Savings Generated by the Industrial Assessment Center Program: Fiscal Year 1999

Prepared for:

Office of Industrial Technologies
Under Cooperative Agreement
DE-FC01-92CE41022
with the U.S. Department of Energy

by

Rutgers, The State University of NJ

Director
Dr. Michael R. Muller

University City Science Center

Director
Mr. William Clark

Table of Contents

I. Introduction ____ ***1***

II. Program Statistics ____ ***3***

A. General ____ **3**

B. Client Profile ____ **5**

C. Assessment Recommendations ____ **15**

i. General ____ 15
ii. Recommended Savings by Industry Type ____ 19
iii. Recommended Savings by Resource Stream ____ 26
iv. Recommended Savings by Recommendation Type ____ 30

D. Implementation Results ____ **32**

i. General ____ 32
ii. Implemented Savings by Industry Type ____ 46
iii. Implemented Savings by Resource Stream ____ 53
iv. Implemented Savings by Recommendation Type ____ 57

III. Standard Financial Calculations ____ ***59***

IV. Regional Reports ____ ***61***

A. Eastern Region ____ **61**

Major Activities and Highlights of the Eastern Region ____ 61

B. Western Region ____ **63**

I. Major Activities and Highlights ____ 63

Appendix I. ____ ***a***

Assumptions Used in Carbon Equivalent Calculations ____ **a**

For IAC Contact List see www.oipea.rutgers.edu

Table of Figures

Figure 1. Plants Served in FY99 by Industry Type 9
Figure 2. Average Client Sales by Fiscal Year 11
Figure 3. Average Client Energy Usage by Fiscal Year 12
Figure 4. Average Client Energy Costs by Fiscal Year 12
Figure 5. Energy Use of Plants Served in FY99 by Energy Stream 13
Figure 6. Energy Costs of Plants Served in FY99 by Energy Stream 14
Figure 7: Average Recommended Electric Consumption Per Assessment by Fiscal Year 16
Figure 8. Average Recommended Energy Conserved by Fiscal Year 16
Figure 9. Average Recommended Cost Savings by Fiscal Year 17
Figure 10. Average Recommended Barrels of Oil Avoided by Fiscal Year 17
Figure 11. Average Recommended Carbon Avoided by Fiscal Year 18
Figure 12. Recommended Electric Consumption Conserved by Industry Type 20
Figure 13. Recommended Energy Conserved by Industry Type 20
Figure 15. Recommended Barrels of Oil Avoided by Industry Type 22
Figure 16. Recommended Carbon Avoided by Industry Type 22
Figure 17. Average Recommended Electric Consumption Conserved by Industry Type 23
Figure 18. Average Recommended Energy Saved by Industry Type 24
Figure 19. Average Recommended Cost Savings by Industry Type 24
Figure 20. Average Recommended Barrels of Oil Saved by Industry Type 25
Figure 21. Average Recommended Carbon Avoided by Industry Type 25
Figure 22. Composition of Recommended Energy Conserved by Energy Stream 27
Figure 23. Composition of Recommended Cost Savings by Energy Stream 27
Figure 24. Recommended Non-Energy Cost Savings 29
Figure 25. Recommended Cost Savings by Resource Stream 29
Figure 27. Percent of Recommendations Implemented by Fiscal Year 33
Figure 28. Recommended vs. Implemented Simple Payback 35
Figure 29. Seven Year Cumulative Energy Savings 35
Figure 30. Seven Year Cumulative Cost Savings 36
Figure 31. Seven Year Cumulative Barrels of Oil Avoided 36

Table of Figures (continued)

Figure 32. Seven Year Cumulative Carbon Avoided....37
Figure 33. Average and Median Implemented Energy Conservation by Fiscal Year....38
Figure 34. Average Implemented Cost Savings by Fiscal Year....39
Figure 35. Average Implemented Barrels of Oil Avoided by Fiscal Year....39
Figure 36. Average Implemented Carbon Avoided by Fiscal Year....40
Figure 37. Average & Median Implemented Energy Conserved Per Assessment (3 Yr Avg)....40
Figure 38. Average & Median Implemented Energy Cost Savings Per Assessment (3 Yr Avg)....41
Figure 39. Avg & Median Implemented Barrels of Oil Avoided Per Assessment (3 Yr Avg)....41
Figure 40. Average and Median Implemented Carbon Avoided Per Assessment (3 Year Avg)....42
Figure 41. Average First Year Implemented Electric Consumption by Fiscal Year....43
Figure 42. Average First Year Implemented Energy Conserved by Fiscal Year....44
Figure 43. Average First Year Implemented Cost Savings by Fiscal Year....44
Figure 44. Average First Year Implemented Barrels of Oil Avoided by Fiscal Year....45
Figure 45. Average First Year Implemented Carbon Avoided by Fiscal Year....45
Figure 46. Implemented Electric Consumption by Industry Type....47
Figure 47. Implemented Energy Conserved by Industry Type....47
Figure 48. Implemented Cost Savings by Industry Type....48
Figure 49. Implemented Barrels of Oil Avoided by Industry Type....48
Figure 50. Implemented Carbon Avoided by Industry Type....49
Figure 51. Average and Median Implemented Electric Consumption by Industry Type....51
Figure 52. Average and Median Implemented Barrels of Oil Avoided by Industry Type....51
Figure 53. Average and Median Implemented Carbon Avoided by Industry Type....52
Figure 54. Average Implemented Cost Savings by Industry Type....52
Figure 55. Composition of Implemented Energy Conserved by Energy Stream....54
Figure 56. Composition of Implemented Energy Cost Savings by Energy Stream....54
Figure 57. Composition of Non-Energy Implemented Savings....56
Figure 58. Composition of Total Implemented Cost Savings....56
Figure 59. Number of Implemented Recommendations by Recommendation Type....58
Figure 60. Breakdown of Total Recommended Cost Saving Measurres....66

List of Tables

Table 1. Assessments Performed by Fiscal Year 3
Table 2. Geographic Distribution of Assessments by State 5
Table 2. (continued) Geographic Distribution of Assessments by State 6
Table 3. Geographic Distribution of Assessments by Center 7
Table 3. (continued) Geographic Distribution of Assessments by Center 8
Table 4. Number of Assessments Performed by Industry Type 9
Table 5. Average Client Energy Use and Sales by Fiscal Year 10
Table 6. Energy Use and Cost by Energy Streams 13
Table 7. Recommended Savings Figures by Fiscal Year 15
Table 8. Average Recommended Energy Conservation and Cost Savings 18
Table 9. Recommended Cost and Energy Savings by Industry Type 19
Table 10. Average Recommended Conservation and Cost Savings by Industry Type 23
Table 11. Recommended Conservation and Cost Savings by Resource Stream 26
Table 12. Recommended Non-Energy Cost Savings by Resource Type 28
Table 13. Recommendations by Recommendation Type 30
Table 14. No. of Recommendations and Implemented Recommendations by Fiscal Year 32
Table 15. Implemented Savings by Fiscal Year 33
Table 16. Recommended and Implemented Simple Payback 34
Table 17. Seven Year Cumulative Conservation and Cost Savings 35
Table 18. Average Implemented Energy and Cost Savings by Fiscal Year 37
Table 19. Median Implemented Energy and Cost Savings by Fiscal Year 38
Table 20. Average First Year Implemented Savings by Fiscal Year 43
Table 21. Implemented Energy and Cost Savings by Industry Type 46
Table 22. Average Implemented Energy and Cost Savings by Industry Type 50
Table 23. Implemented Energy and Cost Savings by Resource Stream 53
Table 24. Total Implemented Non-Energy Cost Savings 55
Table 25. Number of Implemented Recommendations by Recommendation Type 57
Table 26. Standard Financial Calculations of IAC Results 60
Table 27. History of Eastern Centers 62

I. Introduction

Established in 1976 as a result of oil shortages and the increased awareness of the importance of energy conservation, the Energy Analysis and Diagnostic Center (EADC) program grew from the original four schools to thirty in Fiscal Year 1994. The Centers conducted energy audits for small to medium sized manufacturers through funding provided by the Office of Industrial Technologies (OIT) of the U.S. Department of Energy.

Since the inception of the program, there have been 38 Universities involved with the program. Nearly 100 faculty members have had the opportunity to enhance their classroom activities by taking students into the field, or more accurately, the factory floor. Most importantly, perhaps is the continued contribution that the over 2200 students who have "graduated' from the program are making to the industrial and commercial sector in which they now work.

In FY94, the EADC program was modified to include waste reduction and pollution prevention, with new combination Centers called "Industrial Assessment Centers" (IAC). It was decided to start with a small group of experienced Centers to provide a smooth transitional period. For this first year, the six IACs each conducted a minimum of ten combination, or industrial, assessments.

The remaining experienced EADCs were trained in August of 1994 to bring them into the IAC program with the start of Fiscal Year 1995. By Fiscal Year 1996 all centers were conducting "Industrial Assessments" and the title "Energy and Diagnostic Center" (EADC) was retired in favor of Industrial Assessment Center. In FY99, the 30 Centers performed 734 assessments (formerly called energy audits), including recommendations for both energy conservation and waste reduction/pollution prevention.

In FY96, changes were made to the reporting of electricity use and savings to better reflect the method of billing by most electric utilities. In the past, average cost of electricity (per kilowatt/hour) was used; starting in FY96 this value was broken up into electric consumption (kwh), demand charges (kw-month/year), and other electric fees. Also in August of 1996 the center directors were trained in productivity enhancing recommendations.

IAC assessments consist of faculty led teams from accredited engineering universities performing a one-day visit to a manufacturing plant following an extensive data gathering function. Manufacturers qualified for assessments if they met three of these four requirements: employment was under 500 persons at the site, annual sales were less than $75 million, annual energy bills under $1.75 million, and no professional staff were on hand to do the analyses.

Introduction (continued)

The resulting report produced for the manufacturer included data about the plant's energy use, waste production, processes and other information.

In addition, the reports produced contained several assessment recommendations, written with sufficient detail to provide anticipated energy, waste, or productivity cost savings, as well as implementation costs and simple paybacks. Within one year the staff of each Center conducted a survey of the assessed manufacturers to determine which recommended conservation measures were adopted.

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

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

This report changes how we calculate MMBtu's saved, MMBtu's saved is the sum of site fuels saved and the MMBtu's needed to generate the electricity consumed at the site. Site usage of KWH is now being reported..

II. Program Statistics

A. General

In Fiscal Year 1999, 734 assessments were performed, bringing the program database total to 9,075 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 9,060. Unless otherwise noted, figures are for FY99. Table 1 shows the number of assessments performed by Fiscal Year.

Fiscal Year	Total No. of Assessments Performed	No. of Industrial Assessments Performed
82	253	n/a
83	211	n/a
84	248	n/a
85	368	n/a
86	298	n/a
87	324	n/a
88	388	n/a
89	340	n/a
90	360	n/a
91	455	n/a
92	531	n/a
93	585	n/a
94	776	61
95	879	237
96	867	867
97	720	720
98	723	723
99	734	734
Total	**9,060**	**3,342**

Table 1. Assessments Performed by Fiscal Year

The total amount of recommended Energy Conservation measures in FY99 was approximately 6,300,000 Million British Thermal Units (MMBTU) with a dollar value of almost $32 million. Waste Reduction and Pollution Prevention cost savings amounted to $13 million, and Productivity recommendations were over $90 million. The resultant total recommended savings were $135 million.

The FY99 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 2,800,000 MMBTU, with a dollar value of $11 million. This equates to 475,000 barrels of oil measured in barrels of oil equivalent (BOE), and 60,000 metric tons of carbon avoided measured in carbon equivalent (CE).[1] . The implemented Waste Reduction and Pollution Prevention (P2) measures amounted to $6 million and Productivity measures realized over $32 million. The total amount of money saved by clients as a result of implemented measures was $50 million. If all implemented energy saving recommendations made over the past 7 years are still in place, the energy savings to the clients would be 15,461,000.

[1] Carbon avoidance is a generally accepted method of quantifying the production of Carbon Dioxide (CO_2), a known "greenhouse" gas, by the combustion of fossil fuels.

B. Client Profile

Each Center operates in a geographic area based on its location and the state that it resides in. The distribution of assessments in FY99 is shown in the following table by state. In FY99, the IACs served manufacturers in 43 states.

STATE	No. of Assessments Performed in Each State	Industrial Assessment Center	No. of Assessments Performed by Each IAC	Percent of Assessments Performed in Each State
Alabama	3	Georgia Tech. Mississippi State University	1 2	33% 67%
Arizona	25	Arizona State University	25	100%
Arkansas	21	Univ. of Arkansas - Little Rock	21	100%
California	62	University of Nevada San Diego State University San Francisco State University	12 25 25	19% 40% 40%
Colorado	20	Colorado State University	20	100%
Connecticut	10	Hofstra University University of Massachusetts	7 3	70% 30%
Florida	25	University of Florida	25	100%
Georgia	24	Georgia Tech.	24	100%
Idaho	2	Orgon State University	2	100%
Illinois	42	Bradley University University of Missouri – Rolla Univ. of Wisconsin - Milwaukee	25 3 14	60% 7% 33%
Indiana	27	Notre Dame University University of Louisville	21 6	78% 22%
Iowa	21	Iowa State University	21	100%
Kansas	16	University of Kansas	16	100%
Kentucky	24	University of Louisville University of Tennessee	19 5	79% 21%
Maine	17	University of Maine	17	100%
Maryland	2	Old Dominion University West Virginia University	1 1	50% 50%
Massachusetts	17	University of Massachusetts	17	100%
Michigan	24	Notre Dame University University of Michigan	4 20	17% 83%
Minnesota	22	Iowa State University South Dakota State University	2 20	9% 92%
Mississippi	23	Mississippi State University	23	100%
Missouri	28	University of Kansas University of Missouri - Rolla	6 22	21% 79%

Table 2. Geographic Distribution of Assessments by State

STATE	No. of Assessments Performed in Each State	Industrial Assessment Center	No. of Assessments Performed by Each IAC	Percent of Assessments Performed in Each State
Nebraska	6	Colorado State University	1	17%
		Iowa State University	2	33%
		University of Kansas	3	50%
Nevada	13	University of Nevada	13	100%
New Hampshire	7	University of Maine	6	86%
		University of Massachusetts	1	14%
New Jersey	7	Hofstra University	7	100%
New Mexico	3	Colorado State University	3	100%
New York	11	Hofstra University	9	82%
		University of Massachusetts	2	18%
North Carolina	30	North Carolina State Univ.	24	80%
		Old Dominion University	2	7%
		University of Tennessee	4	13%
Ohio	32	University of Dayton	25	78%
		University of Michigan	5	16%
		West Virginia University	2	6%
Oklahoma	25	Oklahoma State University	25	100%
Oregon	15	Oregon State University	15	100%
Pennsylvania	11	Hofstra University	2	18%
		West Virginia University	9	82%
Rhode Island	2	University of Massachusetts	2	100%
South Carolina	3	North Carolina State Univ.	1	33%
		University of Tennessee	2	67%
South Dakota	5	South Dakota State Univ.	5	100%
Tennessee	16	Univ. of Arkansas - Little Rock	4	25%
		University of Tennessee	12	75%
Texas	34	Texas A&M - College Station	25	74%
		Texas A&M – Prairie View	9	26%
Vermont	2	University of Maine	2	100%
Virginia	24	Old Dominion University	22	92%
		University of Tennessee	2	8%
Washington	8	Oregon State University	8	100%
West Virginia	13	West Virginia University	13	100%
Wisconsin	11	Univ. of Wisconsin - Milwaukee	11	100%
Wyoming	1	Colorado State University	1	100%

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

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

Industrial Assessment Center	No. of Assessments Performed by Each IAC	STATE	No. of Assessments Performed in Each State	Percent of Assessments Performed by IAC in a State
Arizona State University	25	Arizona	25	100%
Bradley University	25	Illinois	25	100%
Colorado State University	25	Colorado	20	80%
		Nebraska	1	4%
		New mexico	3	12%
		Wyoming	1	4%
Georgia Tech.	25	Alabama	1	4%
		Georgia	24	96%
Hofstra University	25	Connecticut	7	28%
		New Jersey	7	28%
		New York	9	36%
		Pennsylvania	2	8%
Iowa State University	25	Iowa	21	84%
		Minnesota	2	8%
		Nebraska	2	8%
Mississippi State Univ.	25	Alabama	2	8%
		Mississippi	23	92%
North Carolina State Univ.	25	North Carolina	24	96%
		South Carolina	1	4%
Notre Dame University	25	Indiana	21	84%
		Michigan	4	16%
Oklahoma State Univ.	25	Oklahoma	25	100%
Old Dominion University	25	Maryland	1	4%
		North Carolina	2	8%
		Virginia	22	88%
Oregon State University	25	Idaho	2	8%
		Oregon	15	60%
		Washington	8	32%
San Diego State University	25	California	25	100%
San Francisco State Univ.	25	California	25	100%
South Dakota State Univ.	25	Minnesota	20	80%
		South Dakota	5	20%
Texas A&M - College Station	25	Texas	25	100%
Texas A&M – Prairie View	9	Texas	9	100%
Univ. of Arkansas - Little Rock	25	Arkansas	21	96%
		Tennessee	4	4%
University of Dayton	25	Ohio	25	100%
University of Florida	25	Florida	25	100%

Table 3. Geographic Distribution of Assessments by Center

Industrial Assessment Center	No. of Assessments Performed by Each IAC	STATE	No. of Assessments Performed in Each State	Percent of Assessments Performed by IAC in a State
University of Kansas	25	Kansas	16	64%
		Missouri	6	24%
		Nebraska	3	12%
University of Louisville	25	Indiana	6	24%
		Kentucky	19	76%
University of Maine	25	Maine	17	68%
		New Hampshire	6	24%
		Vermont	2	8%
University of Massachusetts	25	Connecticut	3	12%
		Massachusetts	17	68%
		New Hampshire	1	4
		New York	2	8%
		Rhode Island	2	8%
Univ. of Michigan - Ann Arbor	25	Michigan	20	80%
		Ohio	5	20%
University of Missouri - Rolla	25	Illinois	3	12%
		Missouri	22	88%
University of Nevada	25	California	12	48%
		Nevada	13	52%
University of Tennessee	25	Kentucky	5	20%
		North Carolina	4	16%
		South Carolina	2	8%
		Tennessee	12	48%
		Virginia	2	8%
Univ. of Wisconsin - Milwaukee	25	Illinois	14	56%
		Wisconsin	11	44%
West Virginia University	25	Maryland	1	4%
		Ohio	2	8%
		Pennsylvania	6	24%
		West Virginia	13	52%

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

The IAC program serves manufacturers with a two digit Standard Industrial Classification (SIC) from 20 to 39 inclusive (Table 4). Figure 1 shows the distribution of assessments performed in each classification for FY99.

2-digit SIC Code	Industry	No. of Assessments Performed
20	Food and Kindred Products	68
21	Tobacco Products	1
22	Textile Mill Products	14
23	Apparel and Other Textile Products	12
24	Lumber and Wood Products	35
25	Furniture and Fixtures	19
26	Paper and Allied Products	30
27	Printing and Publishing	27
28	Chemicals and Allied Products	29
29	Petroleum and Coal Products	8
30	Rubber and Misc. Plastics Products	115
31	Leather and Leather Products	3
32	Stone, Clay, and Glass Products	38
33	Primary Metal Industries	43
34	Fabricated Metal Products	103
35	Industrial Machinery and Equipment	77
36	Electronic and Other Electric Equip.	50
37	Transportation Equipment	39
38	Instruments and Related Products	17
39	Miscellaneous Manufacturing Industries	6
Total		**734**

Table 4. Number of Assessments Performed by Industry Type

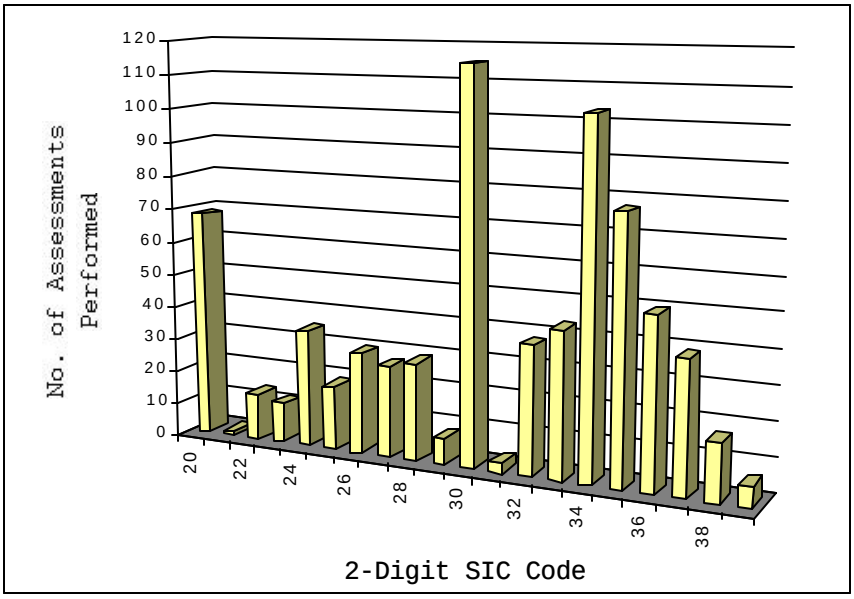


Figure 1. Plants Served in FY99 by Industry Type

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

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

In FY99, the total energy usage of the clients was 77 million MMBTU, costing $ 331.4 million. There was an average of 160 employees at each location. The companies had total sales of $ 20.7 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	59,472	231,913
83	15,439,405	76,980	320,200
84	13,543,984	65,989	312,849
85	14,308,457	76,586	329,205
86	21,558,916	96,056	416,228
87	19,438,333	81,140	334,472
88	18,515,013	104,010	361,374
89	23,309,162	105,757	413,965
90	25,126,931	116,491	441,287
91	25,707,204	104,961	382,786
92	24,500,738	143,617	428,295
93	27,333,166	129,428	499,311
94	28,090,421	97,643	437,531
95	29,077,218	90,974	412,759
96	30,609,175	92528	419,120
97	29,801,416	82,843	386,008
98	31,756,512	108,847	481,024
99	28,255,145	105,316	451,489

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

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

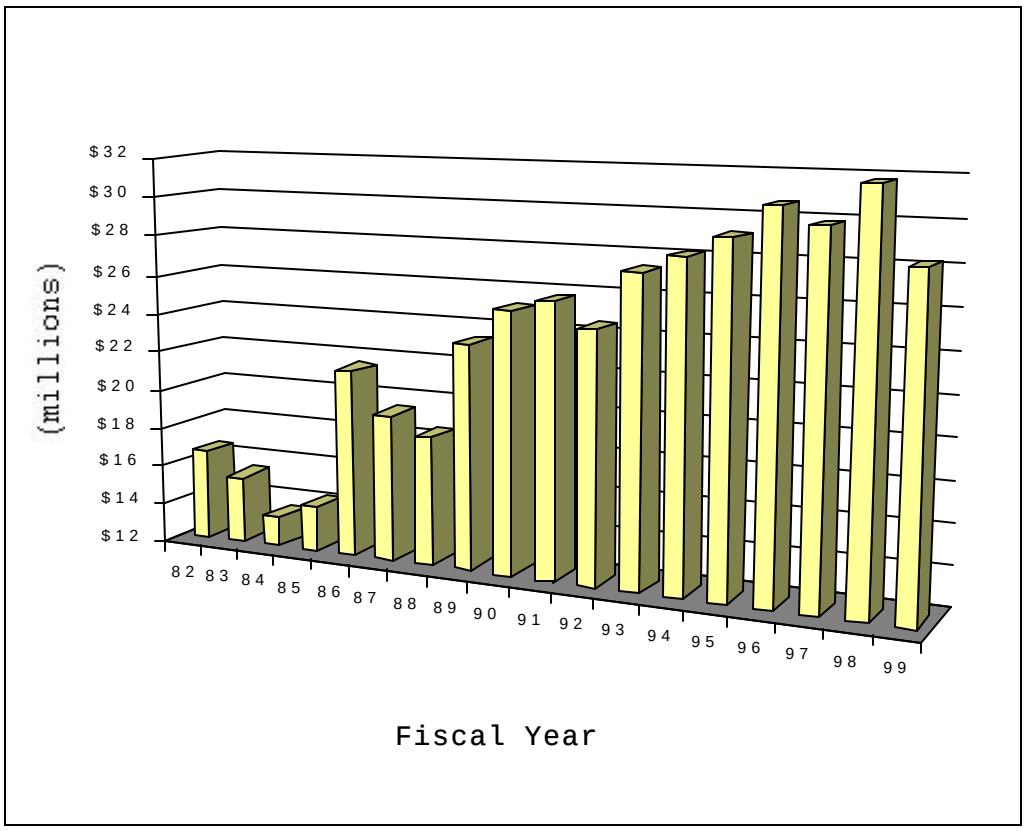


Figure 2. Average Client Sales by Fiscal Year

The average plant served in FY99 had purchased energy use of 105,000 MMBTU (Source) with an associated cost of $451,000. Electricity cost the typical client $15.65/ MMBTU (Site) and natural gas cost $3.29/ MMBTU. (Site) The average energy use and associated costs are shown in Figures 3 and 4. The DOE estimates that it takes 10,250 BTU's of thermal energy to get 1 KWH of electricity this equals an efficiency of about 33.29%.

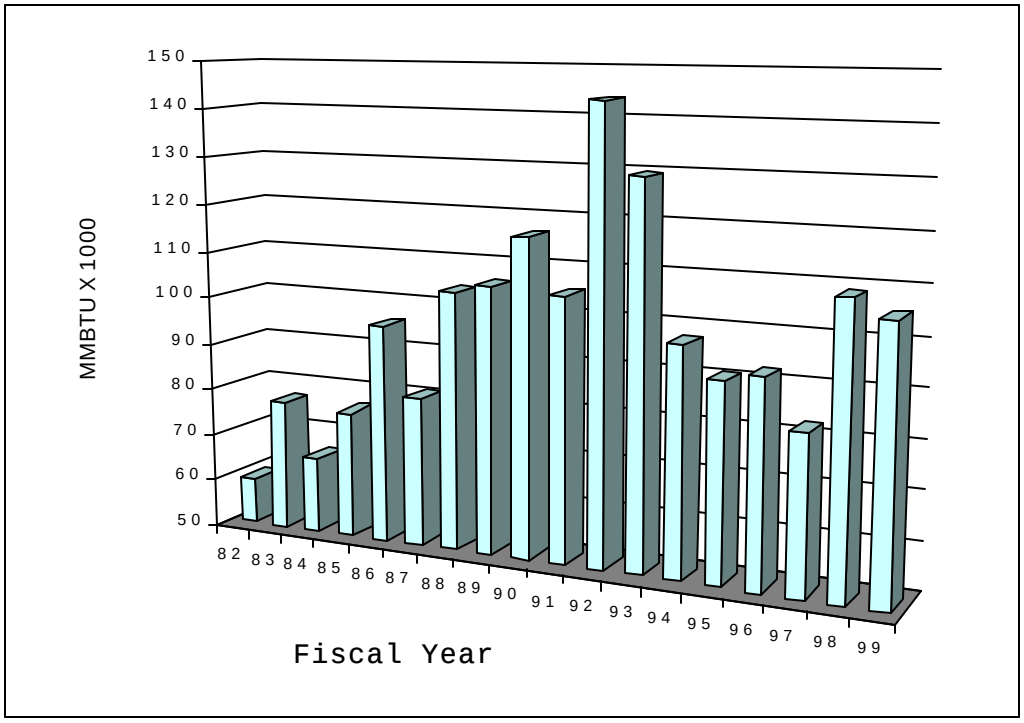


Figure 3. Average Client Energy Usage by Fiscal Year

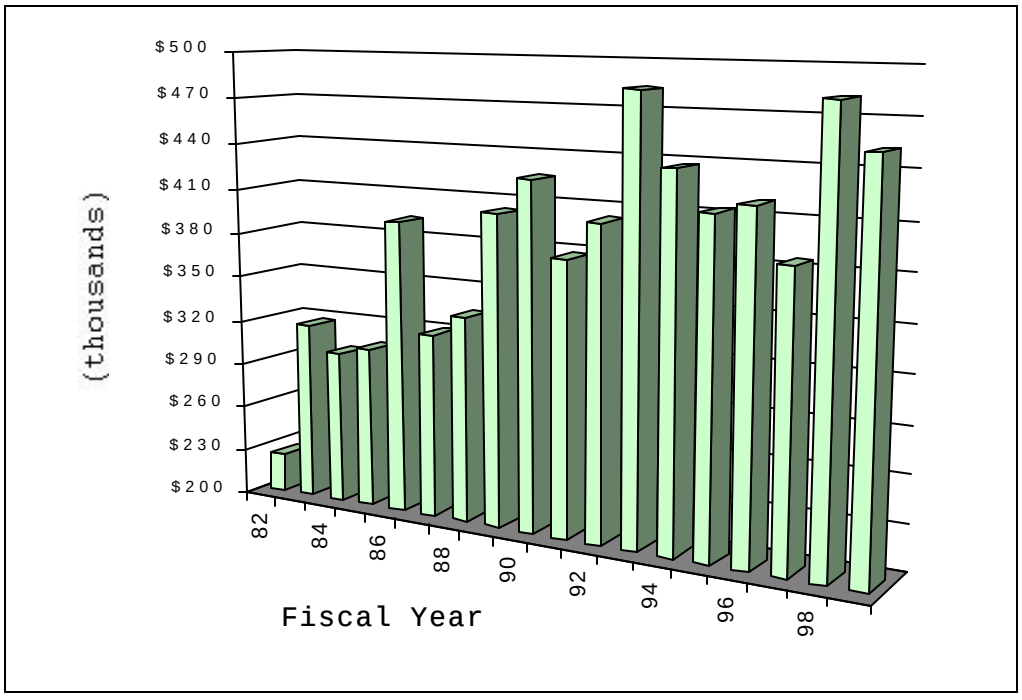


Figure 4. Average Client Energy Costs by Fiscal Year

The program database breaks energy use into eleven specific streams and one category for "other" energy. "Other Energy" in FY99 consisted mainly of purchased steam. The breakdown of the different energy streams is shown in Table 6, and Figures 5 and 6.

Energy Stream	Energy Usage (MMBtu) Unless Noted	Total Cost ($)
Electricity		
Demand	13,055,339 KW-months/yr	74,936,006
Fees		5,875,019
Consumption		
Site(KWH)	4,428,715,222	155,603,976
Source(MMBtu)	45,394,334	
Natural Gas	24,290,984	79,985,324
L. P. G.	153,779	947,294
Fuel Oil #1	0	0
Fuel Oil #2	305,930	1,463,627
Fuel Oil #4	35,578	131,947
Fuel Oil #6	294,576	890,765
Coal	5,729,042	7,981,322
Wood	274,795	633,640
Paper	0	0
Other Gas	571,567	3,303,017
Other Energy	251,567	485,143
Totals	**77,302,152**	**332,237,080**

Table 6. Energy Use and Cost by Energy Streams

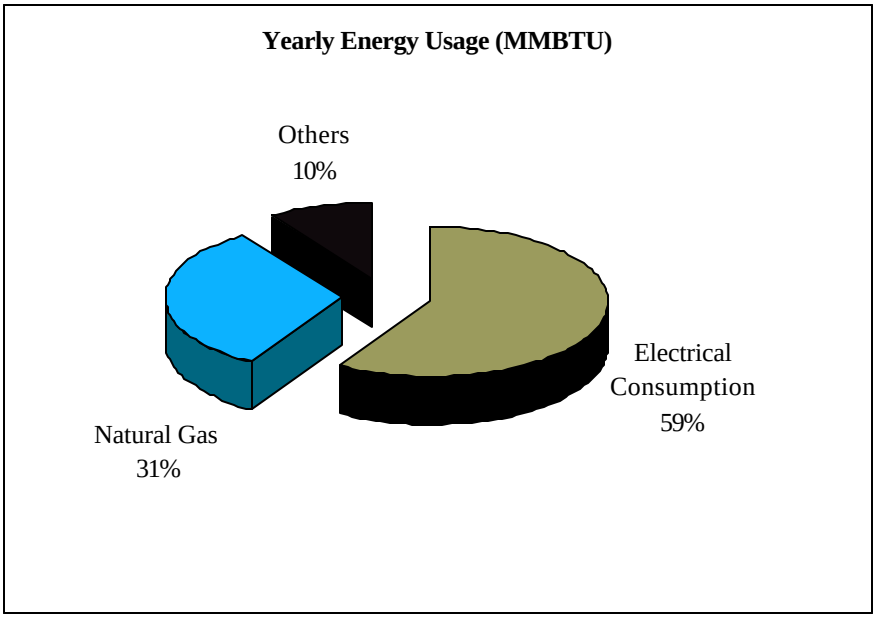


Figure 5. Energy Use of Plants Served in FY99 by Energy Stream

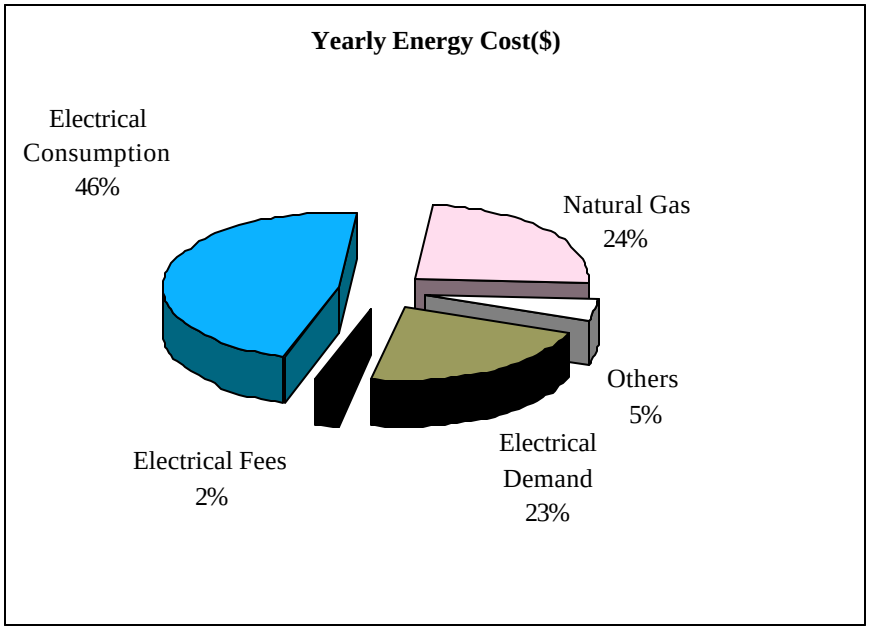


Figure 6. Energy Costs of Plants Served in FY99 by Energy Stream

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 FY99 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. Starting in FY99 the total energy savings is calculated using both the energy needed to generate electricity at the source and the site use of fuels.

Fiscal Year	Recommended Energy Conservation						Recommended Cost Savings ($)			
	Site (KWH)	Source Electric (MMBtu)	Site Fuels (MMBtu)	Total (MMBtu)	(B.O.E.)	(C.E., mt)	Energy	Waste	Productivity	Total
82	62,096,114	636,439	894,877	1,531,316	260,428	35,418	6,699,075	n/a	n/a	6,699,075
83	60,832,937	633,505	1,313,411	1,946,916	331,108	45,031	8,712,422	n/a	n/a	8,712,422
84	59,031,622	605,003	1,078,172	1,683,175	286,254	38,931	8,970,862	n/a	n/a	8,970,862
85	119,194,572	1,221,632	1,779,864	3,001,496	510,459	69,422	13,917,009	n/a	n/a	13,917,009
86	165,818,543	1,699,559	1,097,081	2,796,640	475,619	64,684	13,670,029	n/a	n/a	13,670,029
87	140,209,513	1,437,032	623,132	2,060,164	350,368	47,650	10,742,173	n/a	n/a	10,742,173
88	185,648,245	1,902,772	868,209	2,770,981	471,255	64,091	13,585,868	n/a	n/a	13,585,868
89	135,267,821	1,386,395	1,310,232	2,696,627	458,610	62,371	13,052,451	n/a	n/a	13,052,451
90	160,188,406	1,641,815	1,019,706	2,661,521	452,640	61,559	13,970,285	n/a	n/a	13,970,285
91	230,266,921	2,360,082	504,660	2,864,742	487,201	66,259	17,369,605	n/a	n/a	17,369,605
92	275,096,064	2,819,542	1,089,038	3,908,580	664,724	90,403	21,749,395	n/a	n/a	21,749,395
93	341,994,623	3,505,204	1,263,902	4,769,106	811,072	110,306	26,253,156	66,793	3,323,992	29,643,941
94	505,826,680	5,184,444	1,796,790	6,981,234	1,187,285	161,471	34,764,310	3,410,391	3,463,564	41,638,265
95	471,717,398	4,834,817	1,041,729	5,876,546	999,413	132,281	32,918,127	10,459,571	6,741,345	50,119,043
96	306,900,235	3,145,448	682,091	3,827,539	650,942	84,129	24,081,673	26,439,503	14,477,738	64,998,914
97	256,344,303	2,627,338	1,685,195	4,312,533	733,424	88,364	23,115,188	15,088,878	104,279,472	142,483,538
98	360,308,430	3,692,982	772,447	4,465,429	759,427	100,427	25,799,269	22,597,667	88,073,618	136,470,554
99	467,127,428	4,838,173	1,455,191	6,293,364	1,070,300	139,146	31,781,311	12,911,453	89,945,497	134,638,261
Totals	4,303,869,855	44,172,182	20,275,727	64,447,909	10,960,529	1,461,943	341,152,208	90,974,256	310,305,226	742,431,690

Table 7. Recommended Savings Figures by Fiscal Year

The Figures 7 through 11, and Table 8 show average recommended savings figures per assessment by Fiscal Year.

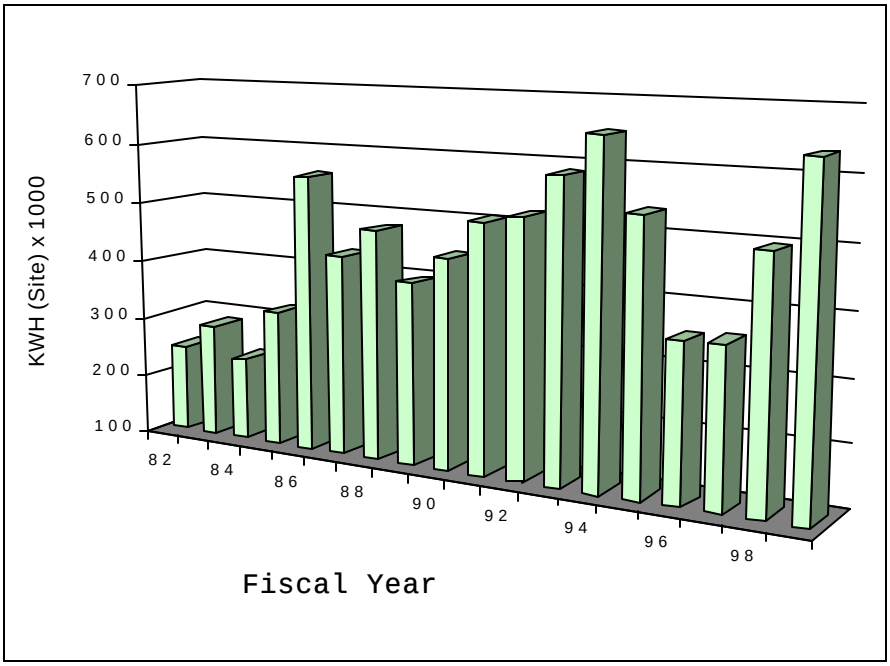


Figure 7: Average Recommended Electric Consumption Conserved Per Assessment by Fiscal Year

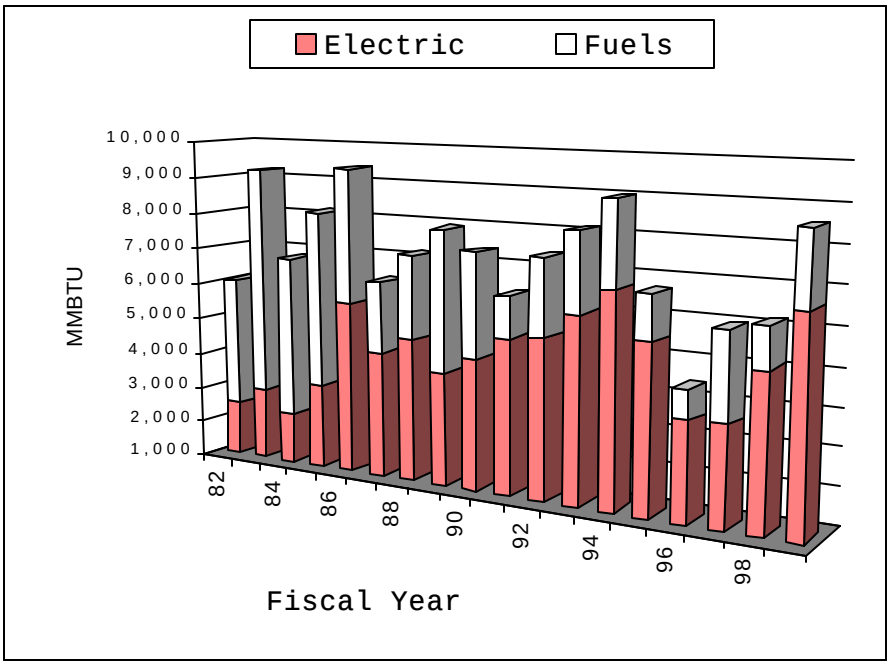


Figure 8. Average Recommended Energy Conserved by Fiscal Year

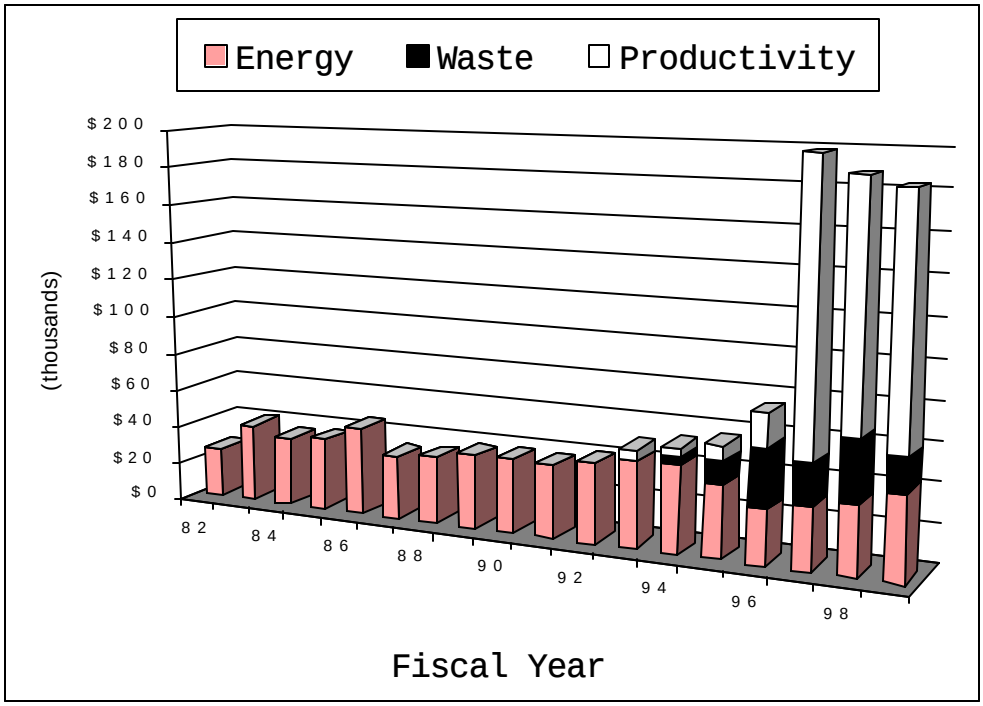


Figure 9. Average Recommended Cost Savings by Fiscal Year

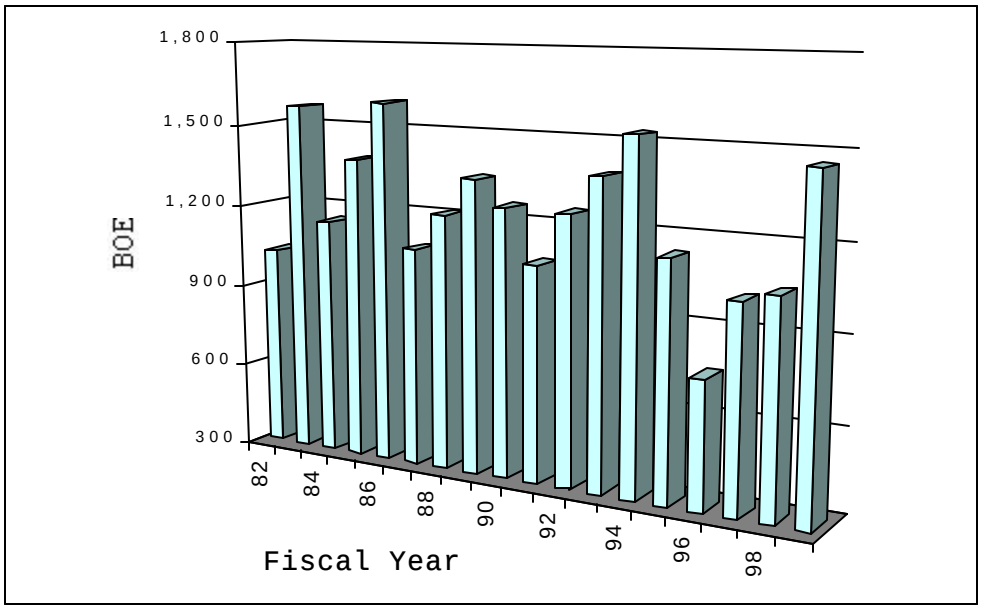


Figure 10. Average Recommended Barrels of Oil Avoided by Fiscal Year

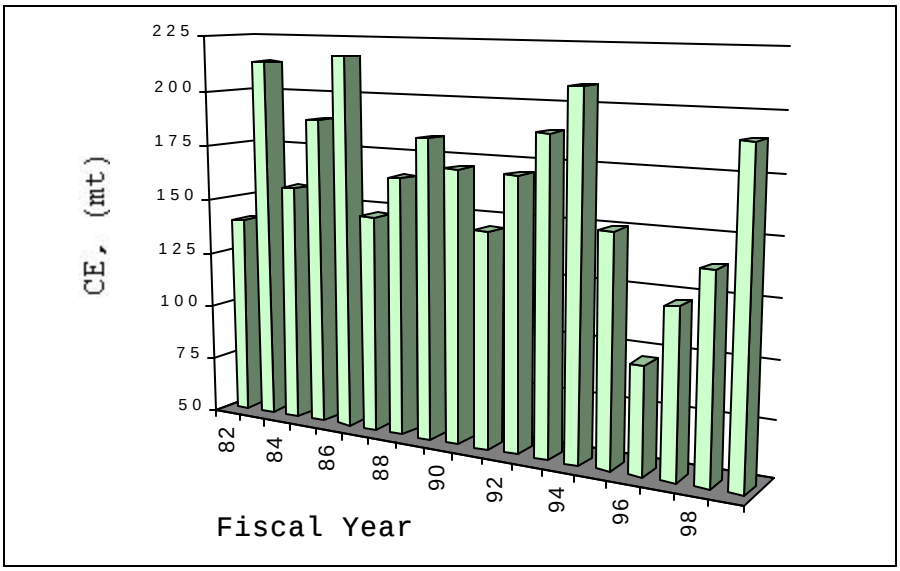


Figure 11. Average Recommended Carbon Avoided by Fiscal Year

Fiscal Year	Recommended Energy Conservation						Recommended Cost Savings ($)			
	Site (KWH)	Source Electric (MMBTU)	Site Fuels (MMBTU)	(MMBtu)	(B.O.E.)	(C.E., mt)	Energy	Waste	Productivity	Total
82	245,439	2,516	3,537	6,053	1,029	140	26,479	N/A	N/A	26,479
83	288,308	3,002	6,225	9,227	1,569	213	41,291	N/A	N/A	41,291
84	238,031	2,440	4,347	6,787	1,154	157	36,173	N/A	N/A	36,173
85	323,898	3,320	4,837	8,156	1,387	189	37,818	N/A	N/A	37,818
86	556,438	5,703	3,681	9,385	1,596	217	45,873	N/A	N/A	45,873
87	432,745	4,435	1,923	6,359	1,081	147	33,155	N/A	N/A	33,155
88	478,475	4,904	2,238	7,142	1,215	165	35,015	N/A	N/A	35,015
89	397,847	4,078	3,854	7,931	1,349	183	38,390	N/A	N/A	38,390
90	444,968	4,561	2,833	7,393	1,257	171	38,806	N/A	N/A	38,806
91	506,081	5,187	1,109	6,296	1,071	146	38,175	N/A	N/A	38,175
92	518,072	5,310	2,051	7,361	1,252	170	40,959	N/A	N/A	40,959
93	584,606	5,992	2,161	8,152	1,386	189	44,877	114	5,682	50,673
94	651,839	6,681	2,315	8,996	1,530	208	44,799	4,395	4,463	53,658
95	536,652	5,500	1,185	6,685	1,137	150	37,450	11,899	7,669	57,018
96	353,980	3,628	787	4,415	751	97	27,776	30,495	16,699	74,970
97	356,034	3,649	2,341	5,990	1,019	123	32,104	20,957	144,833	197,894
98	498,352	5,108	1,068	6,176	1,050	139	35,684	31,255	121,817	188,756
99	636,413	6,592	1,983	8,574	1,458	190	43,299	17,591	122,542	183,431
	447,121	4,589	2,693	7,282	1,238	166	37,673	22,440	82,712	67,696

Table 8. Average Recommended Energy Conservation and Cost Savings

ii. Recommended Savings by Industry Type

Savings recommended by industry type in Fiscal Year 1999 is shown in Table 9 and Figures 12 through 16. The largest amount of recommended energy conserved occurred during SIC 24 (Wood Products) assessments replacing SIC 20 (Food and Kindred Products) in FY98. The largest recommended cost savings was in SIC 30 (Rubber and Plastic Products) for the second year in a row. 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	Site (KWH)	Source Electric (MMBtu)	Site Fuels (MMBtu)	Total (MMBtu)	(B.O.E.)	(C.E., mt)	Energy	Waste	Productivity	Total
20	Foods	21,924,380	224,713	22,973	247,686	42,123	5,476	2,286,504	531,712	9,899,402	12,717,618
21	Tobacco Prod.	1,370,164	14,044	0	14,044	2,388	311	44,863	0	0	44,863
22	Textile Mills	4,729,192	48,471	117,252	165,723	28,184	3,664	958,892	142,475	569,170	1,670,537
23	Apparel	3,475,377	35,618	20,108	55,726	9,477	1,232	196,798	80,075	638,504	915,377
24	Wood Prod.	78,701,053	806,677	59,650	866,327	147,335	19,154	3,302,378	186,349	1,778,601	5,267,328
25	Furniture	5,378,956	55,130	79,201	134,331	22,845	2,970	586,884	529,029	2,339,138	3,455,051
26	Paper Prod.	14,432,004	147,918	14,116	162,034	27,557	3,583	873,885	1,227,628	3,059,546	5,161,059
27	Printing	5,453,687	55,892	8,372	64,264	10,929	1,421	330,085	112,745	1,734,255	2,177,085
28	Chemical Prod	66,916,172	685,881	104,440	790,321	134,408	17,474	3,108,615	449,503	9,236,429	12,794,547
29	Petroleum	1,375,439	14,099	291,613	305,712	51,992	6,759	875,997	91,245	1,018,322	1,985,564
30	Rubber & Plast.	66,159,719	728,405	-15,947	712,458	121,166	15,752	3,851,110	4,686,938	11,102,165	19,640,213
31	Leather Prod.	1,024,328	10,498	1,964	12,462	2,119	276	56,143	35,938	467,510	559,591
32	Stone & Glass	26,946,069	276,191	436,056	712,247	121,130	15,748	2,532,664	728,931	6,182,457	9,444,052
33	Primary Metal	22,533,703	230,959	171,940	402,899	68,520	8,908	2,862,551	1,206,880	6,370,236	10,439,667
34	Fab. Metal	71,514,355	732,997	12,010	745,007	126,702	16,472	5,039,759	1,851,053	10,989,874	17,880,686
35	Ind. Machinery	27,986,809	286,848	65,315	352,163	59,892	7,786	1,928,663	1,657,333	6,009,268	9,595,264
36	Electronics	13,327,951	136,602	10,224	146,826	24,970	3,246	982,894	362,200	5,775,006	7,120,100
37	Trans. Equip.	27,392,141	280,759	56,438	337,197	57,346	7,455	1,526,531	-1,019,408	11,662,355	12,169,478
38	Instruments	5,579,424	57,183	-1,203	55,980	9,520	1,238	368,963	42,083	482,556	893,602
39	Misc. Manuf.	906,505	9,288	669	9,957	1,693	220	67,132	8,744	630,703	706,579
Totals		**467,127,428**	**4,838,173**	**1,455,191**	**6,293,364**	**1,070,300**	**139,146**	**31,781,311**	**12,911,453**	**89,945,497**	**134,638,261**

Table 9. Recommended Cost and Energy Savings by Industry Type

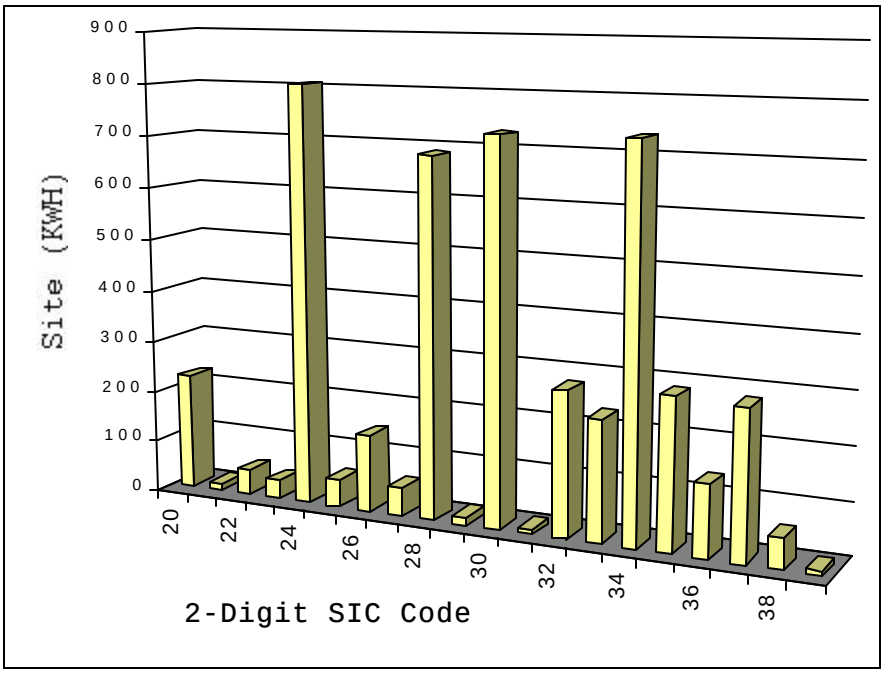


Figure 12. Recommended Electric Consumption Conserved by Industry Type

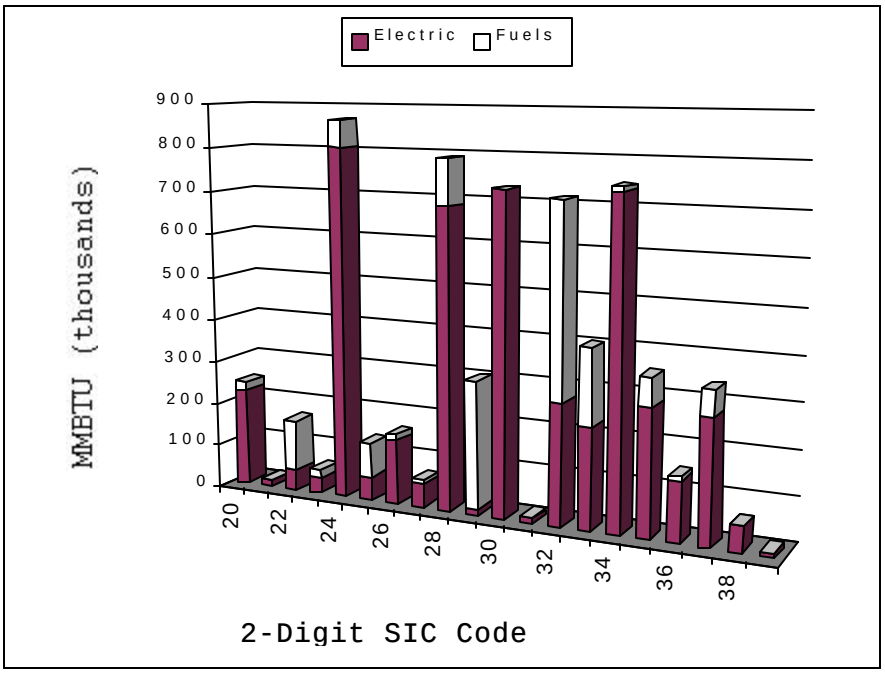


Figure 13. Recommended Energy Conserved by Industry Type

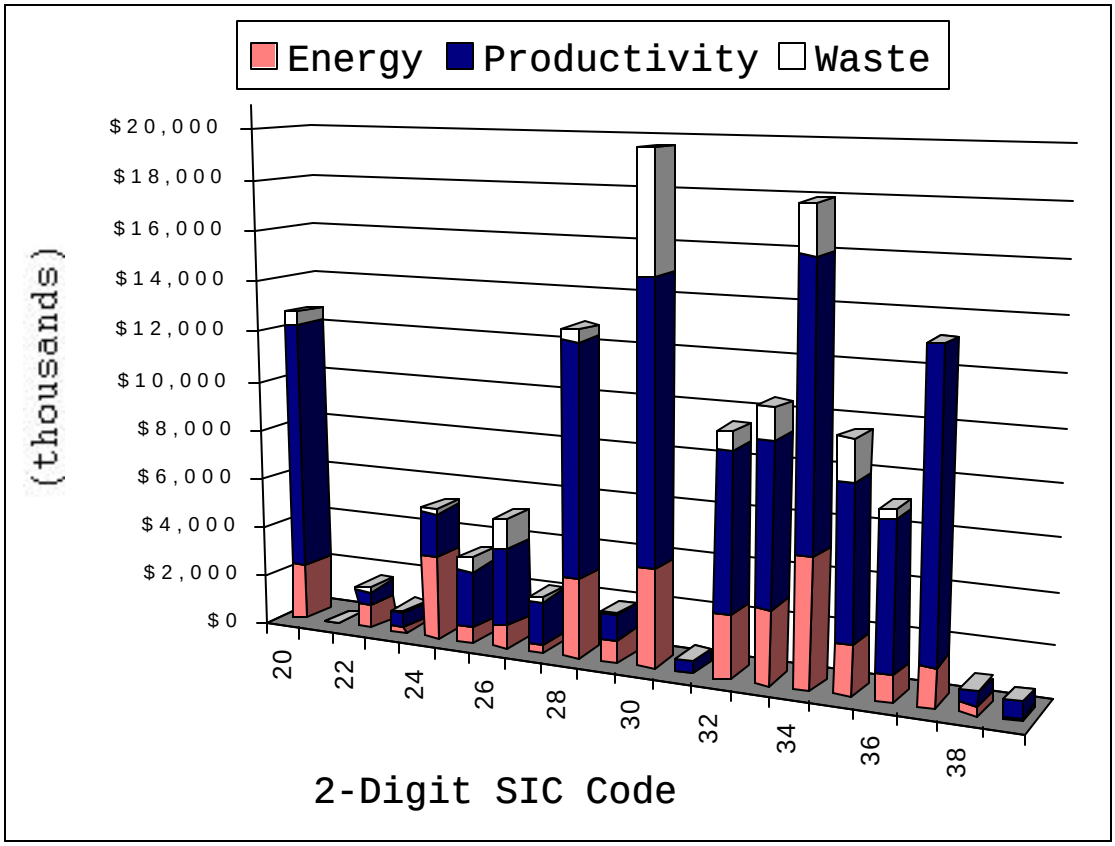


Figure 14. Recommended Cost Savings by Industry Type

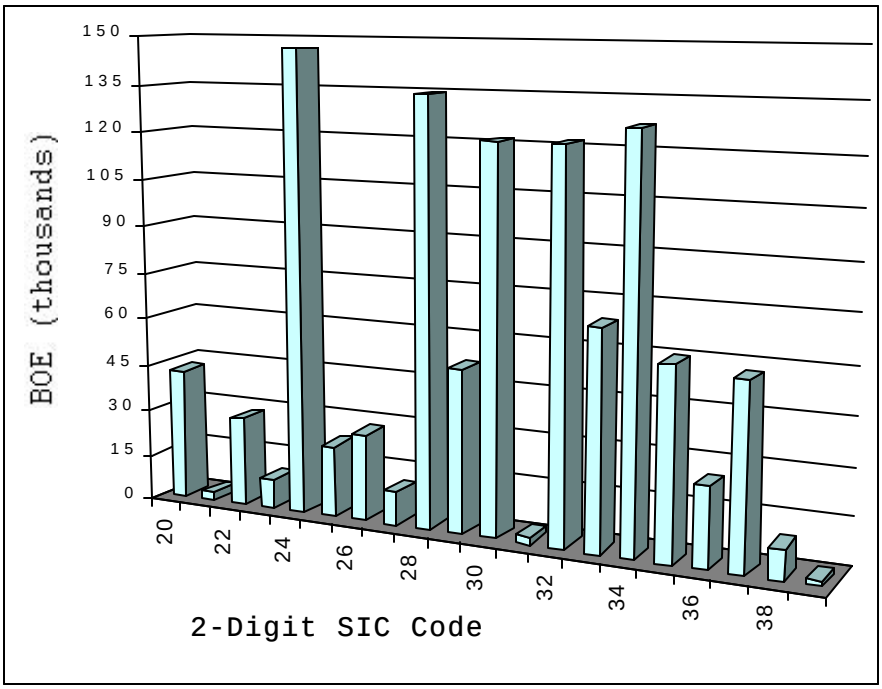


Figure 15. Recommended Barrels of Oil Avoided by Industry Type

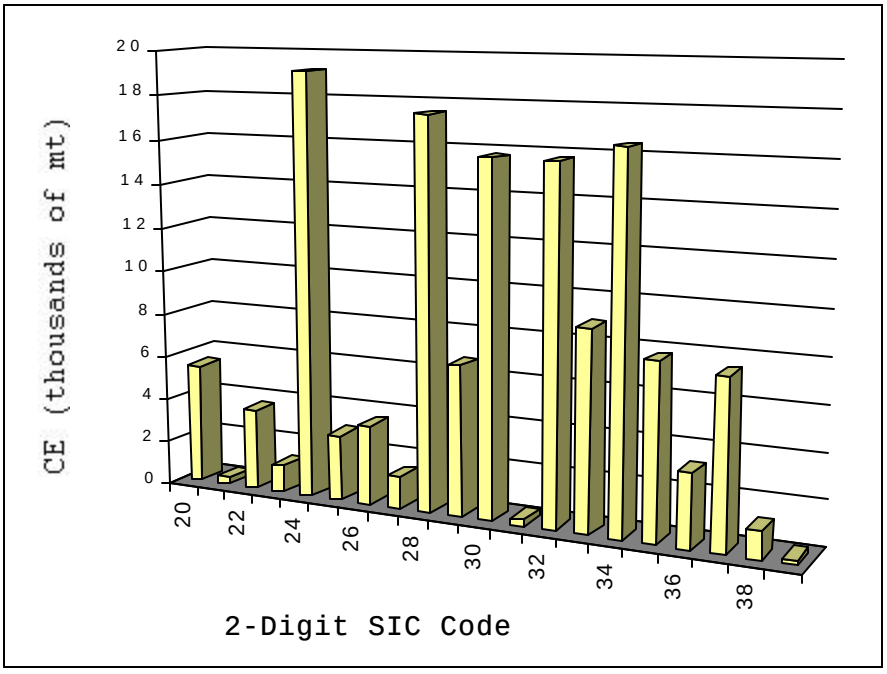


Figure 16. Recommended Carbon Avoided by Industry Type

Average recommended figures per assessment are shown in Table 10, and Figures 15 through 18.

SIC Code	Industry Description	Recommended Energy Conservation						Recommended Cost Savings ($)			
		Site (KWH)	Source Electric (MMBtu)	Site Fuels (MMBtu)	Total (MMBtu)	(B.O.E.)	(C.E., mt)	Energy	Waste	Productivity	Total
20	Foods	322,417	3,305	338	3,642	619	81	33,625	7,819	145,579	187,024
21	Tabacco Prod.	1,370,164	14,044	0	14,044	2,388	311	44,863	0	0	44,863
22	Textile Mills	337,799	3,462	8,375	11,837	2,013	262	68,492	10,177	40,655	119,324
23	Apparel	289,615	2,968	1,676	4,644	790	103	16,400	6,673	53,209	76,281
24	Wood Prod.	2,248,602	23,048	1,704	24,752	4,210	547	94,354	5,324	50,817	150,495
25	Furniture	283,103	2,902	4,168	7,070	1,202	156	30,889	27,844	123,113	181,845
26	Paper Prod.	481,067	4,931	471	5,401	919	119	29,130	40,921	101,985	172,035
27	Printing	201,988	2,070	310	2,380	405	53	12,225	4,176	64,232	80,633
28	Chemical Prod.	2,307,454	23,651	3,601	27,252	4,635	603	107,194	15,500	318,498	441,191
29	Petroleum	171,930	1,762	36,452	38,214	6,499	845	109,500	11,406	127,290	248,196
30	Rubber & Plast.	575,302	6,334	-139	6,195	1,054	137	33,488	40,756	96,541	170,784
31	Leather Prod.	341,443	3,499	655	4,154	706	92	18,714	11,979	155,837	186,530
32	Stone & Glass	709,107	7,268	11,475	18,743	3,188	414	66,649	19,182	162,696	248,528
33	Primary Metal	524,040	5,371	3,999	9,370	1,593	207	66,571	28,067	148,145	242,783
34	Fab. Metal	694,314	7,116	117	7,233	1,230	160	48,930	17,971	106,698	173,599
35	Ind. Machinery	363,465	3,725	848	4,574	778	101	25,048	21,524	78,042	124,614
36	Electronics	266,559	2,732	204	2,937	499	65	19,658	7,244	115,500	142,402
37	Trans. Equip.	702,363	7,199	1,447	8,646	1,470	191	39,142	-26,139	299,035	312,038
38	Instruments	328,201	3,364	-71	3,293	560	73	21,704	2,475	28,386	52,565
39	Misc. Manuf.	151,084	1,548	112	1,660	282	37	11,189	1,457	105,117	117,763
Average		**636,413**	**6,592**	**1,983**	**8,574**	**1,458**	**190**	**43,299**	**17,591**	**122,542**	**183,431**

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

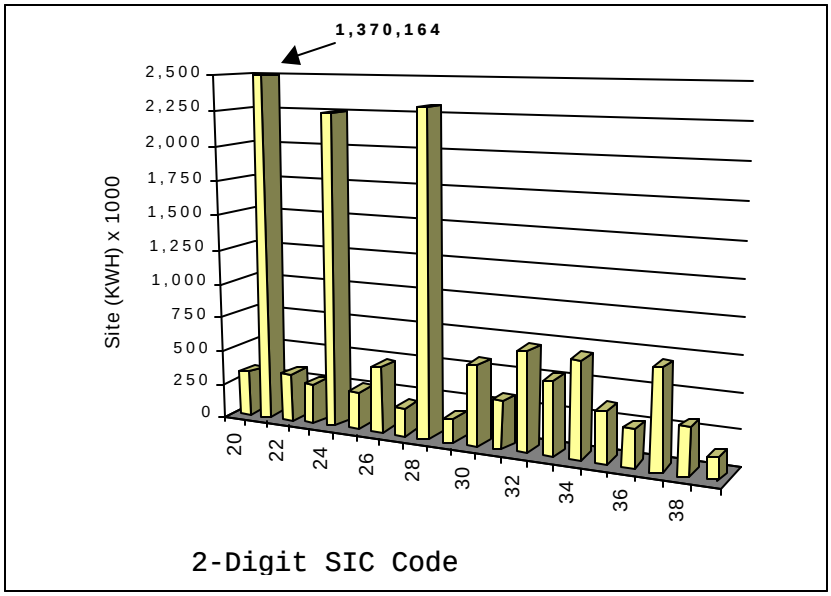


Figure 17. Average Recommended Electric Consumption Conserved by Industry Type

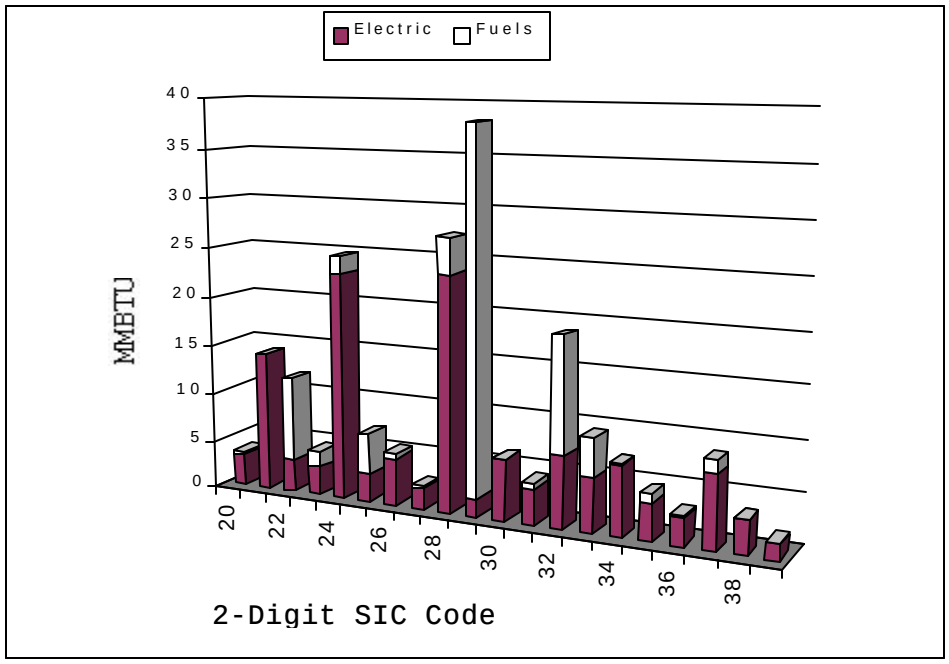


Figure 18. Average Recommended Energy Saved by Industry Type

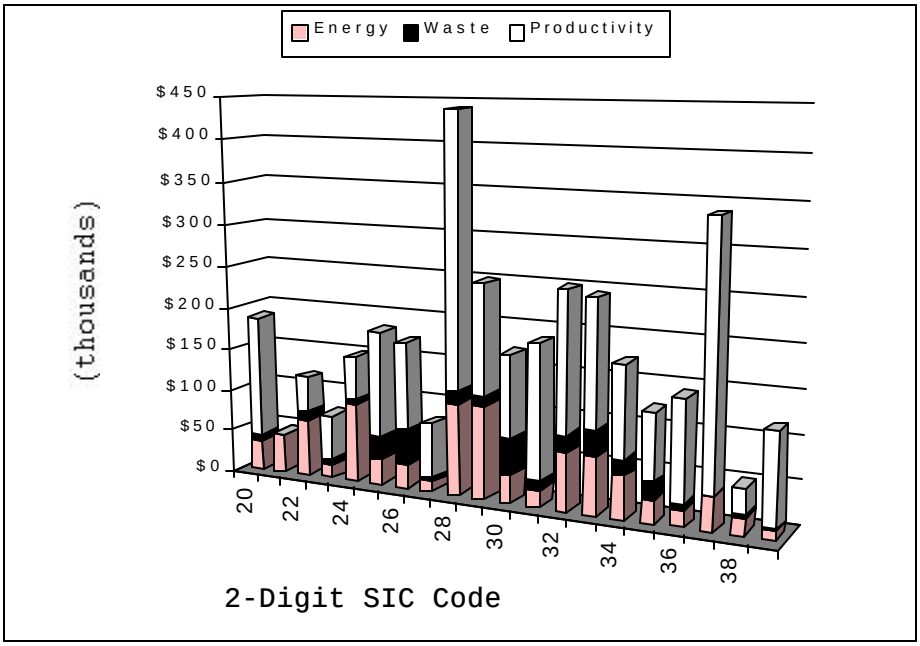


Figure 19. Average Recommended Cost Savings by Industry Type

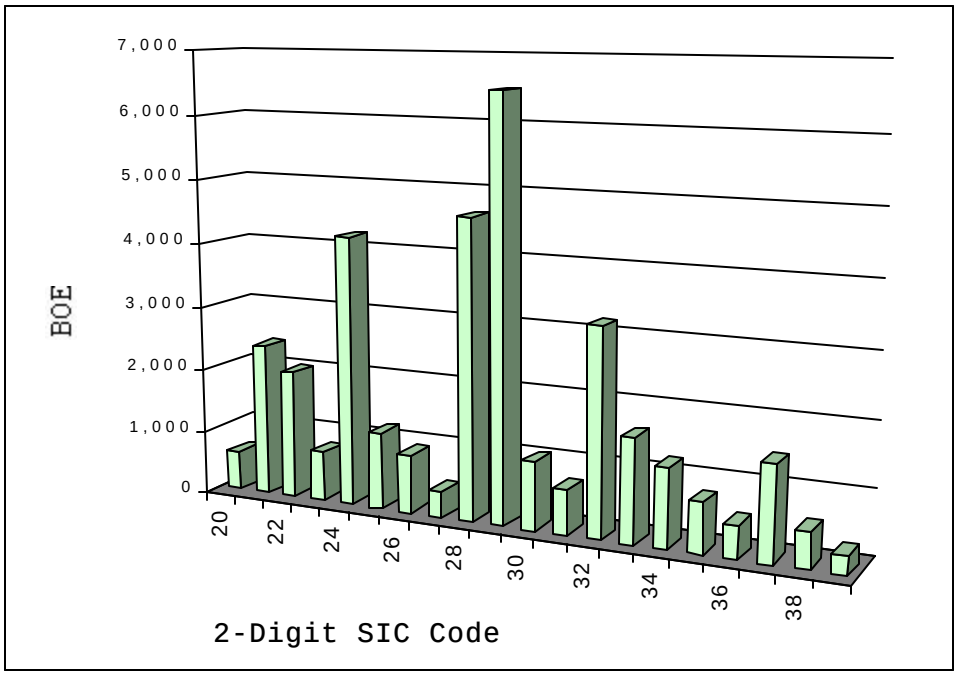


Figure 20. Average Recommended Barrels of Oil Saved by Industry Type

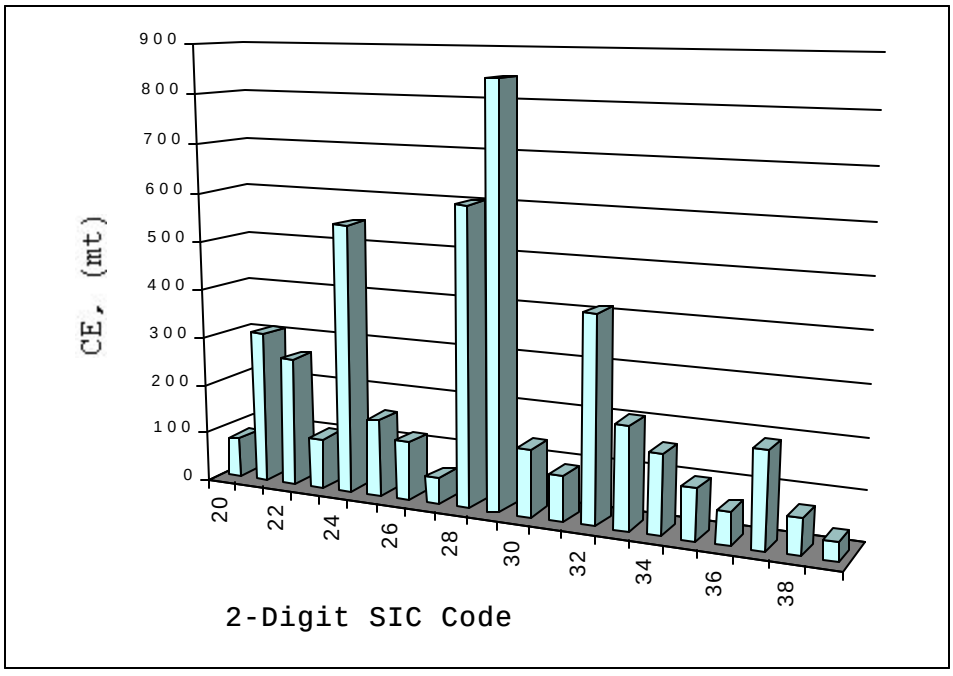


Figure 21. Average Recommended Carbon Avoided by Industry Type

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 FY99 was 6.3 million MMBTUs, with a dollar amount of almost $32 Million. Including non-energy dollars, the total recommended savings in FY99 amounted to $134.6 Million. This data is shown in Table 11, with the percentages by energy type in Figures 19 and 20. For the sake of clarity, it should be pointed out that some recommendations, such as co-generation and fuel switching, result in increased energy consumption (negative energy savings). 90% of the other energy savings is steam from a combined heat and power recommendation.

Energy Stream	Recommended Energy Conservation (MMBTU) Unless Noted	Recommended Energy Cost Savings ($)
Electricity		
Demand	719,924 KW-months/yr	7,450,636
Fees		566,758
Consumption – Site	467,127,428 KWH	
Consumption - Source	4,838,173	18,740,052
Natural Gas	887,638	3,046,482
L. P. G.	74,370	400,047
Fuel Oil #2	-87,188	-247,591
Fuel Oil #4	3,892	13,275
Fuel Oil #6	37,941	121,905
Coal	392,341	654,269
Wood	51,382	155,574
Other Energy	95,546	883,349
Energy Totals	**6,293,364**	**31,781,311**
Waste	n/a	12,911,453
Productivity	n/a	89,945,497
Program Totals	**6,293,364**	**134,638,261**

Table 11. Recommended Conservation and Cost Savings by Resource Stream

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

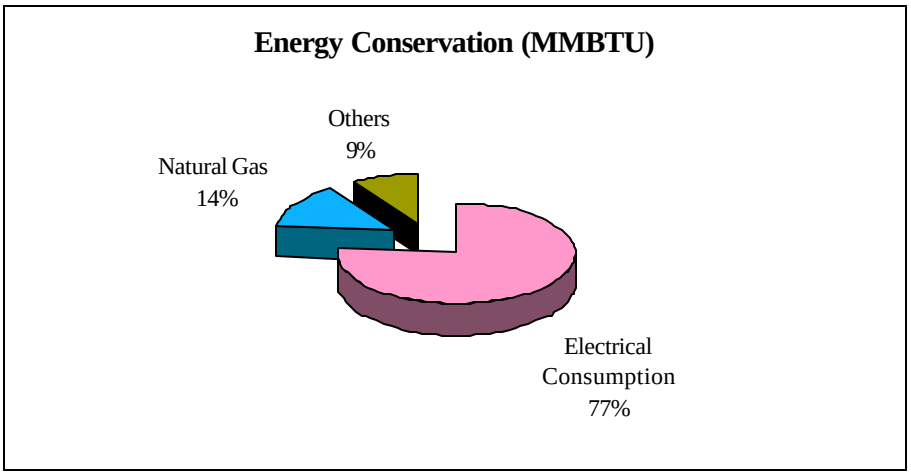


Figure 22. Composition of Recommended Energy Conserved by Energy Stream

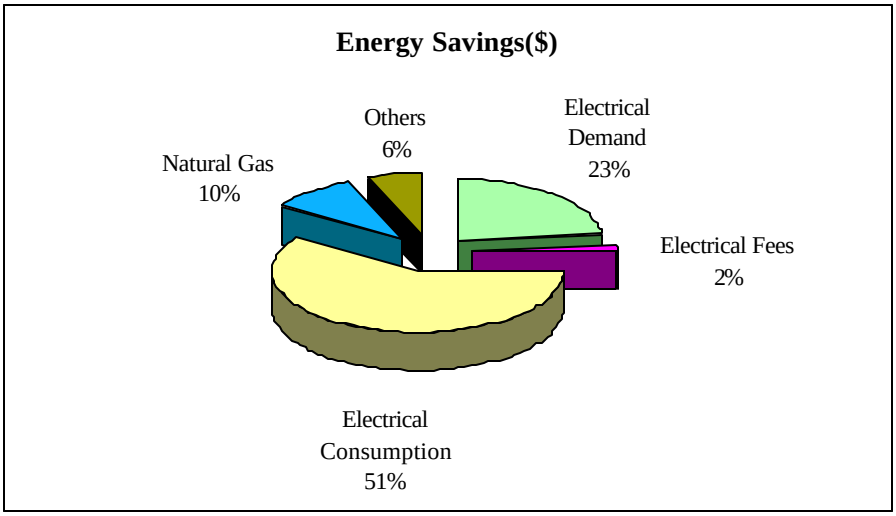


Figure 23. Composition of Recommended Cost Savings by Energy Stream

The database is broken into four resource stream types: energy, waste reduction, resource costs, and production. Table 12 shows the recommended cost savings grouped by non-energy resource type. Figure 24 shows the composition of the recommended non-energy cost savings.

Stream Type	Total Recommended Non-Energy Cost Savings ($)
Production	
Primary Product	41,605,735
Byproduct Production	1,437,768
Resource Costs	
Personnel Changes	23,171,199
Administrative Costs	9,722,607
Primary Raw Material	6,367,697
Ancillary Material Cost	3,519,732
Water Consumption	1,048,044
One Time Revenue of Avoided Costs	3,072,715
Waste Reduction	
Water Disposal	2,173,789
Other Liquid (non-haz)	876,794
Other Liquid (haz)	2,690,638
Solid Waste (non-haz)	6,747,872
Solid Waste (haz)	225,446
Gaseous Waste (haz)	196,914
Non-Energy Total	**102,856,950**

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

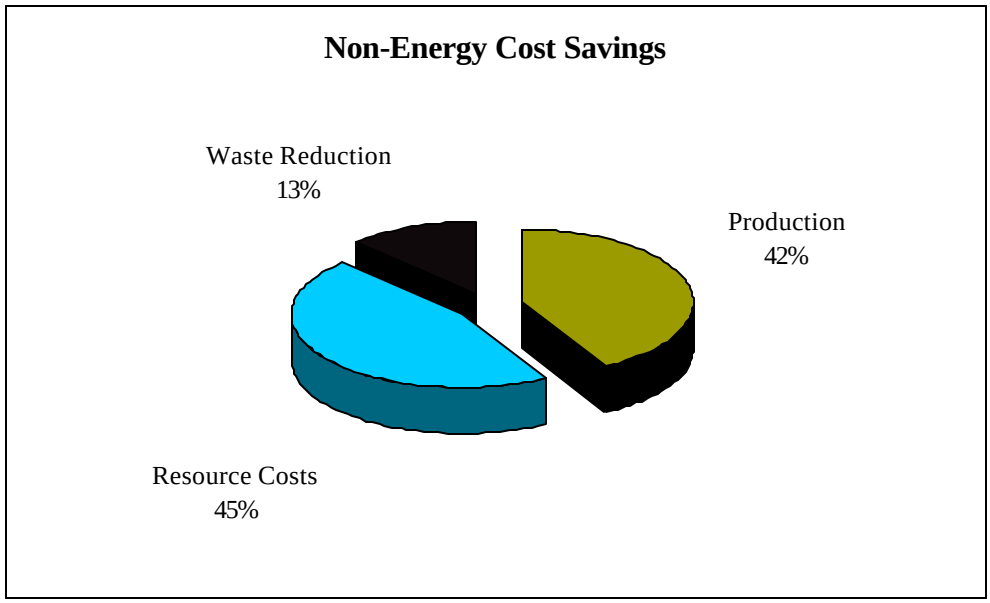


Figure 24. Recommended Non-Energy Cost Savings

Figure 24 indicates the composition of the total recommendations by resource stream for FY99.

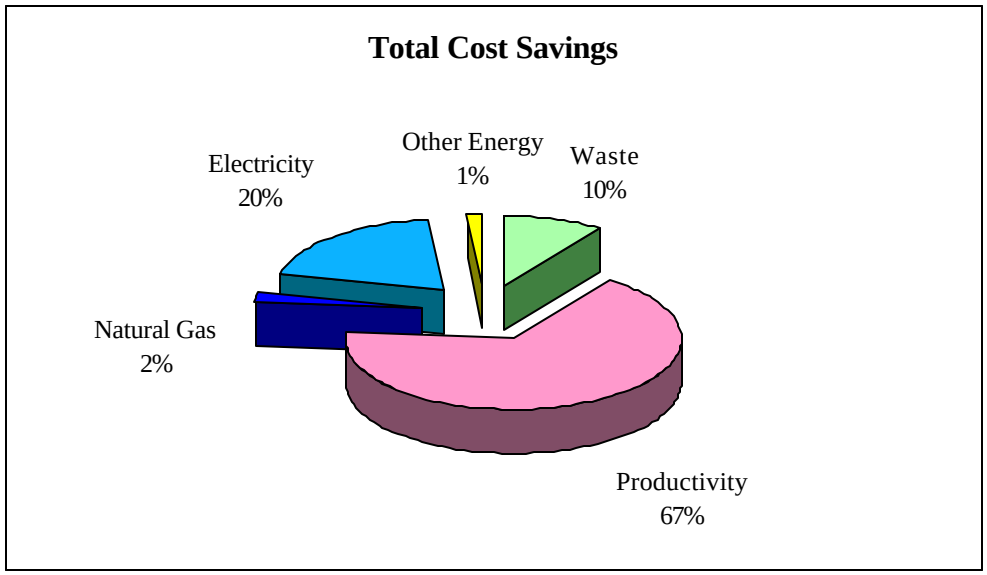


Figure 25. Recommended Cost Savings by Resource Stream

iv. Recommended Savings by Recommendation Type

Energy conservation recommendations are categorized by use of a detailed expert system known as Assessment Recommendation Codes (ARC). There were more than 300 coded recommendations broken into nine major 2-digit categories for energy. Fiscal Year 1994 saw the introduction of the single digit categories 3 (waste minimization and pollution prevention) and 4 (productivity enhancements). There were almost 300 different recommendations in these categories. Table 13 shows the category description and number of recommendations by assessment recommendation (AR) type for FY99. Figure 23 shows the frequency of the recommendations.. The average number of recommendations was eight. 76 recommendations were used only once. And 198 recommendations were used five or less times. A review of Table 13 and Figure 26 further illustrate the fact that most recommendations were process oriented.

2-Digit ARC Code	Category Description	No. of Recommendations
2.1	Combustion Systems	250
2.2	Thermal Systems	490
2.3	Electrical Power	215
2.4	Motor Systems	1211
2.5	Industrial Design	7
2.6	Operations	128
2.7	Buildings and Grounds	1140
2.8	Ancillary Costs	148
2.9	Alternate Energy Use	1
3.1	Operations	85
3.2	Equipment	62
3.3	Post Generation Treatment/Minimization	43
3.4	Water Use	207
3.5	Recycling	338
3.6	Waste Disposal	162
3.7	Maintenance	65
3.8	Raw Materials	54
4.1	Manufacturing Enhancements	184
4.2	Purchasing	62
4.3	Inventory	29
4.4	Labor Optimization	272
4.5	Space Utilization	83
4.6	Reduction of Downtime	151
4.7	Management Practices	9
4.8	Other Administrative Savings	76
	Total	**5472**

Table 13. Recommendations by Recommendation Type

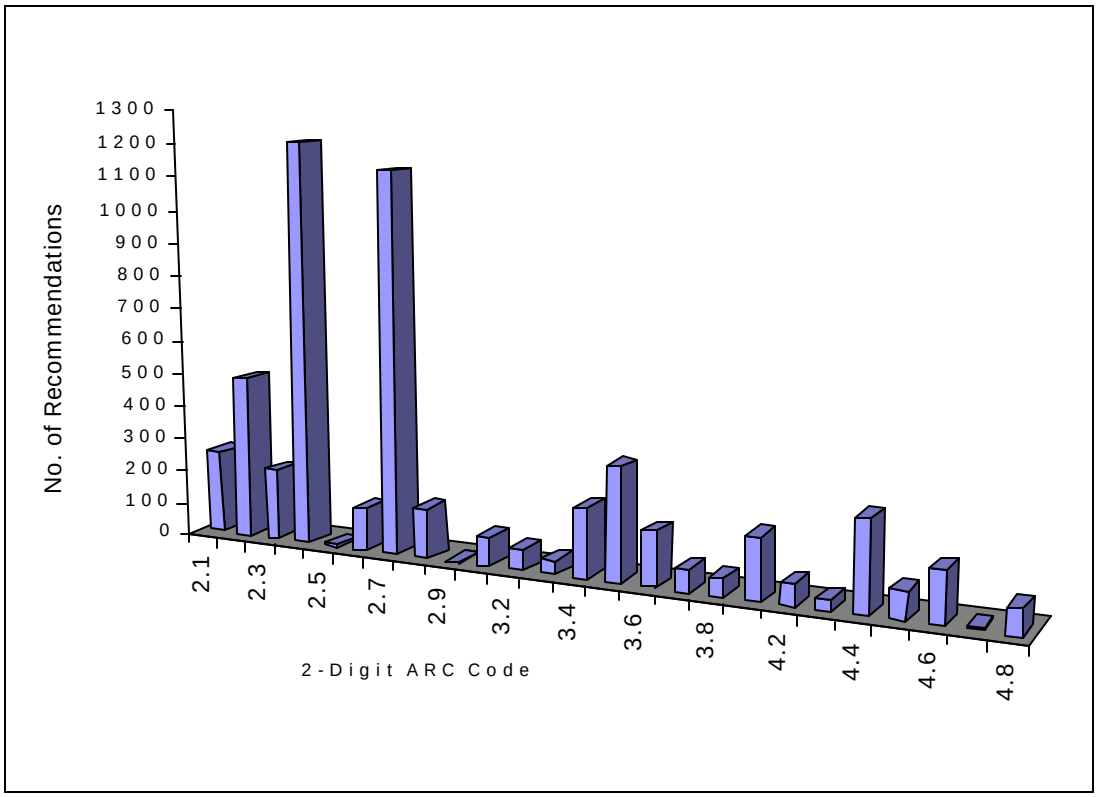


Figure 26. Number of Recommendations by Recommendation Type

D. Implementation Results

i. General

The IAC program has historically enjoyed a high rate of implementation of recommendations. The results of the 1999 program year showed an implementation rate of almost 50%. This rate represents the ratio of the number of recommendations that are adopted, as reported by the clients, to the number of recommendations with known results made by the Centers. The implementation rate as defined as the amount of energy (MMBTU) saved compared to the amount recommended was 44%, and as energy cost ($) saved to recommended was 35%. Tables 14 through 24, and Figures 27 through 57 are all related to implementation results.

Fiscal year	Energy Recommendations			Waste Recommendations			Productivity Recommendations			All Recommendations		
	Recommendations with Known Results	Implemented	% Implemented	Recommendations with Known Results	Implemented	% Implemented	Recommendations with Known Results	Implemented	% Implemented	Recommendations with Known Results	Implemented	% Implemented
82	1,152	317	28%	N/A	N/A	N/A	N/A	N/A	N/A	1,152	317	28%
83	1,150	352	31%	N/A	N/A	N/A	N/A	N/A	N/A	1,150	352	31%
84	1,746	1,050	60%	N/A	N/A	N/A	N/A	N/A	N/A	1,746	1,050	60%
85	2,377	1,400	59%	N/A	N/A	N/A	N/A	N/A	N/A	2,377	1,400	59%
86	1,998	1,254	63%	N/A	N/A	N/A	N/A	N/A	N/A	1,998	1,254	63%
87	2,175	1,404	65%	N/A	N/A	N/A	N/A	N/A	N/A	2,175	1,404	65%
88	2,629	1,581	60%	N/A	N/A	N/A	N/A	N/A	N/A	2,629	1,581	60%
89	2,380	1,402	59%	N/A	N/A	N/A	N/A	N/A	N/A	2,380	1,402	59%
90	2,417	1,395	58%	N/A	N/A	N/A	N/A	N/A	N/A	2,417	1,395	58%
91	3,091	1,766	57%	N/A	N/A	N/A	N/A	N/A	N/A	3,091	1,766	57%
92	3,749	1,828	49%	N/A	N/A	N/A	N/A	N/A	N/A	3,749	1,828	49%
93	3,963	2,041	52%	29	11	38%	1	0	0%	3,993	2,052	51%
94	5,104	2,516	49%	169	66	39%	8	3	38%	5,281	2,585	49%
95	5,339	2,846	53%	475	203	43%	12	7	58%	5,826	3,056	52%
96	4,912	2,715	55%	1,267	573	45%	59	33	56%	6,238	3,321	53%
97	3,532	1,866	53%	1,304	537	41%	678	328	48%	5,514	2,731	50%
98	3,624	1,889	52%	1,155	503	44%	791	381	48%	5,570	2,773	50%
99	3,358	1,528	46%	950	358	38%	797	332	42%	5,105	2,218	43%
Totals	**54,696**	**29,150**	**53%**	**5,349**	**2,251**	**42%**	**2,346**	**1,084**	**46%**	**62,391**	**32,485**	**52%**

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

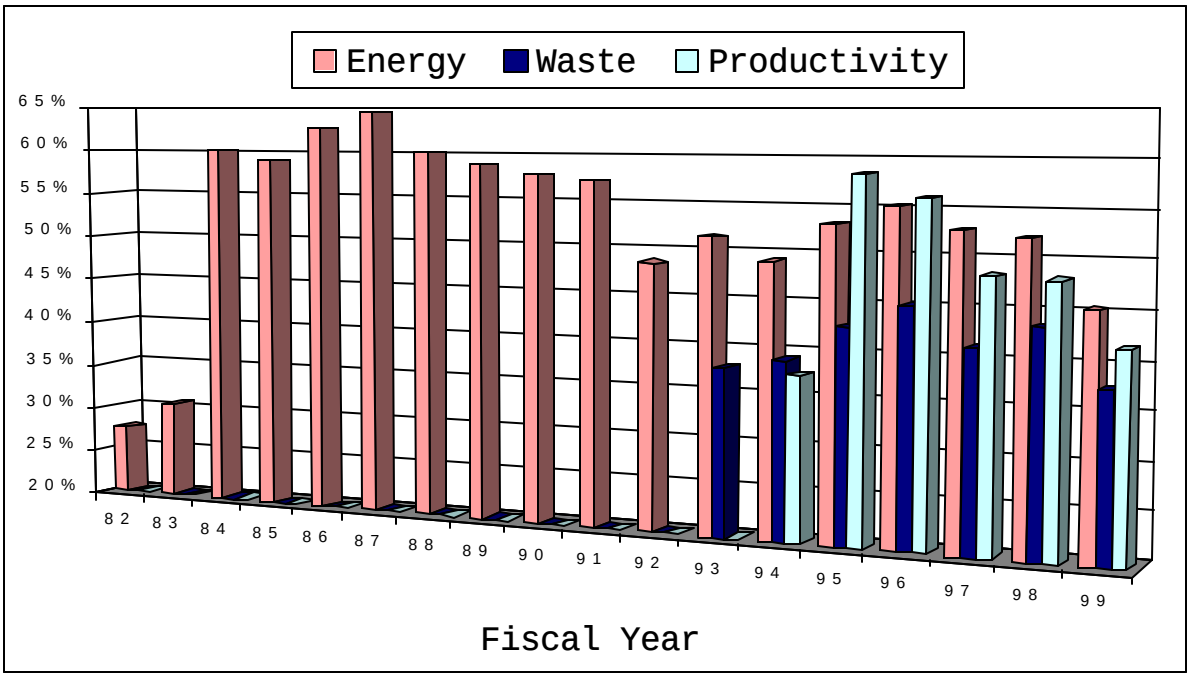


Figure 27. Percent of Recommendations Implemented by Fiscal Year

Fiscal Year	Implemented Energy Conservation						Implemented Cost Savings ($)			
	Site (KWH)	Source Electric (MMBtu)	Site Fuels (MMBtu)	Total (MMBtu)	(B.O.E.)	(C.E., mt)	Energy	Waste	Productivity	Total
82	13,269,047	135,989	308,724	444,713	75,631	10,286	1,839,122	N/A	N/A	1,839,122
83	11,012,604	112,873	313,856	426,729	72,573	9,870	1,923,834	N/A	N/A	1,923,834
84	29,029,583	297,507	557,897	855,404	145,477	19,785	4,583,098	N/A	N/A	4,583,098
85	57,900,606	593,407	928,192	1,521,599	258,775	35,193	7,006,147	N/A	N/A	7,006,147
86	60,748,216	622,620	696,206	1,318,826	224,290	30,503	6,667,801	N/A	N/A	6,667,801
87	59,721,543	612,062	623,212	1,235,274	210,081	28,571	5,866,646	N/A	N/A	5,866,646
88	60,931,075	624,469	838,100	1,462,569	248,736	33,828	6,132,078	N/A	N/A	6,132,078
89	84,842,878	869,577	697,287	1,566,864	266,473	36,240	7,479,996	N/A	N/A	7,479,996
90	70,986,485	727,539	615,259	1,342,798	228,367	31,058	6,570,825	N/A	N/A	6,570,825
91	91,441,640	937,190	479,719	1,416,909	240,971	32,772	8,460,459	N/A	N/A	8,460,459
92	125,912,635	1,290,512	744,351	2,034,863	346,065	47,065	10,168,974	N/A	N/A	10,168,974
93	107,599,596	1,102,764	786,084	1,888,848	321,233	43,688	9,366,098	15,800	1,586,457	10,968,355
94	154,128,321	1,579,680	734,560	2,314,240	393,578	53,527	12,107,654	1,688,656	1,488,956	15,285,266
95	185,512,579	1,901,352	630,148	2,531,500	430,527	54,782	13,242,626	4,557,805	2,633,195	20,433,626
96	190,188,971	1,949,277	564,934	2,514,211	427,587	54,734	13,300,146	7,061,972	7,016,918	27,379,036
97	115,360,456	1,182,335	563,999	1,746,334	296,996	36,952	9,549,476	5,207,156	24,311,830	39,068,462
98	112,567,232	1,153,717	525,496	1,679,213	285,580	35,431	8,619,242	5,376,382	35,664,957	49,660,581
99	172,812,108	1,821,533	964,636	2,786,169	473,838	59,485	11,013,975	6,084,221	33,092,749	50,190,945
Totals	1,703,965,575	17,514,403	11,572,660	29,087,063	4,946,779	653,771	143,898,197	29,991,992	105,795,062	279,685,251

Table 15. Implemented Savings by Fiscal Year

Figure 28 and Table 16 show a comparison of the simple payback of the measures recommended to the simple payback of the measures that were implemented. In FY99, the directors used over 375 different recommendations, of which 265 were implemented

Table 16. Recommended and Implemented Simple Payback

Fiscal Year	Recommended Quantities			Implemented Quantities			% of Recommended Cost Savings Implemented
	Cost Savings ($)	Implemention Cost ($)	Simple Payback Period (years)	Cost Savings ($)	Implemention Cost ($)	Simple Payback Period (years)	
82	6,699,075	9,158,809	1.4	1,839,122	2,047,222	1.1	27%
83	8,449,809	10,385,259	1.2	1,924,094	1,708,454	0.9	23%
84	8,991,122	8,847,422	1.0	4,598,839	3,222,790	0.7	51%
85	14,153,056	18,538,810	1.3	7,022,498	4,517,755	0.6	50%
86	13,945,808	17,469,216	1.3	6,880,489	3,984,805	0.6	49%
87	11,517,583	15,057,528	1.3	5,947,899	7,613,376	1.3	52%
88	13,942,973	16,533,416	1.2	6,550,084	4,392,033	0.7	47%
89	14,562,259	16,496,742	1.1	8,027,428	6,338,466	0.8	55%
90	14,919,268	19,176,962	1.3	7,588,905	7,191,266	0.9	51%
91	18,148,895	16,303,282	0.9	8,862,728	8,155,209	0.9	49%
92	22,441,561	35,954,528	1.6	11,179,352	16,777,959	1.5	50%
93	29,643,941	45,521,405	1.5	10,973,815	9,447,658	0.9	37%
94	41,638,265	65,574,847	1.6	15,285,266	16,990,827	1.1	37%
95	50,119,043	72,855,526	1.5	20,437,610	23,834,919	1.2	41%
96	64,998,914	71,511,907	1.1	27,214,344	29,659,638	1.1	42%
97	142,483,538	100,564,895	0.7	38,949,395	26,314,346	0.7	27%
98	136,470,554	143,787,752	1.1	49,147,704	39,083,070	0.8	36%
99	134,638,261	149,689,551	1.1	50,190,680	60,965,903	1.2	37%
Totals	**613,125,664**	**683,738,306**	**1.1**	**232,429,572**	**211,279,793**	**0.9**	**38%**

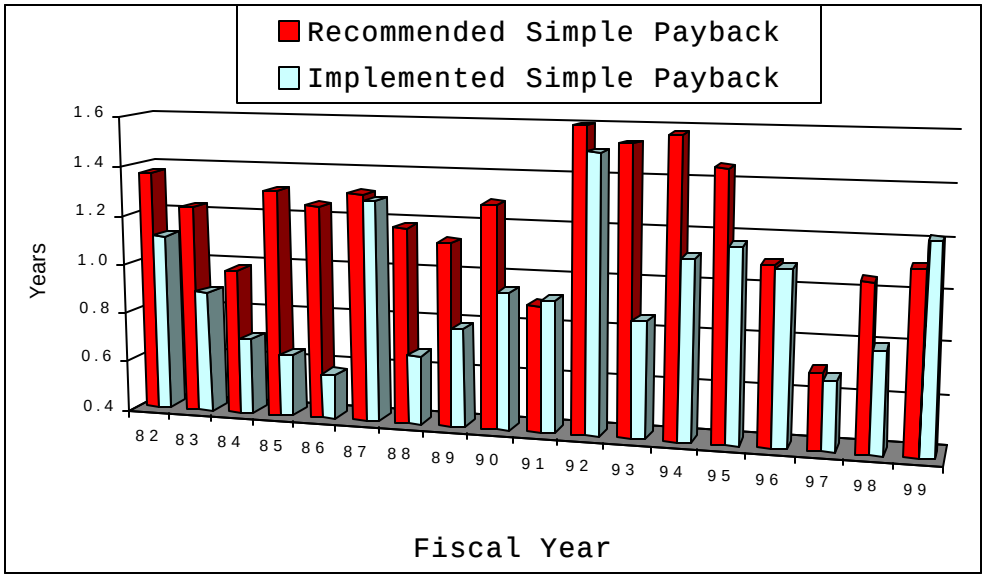


Figure 28. Recommended vs. Implemented Simple Payback

Assuming that the useful life of any one implemented energy conservation measure is not indefinite; Table 17 and Figures 29 through 32 show the cumulative effect of these measures if each remained in place over a seven-year time frame.

	Implemented Energy Conservation (in thousands)						Implemented Cost Savings ($) (in thousands)			
Fiscal Year	Site (KWH)	Source Electric (MMBtu)	Site Fuels (MMBtu)	Total (MMBtu)	(B.O.E.)	(C.E., mt)	Energy	Waste	Productivity	Total
82	13,269	136	309	445	76	10	1,839	N/A	N/A	1,839
82-83	24,282	249	623	871	150	20	3,763	N/A	N/A	3,763
82-84	53,311	546	1,180	1,727	296	40	8,346	N/A	N/A	8,346
82-85	111,212	1,140	2,109	3,248	558	75	15,352	N/A	N/A	15,352
82-86	171,960	1,762	2,805	4,567	784	106	22,020	N/A	N/A	22,020
82-87	231,682	2,374	3,428	5,803	996	134	27,887	N/A	N/A	27,887
82-88	292,613	2,999	4,266	7,265	1,247	168	34,019	N/A	N/A	34,019
83-89	364,187	3,733	4,655	8,387	1,440	194	39,660	N/A	N/A	39,660
84-90	424,160	4,347	4,956	9,303	1,597	215	44,307	N/A	N/A	44,307
85-91	486,572	4,987	4,878	9,865	1,694	228	48,184	N/A	N/A	48,184
86-92	554,584	5,684	4,694	10,378	1,782	240	51,347	N/A	N/A	51,347
87-93	601,436	6,164	4,784	10,948	1,880	253	54,045	16	1,586	55,647
88-94	695,843	7,132	4,895	12,027	2,065	278	60,286	1,704	3,075	65,066
89-95	820,424	8,409	4,687	13,096	2,248	299	67,397	6,262	5,709	79,368
90-96	925,770	9,488	4,555	14,043	2,411	318	73,217	13,324	12,726	99,267
91-97	970,144	9,943	4,504	14,447	2,480	324	76,195	18,531	37,037	131,764
92-98	991,270	10,160	4,550	14,709	2,502	326	76,354	23,908	72,702	172,964
93-99	1,038,169	10,691	4,770	15,461	2,629	339	77,199	29,992	105,795	212,986
Totals	8,770,888	89,943	66,648	156,591	26,834	3,567	781,416	93,738	238,631	1,113,785

Table 17. Seven Year Cumulative Conservation and Cost Savings

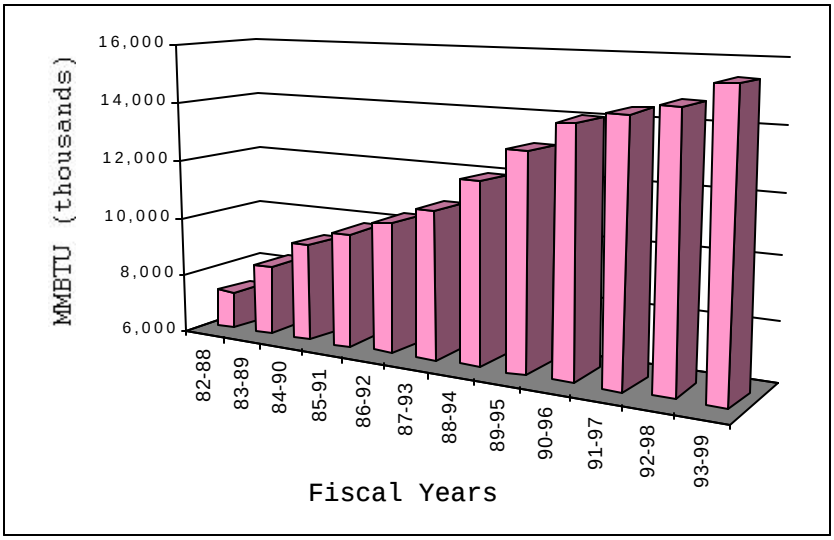


Figure 29. Seven Year Cumulative Energy Savings

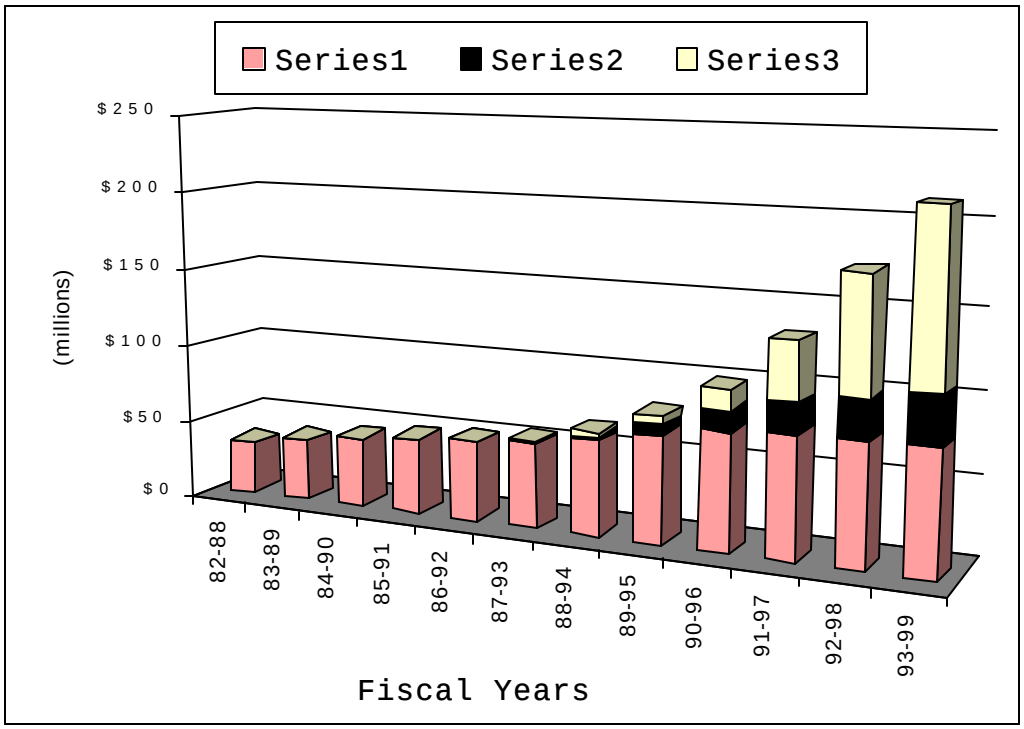


Figure 30. Seven Year Cumulative Cost Savings

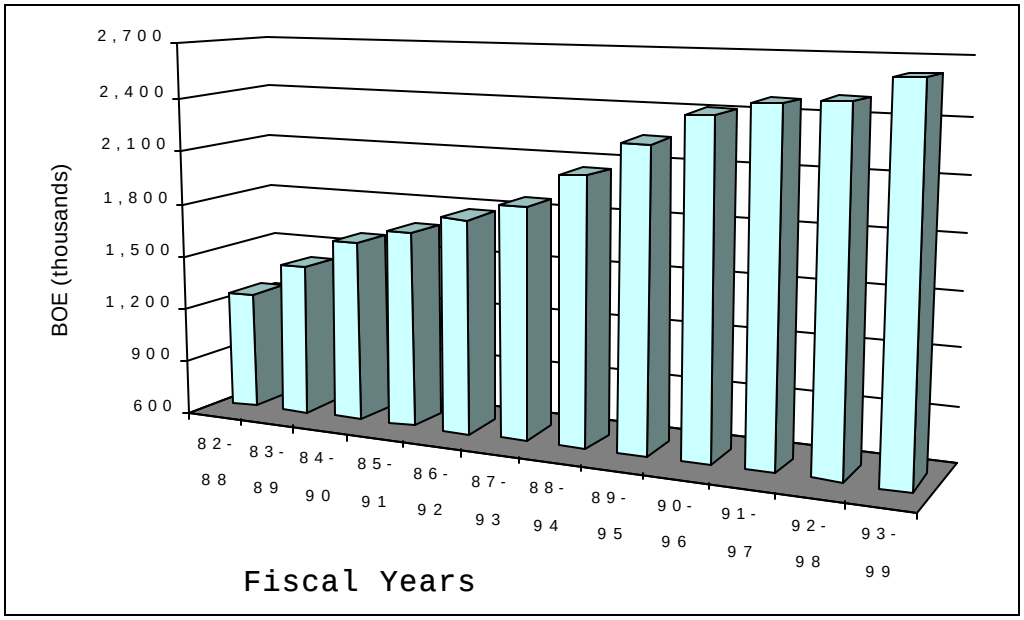


Figure 31. Seven Year Cumulative Barrels of Oil Avoided

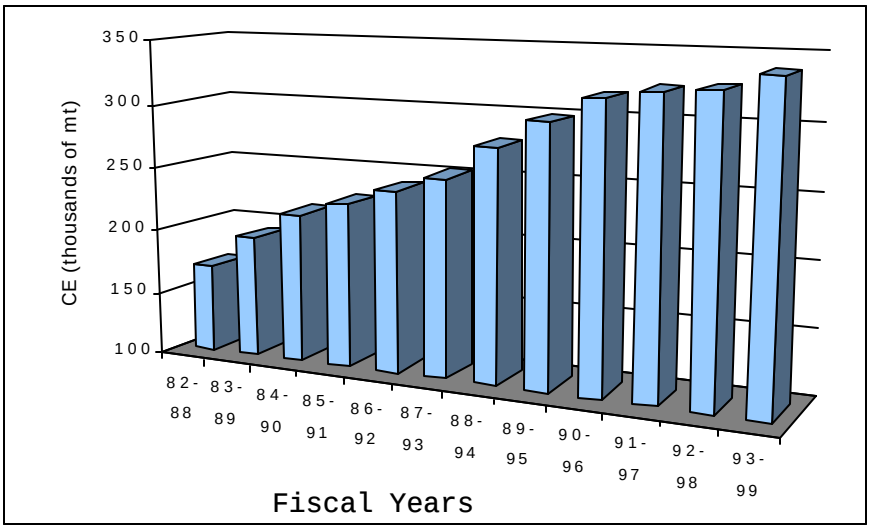


Figure 32. Seven Year Cumulative Carbon Avoided

Similar to the charts in the previous section showing recommended savings, the average and median energy and cost saved due to the implementation of recommended measures is shown per assessment for FY99 and as a three year average. This can be seen in Table 18-19 and Figures 33-40.

Table 18. Average Implemented Energy and Cost Savings by Fiscal Year

Fiscal Year	Implemented Energy Conservation						Implemented Cost Savings ($)			
	Site (KWH)	Source Electric (MMBtu)	Site Fuels (MMBtu)	Total (MMBtu)	(B.O.E.)	(C.E., mt)	Energy	Waste	Productivity	Total
82	52,447	538	1,220	1,758	299	41	7,269	N/A	N/A	7,269
83	52,192	535	1,487	2,022	344	47	9,118	N/A	N/A	9,118
84	117,055	1,200	2,250	3,449	587	80	18,480	N/A	N/A	18,480
85	157,339	1,613	2,522	4,135	703	96	19,038	N/A	N/A	19,038
86	203,853	2,089	2,336	4,426	753	102	22,375	N/A	N/A	22,375
87	184,326	1,889	1,923	3,813	648	88	18,107	N/A	N/A	18,107
88	157,039	1,609	2,160	3,770	641	87	15,804	N/A	N/A	15,804
89	249,538	2,558	2,051	4,608	784	107	22,000	N/A	N/A	22,000
90	197,185	2,021	1,709	3,730	634	86	18,252	N/A	N/A	18,252
91	200,971	2,060	1,054	3,114	530	72	18,594	N/A	N/A	18,594
92	238,923	2,449	1,412	3,861	657	89	19,296	N/A	N/A	19,296
93	190,105	1,948	1,389	3,337	568	77	16,548	28	2,803	19,379
94	206,054	2,112	982	3,094	526	72	16,187	2,258	1,991	20,435
95	218,507	2,240	742	2,982	507	65	15,598	5,368	3,102	24,068
96	224,810	2,304	668	2,972	505	65	15,721	8,347	8,294	32,363
97	174,789	1,791	855	2,646	450	56	14,469	7,890	36,836	59,195
98	164,092	1,682	766	2,448	416	52	12,564	7,837	51,990	72,392
99	250,816	2,644	1,400	4,044	688	86	15,985	8,831	48,030	72,846

Fiscal Year	Implemented Energy Conservation			Implemented Cost Savings ($)
	(MMBtu)	(B.O.E.)	(C.E., mt)	Energy
82	1,208	205	28	5,493
83	1,321	225	31	7,954
84	1,626	277	38	11,447
85	1,633	278	38	10,616
86	2,153	366	50	12,621
87	1,689	287	39	10,224
88	1,445	246	33	9,805
89	1,844	314	43	11,658
90	1,944	331	45	11,643
91	2,367	403	55	18,234
92	1,558	265	36	9,545
93	1,429	243	33	10,330
94	1,590	270	37	9,999
95	1,533	261	33	9,489
96	1,446	246	31	9,111
97	1,294	220	27	7,677
98	1,217	207	26	7,370
99	1,157	197	25	7,102

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

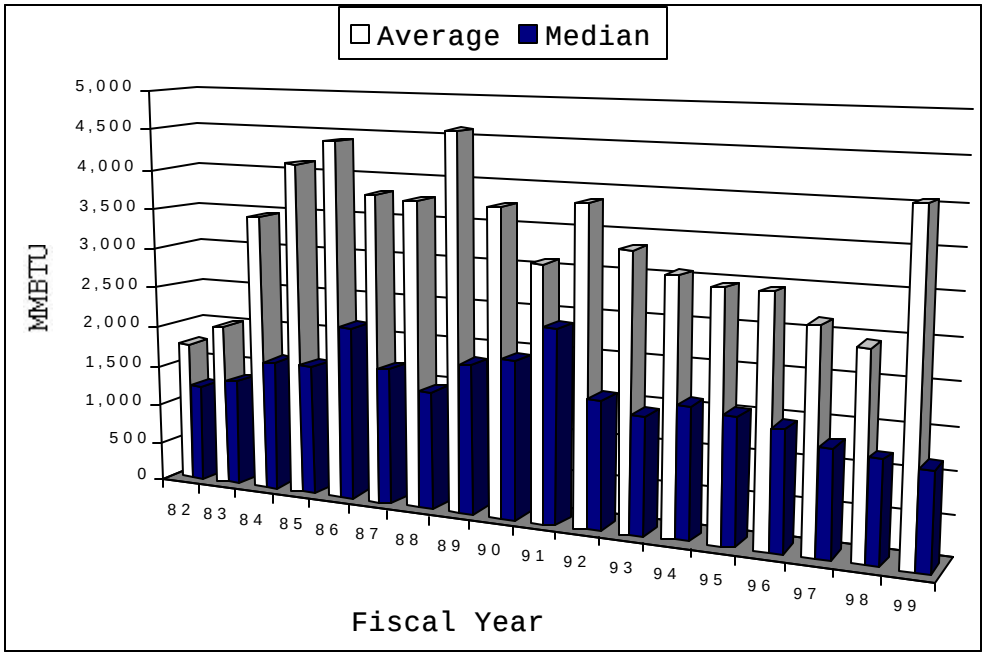


Figure 33. Average and Median Implemented Energy Conservation by Fiscal Year

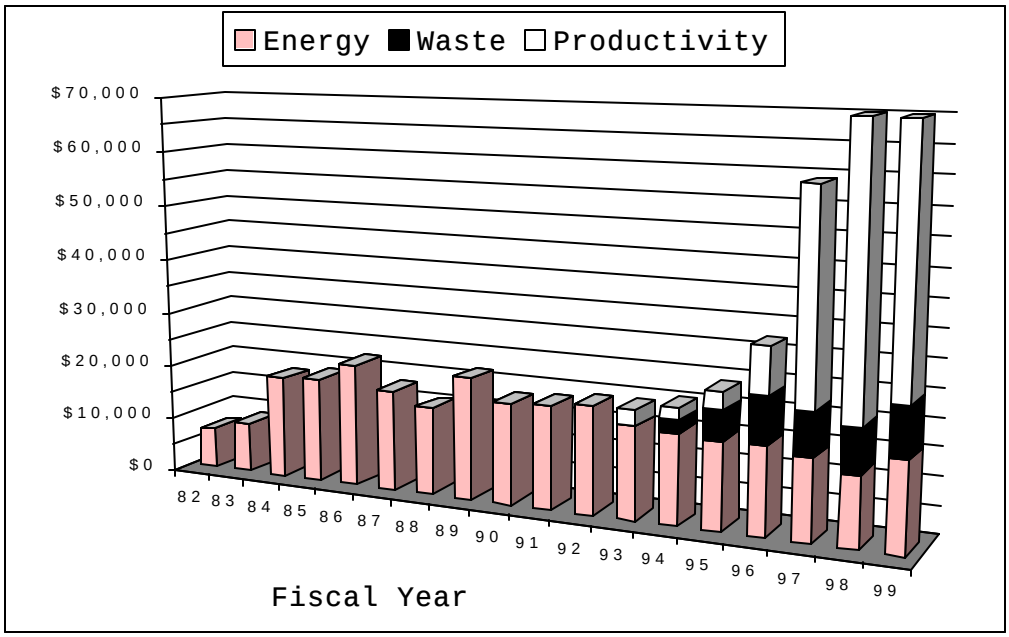


Figure 34. Average Implemented Cost Savings by Fiscal Year

Due to the low distribution of data, the values of median dollars approach zero, and therefore are not shown in Figure 34.

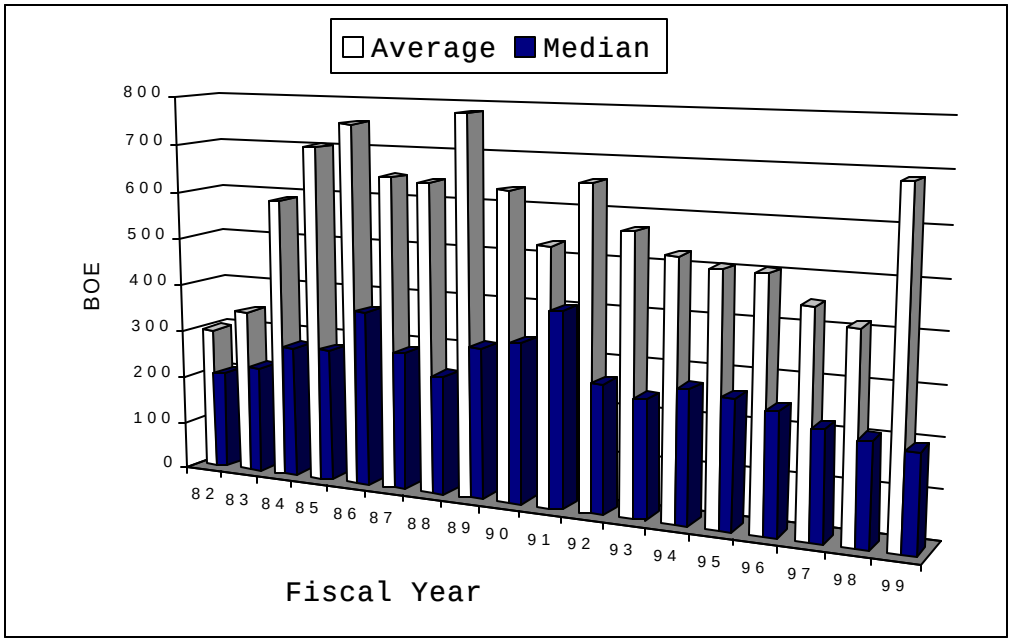


Figure 35. Average Implemented Barrels of Oil Avoided by Fiscal Year

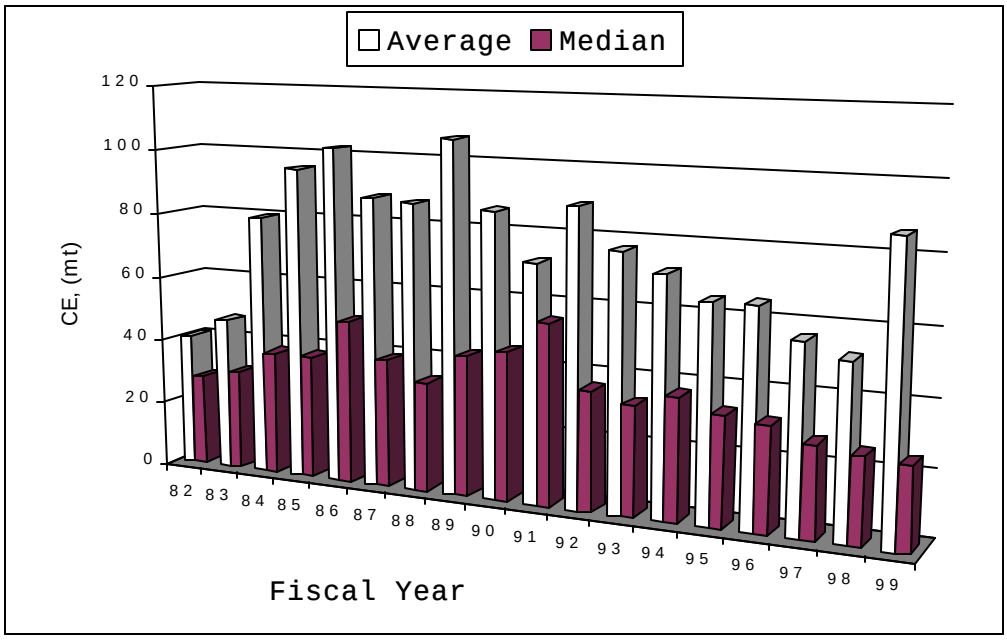


Figure 36. Average Implemented Carbon Avoided by Fiscal Year

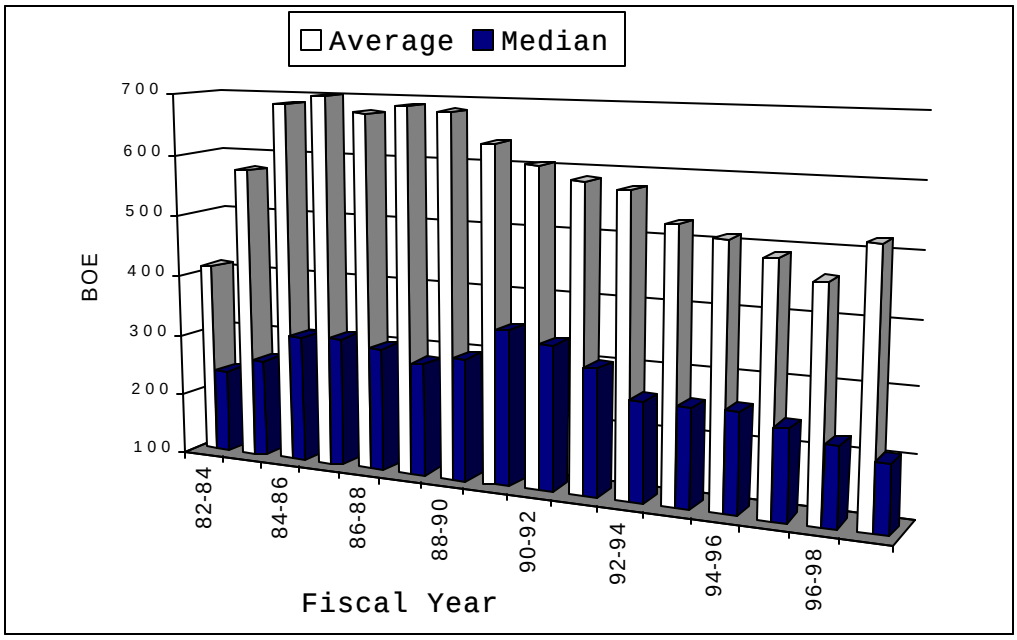


Figure 37. Average and Median Implemented Energy Conserved Per Assessment (3 Year Average)

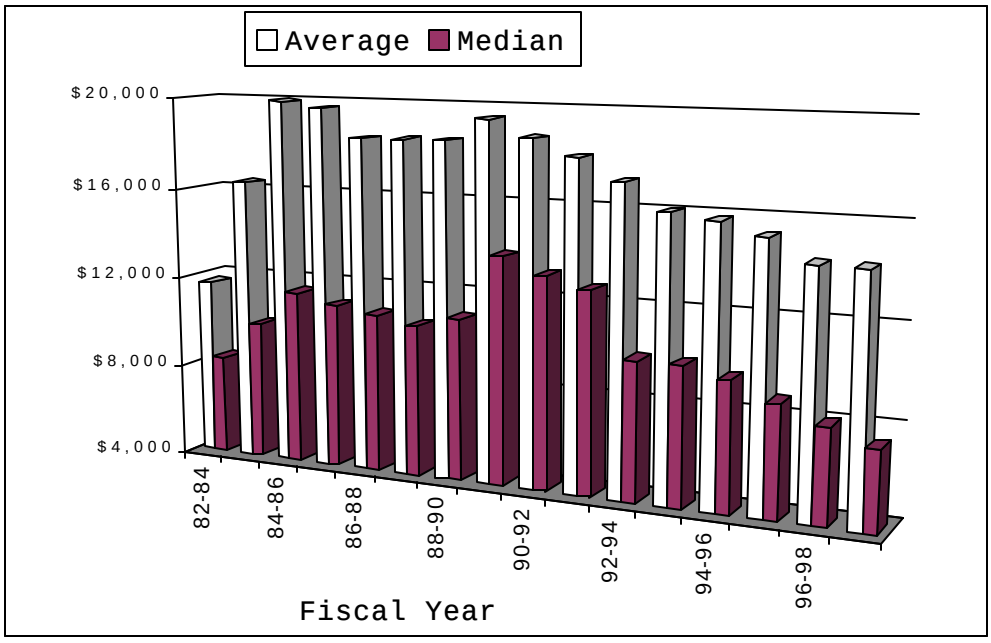


Figure 38. Average and Median Implemented Energy Cost Savings Per Assessment (3 Year Average)

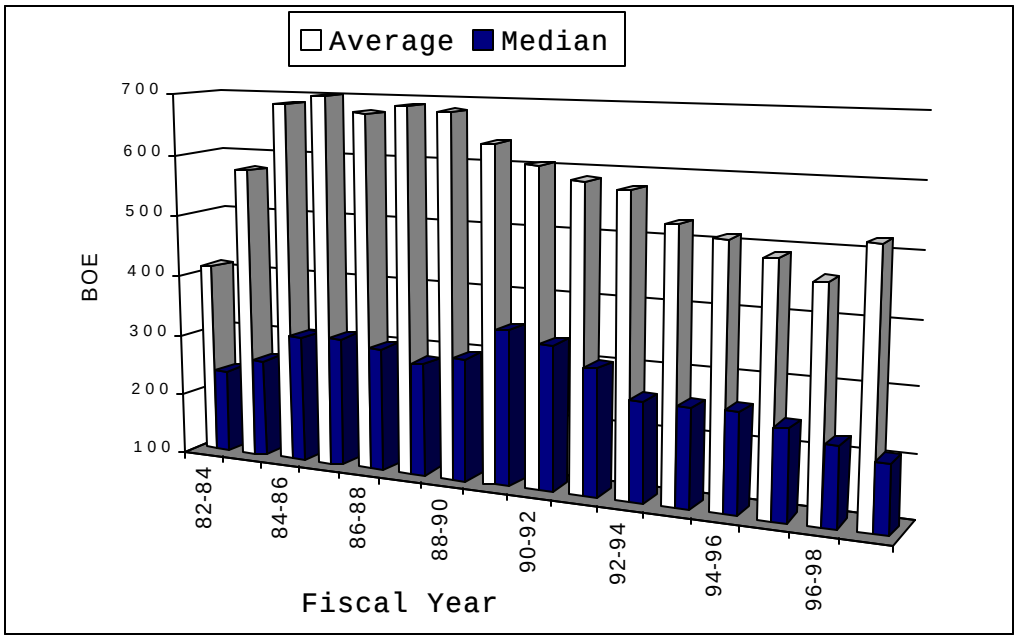


Figure 39. Average and Median Implemented Barrels of Oil Avoided Per Assessment (3 Year Average)

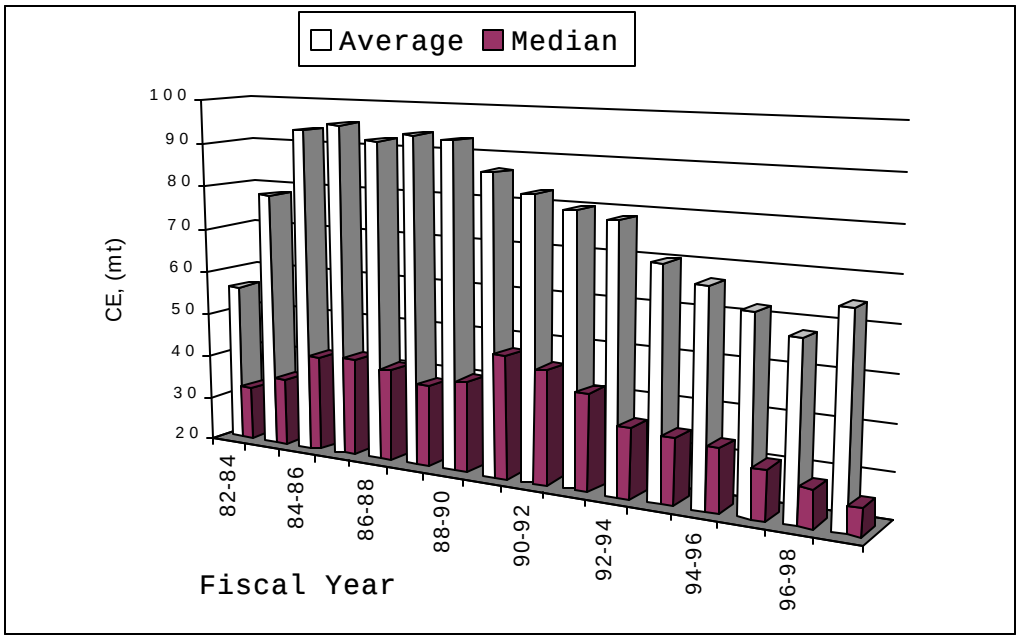


Figure 40. Average and Median Implemented Carbon Avoided Per Assessment (3 Year Average)

In some cases, immediate implementation of a measure was not recommended due to financial restrictions, time constraints, or other considerations. Starting in FY92 these recommendations (called incremental) were flagged to prevent skewing the program database. Table 20 and Figures 41 through 45 show the average first year energy and dollars conserved per assessment. A comparison with Table 18 shows the effect that incremental recommendations represent.

Fiscal Year	Implemented Energy Conservation						Implemented Cost Savings ($)			
	Site (KWH)	Source Electric (MMBtu)	Site Fuels (MMBtu)	(MMBtu)	(B.O.E.)	(C.E., mt)	Energy	Waste	Productivity	Total
82	52,447	538	1,220	1,758	299	41	7,269	N/A	N/A	7,269
83	52,192	535	1,487	2,022	344	47	9,118	N/A	N/A	9,118
84	117,055	1,200	2,250	3,449	587	80	18,480	N/A	N/A	18,480
85	157,339	1,613	2,522	4,135	703	96	19,038	N/A	N/A	19,038
86	203,853	2,089	2,336	4,426	753	102	22,375	N/A	N/A	22,375
87	184,326	1,889	1,923	3,813	648	88	18,107	N/A	N/A	18,107
88	157,039	1,609	2,160	3,770	641	87	15,804	N/A	N/A	15,804
89	249,538	2,558	2,051	4,608	784	107	22,000	N/A	N/A	22,000
90	197,185	2,021	1,709	3,730	634	86	18,252	N/A	N/A	18,252
91	200,971	2,060	1,054	3,114	530	72	18,594	N/A	N/A	18,594
92	238,923	2,298	1,393	3,691	628	85	18,406	N/A	N/A	18,406
93	139,680	1,432	1,330	2,762	470	64	13,558	28	2,796	16,382
94	154,228	1,581	936	2,516	428	58	12,944	2,193	1,979	17,116
95	154,639	1,585	731	2,316	394	50	12,195	5,329	2,938	20,462
96	177,845	1,823	657	2,479	422	54	12,962	8,071	7,457	28,490
97	138,923	1,424	822	2,246	382	48	12,165	7,660	35,215	55,040
98	133,964	1,373	752	2,125	361	45	10,743	7,589	49,500	67,833
99	234,655	2,478	1,380	3,858	656	82	14,363	8,558	45,173	68,094

Table 20. Average First Year Implemented Savings by Fiscal Year

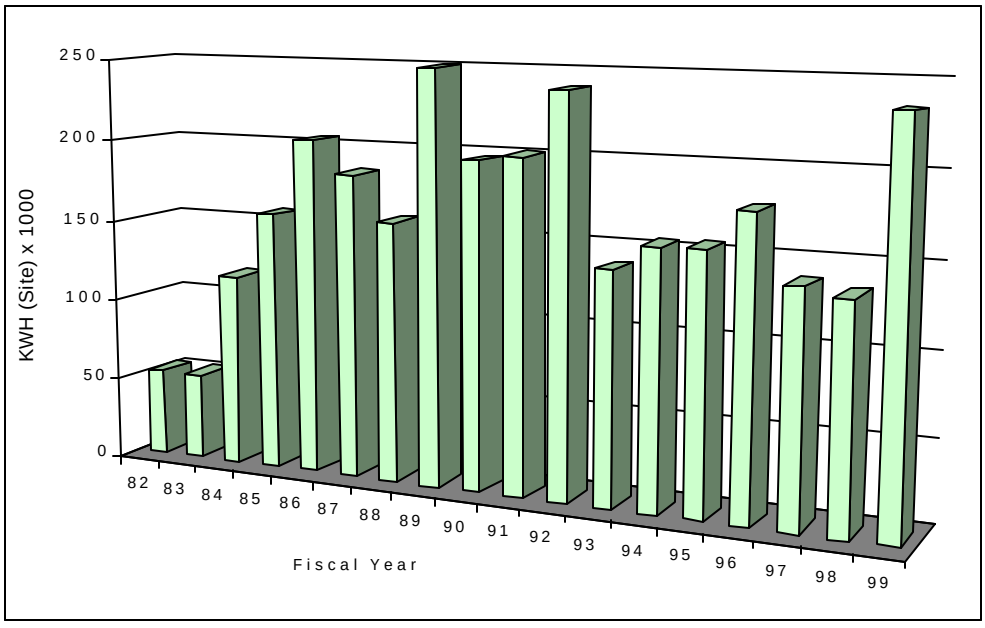


Figure 41. Average First Year Implemented Electric Consumption Conserved by Fiscal Year

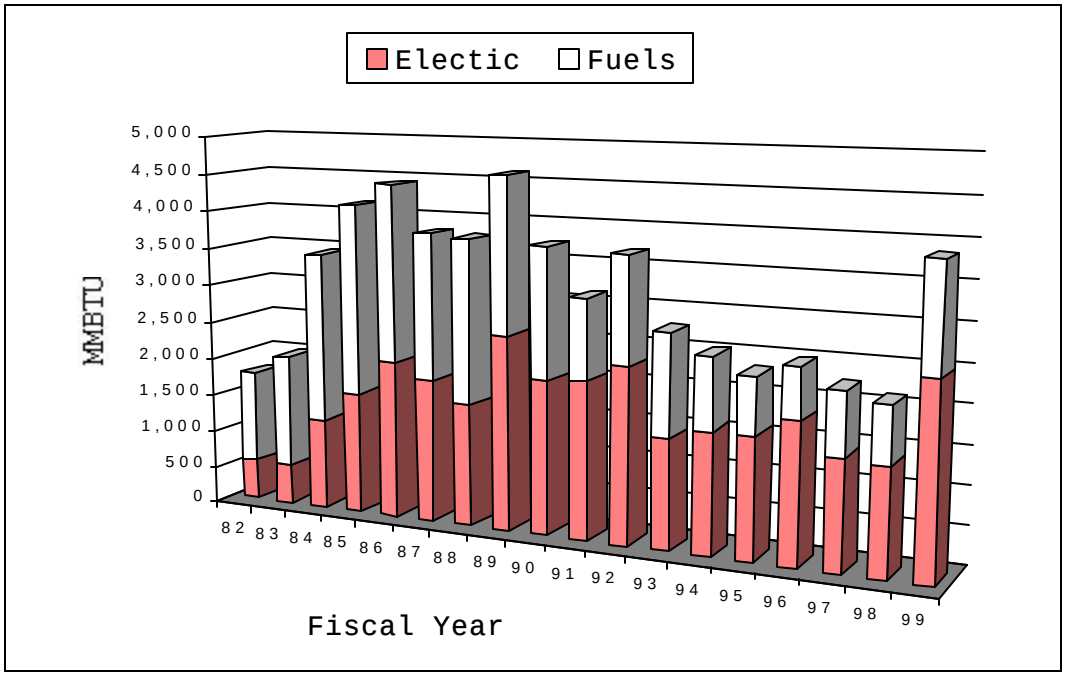


Figure 42. Average First Year Implemented Energy Conserved by Fiscal Year

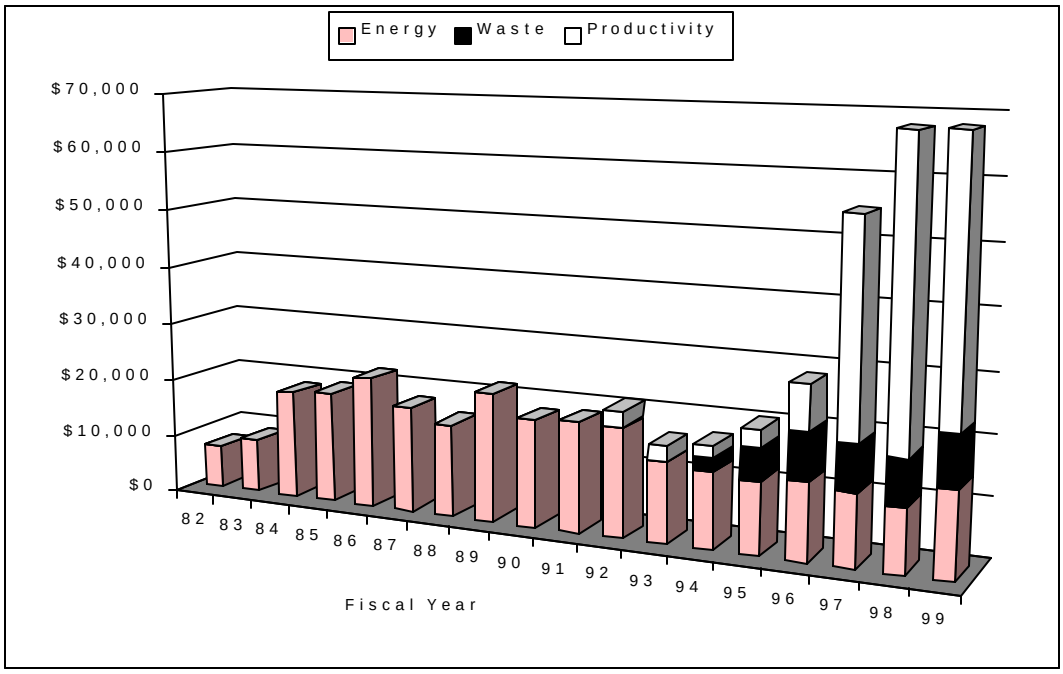


Figure 43. Average First Year Implemented Cost Savings by Fiscal Year

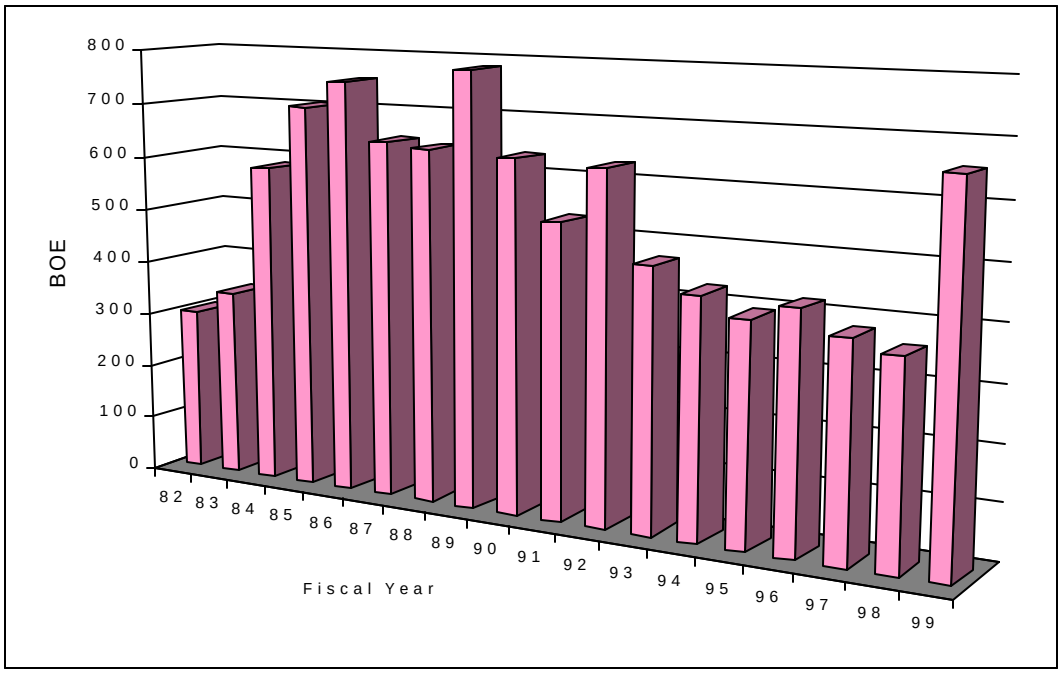


Figure 44. Average First Year Implemented Barrels of Oil Avoided by Fiscal Year

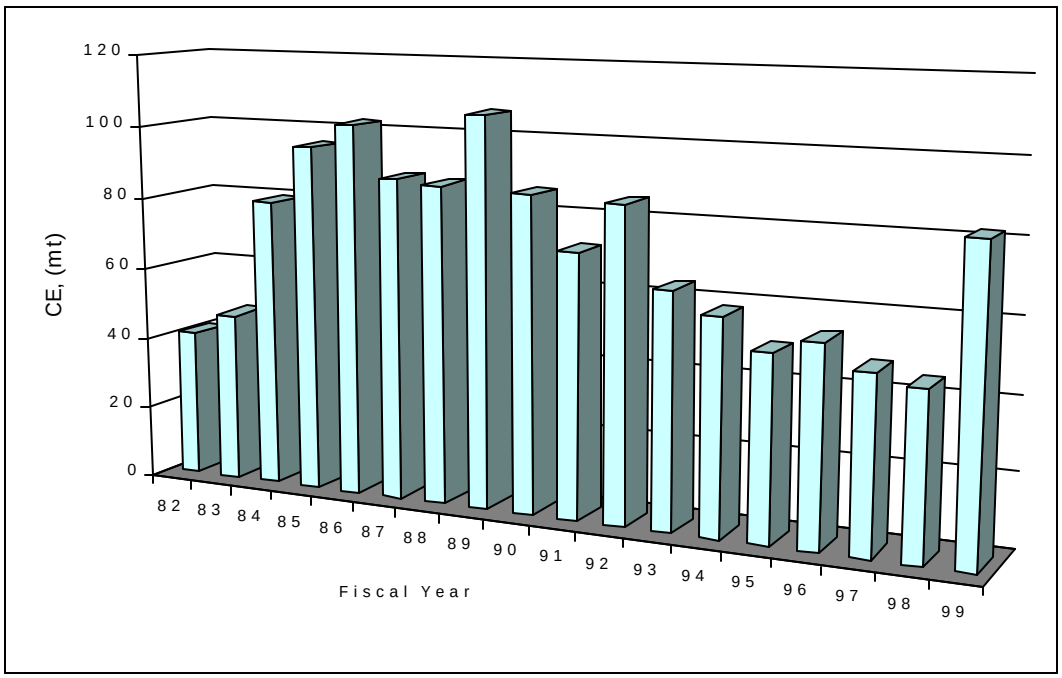


Figure 45. Average First Year Implemented Carbon Avoided by Fiscal Year

ii. Implemented Savings by Industry Type

Energy conservation and cost savings resulting from implemented recommendations by industry type is shown in Table 21 and Figures 46-50. The greatest amount of energy conserved was in SIC 28 (Chemical Products); the largest in cost savings was SIC 34 (Fabricated Metal Products).

SIC Code	Industry Description	Implemented Energy Conservation						Implemented Cost Savings ($)			
		Site (KWH)	Source Electric (MMBtu)	Site Fuels (MMBtu)	Total (MMBtu)	(B.O.E.)	(C.E., mt)	Energy	Waste	Productivity	Total
20	Foods	5,587,042	57,260	49,823	107,083	18,211	2,368	495,818	118,051	1,137,616	1,751,485
21	Tobacco Products	117,526	1,205	0	1,205	205	27	4,321	0	0	4,321
22	Textile Mills	1,357,855	13,916	36,834	50,750	8,631	1,122	284,133	20,876	374,673	679,682
23	Apparel	1,344,958	13,784	10,111	23,895	4,064	528	101,042	58,594	203,447	363,083
24	Wood Prod.	5,036,634	51,622	5,725	57,347	9,753	1,268	260,620	14,080	478,122	752,822
25	Furniture	859,905	8,811	1,816	10,627	1,807	235	57,292	21,918	368,653	447,863
26	Paper Prod.	2,431,125	24,914	27,003	51,917	8,829	1,148	222,421	876,788	91,800	1,191,009
27	Printing	1,889,214	19,362	2,924	22,286	3,790	493	108,242	60,161	558,648	727,051
28	Chemical Prod.	61,316,233	628,487	37,746	666,233	113,305	14,730	2,524,633	151,270	6,492,428	9,168,331
29	Petroleum	308,616	3,164	219,344	222,508	37,841	4,920	543,465	86,520	296,488	926,473
30	Rubber & Plast.	23,428,191	290,417	20,353	310,770	52,852	6,871	1,435,273	1,058,938	3,484,824	5,979,035
31	Leather Prod.	642,146	6,582	550	7,132	1,213	158	35,915	35,938	204,400	276,253
32	Stone & Glass	8,477,724	86,892	464,053	550,945	93,698	12,181	1,529,450	603,252	2,958,451	5,091,153
33	Primary Metal	7,429,366	76,144	27,409	103,553	17,611	2,290	452,061	663,456	2,497,576	3,613,093
34	Fab. Metal	20,419,401	209,289	-2,917	206,372	35,097	4,563	1,222,753	1,119,580	6,970,699	9,313,032
35	Ind. Machinery	13,717,176	140,595	50,635	191,230	32,522	4,228	926,483	287,049	2,614,295	3,827,827
36	Electronics	2,094,075	21,462	3,992	25,454	4,329	563	263,910	168,759	2,595,239	3,027,908
37	Trans. Equip.	12,736,809	130,546	8,310	138,856	23,615	3,070	311,782	725,327	1,449,463	2,486,572
38	Instruments	3,498,241	35,853	-10	35,843	6,096	792	220,456	7,648	63,219	291,323
39	Misc. Manuf.	119,871	1,228	935	2,163	368	48	13,905	6,016	252,708	272,629
Totals		**172,812,108**	**1,821,533**	**964,636**	**2,786,169**	**478,312**	**61,602**	**11,013,975**	**6,084,221**	**33,092,749**	**50,190,945**

Table 21. Implemented Energy and Cost Savings by Industry Type

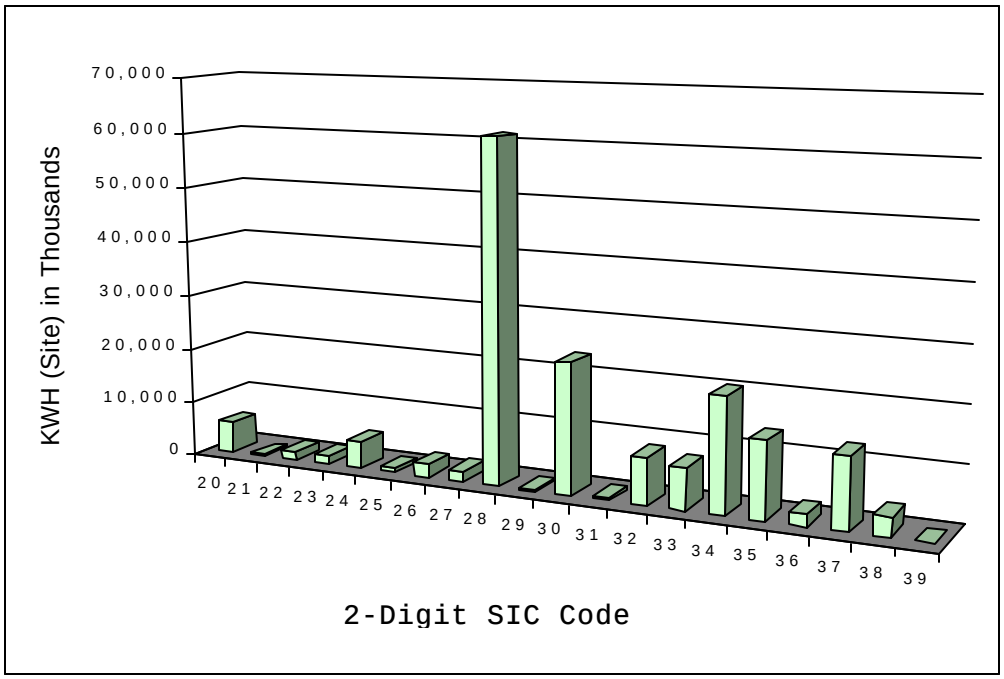


Figure 46. Implemented Electric Consumption by Industry Type

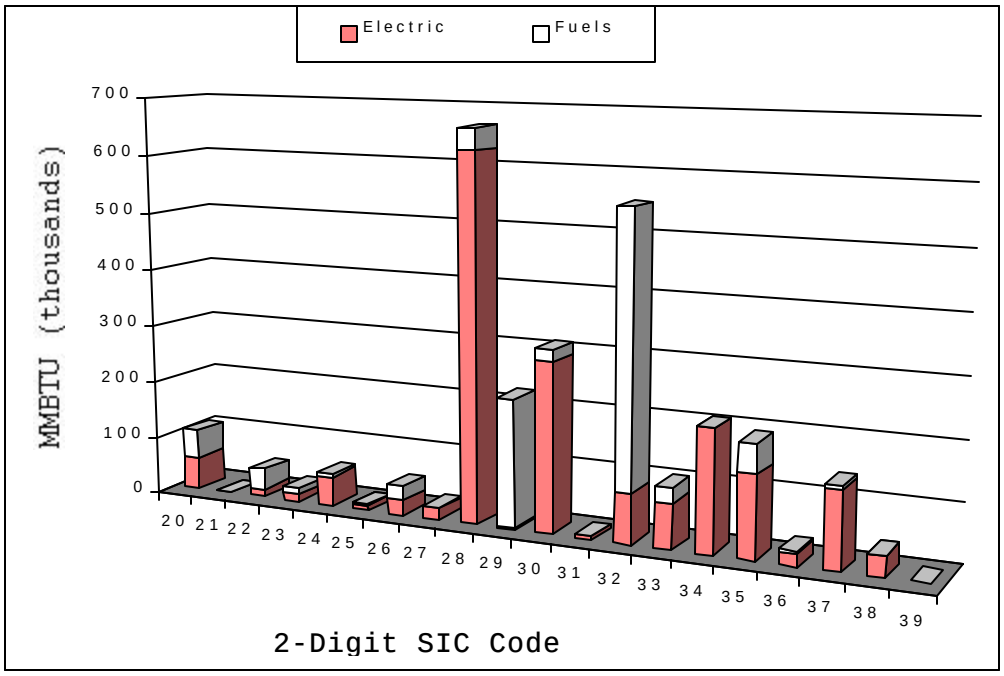


Figure 47. Implemented Energy Conserved by Industry Type

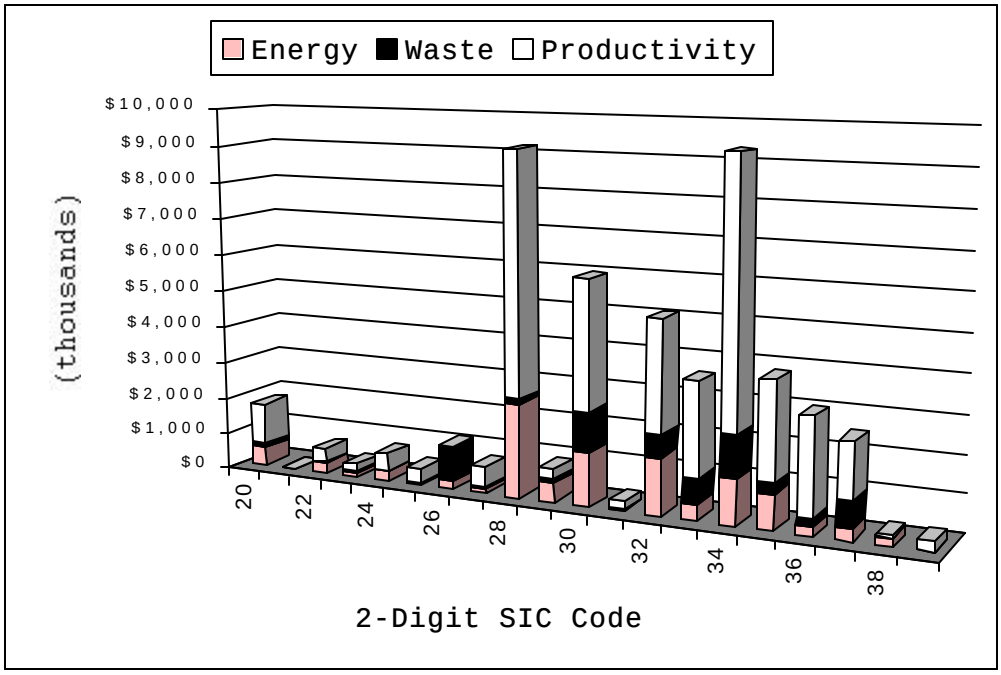


Figure 48. Implemented Cost Savings by Industry Type

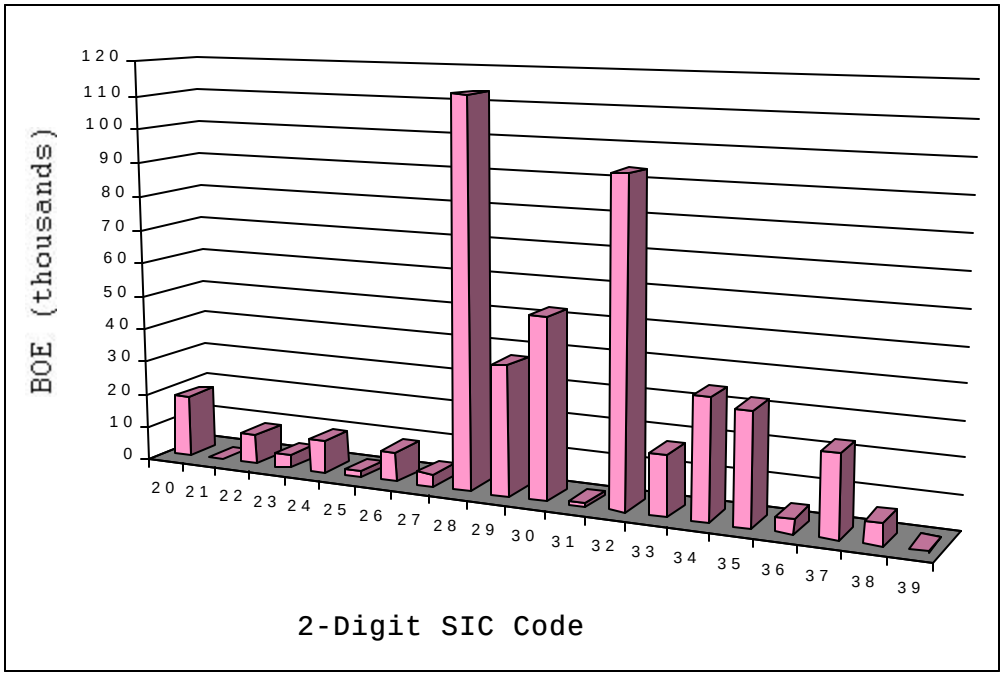


Figure 49. Implemented Barrels of Oil Avoided by Industry Type

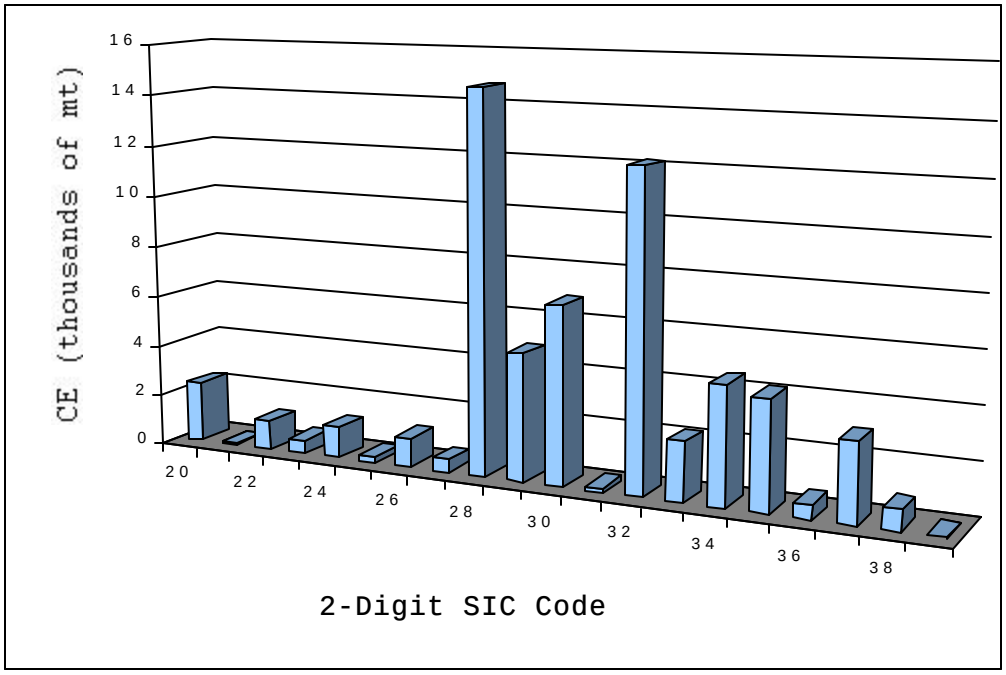


Figure 50. Implemented Carbon Avoided by Industry Type

Table 22 and Figures 51-54 show the average implemented energy and cost savings by industry type per assessment.

SIC Code	Industry Description	Implemented Energy Conservation (thousands)						Implemented Cost Savings (thousands $)			
		Site (KWH)	Source Electric (MMBtu)	Site Fuels (MMBtu)	Total (MMBtu)	(B.O.E.)	(C.E., mt)	Energy	Waste	Productivity	Total
20	Foods	88,683	909	791	1,700	289	38	7,870	1,874	18,057	27,801
21	Tobacco Products	117,526	1,205	0	1,205	205	27	4,321	0	0	4,321
22	Textile Mills	96,990	994	2,631	3,625	616	80	20,295	1,491	26,762	48,549
23	Apparel	122,269	1,253	919	2,172	369	48	9,186	5,327	18,495	33,008
24	Wood Prod.	157,395	1,613	179	1,792	305	40	8,144	440	14,941	23,526
25	Furniture	45,258	464	96	559	95	12	3,015	1,154	19,403	23,572
26	Paper Prod.	90,042	923	1,000	1,923	327	43	8,238	32,474	3,400	44,111
27	Printing	72,662	745	112	857	146	19	4,163	2,314	21,486	27,964
28	Chemical Prod.	2,270,972	23,277	1,398	24,675	4,196	546	93,505	5,603	240,460	339,568
29	Petroleum	38,577	396	27,418	27,814	4,730	615	67,933	10,815	37,061	115,809
30	Rubber & Plast.	221,021	2,740	192	2,932	499	65	13,540	9,990	32,876	56,406
31	Leather Prod.	214,049	2,194	183	2,377	404	53	11,972	11,979	68,133	92,084
32	Stone & Glass	223,098	2,287	12,212	14,499	2,466	321	40,249	15,875	77,854	133,978
33	Primary Metal	181,204	1,857	669	2,526	430	56	11,026	16,182	60,916	88,124
34	Fab. Metal	204,194	2,093	-29	2,064	351	46	12,228	11,196	69,707	93,130
35	Ind. Machinery	190,516	1,953	703	2,656	452	59	12,868	3,987	36,310	53,164
36	Electronics	44,555	457	85	542	92	12	5,615	3,591	55,218	64,424
37	Trans. Equip.	385,964	3,956	252	4,208	716	93	9,448	21,980	43,923	75,351
38	Instruments	233,216	2,390	-1	2,390	406	53	14,697	510	4,215	19,422
39	Misc. Manuf.	19,979	205	156	361	61	8	2,318	1,003	42,118	45,438
Average		**250,816**	**2,644**	**1,400**	**4,044**	**694**	**89**	**15,985**	**8,831**	**48,030**	**70,487**

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

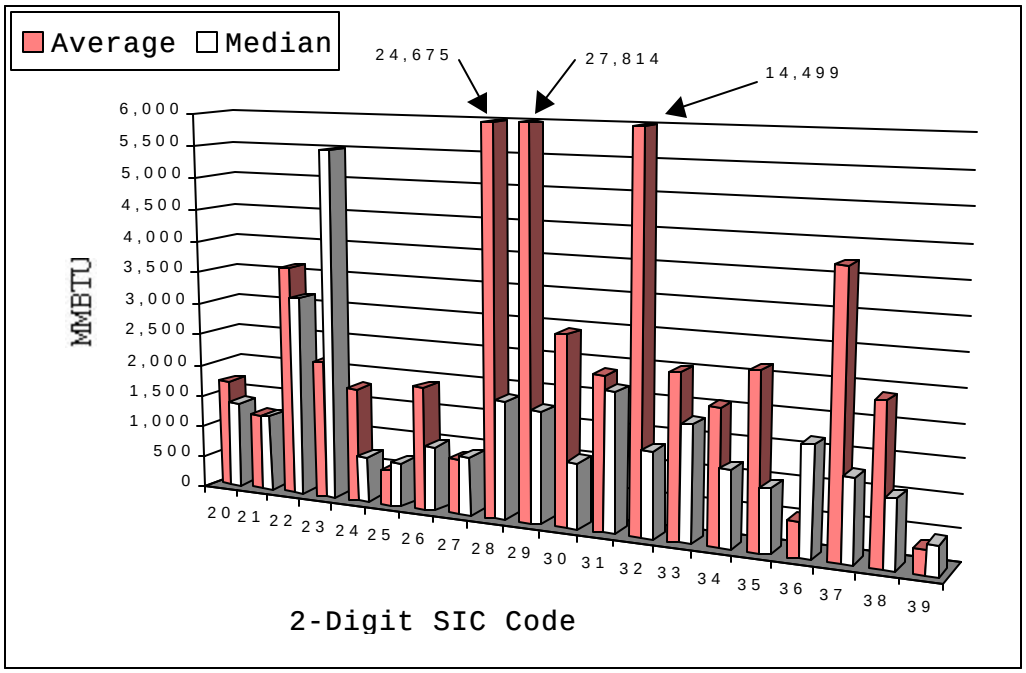


Figure 51. Average and Median Implemented Electric Consumption by Industry Type

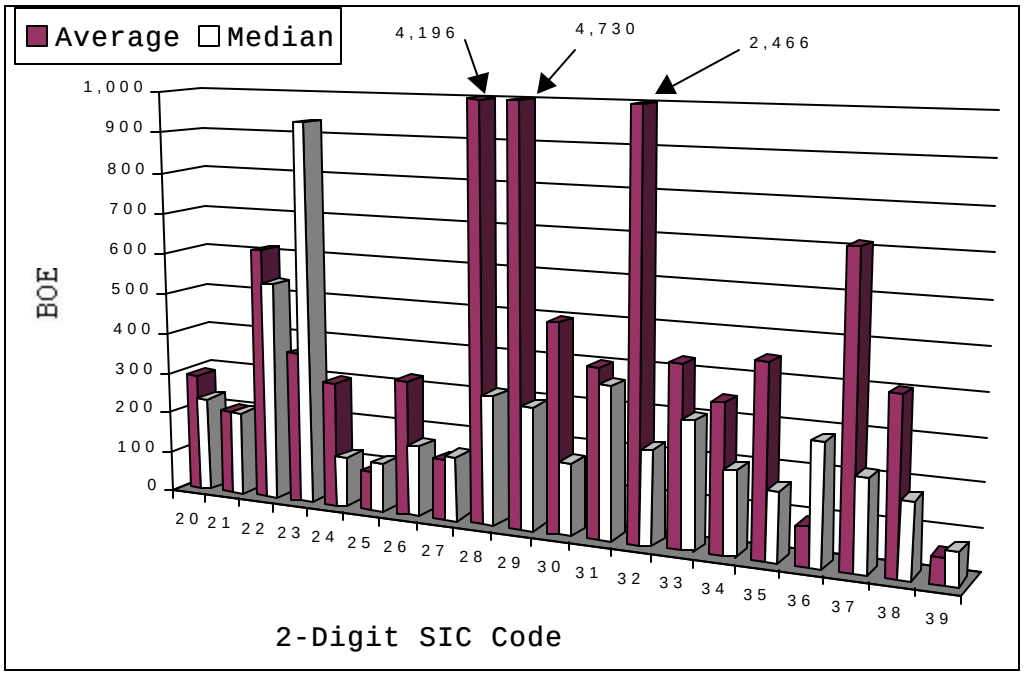


Figure 52. Average and Median Implemented Barrels of Oil Avoided by Industry Type

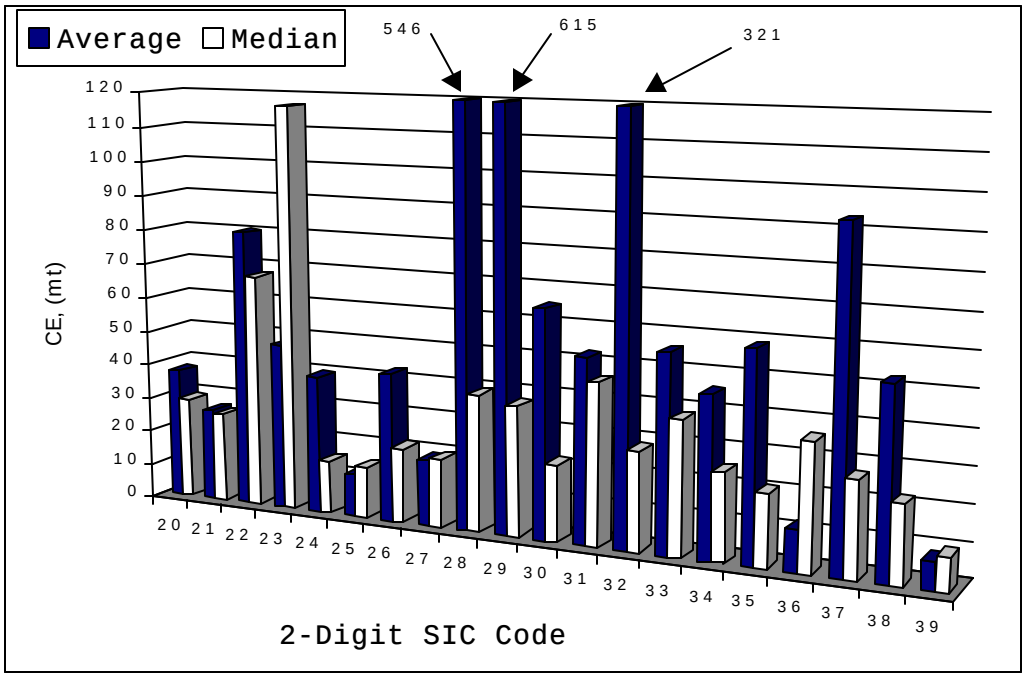


Figure 53. Average and Median Implemented Carbon Avoided by Industry Type

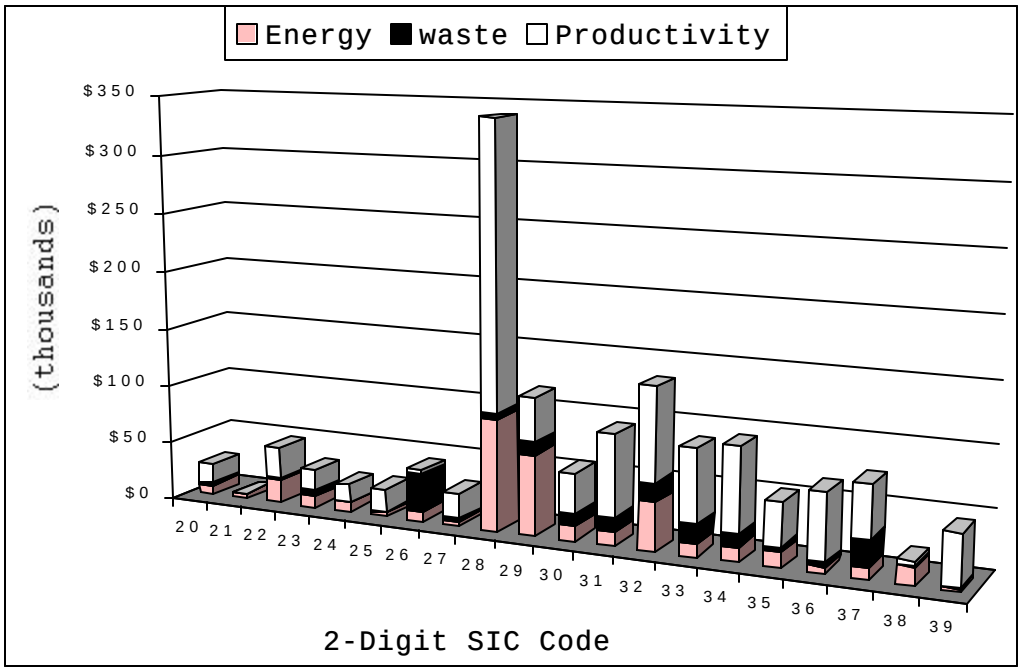


Figure 54. Average Implemented Cost Savings by Industry Type

iii. Implemented Savings by Resource Stream

Table 23 and Figures 55-56 reflect implemented energy and cost savings broken down by energy stream.

Energy Stream	Implemented Energy Conservation (MMBTU)	Implemented Energy Cost Savings ($)
Electricity		
Demand	179,895 KW-months/yr	1,876,614
Fees		210,101
Consumption - Site	172,812,108 KWH	
Consumption - Source	1,821,533	6,239,111
Natural Gas	563,002	1,847,380
L.P.G.	14,540	96,471
Fuel Oil #1	0	0
Fuel Oil #2	14,040	80,011
Fuel Oil #4	3,602	12,030
Fuel Oil #6	5,598	18,949
Coal	360,356	602,049
Wood	1,247	4,366
Other Gas	0	0
Other Energy	2,251	26,893
Energy Totals	**2,786,169**	**11,013,975**
Non-Energy	n/a	39,176,970
Program Totals	**2,786,169**	**50,190,945**

Table 23. Implemented Energy and Cost Savings by Resource Stream

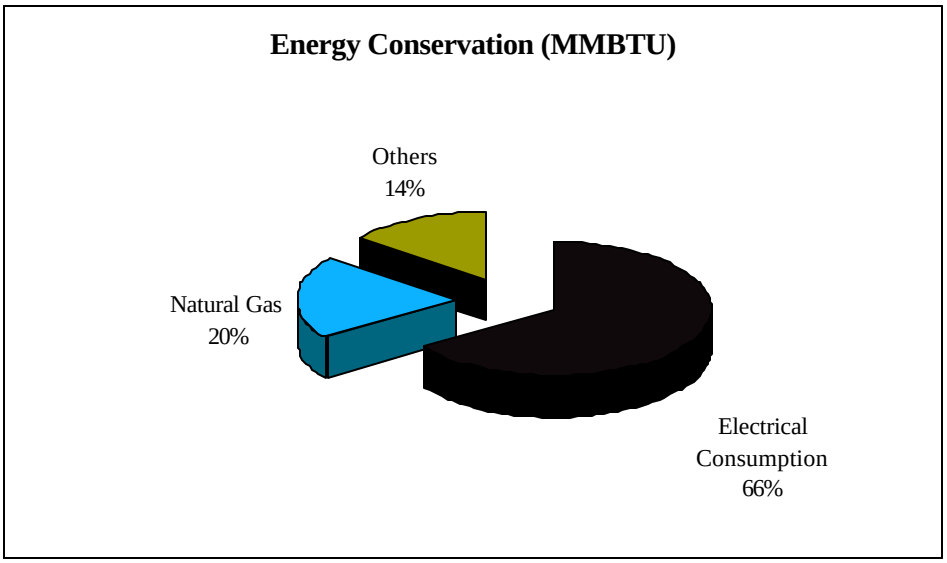


Figure 55. Composition of Implemented Energy Conserved by Energy Stream

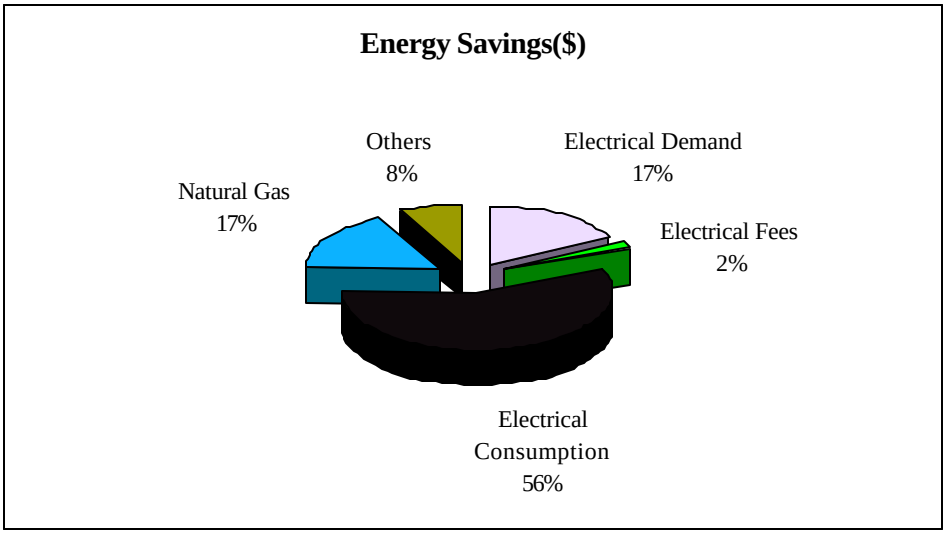


Figure 56. Composition of Implemented Energy Cost Savings by Energy Stream

The breakdown of non-energy savings by resource stream type is shown in Table 24, and Figure 57. The total implemented cost savings by resource stream are shown in Figure 58.

Stream Type	Total Implemented Non-Energy Cost Savings ($)
Primary Product	18,077,727
Byproduct Production	448,546
Resource Costs	
Personnel Changes	5,876,186
Administrative Costs	4,284,313
Primary Raw Material	2,230,742
Ancillary Material Cost	1,197,391
Water Consumption	235,385
One-time Revenue or Avoided Cost	742,459
Waste Reduction	
Water Disposal	1,345,030
Other Liquid (non-haz)	395,630
Other Liquid (haz)	947,694
Solid Waste (non-haz)	3,163,549
Solid Waste (haz)	52,427
Gaseous Waste (haz)	179,891
Non-Energy Total	**39,176,970**

Table 24. Total Implemented Non-Energy Cost Savings

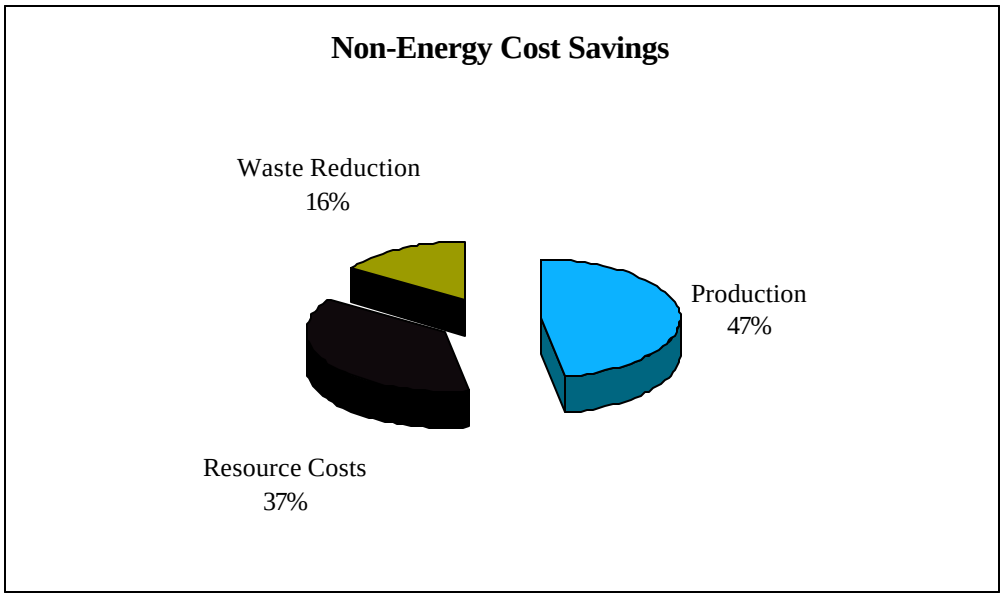


Figure 57. Composition of Non-Energy Implemented Savings

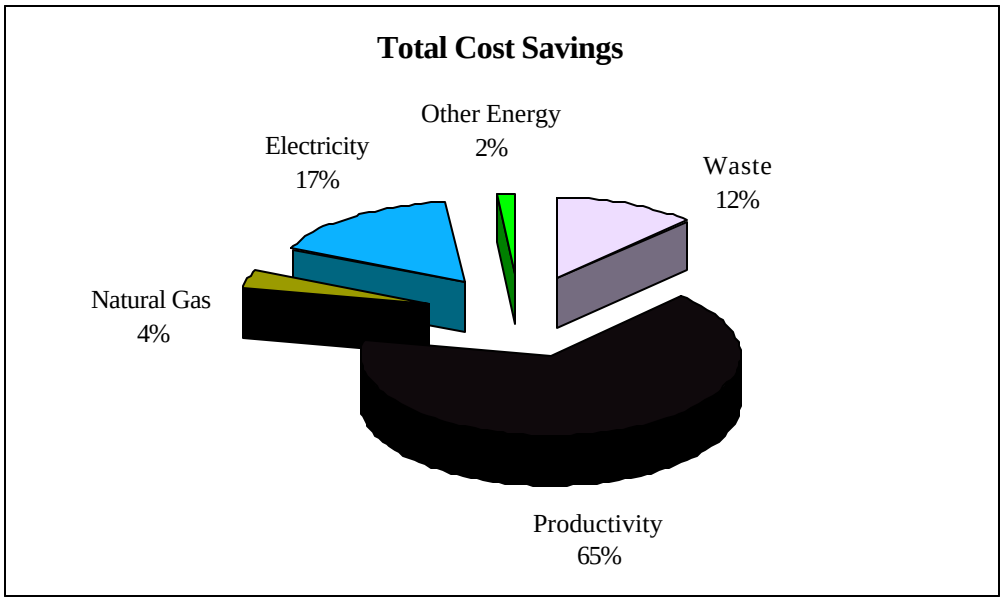


Figure 58. Composition of Total Implemented Cost Savings

iv. Implemented Savings by Recommendation Type

Finally, the number of implemented recommendations by type for Fiscal Year 1999 is shown in Table 25 and Figure 59.

2-Digit ARC Code	Category Description	No. of Implemented Recommendations	No. of Recommendations with client followups	% of Implemented Recommendations
2.1	Combustion Systems	81	229	35.4%
2.2	Thermal Systems	155	461	33.6%
2.3	Electrical Power	66	203	32.5%
2.4	Motor Systems	637	1132	56.3%
2.5	Industrial Design	4	6	66.7%
2.6	Operations	69	124	55.6%
2.7	Buildings and Grounds	458	1064	43.0%
2.8	Ancillary Costs	58	139	41.7%
2.9	Alternate Energy Use	0	0	0.0%
3.1	Operations	39	78	50.0%
3.2	Equipment	25	60	41.7%
3.3	Post Generation Treatment /	12	42	28.6%
3.4	Water Use	77	192	40.1%
3.5	Recycling	131	313	41.9%
3.6	Waste Disposal	44	156	28.2%
3.7	Maintenance	18	57	31.6%
3.8	Raw Materials	12	52	23.1%
4.1	Manufacturing Enhancements	65	169	38.5%
4.2	Purchasing	21	56	37.5%
4.3	Inventory	13	28	46.4%
4.4	Labor Optimization	90	255	35.3%
4.5	Space Utilization	32	77	41.6%
4.6	Reduction of Downtime	64	138	46.4%
4.7	Management Practices	4	9	44.4%
4.8	Other Administrative Savings	43	65	66.2%
	Total	**2218**	**5105**	**43.4%**

Table 25. Number of Implemented Recommendations by Recommendation Type

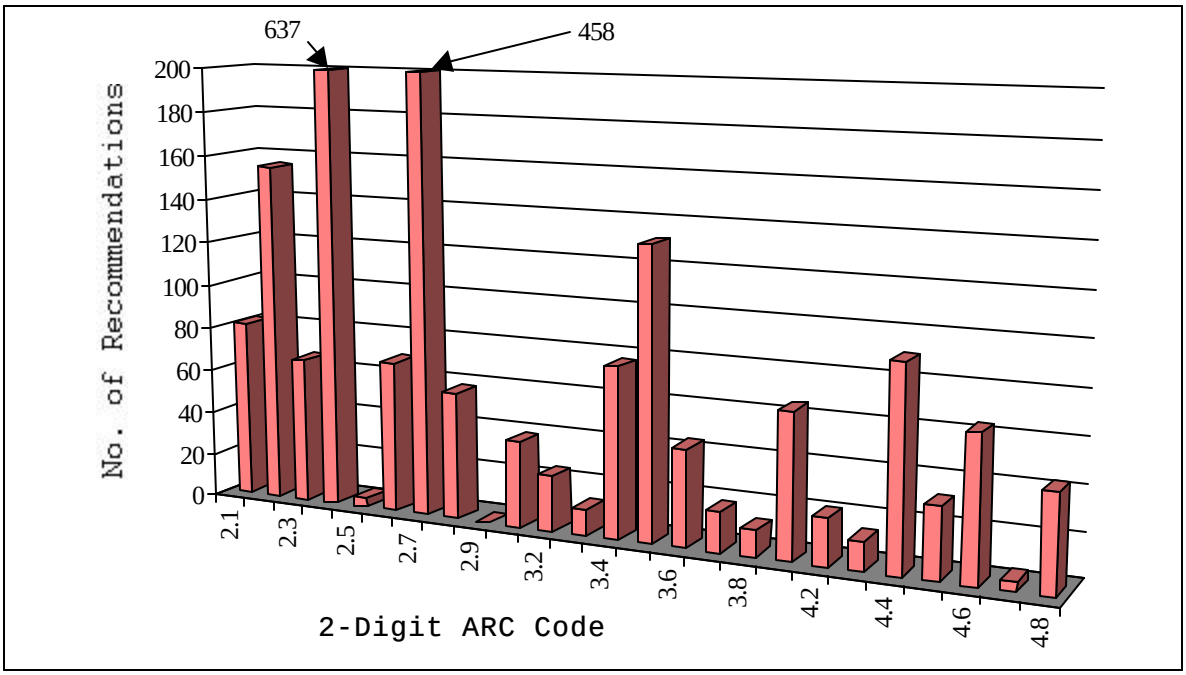


Figure 59. Number of Implemented Recommendations by Recommendation Type

2.1	Combustion Systems.	3.1	Operations	4.1	Manufacturing
2.2	Thermal Systems	3.2	Equipment	4.2	Purchasing
2.3	Electrical Power	3.3	Post Generation Treatment	4.3	Inventory
2.4	Motor Systems	3.4	Water Use	4.4	Labor Optimization
2.5	Industrial Design	3.5	Recycling	4.5	Space Utilization
2.6	Operations	3.6	Waste Disposal	4.6	Downtime
2.7	Building / Grounds	3.7	Maintenance	4.7	Mgt. Practices
2.8	Ancillary Costs	3.8	Raw Materials	4.8	Administrative Savings
2.9	Alternate Energy				

III. Standard Financial Calculations

Standard Financial Calculations, FY99

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

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

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

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

in which CF = cash flow

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

i = IRR

A similar net present value method was used to calculate leverage ratios or profitability indices. For the same series of annual cash flows (until all loans have been amortized) based upon actual implementation, a rate (for example, 10%) is assumed in order to discount these future cash flows to the initial period of the investment. The leverage ratio for manufacturers is the ratio of the sum of discounted future cash flows to the sum of all capital investments made to implement the assessment recommendations. For the federal government, the leverage ratio is the ratio of the sum of discounted future cash flows to the program support provided by the federal government for FY99.

These leverage ratios (or profitability indices) show that, at a 10% discount rate, the federal government will realize $4.11 to $6.12 for every federal dollar spent on the program in FY99. Similarly, manufacturers will, as a group, receive $1.75 to $2.44 for every dollar invested in implementing cost-saving measures.

Standard Financial Calculations of IAC Results

IMPCOST GROWTH	ENSAV GROWTH	BORR RATE	FEDERAL GOVERNMENT			MANUFACTURERS		
%	%	%	IRR	LR_{10}	LR_{15}	IRR	LR_{10}	LR_{15}
3	3	3	77.3	5.31	4.17	529	2.16	1.77
3	3	6	74.3	5.14	4.02	461	2.10	1.72
3	3	9	71.3	4.97	3.87	404	2.04	1.67
3	3	6	74.3	5.14	4.02	461	2.10	1.72
6	3	6	73.2	5.06	3.95	454	2.07	1.70
6	0	6	66.2	4.11	3.19	428	1.75	1.43
6	3	6	73.2	5.06	3.95	454	2.07	1.70
6	6	6	80.2	6.12	4.80	480	2.44	1.99
12	6	6	78.1	5.94	4.65	467	2.38	1.94

Table 26. Standard Financial Calculations of IAC Results

GLOSSARY

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

IV. Regional Reports

A. Eastern Region

Major Activities and Highlights of the Eastern Region

In Fiscal Year 1999, 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 FY99, the Eastern Region was comprised of fifteen experienced Centers performing 25 assessments. The addresses and phone numbers of all Centers is given in the appendix. The schools and directors participating in the program in FY99 are shown below.

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

The history of the Centers, the directors' experience, and the student participation is shown in Table 27. The eastern region boasts an experienced and stable group of directors, with a total of over 100 years of experience in the program and an average of over 8 years.

Centers	Date Entered Program	96 Assessments Completed	Director's Years in Program	Student Participation	
				Graduate	Under Grad.
GT	FY82	25	9	0	6
HO	FY92	25	4	1	7
MA	FY84	25	16	0	7
ME	FY93	25	7	0	12
MS	FY94	25	6	0	11
NC	FY93	25	6	4	2
ND	FY91	25	9	1	20
OD	FY94	25	6	3	7
TN	FY76	25	24	7	12
UD	FY76	25	2	0	3
UF	FY91	25	9	8	19
UL	FY94	25	2	0	24
UM	FY94	25	6	5	12
WI	FY87	25	13	1	5
WV	FY93	25	7	13	1

Table 27. History of Eastern Centers

In FY99 experienced centers were awarded extra assessment-days, in order to further investigate larger recommendations which required additional information. In addition three centers, University of Massachusetts, University of Tennessee, and Georgia Institute of Technology were awarded special projects.

Two eastern regional students were chosen to receive an outstanding achievement award at the OIT Expo in Washington.

B. Western Region

I. Major Activities and Highlights

During FY 99, the Industrial Technology and Energy Management division (ITEM) of the University City Science Center provided field management for the western region where 15 centers served a total of 359 manufacturers. The western region IACs are listed below, along with the IAC director and student participation during FY 99. The addresses and phone numbers of the western region directors are given in the Appendix.

					Student Participation	
IAC	Date Entered Program	FY 99 Director	Years as Director	FY 99 Plants	Graduate	Under-graduate
Arizona State University	FY 90	Patrick E. Phelan	3	25	2	13
Univ. of Arkansas-Little Rock	FY 93	Mamdouh Bakr	4	25	0	12
Bradley University	FY 94	D. Paul Mehta	6	25	7	7
Colorado State University	FY 84	Harry W. Edwards	3	25	4	14
Iowa State University	FY 91	Gregory M. Maxwell	1	25	3	19
University of Kansas	FY 81	Jerry D. Swearingen	4	25	2	7
University of Missouri-Rolla	FY 90	John Sheffield	1	25	1	16
University of Nevada-Reno	FY 94	Yunus A. Cengel	3	25	1	8
Oklahoma State University	FY 81	Clint Christenson	1	25	8	15
Oregon State University	FY 87	George M. Wheeler	13	25	8	18
Prairie View A&M University	FY 99	Paul O. Biney	1	9	0	7
San Diego State University	FY 91	Asfaw Beyene	3	25	5	12
San Francisco State University	FY 93	Ahmad Ganji	7	25	5	7
South Dakota State University	FY 94	Kurt Bassett	6	25	3	3
Texas A&M University	FY 87	Warren M. Heffington	13	25	7	12

The western region IACs performed a total of 20 extended assessment days during the program period. The additional time at the plant sites permitted the IACs to obtain additional data to support specific assessment recommendations.

Special projects were funded at the Colorado State University, South Dakota State University, and Texas A&M University IACs. Colorado State University's project is to develop a Theory of Constraints Productivity Tool for IAC students used to prepare IAC students for tasks related to productivity improvement recommendations. South Dakota State University's project focuses on the experimental validation of predicted energy savings for typical compressed air energy conservation opportunities. The focus of Texas A&M's special project is the determination of correlations between annual energy savings and implementation costs for selected, often-recommended assessment recommendations.

Two outstanding western region IAC students were selected from among 13 nominees to receive awards at the OIT Expo in February 1999.

Western region IACs recommended 2,641 measures with potential cost savings of $63.1 x 10^6/yr during FY99. Manufacturers implemented 1,065 measures (44% of those recommended with known results) resulting in cost savings of $20.2 x 10^6/yr.

Energy conservation measures accounted for 20% of the total implemented cost savings, while the waste minimization and productivity enhancement measures accounted for remaining cost savings at 14% and 66%, respectively. The best implementation rate of 46% was achieved from energy conservation, followed by productivity enhancement and waste minimization at 40% and 39%, respectively, based on recommended measures with known results.

When comparing the average cost savings per AR among the different categories of measures, it is expected that the productivity enhancement measures should be the largest followed by waste minimization and energy conservation. In FY 99 the average cost savings per AR for an implemented energy conservation AR was about $5,500/yr, whereas for waste minimization it was about $16,800/yr, and for productivity enhancement it was about $87,900/yr.

The average implemented cost savings of $56,400/yr/plant in FY99 was 20% less than last year with a 7 percentage point decrease in the number of ARs implemented as shown below:

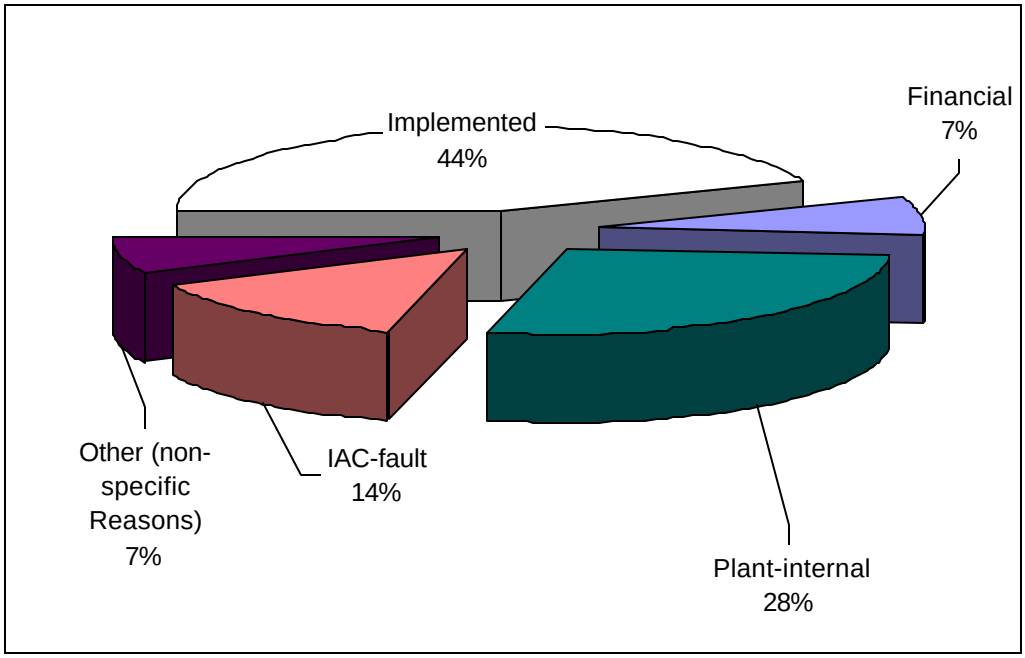
	FY99	FY98	FY97	FY96	FY95
Implemented Cost Savings $/yr/plant	56,400	69,900	56,700	35,600	23,900
Implementation Rate, % ARs Implemented	44	51	51	58	57

Although this year resulted in the $56,400/yr of implemented cost savings per plant, there was still about $37.1 x 10^6/yr or an average of about $103,500/yr/plant of non-implemented cost savings potential identified by the IACs in FY99. About 30% of the non-implemented savings was in energy conservation category, 12% in waste minimization, and 58% in productivity enhancement.

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

Category of Reason	**% of Non-Implemented Cost Saving Measures**
Plant-internal	51%
Financial	13%
IAC-fault	25%
Other	12%
Total Non-Implementation	100%

Note that 64% of non-implemented cost saving measures were attributed to plant-internal and financial factors while 25% are due to the fault of the IAC. As a whole, the recommendations which manufacturers viewed as poor quality ARs only represents 14% of the recommended cost saving measures as shown in Figure 60.



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

(FY 99 Western Region)

Figure 60. Breakdown of Total Recommended Cost Saving Measurres

Appendix I.

Assumptions Used in Carbon Equivalent Calculations

1.) Carbon Avoided was calculated for three sources; natural gas, electricity, and other (fuel oil)

2.) These sources were calculated separately by percentage for Recommended Savings and for Implemented Savings.

3.) Efficiencies for on site fossil fuel savings (natural gas, fuel oil) are inherent in the reported values.

4.) Carbon Avoided for Electricity saved was calculated using average US generation values.

5.) Electric generation site to source MMBtu's relationship is:

3412 MMBtu's site = 10,250 Source MMBtu's

This is a Fossil Fuel generation efficiency of 33.29%

6.) For purposes of this report those values were:

Coal	80.0 %
Natural Gas	15.0 %
Fuel Oil	5.0 %
Fossil Fuel Total	100%

Carbon Equivalents

CE_{coal}:	56.669 lb. of Carbon per MMBtu
CE_{oil}:	43.439 lb. of Carbon per MMBtu
CE_{gas}:	32.414 lb. of Carbon per MMBtu
$CE_{electricity}$:	119.8 lb. of Carbon per MMBtu
FY99 Implemented Average	69.6 lb. of Carbon per MMBtu