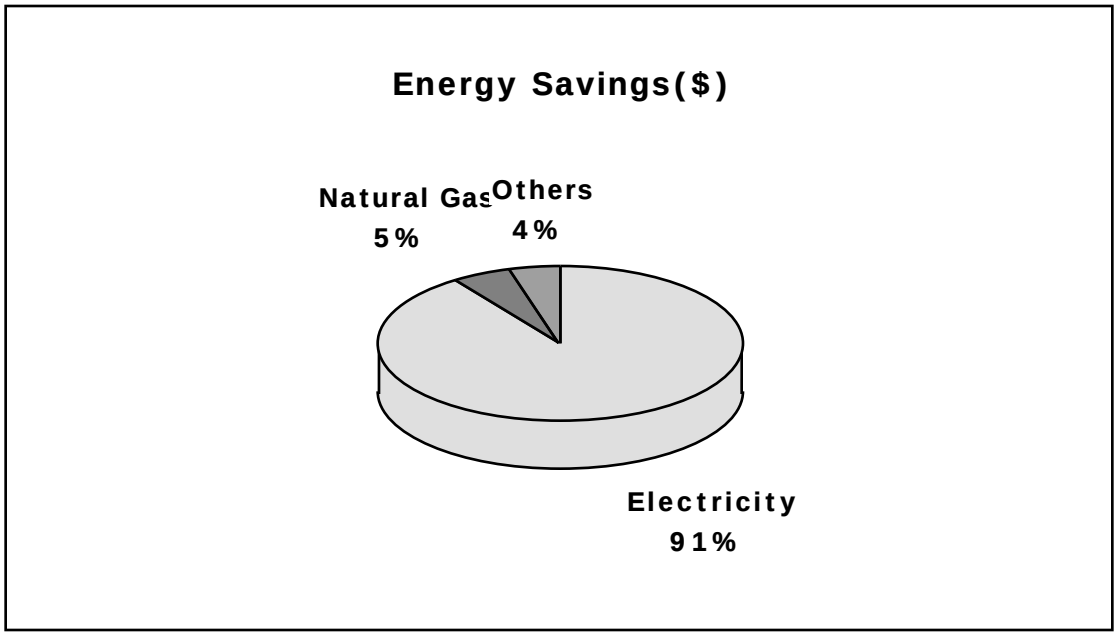

Figure 28. Composition of Recommended Cost Savings by Energy Stream

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	128,008
Byproduct Production	1,727,706
Resource Costs	
Personnel Changes	195,830
Administrative Costs	3,637,757
Primary Raw Material	221,104
Ancillary Material Cost	669,758
Water Consumption	156,594
Waste Reduction	
Water Disposal	2,891,527
Other Liquid (non-haz)	1,170,129
Other Liquid (haz)	1,433,183
Solid Waste (non-haz)	4,150,727
Solid Waste (haz)	647,048
Gaseous Waste (haz)	166,957
Non-Energy Total	**17,196,328**

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

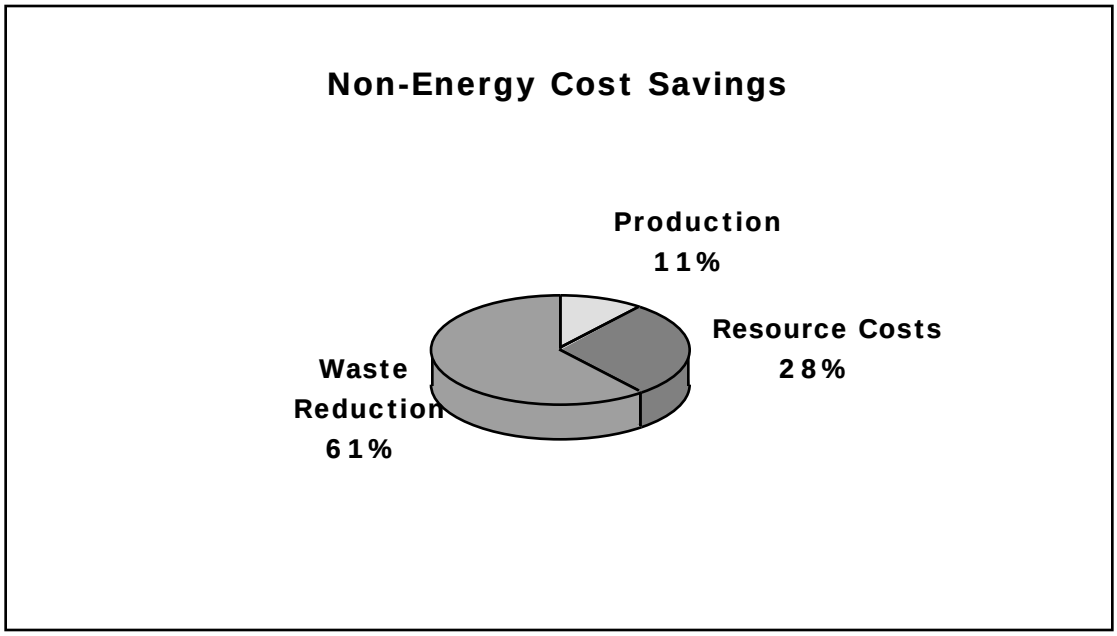

Figure 29. Recommended Non-Energy Cost Savings

Figure 30 indicates the composition of the total recommendations by resource stream for FY95.

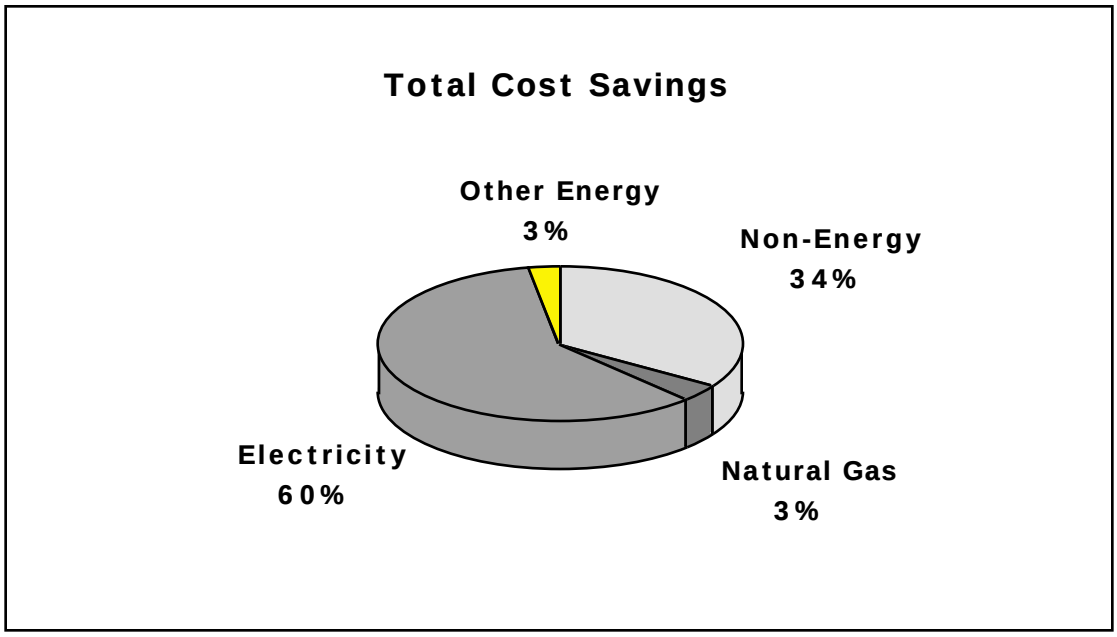

Figure 30. Recommended Cost Savings by Resource Stream

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 FY95. Figure 31 shows the frequency of the recommendations.

2-Digit ARC Code	Category Description	No. of Recommendations
2.1	Combustion Systems	347
2.2	Thermal Systems	605
2.3	Electrical Power	268
2.4	Motor Systems	2052
2.5	Industrial Design	6
2.6	Operations	201
2.7	Buildings and Grounds	1911
2.8	Ancillary Costs	152
2.9	Alternate Energy Use	0
3.1	Operations	77
3.2	Equipment	18
3.3	Post Generation Treatment/Minimization	30
3.4	Water Use	113
3.5	Recycling	123
3.6	Waste Disposal	71
3.7	Maintenance	26
3.8	Raw Materials	42
4.x	Productivity Enhancement	13
	Total	6055

Table 14. Recommendations by Recommendation Type

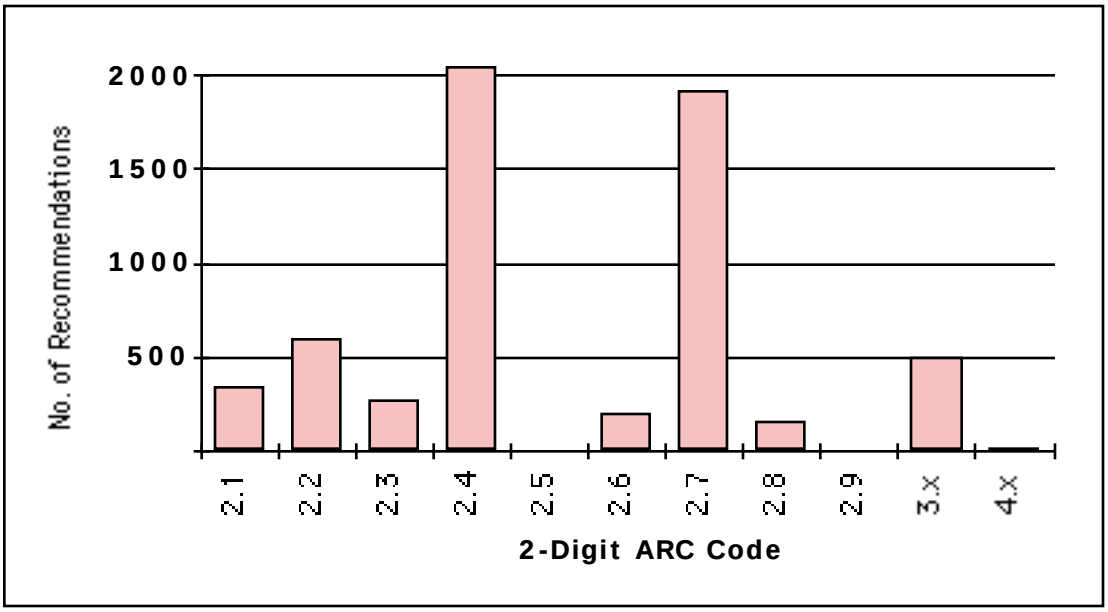

Figure 31. Number of Recommendations by Recommendation Type

D. Implementation Results

i. General

The IAC/EADC program has historically enjoyed a high rate of implementation of recommendations. The results of the 1995 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 47%, and as cost ($) saved to recommended was 40%. 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	3,044	50%
Totals	40,551	21,431	Average 53%

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

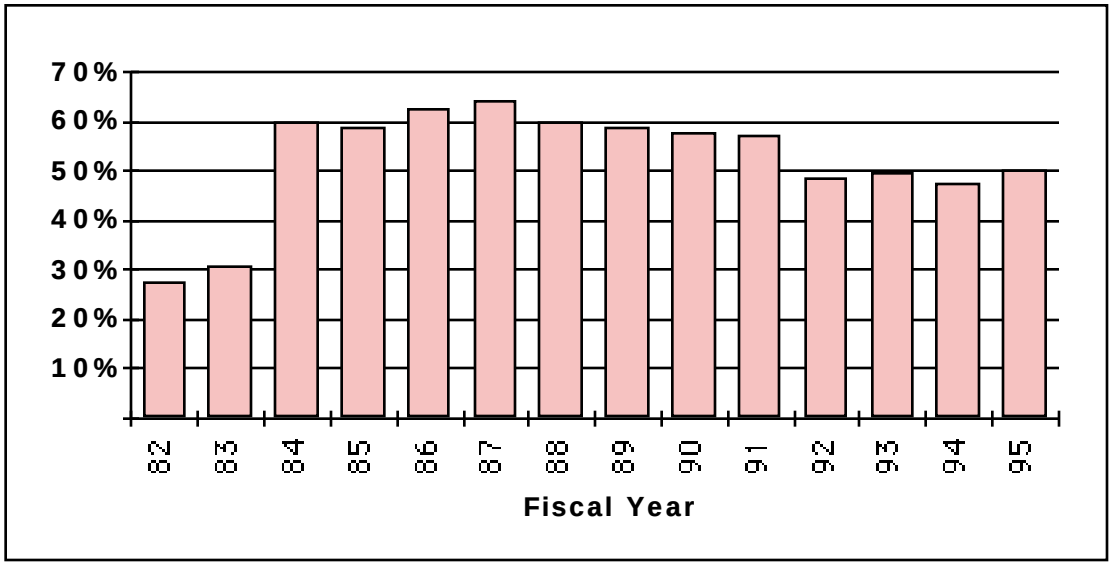

Figure 32. Percent of Recommendations Implemented by Fiscal Year

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	1,245,613	213,839	35,664	13,139,101	6,775,750	19,914,851

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 FY95, the directors used over 348 different recommendations. The average number of recommendations was seven, and 110 recommendations were used only once. A review of Table 14 and Figure 31 further illustrate the fact that most recommendations were process oriented.

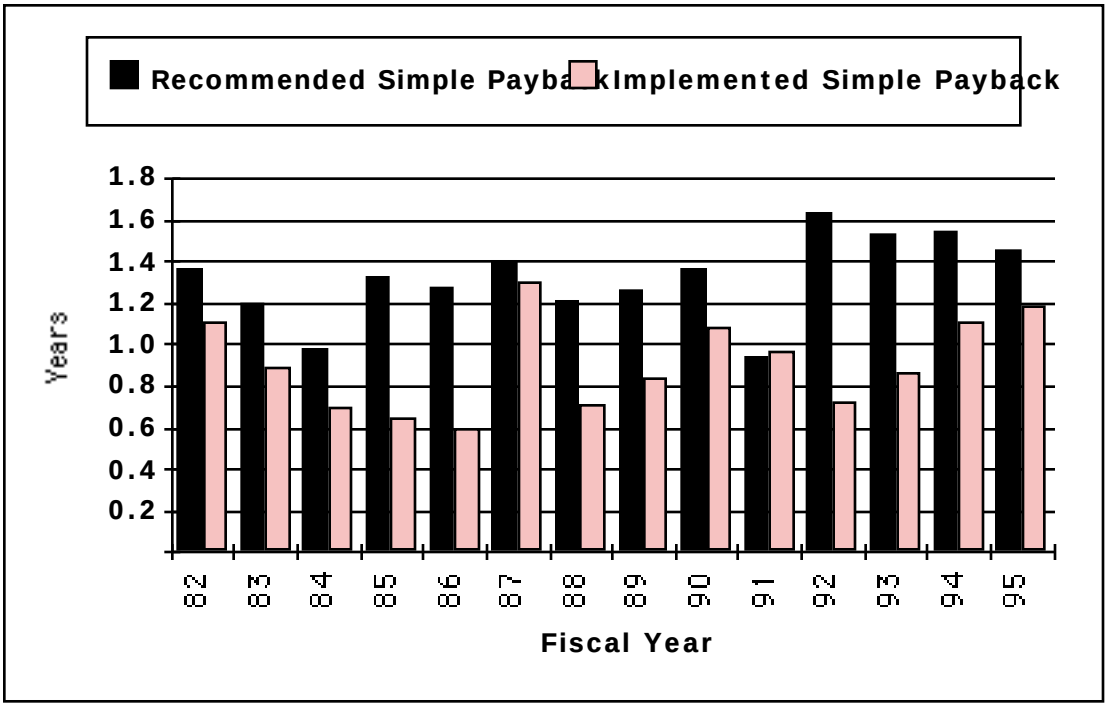

Figure 33. Recommended vs. Implemented Simple Payback

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	19,914,851	23,642,743	1.2
Totals	264,766,136	367,201,905	1.4	113,023,706	106,513,303	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
86-95	10,259	1,761	294	86,155	11,505	97,660
Totals	77,740	13,346	1,855	563,362	17,842	581,204

Table 18. Ten Year Cumulative Conservation and Cost Savings

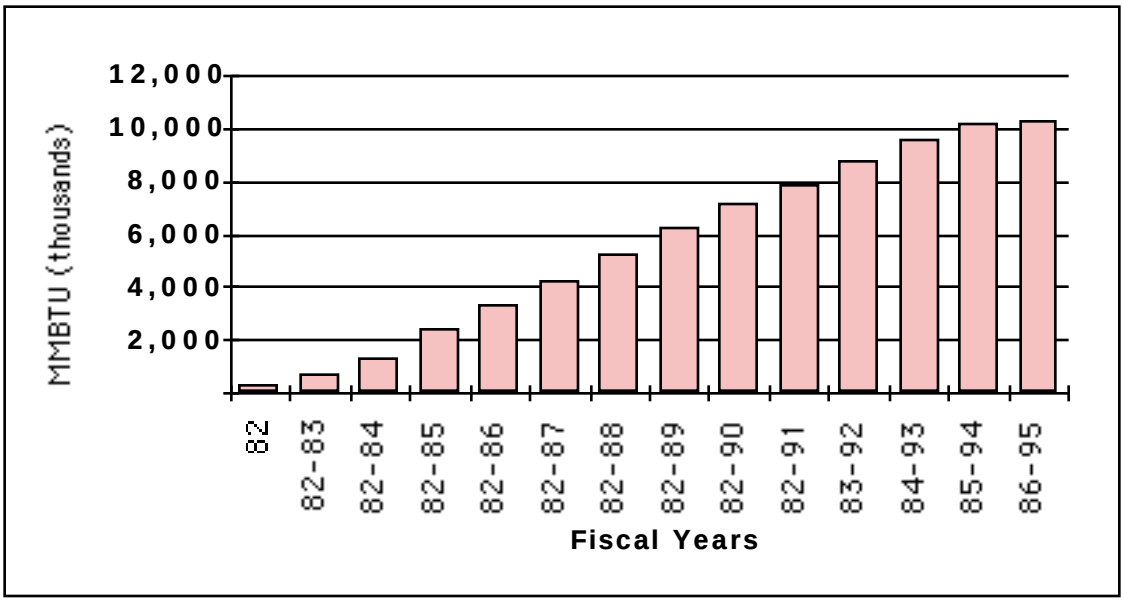

Figure 34. Ten Year Cumulative Energy Savings

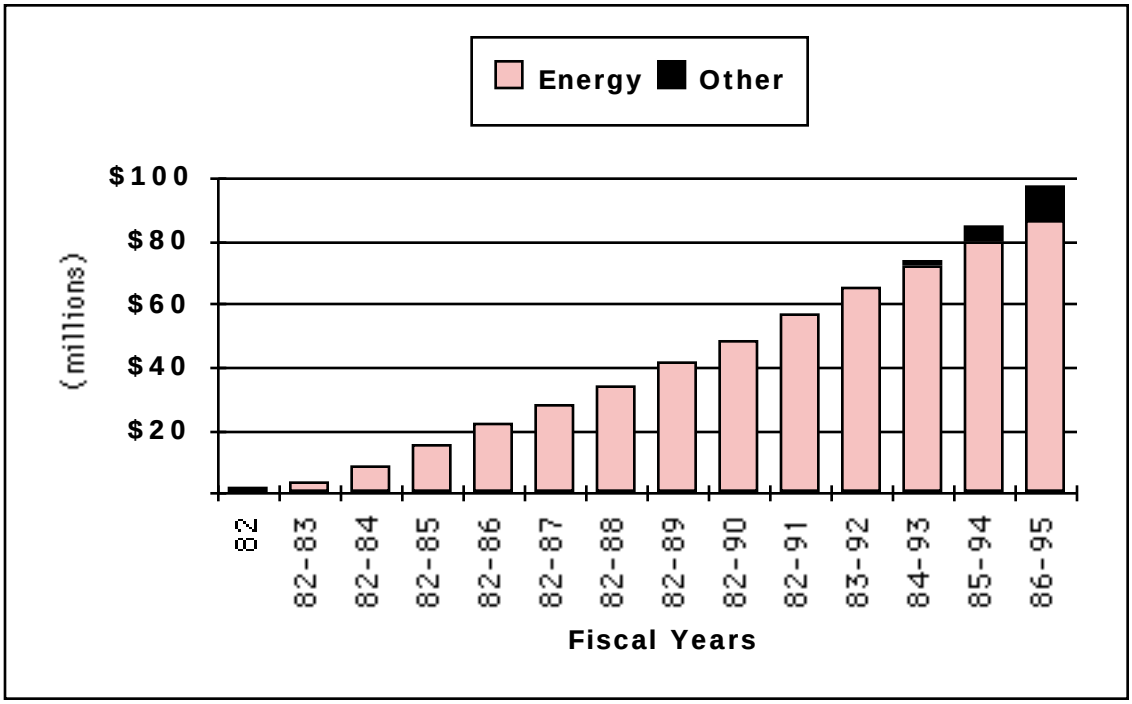

Figure 35. Ten Year Cumulative Cost Savings

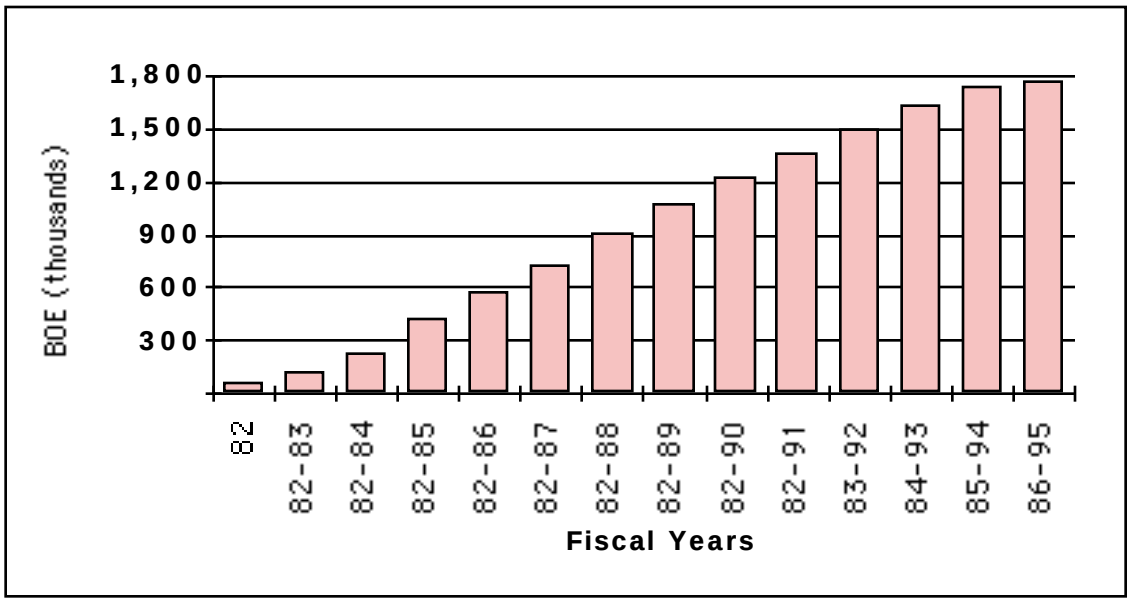

Figure 36. Ten Year Cumulative Barrels of Oil Avoided

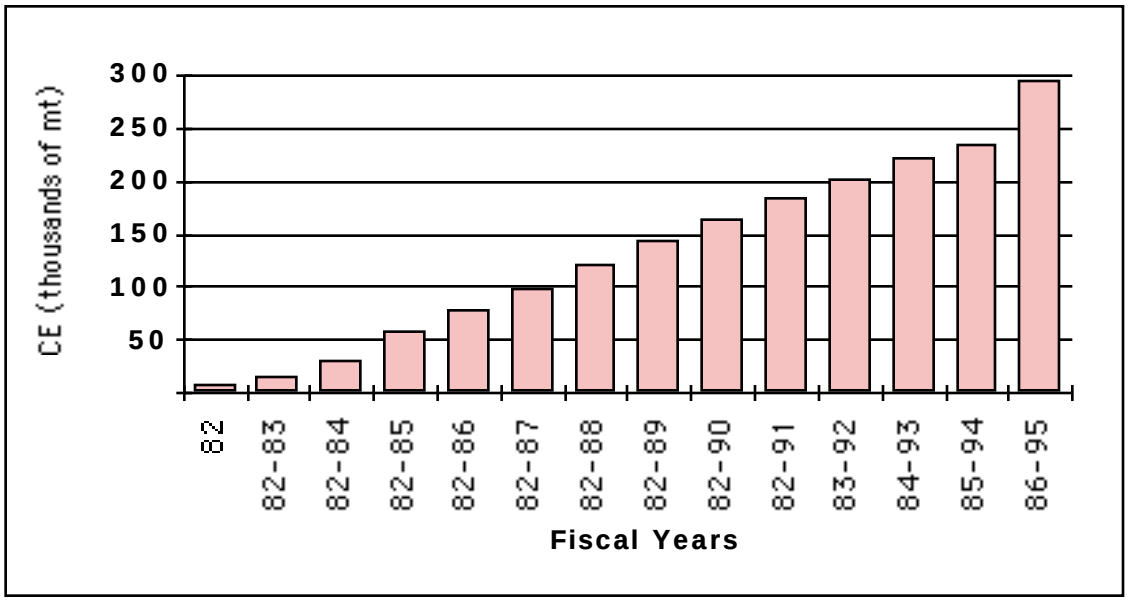

Figure 37. Ten Year Cumulative Carbon Avoided

Similar to the charts in the previous section showing recommended savings, the average energy and cost saved due to the implementation of recommended measures is shown per assessment for FY95 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	14,948	7,708	22,656

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

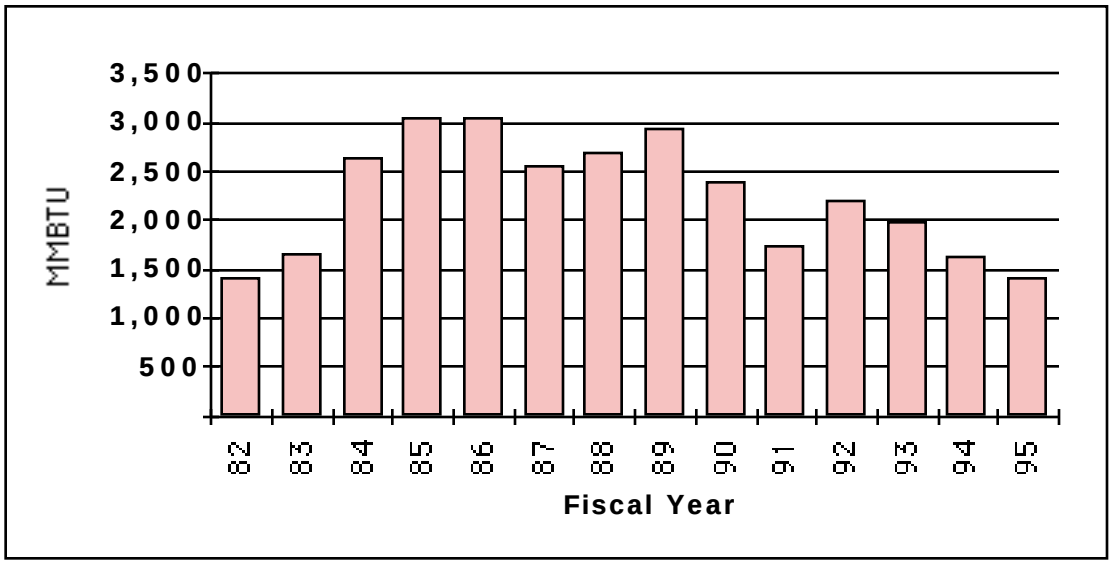

Figure 38. Average Implemented Conservation by Fiscal Year

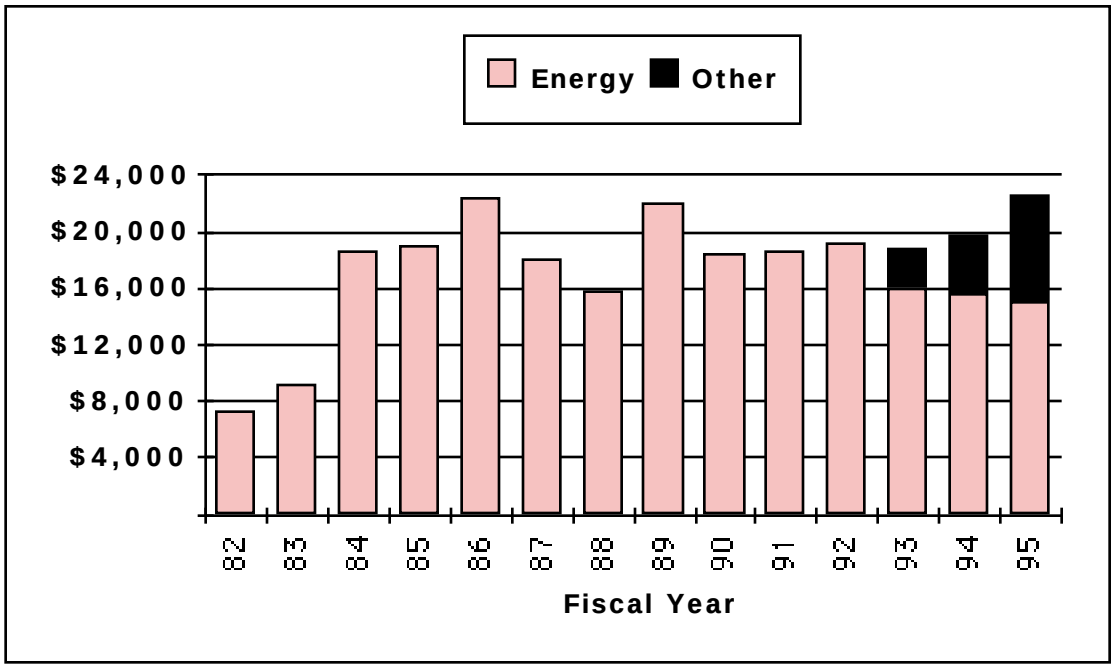

Figure 39. Average Implemented Cost Savings by Fiscal Year

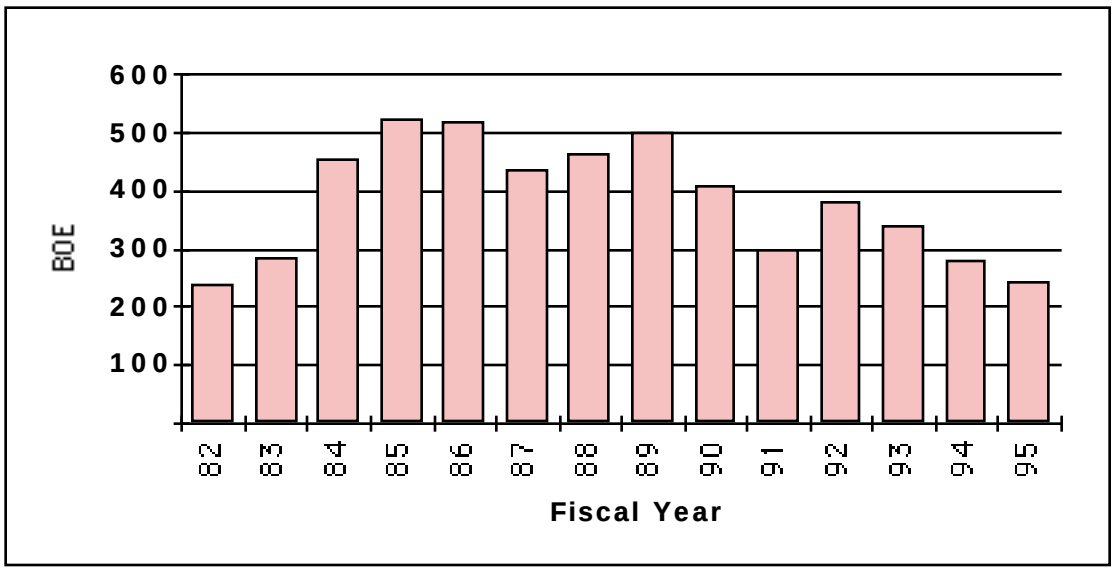

Figure 40. Average Implemented Barrels of Oil Avoided by Fiscal Year

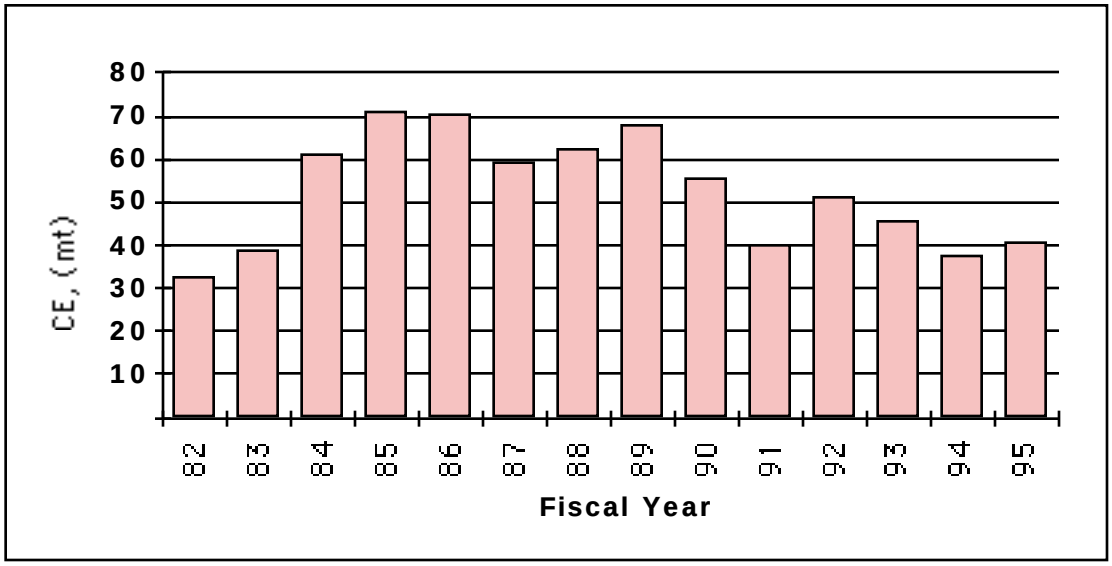

Figure 41. Average Implemented Carbon Avoided by Fiscal Year

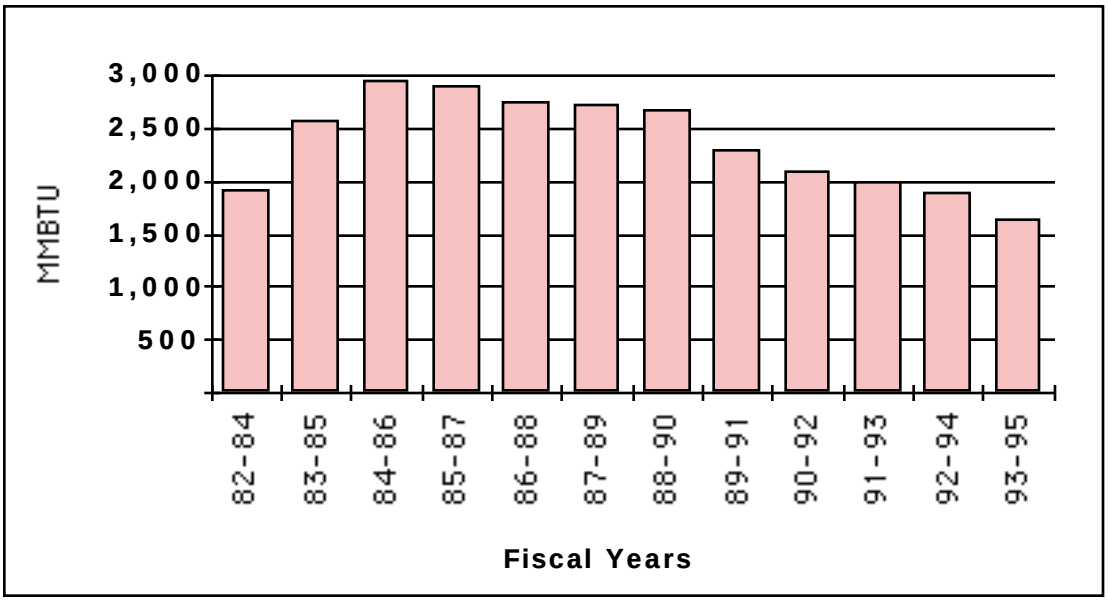

Figure 42. Implemented Energy Conserved Per Assessment (3 Year Average)

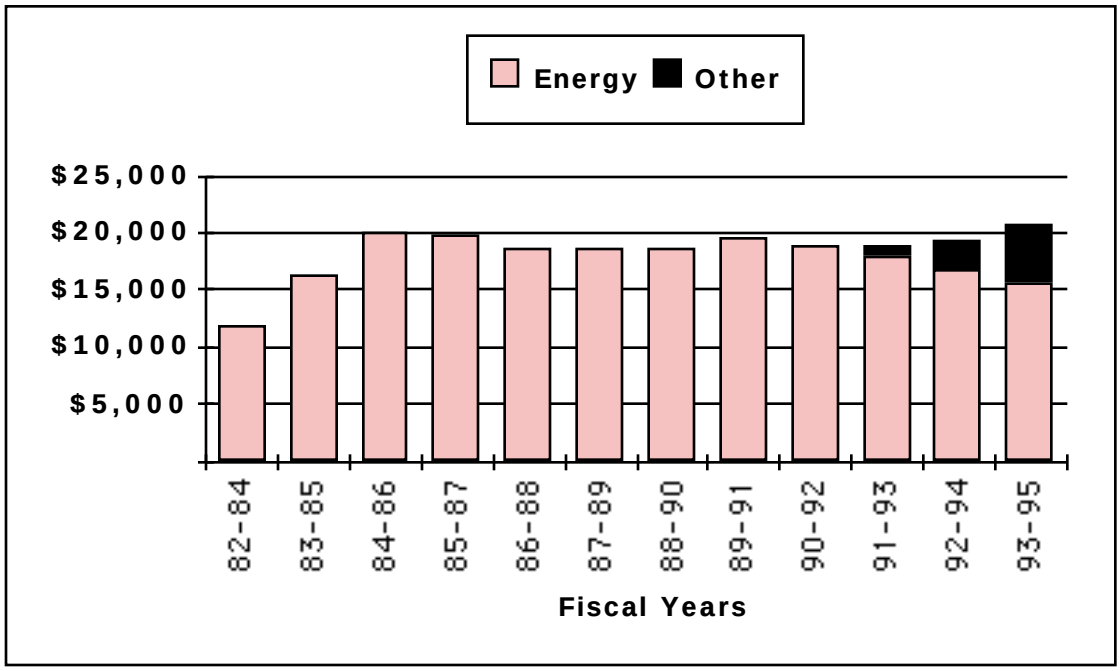

Figure 43. Average Implemented Cost Savings Per Assessment (3 Year Average)

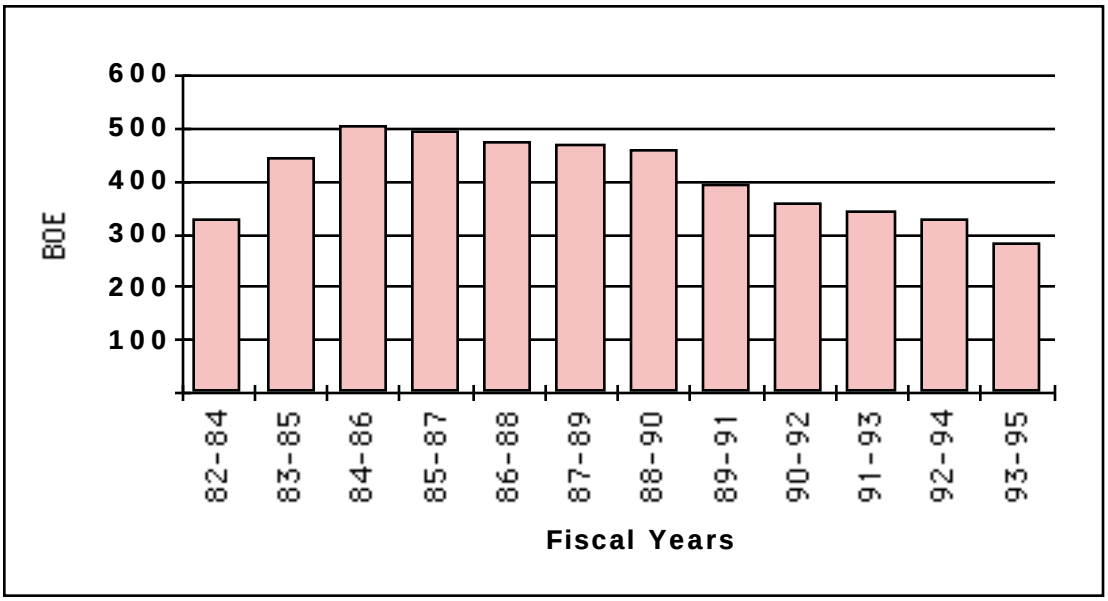

Figure 44. Average Implemented Barrels of Oil Avoided Per Assessment (3 Year Average)

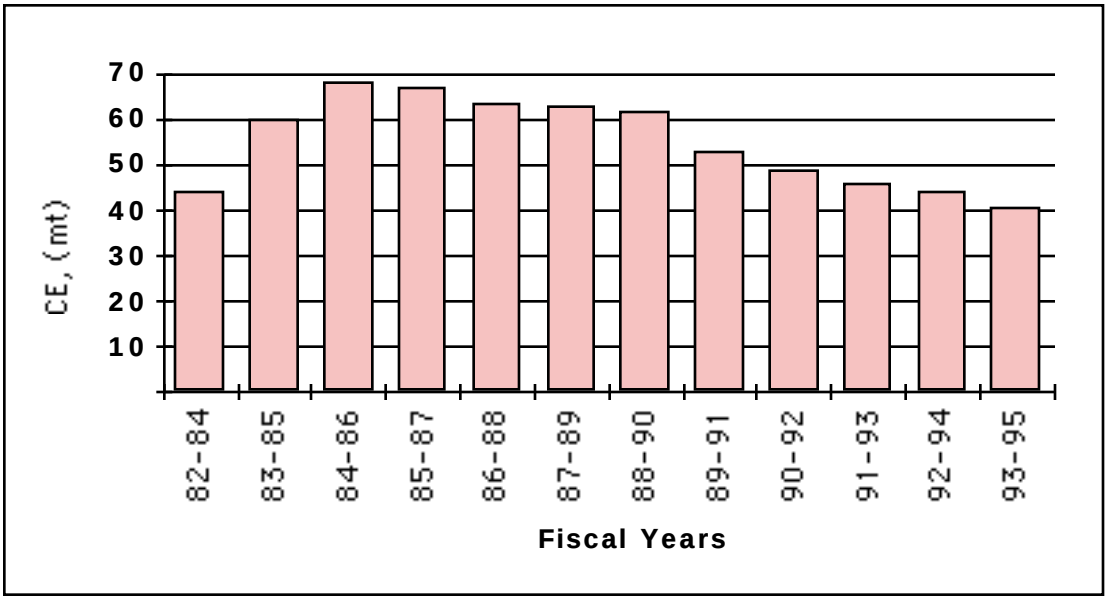

Figure 45. Average Implemented Carbon Avoided Per Assessment (3 Year Average)

ii. Implemented Savings by Industry Type

Energy conservation and cost savings resulting from implemented recommendations by industry type is shown on Figures 46 through 49. The greatest amount of energy conserved was in SIC 20 (food and kindred products); the largest in cost savings was SIC 34 (fabricated metals).

SIC Code Industry Description	Implemented Energy Conservation			Implemented Cost Savings ($)		
	(MMBtu)	(B.O.E.)	(C.E., mt)	Energy	Non-Energy	Total
20 Foods	211,497	36,308	6,055	1,363,795	598,076	1,961,871
21 Tobacco Prod.	1,244	214	36	11,646	0	11,646
22 Textile Mills	80,395	13,802	2,302	652,716	292,964	945,680
23 Apparel	12,280	2,108	352	220,376	9,365	229,741
24 Wood Prod.	64,523	11,077	1,847	661,794	494,651	1,156,445
25 Furniture	14,812	2,543	424	219,967	414,334	634,301
26 Paper Prod.	41,962	7,204	1,201	492,231	175,631	667,862
27 Printing	36,525	6,270	1,046	559,385	191,081	750,466
28 Chemical Prod.	86,324	14,820	2,472	571,019	943,591	1,514,610
29 Petroleum	6,987	1,199	200	63,574	26,000	89,574
30 Rubber & Plast.	86,444	14,840	2,475	1,341,804	410,700	1,752,504
31 Leather Prod.	67	12	2	2,064	0	2,064
32 Stone & Glass	57,138	9,809	1,636	543,693	493,669	1,037,362
33 Primary Metal	136,424	23,420	3,906	1,047,608	1,047,229	2,094,837
34 Fab. Metal	134,952	23,168	3,864	1,818,577	855,698	2,674,275
35 Ind. Machinery	83,533	14,340	2,392	932,148	309,184	1,241,332
36 Electronics	105,501	18,112	3,021	1,423,305	220,439	1,643,744
37 Trans. Equip.	36,944	6,342	1,058	630,239	182,584	812,823
38 Instruments	39,658	6,808	1,135	394,841	16,954	411,795
39 Misc. Manuf.	8,403	1,443	241	188,319	93,600	281,919
Totals	1,245,613	213,839	35,664	13,139,101	6,775,750	19,914,851

Table 20. Implemented Energy and Cost Savings by Industry Type

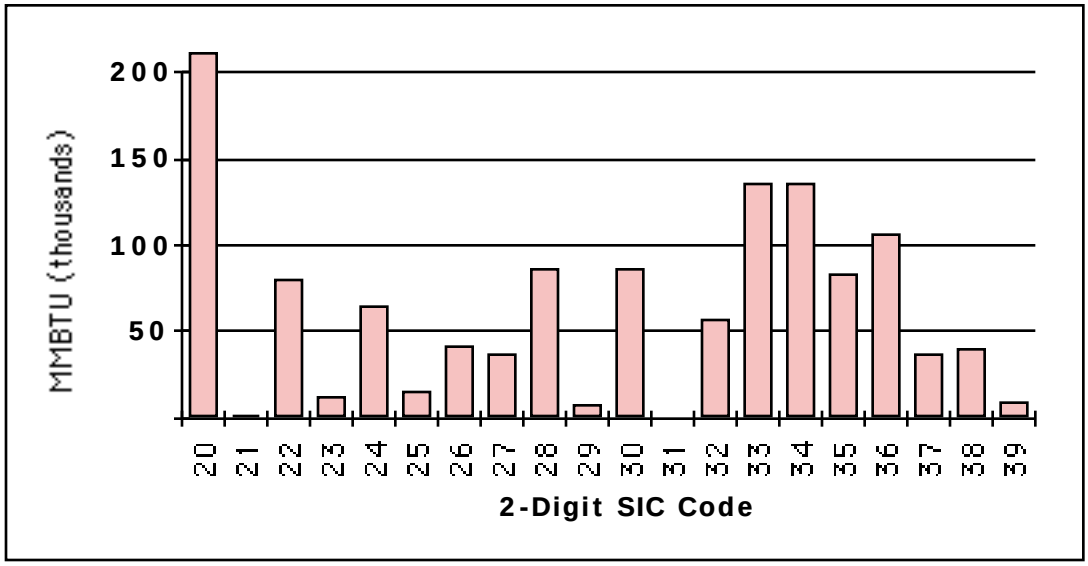

Figure 46. Implemented Energy Conserved by Industry Type

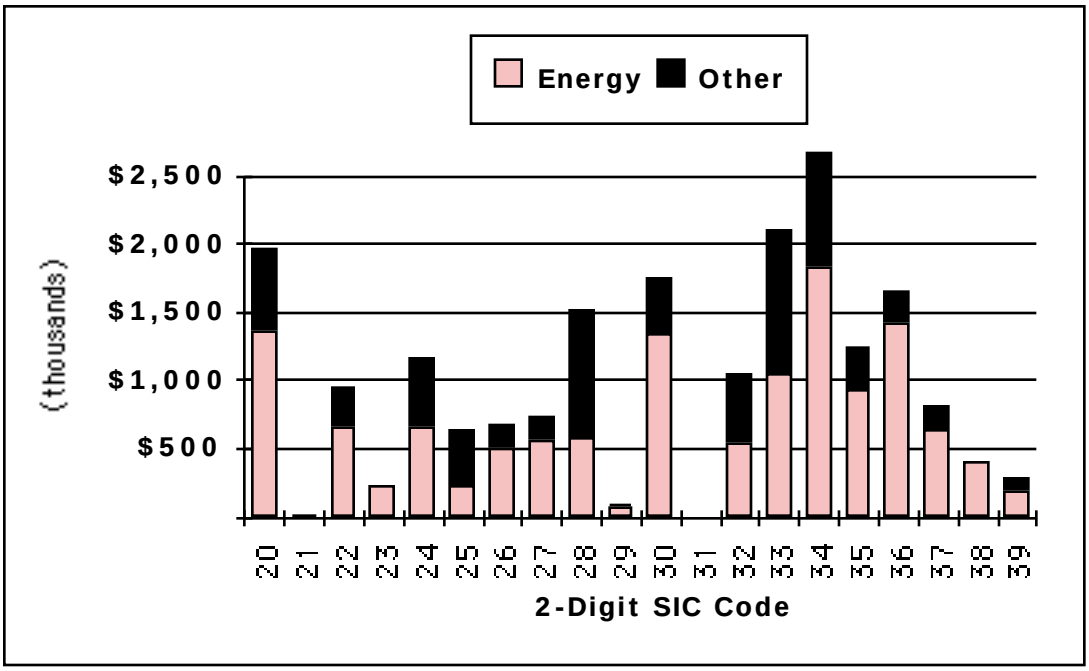

Figure 47. Implemented Cost Savings by Industry Type

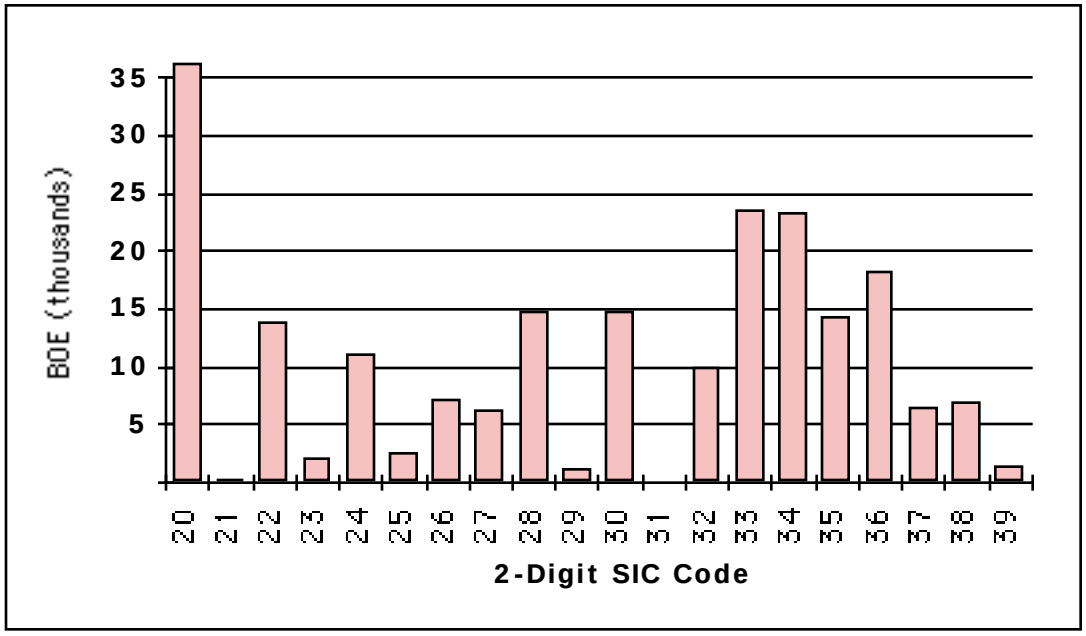

Figure 48. Implemented Barrels of Oil Avoided by Industry Type

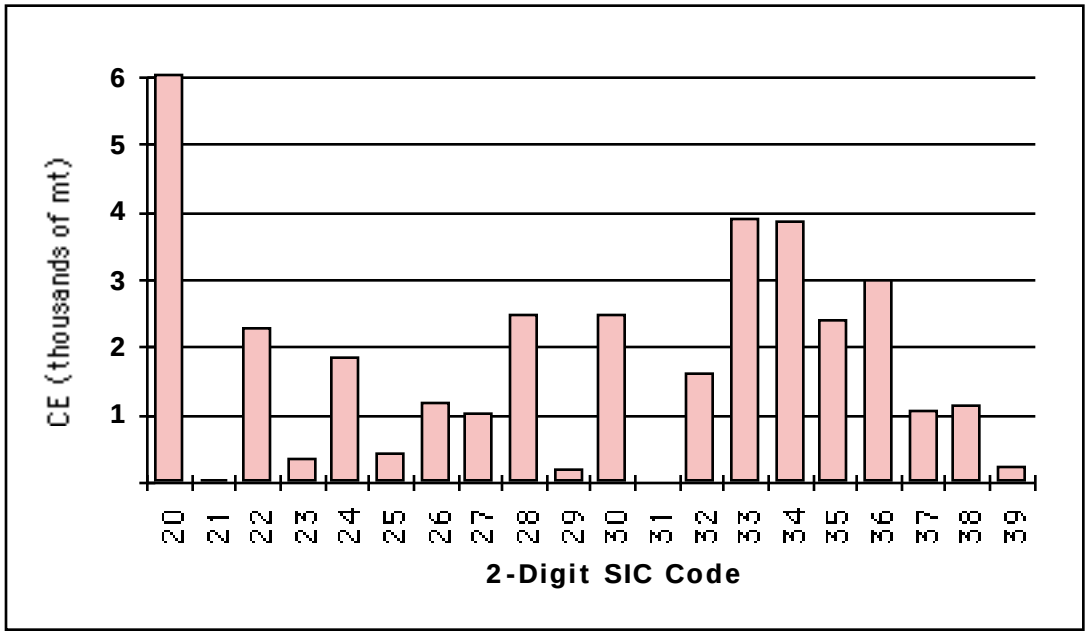

Figure 49. Implemented Carbon Avoided by Industry Type

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	2,053	353	59	13,241	5,807	19,047
21	Tobacco Products	1,244	214	36	11,646	0	11,646
22	Textile Mills	2,978	511	85	24,175	10,851	35,025
23	Apparel	585	100	17	10,494	446	10,940
24	Wood Prod.	1,744	299	50	17,886	13,369	31,255
25	Furniture	617	106	18	9,165	17,264	26,429
26	Paper Prod.	874	150	25	10,255	3,659	13,914
27	Printing	937	161	27	14,343	4,900	19,243
28	Chemical Prod.	2,333	401	67	15,433	25,502	40,935
29	Petroleum	1,397	240	40	12,715	5,200	17,915
30	Rubber & Plast.	971	167	28	15,076	4,615	19,691
31	Leather Prod.	22	4	1	688	0	688
32	Stone & Glass	2,286	392	65	21,748	19,747	41,494
33	Primary Metal	2,480	426	71	19,047	19,041	38,088
34	Fab. Metal	1,063	182	30	14,320	6,738	21,057
35	Ind. Machinery	908	156	26	10,132	3,361	13,493
36	Electronics	1,599	274	46	21,565	3,340	24,905
37	Trans. Equip.	803	138	23	13,701	3,969	17,670
38	Instruments	2,479	426	71	24,678	1,060	25,737
39	Misc. Manuf.	467	80	13	10,462	5,200	15,662
Average		1,417	243	41	14,948	7,708	22,649

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

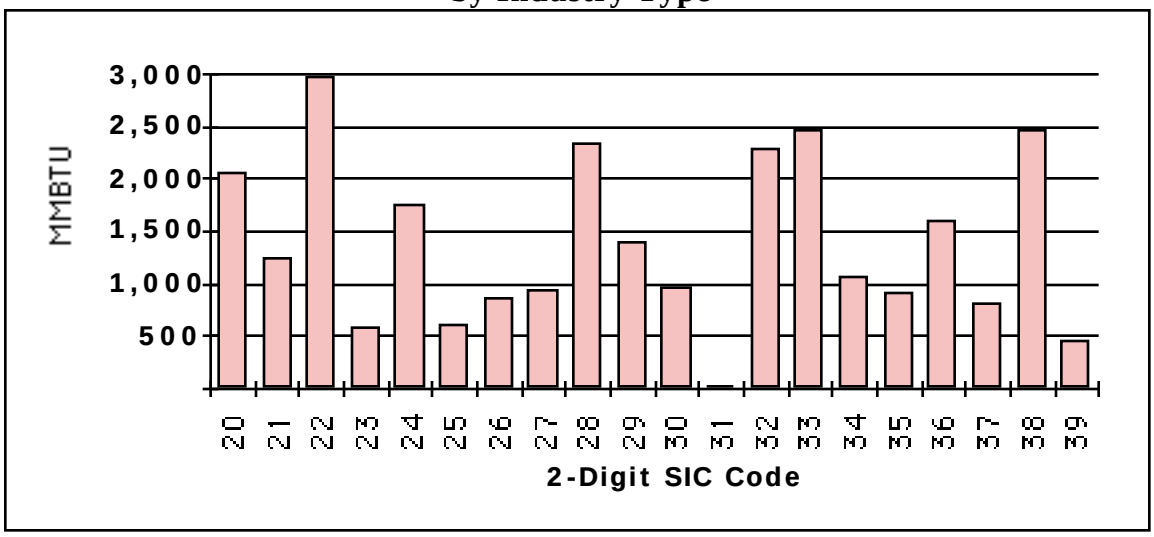

Figure 50. Average Implemented Energy Savings by Industry Type

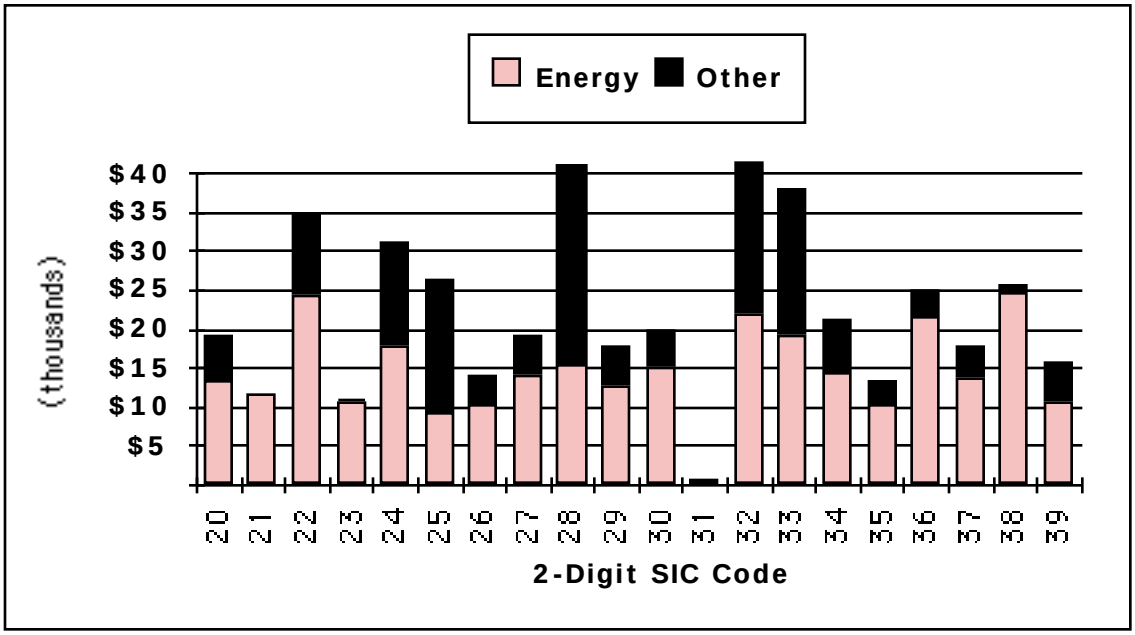

Figure 51. Average Implemented Cost Savings by Industry Type

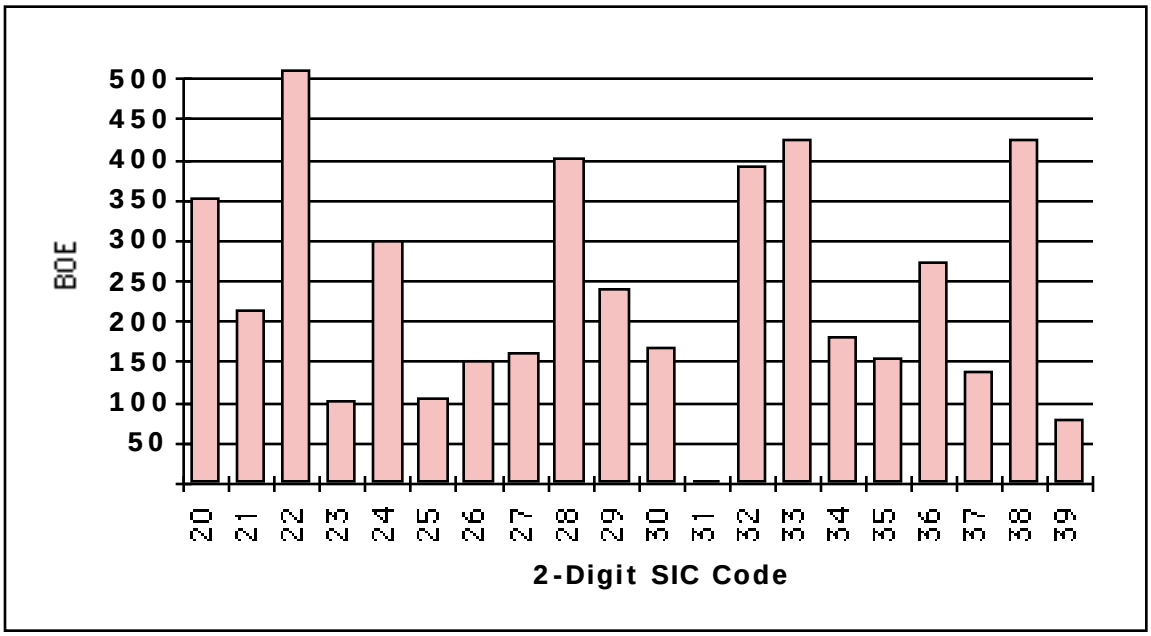

Figure 52. Average Implemented Barrels of Oil Avoided by Industry Type

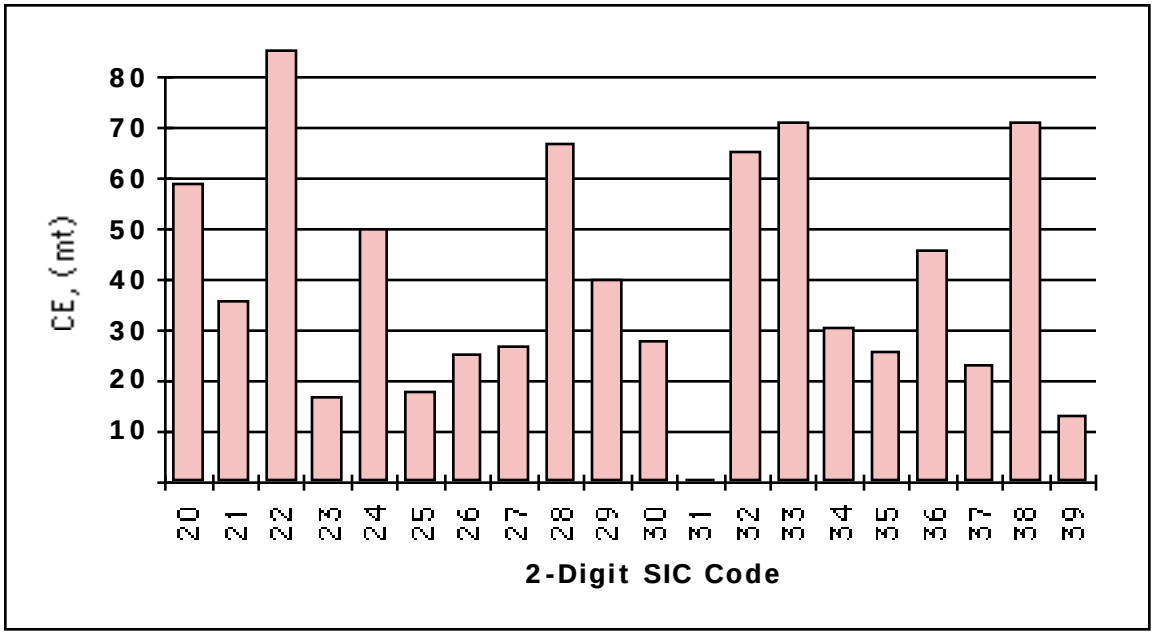

Figure 53. Average Implemented Carbon Avoided by Industry Type

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	629,351	11,088,015
Natural Gas	549,753	1,862,399
L. P. G.	17,379	88,682
Fuel Oil #1	557	2,379
Fuel Oil #2	9,765	36,243
Fuel Oil #4	1,492	5,048
Fuel Oil #6	10,799	30,343
Wood	23,473	12,777
Other Gas	37	346
Other Energy	3,002	12,864
Energy Totals	1,245,613	13,139,101
Non-Energy	n/a	6,775,750
Program Totals	1,245,613	19,914,851

Table 22. Implemented Energy and Cost Savings by Resource Stream

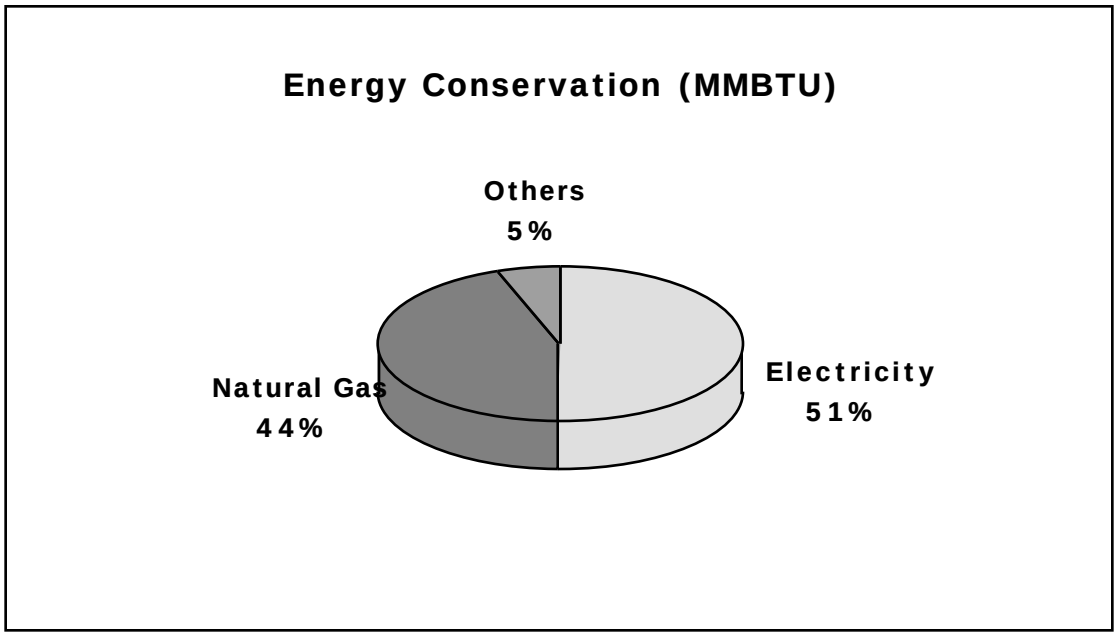

Figure 54. Composition of Implemented Energy Conserved by Energy Stream

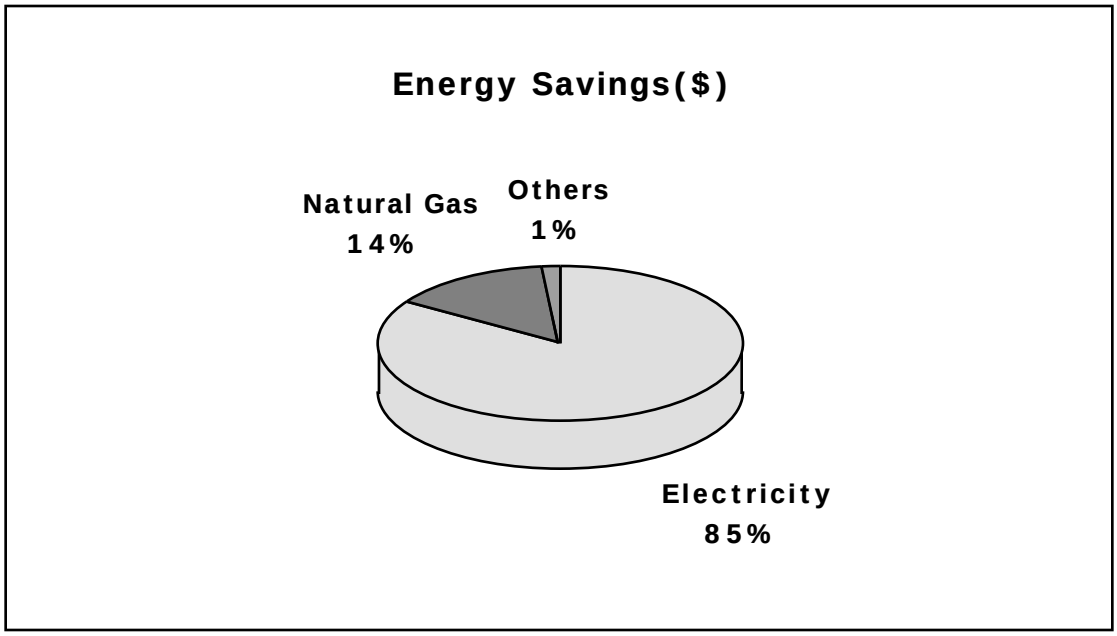

Figure 55. Composition of Implemented Energy Cost Savings by Energy Stream

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	52,648
Byproduct Production	20,568
Resource Costs	
Personnel Changes	160,959
Administrative Costs	1,756,366
Primary Raw Material	248,331
Ancillary Material Cost	297,650
Water Consumption	96,069
Waste Reduction	
Water Disposal	1,313,573
Other Liquid (non-haz)	95,611
Other Liquid (haz)	714,175
Solid Waste (non-haz)	1,778,821
Solid Waste (haz)	211,543
Gaseous Waste (haz)	29,436
Non-Energy Total	6,775,750

Table 23. Total Implemented Non-Energy Cost Savings

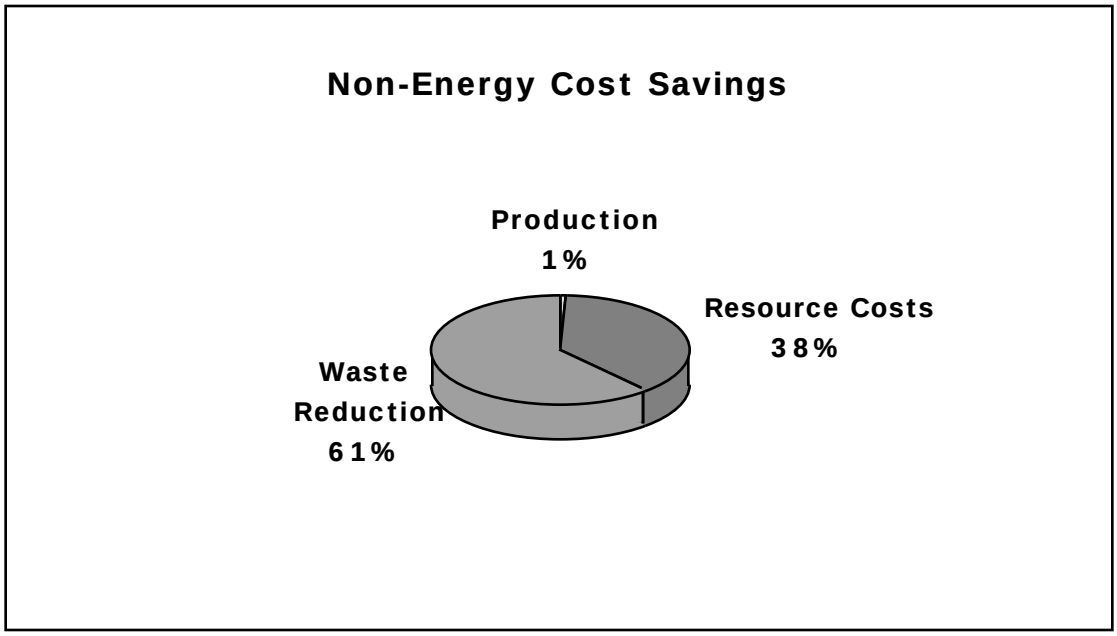

Figure 56. Composition of Non-Energy Implemented Savings

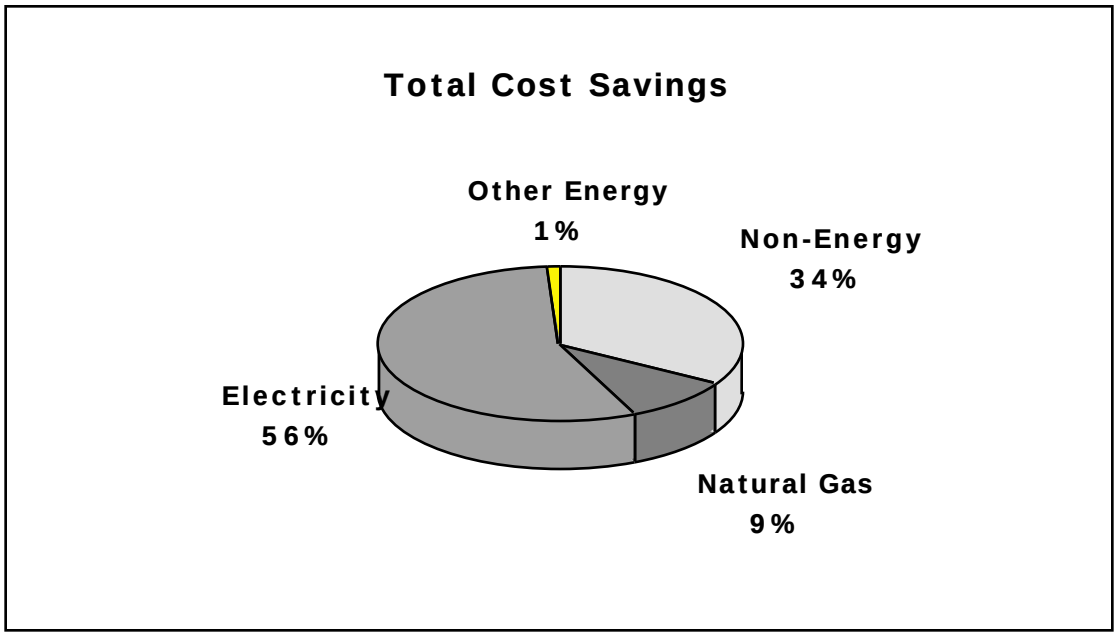

Figure 57. Composition of Total Implemented Cost Savings_

iv. Implemented Savings by Recommendation Type

Finally, the number of implemented recommendations by type for Fiscal Year 1995 is shown in Table 24 and Figure 58.

2-Digit ARC Code	Category Description	No. of Implemented Recommendations
2.1	Combustion Systems	158
2.2	Thermal Systems	230
2.3	Electrical Power	84
2.4	Motor Systems	1226
2.5	Industrial Design	1
2.6	Operations	92
2.7	Buildings and Grounds	970
2.8	Ancillary Costs	74
2.9	Alternate Energy Use	0
3.1	Operations	23
3.2	Equipment	6
3.3	Post Generation Treatment / Minimization	7
3.4	Water Use	51
3.5	Recycling	62
3.6	Waste Disposal	29
3.7	Maintenance	13
3.8	Raw Materials	11
4.x	Productivity Enhancement	7
	Total	3044

Table 24. Number of Implemented Recommendations by Recommendation Type

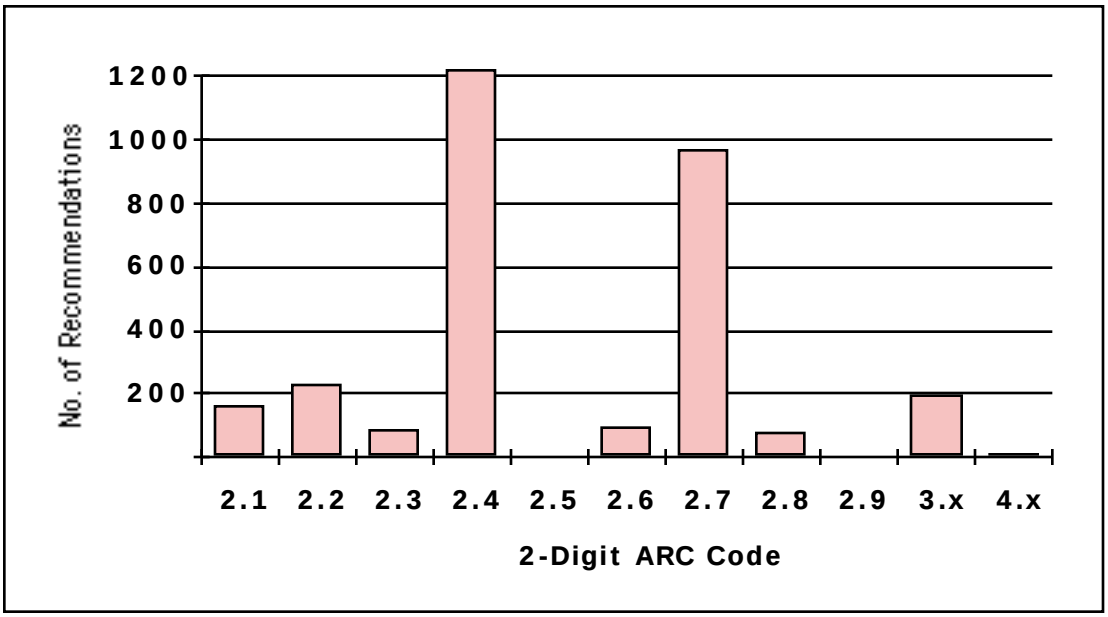

Figure 58. Number of Implemented Recommendations by Recommendation Type

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
3.x Waste Minimization/Pollution Prevention
4.x Productivity Enhancement

III. Standard Financial Calculations

Standard Financial Calculations, FY95

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:

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

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 FY95.

These leverage rates (or profitability indices) show that, at a 10% discount rate, the federal government will realize $1.08 to $1.87 for every dollar spent on the program in FY95. Similarly, manufacturers will, as a group, receive $1.75 to $2.41 for every dollar invested in implementing cost-saving measures.

Standard Financial Calculations of EADC/IAC Results
1994-95

IMPCOST GROWTH	ENSAV GROWTH	BORR RATE	FEDERAL GOVERNMENT			MANUFACTURERS		
%	%	%	IRR	LR_{10}	LR_{15}	IRR	LR_{10}	LR_{15}
3	3	3	36.9	1.54	1.08	265	2.13	1.75
3	3	6	35.2	1.47	1.02	228	2.07	1.69
3	3	9	33.6	1.40	0.95	198	2.01	1.63
3	3	6	35.2	1.47	1.02	228	2.07	1.69
6	3	6	34.9	1.45	1.00	225	2.06	1.68
6	0	6	29.9	1.08	0.70	209	1.75	1.43
6	3	6	34.9	1.45	1.00	225	2.06	1.68
6	6	6	39.9	1.87	1.34	241	2.41	1.96
12	6	6	39.3	1.84	1.31	235	2.38	1.93

Table 25. Standard Financial Calculations of IAC/EADC 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

In Fiscal Year 1995, Field Management for the Eastern IAC/EADC 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/EADC database for the entire program.

In FY95, the Eastern Region was comprised of twelve experienced Centers performing 30 assessments each, including at least 10 industrial, or combination assessments, and three Centers performing 30 energy-only audits. The addresses and phone numbers of all Centers is given in the appendix. The schools and directors participating in the program in FY95 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 26.

Centers	Date Entered Program	95 Assessments Completed	Director's Years in Program	Student Participation	
				Graduate	Under Grad.
GT	FY82	30	5	0	4
HO	FY92	30	4	0	9
MA	FY84	30	12	9	2
ME	FY93	30	3	1	10
MS	FY94	30	2	3	10
NC	FY93	30	2	6	8
ND	FY91	30	5	3	22
OD	FY94	30	2	7	1
TN	FY76	30	20	3	5
UD	FY76	30	20	1	1
UF	FY91	30	5	13	26
UL	FY94	30	2	1	18
UM	FY94	30	2	5	3
WI	FY87	30	9	1	6
WV	FY93	30	3	11	0

Table 26. History of Eastern Centers

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 FY95 allows an opportunity for reviewing the results of an industrial assessment. The recommended and implemented results from only the FY95 industrial assessments are presented here. Comparisons between the average industrial assessment and the average program results are also shown here.

General

Twenty-one Centers conducted 237 Industrial Assessments in FY95. The distribution of the industrial assessments by industry type is shown in Table 27. Note that no industrial assessments were performed in SIC 21 (Tobacco Products) in FY95.

2-digit SIC Code	Industry	No. of Assessments Performed
20	Food and Kindred Products	20
22	Textile Mill Products	11
23	Apparel and Other Textile Products	5
24	Lumber and Wood Products	5
25	Furniture and Fixtures	6
26	Paper and Allied Products	10
27	Printing and Publishing	17
28	Chemicals and Allied Products	16
29	Petroleum and Coal Products	2
30	Rubber and Misc. Plastics Products	20
32	Stone, Clay, and Glass Products	6
33	Primary Metal Industries	16
34	Fabricated Metal Products	40
35	Industrial Machinery and Equipment	22
36	Electronic and Other Electric Equipment	19
37	Transportation Equipment	16
38	Instruments and Related Products	3
39	Miscellaneous Manufacturing Industries	3
Total		237

Table 27. Number of Industrial Assessments Performed by Industry Type

Table 28 lists the total number of recommendations and implemented recommendations which resulted from the industrial assessments, grouped by recommendation type. Fifty-six percent of the energy management recommendations were implemented, as compared to forty-one percent for the waste minimization and pollution prevention recommendations. 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	132	65
2.2	Thermal Systems	163	79
2.3	Electrical Power	69	19
2.4	Motor Systems	587	392
2.5	Industrial Design	2	1
2.6	Operations	58	29
2.7	Buildings and Grounds	484	258
2.8	Ancillary Costs	63	30
2.9	Alternate Energy Use	0	0
Waste Minimization/Pollution Prevention			
3.1	Operations	75	23
3.2	Equipment	15	6
3.3	Post Generation Treatment / Minimization	27	7
3.4	Water Use	91	41
3.5	Recycling	111	57
3.6	Waste Disposal	67	27
3.7	Maintenance	24	12
3.8	Raw Materials	42	11
Direct Productivity Enhancements			
4.1	TQM (Total Quality Management)	9	3
Total		2019	1060

Table 28. Number of Recommendations by Recommendation Type (Industrial Assessments)

Savings by Stream Type

Table 29 summarizes the recommended and implemented cost savings totals by resource stream type, and Figure 59 shows each of the implemented values as a percentage of the total implemented cost savings for the industrial assessments.

Stream Type	Total Recommended Cost Savings ($)	Total Implemented Cost Savings ($)
Non-Energy	14,626,695	5,720,279
Electricity	8,695,246	3,455,775
Natural Gas	902,564	650,526
Other Energy	389,155	107,781
Program Total	24,613,660	9,934,361

Table 29. Cost Savings by Stream Type (Industrial Assessments)

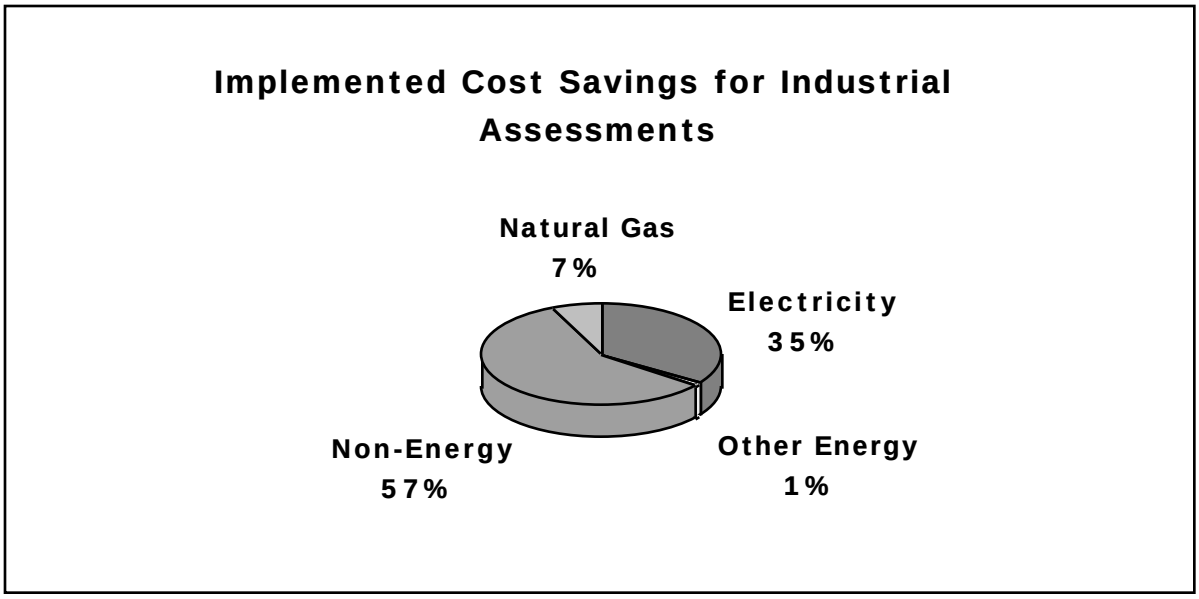

Figure 59. Composition of Total Implemented Cost Savings by Stream Type (Industrial Assessments)

.

Comparison of Industrial Assessments to Program Totals

Table 30 shows recommended and implemented cost savings and energy conservation for industrial assessments, and for the combined IAC/EADC program on an average (per assessment) basis.

FY95 Results (per assessment)	All Assessments	Industrial
	Recommended Quantities	
Recommended Energy Conservation (MMBTU)	3,016	3,753
Recommended Energy Cost Savings ($)	37,455	42,139
Recommended Non-Energy Cost Savings ($)	19,564	61,716
Recommended Total Cost Savings ($)	57,018	103,855
	Implemented Quantities	
Implemented Energy Conservation (MMBTU)	1,417	1,915
Implemented Energy Cost Savings ($)	14,948	17,781
Implemented Non-Energy Cost Savings ($)	7,708	24,136
Implemented Total Cost Savings ($)	22,656	41,917

Table 30. Comparison between Average Assessments and Industrial Assessments for FY95

The additional resources allocated to industrial assessments achieved a considerable effect on the program averages. The industrial assessment resulted in almost double the cost savings recommended and implemented. There had been concern that time and resource constraints as well as requirements to produce waste/P2 recommendations would result in reduced recommendations in the energy sector. The results seem to indicate that the Centers made fewer, more cost effective energy recommendations, with a higher implementation rate than last year. The implementation rate of the industrial assessment was 40%, the same as the program average.

B. Western Region

I. Major Activities and Highlights

During FY95 the ITEM division of University Science Center provided field management for the western region where 15 centers served a total of 427 manufacturers. Nine of the western region IACs completed ten industrial assessments plus 20 energy audits each, while the other six centers performed a total of 157 energy audits. The centers are listed below, along with the directors and the number of audits and industrial assessments completed.

IAC/EADC	FY95 Director	Audits Completed	Assessments Completed
Arizona State University	Dr. Byard Wood	30	-
University of Arkansas at Little Rock	Mr. Burton Henderson	20	10
Bradley University	Dr. Paul Mehta	30	-
Colorado State University	Dr. C. Byron Winn	20	10
Iowa State University	Dr. Howard N. Shapiro	20	10
University of Kansas	Dr. M. Clay Belcher	7	-
University of Missouri-Rolla	Dr. Burns E. Hegler	20	10
University of Nevada-Reno	Dr. Robert Turner	30	-
Oklahoma State University	Dr. Wayne C. Turner	20	10
Oregon State University	Dr. George M. Wheeler	20	10
San Diego State University	Dr. Halil M. Guven	20	10
San Francisco State University	Dr. Ahmad Ganji	20	10
South Dakota State University	Dr. Kurt Basset	30	-
Texas A&M University (College Station)	Dr. Warren M. Heffington	20	10
Texas A&M University-Kingsville	Dr. Yousri Elkassabgi	30	-
		337	90

The six centers which conducted only energy audits in FY95 were trained to begin doing industrial assessments in FY96.

ITEM staff arranged for four engineering professors from Mexico to visit DOE, the Science Center, and Rutgers University in late June, 1995, to discuss the EADC/IAC program and future performance of industrial energy audits in Mexico modeled after EADC/IAC. The professors underwent industrial energy audit training at Colorado State University during the week of July 31, 1995, and attended the 1995 directors' meeting and the industrial assessment training session held in Baltimore, Maryland.

Merritt Kirk and Gwen Looby of ITEM prepared material for and participated in an exhibit of the IAC program for the First Industrial Energy Efficiency Symposium and Exposition in Washington, DC on May 1,2, and 3, 1995.

ITEM staff participated in the review of proposals received from the state energy offices to conduct collaborative workshops in conjunction with IACs. Under DOE's direction, awards were made to state/IAC teams in Arizona, California, Missouri, Texas, and Washington in the Western Region.

At the request of the DOE and EPA, ITEM staff began work to develop case studies for specific industries based on IAC assessments.

II. Analysis of Results

There is a large volume of historic energy data to use in evaluating the results of EADCs' energy-conserving efforts in FY95. For example, the FY95 western plants were, on average, a little smaller in terms of energy consumed than their FY94counterparts, as these data show:

Averages	FY94	FY95
Energy Consumed/plant, 10^9 BTU/yr	58.3	53.8
Energy Cost/plant, $/yr	421,000	388,000
Employment/plant	169	169
Sales/plant, $million/yr	27.3	27.4

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 data 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 decreased to 35.7%, but FY95 saw an improvement to 43.1% Those numbers led us at ITEM 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.

	FY94 IMPLEMENTED		NON-IMPL	FY95 IMPLEMENTED		NON-IMPL
DESCRIPTION	PAYBACK (yr)	IMPL. RATE (%)	PAYBACK (yr)	PAYBACK (yr)	IMPL. RATE (%)	PAYBACK (yr)
COMBUSTION	0.46	42.3	0.96	0.47	64.0	1.45
STEAM	0.23	65.1	0.20	0.32	68.5	0.39
UTILITIES	0.63	54.1	1.09	0.45	55.9	1.13
SCHEDULING	0.08	45.8	0.55	0.05	41.8	0.98
PROCESS	1.41	42.5	1.32	1.15	47.8	1.22
BUILDINGS / GROUNDS	1.19	53.6	1.92	1.32	54.3	1.94
ALTERNATE SOURCE	1.90	4.8	3.56	0.92	7.7	2.85
ALL MEASURES	0.96	35.7	2.36	0.87	43.1	1.95

Table 31. FY94 and FY95 Payback and Implementation Rates

From these results for western region EADCs we observe that:

- Payback times for aggregated implementation measures were very similar at 0.96 year for FY94 and 0.87 year for FY95.
- Payback times for aggregated non-implemented measures were a little shorter in FY95 than in FY94 (1.95 years versus 2.36 years).
- All major categories consistently showed a shorter payback time for implemented than for non-implemented measures
- 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 from electricity to natural gas), and using waste as fuel.

At a higher level of detail, we examined the western region's subcategories of measures recommended and implemented. Fourteen subcategories that were responsible for 92.7% of the cost savings recommended in FY94 are compared in the attached table with the same subcategories that were responsible for 93.5% of the cost savings recommended in FY95. In FY94 they accounted for 88.1% of the implemented savings, and in FY95, for 91.7%.

Those percentages suggest that IACs' efforts were a little more highly targeted in FY95. However, implementation rates for these subcategories were greater than or about equal to their FY94 counterparts in all but two subcategories: electricity supply and process heat confinement.

It appears, therefore, that the gain in FY95 implementation rate over its FY94 value has a broad basis and is not due to a single factor.

These observations 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	FY95
With the alternate source category	40.3	35.7	43.1
Without the alternate source category	46.7	49.6	53.4

The strongest negative influence on cost-saving implementation rate is clearly the poor record of "alternate source" measures, especially cogeneration. In FY94 as well as FY95 this implementation rate for cogeneration was zero.

The cost-saving implementation rates of 49.6% in FY94 and 53.4% in FY95 for the aggregate of all other measures are indeed very attractive.

Recommendation Type:	FY 1995 Recommended Savings ($/yr)	FY 1995 Implemented Savings ($/yr)	FY 1995 Implem. Rate	FY 1994 Recommended Savings ($/yr)	FY 1994 Im
Combustion Equipment Efficiency: Operational	539,023	333,342	61.8%	470,887	
Combustion Heat Recovery	473,013	66,281	14.0%	505,323	
Electricity Supply	1,201,312	520,658	43.3%	1,268,480	
Compressed Air	1,135,810	760,715	67.0%	1,453,086	
Equipment Scheduling	769,778	339,588	44.1%	564,372	
Equipment Maint., Repair, and Replacement: General	1,018,628	595,909	58.5%	1,197,446	
Operations and Process Design: General	240,967	112,311	46.6%	181,927	
Techniques Specific to Certain Processes	871,368	275,036	31.6%	568,314	
Process Heat Recovery	607,953	61,842	10.2%	182,979	
Process Heat Confinement	563,490	359,726	63.8%	669,281	
Lighting	2,372,283	1,539,506	64.9%	2,696,278	
Space Heating, Cooling, and Ventilation	1,201,659	378,295	31.5%	898,840	
Conversion to More Efficient or Economical Fuel	2,061,188	268,990	13.1%	1,091,943	
Cogeneration	3,502,716	0	0.0%	2,263,917	
Total for these 14 Recommendation Types	16,559,188	5,612,199	33.9%	14,013,073	
Total for all Recommendation Types	17,869,214	6,372,081	35.7%	14,989,753	

Table Y RECOMMENDED AND IMPLEMENTED SAVINGS FOR FISCAL YEARS 1994 AND 1995

Appendix I.

IAC/EADC Program Contact List

Appendix II.

IAC/EADC Territory Maps