ENERGY CONSERVATION IN STATE FACILITIES - A PROGRESS REPORT

State of New Jersey
Department of Energy
101 Commerce Street
Newark, New Jersey 07102

Brendan Byrne
Governor

Joel R. Jacobson
Commissioner

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EXECUTIVE SUMMARY AND CONCLUSIONS

In retrospect, 1973 has become a "history book" year. Certain dates in this century such as 1903, 1918, 1929, 1939, tend to stick out as turning points. The year 1973 has become such a watershed, fixed in popular legend as the year of the "oil crisis"; the year the first long lines at gas stations appeared and prices began their long march upward.

Prices for all energy sources have gone up since then. From 1973 to 1979, for instance, the price of No. 6 fuel oil, a major heating source, increased from 11 cents to 40 cents a gallon, a total of 260 percent. (By 1980, fuel oil had gone up over 500 percent.) Natural gas prices have gone up from 15-30 to 30-50 cents per therm, depending on a number of factors. The price of electricity went up over 200 percent during that period, from 1.5 cents per Kwh to 3.9 cents per Kwh.

New Jersey's State-owned facilities, obviously, were severely impacted by radically higher energy costs during this time. While the gross area of State facilities increased 17 percent to 40.6 million square feet (with almost all of the increase in higher education), expenditures for energy went up 238 percent from $15.1 million in FY 1973 to $51.1 million in FY 1979.

Strikingly, this has happened while actual energy consumption has grown at a much slower rate, even less than the rate of growth in square footage.

For example, while square footage increased, fuel oil consumption remained almost constant, at 44.8 million gallons during this period.

Electric consumption during this time rose some 19 percent, to 522.8 million Kwh* (and an additional 53.9 million Kwh was used for non-space applications), much of the increase due to the rise in square footage and increased air-conditioning load.

Natural gas consumption rose by 63 percent, to 17.7 million therms. Superficially, this seems like a large jump, but it isn't when seen in context.

A major problem in making comparisons in the State's energy usage is how to measure the major energy sources: fuel oil is measured in gallons, electricity in kilowatt hours and natural gas in Ccf (or therms). Obviously, this is comparing apples to oranges to pears.

In making calculations of the State's energy consumption, we reduced these three major energy sources to the one measurement they have in common, the British thermal unit (Btu).*

The Btu is a measure of how much energy is in a certain amount of fuel. A gallon of No. 6 fuel oil for instance, has 143,000 Btu; a Ccf (one hundred cubic feet) or therm of natural gas contains 100,000 Btu; a kilowatt hour of electricity has 11,600 Btu.*

By converting the various energy sources into Btu equivalents and combining them, we found that energy consumption over the FY 1973 to FY 1979 period increased 13 percent, to 14.2 trillion Btu.

Two other calculations were made. Since there was a substantial space increase in State facilities, we calculated Btu on a per-gross-square-foot basis, to give a better idea of qualitative energy use; and we added a factor to even out weather variations.

That energy costs have risen so far so fast is bad news, but it could have been worse. A conservation program instituted in State facilities

* See section II for definitions

under Executive Order No. 13 (December, 1974) and the Department of Energy Act (N.J.S.A. 52:27F-1 et seq.,) helped reduce energy use from previous high levels. As a result of these conservation efforts, combined energy use, when measured on a Btu-per-square-foot basis and normalized for weather variations, actually went down by 11 percent from FY 1973 to FY 1979.

Stated in Btu-per-square-foot and normalized for weather variations, overall energy use in State facilities went down from 377,199 Btu-per-square-foot to 333,961 Btu-per-square-foot.

Broken down, fuel use (fuel oil and natural gas) was reduced 17 percent, from 239,900 to 199,600 Btu-per-square-foot; electrical use was reduced from 11.84 Kwh-per-square-foot to 11.59 Kwh-per-square-foot, a two percent reduction. When allowance is made for increased percentage of space air-conditioned during this period, electrical use reduction was approximately six percent.

In dollar terms, conservation saved $4.8 million a year in FY 1979, when compared to FY 1973 consumption levels. At estimated 1980 energy prices and without further reductions in consumption, the saving is $7.5 million a year.

CONCLUSIONS

Price increases are responsible for almost all of the increase in state energy expenditures. These price increases will continue in the foreseeable future and underscore the value of conservation savings. Without a continued, total conservation effort, state energy costs could exceed $75 million by FY 1981.

Conservation results achieved through FY 1979 resulted largely from efforts in operations and maintenance, and to a much lesser extent from a few emergency retrofit projects.

Conservation results to date have been achieved despite the fact that maintenance appropriations actually declined for many departments over the FY 1973-FY 1979 period, when measured in constant dollars. Because of the overall poor conditions and advanced age of many State buildings, the status of maintenance needs in State facilities should be reviewed and revised.

Analysis of percentage reductions achieved at specific facilities shows that operation and maintenance conservation measures can achieve up to 30 percent reductions in energy consumption. This is considerably greater than immediate NJDOE goals of 15 percent reductions in energy consumption through operations and maintenance.

The cost and energy conservation importance of electricity has been somewhat neglected. Electrical use was reduced six percent (after adjustement for air-conditioning load), short of the 15 percent reduction goal. Rather than deemphasize fuel conservation, greater future effort should be given electricity.

At present energy price levels, capital intensive retrofit projects that were once uneconomical have now reached the stage of providing rapid payback, provided that sites are carefully selected. At least 15 percent energy savings could be attained through capital intensive retrofit based on analysis of data from other states. While New Jersey has made considerable progress to date, it still has much further to go to match the energy consumption levels of those states.

The cost-benefit orientation of the present conservation program is shown to provide administrative benefits while accurately reflecting the energy units conserved.

INTRODUCTION

All State departments and agencies have multiple motivations for energy conservation: the national interest, legal responsibility and cost savings.

Following the oil embargo of 1973, there was a concerted effort to conserve energy. Executive Order No. 13 issued December, 1974, by Governor Byrne ordered the various State departments to submit data on electric and fuel use on a monthly basis and other information as the (then) State Energy Office required.

However, as time passed, the initial effort faded and energy consumption began to rise again at many facilities.

With the creation of the New Jersey Department of Energy, under Public Law S3179, there came a renewed emphasis on energy conservation.

The Department of Energy Act "... require(s) the annual submission of energy utilization reports and conservation plans by State government departments and agencies," and directs the Department of Energy to "... evaluate said plans and the progress of the departments and agencies in meeting these plans, and order changes in the plans or improvements in meeting the goals of the plans." (N.J.S.A. 52:27F-11CN)

With this mandate from the State Legislature, the Department of Energy (NJDOE) immediately set out to implement an energy conservation and monitoring program in State owned or operated facilities. Responsibility for the program was placed in the Office of Energy Operations within the NJDOE in January, 1978. A staff was immediately hired.

By the end of February, 1978, a "Preliminary Program for Energy Utilization Reports and Conservation Plans by State Government Departments" was submitted to and approved by Assistant Commissioner Charles A. Richman.

On March 3, 1978, the NJDOE requested the commissioners of the various departments to appoint or confirm department energy coordinators who would become responsible for coordinating each department's response to the Department of Energy Act.

On May 4, 1978, the NJDOE met with the various department energy coordinators with the following objectives:

1. To familiarize them with the State's specific goals in energy conservation;
2. To familiarize the NJDOE with the various departments' problems and needs in developing energy conservation plans; and
3. To explain the data requirements for which the NJDOE is held responsible.

On November 28, 1978, the NJDOE met with the department energy coordinators with the following objectives:

1. To stress the immediate goals of a 15 percent reduction in energy use through maintenance and operation, with 15 percent further reduction through repair and retrofit;
2. To remind them that departmental conservation plans are mandated under the Department of Energy Act, must be submitted as promptly as possible, and would be monitored;
3. To repeat that monthly reporting of energy use was required; and
4. To outline available manuals, guides, and energy audit forms specifically suited to state operations.

During this period and subsequently, the NJDOE developed a data base that is partly reflected in the figures in this report. Earlier data collected under Executive Order No. 13 was incomplete and inconsistent, and the effort included resolving these problems. An inventory of State facilities by area and function was completed, current data reporting on a standardized basis was initiated, and uniform procedures for data analysis were developed.

To the extent of the NJDOE's limited manpower, it initiated field visits to specific facilities for energy surveys, delamping programs, efficiency measurements, etc., where consumption analysis indicated a need; and provided technical assistance on conservation matters where requested. This is a continuing effort.

Beginning with March 7, 1979, the NJDOE sent each department a report of its energy conservation status with suggestions for areas requiring attention and reviewed the data with them in person.

DEFINITIONS

Any evaluation must have a base for comparison. For this report, the yardstick or base period is Fiscal Year 1973, with heating energy normalized to 5000 degree days, and areas expressed in gross square feet. Some basic terms also need to be defined.

Base Year--Under the plan adopted in 1978 by the NJDOE, the fiscal year (FY) from July 1 to June 30 was the time period selected for reporting and analysis. It coincides with budgeting, appropriations and other State reporting practices as well as including the full heating season. FY 1973 became the base year because it represents the last full year before the Arab oil embargo of November 1973, which triggered energy conservation efforts and ended "business as usual."

Btu--The British thermal unit (Btu) is the standard non-metric measure of energy quantity. It is the quantity of heat required to raise the temperature of one pound of water by one degree Fahrenheit. A gallon of No. 6 fuel oil, for example, contains about 143,000 Btu.

Btu/Kwh (source energy factor)--It is often desirable to convert electricity in kilowatt-hours (Kwh) to Btu for comparison with fuel in Btu, or to calculate a combined or total Btu figure. For that purpose, this report uses the federal source energy factor of 11,600 Btu per Kwh. This factor is an approximation of the energy consumed in generating and transmitting one Kwh to the end user, and thus reflects the energy saved by conserving one Kwh, as well as approximating its relative cost. (In the development of this factor, it was acknowledged that the exact figure varies from utility to utility, seasonally, and even with time of day.)

Btu/Kwh (heat release factor)--The factor of 3,413 Btu per Kwh is frequently encountered because of its use in engineering to indicate the heat released per Kwh in electric resistance heating and similar applications. (Heat pumps and air conditioning applications require other factors, usually expressed as COP's, or coefficients of performance.) In short, the source energy factor represents the heat input to make electricity, and the heat release factor represents what one gets out under certain conditions.

Ccf--This is the abbreviation for one hundred cubic feet. A Ccf of natural gas contains about 100,000 Btu. (A therm of natural gas is exactly 100,000 Btu by definition.)

Degree Days--See Section III, Weather

Gross square feet--This is a measure of area widely used in conservation and was adopted for federal use. Gross area is defined as that enclosed by the outer perimeter of a building and typically is about 10 percent greater than the largest of the standard measure of internal or useful area.

Normalized--See Section III, Weather.

Total Btu --To permit better analysis of energy use, fuel and electric data have generally been disaggregated and reported separately as Btu/sq. ft. and Kwh/sq. ft. If total Btu is required for comparison with published figures, it may be computed as follows:

Total Btu = Fuel Btu + (Kwh x 11,600)

WEATHER

Heating Season--While the average winter temperature in New Jersey for the seven seasons from FY 1973 through FY 1979 was within two percent of the long-term average, the period included the warmest winter since World War II and two of the coldest winters in 50 years (See Figure 1). These variations in winter weather are particularly significant in evaluating changes in energy use from year to year when 40 to 60 percent of building energy use is for heating loads, which is typical of New Jersey State facilities. Without compensating for weather variations, it is impossible to determine if changes in energy consumption are due to conservation or simply reflect changes in weather.

Degree days--An accurate measure of heating load when used for periods of a month or more is the "Degree Day." The 50-year average for Newark* is 5020 degree days per heating season. During development of the New Jersey energy data base, research determined that Newark data were usable state-wide (Sussex County and the Cape May area are the exceptions) to measure relative change in winter loads. As a result, the Department of Energy has standardized on Newark data with 5000 degree days as the norm.

Normalization--This rating of heating energy consumption enables year-to-year comparison of energy consumption rates by using degree day data to reduce or eliminate the effect of annual variations in winter weather.

In normalization, it is first necessary to determine the base load (defined for the purposes of this report as energy for uses other than heating), by analysis of month-by-month consumption. Sensitivity analysis

* All degree day figures refer to National Weather Service data for Newark Airport Station.

shows that for the degree day and load ranges involved, an error of 10 percent in estimating base load results in an error of 0.9 percent or less in the normalized consumption figure.

The formula for normalizing fuel use is:

$$\text{Normalized Btu} = \text{Heating Btu} \times \frac{5000}{\text{Degree Days}} + \text{Base Load Btu}$$

The methodolgy can be clarified with an example:

Fuel use 200,000 Btu/sq.ft./yr.

Base Load 40 percent; 4545 degree days

0.4 x 200,000 = 80,000 (Base Load)

0.6 x 200,000 = 120,000 (Heating Load)

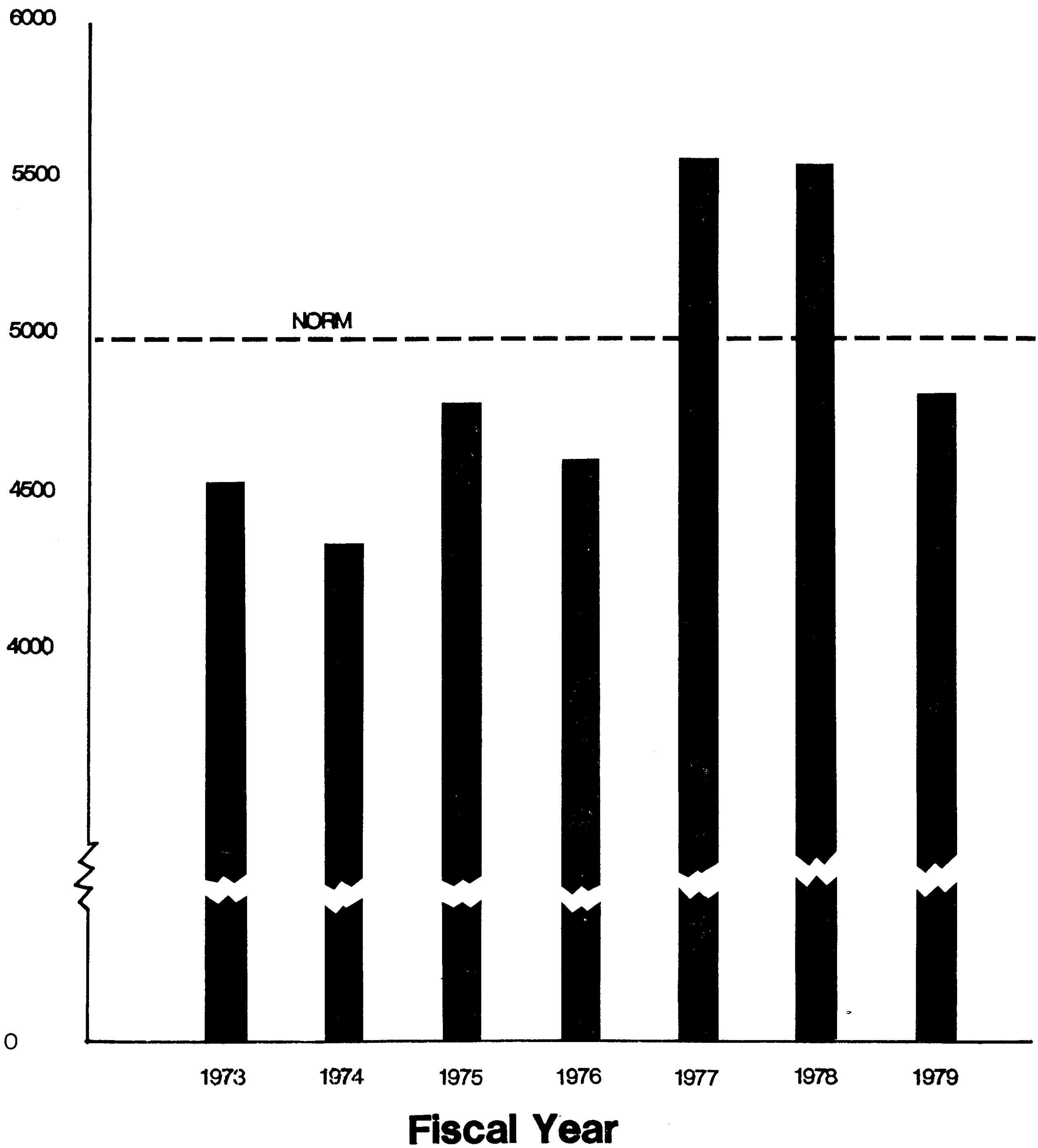
$$\text{Normalized Btu} = 120{,}000 \times \frac{5000}{4545} + 80{,}000 = 212{,}000 \text{ Btu}$$

For the example above, the raw performance level of 200,000 Btu/sq.ft. is equivalent to 212,000 Btu/sq.ft. consumption in a 5000-degree day year, and that figure then becomes comparable to performance data for other years that have also been normalized (compensated upward or downward) to 5000 degree days. Without at least rudimentary normalization, one can be misled as to conservation progress by results in warm or cold winters, and as the degree day chart indicates, wide variation ($\pm$ or - 10 percent) has been common in this decade.

Cooling Season--It would be useful to compensate energy figures for changes in air-conditioning load as well as heating load, but efforts to date have not been successful. The National Weather Service recently began to provide cooling degree days, but these have not received wide acceptance in the engineering profession, and their application to data for New Jersey buildings does not provide consistent correlation with actual energy consumption. It is hoped that research on a more complex index, including a humidity factor and the temperature buildup or "fly wheel" effect on buildings will provide a practical means of normalizing summer loads in the future.

FIGURE 1

Seasonal Degree Days *



*DATA: NATIONAL WEATHER SERVICE NEWARK AIRPORT

AREA AND BUILDINGS

Owned Space--In FY 1979, State facilities covered in this report totalled 40.6 million sq. ft., comprising 2920 buildings (Figure 2). In FY 1973, there were 34.7 million sq. ft. The area increased over the seven-year period by approximately 5.9 million sq. ft. or 17 percent (Figure 3), with over 90 percent of the increase in college and university space.

The FY 1979 figure includes a small amount of leased space for which the State supplies all energy (less than one percent), and excludes some unheated, temporary, and other miscellaneous space (less than one percent).

The FY 1979 figure also includes 4.5 million sq. ft. of student dormitory and activity space whose energy is supplied largely from campus central steam plants and substations. The cost of operating this space comes from student fees rather than the General Fund; however, the lack of submetering makes it impossible in many cases to accurately separate this consumption. A good portion of this space was financed by the New Jersey Educational Facilities Authority.

The diversity in age and size of buildings is extreme. Many were built in the nineteenth century, with a few approaching 150 years of age, and several were built in the eighteenth century.

Structures range from storage or maintenance sheds of a few square feet in size to buildings half a million square feet in area or larger, such as the Labor and Industry Building in Trenton, the Medical School in Newark, and Greystone Hospital.

Heating and ventilating systems are as diverse as the age and area of the buildings. Over 60 percent of the total space is supplied by central steam systems serving two or more buildings. Less than 50 percent of the space is air-conditioned (or cooled), but an increasing percentage of existing space is being air-conditioned, typically by small systems or individual room air-conditioners for offices or other special use areas.

Leased Space--The State also leases 4.6 million sq. ft. of office and storage space in 475 buildings (1978 data). Energy consumption for this space is not covered in this report.

Total Area--The leased and owned space totals 45.2 million sq. ft. in approximately 3500 buildings.

Figure 2

AREA OF STATE BUILDINGS -- FY 1979

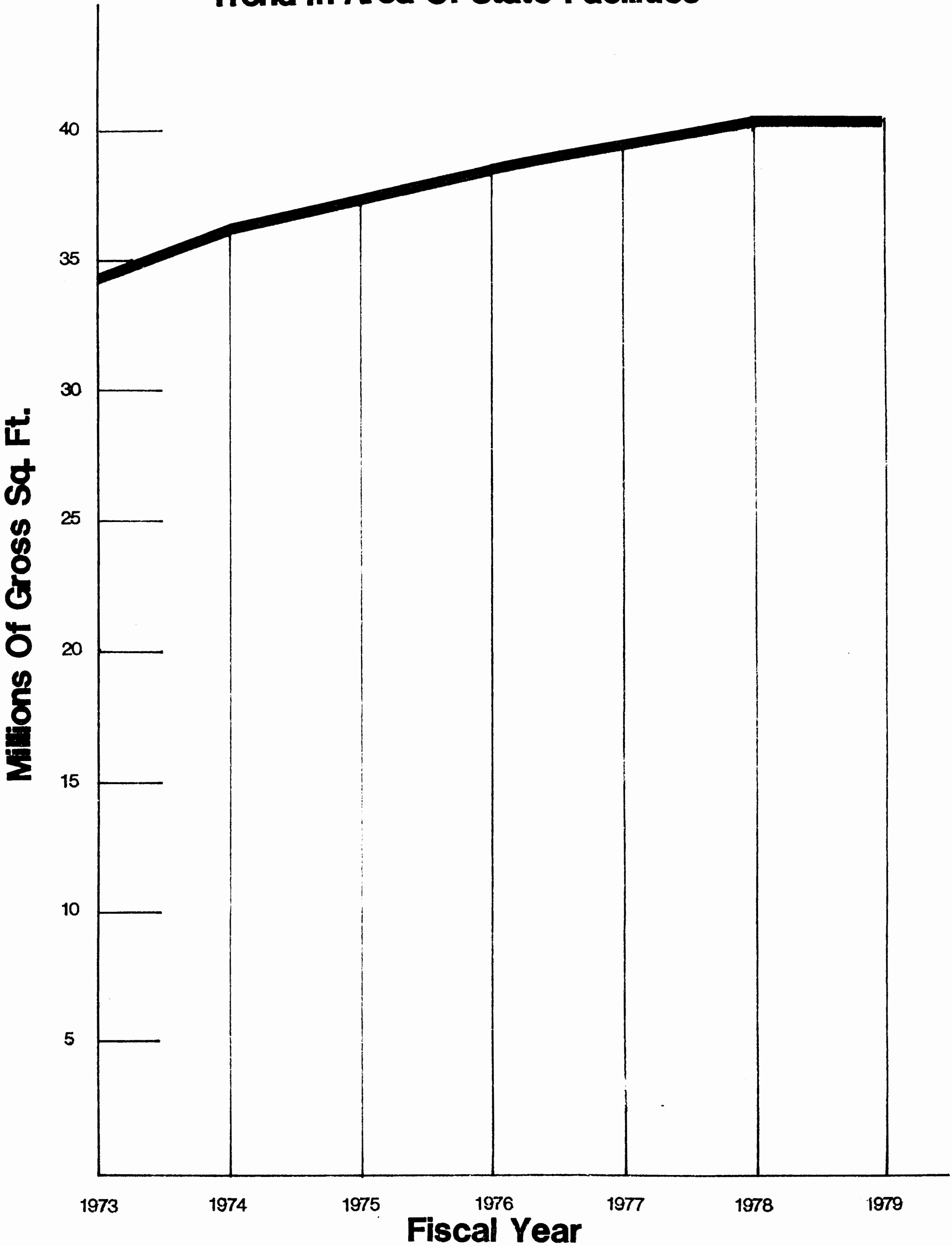
State Account No.	Department *		Gross Sq. Ft.	Percent
100	Law & Public Safety		775,000	1.9
200	Treasury (Capitol Services)		1,592,000	3.9
340	Defense		2,077,000	5.1
350	Energy (Public Broadcasting)		60,000	0.1
400	Environmental Protection		956,000	2.4
500	Education		710,000	1.7
540	Higher Education **			
	State Colleges	7,592,000		
	Universities	14,413,000	22,005,000	54.2
600	Transportation		1,124,000	2.8
700	Human Services		9,709,000	23.9
860	Corrections		1,624,000	4.0
	Total		40,632,000	100.0

* Those departments not listed occupy leased space, space operated by Capitol Services, or have less than 25,000 sq. ft. of owned space.

** Includes 4.5 million sq. ft. of student dormitory and activity areas.

FIGURE 3

Trend In Area Of State Facilities



OTHER CONSERVATION PROGRAMS

Leased Space--The program for leased space includes direction to departments using such space to implement programs to insure that lighting and temperature levels are in compliance with Executive Order No. 13.

Staffs are motivated to conserve electricity by reminders that energy use in leased space is directly reflected in State costs through rent and escalation clauses. Equipment or design for reduced energy consumption have been part of recent remodeling projects for leased space, such as the New Jersey Public Broadcasting studio in Newark. Responsibility for developing lease incentives for owners to reduce energy consumption has been placed with the Treasury Department's Energy Coordinator.

Gasoline--Under the Preliminary Program adopted by the Department of Energy, an approach to motor fuel conservation through the State's master fuel contracts was recommended. This approach was selected because experience with department-by-department programs in 1974 and 1975 indicated that results were not proportional to the effort required.

In the Spring of 1979, the necessity for fuel allocation resulted in a complete inventory of gasoline storage and distribution facilities and development of accurate monthly consumption data for each supply point. Based on this data, a coupon rationing system of gasoline-use control was introduced by the Treasury Department's Energy Coordinator at the start of FY 1980. This is expected to substantially reduce motor fuel use.

The importance of the gasoline control program is underscored by the fact that for FY 1979 the State spent $6.3 million for approximately 11.7 million gallons of gasoline.

Procurement--The Energy Efficient Procurement Office in the Division of Purchase and Property was initially funded through a grant obtained by the NJDOE from the federal DOE. This office is developing State purchasing specifications for lamps, fixtures, air-conditioners and other items that will reflect the item's life cycle cost, and thus its energy consumption.

ENERGY SUPPLY

The mix of energy sources used in FY 1979 is shown in detail in Figure 4. The State also used a small amount of No. 1 fuel oil or kerosene (less than 0.5 percent of total energy use), which is included in the No. 2 fuel oil figure; and minor amounts of propane (less than 0.1 percent of total energy use), which was included on a Btu basis with facility fuel oil or natural gas figures.

Shifts in consumption of the three principal energy sources -- fuel oil, natural gas, and electricity -- that occurred between FY 1973 and FY 1979 are shown in Figure 5. Fuel oil consumption remained almost exactly constant. The increase in overall fuel consumption was accounted for by a 63 percent growth in the use of natural gas. There was also a 19 percent increase in the use of electricity.

Fuel Oil--Calculating total energy use (using a source energy basis for electricity of 11,600 Btu/Kwh), fuel oil is the second most important State energy source at 43.1 percent. The detailed breakdown of fuel oil consumption by type (No. 2, No. 4, and No. 6) is not complete for prior years, but No. 6 fuel oil consumption appears to have remained fairly constant, while there was about 20 percent conversion from No. 2 to less expensive No. 4 fuel oil.

Natural Gas--An increase in natural gas consumption came about primarily as a result of shifts from oil to gas at facilities equipped for dual fuel use (combination gas/oil burners). To a lesser extent, use increased due to growth in size of facilities equipped for gas only, such as Ramapo and Stockton State Colleges. To a still lesser extent, there has been growth in natural gas use due to installation of gas-fired hot water and heating units for individual buildings.

The shift to natural gas did not occur at a uniform rate. Shortages of natural gas, particularly for lowest-cost interruptible service, reversed the trend in 1976. The shift was futher slowed by natural gas rate increases that made gas more costly than oil on a Btu basis for some facilities until 1978.

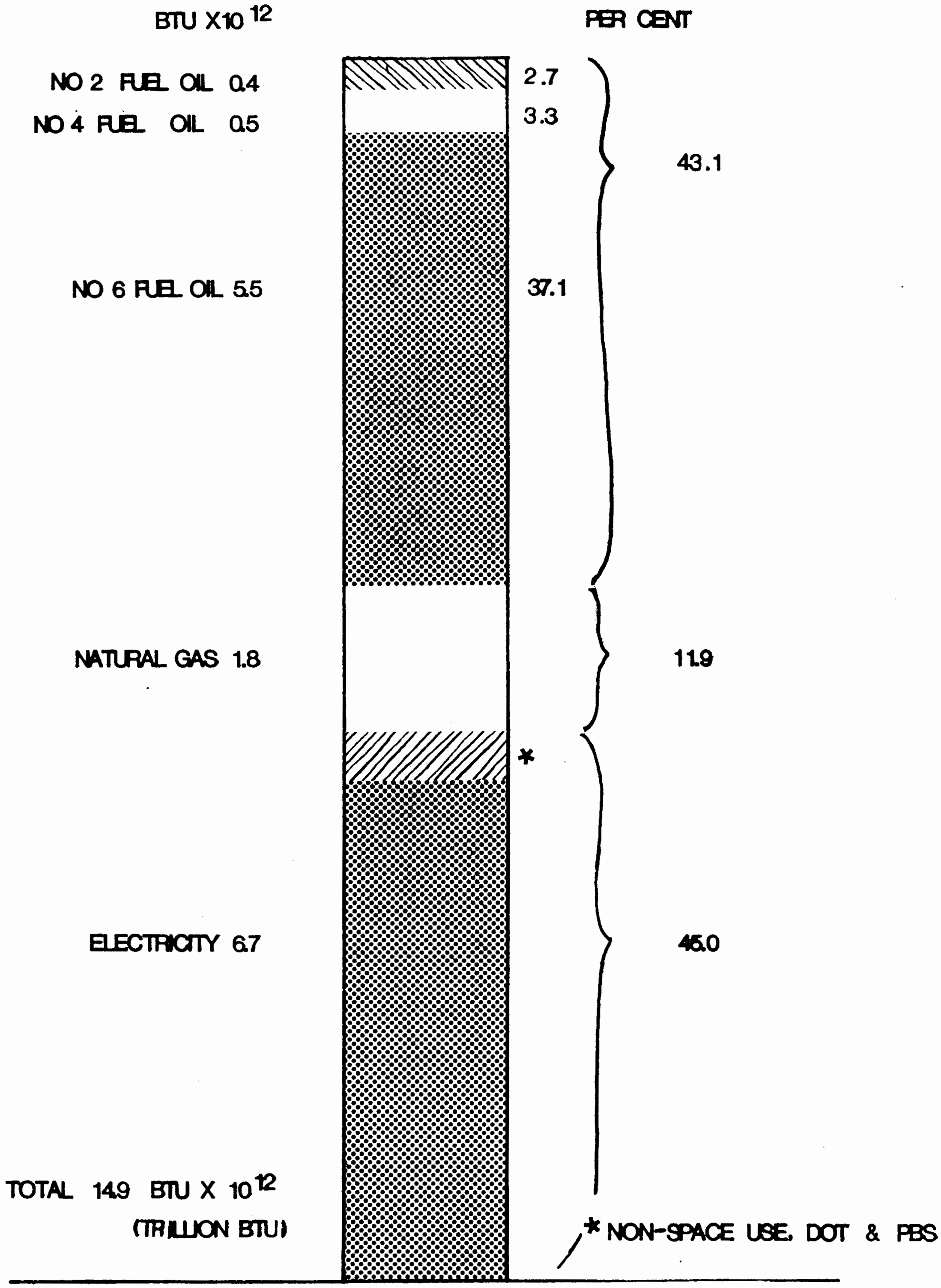
Electricity--The increase in electric consumption closely paralleled the increase in facility area over the period. There have been no significant shifts to or from electricity involving other energy sources.

FIGURE 4

Energy Consumption

FY 1979

(ELECTRICITY AT 11,600 BTU/KWH)

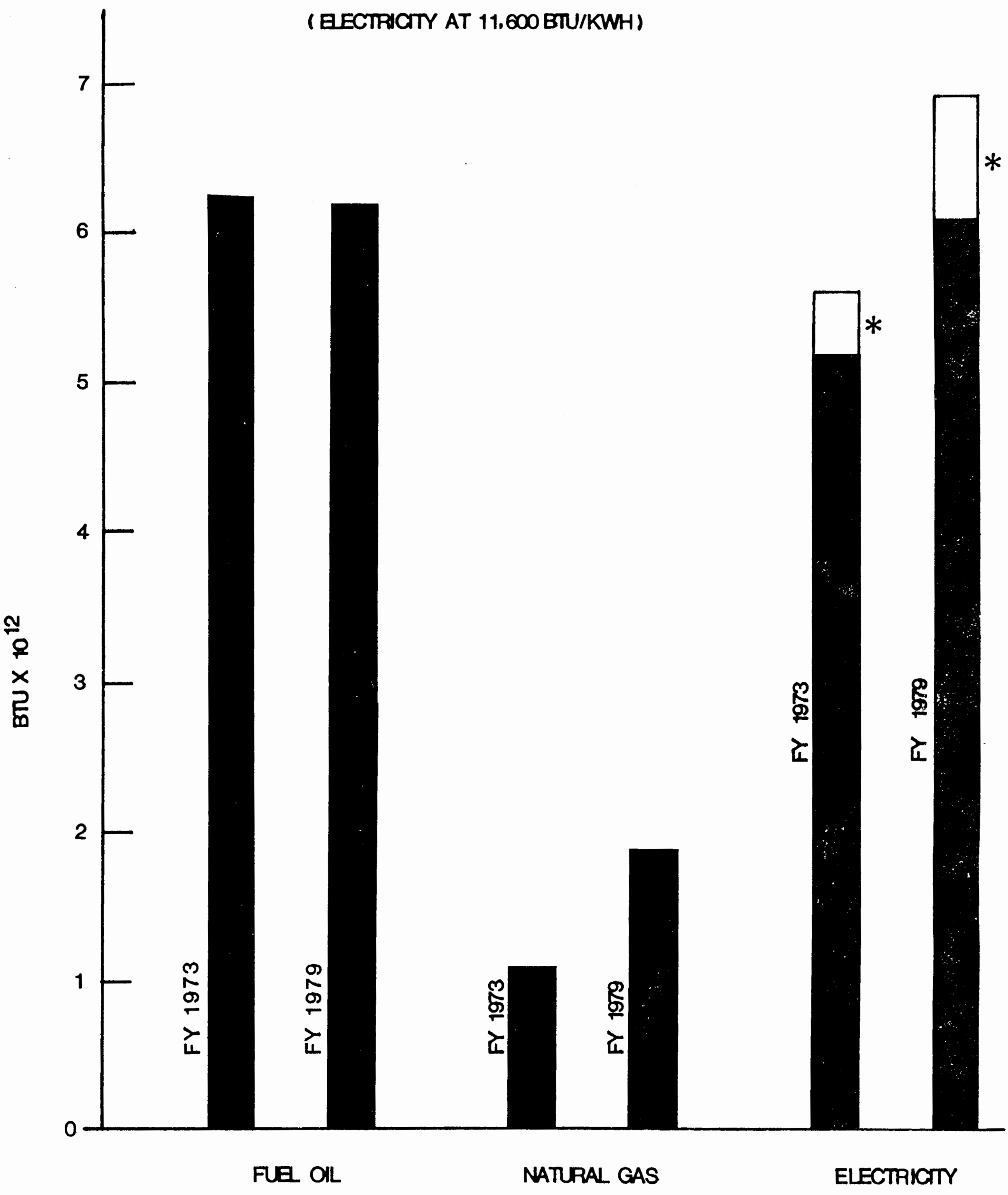


(TOTAL 14.2 BTU X 10^{12} EXCLUDING NON-SPACE USE)

FIGURE 5

Change In Energy Supply Components

FY 1973 TO 1979



* NON-SPACE USE OF ELECTRICITY

ENERGY PRICE TRENDS

Fuel Oil--Price data for No. 6 fuel oil is shown in Figure 6. Because oil prices have tended to rise in steps rather than at a constant rate, it is necessary to consider the price over at least a decade to evaluate the price trend, and, even then, the estimate of the slope remains somewhat subjective. However, an overall rate of increase of 25 percent per year compounded appears reasonable and is indicated in Figure 7.

The steplike pattern of all price increases has tended to spur conservation efforts following a sharp price increase, with a slackening of effort when price remains on a temporary plateau. The net effect of this pattern is discussed in Section VIII, Conservation Results.

The fact that oil prices have risen at an annual rate at least 15 percent higher than inflation has radically improved the economics of major retrofit projects to save energy. For example, a retrofit project that in 1970 had an installed cost of $250,000, and saved 250,000 gallons of oil per year, saved $25,000 per year and had a payback of 10 years. By 1979, that project's cost would have risen to $500,000 as a result of inflation, but the fuel saving would have risen to $100,000 per year, for a payback of five years. By 1980, fuel price increases had reduced the payback period to less than three years.

Natural Gas--FY 1979 consumption is not directly comparable to FY 1973 in terms of rate schedules and other cost factors; however, data for individual facilities shows price increases over the period ranging from 100 percent to 300 percent.

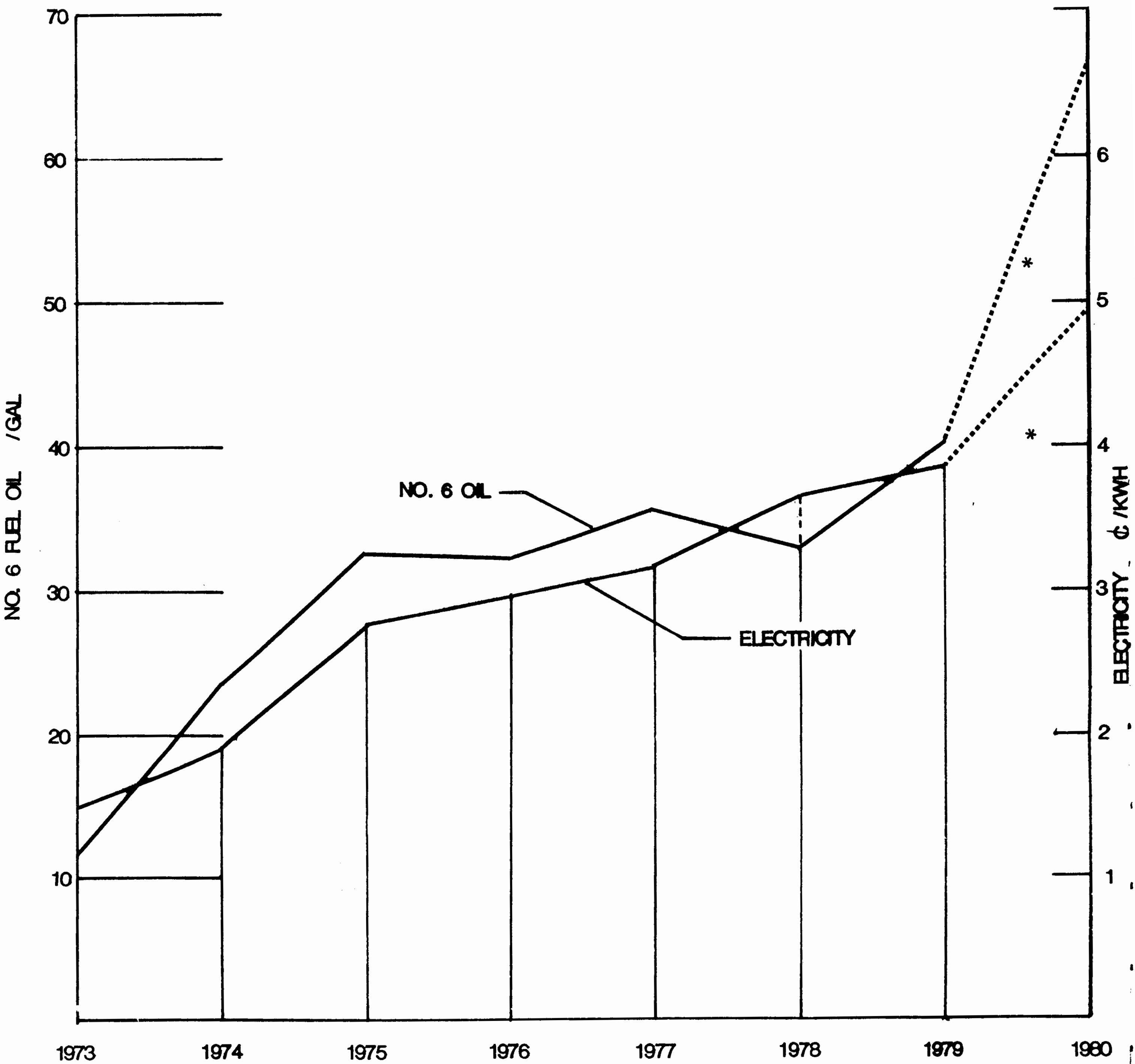
Electricity--Price data for electricity is also shown in Figure 6. These figures reflect the fact that nearly 80 percent of the electricity is purchased under large volume or high tension power rates, and some individual facilities pay rates up to three times as high.

No trend line is shown for electric cost, since data available at the time this report was prepared indicates that the increase for all electric rates is accelerating. Unusual circumstances affecting GPU subsidiary Jersey Central Power and Light will have some effect on the average statewide rate.

Analysis of energy price trends indicates that conservation of electricity warrants effort equal to conservation of fuel when potential cost savings are considered.

FIGURE 6

Energy Price

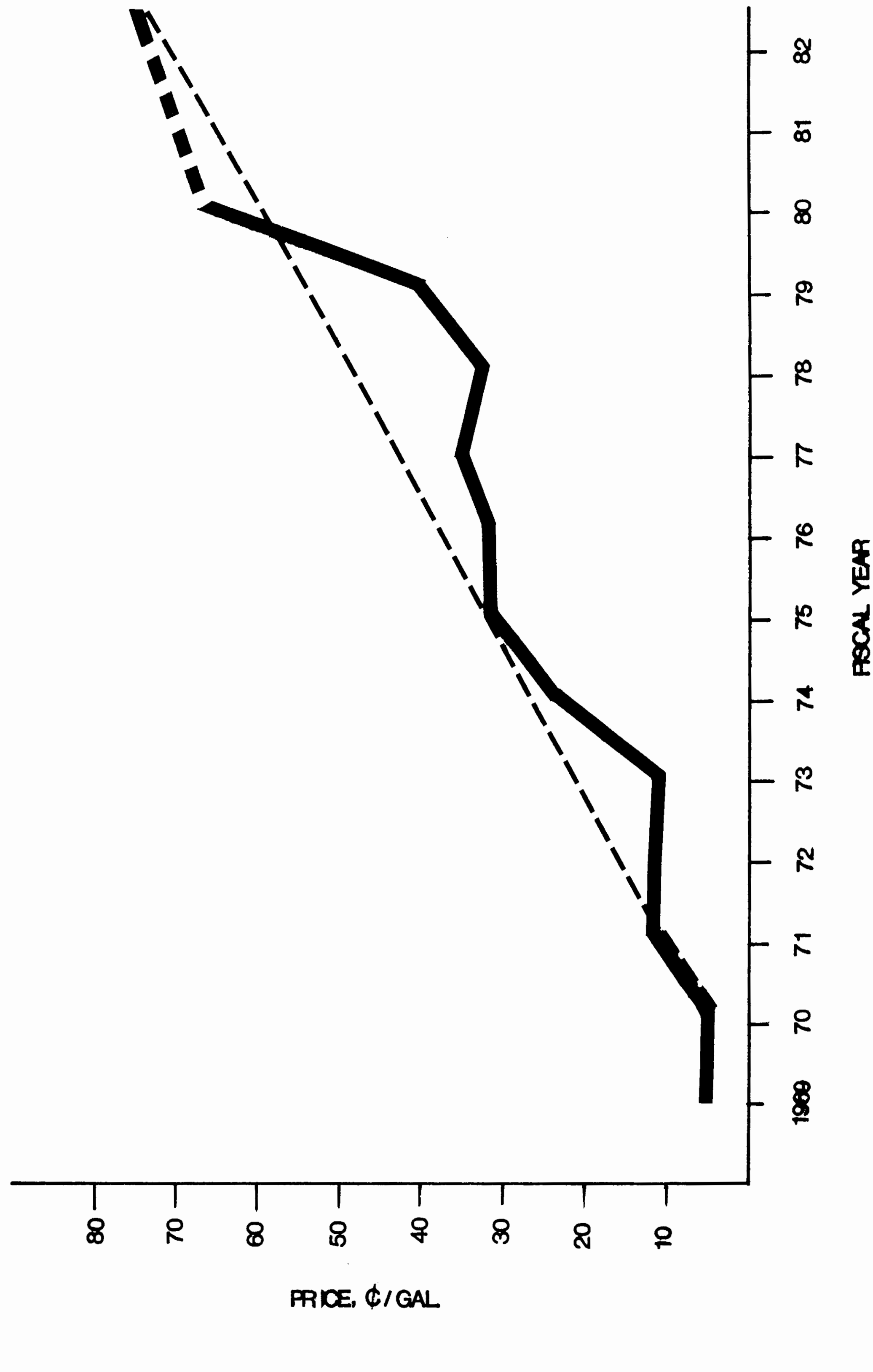


Fiscal Year

* DATA INCOMPLETE

FIGURE 7

Long Term Price Trend, No. 6 Fuel Oil



CONSERVATION RESULTS

Area and energy data for FY 1979 and the base period FY 1973 are presented in Figure 8 by department, and statewide. To enable comparison of FY 1979 performance with the base period, fuel use is reduced to Btu/sq. ft. and electricity use to Kwh/sq. ft.

The overall performance shown by the data in Figure 8 is summarized in the weighted average for comparable facilities:

	FY 1973	FY 1979	Percent Change
Fuel, Btu/sq. ft. (norm)	239,855	199,517	- 17.0
Electricity, Kwh/sq. ft.	11.84	11.59	- 2.0
Total, Btu/sq. ft. (11,600 Btu/Kwh)	377,199	333,961	- 11.5

The 17 percent reduction in fuel (Btu/sq. ft.) speaks for itself, but the two percent reduction in electricity (Kwh/sq. ft.) understates the actual saving. A higher proportion of the 5.8 million sq. ft. which was added during FY 1973 to FY 1979 was air-conditioned than was the existing physical plant. The result was an estimated 19 million Kwh in additional air-conditioning load absorbed by conservation during the period from 1973 to 1979. Allowing for this additional air-conditioning, the reduction in electric consumption was 5.9 percent rather than two percent. (There was also some addition to steam load from additonal air-conditioning, which is not reflected in the 17 percent fuel reduction.)

Comparative Performance--In reviewing Figure 8, it is not fair, nor useful, to make comparisons of consumption level between departments because of the radical differences in age, size, and function of their facilities. Differences in consumption level and conservation gains will be discussed separately with each department in the context of their physical plant and its use. It is, however, possible to determine realistic conservation goals for like types of buildings, such as offices, or others, by examining relative conservation performance of the same kind of facility, and this is done in Section X.

Savings From Conservation--The 17 percent reduction in fuel and two percent reduction in electricity for FY 1979 resulted in a saving of $4.8 million per year compared to what expenditure would have been at FY 1973 consumption levels. When allowance is made for the additional air-conditioning load that has been absorbed, the saving increases to $5.7 million per year.

* * *

UPDATE TO 1980

At 1980 energy prices and without further conservation, the annual savings increase to $7.5 million per year, and with allowance for added air-conditioning increases to $8.6 million per year.

* * *

Trends in Energy Conservation--The reduction in energy consumption did not occur at a constant rate. There were variations from facility to facility and among the several departments, but essentially there was a sharp initial reaction to the fuel price increases in 1974-75 and an overall compliance with Executive Order No. 13. But a series of warmer-than-normal winters, and fuel price stability from FY 1975 to FY 1978, as well as specific factors related to electric usage, resulted in an increase in consumption by FY 1977 or FY 1978, as shown in Figure 9. (This data is restricted to the four departments for which relatively complete data is available for the FY 1974 - 1976 period.)

New Jersey was not alone in this experience. A recent report from the Massachusetts Office of Energy Resources noted: "There was a significant reduction in consumption from FY 73 to FY 76. This was due to the oil price increases and the greater awareness of energy in general. From FY 76 to FY 79 there was a slight increase in total energy use. As this report shows, many facilities did enact effective conservation programs, but a large number increased their energy consumption in this period."

In FY 1979, renewed emphasis on energy conservation inititated by the NJDOE had stopped or reversed this upward trend, and a continuing effort coupled with renewed fuel price increases is expected to yield improved results in the future.

FIGURE 8
ENERGY CONSUMPTION DATA

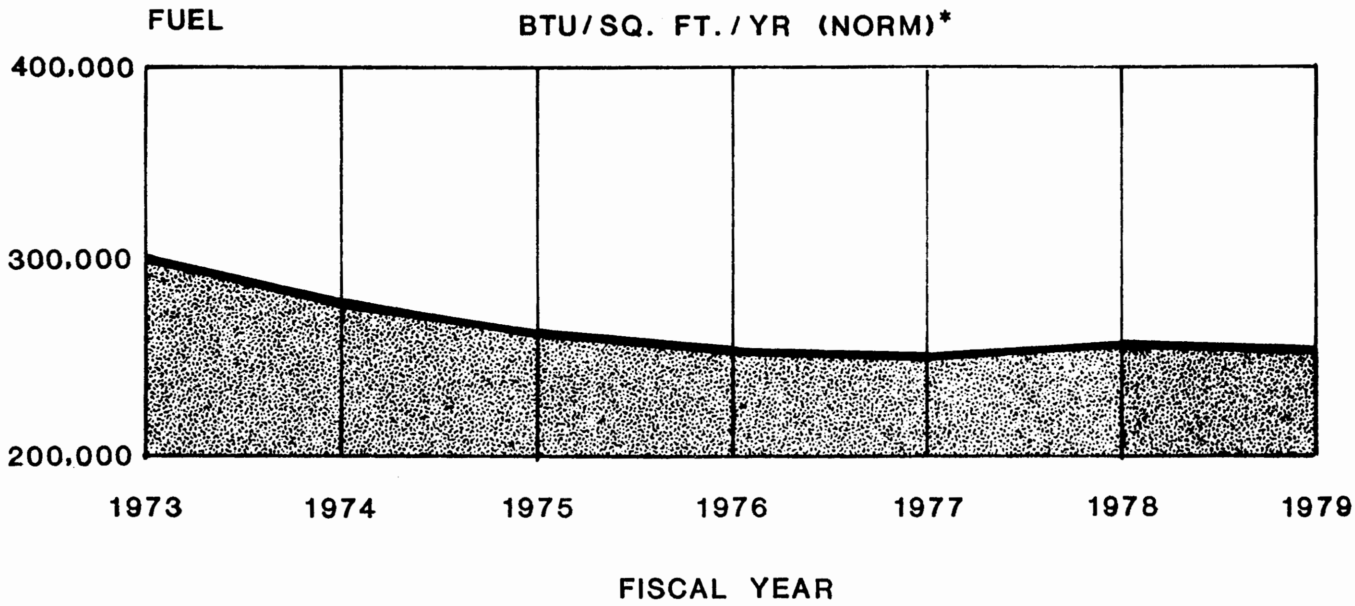
No. Department	FY 1973[a] Area[c] Sq.Ft.	FY 1973[a] Oil Gal	FY 1973[a] Gas Ccf	FY 1973[a] Elect Kwh	FY 1973[a] Btu/ Sq.Ft. Norm[d]	FY 1973[a] Kwh/ Sq.Ft.	FY 1979[b] Area[c] Sq.Ft.	FY 1979[b] Oil Gal	FY 1979[b] Gas Ccf	FY 1979[b] Elect Kwh	FY 1979[b] Btu/ Sq.Ft. Norm[d]	FY 1979[b] Kwh/ Sq.Ft.	Per Cent Change 1979 vs 1973 Btu/ Sq.Ft.	Per Cent Change 1979 vs 1973 Kwh/ Sq.Ft.
	---Thousands---						---Thousands---							
100 Law & Pub. Safety	900	190	65	14,000	40,485	15.56	900	202	69	14,165	36,209	15.67	- 10.6	+ 0.7
200 Treasury (Cap.Services)	1,500	1,125	--	35,500	116,109	23.67	1,527	876	7	30,992	85,245	20.30	- 26.6	- 14.2
340 Defense	2,000	970	81	9,400	79,475	4.70	2,077	911	79	9,867	67,157	4.75	- 15.5	+ 1.1
350 Energy (Pub.Broadcast)	40	--	18	538	49,750	13.45	60	--	16	1,108	32,640	18.47	e	e
400 Envir. Protect.	850	480	--	12,000	87,477	14.12	956	529	--	13,210	81,778	13.82	e	e
500 Education	650	510	5	2,111	139,344	3.77	650	485	6	2,308	129,195	4.12	- 7.3	+ 9.3
540 Higher Education[f]														
State Colleges	5,266	6,798	921	75,649	225,768	14.40	7,592	7,569	1,876	105,870	168,540	13.9	- 25.3	- 3.2
CMDNJ	1,741	1,985	465	49,500	205,452	28.43	3,126	1,733	8,208	89,364	352,406	28.59	e	e
NJIT	831	436	715	11,438	174,158	13.76	837	336	438	9,312	113,248	11.13	- 35.0	- 19.1
Rutgers	8,724	6,879	6,092	109,890	197,531	12.60	10,311	6,473	5,145	124,560	144,190	12.08	- 27.0	- 4.1
600 Transportation	1,100	850	--	10,000	119,660	9.09	1,268	909	66	10,601	111,349	8.36	- 6.9	- 8.0
700 Human Services	9,370	17,956	1,990	79,513	313,810	8.49	9,485	18,055	1,532	81,196	295,791	8.56	- 5.7	+ 0.8
860 Corrections	1,624	6,747	495	30,463	663,846	18.76	1,624	6,781	221	30,204	626,522	18.60	- 5.6	- 0.9
TOTAL	34,596	44,926	10,848	440,002	234,164	12.73	40,413	44,829	17,663	522,757	207,688	12.93	--	--
WEIGHTED AVERAGE FOR COMPARABLE FACILITIES					239,855	11.84					199,517	11.59	- 17.0	- 2.0
Other Electric Usage[g]														
Public Broadcasting										5,380				
Department of Transportation										48,500				
Subtotal										53,880				
TOTAL										576,637				

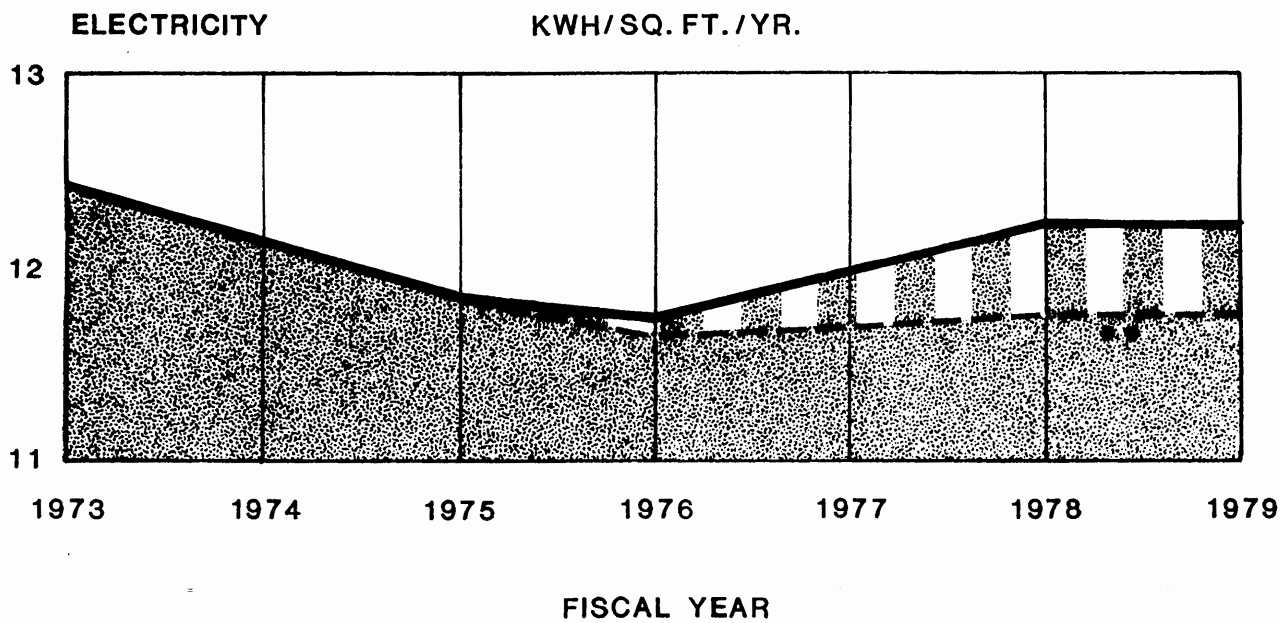
(a) Approximately 5% of total energy use for FY 1973 was calculated from actual expenditures and unit energy prices.
(b) Data for FY 1979 is based on facility consumption reports checked against Treasure Department expenditure reports.
(c) Based on area for energy reporting, and may differ slightly from data in Figure 2.
(d) Heating load normalized to 5000 degree days. See Section III for methodology.
(e) FY 1973 facilities and use not comparable with those for FY 1979
(f) Includes 4.5 million sq. ft. of student dormitory and activity space.
(g) Details of use are provided in Section IX.

FIGURE 9

SEVEN-YEAR ENERGY CONSUMPTION TREND

(FOUR DEPARTMENTS-CORRECTIONS, HIGHER EDUCATION, HUMAN SERVICES, CAPITOL COMPLEX)





*NORMALIZED TO 5000 DEGREE DAYS TO REDUCE EFFECTS OF YEAR-TO-YEAR CHANGES IN WINTER HEATING LOAD

**ESTIMATED CORRECTION FOR ABSORBED INCREASE IN AIR CONDITIONING LOAD

OTHER ELECTRIC USAGE

In addition to the 522.8 million Kwh of electricity used for space-related functions in FY 1979, approximately 53.9 million Kwh was consumed for non-space uses in broadcast transmitters, highway lighting and traffic control. Use of the 53.9 million Kwh is detailed below.

Public Broadcasting--In FY 1979, some 5.38 million Kwh were used for broadcasting. Consumption has been reduced by 14.6 percent per transmitter since 1974, and consumption per broadcast hour has been reduced almost 20 percent over the same period. Savings resulted from close control of operations and the addition of heat recovery equipment to apply waste energy to space heating.

Department of Transportation--Electricity is used for a variety of highway-related functions including metered "strings" of highway lights, lighting provided on a per-pole basis by the electric utilities, lighting shared with municipalities, and for the operation of traffic safety devices. In FY 1979, the approximate consumption was 48.5 million Kwh, estimated from samplings of the several hundred bills received per month and from utility reports of average revenue per kilowatt for street lighting service. FY 1973 was not estimated.

NJDOT is systematically upgrading installations with high efficiency lighting providng up to 170 percent more output per Kwh. However, it was deemed impractical to measure the results because of the increase in number of installations in recent years, and the fact that increased efficiency is used for better highway safety as well as to reduce power input.

CONSERVATION GOALS

Two aspects of realistic conservation goals will be examined in this section: percentage reduction and consumption level. Percentage reduction figures can be established for facilities which have average consumption to begin with, but if consumption levels are excessive, the legitimate goal in reduced consumption must be much greater.

Operations and Maintenance--Taking examples for specific State facilities, whose initial level of energy consumption was within the average range for like institutions, the following table shows actual percentage reductions that were achieved:

Type	Fuel, percent	Electric, percent
Office Space	30	15 - 20
Higher Education	30	30
Hospitals (H.S.)	25	25
Corrections	20	15

One other example shows what can be accomplished with concentrated effort in a given area, starting with a building which was already at or below average consumption. 1100 Raymond Boulevard, Newark, is privately owned, but about 80 percent State leased, has over 400,000 sq. ft. and was built between 1923 and 1970.

	FY 1973	FY 1979	Percent Change
Fuel, Btu/sq. ft. (norm)	53,400	30,030	-43.8

These conservation results were almost entirely through operation, and without any major renewal, modernization or other major expenditure.

Major Capital Retrofit--Two examples are given below of the kind of energy consumption reduction that can be realized when needed capital expenditures are made where initial energy use levels were excessive.

Montclair State College: In the early 1970's, nearly a million dollars was invested in repair and replacement of steam and condensate lines -

Btu/sq. ft. (norm)	FY 1973	FY 1979	Percent Change
	379,701	147,763	- 61.1

Gross reduction in fuel consumption: 900,000 gallons/year, worth $600,000/year at 1980 fuel prices.

Jamesburg Correctional: In 1977-78, approximately $800,000 was invested in major steam line and condensate system replacement -

Btu/sq. ft. (norm)	FY 1978	FY 1979	Percent Change
	941,690	626,651	- 33.5

Not all the benefits of the replacement have been fully realized, but the reduction in fuel consumption was 496,000 gallons/year, worth $325,000/year at 1980 fuel prices.

Consumption Level--One source of data to determine whether facilities are at legitimate levels of energy consumption or whether goals should be based on radically lower consumption figures is found in the experience of other states. This source is important because experience from New Jersey's private industry may not be fully applicable, either through the lack of comparable facilities, or because of radical differences in fiscal policies.

Overall Performance vs Other States--

	State	Btu/sq. ft.	Kwh/sq. ft.	Total Btu/sq.ft. Actual	Total Btu/sq.ft. Normalized*
1.	New Jersey	200,000	11.6	334,000	334,000
2.	Massachusetts	-	-	332,000	-
3.	Pennsylvania	187,300	8.5	285,900	264,400
4.	Minnesota	142,000	9.9	256,900	220,000

* Estimated normalization to 5000 degree days.

1. The Btu/sq. ft. figure for New Jersey is normalized, while that for other states is not. The data excludes the medical college at Newark since data for the other states does not include a major teaching hospital.

2. Massachusetts data is based on 46.5 million sq. ft. and 15 trillion Btu vs 40.6 million sq. ft. and 14.2 trillion Btu for New Jersey. The average degree days was more than 20 percent

higher than the New Jersey level. With an adjustment for this, the total figure becomes about 280,000 Btu/sq. ft.

3. Pennsylvania data is based on 67 million sq. ft. and reflects about 20 percent higher degree days than the New Jersey norm. Most significant is the difference in electric consumption.

4. Minnesota data is based on 21.8 million sq. ft. and reflects a range of 8500 to 9500 degree days. With correction for the degree day difference, the Btu/sq. ft. level would become about 100,000 and the total Btu figure about 220,000. Perhaps the most significant factor to account for the sharp difference in energy consumption is that the average age for the Minnesota facilities is 28 years -- markedly newer than the average age of New Jersey facilities.

One factor that may have affected comparative performance for Pennsylvania and Minnesota is energy monitoring. Pennsylvania has monitored energy performance through a central office for over 50 years, in order to identify poor performance and to determine where major maintenance or replacement of physical plant is needed. Minnesota has had central energy monitoring for similar purposes for 20 years.

Another factor applies to Minnesota. It appears that the very low winter temperatures in Minnesota resulted in better thermal insulation in building construction. Specifically, without wall insulation and thermopane or double glazed windows in Minnesota public facilities, space near outer walls would have been virtually useless during winter months.

Departmental Performance vs Other States--Figure 10 presents these comparisons in summary form. Clearly, the data for Minnesota is sharply divergent and far superior to the other states. Perhaps it best indicates a future goal for New Jersey after major capital improvements in State

DISTRIBUTION OF ENERGY EXPENDITURES

The overall trend in State expenditures for fuel and utilities is shown in Figure 11, which reflects the 238 percent increase from $15.1 to $51.1 million from FY 1973 to FY 1979. Without the savings through conservation noted previously, the total expenditure would have been at least $55.9 million in FY 1979. The value of a further 15 percent reduction in energy consumption would be about $7.5 million per year.

Comparing the 238 percent increase in expenditure with the 17 percent growth in area of facilities, it is clear that the expenditure increase is almost entirely due to the increase in energy prices.

Figure 12 provides a breakdown of expenditure by department, including $47.3 million which is space-related and $3.8 million for non-space use of electricity. Somewhat more informative is the distribution of expenditure between fuel and electricity:

	$ Millions	Percent
Fuel	24.8	52
Electricity	22.5	48
	47.3	100

If non-space use of electricity is included, the cost importance of electric conservation is even clearer:

	$ Millions	Percent
Fuel	24.8	49
Electricity	26.3	51
	51.1	100

Considering the results of conservation efforts to date (17 percent reduction in fuel, six percent reduction in electricity, after allowance for additional air conditioning load), it is obvious that while efforts to save fuel must not slacken, there must be much greater emphasis on conservation of electricity than has been the case in the past.

*　　　*　　　*

UPDATE TO 1980

The abrupt increase in oil price and accelerating rate increases for electricity in FY 1980 have already made the figures given here somewhat misleading as a basis for planning energy related maintenance and capital expenditures. Based on part-year data, and without allowance for conservation efforts or weather variations, the projected FY 1980 expenditure for fuel and utilities is $64.3 million (± $3.2 million), and including non-space use of electricity is $68.5 million (± $3.2 million).

On this basis, the value of a further 15 percent reduction in energy consumption is now about $10 million per year.

FIGURE 11

Fuel & Utility Expenditures

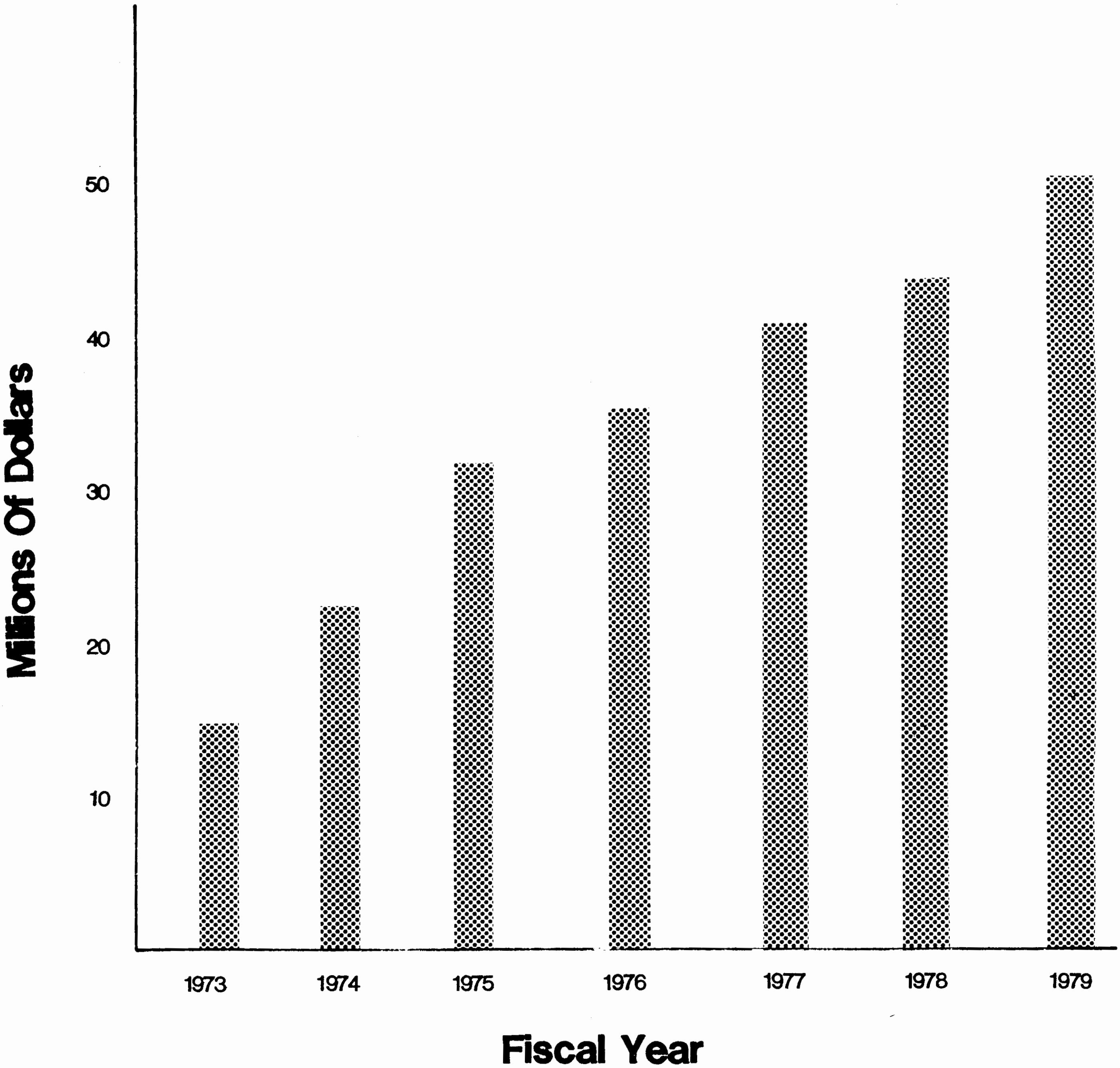


Figure 12

ENERGY EXPENDITURES FOR STATE BUILDINGS -- FY 1979

State Account No.	Department (1)		$	Percent
100	Law & Public Safety		934,000	1.8
200	Treasury (Capitol Services)		1,830,000	3.6
340	Defense		969,000	1.9
350	Energy (Public Broadcasting) (2)		314,000	0.6
400	Environmental Protection		979,000	1.9
500	Education		736,000	1.4
540	Higher Education (3)			
	State Colleges	8,192,000		
	Universities	16,295,000	24,487,000	47.9
600	Transportation (4)		4,492,000	8.8
700	Human Services		11,520,000	22.5
860	Corrections		4,653,000	9.1
---	Miscellaneous (5)		220,000	0.5
	Total		$51,134,000	100.0 %

(1) Those departments not listed occupy leased space, space operated by Capitol Services, or have less than 25,000 sq. ft.

(2) Includes approx. $220,000 electric cost for broadcasting.

(3) Includes approx. $3.6 million for dormitory and activity areas paid from student fees.

(4) Includes approx. $3.5 million for electricity for street lighting and traffic signals.

(5) Independent Commissions, Civil Service, Agriculture, Health, and Labor & Industry.

MAINTENANCE CONSIDERATIONS

To determine the level of maintenance expenditure and the recent trend for this item, appropriation data for recurring and non-recurring maintenance of buildings and grounds were analyzed for the period FY 1973 through FY 1979. Not all expenditures for buildings and grounds affect energy, and actual expenditures may fall short of appropriation or exceed it, but the appropriation level reflects attitude toward maintenance.

Data for the five departments for which information was available -- Human Services, Corrections, Capitol Services, Defense, and Higher Education (State Colleges) -- is shown in Figure 13, both in terms of appropriation and in constant 1973 dollars. There was a net decrease of three percent from FY 1973 to FY 1979 over-all in constant dollars.

Only the State College sector showed a net increase over the period. Data for the remaining four departments is shown in Figure 14, which reflects a net decline of 12 percent in constant dollars.

The downward trend in constant-dollar appropriation for maintenance is particularly disturbing when contrasted with the overall condition of the State's physical plant as found in several reports: In 1968, the Governor's Capital Needs Commission noted a "...massive accumulation of deferred maintenance."

In 1975, the McNaughton Commission reported "...short-sighted, inadequate maintenance of State properties." In 1977, the Capital Planning Unit emphasized the massive accumulation of deferred maintenance projects. Preserving New Jersey's Investments, issued by the Commission on Capital Budgeting and Planning in April, 1979, deals in detail with ways to correct the conditions noted in the earlier reports.

Because maintenance appropriation levels for the State College sector varied widely over the period, and energy consumption data was available for all of the years, an attempt was made to determine if a correlation existed between maintenance levels and energy consumption. The result is shown in Figure 15, which plots constant-dollar maintenance appropriation level against conservation results for the second, following year. The plot suggest that a positive correlation does exist, but the data is far short of being conclusive.

FIGURE 13

MAINTENANCE APPROPRIATIONS FOR BUILDINGS & GROUNDS* (FIVE DEPARTMENTS INCLUDING STATE COLLEGE

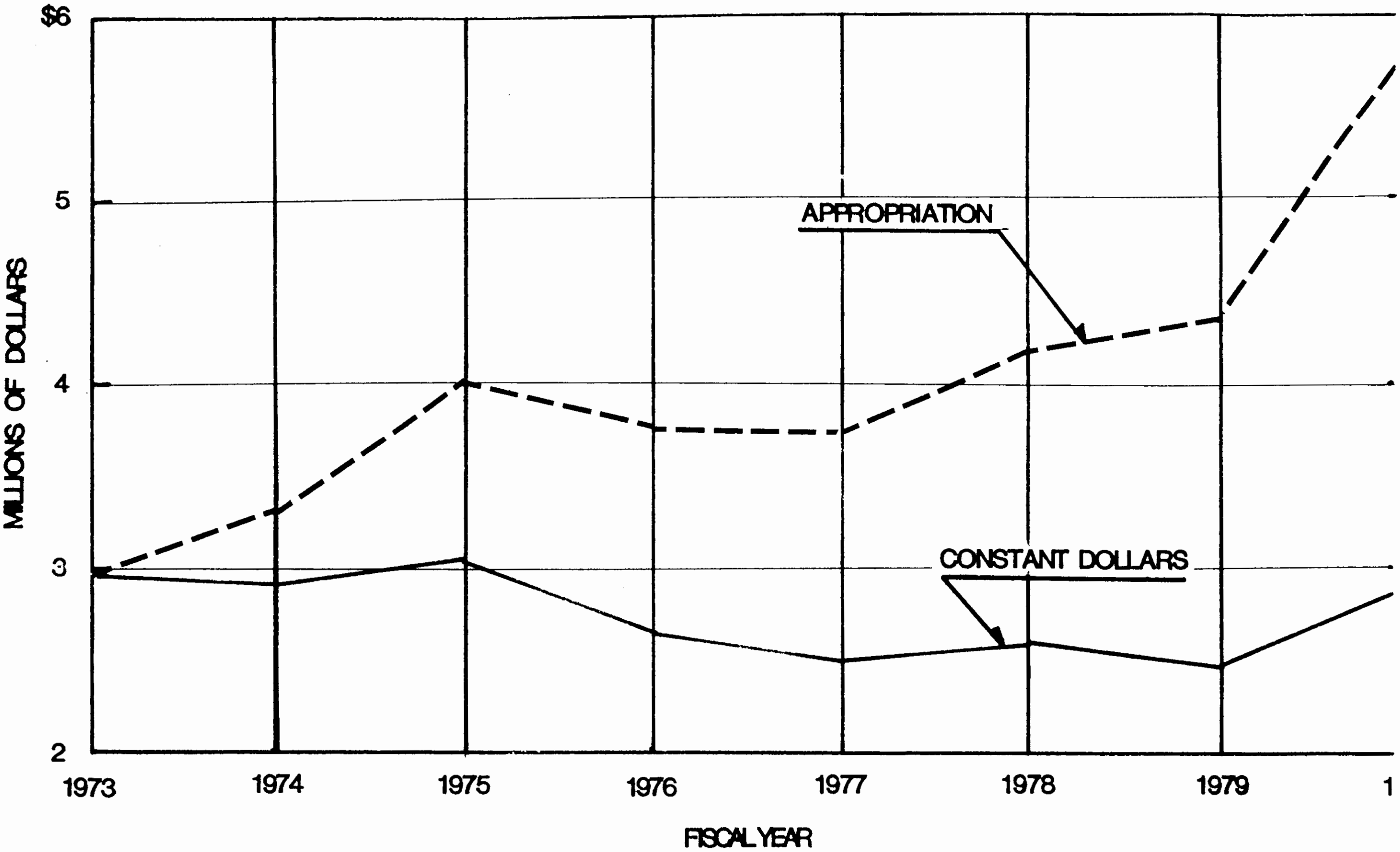
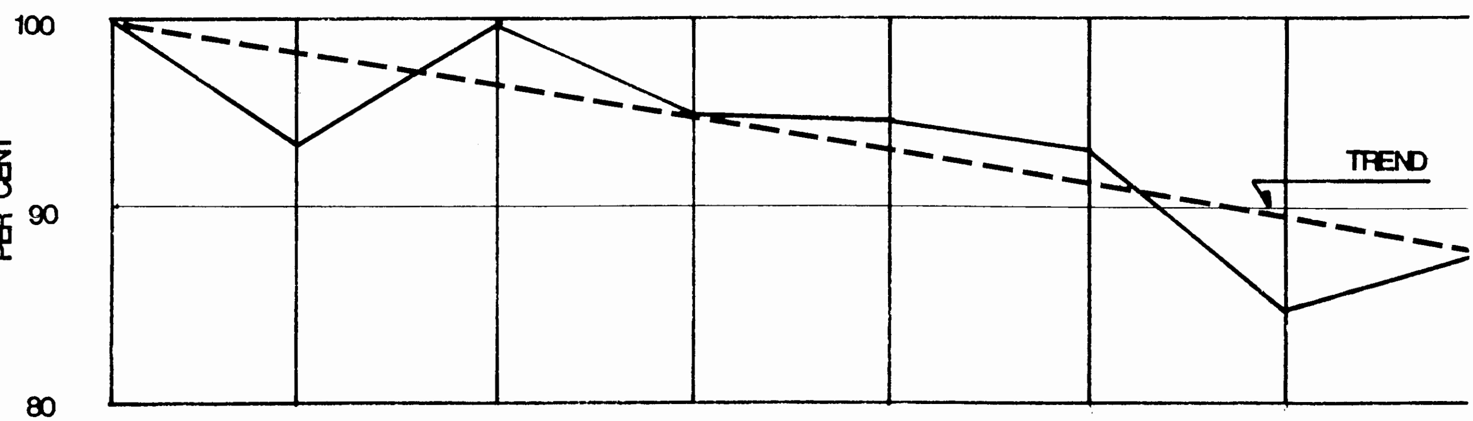


FIGURE 14

TREND IN MAINTENANCE APPROPRIATIONS (EXCLUDING STATE COLLEGES)

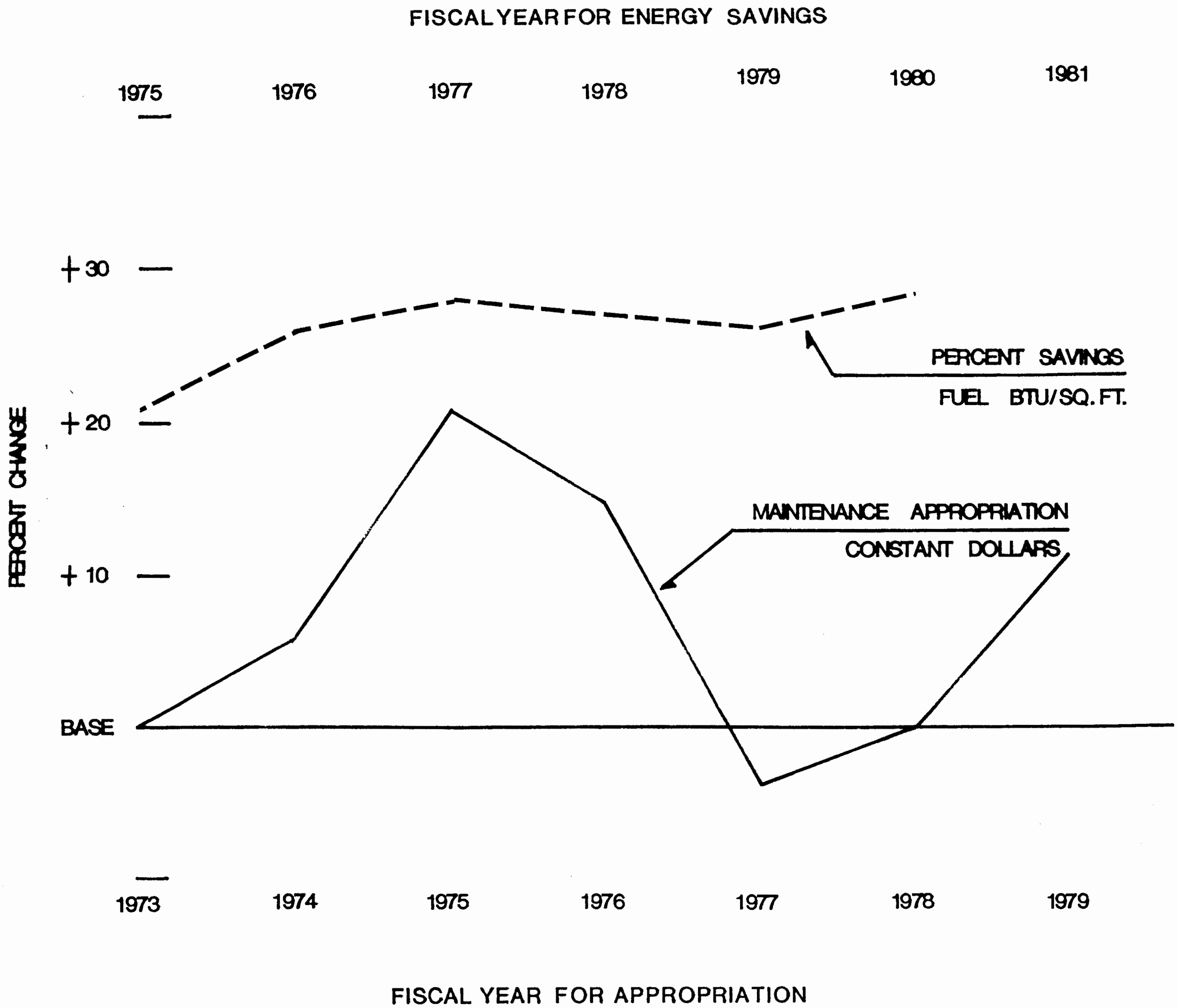
LEVEL IN CONSTANT DOLLARS AS PER CENT OF FY 1973 LEVEL



*SOURCE: APPROPRIATIONS HANDBOOK

FIGURE 15

Maintenance Appropriation Vs Savings In Fuel Consumption (State Colleges)



ENERGY POLICY CONSIDERATIONS

Although it is not the function of this report to evaluate energy policy, it is appropriate to review the energy policy aspect of the present program.

It has been implicit since 1973 that reducing oil consumption to reduce import dependence was in the national interest. However, the Preliminary Program has been cost-oriented rather than energy-source oriented. This course was chosen because it is often more effective to motivate administrative and operating personnel to achieve cost savings than more abstract "energy" savings, and always easier to obtain funding. Considering this, the question can be raised whether it presents potential future policy conflicts.

In 1980, energy cost savings (using the federal source energy factor for electricity) were calculated at:

Saving $1 million of fuel oil saves the	energy equivalent of 30,200 barrels of oil
Saving $1 million of natural gas saves the	energy equivalent of 33,000 barrels of oil
Saving $1 million of electricity saves the	energy equivalent of 33,300 barrels of oil

Savings in natural gas use release this fuel to replace oil at another State facility, or elsewhere in the region.

The situation for electric savings is more complex.

At present, about 20 percent of New Jersey's electricity comes from oil. Reducing electrical consumption will allow the remaining fuels used by New Jersey utilities -- gas, coal, nuclear -- to be used to displace oil in some other application.

So in short, it appears that a cost-oriented approach is effective equally in conservation of all forms of energy, and potentially more effective in accomplishing the overall conservation task.