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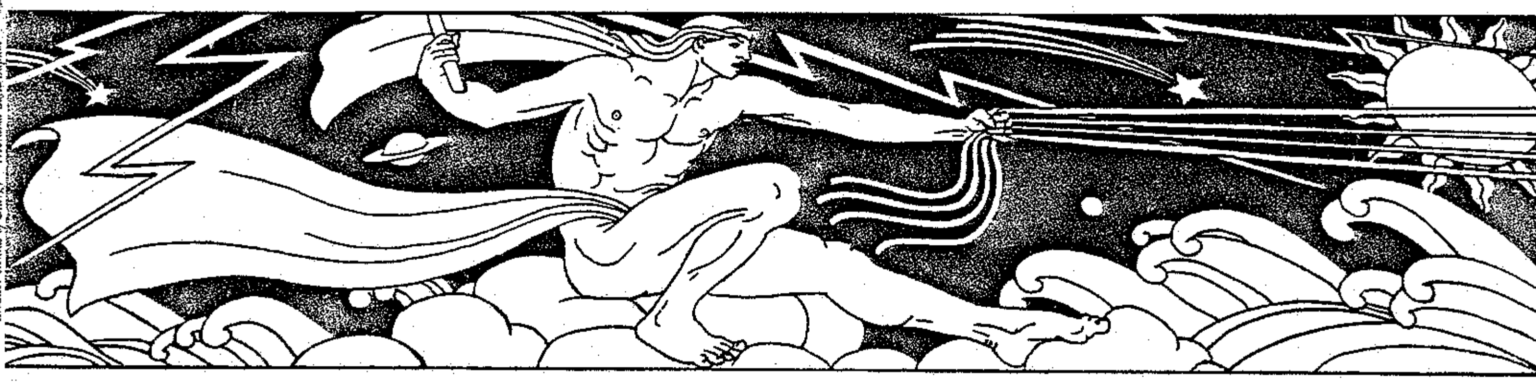

Photo courtesy of the Nebraska State Historical Society

EVALUATION OF STATE BUILDINGS AUDIT PROGRAM

A REPORT TO THE LEGISLATURE

JUNE 1, 1984

STATE OF NEBRASKA

NEBRASKA ENERGY OFFICE, BOX 95085, LINCOLN, NEBRASKA 68509 PHONE (402) 471-2867

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SUMMARY

The Nebraska Energy Office has performed energy audits of all state-owned buildings. This effort was begun in 1978 under the U.S. Department of Energy's Institutional Conservation Program, and continued from 1981 through 1983 after the passage of LB 158. The goal of the audit program is to improve the efficiency of state government by increasing the energy efficiency of state buildings. Progress toward achieving this goal was evaluated upon conclusion of the audit program in September, 1983.

The evaluation found that the energy efficiency of state buildings has increased by 9.6% in the past three years which is equivalent to an annual cost avoidance of over $1,690,000. In addition, 84% of the building operators responding to a survey reported a positive response to the energy audit. Of the 9.6% improvement noted above, 15-30% can realistically be attributed to the impact of the audit program. Thus, the audit program at a cost of $105,000 is generating annual savings of approximately $338,000. In addition, it is expected that the savings will increase as state agencies have more time and resources available to implement energy conservation projects. A summary of the improvement in state buildings' energy efficiency is included in Appendix D, page 46.

The evaluation report concludes by examining the impediments to improving the energy efficiency of state facilities, and suggests several options which may be useful in surmounting those obstacles.

THE NEBRASKA STATE BUILDINGS ENERGY AUDIT PROGRAM

Introduction

This program was created by Legislative Bill 158, which took effect August 30, 1981. The Bill required the Nebraska Energy Office (NEO) to perform energy audits of all state-owned buildings within two years of the effective date. Building owners (state agencies) were required to reimburse the Energy Audit Revolving Fund for the cost of providing the audit.

The initial program activity was a survey form which was filled out for each building by the operating agency. This form described the building's general structural and mechanical characteristics and included a one year fuel consumption history (see Appendix A, page 20).

The major program activity, walk-through energy audits, was performed by seven auditors trained and employed by NEO. During the audit the auditor discusses the operation of the building with maintenance personnel and physically examines the building's structure and energy using systems and equipment. A report is then prepared for each building and sent to the administrator of the facility. The report describes the building and the mechanical equipment and identifies energy conservation opportunities (ECO's). These opportunities include changes in operation and maintenance procedures (O & M's) which can be implemented at little or no cost, and energy conservation measures (ECM's) which require a considerable investment. Examples of the former include lowering thermostat settings, closing outside air intake dampers, and limiting exhaust fan operation. Typical ECM's include replacing old windows and furnaces and adding insulation. Whenever possible the report includes the annual savings in dollars and btu which can be expected if a project is implemented. A representative report is included in Appendix B, page 26.

The cost of implementing these projects was not calculated for several reasons. Costs vary considerably between agencies and in different locations. Rule-of-thumb estimates would be deceptively inaccurate, and drawing up bid specifications and cost estimating was beyond the scope and time limitations of the program. It was felt that building operators should develop project costs estimates, compare these with the savings estimates provided in the audit, and then prioritize the ECO's.

Upon conclusion of the program in September, 1983, 948 buildings had been audited. An additional 320 state buildings were audited between July, 1979 and December 1981 under a federally funded program. This program also employed NEO auditors and used the same methodology.

Goal

One of the NEO's primary missions is to improve the energy efficiency of state government. The goal of this program is to increase the energy efficiency of state buildings. This will result in lower state agency budgets and lower tax rates than would be the case if state buildings continue to be operated and maintained as per the status quo.

Model

The model implicit in the program assumes that state buildings are not as as energy efficient as they can be and should be. One of the major explanations of this shortcoming is that buildings operators lack knowledge and expertise in energy conservation. The energy auditing process, by correcting this deficiency, will remove a major impediment to increasing the energy efficiency of state buildings.

Another aspect of the model involves the funding of the program. State agencies were required to pay for the cost of the audit on the assumption that the building operator could easily implement low and no-cost O&M's which would generate annual savings greater than the cost of the audit. In other words, in most cases the easily available energy savings would reimburse the agency for the cost of the audit.

Research Design

The research design utilizes a random sample of state buildings for which "after energy audit" fuel consumption is compared with "before energy audit" fuel consumption. The random sample was drawn by taking every fifth building from a Department of Administrative Services-State Buildings Division master list, and then deleting unheated buildings such as Department of Roads salt storage sheds. Every complex heated by a central plant power, such as state colleges and regional centers, received one questionnaire. Admittedly, this approach overrepresents the larger institutions and underrepresents individually metered buildings such as those operated by the Department of Roads and the Game and Parks Commission. We feel this loss of randomness to be more apparent than real because the over and underrepresentation is only a factor when all the buildings are taken together. The subset of individually metered buildings is validly represented by the sample minus the 15 central power plants. These in turn are fully represented rather than sampled, giving solid data for nearly 400 buildings with no need for extrapolation or confidence levels.

127 questionnaires (Appendix C, page 49) were distributed the week of November 7-10. Of the approximately 500 individually heated buildings, 112 were sampled. The questionnaire includes the most recent twelve months usage of all fuels, questions eliciting the building operator's response to the energy audit, and information on the operator's perception of obstacles to improving the energy efficiency of his buildings.

By January 25, 1984, 85 questionnnaires had been returned. A computer program has been developed which divides the state into twelve climatic regions, with monthly weather data beginning in 1976. This program compares the heating degree days for the before and after twelve month periods in question and develops develops "normalized" fuel consumption figures which are adjusted for year-to-year climatic variation. Btu per square foot per degree day (btu/ft/DD) figures are also calculated for the two periods. These two sets of figures can then be compared and percent increase or decrease calculated. Control of change in building size (additions), differential fuel use, and climatic variation is inherent in the btu/ft/DD measure. It should be noted that cooling degree days are not used because they are a very inaccurate predictor of air conditioning cost, which is greatly affected by internal heat gains and relative humidity. In other words, heating energy is far more proportional to heating degree days than cooling energy is to cooling degree days. Therefore, our measure uses only heating degree days, though the evaluation examines the efficiency with which <u>all</u> fuels are used, whether for heating, cooling, lighting, or office machines.

Findings

The subset of individually metered buildings covers primarily those operated by the Game and Parks Commission, the Department of Roads and the Military Department. Energy efficiency in the sample, covering 42 buildings out of a population of 500, has increased by 7.5%. This is equivalent to an annual cost-avoidance of $361,345 and an energy savings of 82,623 million btu. The 15 central power plants include facilities operated by the University, state colleges, the Department of Public Institutions, and the Department of Corrections. Energy Efficiency in this group increased by 10.4%. The annual avoided cost in these buildings is $1,328,884 and the energy saved is 313,916 million btu. The total annual savings being generated in all state buildings is $1,690,000 and 396,540 million btu, which is equivalent to 2,832,400 gallons of heating oil.

Most building operators responded favorably to the energy audit. 65% felt the audit "made good recommendations, but we were already aware of some of them", and 19% thought the audit "was very thorough and made many good recommendations." 12% felt the audit "didn't tell them much they didn't know before", and 4% thought the "audit made unrealistic or unfeasible recommendations". In other words, 84% of the respondents saw the audit in a favorable light, and only 6% thought the audit "didn't really have much value for us."

The most widely reported obstacle to increasing the energy efficiency of the respondents' buildings is lack of funds (62%). Other impediments include lack of technical/engineering expertise (3%), problems in prioritizing the energy conservation projects (5%), difficulty in justifying the projects to higher management (8%), and not enough time to take on new projects and responsibilities (9%). Only 1% of the respondents hadn't identified any energy conservation projects in their buildings.

Most building operators report that they keep fuel consumption records, but only 26% have an energy manager or coordinator or a building committee. By an overwhelming margin, the respondents felt the need for "an innovative method of financing which wouldn't affect program funding levels." Only 18% felt the need for an energy manager, a building committee or better fuel consumption records.

Cost Effectiveness

The Nebraska Energy Office provided energy audits of 948 buildings at a cost of $105,000. Over 4,000 specific energy conservation opportunities were identified. In addition, numerous recommendations were made which were of a more general nature for which savings were not calculated, but which nevertheless have good potential as cost-effective O & M's and ECM's. These items include caulking, weatherstripping, relamping, and preventative maintenance items. The total potential annual energy savings if all ECO's were to be implemented is approximately 275,000 million btu, which is equivalent to almost 2 million gallons of fuel oil. At 1983 prices this energy is worth approximately $2 million. It should be noted that this includes all ECO's regardless of cost-effectiveness. Some may return the investment required within one heating season, while others may require ten or more years to do so.

A follow-up survey was conducted by mail and phone during the fall of 1983 which attempted to determine the degree of implementation of audit recommendations. In spite of the fact that hundreds of buildings had been audited during the previous six months and that some building operators had had little time to budget for and implement energy conservation projects, encouraging results were reported. Energy conservation steps recommended by the audit had been taken in 45% of the buildings. The most common energy conservation improvements reported were unoccupied hours thermostat setbacks and the use of high efficiency fluorescent lamps. The estimated annual savings generated by these projects alone is 35,000 million btu, worth approximately $225,000 at 1983 prices. The energy saved, primarily natural gas, is equivalent to 205,000 gallons of heating oil.

It can be concluded that Nebraska's investment in energy audits has been a wise and productive one. In two years--which, it should be noted, were characterized by economic recession, falling tax receipts, and state budget "crises"--state building operators were able to generate annual savings of $225,000 which can be attributed directly to the impact of the audit program. This annual saving is more than double the cost of the audit program. The total annual cost avoidance generated by all sources in state buildings during this period is approximately $1,690,000. The annual energy savings is 396,540 million btu, which is equivalent to 2,832,400 gallons of heating oil.

Needs Assessment

State agency requests submitted for energy conservation projects in 1983 totalled $17 million. A Nebraska Energy Office analysis of energy audit results identified over 4,000 energy conservation measures of which over 1,000 have been implemented. According to preliminary estimates, implementation of projects with simple paybacks of under ten years would cost $6 million. Assuming an average simple payback for this group of projects of five years, $1.2 million in energy costs would be avoided each succeeding year, in constant dollars. If energy prices rise faster than prices in general, the cost avoidance would increase. If energy conservation projects had to clear a five year simple payback hurdle, an investment of approximately $3 million would be required. It is clear that in spite of the progress made in increasing state buildings' energy effficiency, a considerable need exists for additional investment.

Discussion

The encouraging results reported raise questions and point to directions Nebraska can take in the quest for increased efficiency in the operation of state government. We'll first deal with questions raised by the data.

In an uncontrolled research design of this nature, one must ask what other factors may have contributed to the reported improvement in energy efficiency. One factor is a historical trend, evident since the mid-1970's, toward increased energy awareness on the part of the general public. This heightened energy consciousness is no doubt evident among building operators as well, and may have led to changes in building operation which are designed to minimize energy waste.

Rising fuel prices and the publicity surrounding them are certainly another influence on building operators. Natural gas prices experienced annual increases of over 20% during the late 1970's and early 1980's. Increases of this magnitude may certainly have forced some conservation that wouldn't have otherwise taken place. Another effect of rising fuel prices is the proportional increase in the cost-effectiveness of energy conservation projects. A doubling of fuel prices cuts a project's payback period in half.

On the other hand, the period in question, 1979-83, was one of economic recession, falling tax revenues, and very tight state budgets. Energy conservation projects could not often be funded in this environment, which inhibited improving buildings' energy efficiency.

In an effort to sort through these factors, a question on the survey form asked which energy conservation items were implemented as a result of the audit. 45% reported implementing at least one item as a direct result of the audit. In most cases, the energy savings generated by the item(s) were far more than the cost of the audit. In addition, the phone survey found most operators planning to implement projects identified by the audit. In other words, audit-generated savings will increase with time.

Overall, the author's judgement is that 35-45% of the improvement in energy efficiency seen in individually heated buildings is a result of the audit program. In centrally heated complexes, we feel that 15-25% of the improvement can be attributed to the audit program. The differential, both in the degree of improvement (7.5% for individually heated buildings and 10.4% for central power plants) and in the impact of the audit program is discussed below.

The first question is why the energy efficiency of individually metered and heated buildings has improved less than that of the facilities heated by central power plants. There are several reasons for the differential rates of improvment. One is that the large central plant operators have professional and technical staff dedicated to utility operations. These people have a level of expertise that is often not available at an individual building. The operator of a Department of Roads or a Game and Parks Commission building has numerous programmatic and personnel responsibilities, one of which is facility management. Absent equipment failures, facility management and long range energy planning are not a high priority at these buildings.

Another problem relates to management time and the differential conservation rewards available in relation to management time invested. An example can illustrate the problem. The operator of a large, inefficient boiler can replace the burner and effect an immediate 20% improvement in energyefficiency. Management may have had to spend 400 hours on the project, but the complex will save $40,000 per year. On the other hand, the operator of dozens of individually heated buildings may replace a furnace in one building, insulate a roof on another, and install an insulated overhead door at another. Management may have spent 200 hours on these projects, yet the annual savings are only $1,000. The projects' cost effectiveness may be identical, say a four year simple payback, yet the big project gains recognition, has an immediate, indisputable effect, and has far greater returns in relation to the management time expended on it. A centrally heated complex may not be more energy efficient than an individually heated building, but the central plant is easier to deal with from a management standpoint.

A third and major reason for the better performance of the large complexes is the existence of a Federal program, the Institutional Conservation Program, which provides 50-50 matching grants for energy conservation. This program is open to schools and hospitals, under which headings fall University buildings, the Medical center, the four state colleges, and some facilities at the regional centers. These institutions have been active participants in this program, having received $2,186,300 in grant funds to implement energy conservation measures and $148,200 in grant funds to perform engineering analyses of their buildings. These institutions have also received significant infusions of funds through the efforts of the Building Renewal Task Force. The results are easily seen by the relatively high level of energy efficiency that has been achieved in these facilities.

The next item to be examined is the question of why the individually heated buildings are not operating more efficiently. The primary reason, as reported by the great majority (62%) of our survey's respondents, is lack of funds. However, it should be noted that significant minorities reported other or additional impediments, including "difficulty in justifying projects to higher management" (8%), problems "deciding which projects should have the highest priority" (5%), and being "too busy with my job" to organize and carry out energy conservation projects (9%). These responses point to a phalanx of problems that can be lumped together under the heading of managements not being organized for energy conservation.

Another problem the authors see is a conflict between the payback period of an energy conservation project and the agency's budget period. An example serves to illustrate the dilemma. Assume a project returns its cost in energy dollars saved in three years. This is, no doubt, a very good investment, returning 33% per year and indexed to future increases in fuel prices. However, from the agency's point of view it can look different. The agency sees a $10,000 expense this year, and $3,333 saved next year. This year's cost, even if the project is implemented and a full year's energy savings accrues, is $6,666. The agency could reasonably ask what is in it for them.

Yet another difficulty is brought up by asking what happens to the savings. In the preceeding example, who keeps the $3,333 saved in each year subsequent to the project? It if reverts back to the general fund, out of the agency's control, what did the agency gain? A smaller budget next year? This problem is compounded by the nature of the budget process. A budget line item for fuel is approved as a matter of course, but a line item for a capital improvement can be deleted or postponed, and then the management time spent preparing the project has been for naught.

Our conclusion is that there are significant institutional constraints to improving the energy efficiency of state buildings. The budget process is weighted against capital improvements, energy conservation project payback periods are long in relation to budget periods, there is no guarantee that energy dollars saved will be returned to the agency, and managements are often not organized for energy conservation. This last item should not be taken as a criticism; managements are organized around programmatic objectives, which is as it should be. Nevertheless, energy literally falls through the cracks of both the building and the organizational structure.

The impediments to increasing the energy efficiency of state buildings should in no way overshadow the solid gains achieved and the excellent response of building operators to the audit program. 45% of the facilities audited have taken advantage of at least one of the energy conservation opportunities identified by the audit. The most common energy conservation steps taken are the use of more efficient fluorescent lamps and unoccupied hours thermostat setbacks. We are pleased to report that 76% of the survey's respondents are now using thermostat setbacks in their buildings, and that this simple energy conservation step reduces heating fuel use by 15% to 30%. The response to Nebraska's audit program compares favorably with the response to the free energy audits performed by New York state for small commercial and industrial facilities. In forty per cent of these facilities not even the most basic no-cost conservation items have been implemented. A report on the Arkansas Power and Light Conservation Program found that only 15% of AP&L's customers have made energy efficiency investments identified as economically attractive. The response of state building operators in Nebraska, during two years characterized by economic downturn, falling tax receipts, and tight budgets, is exemplary.

Recommendations

The preceding analysis of the energy audit program and energy management in state buildings concludes that much has been accomplished, yet much more remains to be done. The following policy options have great potential for improving the energy efficiency of state government.

In an effort to improve the incentive structure, agencies could be allowed to keep all or part of avoided utility costs in their budgets. One method would be to allow the agency to use the savings for a specified time period. Each agency could be allowed to use energy dollars saved to form an Energy Cost Avoidance Fund which could be used to finance additional improvements. This would allow coherent energy management plans to be implemented and energy dollar savings to "snowball."

An interagency office could be established to monitor buildings' energy use and provide reports to building operators. Although most operators keep records of fuel expense, few perform a critical analysis of the data. The central office could provide an operator with the building's weather-adjusted "miles per gallon", and calculate cost-avoidance due to energy conservation projects. This information could be used in conjunction with an agency's Energy Cost Avoidance Fund and as a control for shared savings agreements. The Nebraska Energy Office has developed a computer program for use in energy conservation grant programs which can easily be adapted to this service.

The state could set up an Energy Conservation Revolving Fund. This fund could function as a shared-savings arrangement, whereby a portion of the energy dollar savings reimburses the fund, and a portion of the savings stays with the agency in an Energy Cost Avoidance Fund, which finances additional improvements. The Revolving Fund could be operated in the same manner as the Institutional Conservational Program, with agencies competing for scarce energy conservation dollars. This would ensure that funds would flow to the most cost-effective projects. As an alternative to this type of grant program, agencies could borrow from the fund to finance energy conservation projects, and would reimburse the fund from the savings generated by the projects.

Another option is third-party financing, including shared savings and leasing programs. Due to tax advantages available to the outside party, these arrangements can be attractive to the end user. Innovative financing is the subject of a separate report, and will not be examined in detail here.

These options should be evaluated in greater detail than is appropriate here. We feel that a combination of these items can have an impressive impact on the cost of operating state government.

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APPENDIX A

Preliminary Energy Audit

NAME OF BUILDING	COUNTY
STREET OR OTHER MAILING ADDRESS	TYPE OF FACILITY
CITY STATE ZIP CODE	ADMINISTRATOR TELEPHONE

Section 1: Consumption History

Begin with the month which is exactly 12 months previous to this month and complete all 12 months. Please complete the "PRIMARY FUEL" chart with the fuel you use for the greatest amount of heating. If this fuel is natural gas, the unit will be MCF; if it is heating oil, the unit will be GALLONS. Please also chart your "ALTERNATE FUEL" in the same manner. Please specify the types of primary and alternate fuels.

TYPE OF PRIMARY FUEL USED	TYPE OF ALTERNATE FUEL USED

PRIMARY FUEL				ALTERNATE FUEL				ELECTRICITY			
MONTH	YEAR	UNITS	DOLLARS	MONTH	YEAR	UNITS	DOLLARS	MONTH	YEAR	UNITS	DOLLARS
TOTALS				TOTALS				TOTALS			

ELECTRICAL DEMAND *(Answer only if your electric utility bills you on a demand rate. Enter the highest measured electrical demand and the month for which it was recorded.)*

HIGHEST MEASURED DEMAND	MEASURED IN MONTH OF
_____Kilowatts	

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Section 2: Major Energy Systems

(Circle the number(s) that describes each of the following systems and fuels in the building.)

1. PRIMARY HEATING SYSTEM

1 Hot water or steam supplied from central plant
2 Steam boiler
3 Hot water boiler
4 Radiant (baseboard)
5 Heat pump
6 Forced air
7 Solar
8 Other (Specify)__________

Age of heating plant:_____ years

2. HEATING FUEL(S)

1 Electricity
2 Natural gas
3 Fuel oil number 2
4 Fuel oil number 6
5 Coal
6 LPG (propane)
7 Solar
8 Other (Specify)__________

3. DOMESTIC HOT WATER SYSTEM(S)

(Circle the number that describes how domestic hot water is heated.)

1 Hot water or steam supplied from central plant
2 Electricity
3 Natural gas
4 Fuel oil number 2
5 Fuel oil number 6
6 Coal
7 LPG (propane)
8 Solar
9 Other (Specify)__________

4. COOLING SYSTEM(S)

0 None
1 Chilled water supplied from central plant
2 Chilled water—centrifugal
3 Chilled water—absorption
4 Refrigeration—electric, compressor—water cooled
5 Refrigeration—electric, compressor—air cooled
6 Refrigeration—steam turbine compressor
7 Evaporative cooling unit
8 Window air conditioner(s)
9 Other (Specify)__________

Age of cooling plant: _____ years

5. COOLING FUEL(S)

0 None
1 Electricity
2 Natural gas
3 Fuel oil number 2
4 Fuel oil number 6
5 Coal
6 LPG (propane)
7 Solar
8 Other (Specify)__________

6. TERMINAL SYSTEM(S)

1 Unitary (rooftop, furnace, unit heater, etc.)
2 Fan—coil units
3 Unit ventilators
4 Variable air volume
5 Dual duct
6 Terminal reheat
7 Heat pump
8 Cast iron radiators
9 Fin—tube perimeter radiation
10 Forced air
11 Other (Specify)__________

7. LIGHTING SYSTEM(S)

1 Fluorescent
2 Incandescent
3 Mercury vapor
4 Metal halide
5 High pressure sodium
6 Low pressure sodium
7 Other (Specify)__________

8. OTHER ENERGY USING SYSTEM(S)

(Circle the number(s) that best describes any other energy using system in the building.)

0 None
1 Food service
2 Laundry service
3 Major computer systems
4 Special diagnostic equipment
5 Swimming pool
6 Other (Specify)__________

9. HEATING SYSTEM LOCATION

(Circle the number(s) that best describes the location of the primary heating system.)

1 Outside the building
2 Within the building on the ground floor
3 Within the building in the basement
4 On the roof
5 Other (Specify)__________

(If the heating system is within the building or on the roof, circle the number from the following list which best describes the type of heating system.)

6 Centrally located
7 Multiple units
8 Central and multiple units

Section 3: Building Characteristics

1. GROSS SQUARE FEET

(Enter the square footage of all heated or cooled floor areas enclosed in the building. Calculate square footage from the outside building dimensions, or from the center line of common walls, if building is attached to another building.)

2. NUMBER OF STORIES

(Enter the number of stories in this building. Do not count basement, if unoccupied.)

3. LAST MAJOR ADDITION

(Enter the year of the last major addition to the building, if any.)

4. YEAR

(Enter the year building was first placed into service.)

5. LOCATION

(Circle the number which best describes the location of the building.)

1 Urban 2 Suburban 3 Rural

6. FUNCTIONAL USE CHANGES

(Circle the number(s) from the following list that describes major changes planned in functional use or mode of operation in the next 15 years, if any.)

0 None
1 Demolition
2 Disposal
3 Rehabilitation
4 Conversion (e.g. from office to warehouse) (Specify)__________
5 Other (Specify)__________

7. BUILDING CONDITIONS

(Circle the number that best describes general building conditions. Please include a brief explanation.)

1 Excellent
2 Good
3 Fair
4 Poor

Explanation:

8. BUILDING SHAPE

1 Square
2 Rectangular
3 E Shaped
4 H Shaped
5 L Shaped
6 Other (Specify)__________

9. BUILDING LIFE EXPECTANCY

10. CONSTRUCTION

☐Wood ☐Block ☐Steel ☐Other__________

11. AVERAGE NUMBER OF PERSONS HOUSED

12. NUMBER OF HOURS OCCUPIED PER WEEK

13. ARE BLUEPRINTS OF THIS BUILDING AVAILABLE?

☐Yes ☐No

Section 4: Weatherization Data

1. CONDITION OF WEATHERSTRIPPING ☐Good ☐Fair ☐Poor ☐None	**2. CONDITION OF CAULKING** ☐Good ☐Fair ☐Poor ☐None	**3. STORM WINDOWS** *(to nearest percentage)* ☐0% ☐25% ☐50% ☐75% ☐100%
4. CEILING OR ROOF INSULATION *(Specify type and thickness)*		**5. DOUBLE PANE WINDOWS** ☐Yes ☐No

Section 5: Operation and Energy Management

1. Do you maintain a thermostat setback program? ☐Yes ☐No	2. Number of hours per week (winter or night setback including weekends) _____Hours	3. To what temperature is the thermostat set back? _____°F
4. What is the temperature setting during daytime/occupied hours? _____°F	5. Do you zone areas of your building for different heating needs? ☐Yes ☐No	6. How many space-conditioned zones do you maintain? __________________
7. Are the thermostats tamper proof? ☐Yes ☐No	8. If your building is air conditioned what is your normal daytime thermostat setting during the cooling season? _____°F	9. What is your summer night thermostat setting? _____°F

10. ENERGY MONITOR
(Check yes if a person has been designated to monitor and evaluate energy use in the building.) ☐Yes ☐No
If yes, enter:

NAME	POSITION	PHONE

11. BUILDING ENGINEER, HEAD CUSTODIAN, OR SUPERINTENDENT
(i.e. the person who is most responsible for the building's mechanical systems.)

NAME	TITLE	PHONE

Section 6: Hot Water System

1. Have you taken inventory of pipes and faucets to determine the amount of leakage? ☐Yes ☐No	2. Do you have a policy to reduce the amount of hot water used? ☐Yes ☐No
3. What is the setting for your domestic hot water heater? _____°F	4. Is your hot water supplied by your heating boilers? ☐Yes ☐No

Section 7: Lighting

1. Do you think that you use natural light to its greatest potential? ☐Yes ☐No	2. Have you measured the light levels in your building with a light meter? ☐Yes ☐No
3. Have you reduced lighting levels within the past year? ☐Yes ☐No	4. If you have reduced lighting levels, what is the total reduction in wattage? _____watts
5. Have you installed high efficiency lamps? ☐Yes ☐No	6. If you have installed high efficiency lamps, what type and wattage are they?
7. Normal hours for building cleaning	
8. Is cleaning done when the building is occupied? ☐Yes ☐No	9. Have you modified this activity within the last year? ☐Yes ☐No

Section 8: General Management Data

1. Do you have a policy of cleaning all heat transmitting surfaces? ☐Yes ☐No	2. Do you clean all motors, fans, and filters on a regular basis? ☐Yes ☐No	3. Do you use and maintain steam traps? ☐Yes ☐No
4. If yes, have you conducted a steam trap survey? ☐Yes ☐No	5. Are your steam pipes insulated? ☐Yes ☐No	

Section 9: Additional Energy Management Activities

1. Please list the energy management activities you have instituted which are not included in this form or which you think are unique:

2. Please list major energy conservation measures which have been implemented in the building, if any.

MEASURE	COST	ANNUAL ENERGY SAVINGS (if known)
Example: Additional roof insulation	$2400	2500 CCF Natural Gas

Section 10: Building Description

Please provide a written description of your building site. Provide a simple sketch (indicate north) in the space provided on the page 5. If building floor plans are available, it would be helpful if they were included.

BUILDING AND SURROUNDING AREA

Section 11: Solar Energy

1. What is the exterior construction material used on the south facing wall of your building

☐Wood ☐Brick ☐Concrete block
☐Other (Specify)__________

2. What is the character of the setting within which your building is located?

☐Urban ☐Rural ☐Suburban

3. Is the roof of your building:

☐Flat ☐Pitched

4. If the roof is pitched, does it have a southern exposure?

☐Yes ☐No

5. What is the approximate proportion of glass area on the southern facing wall of your building?

☐Less than 25% ☐25% to 50%
☐50% to 75% ☐Greater than 75%

6. Indicate whether open land such as fields, yards and parking areas are available within the immediate vicinity of the building

☐Yes ☐No

If yes, is the area heavily shaded? ☐Yes ☐No

7. PRIMARY STRUCTURAL ROOF COMPONENTS
(Circle the number(s) that describe(s) the structural characteristics of the roof of the building.)

1 Steel
2 Wood
3 Concrete
4 Other (Specify) __________

8. ROOFING MATERIAL
(Circle the number(s) that describes the materials used to construct the roof of the building.)

1 Shingles (wood, asbestos, etc.)
2 Slate or tile
3 Built up materials
4 Metal
5 Other (Specify) __________

9. Are there any rooftop obstructions such as chimneys, stairwells, water towers, etc.?

☐Yes ☐No

10. Is more than half the roof area or the southern exposure of your building heavily shaded for more than four hours per day?

☐Yes ☐No

____
SIGNATURE OF PERSON PREPARING THIS FORM

____
DATE

APPENDIX B

GAME AND PARKS COMMISSION

CENTRAL OFFICE AND WILDLIFE LABORATORY

Sim Gurewitz

June 13, 1983

State of Nebraska—Nebraska Energy Office

energy audit

Box 95085 Lincoln, Nebraska—(402) 471-2867

STATE OF NEBRASKA

ROBERT KERREY • GOVERNOR • KANDRA HAHN • DIRECTOR

June 13, 1983

Mr. Frank Bunker
Game and Parks Commission
P.O. Box 30370
Lincoln, NE 68503

Dear Mr. Bunker:

The following report details energy conservation opportunities identified during our energy audit of the Game and Parks Commission Central Office and Wildlife Laboratory building. Our major recommendations are to install timeclocks on restroom exhaust fans; to reduce the night setback to 50 degrees; to examine the feasibility of converting the constant volume air handling system to a variable volume system; and to reevaluate the cleaning crew's scheduling.

We hope this report will be helpful in your energy conservation and management effort. Our thanks to Harold Sheldon, Mark Dicke, and Phil Swinscoe for their able assistance during our audit. If there are any questions or if we can be of further assistance, feel free to contact the Nebraska Energy Office.

Sincerely,

NEBRASKA ENERGY OFFICE

Sim Gurewitz
Energy Conservation Coordinator

Enclosures

NEBRASKA ENERGY OFFICE, BOX 95085, LINCOLN, NEBRASKA 68509-5085 PHONE (402) 471-2867

Building Profile

The Nebraska Game and Parks Commission Headquarters complex is composed of two buildings with a total of 64,446 square feet. The two-story wildlife laboratory entered service in 1969 and the four-story Central Office building was occupied in 1970. The two buildings are connected by a second floor walkway.

The walls are brick on concrete block with cavity insulation, and have an estimated R-value of 7. There is a moderate amount of aluminum sash, double glazed window area, most of which is not operable. Spandrel glass backed with batt insulation, is used extensively. The original flat built-up roof on 3 inches of rigid insulation on a concrete deck suffered water damage and was reroofed in 1975, with 2 inches of insulation added. The present R-value is estimated to be 10.5.

Mechanical Systems

Space conditioning is by two constant volume dual duct milti-zone air handling units powered by seven motors which total 127.5 horsepower. System control is by a Honeywell W7010/20G control panel which limits KW demand by shedding loads and which schedules equipment usage. The air handlers are equipped with steam humidification and the motors are equipped with capacitors to improve the power factor. Night setback and morning start-up are timeclock controlled.

Steam is supplied by three Kewanee boilers fired by interruptible natural gas and No. 2 fuel oil, with each boiler taking an input of 1.75 million BTUs. Chemical feed is automatic, boiler water is tested regularly, and steam traps are checked annually.

Chilled water is supplied by two chillers of 125 ton and 100 ton capacity. The larger unit is driven by two reciprocating compressors and the smaller unit by three reciprocating compressors. The compressors are staged and cut in sequentially as the load increases. Condenser water is handled by two forced draft cooling towers.

During the heating season, domestic hot water is produced by a steam coil in a 1,000 gallon storage tank. When space heating is not necessary a 100,000 BTU natural gas fired water heater serves the storage tank. The ciruclating pump is timeclock controlled and shut off during unoccupied hours.

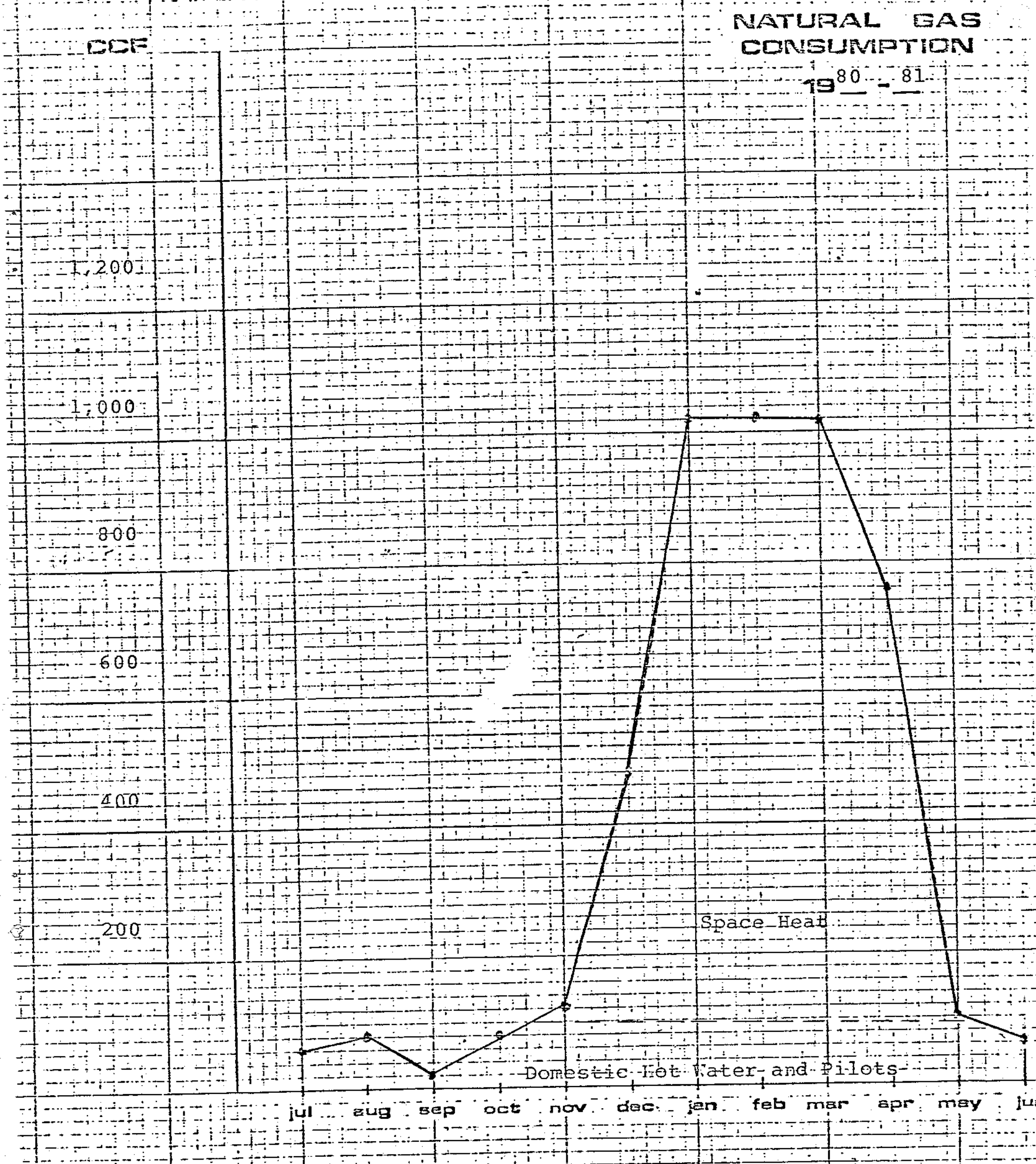
Annual Operating Hours: 2,600

Life Expectancy: 50 years

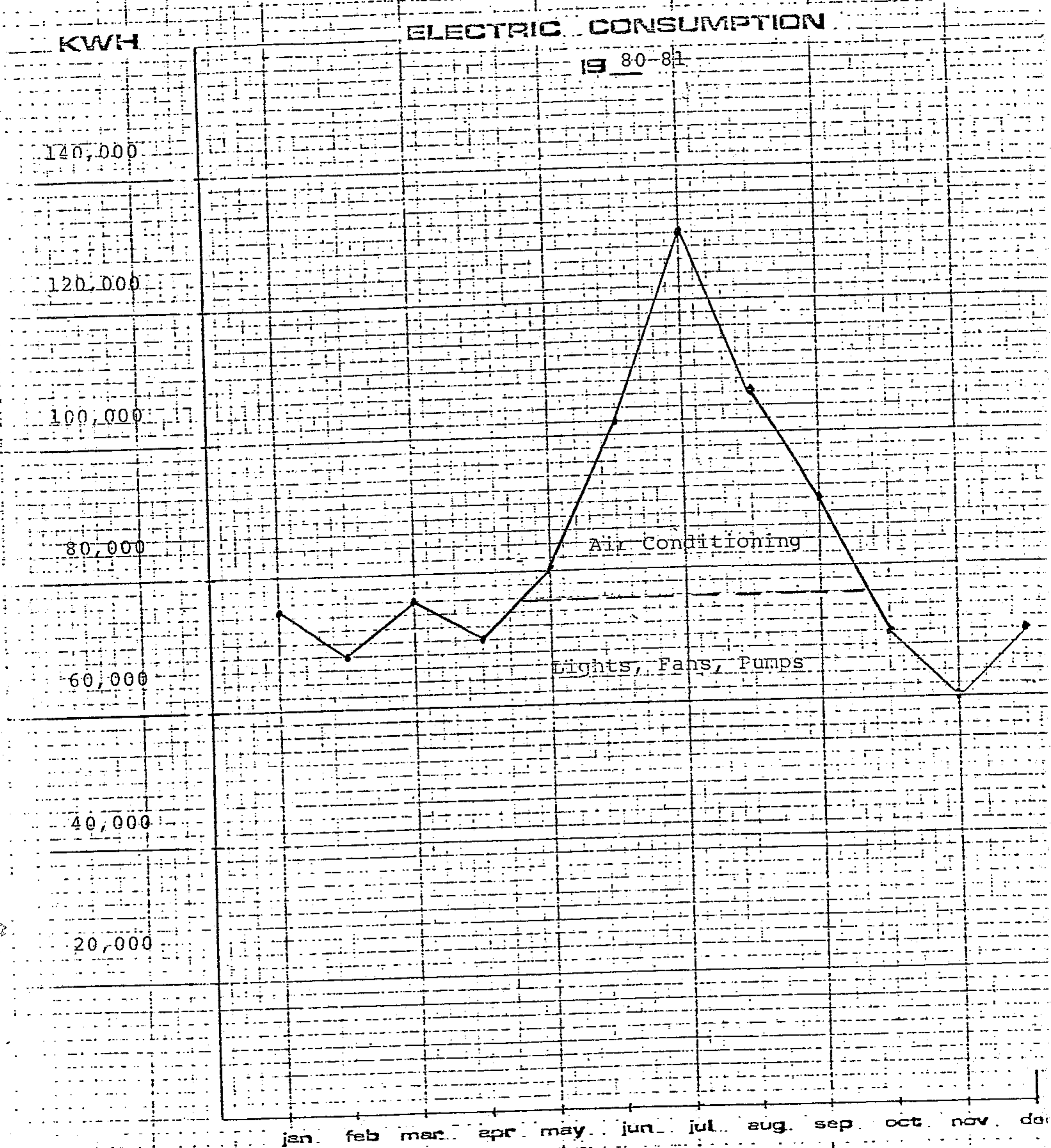
Solar Potential

This building's potential for solar conversion is good. The roof is flat, unshaded, and largely unobstructed, and there is some open and unshaded space around the building. A domestic hot water system could be considered, particularly in view of the large volume of hot water required by the photographic lab.

GAME AND PARKS COMMISSION H.



GAME AND PARKS COMMISSION H.Q.



ENERGY USE AND COST SUMMARY

Game and Parks Commission H.Q.

ENERGY USE	FUEL	ENERGY	% ENERGY	COST	% COST
Lights, Fans, Pumps	Electricity	850,000KWH(2900×10^6) BTU's	35	38,250	66
Air Conditioning	Electricity	150,000KWH(512×10^6) BTU's	6	6,750	12
Domestic Hot Water, Pilots	Natural Gas	1,000 CCF(100×10^6 BTU's	1	275	1/2
Space Heat	Natural Gas	47,340CCF($4,734 \times 10^6$) BTU's	58	13,020	21 1/2

NOTES: Natural Gas $.275/CCF

Electricity .045/KWH

Observations & Recommendations

We noted the following areas in which energy conservation improvements can be made:

1. The overhead doors at the garage and loading dock could be replaced with better fitting, insulated doors.

2. The walk-through doors in the garage and loading area should be adjusted for a better fit and a daytime latch should be installed.

3. If the buildings are being cleaned simultaneously you might consider switching to cleaning them sequentially. This way the air handling system in the building cleaned first could be shut down. This could save approximately $660.00 (33,000 KWH) per year.

4. In line with the recommendation above, note that the two air handling units draw approximately 127 KW and cost $2.50 per hour to operate (not considering demand charges).

5. Consider adding two of the three elevators to the load shedding program. If two of the elevators happen to run during the peak demand period, it would add 50 KW, which would add $2,770.00 to the building's electric bills over the following 12 months.

6. Check the exhaust air and fresh air dampers and make sure they close fully when the system is in the night setback mode. Adjust the linkages, if necessary.

7. Investigate the economic feasibility of installing an "enthalpy economizer." This compares the total heat content (temperature and humidity) of the return air and the outside air, and sets the dampers to use whichever requires the least conditioning.

   This analysis should be done carefully because the building operating staff is presently adjusting the system manually and achieving some of the savings that an enthalpy economizer would achieve. The staff could operate the building more efficiently if they had return air and outside air humidity information in addition to temperature. The installation of sensors which read in the maintenance office would be relatively inexpensive and would allow the staff to operate the system more efficiently.

The building is operated efficiently and conscientiously. Among the many energy conservation opportunities taken advantage of in this building, we noted the following:

1. Seven-day setback night thermostat.

2. Improved water treatment of the boilers and chillers.

3. Steam traps are checked and repaired on a regular schedule.

4. The summerdomestic water heater has a flue damper and a timeclock controls the circulating pump.

5. The installation of an electrical load shedding device to cut down on peak demand and monitor usage.

6. The installation of capacitors on all large motors.

7. The removal of many unnecessary fluorescent lights and ballasts.

8. The installation of key switches on excess hall and restroom lights.

9. The photographic labs have been equipped with recirculating water heaters for their process water.

10. Spandrel glass has been reinsulated and mullions have been filled with foam insulation.

11. More efficient 34 watt fluorescent lamps are being used to replace 40 watt lamps.

12. In many areas lights had been left on after the occupants left. These switches have been replaced by timeclocks.

ENERGY AUDIT CHECKLIST

OPERATION AND MAINTENANCE

EXISTING CONDITION:

The building is presently being set back to 58 degrees during unoccupied hours during the heating season.

Suggested O & M Options:

Reduce the setback to 50 degrees.

Suggested Energy Measures: (Retrofit)

POTENTIAL ENERGY SAVING:

$3150.00 (700 million BTUs) saved yearly.

COMMENTS

Natural gas $.45 per 100 cubic feet
Heating fuel consumption 80,000 BTU/sq. ft.
Actual saving will be somewhat greater due to reduced hours of air handler operation during unoccupied hours.

ENERGY AUDIT CHECKLIST

HOT AND COLD DECK RESET

EXISTING CONDITION:

Hot and cold deck are probably reset by outside temperature condition rather than by the condition of the coldest (or hottest in summer) zone. This results in mixing air that's too hot with air that's too cold.

Suggested O & M Options:

Suggested Energy Measures: (Retrofit)

If cost-effective, install a load analyzer which will set the hot deck so that the coldest zone is satisfied. Less mixing is necessary because deck temperature would then be responsive to the actual load.

POTENTIAL ENERGY SAVING:

$1,067.00 (150 million BTUs heating energy and 67 million BTUs cooling energy) annually.

COMMENTS

2 cents/KWH, cop of 3.
$.45/CCF of natural gas.
1.5 BTU/lb cold deck reset.
1 degree F. hot deck reset in summer, 2 degrees F. in winter.

ENERGY AUDIT CHECKLIST

VARIABLE AIR VOLUME

EXISTING CONDITION:

Both buildings have constant volume air handling systems powered by 7 motors totaling 127.5 horsepower.

Suggested O & M Options:

Suggested Energy Measures: (Retrofit)

If cost-effective, install variable volume air handling equipment.

POTENTIAL ENERGY SAVING:

$4600.00 (230,000 KWH) saved annually at 70 hours a week occupied.

COMMENTS

2 cents/KWH
50% motor energy reduction
1 KWH per HP
This will not affect peak demand unless you reprogram the load shedder to throttle down fans during peak demand periods.

ENERGY AUDIT CHECKLIST

OPERATION AND MAINTENANCE

EXISTING CONDITION:

Four restroom exhaust fans are on 24 hours a day.
Total CFM 2,095 and .375 horsepower.

Suggested O & M Options:

Install timeclocks on the fans and shut them off during unoccupied hours (average of 105 per week).

Suggested Energy Measures: (Retrofit)

POTENTIAL ENERGY SAVING:

$810.00 (180 million BTUs) saved yearly in heating fuel and $52.00 (2600 KWH) in electric power.
Total annual savings = $862.00.

COMMENTS

2 cents per KWH, 475 watts drawn by the motors, $.45 per CCF of natural gas.
If there is a problem with back drafts, install dampers to prevent cold air entry.

ENERGY AUDIT CHECKLIST

OPERATION AND MAINTENANCE

EXISTING CONDITION:

Both buildings air handling systems are presently working until 8:30 p.m. for custodial crews.

Suggested O & M Options:

Go to night set-back position one hour earlier, saving 260 hours of operation annually.

Suggested Energy Measures: (Retrofit)

POTENTIAL ENERGY SAVING:

$660.00 (33,000 KWH) saved annually.

COMMENTS

127 KW of fan power.
2 cents/KWH.

Very little discomfort will be noticed by cleaning staff in this one hour. There will be some additional savings due to air conditioning and heating energy not used.

ENERGY AUDIT CHECKLIST

OPERATION AND MAINTENANCE

EXISTING CONDITION:

Morning air handling unit start-up is timeclock controlled.

Suggested O & M Options:

Convert the start-up to an "optimal start" program which varies start-up times according to outside conditions and past experience with warm-up (cool down) times.

Suggested Energy Measures: (Retrofit)

POTENTIAL ENERGY SAVING:

$660.00 (33,000 KWH) annually.

COMMENTS

2 cents per KWH.
Average saving of 1 hour of run time per day.
1 KW per horsepower.

There will be some additional savings in heating and cooling energy.

ENERGY AUDIT CHECKLIST

LOW-LEAK DAMPERS

EXISTING CONDITION:

Assuming that the exhaust air and fresh air dampers are "closed" in the night setback mode, it is nevertheless likely that the type of damper used leaks 10% or 6410 CFM.

Suggested O & M Options:

Suggested Energy Measures: (Retrofit)

If cost-effective, install low-leak (1%) dampers.

POTENTIAL ENERGY SAVING:

$740.00 (165 million BTUs) annually.

COMMENTS

Assumes air handler operation 25% of the unoccupied heating season hours, or 675 hours per year. $.45 per CCF of natural gas, 75% boiler efficiency. There will be some additional savings due to fewer hours of air handler operation.

ENERGY AUDIT CHECKLIST

ROOF

EXISTING CONDITION:

The 30,500 square foot roof has an R-value of 10.

Suggested O & M Options:

Suggested Energy Measures: (Retrofit)

If cost-effective, increase the R-value to R-20 during the next reroofing.

POTENTIAL ENERGY SAVING:

$1318.00 (293 million BTUs) annually.

COMMENTS

Assumes $.45 per CFM of natural gas.
75% boiler efficiency.

ENERGY AUDIT CHECKLIST

OVERHEAD DOORS

EXISTING CONDITION:

The 3 overhead doors, one in the west loading dock and two in the garage area, 344 square feet, have an R-value of approximately 1 and an infiltration rate of 6 CFM per L. foot.

Suggested O & M Options:

Suggested Energy Measures: (Retrofit)

If cost-effective, replace with insulated overhead doors, assumed here to be R-10 with an infiltration rate of .5 CFM per L. foot.

POTENTIAL ENERGY SAVING:

$679.00 (151 million BTUs) annually.

COMMENTS

Assumes natural gas at $4.50 per million BTU, 75% furnace efficiency, 60 degrees inside temperature (4500 degree days)

ENERGY AUDIT CHECKLIST

LIGHTING

EXISTING CONDITION:

The outside of the building is lighted by 33-100 watt mercury lights
(4,100 initial lumens each, 16,000 hour life)

Suggested O & M Options:

Suggested Energy Measures: (Retrofit)

If cost-effective, replace with 35 watt low-pressure sodium lamps.
(4800 lumens, 18,000 hour life)

POTENTIAL ENERGY SAVING:

$120.00 (6,000 KWH) annually.

COMMENTS

Assumes operation 10 hours/day at 2 cents/KWH.
Compare lighting options carefully; many different systems can be used to light a space.
Assumes mercury and low-pressure sodium ballasts use the same energy.
Lamp replacement cost is about equal.

ENERGY AUDIT CHECKLIST

LIGHTING

EXISTING CONDITION:

The outside of the building is lighted by 33 100 watt mercury lights
(4,100 initial lumens each, 16,000 hour life)

Suggested O & M Options:

Suggested Energy Measures: (Retrofit)

If cost-effective, replace with 35 watt low-pressure sodium lamps.
(4800 lumens, 18,000 hour life)

POTENTIAL ENERGY SAVING:

$120.00 (6,000 KWH) annually.

COMMENTS

Assumes operation 10 hours/day at 2 cents/KWH.
Compare lighting options carefully; many different systems can be used to light a space.
Assumes mercury and low-pressure sodium ballasts use the same energy.
Lamp replacement cost is about equal.

ENERGY CONSERVATION TOTALS

O & M CHANGES:

Heat Loss Savings	=	880 $\frac{MBtu}{yr}$	1,114 $\frac{MBtu}{yr}$
Electrical Savings	=	68,600 $\frac{KWH}{yr}$	
Cost Savings	=	5,332 $\frac{\$}{yr}$	

ECM RETROFITS:

Heat Loss Savings	=	759 $\frac{MBtu}{yr}$	1,631 $\frac{MBtu}{yr}$
Electrical Savings	=	255,630 $\frac{KWH}{yr}$	
Cost Savings	=	8,524 $\frac{\$}{yr}$	

ENERGY SOURCES CONSERVED (ECM TOTALS):

Primary Fuel, natural gas	=	1,639 $\frac{MBtu}{yr}$	60 %
Secondary Fuel, ______	=	$\frac{MBtu}{yr}$	%
Electricity	=	1,106 $\frac{MBtu}{yr}$	40 %
TOTAL	=	2,745 $\frac{MBtu}{yr}$	100%

APPENDIX C

NAME OF BUILDING	COUNTY
STREET OR OTHER MAILING ADDRESS	TYPE OF FACILITY
CITY STATE ZIP CODE	ADMINISTRATOR TELEPHONE

Section 1: Consumption History

Begin with the most recent month for which you have utility bills and go back 12 months so we have a complete one year history. Specify the primary fuel used and the alternate fuel, if any.

TYPE OF PRIMARY FUEL USED	TYPE OF ALTERNATE FUEL USED

PRIMARY FUEL				ALTERNATE FUEL				ELECTRICITY			
MONTH	YEAR	UNITS	DOLLARS	MONTH	YEAR	UNITS	DOLLARS	MONTH	YEAR	UNITS	DOLLARS
TOTALS				TOTALS				TOTALS			

ELECTRICAL DEMAND *(Answer only if your electric utility bills you on a demand rate. Enter the highest measured electrical demand and the month for which it was recorded.)*

HIGHEST MEASURED DEMAND	MEASURED IN MONTH OF
____Kilowatts	

Square feet ____________

Number of persons housed ____________

Number of floors ______

Have you changes this building's hours of operation within the past two years?
No ______
Yes, more hours ______
per week added ______
Yes, fewer hours ______
per week less ______

Have you added energy using equipment equipment within the past two years?
No ______ Yes ______
If yes, please describe:

____

____

Have you increased or decreased the amount of heated space within the past two years (such as closing rooms or floors or building an addition)?
No _____ Yes _____
Increased by __ sq. feet
Decreased by __ sq. feet

Which one of the following statements best characterizes your response to the energy audit you received?

____ it was very thorough and made many good recommendations
____ it made good recommendations, but we were already aware of some of them
____ it didn't tell us much we didn't know before
____ it made unrealistic or unfeasible recommendations
____ other response or comment ________________________________

Which parts of the audit did you find to be of most value? (check as many as apply)

____ identification of energy conservation opportunities
____ description of the building
____ estimates of the energy dollars the projects can save
____ low and no-cost operation and maintenance measures we could easily put into practice
____ didn't really think the audit had much value for us

If you had money available to invest in energy conservation, what three projects would have your highest priority? Please list the most important projects first.

		Estimated Cost	Estimated Energy Dollar Savings
Most Important Project	________	________	________
Project #2	________	________	________
Project #3	________	________	________

Check any of the following which apply or are in use at your building:

1) ___ thermostat setback
___ number of degrees set back
___ number of hours/week set back
2) ___ chemical treatment for boiler/chiller
3) ___ steam trap survey/repair
4) ___ flue gas analysis
5) ___ computerized energy mgt system
6) ___ peak shaving/load shedding
7) ___ wood heat
8) ___ reduced wattage fluorescent lamps (watt-mizer, econo-watt, super-saver, etc.)

Which of the above have been implemented as a result of the audit (write in the numbers) ________________________

How many dollars a year do you think you are saving because of the conservation steps you have taken? ____________

Describe briefly any other energy conservation measures you have implemented in this building since or because of the energy audit.

ITEM	COST	Date Started	Estimated annual energy energy dollar savings

Which of the following do you feel are obstacles to increasing the energy efficiency of your building? (check as many as apply)

_____1. Haven't identified any energy conservation projects.

_____2. Budget pressures, no money, available funds are necessary for programs, etc.

_____3. Have identified energy conservation projects, but lack engineering/technical expertise necessary to get them off the ground.

_____4. Know areas where we can conserve, but aren't sure which energy conservation projects should have the highest priority. Where to begin?

_____5. Know what we should do, but have difficulty in justifying the projects to higher management.

_____6. Have ideas as to what we should do, but am too busy with my job to do research, get bids, etc. Not enough hours in the day.

_____7. There's no one person responsible for energy, not sure who to approach with ideas.

_____8. Other ____

Which of the following are available in your agency or building? Which do you think would be useful? (check all that apply)

WE NOW HAVE		WE COULD USE
________	Energy Manager or Coordinator	________
________	An Energy or Building Committee	________
________	Fuel Consumption Records—Charts Graphs, Reports Which Show How The Building Is Doing	________
________	An Innovative Method of Financing Which Wouldn't Affect Program Funding Levels	________

List any other items you feel would be helpful in your energy conservation effort:

____

____

____

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APPENDIX D

STATE BUILDINGS' IMPROVEMENT IN ENERGY EFFICIENCY

1979-1983

Central Plants - UNL, UNO, UNO Med Center, State Colleges, DPI, Corrections

All Fuels	Electricity Excluded	Cost Avoided	BTU Saved
10.4%	14.5%	$1,328,884	313,916 x 10^6

Individual Buildings - Department of Roads, Game & Parks Commission, Military Department

All Fuels	Electricity Excluded	Cost Avoided	BTU Saved
7.5%	10.9%	$361,345	82,623 x 10^6
	TOTALS:	$1,690,229	396,539 x 10^6

607E