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I am submitting herewith a dissertation written by Robert J. Doran entitled "A Study of Selected ACUHO Related Colleges and Universities' Energy Conservation Practices with Recommendations for Implementing a Residence Hall Energy Conservation Program." I have examined the final copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Education, with a major in Educational Administration and Supervision.

John T. Lovell

John T. Lovell, Major Professor

We have read this dissertation and recommend its acceptance:

Accepted for the Council:

Vice Chancellor
Graduate Studies and Research

A STUDY OF SELECTED ACUHO RELATED COLLEGES AND UNIVERSITIES' ENERGY CONSERVATION PRACTICES WITH RECOMMENDATIONS FOR IMPLEMENTING A RESIDENCE HALL ENERGY CONSERVATION PROGRAM

A Dissertation

Presented for the

Doctor of Education

Degree

The University of Tennessee, Knoxville

Robert J. Doran

August 1981

ACKNOWLEDGMENTS

This dissertation is dedicated to my wife, Jamie, and my daughters, Jacquelyn and Jennifer, who graciously gave of themselves and their time in order that I might complete this study. They were both a source of support and encouragement to whom I owe a great debt of gratitude.

I wish to acknowledge the support, encouragement and guidance provided throughout my entire doctoral program by members of my doctoral committee: Dr. John T. Lovell, Chairman, Dr. William Coffield, Dr. Howard Aldmon and Dr. S. C. Dietz, who became a committee member in April 1981. A special note of thanks is extended to Dr. Lovell for his sound advice, patience, understanding and guidance throughout the development and completion of this dissertation.

To Drs. Edmond Marks and Dennis M. Roberts, of The Pennsylvania State University, I extend a heartfelt thanks for their advice and guidance with the statistical analysis portion of this study. To Dr. Raymond O. Murphy, Vice President for Student Affairs, The Pennsylvania State University, I owe a special thanks and debt of gratitude. In addition to providing a continued source of personal encouragement and support, Dr. Murphy served as a constant mentor whose critiques and suggestions were invaluable in the writing of this dissertation. Lastly, I wish to thank Mrs. Melba Wilkins, secretary for the EA&S Department, the University of Tennessee, for her help and assistance in arranging the technical aspects of the production of this dissertation.

ABSTRACT

The purposes of this study were to: (1) identify and determine the effectiveness of elements of established energy conservation programs; (2) systematically examine the development, cost and incentive features of existent residence hall energy conservation practices and programs; and (3) develop a set of recommendations for implementing a residence hall energy conservation program. Major elements of established programs were identified in the literature and used to form the Conservation Program Elements Index (CPEI). The CPEI was used to determine the extent to which selected ACUHO related colleges and universities had implemented the identified conservation elements. The Perceived Energy Effectiveness Scale (PEES) was used to ascertain housing administrators' perceptions of the effectiveness of the elements listed in the CPEI. Both the CPEI and PEES were sub-sections of an original survey instrument, the Residence Hall Energy Conservation Questionnaire (RHECQ). Data on the development, cost and incentive features of college and university residence halls were obtained in section three of the RHECQ.

Twenty-nine chief housing officers, 83% of those contacted, in ACUHO related institutions in twenty states participated in the study. Total enrollment of the surveyed institutions ranged from 3,400 to over 50,000. The number of residence halls at the surveyed institutions ranged from three to ninety-two with residence hall populations of between 659 and 17,086 students.

This study identified sixteen elements, regarded by various energy experts as important components of effective energy conservation

programs. Although all sixteen elements, which comprised the CPEI, were utilized in varying degrees at various institutions, four of the elements had significantly lower utilization rates than the other twelve.

An item-analysis of the sixteen-element PEES, which utilized high-low "contrast" group scores, showed that although there was some variability in the responses of the "contrast" groups, the groups tended to be consistent in rating the elements as either effective or ineffective. The results showed that there was greater agreement among the "contrast" groups of the PEA sub-scale items than there was among the "contrast" groups of the PET sub-scale items.

Three types of energy conservation programs were identified, with the majority of institutions utilizing low-cost Quick-fix programs. Housing administrators were identified as the primary group of individuals involved in the establishment of objectives for residence hall energy conservation programs. Residence hall conservation programs were implemented primarily on the basis of "ease of implementation" and "minimum cost" with actual costs ranging from "small or minimal" to $300,000 and conservation cost avoidance figures ranging from unknown to $1,300,000.

Institutional recognition of staff efforts to conserve energy was generally in the form of a "pat on the back." Only one institution reported that a reduction in energy related operating costs resulted in a portion of the savings being allocated to the housing department. Few housing departments conducted student incentive based residence hall conservation programs. Of those departments which did have incentive based programs, incentives or awards were generally in the form of specific cash prizes or recreational equipment.

Eleven recommendations for implementing residence hall energy conservation programs were enumerated. Four recommendations regarding future areas of study were also listed.

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CHAPTER I

INTRODUCTION

Introduction and Statement of the Problem

In recent years, specifically since December 1973, considerable attention, interest and concern were focused on ways to conserve the nation's energy. The 1973 Arab oil embargo dramatized the nation's energy crisis and precipitated a reassessment of an American life style predicated on the availability of low-cost energy.

America's energy crisis, in large part, stemmed from its voracious appetite for energy and its proclivity for energy waste. It was estimated that Americans, on a per capita basis, used five times more energy than any other people in the world and that the amount of wasted energy was equivalent to the total energy consumed by 105 million Japanese (Anderson, Summer, 1975).

In higher education, inflation and escalating energy costs dealt a severe blow to many colleges and universities attempting to cope with a state of financial exigency (Bowen, 1975). The already-strained financial base stemmed from a series of conditions brought on by legislative demands for accountability, declining enrollments, empty residence halls, expanded facilities, overstaffed faculties, and a disenchantment with higher education (Weathersby and Jackson, 1977). The burden imposed by rising energy and utility costs cut deep into institutional operating budgets and forced many institutions to adjust instructional programs, limit the size of faculty, and curtail capital spending (Bowen, 1975). Simultaneously, many institutions were compelled to institute large fee and tuition increases to offset the price spiral for basic goods and services (Jenny, 1976).

Studies showed that the cost of higher education escalated from one billion a year in 1960 to over seven billion in 1974 (Young, ed., 1974; Carnegie Foundation, 1975). During a four-year period from 1970 to 1975, college and university utility costs rose over 53%, with the major increase coming in fiscal 1973-74 (Halstead, 1975). The Arab oil embargo and higher oil prices for imported oil were significant contributing factors which fired the nation's inflationary spiral (Lipton, 1976).

In 1972-73, the cost of energy for 536 institutions of higher education was approximately $555 million. By 1975, the energy costs had nearly doubled to $944 million, despite a 6% reduction in energy consumption (Sheppard, ed., January, 1977). Sheppard noted that on a per student basis, energy costs rose from $79 in 1972-73 to $124 in 1974-75. The square foot cost of energy for all institutions rose from approximately 27.6¢ in 1972-73 to 43.4¢ in 1974-75 (Sheppard, ed., January, 1977). By late 1978, the nation's colleges and universities spent close to $3 billion for maintenance and operation budgets with energy costs a prime factor in the continual upward push. It was projected that energy costs, both the absolute and proportional numbers, would continue to increase more rapidly than any other category of expenditure (Vlodeck, 1978 - 1979). The impact of rising energy costs and the scarcity of available energy was a cause of great concern for many institutions. As a result, many institutions of higher education began to explore avenues of decreasing energy consumption in all facets of their operation. The impetus to decrease energy consumption stemmed largely from institutional concerns over ways to minimize rising costs in the face of limited or constricted budgets (The Energy Task Force, 1977).

Although administrators were confronted with the difficult task of adjusting institutional budgets to accommodate rising energy costs, concern about energy and its cost was not lost on students. The American Council on Education and the University of California at Los Angeles, in their annual survey of freshmen, found that the energy problem replaced environmental concerns as the major issue for American students (The Times, Higher Education, February, 1978). Furthermore, nearly 82% of the students surveyed said that the government should be doing more to discourage energy consumption. This evidence suggested that students could be effectively incorporated in institutional efforts or programs to reduce energy consumption. Those institutions with residence hall populations were in a very tenable position to utilize student involvement in energy reduction programs, particularly in residence halls.

Residence halls, which consume a significant portion of an institution's overall energy, experienced the same fiscal constraints common to the institution as a whole. Like their institutional counterparts, college and university residence hall administrators registered serious concern over the impact of escalating energy costs on their own departmental operating budgets (SEAHO/NACUFS, 1976). At the University of Kentucky, for example, energy costs represented 52% of the Housing Department's expense budget during the 1975-76 fiscal year (SEAHO/NACUFS, 1976). Northern Illinois University, in an attempt to conserve energy and hold down utility costs, ordered all buildings closed for a two-week period during the winter of 1976. The move was estimated to save approximately $120,000 in utility costs (Lattore, ed., March, 1976). Due to an energy shortage, many educational institutions, as well as industrial plants, in Indiana and Ohio were ordered closed during the winter of 1975-76.

Statement of the Problem

The methods by which college and university housing administrators could reduce energy consumption in college and university residence halls was the problem undertaken in this study. In the past few years, college and university residence hall administrators have registered serious concern over the impact of rising energy costs. At the same time, administrators were seeking ways to utilize energy more effectively. The problem confronting residence hall administrators was how to reduce energy consumption in residence halls so as to minimize the impact of rising energy costs on residence hall operating budgets. The need for directors of residence hall operations to make more effective use of energy became even more critical when institutions began to slash departmental budgets and reduce the scope of many programs.

The Association of College and University Housing Officers (ACUHO) is a national organization devoted to the effective management of all aspects of college and university residence halls. As such, it is committed to finding ways to reduce unnecessary energy consumption and in conjunction with institutional physical plant and maintenance administrators, has considered various ways by which all utility costs could be reduced.

One management technique which received considerable interest and was designed to reduce rising utility costs was energy conservation. As more and more higher education institutions began to develop energy conservation programs, the need for more research on their effectiveness and their applicability to higher education and residence hall operations became essential. Data relative to the development and implementation of conservation programs and the effectiveness of specific conservation practices were minimal or nonexistent. The absence of research, which identified and analyzed effective energy conservation practices, constituted a continued hindrance to administrative efforts to curtail energy consumption and stem the growing loss of administrative control of the operating budget.

Purpose of the Study

The purposes of this study were threefold. The first purpose was to identify and determine the effectiveness of elements of established energy conservation programs. The second purpose was to systematically examine the development, cost and incentive features of existent residence hall energy conservation practices and programs. The third purpose of this study was to develop a set of recommendations for implementing a residence hall energy conservation program. While primarily descriptive in nature, this study, by means of a review of the literature and an analysis of the data obtained from a survey questionnaire, sought to:

1. Identify the major elements or components of established and effective energy conservation programs.

2. Develop an institutional energy conservation program index.

3. Determine the types, cost, development, and incentive features of residence hall conservation programs.

4. Analyze the major features of residence hall conservation practices and programs.

5. Develop a set of recommendations for planning and implementing an energy conservation program in college and university residence halls.

Questions Which Directed the Study

1. What are the major elements or components of established and effective energy conservation programs?

2. How effective are the previously identified conservation elements in a college or university energy conservation program?

3. What are the types and characteristics of residence hall energy conservation programs?

4. What types of incentives are incorporated in residence hall conservation programs?

5. What recommendations could be advanced to improve the utilization of energy in college and university residence halls?

Rationale for the Study

Given the "energy shortages" and the forced closings of colleges and universities during the winters of 1977 and 1978, energy conservation became, without question, a priority concern for campus administrators. This study was an attempt to address a crucial issue, that of energy utilization and conservation, which was confronting campus housing officers, higher education, and the nation as a whole.

For many colleges and universities, inflation and escalating energy costs seriously eroded administrative control over a large portion of the institutional operating budget. The implementation of an energy conservation program, as suggested by this study, would have the effect of enabling institutions to:

1. Reduce residence hall energy consumption and energy related operating costs.

2. Provide an additional element of administrative control over operating budgets.

3. Help to control or stabilize residence hall and institutional operating costs.

4. Demonstrate the seriousness of institutional pledges to become more cost conscious in the face of accountability demands.

5. Illustrate to the nation the seriousness of the energy crisis and place higher education in a leadership position with respect to energy conservation.

6. Conserve energy and thereby preserve natural resources.

Assumptions Underlying the Study

1. The supply of traditional energy resources is limited.

2. A continued demand for these limited resources will cause their price to increase. The demand is expected to continue.

3. Residence halls are major consumers of energy on college and university campuses.

4. Housing directors are interested in identifying methods of reducing energy consumption and related costs.

5. There is a body of knowledge that deals with effective energy utilization.

6. Housing directors have instituted energy conservation practices and implemented energy conservation programs in college and university residence halls.

Limitations of the Study

Variables over which the study had no control:

1. The respondent's understanding of the institutional and residence hall energy conservation practices.

2. The respondent's ability to identify current energy conservation practices.

3. The accuracy of the respondent's perception of the effectiveness of specific institutional energy conservation practices.

Delimitations of the Study

1. Responses to the questionnaire were only sought from chief housing officers at residential colleges and universities.

2. The institutions in the Association of College and University Housing Officers' "1976-77 Room and Board Survey" were included in the survey (thirty-five institutions).

3. Data were only sought on residence halls as defined in the traditional sense of the word.

4. Energy costs associated with residence hall dining facilities were not included in the design of the questionnaire.

Definition of Terms Used in the Study

Energy - that commodity which has the capability to do mechanical work or to produce a change in temperature.

Conservation - the planned management of a natural resource to prevent exploitation, destruction, or waste.

Practice - a singular systematic procedure employed to gain proficiency.

Conservation Program - a formalized, planned program of energy conservation practices.

Chief Housing Officer - the institutional administrator who has direct responsibility for all aspects of a residential housing program.

Energy Conservation Practice - a singular action or measure designed to conserve energy (may or may not be a part of a formal program).

Energy Conservation Program - a coordinated group of energy conservation practices organized in a systematic manner so as to constitute a formal program.

Residence Hall - a campus facility consisting of rooms or suites designed to house resident students; excludes apartments, suites, etc., where utility costs are individually metered and charged separately to the occupant.

Life-Cycle Costing - an evaluation technique that considers the sum total of all costs associated with an expenditure during expected life span.

HVAC - heating, ventilating, and air conditioning systems.

ACUHO-The Association of College and University Housing Officers.

Organization of the Study

Chapter I serves as an introductory chapter and concerns itself with the delineation of the problem; a statement of the problem; purpose and rationale for the study; basic assumptions, limitations and delimitations; question which directed the study; definitions of terms and an organization of the study. Chapter II contains an extensive review of selected literature and research related to the problem. Chapter III addresses itself to the methods and procedures employed to undertake the study. Chapter IV constitutes a presentation and analysis of the data, Chapter V consists of a summary, findings, conclusions and recommendations.

CHAPTER II

REVIEW OF THE LITERATURE

Purpose of the Review of the Literature

A review of the literature was undertaken in order to examine (1) the causes leading to America's energy crisis and its impact on U.S. colleges and universities and (2) the role of conservation as a viable response. Energy conservation, defined as the prudent and effective use of energy, was regarded as an immediate and viable response, both to the threatened energy shortages and as a means of slowing or limiting the impact of rising energy costs on residence hall operating budgets. It was believed that a presentation of the facts regarding the current energy crisis would contribute to a greater understanding of the need to conserve energy and the benefits to be obtained from the implementation of an effective institutional energy conservation program.

A second major purpose of the review of the literature was to identify common elements of energy conservation programs that energy experts regarded as essential or important to an effective conservation program. Sources examined in the review of the literature included publications by business, industry, educational institutions and state and federal governments. The major elements of conservation programs identified in the review of the literature were incorporated as a major section of the Residence Hall Energy Conservation Questionnaire (RHECQ). The RHECQ was designed to obtain descriptive data regarding the characteristics of and the extent to which college and university residence halls had implemented energy conservation practices or programs.

Inflation and Its Economic Impact

In the early 1970s, the inflationary concerns confronting the nation's colleges and universities were indigenous to the larger economic problems facing the United States: dramatic increases in the costs of goods and services; rising energy costs; restricted fuel supplies; lack of a national energy policy; and, the inflationary impact of escalating fuel costs on every segment of the U.S. economy (Bowen, 1975; Anderson, Summer, 1975). For institutions of higher education, inflationary concerns stemmed from a number of factors including problems carried over from the rapid expansion of the enrollment, staff, and physical plants in the 1960s; declining enrollments in the 1970s; and the unforeseen and significant price hikes in the cost of utilities and energy (Jenny, 1976; Vlodeck, 1978 - 1979).

The Energy Task Force, a consortium of the American Council on Education (ACE), the National Association of Colleges and Universities Business Officers (NACUBO), and the Association of Physical Plant Administrators (APPA) in a study of 536 colleges and universities found that between 1970 and 1975 the average institution's energy costs rose by 146% while a few experienced an increase of over 300% (Coffield and Gaither, Fall, 1976). The cost of energy at Yale University for example, jumped from $2.4 million in 1970 to $8.7 million in the 1974-75 academic year, despite significant energy reduction efforts (Coffield and Gaither, Fall, 1976).

Before 1970, the cost of a million British Thermal Units (BTUs) ranged from 30¢ to 50¢ and an electric kilowatt approximately 1¢. In 1976, the average institution paid roughly $2 per million BTUs for fuel heat and 2.5¢ per kilowatt of electrical energy which was equal to $7 per million BTUs (The Energy Task Force, 1977, p. 15). Since that time, the cost of primary fuels had more than doubled and costs were expected to continue their upward spiral.

A significant contributing factor, which fueled the U.S. inflationary spiral, was the increased costs of imported crude oil (Abrahamson, 1976). The Federal Energy Administration hereafter referred to as the FEA, found that beginning in late 1973, many colleges and universities saw a doubling or tripling of their utility costs within a relatively short period of time (FEA, Vol. I, 1976). As late as 1977, a number of colleges and universities, unaffected by the initial increases, began to experience the budget-disturbing impact of energy related price hikes. While business and industry were able to quickly pass along the increased costs, most institutions of higher education, with limited cost pass-through capabilities and locked into twelve- to eighteen-month budgets, were much slower to respond (The Energy Task Force, 1977).

To combat rising energy costs, many institutions began to examine and alter the ways in which energy was used. Energy management programs began to develop as administrators sought to implement conservation programs as a means of regaining control over institutional operating budgets (The Energy Task Force, 1977; FEA, Vol. I, 1976). In a 1975 pilot project involving ten buildings, North Carolina State University utilized time clocks and a leased computer control system to control energy consumption. The program resulted in a cost avoidance of $151 a day, or $42,280 annually. The University of Texas, by generating its own electrical power rather than purchasing it from a utility, instituted a program to reduce electric consumption and had an estimated cost avoidance of $634,000 in 1975-76. Kent State, using a shut-off or control oriented conservation program, had an annual cost avoidance of $157,810 (FEA, Vol. II, 1976).

Although removed from traditional academic and administrative purview, energy consumption and energy-related issues began to receive increasing amounts of attention in institutional planning (Coffield and Gaither, 1976). To gain a perspective on the impact of energy issues on the U.S. economy and the nation's colleges and universities, it was deemed necessary to examine some of the major factors which contributed to the current energy problems facing the United States.

The U.S. Energy Crisis

In 1972, the United States, with less than 6% of the world's population, consumed over 34% of the world's energy (Diamond, ed., 1973). Concomitantly, three-quarters of its energy was derived from petroleum and natural gas. And, in a matter of three decades, the U.S. had changed from being a net exporter of energy to a large importer, including 50% of its oil (Hatfield, March, 1979).

Between 1960 and 1970, the U.S. consumed as much energy as it had in its entire previous history. Trends indicated that U.S. oil and gas consumption would double by 1983. It was predicted that supply problems would be compounded in that many other nations had energy consumption patterns that were growing at a rate faster than that of the U.S. (The Energy Task Force, 1977). The percent of total demand supplied by domestic sources had been on the decline since 1950, when domestic production supplied almost 99% of gross energy use in the U.S. By 1960, domestic production dropped to 94% and by mid 1973, had slid even further to 86.5%. It was projected that this figure would decline to 76% by 1985 (U.S. Citizens' Advisory Commission, 1974).

Prior to 1970, the availability of relatively cheap domestic and foreign energy contributed to an atmosphere in which energy use and resources received scant attention from industrial or private consumers (The Organization for Economic Cooperation and Development, 1976). The oil shortage, brought on by the 1973 embargo and subsequent price hikes for all grades of crude oil and fossil fuels, jolted the United States into a reexamination of its energy supply, transformation, and consumption patterns. It was estimated that at 1975-76 consumption rates, domestic reserves of petroleum and natural gas would last only for a few more decades at best (Cornish, ed., October, 1977). Other estimates indicated that there was little prospect for new sources of power before 1980 (Diamond, ed., 1973). Furthermore, there was general agreement that regardless of the actions taken, the U.S. would encounter a deepening energy crisis by 1983 (Breckenridge, 1977; Mancke, 1976).

Given the existent consumption rates and the amount of known reserves, it became clear that the world was running out of oil. Within the last twenty-five years, world fuel consumption tripled, oil and gas consumption quintupled, and the generation of electricity grew almost seven-fold (Mancke, 1976). Denis Hayes (1977), in "The Coming Energy Transition," cautioned that the world's energy consumption rate of the past two decades could not be sustained indefinitely.

The Arab Oil Embargo

In October 1973, the Arab Organization of Petroleum Exporting Countries (AOPEC) initiated an oil embargo against the United States. At the same time, the Organization of Petroleum Exporting Countries (OPEC) unilaterally raised the tax on each barrel of oil by $3 (Lipton, 1976). This action pushed the estimated market value of crude oil to approximately $3.65 per barrel. On January 1, 1974, OPEC further increased the tax to $7 per barrel (Abrahamson, 1976). By the summer of 1979, the contract price of Arabian crude was set at $18 a barrel. On the open or spot market, members of OPEC were selling oil at prices over $45 a barrel.

During the three months of the Arab oil embargo, it became clearer than any time in the past, that the industrial world, and the U.S. in particular, was prepared to pay significantly more for oil than it had been paying. Between 1972 and 1975, the cost of oil rose from less than a dollar a barrel to approximately $11 per barrel (Gonzalez, 1976). For the American consumer, the cost of the nation's "growth fuel" rose from approximately 50¢ per million BTUs to $2 per million BTUs (The Energy Task Force, 1977).

America's response to the oil embargo necessitated the conservation of energy on a national scale. For the most part, conservation efforts were voluntary in nature and the end of the embargo signaled a return to a "business as usual" attitude for much of the nation. For many, the shortage experience during the embargo was thought to have been contrived. Years later, many people were still convinced that the "energy crisis" was a hoax (Anderson, 1975; Breckenridge, 1977).

Technological Outlook for the Future

Among the reasons cited for continuation of the energy crisis were: (1) the long lead time for the research and development of commercial finds; (2) environmental concerns; (3) the lead time required for the development of production facilities and transportation systems; and (4) the lack of a national comprehensive energy policy (Cornish, ed., October 1977). A two-year study, conducted by Don E. Kash (1976) and colleagues at the University of Oklahoma, arrived at a similar conclusion. Despite major disagreements on a number of issues, Kash and his colleagues concluded that:

1. Fossil fuels (oil, coal and gas) would remain major sources of energy in the U.S. well into the next century.

2. There was little evidence to suggest that nuclear or advanced solar, geothermal or wind-driven power systems would provide any major share of the country's total energy requirements before the 1980's.

3. Energy costs would continue to rise and demand an increasingly larger percentage of the consumer's dollar.

Aside from fossil fuels, the prospects for the development of large-scale alternate energy sources, which would ameliorate the current crisis, were regarded as minimal. In a review of the near term prospects for alternate energy sources, the Educational Facilities Laboratory (1973), hereafter referred to as the FFL, arrived at a number of conclusions similar to those enumerated in the Kash (1976) study. The EFL (1973), in its analysis of future energy supplies, concluded that nuclear energy, the heralded hope of the future which had over the past decades received the majority of federal research and development funds, had become the target of a lot of criticism, particularly in regard to practicality and safety. It further stated that conventional nuclear fission reactors posed a number of complex problems relating to: (1) the disposal of radioactive waste materials; (2) low-level radioactive leakage; (3) safeguards against sabotage; and (4) the thermal pollution of cooling systems.

With respect to nuclear fusion, which was regarded as a viable and plentiful source of energy that could satisfy the world's energy needs for millions of years, the technical problems were viewed as monumental. The major problem with fusion reactors centered on the development of a method which could confine the core "plasma" (ionized gases with temperatures ranging up to 100 million degrees F) from coming in contact with the combustion chamber walls. Any contact of the ultra-hot plasma would cool the gaseous ions and reduce the temperatures required to sustain the fusion reaction (EFL, 1973).

Even before the 1979 accident at Three Mile Island (TMI), nuclear (fission) power had come under attack. The TMI incident merely served to strengthen the argument against the "power source of the future." America was faced with the prospect of determining its energy future and according to Hayes (1977), not only the U.S. but the entire world was on the throes of another great energy transition. In an earlier transition, coal had displaced wood and wind as an energy source and accelerated the industrial revolution. The dawn of the

20th century brought a shift to petroleum which altered the nature of the world by shrinking the planet and reshaping its cities. The predicted energy transition was expected to have a profound influence in the restructuring of the world of tomorrow. Decisions made during the late 1970s and early 1980s were expected to dramatically determine how the world would look in a few decades (Hayes, 1977).

McKelvey (1976) reinforced the notion that the time frame for producing energy alternatives was very short but believed that the prudent use of currently available fossil resources could stretch that time span well beyond current estimates. John Schacter, chairman of the American Institute of Chemical Engineers, was equally emphatic and warned that the U.S. faced catastrophic results even with energy conservation unless it rapidly developed alternative energy sources (The Knoxville Journal, February 16, 1978).

The preponderance of the evidence suggested that unless the U.S. began to reduce its energy consumption and implement strong and effective energy conservation programs, it was inviting economic, political and social disaster (The Upper Mid-West Council, 1974). Whatever the long-term implications, energy conservation was viewed as a viable alternative for both the short-term as well as the long haul, if the U.S. was to avert the predicted demise.

The Meaning and Rationale of Conservation

Energy conservation has been variously referred to as: (1) the nation's first important new source of energy (The Executive Office, 1977); (2) a means of holding off a fuel shortage(EFL,1973); or (3) a word that is synonymous with the elimination of energy waste (The Energy Task Force, 1977). Energy conservation was, however, generally defined as the most efficient use of energy resources (Males, 1976).

Gibbons and Sant (1976) pointed out that the amount of energy used was primarily a function of its price relative to the cost of alternatives or substitutes, i.e., labor, material, or capital. Experts agreed that in considering the monetary benefits of energy conservation, it was important to distinguish between "savings" which implied budget reductions and the more appropriate term "cost avoidance" which implied a cost difference between what would have been paid and the amount actually paid due to conservation efforts (Stephen, December, 1977; FEA Vol. II, 1976). Stephen (December, 1977) however, cautioned that it was important to distinguish between "true conservation," i.e., the efficient use of energy, and a curtailment, i.e., the reduction of an activity or the use of a facility.

Economically, conservation was viewed as the easiest way to reduce the growing gap between the nation's voracious appetite for energy and its ability to meet that demand. It was also seen as being the most viable way of reducing energy related operating costs. According to Dubin, Mindell and Bloome (1975), energy conservation, contrary to popular belief, should not be equated with a substandard life style or a bleak utilitarian society. Rather, they suggested, it should be viewed as an economic and environmental activity that can be accomplished without major disruption or hardship largely through the efficient utilization of non-renewable energy resources. Nonetheless, the idea of conservation went contrary to traditional American habits. America's penchant for large gas guzzling cars, over-heated and over-lighted buildings, were historically two of its well-noted wasteful habits. Long accustomed to "limitless" sources of cheap energy, Americans in the late 1960s and early 1970s consumed nearly nine times as much energy as the average non-American (EFL, 1973). And, the tragedy was that the nation wasted up to one half of the energy it gained from the fuel it burned (Diamond, ed., 1973).

Many energy experts were not technological optimists with regard to future energy sources and supplies and predicted future energy constrained life-styles (Smith, 1977; Upper Mid-West Council, 1974), The caveat, as Smith (1977) saw it, was not for nations, governments, cities, or industries, but for all of the people who were the consumers of energy. Smith (1977) maintained that Americans, as consumers, needed to reexamine and eventually alter their values and habits since they were the ones who threw the switches, opened the valves, and filled the tanks that consumed the world's energy. To avert the predicted demise, Smith (1977) cautioned that Americans needed to:

1. Change their perception and values regarding the use and consumption of energy.
2. Develop tools or techniques to manage energy wisely.
3. Eliminate waste.
4. Reduce inefficient equipment or operations.

Dubin, Mindell, and Bloome (1975) estimated that where energy conservation programs had been utilized in industrial, institutional and commercial buildings, fuel and electrical consumption in some instances had been reduced by almost 50%. It was estimated that energy savings in the 20% - 50% range were indicative of the potential for all buildings then in use (EFL, 1973).

Although many saw energy conservation as a viable strategy for dealing with the energy crunch, there were others who cited cogent arguments for conserving energy resources that went far beyond an institution's effort to save money by reducing operating costs. Dubin, Mindell, and Bloome (1975), for example, listed six additional advantages that accrued to an institution which utilized energy conservation techniques or practices. Accordingly, energy conservation was thought to:

1. Extend the useful life of existing equipment and eliminate the need for premature replacement costs.

2. Increase the reserve capacity of the existing central plant systems and meet future building extensions without installing extra boilers, chillers or transformers.

3. Reduce the likelihood of shutdown or curtailment of operations due to fuel or power shortages which are inevitable if demand continues to outstrip supply.

4. Reduce airborne pollution resulting from the combustion of oil, gas, or coal and possibly save the installation cost of pollution control equipment.

5. Reduce waste and thereby induce fuel economy without a reduction of health and comfort standards or a curtailment of building services or functions.

6. Reduce peak electric loads and power demand charges while easing the burden on existing power generating and distribution systems.

Educational institutions, including colleges and universities, were viewed as having a stake in stressing the need for energy conservation. According to the EFL (1973), institutional commitment to energy conservation was based on the fact that (1) there were long-term economic benefits that accrued to an institution as a result of a more efficient physical plant operation; (2) educational institutions, which introduced the systems building concept to building technology, owed the public sector and taxpayers an even greater obligation and effort to develop effective conservation programs; and (3) institutions could serve as models and exemplify the conservationist's attitude.

Energy Management Programs

Higher education, the traditional solution seeking sector of the nation, was called upon to assume a leadership role as America moved toward a goal of energy and economic independence (The Energy Task Force, 1977). Institutions of higher education were urged to develop programs and ideas that would not only assist other segments of the nation, but also develop programs and ideas that would enable colleges and universities to help themselves. Ironically, relatively few studies addressed the issue of the impact of energy conservation programs on post-secondary institutions. Fewer still focused on the type, nature and impact of conservation programs in college and university residence halls.

Energy management programs were seen as consisting of three primary functional areas: (1) energized systems consisting of boilers, chillers, and generators; (2) nonenergized systems such as controls, insulation, and building envelope; and (3) the human system made up of all people who worked with or utilized the facilities. Formidable as they were, the technological obstacles (energized and nonenergized systems) were thought to present fewer difficulties than the sociological obstacles to solving the energy crisis (EFL, 1973). Stated another way, no matter how much time, effort or ingenuity was expended on technical aspects or equipment, an energy management program was bound to be less effective without the acceptance and support of the campus community (The Energy Task Force, 1977).

Clearly stated and realistic goals and the means by which they were to be achieved were viewed as crucial elements in the development of an energy management program. In determining institutional goals, which could be achieved through a series of predetermined actions that focused on the modification of the energized and nonenergized systems, decision makers were urged to take into account those policies which incorporated principles of human behavior. Duga, Malone and Davis (1976) in Energy: The Policy Planning Framework, suggested that voluntariness and the meaning and "role" of policy were paramount in the discussion of energy management programs. An understanding of what people thought, what they perceived and, above all, what they did were deemed crucial factors in the development of any policy. Duga, Malone and Davis (1976) cautioned, however, that because of the voluntariness on the part of consumers, voluntary actions were the most difficult to evaluate. Consequently, in determining "policy," planners, committees and institutions were urged to adopt measures or policies that were realistic in terms of human behavior.

Numerous studies and energy experts underscored the importance of the human factor in energy conservation programs. Duga, Malone and Davis (1976) emphasized a method of policy development that took into account people's behavioral patterns. The Energy Task Force (1977) and the South East Association of Housing Officers (SEAHO/NACUFS, 1976) emphasized commitment and community awareness. The National Energy Plan (The Executive Office of the President, 1977) underscored the importance of incentives as a way of soliciting and maintaining public support for conservation programs. In its summary of a series of meetings on public participation in conservation programs, The Executive Office of the President (1977) concluded that due to the voluntariness of the programs, incentives, monetary or otherwise, were critical if programs were to be truly effective.

Although there were quite a few experts in the public sector who stressed the use of incentives and educational programs as a means of involving the public (consumers) in conservation programs, the utilization of incentive based conservation programs by residence hall administrators were found to be minimal. In a study conducted by the Association of College and University Housing Officers (1976), only 22 of 159 institutions reported any type of educational or incentive related conservation program. Of the twenty-two institutions, only three were cited as incorporating some type of incentive program. Examples of incentive based programs included the University of Kansas which awarded steak dinners as prizes whereas the University of Connecticut gave cash awards and Florida State University provided recreational equipment to the winners of their energy reduction contests (Association of College and University Housing Officers, 1976).

The energy conservation program at the University of Arkansas (Fayetteville) exemplified how incentives were incorporated in a residence hall program (Lattore, ed., December, 1976). In the first phase of the program, students were urged to conserve electricity and competed for prize money to buy recreational equipment. Each hall competed for specific time periods against its own previous year's record of kilowatt consumption. The second phase involved competition between halls in three areas of utility consumption (water, electricity and heat) for a specific time frame. Prizes of $100 were awarded to the halls with the lowest consumption in each of the specific areas. In addition, $500 was awarded to the hall which had the best overall performance in a combination of all three areas for the entire contest period (Lattore, ed., December, 1976).

Energy Conservation on Campus, a two-volume monograph prepared for the Federal Energy Commission (1976) by its Energy Task Force, was one of the initial studies on higher education's attempt to deal with the growing energy crisis and escalating prices. The expressed purpose of the task force was to identify and develop guidelines which would assist colleges and universities in the development and implementation of effective institutional energy management programs.

The FEA (Vol. I, 1976) study, in its search for practices that would quickly reduce energy consumption, found that many college and university buildings, largely by virtue of their design, needlessly consumed or wasted large amounts of energy. Faced with projections of spiraling energy costs and the reality that major alterations to existing facilities would be expensive and difficult, many administrators, the researchers discovered, were looking for low-cost alternatives in their effort to reduce energy consumption. In its analysis of various energy conservation practices, the FEA (Vol. I, 1976) study identified five basic elements which it regarded as essential to any effective energy management program. The five elements were: Commitment; Energy Conservation Committee; Energy Management Officer; Energy Use and Information; and Results, Measurement and Evaluation.

Commitment

According to the FEA (Vol. I, 1976), to be effective, an energy management program had to have the enthusiastic support of the institution's chief executive officer. The support and commitment of the chief executive officer were deemed critical not only in terms of the allocation of institutional resources (money, personnel, etc.), but also in terms of the executive's ability to gain the support and cooperation of the campus leaders (FEA, Vol. I, 1976). Robinson (1977), in his analysis of industrial energy conservation programs, also underscored the importance of top level support and commitment. Anderson (1977) likewise examined energy conservation programs from a managerial perspective and maintained that since management was the originator of conservation programs, successful programs, of necessity, required the top level commitment. Smith (1977), held a similar view and reasoned that because energy conservation involved all employees, top management was the only practical vehicle through which the cooperation and support of all employees could be obtained. The chief executive was viewed as having the authority to develop or establish policy along with recourse to the institutional resources needed to implement the policy. Since the development of policy often required changes, a clear and well conceived commitment from the chief executive was considered essential if the hard decisions were to be implemented.

Energy Conservation Committee

In addition to the support and commitment of the chief executive officer, the establishment of an Energy Conservation Committee representing all segments of the campus community was viewed as being of significant value (FEA, Vol. I, 1976). It was recommended that the committee be representative of all campus groups or departments that influenced the cost and/or usage of energy (FEA, Vol, 1, 1976; Anderson, 1977).

Stenzler's (March, 1979) approach to implementing energy conservation programs differed from the FEA's (Vol. I, 1976) program in that it included a management team or task force as the second or intervening variable between commitment and conservation committee. The program, as outlined by The Energy Task Force (1977), had a similar intervening variable, consisting of the physical plant director and the institution's business officer. The Energy Task Force (1977) advocated this arrangement because it felt that these individuals were in the best position to review the feasibility of all plans and recommendations put forth by the conservation committee.

According to FEA (Vol. I, 1976), the committee's primary task was seen as developing an energy management program that promoted the most efficient use of institutional energy systems. Secondarily, the committee was charged with the responsibility for establishing realistic goals, policies, and the methods for evaluating the results of those measures. Other committee responsibilities included the selection of various subcommittees with specific task objectives and realistic time frames; the identification and review of initial low cost energy conservation practices;

the establishment of energy conservation guidelines and criteria for the construction and financing of new facilities; and the communication of the committee's actions and program results to the campus community (FEA, Vol. I, 1976).

Baisya (October, 1975) stated that the responsibilities of an energy committee were to: (1) assess the program's progress and identify areas needing further study; (2) promote and maintain community interest; (3) evaluate the program's effectiveness; (4) provide a sounding board for ideas and suggestions; (5) improve the cooperative spirit; (6) manifest a willingness, as a leader, to conserve energy; and (7) revise and update the program. Local governments, likewise, had utilized energy advisory committees and determined that the success of the conservation programs was directly related to the effectiveness of the advisory committees (Upper Midwest Council, 1974).

Energy Management Officer

To insure the success of their program, institutions were urged to employ full-time Energy Management Officers who had the technical know-how to manage a program and coordinate the activities of an energy conservation team (FEA, Vol. I, 1976). The need for having a full-time Energy Management Officer was also underscored by Kruza (November, 1979). In addition to the technical know-how, Kruza stated imagination and ingenuity were the most important prerequisites for the job.

As outlined by the FEA (Vol. I, 1976), the primary responsibilities assigned to an Energy Management Officer included (1) the coordination of all energy audits; (2) the determination of the amount, type, and location of energy consumed; (3) the establishment of an energy data base; and (4) a continual analysis of all available data. To do his job effectively, the Energy Management Officer was seen as requiring the assistance of highly trained and knowledgeable technical personnel (Kruza, November, 1979).

During the 1975-76 academic year, the University of Michigan attributed a cash avoidance of $500,000 to its decision to establish an energy management group with a full-time person in charge (Sheppard, ed., February, 1976). Of particular importance to the perceived effectiveness of the program was the fact that the personnel involved could concentrate on the issues on a full-time basis.

Energy Use and Cost Information

The collection of energy cost and consumption data was viewed as an initial step in the development of an energy management program. The direction and implementation of a program were seen as being shaped largely on the basis of decisions made as a result of the initially collected data derived from a systematic audit and survey of the entire institution. The FEA (Vol. I, 1976) study recommended that data collection consist of information obtained from three sources:

1. Overall campus energy or total energy input in the campus including the identification of each energy source.
2. Building energy use detailing the type of energy delivery system in each building.
3. Generation and distribution system survey including central plant operations and delivery systems.

Energy experts agreed that the core of an energy conservation program consisted of an institution's ability to obtain accurate data through an energy audit (FEA, 1976; The Energy Task Force, 1977; SEAHO, 1976). Energy audits were defined as methods of determining the theoretical amount of energy required, the actual energy used, and the variance between the theoretical and actual consumption. According to SEAHO (1976), the primary goal of a conservation program was to reduce the variance to a minimum. The FEA (1977) suggested that in addition to determining how much energy a particular structure consumed, energy audits were also a means of:

1. Developing an energy data base.
2. Monitoring a particular building's energy consumption on a continual basis.
3. Assessing the effects of various conservation measures by providing data on consumption before and after changes have been instituted.
4. Comparing similar buildings to determine which operate more efficiently.
5. Forecasting energy costs for upcoming years by taking the amount of energy used the previous year and applying newly announced energy rates.
6. Establishing energy conservation goals.
7. Determining whether a building is paying the lowest possible utility rates.

Symonds and Snyder (1977) stressed the importance of utilizing the billing audit as a means of developing a historical data base. The billing audit consisted of an analysis of the monthly utility bills which detailed cash and consumption figures. In addition to the billing audit, two other types of audits were recommended. After analyzing the data obtained in the billing audit, Symonds and Snyder (1977) suggested that a field audit be undertaken for the purpose of identifying easily seen Energy Conservation Opportunities (ECO's) such as open windows, lights left on, open doors, and thermostats set at improper settings. In a more detailed technical audit it would have been necessary to obtain data on all of the institution's energy using systems, energy use patterns, operating parameters and local weather or degree day data (Piper, March, 1978). It was recommended that this technical audit be conducted by an engineer (Stenzler, March, 1979; SEAHO, 1976) or an energy audit team (Piper, March, 1978). Piper recommended that the audit team consist of an engineer, architect, contractor, and representatives from equipment manufacturers, utility companies, and trade associations.

An infrared survey was viewed as constituting an excellent method of identifying heat loss from buildings and energy distribution systems. Heat which was escaping through a non-insulated building envelope or piping system was able to be readily identified with the use of an infrared camera. A casual observer could easily identify similar types of heat loss merely by noticing which portion of a roof or which building had bare spots when other roofs were covered with snow.

In "The Impact of the Energy Crisis on School Finance," Calvin Anderson (Summer, 1975) stated that the efforts towards which the energy audit analysis should be directed include:

1. The hiring of competent maintenance personnel and the promotion of salary scales that would attract such personnel. It is estimated that monies spent for this purpose are recouped many times over.

2. The promotion of energy conservation training programs and workshops for maintenance personnel currently on the job.

3. The consideration of life-cycle costing in the planning of new educational facilities.

4. Provisions for the retrofitting of existing facilities in order to create more energy efficient buildings.

5. The purchasing of energy efficient equipment even though it may have a higher initial cost than others which are less efficient.

6. The review and, where possible, the revision of existing building codes to make them more energy efficient.

Cost factors were viewed as constituting a prime consideration in establishing conservation priorities and in choosing alternatives. Many institutions resorted to the use of life-cycle costing techniques as a means of analyzing the cost factors involved in contemplated purchases. The FEA (1977) saw life-cycle costing as a technique which attempted to measure the total cost of ownership over the expected life of the energy reduction effort. Griffin (1974) and the American Institute of Architects (AIA)(1976), defined life-cycle costing as a sum of the yearly owning and operating costs and included such variables as initial costs, taxes, amortization, insurance, maintenance materials, labor, and energy costs. The EFL (1973) warned that a system of awarding contracts solely or primarily on the basis of first costs would have dire consequences as the energy crisis intensified and fuel costs rose or became minimally available. In the face of escalating building costs, which had risen dramatically since the late 1960s, the impulse to cut initial costs had a strong appeal for many builders. Invariably, the ill-considered economies saved in the construction phase proved to be more expensive over the long term. Abrahamson (1976) maintained that utilization of life-cycle costing principles had to become automatic in the initial planning of new construction, if energy costs were to be brought under control.

An example of the application of the life-cycle costing concept is illustrated in Figure II-1. In the simplified example, developed by the FEA (1977), four separate criteria were applied to three similar pieces of equipment being considered for purchase. Life-cycle cost analysis was obtained by multiplying the energy and maintenance costs by the lifetime expectancy and then adding the initial cost. This sum was then divided by the lifetime expectancy to arrive at an annual cost of $290 for Brand A, $230 for Brand B and $195 for Brand C.

	Brand Name		
	A	B	C
Initial cost	$500	$600	$700
Lifetime	2 yrs.	3 yrs.	4 yrs.
Maintenance cost per year	$ 15	$ 10	$ 5
Energy cost per year	$ 25	$ 20	$ 15

Figure II-1

Illustration of the Life-Cycle Concept

Source: FEA, 1977.

Three variations of the life-cycle costing technique were identified: (a) benefit-cost analysis, (b) time-to-recoup analysis, and (c) the return-on-investment. A benefit cost analysis was considered appropriate if the goal was to balance the costs, in terms of time and labor, against the benefits, in terms of the time saved, and energy or operational costs (Griffin, 1974). Use of this technique required that all costs or benefits be assigned a numerical (dollar) value and a computed ratio. According to the AIA, a project was seen as economically justified if benefits exceeded costs. A time-to-recoup analysis, or payback method, involved the calculation of the amount of time needed to recoup an original investment through annual operating and maintenance savings. If the calculated time was less than the estimated useful life of the added purchase, the investment was regarded as economically justified. The resultant savings would then be used to pay the interest required to amortize the capital investment loan (EFL, 1973).

One method was seen as being quite useful in comparing energy investments with alternative investments, particularly when borrowed funds were involved. The method, known as the Return-on-Investment (ROI) analysis was used to calculate whether or not the annual savings were sufficient to pay back the principal and interest as well as other annual costs. If the calculated return was significant, it was generally sufficient to undertake the investment (FEA, 1977).

Although life-cycle costing was regarded as an excellent evaluative tool, it also had some disadvantages, if improperly applied. According to the EFL (1973), the most common mistake involved attempts to directly compare initial cash investment with annually incurred costs. It was not accurate, for example, to state that a $100,000 capital investment was paid off in ten years if it cut operating and maintenance costs by $10,000 per year. At 6% interest, it would take more than fifteen years to recoup the initial investment (EFL, 1973). The operating and maintenance costs would had to have been discounted at the 6% rate to accurately reflect the true life-cycle cost.

The Energy Task Force (1977) found that the formulas used to evaluate energy investment opportunities varied from institution to institution. It suggested, however, that in selecting a particular formula, institutions should give prime consideration to (a) their source of funding, (b) existent institutional financial practices, and (c) type of project contemplated.

Results, Measurement and Evaluation

Typically, the success of conservation programs was measured in terms of the results achieved in relation to the stated goals. The assessment of the stated goals, however, was seen as being dependent upon an effective monitoring system that provided for the collection and analysis of pertinent and accurate data. The availability of such data allowed for the reassessment of priorities and gave flexibility to the program. In *Energy Management for Industry*, (1975), the Industrial Power Services Section of the City of Los Angeles emphasized the fact that in addition to being realistic, goals needed to be attainable, measurable and tailored to the needs of the institution.

The Energy Task Force (1977) stressed the need for the collection and analysis of accurate data as the means by which the institution (1) determined priorities for action, (2) monitored and assessed the progress of the program, and (3) discussed energy management problems with energy conservation consultants and others involved in the program. The Energy Task Force indicated that the types of information needed to effectively monitor energy use and consumption included data on (1) primary energy use, (2) conversion efficiency, (3) distribution losses, and (4) energy end-use. Collectively the categories constituted the core of a useful energy baseline.

The Energy Task Force (1977) stated that primary energy use data consisted of information on the type, cost, and quantity of fuel being purchased. Conversion-efficiency data was obtained by determining the effectiveness of a boiler or generator to convert primary fuels into end-use energy. Distribution-loss data consisted of information obtained from an analysis of the energy lost in the electrical and steam distribution networks. End-use data was defined in terms of the number of BTUs or KWhs used annually per square foot. Stenzler (March, 1979) proposed that other indices such as BTU per FTE or BTU per degree day could also be utilized. He recommended, however, that they be objectively evaluated since they would vary from institution to institution. In addition to the mere collection of data, institutions were also urged to chart the data for comparative purposes (FEA Vol. 1,1976).

The FEA (Vol. I, 1976) suggested that building energy audits be conducted only after baseline data had been established for various classifications of building types. Data collected from the audit could then be compared against overall campus energy consumption figures to establish a measure of performance for each building. The FEA (Vol. I, 1976) also suggested the use of functional classification of facilities by category of use, i.e., administrative, academic, residence hall, etc., which could lead to a further refinement of the process and the identification of additional conservation opportunities. By using the data obtained from monthly consumption and energy cost charts, it was believed that large energy users could be identified through an analysis of energy end-use by square foot and functional type of building. The constant review of such data was deemed necessary in order to identify additional ECOs and establish and reevaluate management priorities. The Energy Task Force identified this on-going evaluation process as an evolutionary process incorporating the three stages of conservation program development, Quick-Fix, Refit and Systems-Convert described by the FEA (Vol. I, 1976).

Another recommended step in the measurement and evaluation process involved the determination of energy and monetary savings that could result from a change of priorities in operation, management, or maintenance practices (Stenzler, March, 1979). The Energy Task Force (1977) recommended that the highest priority be given to those conservation measures which afforded the greatest return in energy reduction in the shortest amount of time and at the lowest possible cost.

Basic Building Conservation Practices

Griffin (1974) and others pointed out that, in 1973, buildings consumed more than 33% of the total energy used in the United States. That energy, the equivalent of 10 million barrels of oil per day, was used to heat, power, air condition, and light America's buildings at a time when its oil imports were nearing six million barrels a day (Dubin, Mindell and Bloome, 1975). Experts agreed that the energy consumed in most buildings could be reduced by 30% without impairing the indoor environment. An energy reduction program of that magnitude was estimated to have the effect of cutting U.S. oil imports in half (Dubin, Mindell and Bloome, 1975).

The Energy Task Force (1977) estimated that approximately 73% of the total energy used in campus buildings was consumed by heating, ventilating, and air conditioning (HVAC) systems. Student activity centers, for example, were found to consume 210 thousand BTUs and 15 KWhs per square foot per year, whereas residence halls consumed 115 thousand BTUs and 6 KWhs and academic building 140 thousand BTUs and 15 KWhs (The Energy Task Force, 1977). Opportunities for reducing energy consumption at the end of the typical campus energy chain were seen as having a lot of potential. Based on calculations determined by The Energy Task Force (1977), building temperature setbacks and the shutdown of unoccupied areas were estimated to result in an energy reduction of 10 to 30%. Furthermore, the elimination of the simultaneous heating and cooling of dual duct, reheat, and induction systems was estimated to result in an additional savings of 10 to 20%.

The EFL (1973) estimated that energy consumption for lighting could be reduced at least 25% in new buildings and 15% in existing buildings. Other experts, including the AIA, believed this 25 to 15% reduction range was too conservative and saw a 50% potential reduction in lighting levels in new buildings and 25% in existing buildings (Griffin, 1974; AIA, 1976).

A reduction in lighting levels from 150 foot candles to 50 was estimated to produce not only significant energy cost avoidance figures, but also a reduction in energy consumption of up to 90% (The

Energy Task Force, 1977). Local switching timers, lighting for specific local task instead of uniform general levels, the removal of unnecessary lamps and the use of more efficient lamps were cited as common measures that could effectively reduce energy consumption. Using a base figure of 3¢ per KWh, the FEA (1975) estimated an annual savings of $20.55 or 685 KWhs if two 40 watt fluorescent bulbs were substituted for one 300 watt incandescent bulb.

Preventive maintenance was identified as another major area which could lead to a quick and effective reduction in an institution's energy consumption (EFL, 1973; Griffin, 1974). The EFL (1973) found that the mechanical/electrical share of a school districts construction budget had more than doubled from 20% to 45% since World War II. The necessity of a regular and thorough preventive maintenance program was underscored by the fact that long-term operations and maintenance costs had come to represent a greater expenditure than the initial cost of new construction (EFL, 1973). The importance of maintenance was stressed as an economical approach to energy conservation since it not only increased the efficiency but also prolonged the life of the equipment.

The hiring of competent and qualified maintenance personnel was regarded as essential to an effective preventive maintenance program. It was estimated that a competent energy consultant could reduce the energy consumption in most buildings by 10%, without any conservation measure, merely through a well-scheduled operations and maintenance program (Griffin, 1974). Energy experts agreed that inefficient operating and maintenance procedures resulted in a tremendous waste of energy (Griffin, 1974; EFL, 1973). Faulty steam traps and steam leaks, for example, were seen as constituting an enormous waste of money and energy. The Energy Task Force (1977) estimated the cost of various size steam leaks, at 100 pounds of pressure per square inch, using a value of $3/1000 pounds of steam and a fuel value of $2/1000 BTUs. The amount of steam wasted ranged from roughly 52,000 to 800,000 pounds per month depending on the size of the orifice causing the leak (The Energy Task Force, 1977). Figure II-2 provides data on the cost associated with various size steam leaks.

Size of orifice	Pounds of steam wasted per month	Cost per month
1/2"	835,000	$2,500
3/8"	470,000	$1,400
1/4"	210,000	$ 630
1/8"	52,500	$ 157

Figure II-2

Cost Associated with Various Size Steam Leaks

Source: The Energy Task Force, 1977.

According to Griffin (1974), thermal insulation was one of the basic and generally the most effective measure of reducing energy consumption. The insulation of a building, particularly the roof, was thought to yield the greatest long-term economy of any capital investment in a building.

Energy Management: An Evolutionary Process

The Energy Task Force (1977) defined effective energy management as an evolutionary process consisting of a carefully planned and coordinated program of conservation measures that proceeded from a very rudimentary to an increasing level of sophistication. It was a program that stressed the implementation of obvious conservation steps, the retraining of operations and maintenance personnel and the education of the entire community so that the greatest savings (cost avoidance) at the lowest possible cost could be achieved.

The FEA study (Vol. I, 1976) categorized conservation programs as belonging to one of three basic types: Quick-fix, Refit, or Systems-convert. The Southeast Association of Housing Officers (SEAHO) in their unpublished report (1976) similarly identified three stages of energy conservation programs: Level I, Level II, and Level III. The three levels were comparable to the FEA categories with respect to lead time, energy reduction, capital expenditures, cost avoidance, and types of required equipment.

According to the FEA (Vol. I, 1976), a Quick-fix program was defined as one which employed energy reduction practices that yielded rapid and significant energy savings at minimal or no cost. Quick-fix programs emphasized energy conservation practices of a non-technical nature such as the adjustment of building temperatures or lighting levels. The implementation of such programs generally required very little lead time and were estimated to effectively reduce energy consumption by 10 to 15% or more.

The Energy Task Force (1977) identified seven Quick-fix measures that had been effectively implemented at a number of colleges and universities. Characteristically, these measures had immediate application and involved little or no capital expense.

1. Reduction of lighting levels
2. Temperature setbacks or closing of unoccupied spaces
3. Use of warm-up cycles
4. Reduced ventilation rates
5. Resetting of mixed temperatures (terminal reheat system)
6. Resetting of deck temperatures (dual duct system)
7. Increase in the temperature of the chilled water used in the air handling units

A Refit program was classified as one requiring a moderate amount of lead time and capital expenditures of 25¢ to $1.20 per square foot. Implementation of a program of this nature was intended to reduce energy consumption by 10 to 15% beyond those practices employed in a Quick-fix program. In a Refit program, primary consideration was given to measures which analyzed the types and consumption of energy and the cost effectiveness of any HVAC related equipment (FEA, 1976).

In instituting Refit measures, The Energy Task Force (1977) recommended the use of consultants to analyze proposed engineering modifications. Institutions were cautioned, however, to be particularly sensitive to the need to establish Refit priorities due to the limited amount of funds that were generally available. The Energy Task Force (1977) counted the following among the more effective Refit measures:

1. Adding zone demand reset controls
2. Implementing air volume reductions
3. Using outdoor air for cooling
4. Replacing inefficient outdoor air dampers and damper operators
5. Recirculating exhaust air where practical
6. Isolating off-line chillers
7. Isolating off-line boilers
8. Reducing transmission heat losses and gains
9. Modifying lighting controls, fixtures, and space characteristics

A Systems-convert program was categorized as one which required a substantial amount of capital investment to convert or replace existent energy consuming equipment or systems. It generally involved a long lead time with estimated expenditures ranging from $1.25 to $2.00 per square foot (FEA, Vol. I, 1976). The utilization of Quick-fix and Refit techniques combined with a System-convert approach was expected to result in a reduction of energy usage of 30 to 40% (FEA, Vol. I, 1976). Generally, it was recommended that Systems-convert measures be implemented only after thorough Quick-fix and Refit programs had been undertaken. Primary Systems-convert measures included the use of centralized control systems, heat reclamation systems, and solar energy systems.

Due largely to economic reasons, colleges and universities generally utilized central power plants to generate steam, chilled water and, occasionally, electricity. The selection of a centralized power plant was probably most influenced by the fact that it was estimated to be 10 to 15% more efficient than individualized units (The Energy Task Force, 1977). The efficiency was due largely to the type of equipment used and its internal characteristics. Other advantages of centralized systems included their (1) ability to burn cheaper fuel, (2) engineering design for lower total capacity and greater efficiency than individualized units, and (3) adaptability to automatic or computerized control and maintenance economies (EFL, 1973).

In most cases the implementation of a computerized control system was generally incorporated in the third or Systems-convert phase of an energy conservation program (FEA, Vol. I, 1976). Yale University, for example, opted to install a computerized control system after four years of a successful conservation program. The system, which was to be phased in over ten years, was designed to eventually monitor and control the critical mechanical systems in all major buildings and power plants, log and record management information, remotely respond to specific building needs and quickly diagnose and initiate remedial action for the control of malfunctions (FEA, Vol. I, 1976). The Energy Task Force (1977) recommended that a feasibility study be conducted prior to the purchase or conversion to any computerized control system. Griffin (1974) advocated the use of computerized controls, particularly for new buildings and saw automated control systems as reducing three major sources of waste and high operating costs in conventionally operated HVAC systems: (1) excessive labor; (2) inefficient use of all systems; and (3) expensive repairs.

In addition to computerized control systems, waste heat reclamation and solar energy systems were regarded as Systems-convert technologies. Heat reclamation was regarded as a major method of recycling heat which was normally lost to the atmosphere (Griffin,1974). The recovered waste heat had the capability of being utilized for a portion of the energy normally required for heating, cooling, and hot water systems. Waste heat recovery was seen not only as a method of reducing energy consumption but also as a means of reducing operating and peak load demand costs (The Energy Task Force,1977). Some of the more productive waste heat reclamation techniques identified by the EFL (1973) include

1. Recovery of lighting heat loads
2. Exhaust heat recovery
3. Total or on-site generating plants
4. Heat pumps

Although the technology for heat reclamation systems was available for years, it was not generally considered to be economically feasible due to the low cost of fuels and the long pay back periods necessary to recoup the original investment. The rapid increases in the cost of hydrocarbon fuels in recent years has radically changed the economics of waste heat recovery, particularly with respect to new buildings (Kreider and McNeil (eds.), 1977). The Energy Task Force (1977) cautioned that due to the considerable capital expense, the return on investment for some heat reduction systems was not always as attractive as other types of modifications.

With the dramatic rise in the price of fossil fuels, the use of solar energy had likewise become much more economically attractive. As Griffin (1974) pointed out, solar energy was exactly the opposite of electric heat, if viewed from a life-cycle costing perspective. Electrically generated heat was characterized by low capital costs and high operating costs, whereas solar economics exemplified the reverse. Even though solar energy was free, infinite, and pollution free, the costs of the systems required to capture that energy had relegated them more to a conceptual rather than productive stage (Cook, 1976). Currently, solar energy systems have been used primarily for hot water heating and to a lesser degree space heating. Many experts have predicted that as oil prices continue to escalate, solar energy systems will become economically feasible and cost effective (FEA, 1977).

Lane Community College, when confronted with the choice of instituting a total energy conservation program or passing on the increased costs to students and taxpayers, opted for the former (O'Bannion, February, 1979). The program, implemented at a cost of $300,000 consisted of (1) computerized control of building temperatures, (2) utilization of a heat recovery unit, and (3) the use of hot water storage tanks which permitted boilers to heat water in off hours for use during peak demand periods. The program resulted in a 50% reduction in energy demand, a 30% drop in energy consumption, and a 40% reduction in overall energy costs (O'Bannion, February, 1979).

The Energy Task Force (1977) found that the time frame within which conservation programs developed and achieved the desired results varied, dependent upon a variety of factors, including size of institution, source of funding, availability of trained personnel, and institutional commitment. Energy experts recommended that in the first year of a conservation program, the focus should center on the implementation of Quick-fix measures, the analysis of data, and plans for the development of Refit and Systems-convert options (FEA, 1976; The Energy Task Force, 1977). At the end of the first year, it was recommended that attention be directed towards the implementation of feasible Refit measures along with appropriate Quick-fix measures. It was suggested that the third and fourth years of the program, for certain institutions, be devoted to the study of Systems-convert options. Figure II-3 provides data, developed by The Energy Task Force (1977), which illustrates the percentage of energy reduction and the length of the payback period associated with the implementation of the various programs.

	Energy reduction	Payback period
Quick-fix	10% - 20%	Up to 6 months
Refit	10% - 15%	6 months to 3 years
Systems-convert	10% - 15%	2 years to 5 years
	30% - 45%	

Figure II-3

Summary of Conservation Program Reduction and Payback Characteristics

Source: The Energy Task Force, 1977.

Although some institutions had implemented various stages of energy reduction programs, others expressed concern about the high cost of new construction which emphasized energy conservation features. Santamaria (April, 1977) estimated that it was possible to reduce building energy demands by 20 to 30% without adversely affecting building use or significantly affecting initial construction costs. Santamaria maintained that energy reduction demands could be achieved with the purchase of available off-the-shelf technology and a closer scrutiny of exact design requirements.

Alvin Community College, for example, challenged architects and engineers to constrict energy consumption while tripling the size of the campus (Santamaria, April, 1977). The college's administration wanted to add 200,000 square feet, to handle 4,000 additional students, at a cost of $8 million. By cutting back on non-essential lighting, recapturing waste heat, insulating everything possible and letting energy considerations dictate the size and shape of the building, the institution achieved its goal and a savings of $1 million (Santamaria, April, 1977).

Residence Hall Energy Conservation

Little was found in the way of published research, studies or data relating specifically to residence hall energy conservation programs. One exception was a monthly publication entitled "ACUHO News" published by the Association of College and University Housing Officers. However, it merely mentioned examples of energy conservation practices being utilized in residence halls at specifc institutions. It did not present any detailed research data or findings.

Two unpublished reports by residence hall related professional organizations, the Southeast Association of Housing Officers (SEAHO) and the Association of College and University Housing Officers(ACUHO) were indicative of the concern and responsiveness expressed by residence hall administrators to the growing energy problem and its impact on departmental as well as institutional budgets. The first of these reports entitled "Energy Conservation and Other Cost Reduction Programs" was presented at the annual SEAHO/NACUFS conference at Charleston, South Carolina on February 12, 1976. The report, presented jointly by the housing offices of Florida State University and the University of Kentucky, identified nine major components of conservation programs. These components were listed as follows: need, support, leadership, organization, goals, implementation, evaluation, participation, and preventive maintenance.

The SEAHO (1976) report also listed in its appendix, a pamphlet entitled "How to Start an Energy Conservation Program." The pamphlet, prepared by the Office of Energy Programs, U.S. Department of Commerce (1976), listed three elements of effective conservation programs which were deemed essential by SEAHO and are detailed below.

Component	Rationale
Energy Coordinator	Necessary in order to spearhead and coordinate the program
Energy Audit and Audit Balance Sheet	Needed to determine actual energy usage and to identify the variance between theoretical and actual consumption.
Conservation Goals	Required to establish specific goals for each aspect of the program. Goals should be tough, specific, and measurable.

The second unpublished report, "Energy Conservation Survey Results" (1976), stemmed from a study undertaken by ACUHO's Housing, Facilities, and Service Committee. The study was initiated in 1976 to obtain information on emerging residence hall energy conservation practices among member institutions. One of the more significant findings showed that energy costs represented 20 to 70% of the total housing expense budget for more than half of the 109 institutions surveyed.

Energy experts have maintained that successful and effective conservation programs require the assistance and cooperation of the consumers of energy (Upper Midwest Council, 1974; Executive Office, 1977; SEAHO/NACUFS, 1976). Yet, the ACUHO (1976) survey found that only 42 out of 151 institutions distributed consumer oriented materials on energy conservation to their residents. Seventy-three percent of the institutions had no operational energy conservation program.

In addition to detailing the results of the survey, the ACUHO (1976) report provided numerous examples of energy conservation practices that could be implemented in a residence hall environment. Sections two through seven of the report consisted of copies of materials and energy saving tips utilized in conservation programs at various institutions. The last section of the report contained a sample of an Energy Conservation Program Guide and a host of excellent reference materials.

Successful conservation programs were thought to hinge upon the participative interest of those who volunteered or committed themselves to the program. The University of Wisconsin, in an effort to stimulate and reward conservation efforts, offered monetary awards to residence hall students. The awards were made to the three halls which had lowered their consumption per occupant to the greatest degree for a four-month period (Lattore ed., October,1977). Previous year's consumption data were used as a baseline. Awards of $500,$300, and $200 were given in the form of spending power, with all expenditures being approved by the Housing Office(Lattore ed., October, 1977). The success of the program was attributed to the creation of an atmosphere of concern and awareness among students and staff.

The University of Connecticut, in a study of "Student, Staff, and Faculty Attitudes and Behavior with Respect to Energy Use and Conservation" (1976), concluded that energy conservation implied not only making the most efficient use of available material resources but also soliciting the active cooperation of the energy consuming population in workable programs which they accepted as important. The Connecticut study also stressed the need for a systematic study of the students' attitudes toward existent as well as future energy conservation practices. The results of the student assessment constituted the basis for determining how much cooperation actually existed, how much more cooperation was to be expected and what specific new conservation programs might be easiest to implement. The immediate effect of the student assessment analysis was the establishment of the Dormitory Energy Monitor Program, a student operated program. The program, administered by the Physical Plant, was funded through the Housing Office of the Division of Student Affairs and sponsored by the student Inter-Area Residents Council. Although the program cost $11,000 annually, it achieved its target reduction figure of 5% and saved over $87,000. The program was initially directed towards gaining students' attention and increasing their awareness that there were benefits to be derived. It was the function of each of the ten monitors, who lived in the ten geographic residence hall areas, to encourage, educate, and assist the dormitory residents in the conservation of energy (Students, Staff and Faculty Attitudes,1976).

Kent State University utilized a similar approach and hired students to police the campus to turn off unused lights, ventilating units or other power sources (Sheppard, ed., February, 1976). The Student Housing Office at the University of Hawaii also encouraged student participation and recommended a list of suggestions that all students could utilize to save energy, particularly residence hall students (Underwood, ed., July, 1974). The list contained the following suggestions:

1. Reduce usage of all electrical appliances, equipment, etc.
2. Limit the hours of TV use; turn off TV sets or other electrical appliances whenever not in use.
3. Use no electrical displays or decorative items.
4. Turn off incandescent lights whenever a room is unused.
5. Reduce lighting in corridors, laundry rooms, etc., to a minimum level for safety (every other light for example).
6. Keep refrigerators free of frost build-up; unplug them during vacation periods.
7. Check and clean lint filters in clothes dryers; use cold water detergents in washing machines where possible.
8. Do not take lengthy showers; use less hot water.
9. Be sure all faucets are turned off and not dripping when not in use.

10. Report all water faucets, toilets, showers, etc., needing repair as soon as possible.

11. Walk, ride a bike or take the bus as alternatives to driving.

Concern for rising energy costs prompted The Energy Task Force and the U.S. Steel Foundation to jointly sponsor a college and university Cost Reduction Incentive Awards Program (Sheppard, ed., September, 1977). Institutional programs were judged on the basis of: (1) the program's originality; (2) the cost reduction and/or improvement in services rendered without increased costs; (3) the involvement of members of the campus community (other than administrators); and (4) the feasibility of utilizing the practices or techniques on other campuses. Lane Community College won the grand award of $10,000 while seventeen other institutions were awarded cash prizes ranging from $1,000 to $7,500. The savings accrued to the participating institutions as the result of their programs ranged from $4,000 to $360,000 (Sheppard, ed., September, 1977).

Conservation Practices and Programs

In the last few years, a plethora of articles, books and research studies have focused on ways to conserve the nation's energy. The variety and scope of institutional, industrial and governmental energy conservation practices identified in the review of the literature, made it impractical to list or describe all aspects of the varying programs. Instead of developing an exhaustive or extensive list of possible energy conservation practices, whose application may not be appropriate in particular institutions, the major components of selected conservation programs have been outlined. Data obtained in this research study was generated largely on the basis of questions formulated from the components of the conservation programs outlined below.

Readers interested in identifying specific residence hall energy conservation practices are referred to two unpublished reports, "Energy Conservation Survey Results" (ACUHO, 1976), and "Energy Conservation and Other Conservation Cost Reduction Programs" (SEAHO/NACUFS, 1976). Two other sources that deal exclusively with energy conservation practices and programs in college or university settings are Energy Management for Colleges and Universities (The Energy Task Force, 1977), and a two-volume report by the Federal Energy Administration (1976) entitled "Energy Conservation on Campus." Summaries of the energy conservation programs mentioned in this study are presented in the ensuing portion of this chapter.

Summaries of Energy Conservation Programs

"Energy Conservation on Campus" (FEA, Vol. I, 1976) identified five major components of energy management programs and classified the programs as belonging to one of three specific categories: Quick-fix, Refit, or Systems-convert. The components and rationale established by the FEA included the following.

Component	Rationale
1. Commitment	The enthusiastic support of the chief executive is essential if the program is to be successful since it will assist in gaining the cooperation of campus leaders and assure adherence to energy related policies.

Component	Rationale
2. Energy Conservation Committee	A representative committee is needed to assure campus-wide involvement and work towards the establishment of realistic goals, policies, and methods of evaluating the results.
3. Energy Management Officer	A full-time qualified Energy Management Officer is essential for the coordination of activities of the energy conservation committee and all other aspects of the program.
4. Energy Use and Cost Information	Data relative to (a) overall campus energy use, (b) building energy use, and (c) survey data on the generation and distribution systems are necessary for audit, analysis, and life-cycle costing techniques.
5. Results, Measurement, and Evaluation	Requires that an energy use baseline be established; charting of total energy usage; reduction of energy use figures into a common denomination such as BTUs per square foot; and an analysis of central power plant and individual energy systems.

Energy Management for Colleges and Universities (The Energy Task Force, 1977) provided a comprehensive description of the major technical aspects involved in the development of an institutional energy conservation program. Basic components of an energy conservation program as outlined by The Energy Task Force included:

Component	Rationale
1. Energy Data Base	The accumulation of Primary Energy, Conversion, Efficiency, Distribution, and End-Use Data are deemed essential if an appropriate data base is to be established.
2. Evolutionary Approach to Energy Conservation	Energy management is seen as incorporating the use of a multi-step approach to achieve effectiveness involving three separate energy modification categories: Quick-fix, Refit, and Systems-convert.

Component	Rationale
3. Understanding of Purchased Utilities	Requires an understanding of rate structure, computation of utility bills, power factor, demand control, and record keeping.
4. Finance and Investment	Involves the identification of potential sources of funds for an energy management program and the use of economic analysis such as life-cycle costing.
5. Organizational Incentives	Requires cooperation between all levels of the organization: setting of goals, institutional commitment and support, joint advisory committee, an effective monitoring system, and on-going communications.

In addition to outlining the major components of a program, The Energy Task Force stressed the importance of the following as critical, irrespective of the energy conservation steps undertaken.

1. Careful planning at all stages is required so that a well-conceived and coordinated program will yield the desired results.

2. Accurate data on energy cost and consumption, cost of modifications, and return on investment must be developed so that priorities can be established and performance monitored.

3. An evolutionary approach to energy conservation must be the basis of a program so that obvious waste is quickly and cheaply eliminated prior to moving into modifications which require extensive capital and longer payback periods.

4. Constant review and updating of program plans and progress are critical for maintaining momentum and for identifying further conservation economies.

"Energy Conservation and Other Cost Reduction Programs" is a report which was presented at the annual SEAHO/NACUFS conference in

1976. The report, presented jointly by the housing officers of Florida State University and the University of Kentucky, identified nine major components of conservation programs.

Component	Rationale
1. Need	The purpose and rationale for establishing a conservation program must be understood by all constituents.
2. Support	Management must be committed to the program and must demonstrate its commitment throughout its sphere of responsibility.
3. Leadership	Each level within the institution must have knowledgeable and dedicated people willing to assume responsibility.
4. Organization	The program should be tailored to the specific needs and resources of the institution.
5. Goals	Specific goals and objectives must be realistic, attainable, demanding, and measurable.
6. Implementation	An energy <u>survey</u> must be conducted in all segments of the organization in order to identify ECOs. An energy <u>audit</u> should follow after the survey, initially and at predetermined intervals, in order to ascertain the results of the conservation efforts.
7. Evaluation	Continuously analyze and evaluate survey and audit results along with all other facets of the program.
8. Participation	Promote and maintain maximum involvement of all constituents through publicity/awareness programs.
9. Preventive Maintenance	Develop and implement a preventive maintenance program as an integral part of the institutional maintenance program.

In "Energy Conservation: How to Get Organized," Stenzler (1979) identified five levels of activities that applied to institutions of higher education. The first four levels were essentially analogous to the steps outlined by The Energy Task Force (1977). In his fifth level, Stenzler recommended that the actual drawings of proposed retrofit modifications be drawn up by qualified architects and/or engineers and used as a basis for analysis.

Kruza (1979) stressed the fact that the actual organization of an energy management program should be tailored to the specifics of an individual program. Three of the eleven elements comprising his program which were not specifically mentioned in other programs are outlined below:

1. Launch an energy conservation campaign. Determine what people can and should do to conserve energy. Provide motivation by devising methods which are effective in encouraging people to perform the desired activities. Provide feedback and promote awareness through publicity campaigns.

2. Implement an energy education program. Education should be aimed at teachers as well as students. Get people involved through a "hands on" approach. Consider providing incentives by rewarding schools for their conservation efforts.

3. Formulate contingency plans. Keep abreast of national policies and the local supply picture. Being alert to a change in the local or national energy supply will allow time to seek alternative sources or conversions.

In a research study of energy conservation programs in elementary and secondary schools, the Educational Facilities Laboratory (1973) recommended a three-phase approach in the development of a conservation program. The first phase consisted of an analysis of operational and other energy related subsystems. Phase two focused on the modernization of existent buildings. In this phase, particular attention was paid to those buildings which would require considerable capital and investment in new equipment and in architectural design. Phase three involved the application of life-cycle costing techniques to those buildings in which an analysis of the effectiveness and replacement costs of energy sub-systems were being considered.

Carey (1977) described a program that had easy application to the public school domain and involved an understanding of certain energy related principles and their utilization by energy conscious administrators or managers. Key concepts in this model included an understanding of the flow, uses and sources of energy as well as methods of determining how to identify energy loss.

Anderson (1975), in "The Impact of Energy Crisis on School Finance," advocated that institutions adopt realistic and well thought out procedures to deal with the rigidity of habits, lack of responsible government policies and the fact that current energy costs reflected waste as well as scarcity. In addition, he recommended that administrators encourage the review and, where possible, the revision of existing building codes to make them more energy efficient.

Robinson (1976), in his analysis of industrial energy conservation programs, identified nine components of successful conservation programs. The distinguishing component of his program involved the development of a positive way of thinking about energy and opportunities to reduce consumption.

A monograph, prepared by the Office of the Chief Engineer, Federal Power Commission (1974), entitled "Guidelines for Energy Conservation for Immediate Implementation, Small Business, and Light Industries" cited four basic elements which were deemed essential to short-term efforts to conserve energy. The core elements essentially parallel the suggestions contained in the FEA's Quick-fix method of conserving energy.

Operating largely from a technical perspective, Griffin (1974) described energy conservation opportunities, not in terms of their application to a particular business or institution, but as they related to a building from an architectural or engineering point of view. In addition to recommending the use of life-cycle costing (particularly in regard to new buildings), he cited three conservation opportunities often overlooked in many programs.

1. Citing and orientation of a building. These factors effect air conditioning and heating requirements and thereby energy requirements (a rectangular building positioned in an East-West rather than a North-South direction, uses less energy).

2. Wall shading. Blocking the sun's rays from the surface of a building is a basic, yet largely neglected technique for reducing energy consumption. The planting of deciduous trees along the west wall of a low building provides shade in the summer and admits solar radiation in the winter when heat is beneficial.

3. Envelope design. The building "envelope" (i.e., the building framework and covering) consists of two major factors effecting conservation: (1) thermal insulation (resistance to heat flow),

and (2) heat capacity of materials (absorption of thermal energy). Of all the techniques for reducing energy consumption in buildings, thermal insulation had to be regarded as the most effective and most applicable. It, more so than any other capital investment, was likely to yield the greatest long-term economy.

Dubin, Mindell and Bloome (1975) developed an expanded list of program elements. Operating from an engineering perspective, particularly with respect to the construction of new buildings or facilities, they recommended that serious consideration be given to:

1. The identification of specific climatic conditions to which a building is exposed.

2. An examination of the building's structure, normal use and occupancy of the building and mechanical and electrical subsystems.

3. The identification of the magnitude of annual energy usage by quantity of fuel and electricity for each system.

4. The setting of a "goal" or "target" for reduction in energy usage based upon potential savings for each system.

5. A reduction in the "building loads which must be satisfied by the mechanical and electrical systems.

6. A reduction in thermal losses and the power requirements for the HVAC distribution systems.

7. An improvement in the seasonal efficiency of the primary energy conversion equipment.

Anderson (1977) postulated that management must by the originator of and the establisher of the need for a conservation program. In his view there were three definitive phases to an energy management program: (1) an introductory phase which focused on the initial administrative and organizational commitment to a conservation program, (2) an audit and analysis phase, and (3) an implementation phase consisting of goal development, capital investment requirements and priorities, and review and evaluation.

Summary

The escalating energy costs confronting the nation's colleges and universities were indicative of the energy problems facing the nation as a whole (Bowen, 1975; FEA, 1976; The Energy Task Force, 1977). The U.S. "energy crisis" which had been developing for years stemmed from America's energy wastefulness and its dwindling supply of cheap and easily accessible domestic energy sources (Hatfield, 1979; The Organization for Economic Cooperation, 1976).

Energy experts predicted that the world would continue to rely on fossil fuels for at least the next two decades (Cornish, ed., October, 1977; Kash, 1976) and that regardless of the actions taken, the U.S. would encounter a deepening energy crisis by 1983 (Breckenridge, 1977). The prospects for the development of large scale alternate energy sources that would immediately ameliorate the current crisis were regarded as extremely remote. Most experts agreed that irrespective of potential technological breakthroughs, energy conservation, the prudent and efficient use of currently available fossil resources, represented a viable alternative for the short term as well as the long haul (McKelvey, 1976).

Dubin, Mindell and Bloome (1975) identified six major reasons that went far beyond the effort to save money, that accrued to institutions which utilized energy conservation practices. The EFL (1973) stressed the societal role and obligation incumbent upon institutions of higher education to develop energy conservation programs.

The national and institutional response to escalating energy costs resulted in the development of energy management programs. The complexity and sophistication of conservation programs varied widely. Duga, Malone and Davis (1976) stressed the importance of policy and the necessity of its development along behavior based research. The Executive Office (1977), on the other hand, focused on the specificity and attractiveness of incentives particularly with respect to voluntary conservation programs.

One of the few research studies on energy management programs in higher education was conducted by the FEA in 1976. The study identified five basic elements of effective energy management programs: Commitment; Energy Conservation Committee; Energy Management Officer; Energy Use and Information; and Results, Measurement and Evaluation. The function and role of each of these elements was examined in relation to other management programs. The use of energy audits and life-cycle costing techniques emerged as crucial elements in all major programs (FEA, 1976; The Energy Task Force, 1977; SEAHO, 1976; Griffin, 1974).

A general theme implicit in many of the programs was the evolutionary concept of energy management programs (FEA, 1976; The Energy Task Force, 1977; SEAHO, 1976). The evolutionary process was exemplified by the FEA's (1976) categorization of programs according to ease and cost of implementation: Quick-fix, Refit, and Systems-convert. Examples of how various conservation methods were applied at specific institutions were described.

A review of the literature revealed little in the way of published research on the implementation, extent or effectiveness of residence hall energy conservation programs. Two unpublished reports (SEAHO/NACUFS, 1976; ACUHO, 1976) provided an overview of the types of energy conservation practices some institutions had implemented in their residence halls. Interestingly enough, the ACUHO report (1976), in a survey of its professional member institutions, found that 73% had no operational residence hall energy conservation program.

The complexity of those programs identified in the literature ranged from the simplistic to the highly formalized. The University of Hawaii (Underwood, ed., July, 1974) outlined a simple low cost conservation program based on community awareness techniques of conserving energy. The University of Connecticut study, "Student, Staff and Faculty Attitudes" (1976), provided a detailed description of a comprehensive and effective Dormitory Energy Monitor Program. Active student participation and involvement in all phases of the program were viewed as critical. Monetary or related incentives were seen as crucial for establishing and maintaining student participation in residence hall energy conservation programs at a number of institutions.

The final portion of this chapter was devoted to a listing of important references that could be utilized by residence hall administrators interested in identifying conservation practices applicable for use in a residence hall environment. The major elements of thirteen conservation programs were highlighted and described in the final segment of this chapter.

CHAPTER III

METHODS AND PROCEDURES

The methodology adopted for the collection and use of data for this study included: (1) a review of the literature to identify previously developed applicable research instruments; (2) the development and description of the survey instrument; (3) procedures for developing and establishing validity and reliability for the survey instrument; (4) development of the Conservation Program Elements Index and the Perceived Energy Effectiveness Scale; (5) the selection and description of the research population; (6) survey distribution and follow-up procedures; and (7) procedures for treatment of the data.

Review of the Literature

A survey of the literature was undertaken to identify useful instruments or research designs that had adaptability to the purpose of this study. No such instruments or questionnaires were discovered. The absence of a previously developed and validated survey instrument upon which this study could be patterned, necessitated the development of an original instrument.

Two priorities were established to achieve the goals of this study. The first priority involved a re-examination of the literature to identify research on the organizational or institutional elements of previously developed energy conservation programs. The second priority involved the identification of (a) specific residence hall conservation practices, and (b) the major elements of representative business and industrial energy management programs which had transferability to residence hall operations.

The number of published books, articles, or research relating to the development, implementation, or results of energy conservation programs by institutions of higher education was found to be exceedingly small. With the exception of a two-volume report entitled Energy Conservation on Campus (FEA, 1976) and Energy Management for Colleges and Universities (The Energy Task Force, 1977), this researcher found little published research dealing with energy conservation programs on college and university campuses. Consequently, the above mentioned works which focused on a number of the major components of energy management programs, provided much of the substantive as well as the structural framework in the development of the questionnaire.

Similarly, little was found in the way of published research studies or data relating specifically to residence hall energy conservation programs. One exception was a monthly publication entitled "ACUHO News" published by the National Association of College and University Housing Officers. Another was the "College Business Officer," published by the National Association of College and University Business Officers (NACUBO). The publications, however, merely mentioned examples of energy conservation practices utilized in residence halls at specific institutions without the benefit of any research data or analysis. Two unpublished reports by residence hall-related professional organizations, the Southeast Association of Housing Officers (SEAHO/NACUFS, February, 1976), and the Association of College and University Housing Officers (ACUHO, 1976) were also instrumental in providing direction and substance in the development of the research instrument.

Development of the Survey Instrument

Government, business, and industrial publications were examined to identify conservation programs, or portions thereof, that had applicability to a campus setting. The Federal Power Commission (1974), Dubin, Mindell and Bloome (1975), Anderson (1977), Griffin (1974), Robinson (1977), Kruza (1979), and Stenzler (1979) cited examples of various conservation programs. The programs, in terms of sophistication, ranged from simplistic (The Federal Power Commission, 1974) to comprehensive (Griffin, 1974).

The two-volume FEA (1976) report, along with Energy Management for Colleges and Universities (The Energy Task Force, 1977) and the ACUHO (1976) report, served as basic references in the development of the questionnaire. The development of items in the questionnaire was based largely on information, program elements or energy conservation practices identified in the aforementioned studies.

Due to the interrelationship of residence hall and institutional energy conservation programs, the accumulation of institutional, as well as residence hall, energy data was deemed necessary. Additional questions, focusing on other pertinent characteristics of the institution and its conservation program, were also developed.

The questionnaire consisted of two parts. Part One of the questionnaire briefly explained the purpose, listed definitions, and provided respondents with directions for completing the instrument.

Part Two was divided into four sections, with a series of questions relating to each of the following: Institutional Data and Energy Conservation Programs, Residence Hall Data, Residence Hall Conservation Programs, and Institutional/Residence Hall Written Conservation Policies.

Section I of Part Two was concerned with the accumulation of data on institutional power production, distribution, and control systems; types of energy surveys and audits; and the identification of administrative and technical components of institutional energy conservation programs. Respondents were asked to indicate whether the institution had or had not provided for the specified factor relating to energy consumption.

To obtain data on the effectiveness of the particular administrative and technical elements of conservation programs, an effectiveness rating scale was devised. The rating scale consisted of four Likert-type response categories: (1) unimportant, (2) moderately important, (3) very important, and (4) extremely important. Respondents were asked to indicate the degree of effectiveness for each of the stated elements.

Section II dealt with the collection of data on residence hall facilities, square footage, types of fuel used, and whether or not specific fuel or energy consuming utilities were metered. Questions in this section contained both open-ended and forced choice responses.

Section III of Part Two focused on the accumulation of data on residence hall energy conservation programs. Only those institutions which indicated that a formal residence hall energy conservation program had been implemented were requested to complete Section III. Questions in this section were designed to acquire data which identified the year the program was implemented, the type of program implemented, and the cost of implementation. Data on other program elements, including incentives, recognition of savings, and estimated annual savings were also sought. The compilation of twenty questions, involving fifty-four sub-items, resulted in the development of an original survey instrument, the Residence Hall Energy Conservation Questionnaire (RHECQ). See appendix A.

Development of the Conservation Program Elements Index (CPEI) and the Perceived Energy Effectiveness Scale (PEES)

A primary focus of this study centered on the type and number of components or elements required for an effective energy conservation program. For purposes of this study, elements of energy conservation programs identified in the literature and utilized in the questionnaire were classified as either administrative or technical. Administrative elements were categorized as energy conservation practices that were non-technical in nature and required no technical knowledge to implement. Administrative elements were defined as those conservation practices which emanated from the institution's chief executive officer or conservation committee and could be carried out by most members of the campus community. Technical elements were categorized as energy conservation actions or processes which required technical expertise or knowledge of energy usage or conservation techniques in order for the practice to be implemented. The implementation of technical energy conservation practices was viewed as being largely the responsibility of engineers, energy consultants or technicians and highly skilled maintenance personnel.

An analysis of the previously identified conservation programs revealed varying degrees of sophistication with respect to administrative and technical elements. Nonetheless, a number of factors common to many of the programs were delineated. Guidelines used for the selection of program elements and conservation practices utilized in the development of the survey instrument were based upon the following criteria:

1. The program element had been identified in the literature as part of an effective energy conservation program.

2. The conservation practice was currently utilized in colleges and universities and was regarded as effective.

3. Suggestions made by energy experts consulted during the development of the questionnaire.

Sixteen elements, regarded as essential to an effective energy conservation program, were identified. Each of the elements was selected on the basis of meeting one or more of the stated criteria. Eight of the elements, subsequently classified as administrative, were selected and listed as sub-items in question two of the RHECQ. The following eight elements were used to comprise the Administrative Elements Index (AEI):

1. Support of the institution's chief executive.

2. An energy conservation committee with campus-wide representation.

3. A designated energy management/conservation officer.

4. Built-in conservation incentives/rewards.

5. A set of institutional energy objectives.

6. Checks and controls to assure that objectives are achieved.

7. A system for collecting and analyzing actual energy consumption and cost data for all divisions/departments.

8. A continuing and on-going evaluation system.

The remaining eight elements were classified as technical and listed as sub-items in question three. These eight elements were used to comprise the Technical Elements Index (TEI):

1. A life-cycle costing approach in the design of new facilities and/or purchase of new energy consuming equipment.

2. Improved thermal insulation of existing walls, ceiling, windows, doors, pipes, vents, etc.

3. Installed meters to measure energy consumption in each building.

4. Updated and improved mechanical, electrical and lighting systems.

5. Instituted a comprehensive preventive maintenance program.

6. Installed waste heat reclamation equipment or systems.

7. Installed more efficient mechanical electrical HVAC equipment.

8. Utilized solar energy for heating or cooling.

The AEI and TEI sub-indices were combined to form the Conservation Program Elements Index (CPEI). For each item in the index, respondents were asked to affirm whether or not the specified element was part of the institution's overall energy conservation program.

In addition to indicating whether or not the institution had implemented any of the elements contained in the CPEI, the respondents were also asked to rate each statement (element) according to its degree of importance as an effective conservation element. The following Likert type rating scale was used:

1. unimportant
2. moderately important
3. very important
4. extremely important

The Likert type rating responses to the sixteen (items) elements contained in questions two and three were used to form a Perceived Energy Effectiveness Scale (PEES). The PEES was divided into two sub-scales, the Perceived Effectiveness Administrative (PEA) scale and the Perceived Effectiveness Technical (PET) scale. The items which comprised the two sub-scales corresponded, respectively, to the AEI and TEI sub-indices in the Conservation Program Elements Index (CPEI).

Questionnaire Validity and Reliability

Koenker (1971) and Bartz (1973) stated that the validity of a measuring instrument could be established by a critiquing and revision process utilizing experts in the field. Dillman (1978) defined the critiquing process as a tri-part pre-testing process in which a questionnaire was scrutinized by three distinct groups of people. The initial scrutiny was conducted by a group of colleagues familiar with the purpose of the study and whose function was to evaluate the questionnaire in terms of its ability to achieve the goals of the study. The next step was to have the questionnaire reviewed by a group of potential "users" of the data. The "user's" primary responsibility was to critique the instrument in terms of its substantive or content validity. Dillman (1978) characterized the third group as individuals selected from the population to be surveyed and whose main function was not to identify techniques which would improve the questionnaire's content validity but to identify statements or questions which lacked clarity.

To establish validity for the RHECQ, a critiquing process, analogous to the pretesting process outlined by Dillman (1978), was utilized. The initial draft of the RHECQ was developed on the basis of items identified in the review of the literature and suggestions obtained from selected members of the University of Tennessee's Energy Conservation Committee. Subsequently, the initial draft was submitted to this researcher's dissertation committee for its review and comments on the use of the questionnaire as a means of achieving the goals of the study.

The RHECQ was revised and reviewed by selected experts in the field of energy conservation from the University of Tennessee's Environment Center. These individuals were asked to review, critique and evaluate the questions in regard to their adequacy, appropriateness and relevancy to institutional and residence hall energy conservation programs.

Following a second revision of the RHECQ, arrangements were made to have the instrument critiqued by the seven members of ACUHO's Research and Information Committee. Committee members were mailed a letter describing the nature of the research and the request that they critique the RHECQ from the point of view of a practitioner in the field. Five survey questionnaires were returned which contained useful comments and suggestions. Additional suggestions, made by this researcher's doctoral committee, led to a further and final revision of the RHECQ.

The Kuder-Richardson formula KR-20 was used to determine the reliability for the CPEI and the PEES. In the formula as defined by Sax (1979), n is the number of items in a test; S^2 is the variance of the scores; P is the proportion of individuals responding correctly to each item; and (1-P) is the proportion of the subjects who responded incorrectly to each item. Figure III-1 contains the KR-20 formula, as defined by Sax (1979), used to determine the reliability for the CPEI and PEES.

$$\text{KR-20} = \frac{n}{n-1}\left[\frac{S^2 - \sum P(1-P)}{S^2}\right]$$

Figure III-1

KR-20 Formula Used to Determine Reliability
for the CPEI and PEES

Source: Sax, 1979.

The sixteen-item CPEI had a standard deviation of 3.226 and an alpha coefficient of .75. Reliability coefficients were also computed for each of the sub-indices. The eight-item AEI had a standard deviation of 1.941 and an alpha coefficient of .68. The eight-item TEI had a standard deviation of 1.690 and an alpha coefficient of .52. The results showed the CPEI to have a fairly moderate degree of reliability and the individual sub-indices, AEI and TEI, slightly less.

The sixteen-item PEES had a standard deviation of 4.547 and an alpha coefficient of .89. The eight-item PEA sub-scale had a standard deviation of 2.349 and an alpha coefficient of .78. The eight-item

PET had a standard deviation of 2.557 and an alpha coefficient of .85. In applying the formula to the PEES and its sub-scales, a response was counted as correct if the respondent indicated either a (3) very important or a (4) extremely important. Missing responses, as well as those who indicated a (1) unimportant or a (2) moderately important, were counted as incorrect. The results showed the PEES to have a moderately high degree of reliability and the PEA and PET only slightly less. Due to the fairly high reliability coefficients, both the CPEI and PEES were viewed as reliable instruments for purposes of this study.

Selection and Description of the Research Population

The Association of College and University Housing Officers (ACUHO) is a national organization whose members are devoted to the concerns and effective management of college and university housing facilities. Traditionally, ACUHO has emphasized effective management as a means of upgrading all aspects of its housing operation. Within the last few years, rising utility and escalating energy costs have been a major concern of ACUHO members. Given ACUHO's stated interest in effective management and concern over rapidly rising energy costs, its membership was deemed an appropriate body of study for purposes of this research. The thirty-five institutions listed in ACUHO's "1976 Room and Board Survey Results" were selected to comprise the population for this study. See appendix B. Each institution had an on campus residence hall student population and was listed as a member of ACUHO.

Geographically, the thirty-five institutions were located in twenty-one of the contiguous forty-eight states. Of the four geographic regions of the United States (Northeast, Southeast, Northwest, and Southwest) designated by the Library of Congress classification system in Geography Maps Anthropology Recreation (1976), the Northeast contained the majority (21) of the thirty-five institutions surveyed.

The Comparative Guide to American Colleges (Cass and Birnbaum, 1977) was utilized to obtain institutional data on the research population. With respect to financial support, twenty-two institutions were classified as state-supported while thirteen were classified as independent. Total student enrollment, including graduate and undergraduate figures, ranged from 3,400 to over 50,000 students with the largest number of institutions (9) having between 10,001 and 20,000 students. Eight institutions had enrollments of between 20,001 and 30,000 students and one institution had an enrollment of over 50,000 students.

Institutional residence hall populations ranged from 660 to over 12,000 students. Twelve or 34% of the institutions had residence hall populations of between 2,000 and 3,999 students. Table III-1 illustrates institutional characteristics of the survey population with respect to total enrollment and residence hall population.

TABLE III-1

INSTITUTIONAL AND RESIDENCE HALL POPULATION DATA FOR THIRTY--FIVE ACUHO INSTITUTIONS

Total Enrollment Graduate and Undergraduate	Number of Institutions	Total Residence Hall Population	Number of Institutions
3,400 - 10,000	7	660 - 2,000	6
10,001 - 20,000	9	2,000 - 3,999	12
20,001 - 30,000	8	4,000 - 5,999	8
30,001 - 40,000	7	6,000 - 7,999	1
40,001 - 50,000	3	8.000 - 9,999	3
Over 50,000	1	10,000 - 11,999	3
		Over 12,000	1
Total	35		34*

*Residence hall population figures were not reported by one institution.

Source: Cass and Birnbaum, 1977.

Distribution and Follow-Up

The 1977 ACUHO Directory was used to obtain the names and addresses corresponding to the institutions listed in ACUHO's "1976 Room and Board Survey." The RHECQ and an introductory cover letter were mailed to the chief housing officers at each of the thirty-five selected institutions. The introductory letter explained the purpose of the research study and provided a statement indicating that the research was endorsed by ACUHO's Research and Information Committee. See appendix C.

At the end of the three-week period following the initial mailing of the RHECQ, follow-up letters, along with additional questionnaires and self-addressed return envelopes, were mailed to the chief housing officers who had not responded by the initial deadline. See appendix D. A similar procedure was followed at the end of a second three week period. Telephone contacts were made with those housing officers who had not returned completed questionnaires after receiving the initial and subsequent follow-up letter.

Due to the descriptive nature of this study, a minimum acceptable questionnaire return rate of 60% was established prior to the initial mailing of the questionnaire. Twenty-nine of the thirty-five survey questionnaires were returned. This represented an actual return rate of 83% which was considered acceptable for purposes of this study.

Treatment of the Data

The design and purpose of this study were to gather and analyze descriptive data on college and university institutional and residence hall energy conservation programs. Clark and Schkade (1974) defined descriptive statistics as a method of treating data for the purpose of describing their characteristics and involved no inferences or judgments about a larger set of data other than that which was actually observed. Gibbons (1971) stated that descriptive statistics generally related to the calculation and characterization of a set of data and involved no assumptions or questions as to the legitimacy of techniques.

Prior to coding the data obtained from the questionnaire, information on demographic and institutional characteristics which had not been requested on the RHECQ was compiled for each institution. Raw data obtained from the RHECQ was coded, key punched, and programmed for computer use and analysis. In those instances where questionnaire items were left unanswered, a response code indicating that the question had not been answered was used.

Descriptive rather than inferential statistics were used to analyze the data. The Statistical Package for the Social Sciences (SPSS) (Nie et al., 1975) was utilized to perform the specific statistical calculations.

All of the data were initially analyzed through the use of SPSS subprogram FREQUENCIES. Subprogram FREQUENCIES provided an analysis of each variable in terms of frequency of response, percentages and measures of central tendency.

Analysis of the sixteen-item PEES scale was determined through the use of the Likert Attitude Scale Analysis Program (Kohr, 1974). The LIKRT program was used to obtain the means and standard deviations of the high and low "contrast" group scores for each PEES item.

The services of the Computer Center of The University of Tennessee, Knoxville, were used by key punch and to verify the data.

The services of the Computation Center of The Pennsylvania State University, University Park, were used to statistically analyze the data.

Summary

A review of the literature did not prove useful in identifying previously utilized instruments or research designs upon which this study could be patterned. Consequently, an original instrument, the Residence Hall Energy Conservation Questionnaire (RHECQ), was developed. The methodology used to develop the instrument as well as a description of the instrument was outlined. The instrument's validity was ascertained according to a method outlined by Dillman (1978). Kuder-Richardson's formula KR-20 was used to determine the reliability for the CPEI and PEES. The LIKRT program was used to analyze variables comprising the PEES. A description of the research population, questionnaire distribution and follow-up procedures were outlined. The last section of this chapter dealt with an explanation of the procedures used to transcribe and analyze the data.

CHAPTER IV

ANALYSIS OF THE DATA

The primary focus of this study was to identify energy conservation practices that would contribute to the development of an effective residence hall energy conservation program. The study was intended to be descriptive in nature and sought to gather data on institutional energy conservation practices, power facilities and distribution systems, residence hall facilities and energy conservation practices and programs. The data presented in this chapter were collated from the questionnaires of twenty-nine of the thirty-five ACUHO related institutions surveyed in this study.

This chapter is divided into four sections. The four sections are devoted to a presentation of the data relating to four of the five questions which directed this study. The fifth question, which concerns recommendations that could be advanced to improve the utilization of energy in college and university residence halls, is addressed in Chapter V. The questions which directed this study are:

1. What are the major elements or components of established and effective energy conservation program?

2. How effective are the previously identified conservation elements or components in a college or university energy conservation program?

3. What are the types and characteristics of residence hall energy conservation programs?

4. What types of incentives are incorporated in residence hall conservation programs?

The four sections of this chapter are devoted to a presentation and analysis of the data relating to: (1) the variables (elements) comprising he Conservation Program Elements Index (CPEI) and its sub-indices, the Administrative Elements Index (AEI) and the Technical Elements Index (TEI); (2) the variables comprising the Perceived Energy Effectiveness Scale (PEES) and its sub-scales Perceived Effectiveness, Administrative (PEA) and Perceived Effectiveness, Technical (TEI); (3) the types and characteristics of residence hall energy conservation programs, and (4) the types of incentives incorporated in residence hall energy conservation programs.

Question One: What are the Major Elements of Established and Effective Energy Conservation Programs?

The Conservation Program Elements Index (CPEI) was comprised of sixteen conservation elements identified in the literature as essential elements of effective energy conservation programs. The CPEI consisted of an eight-item Administrative Elements Index (AEI) and an eight-item Technical Elements Index (TEI). The elements in the sub-indices which comprised the CPEI are listed below:

Administrative Elements Index (AEI)

1. Support of the institution's chief executive.
2. An energy conservation committee with campus-wide representation.
3. A designated energy management/conservation officer.
4. Built-in conservation incentives/rewards.

5. A set of institutional energy objectives.

6. Checks and controls to assure that objectives are achieved.

7. A system for collecting and analyzing actual energy consumption and cost data for all divisions/departments.

8. A continuing and on-going evaluation system.

Technical Elements Index (TEI)

1. A life-cycle costing approach in the design of new facilities and/or purchase of new energy consuming equipment.

2. Improved thermal insulation of existing walls, ceiling, windows, doors, pipes, vents, etc.

3. Installed meters to measure energy consumption in each building.

4. Updated and improved mechanical, electrical and lighting systems.

5. Instituted a comprehensive preventive maintenance program.

6. Installed waste heat reclamation equipment or systems.

7. Installed more efficient mechanical electrical HVAC equipment.

8. Utilized solar energy for heating or cooling.

The CPEI and its AEI and TEI sub-indices were analyzed on the basis of the number of affirmative or negative responses to each of the elements (variables) in the index. An affirmative response indicated that the element was utilized or incorporated in an institutional conservation program.

Analysis of Conservation Program Elements
Index (CPEI) Response Data

The data showed that ten or 62% of the CPEI elements were utilized or incorporated in a conservation program by at least 55% of the institutions. Three of the elements "conservation incentives," "waste heat" and "solar energy" were utilized by less than 25% of the institutions.

When the eight administrative elements in the AEI sub-index were examined, the data showed that five of the elements, "executive support," "conservation officer," "energy objectives," "collecting cost data" and "evaluation system" were utilized by at least 58% of the institutions. "Support of the institution's chief executive" was the most commonly cited element with a 93.1% affirmative response rate. "Built-in conservation incentives/rewards," with a 13.8% affirmative response rate was the least utilized element. Table IV-1 illustrates the response data to the eight elements comprising the AEI sub-index.

Analysis of the eight-element TEI showed an overall lower affirmative response rate than the AEI. Only four of the TEI elements, "life-cycle costing," "thermal insulation," "improved mechanical systems" and "preventive maintenance program" had an affirmative response rate of 62% or more. "Updated and improved mechanical, electrical and lighting systems" was the most commonly utilized element with a 79.3% affirmative response rate. "Waste heat reclamations systems" with a 24.1% affirmative response rate and "solar energy" with a 6.9% affirmative response rate were the least utilized

TABLE IV-1

NUMBER AND PERCENT OF RESPONSES TO THE ADMINISTRATIVE ELEMENTS INDEX (AEI) OBTAINED BY ACUHO RELATED INSTITUTIONS IN THE SPRING OF 1978

Questions	Response			
	Yes	%	No	%
The institution's energy conservation program has:				
1. The support of the institution's chief executive.	27*	93.1	1*	3.4
2. An energy conservation committee with campus-wide representation.	14	48.3	15	51.7
3. A designated energy management/ conservation officer.	23	79.3	6	20.7
4. Built-in conservation incentives/ rewards.	4	13.8	25	86.2
5. A set of institutional energy objectives.	17*	58.6	11*	37.9
6. Checks and controls to assure that objectives are achieved.	16	55.2	13	44.8
7. A system for collecting and analyzing actual energy consumption and cost data for all divisions/departments.	19	65.5	10	34.5
8. A continuing and on-going evaluation system.	21	72.4	8	27.6

N = 29

*Based on total N of 28.

elements. Table IV-2 illustrates response data to the eight elements comprising the TEI.

The elements in each of the sub-indices were rank ordered to obtain a graphic display of an element's position in relation to the other elements. "Executive support," "conservation officer" and "evaluation system" were, respectively, the highest ranked AEI elements. "Conservation incentives" and "conservation committee were, respectively, the lowest ranked elements. The three highest ranked TEI elements were respectively, "improved systems," "thermal insulation" and "preventive maintenance." "Solar energy" followed by "waste heat" were the lowest ranked elements. Highest affirmative response rate formed the basis for the rankings which are illustrated in Table IV-3.

Discussion

An important consideration in any conservation program is the cost associated with the implementation of the various elements of the program. The decision to include specific elements of a program is often dictated by the amount of funds available. While there are costs associated with the implementation of administrative elements of a conservation program, they are generally considerably less in comparison with the more costly technical elements. Experts have recommended that the ultimate decision, as to which specific administrative or technical elements to include in an institutional conservation program, should be based on a life-cycle costing analysis and used within the context of an evolutionary approach to energy conservation.

TABLE IV-2

NUMBER AND PERCENT OF RESPONSES TO THE TECHNICAL ELEMENTS INDEX (TEI) OBTAINED BY ACUHO RELATED INSTITUTIONS IN THE SPRING OF 1978

Questions	Response			
	Yes	%	No	%
The institution has:				
9. Used a life-cycle costing approach in the design of new facilities and/or purchase of new energy consuming equipment.	18*	62.1	10*	34.5
10. Improved thermal insulation of existing walls, ceilings, windows, doors, pipes, etc.	20	69.0	9	31.0
11. Installed meters to measure energy consumption in each building.	13	44.8	16	55.2
12. Updated and improved mechanical, electrical and lighting systems.	23**	79.3	4**	13.8
13. Instituted a comprehensive preventive maintenance program.	20	69.0	9	31.0
14. Installed waste heat reclamation equipment or systems.	7	24.1	22	75.9
15. Installed more efficient mechanical /electrical HVAC equipment.	13*	44.8	15*	51.7
16. Utilized solar energy for heating or cooling.	2*	6.9	26*	89.7

N = 29

*Based on total N of 28.

**Based on total N of 27.

TABLE IV-3

RANK ORDERING OF THE VARIABLES IN THE ADMINISTRATIVE AND TECHNICAL ELEMENTS INDICES ON THE BASIS OF AFFIRMATIVE RESPONSES OBTAINED BY ACUHO RELATED INSTITUTIONS IN THE SPRING OF 1978

AEI				TEI			
Element	N	Affirmative response	%	Element	N	Affirmative response	%
Executive support	28	27	93.1	Improved systems	27	23	79.3
Conservation officer	29	23	79.3	Thermal insulation	29	20	69.0
Evaluation system	29	21	72.4	Preventive maintenance	29	20	69.0
Cost data	29	19	65.5	Life-cycle costing	28	18	62.1
Energy objectives	28	17	58.6	Installed meters	29	13	44.8
Checks and controls	29	16	55.2	Efficient HVAC equipment	28	13	44.8
Conservation committee	29	14	48.3	Waste heat	29	7	24.1
Conservation incentives	29	4	13.8	Solar energy	28	2	6.9

The data showed that, on a percentage basis, institutions utilized more administrative (AEI) elements than they did technical (TEI) elements. This finding suggested that institutions had, to date, focused more attention on administrative elements than technical elements. One explanation for this finding may be that administrative elements were less costly. Another may be that administrative elements were more easily implemented than technical elements.

When the AEI elements were ranked on the basis of the number currently utilized in an institutional conservation program, the data showed that "executive support," "conservation officer," "evaluation system," and "cost data" were, respectively, the highest ranked elements. The lowest ranked elements were "conservation incentives" and "conservation committee." Collectively, the four top ranked elements were, in a technical sense, inherently more administrative than the lowest ranked elements. These findings suggested that institutional energy conservation programs were highly centralized and administrative in nature. However, there appears to be a need to examine and evaluate the role and function of energy conservation committees and incentives.

When the TEI elements were ranked on the basis of the number currently utilized in an institutional conservation program, the data showed that "improved mechanical, electrical and lighting systems," "thermal insulation," "comprehensive preventive maintenance" and "life-cycle costing" were, respectively, the highest ranked elements. The two lowest ranked elements,"waste heat" and "solar energy" were also the least utilized. The top six ranked TEI elements were also the more commonly utilized and understood technologies, whereas the two lowest ranked elements were relatively new technologies that had only recently garnered attention and support. Parenthetically, they were also the elements, particularly solar, which could only be implemented at considerable expense. This may account for the fact that relatively few institutions had actually implemented these elements.

Number and Percent of Institutional Scores Obtained on the Conservation Program Elements Index (CPEI)

The range of scores for the CPEI was 1 to 14 out of a possible 16 with a mean of 8.86 and a standard deviation of 3.22. The range of scores for the AEI was 0 to 7 out of a possible 8, with a mean of 4.86 and a standard deviation of 1.94. The range of scores for the TEI was 1 to 7, out of a possible 8, with a mean of 4.0 and a standard deviation of 1.69. Table IV-4 illustrates data on the distribution of institutional scores for the CPEI and the AEI and TEI sub-indices.

Question Two: How Effective are the Previously Identified Conservation Elements in a College or University Energy Conservation Program?

Frequency Response, Means and Standard Deviations of the Perceived Energy Effectiveness Scale (PEES) Variables

The sixteen-item PEES scale contained two eight item sub-scales, the Perceived Energy, Administrative (PEA) scale and the Perceived Energy, Technical (PET) scale. A Likert type response scale of four categories was used to measure the respondent's perception of the effectiveness of the listed (elements) variables comprising the CPEI. Respondents were asked to rate each variable in terms of its importance as an effective conservation practice. The response categories were

TABLE IV-4

NUMBER AND PERCENT OF INSTITUTIONAL SCORES OBTAINED ON THE CONSERVATION PROGRAM ELEMENTS INDEX (CPEI) AND ITS ADMINISTRATIVE (AEI) AND TECHNICAL (TEI) SUB-INDICES BY ACUHO RELATED INSTITUTIONS IN THE SPRING OF 1978

CPEI			AEI			TEI		
Score	N	%	Score	N	%	Score	N	%
1	1	3.4	0	1	3.4	1	3	10.3
4	2	6.9	2	2	6.9	2	2	6.9
5	1	3.4	3	5	17.2	3	6	20.7
6	3	10.3	4	5	17.2	4	7	24.1
7	3	10.3	5	2	6.9	5	5	17.2
8	3	10.3	6	6	20.7	6	4	13.8
9	2	6.9	7	8	27.6	7	2	6.9
10	4	13.8		29	100.0		29	100.0
11	4	13.8						
12	2	6.9						
13	2	6.9						
14	2	6.9						
	29	100.0						
Mean 8.862	SD 3.226		Mean 4.862	SD 1.941		Mean 4.0	SD 1.690	
Median 9.250	Mode 10.0		Median 5.250	Mode 7.0		Median 4.0	Mode 4.0	

(1) unimportant, (2) moderately important, (3) very important, and (4) extremely important.

PEA response data. The average mean response for the eight item PEA was 3.01. The means ranged from a high of 3.54 for "conservation officer" to a low of 2.42 for "conservation committee." The standard deviations ranged from a high of 1.08 for "conservation incentives" to a low of 0.67 for "conservation officer." The mode was 3.0. Three of the variables, "executive support," "conservation officer" and "energy objectives" had a mode of 4.0. "Conservation committee" had a mode of 2.0.

The variables "executive support" and "conservation officer" were the highest rated elements and designated as extremely important by 48.3% of the respondents. The variable "conservation incentives" was the lowest rated element and designated as unimportant by 13.8% of the respondents. However, when the unimportant and moderately important categories were combined, "conservation committee" was found to be the least important variable. Table IV-5 provides a summary of the response data, the means and standard deviations for the variables contained in the PEA.

PET response data. The average mean response for the eight item PET was 2.97. The means ranged from a high of 3.40 for "improved systems" to a low of 2.26 for "solar energy." The standard deviations ranged from a high of 1.03 for "installed meters" to a low of 0.64

TABLE IV-5

PERCENT OF FREQUENCY RESPONSE, BY DEGREE OF IMPORTANCE, OF THE VARIABLES IN THE PERCEIVED EFFECTIVENESS, ADMINISTRATIVE (PEA) SCALE OBTAINED BY ACUHO RELATED INSTITUTIONS IN THE SPRING OF 1978

Element	Unimport. (1)	%	Mod. Import. (2)	%	Very Import. (3)	%	Extrem. Import. (4)	%	N Missing	Mean	Mode	SD
1. Executive	1	3.4	4	13.8	8	27.6	14	48.3	2	3.29	4	0.86
2. Committee	2	6.9	10	34.5	7	24.1	2	6.9	8	2.42	2	0.81
3. Officer	0	0.0	2	6.9	6	20.7	14	48.3	7	3.54	4	0.67
4. Incentive	4	13.8	5	17.2	7	24.1	6	20.7	7	2.68	3	1.08
5. Objectives	2	6.9	4	13.8	7	24.1	10	34.5	6	3.08	4	0.99
6. Checks	1	3.4	4	13.8	11	37.9	8	27.6	5	3.08	3	0.83
7. Data	2	6.9	6	20.7	11	37.9	8	27.6	2	2.92	3	0.91
8. Evaluation	1	3.4	4	13.8	13	44.8	8	27.6	3	3.07	3	0.79

N = 29

for "improved systems." The mode was 4.0. Four of the variables, "life-cycle costing," "improved systems," "preventive maintenance" and "efficient HVAC equipment" had a mode of 4.0. Two variables "waste heat" and "solar energy" had a mode of 2.0.

The variable "improved systems" with a mean of 3.40 was the highest rated PET element and designated as extremely important by 41.4% of the respondents. The variable "solar energy" was found to be the lowest rated element and designated as unimportant by 13.8% of the respondents. Table IV-6 provides a summary of the response data, the means, and standard deviations for the PET variables.

Rank order of the PEA and PET variables. A variable score for each of the variables contained in the PEA and PET sub-scales was computed by summing across the twenty-nine institutional responses to each variable. The variables were rank ordered on the basis of highest total score. The mean scores for the eight item PEA and PET scales were 72.6 and 67.1 respectively. The variable score range for the PEA was 39 and 43 for the PET. The results of the ranking for the eight item PEA and PET scales are listed in Table IV-7.

PEES institutional scores. A PEES score for each institution was obtained by summing the instituion's responses to each of the variables in the scale. The maximum possible score was 64 (4, the highest possible response value, multiplied by 16, the number of variables in the scale). The maximum score for each of the sub-scales was 32.

TABLE IV-6

PERCENT OF FREQUENCY RESPONSES, BY DEGREE OF IMPORTANCE, OF THE VARIABLES IN THE PERCEIVED EFFECTIVENESS, TECHNICAL (PET) SCALE, OBTAINED BY ACUHO RELATED INSTITUTIONS IN THE SPRING OF 1978

Element	Unimport. (1)	%	Mod. Import. (2)	%	Very Import. (3)	%	Extrem. Import. (4)	%	N Missing	Mean	Mode	SD
1. Costing	1	3.4	2	6.9	8	27.6	10	34.5	8	3.28	4	0.84
2. Insulation	0	0.0	7	24.1	11	37.9	7	24.1	4	3.00	3	0.76
3. Meters	3	10.3	5	17.2	8	27.6	8	27.6	5	2.87	3	1.03
4. Improved	0	0.0	2	6.9	11	37.9	12	41.4	4	3.40	4	0.64
5. Maintenance	1	3.4	2	6.9	9	31.0	11	37.9	6	3.30	4	0.82
6. Waste	2	6.9	8	27.6	8	27.6	3	10.3	8	2.57	2	0.87
7. Efficient	1	3.4	4	13.8	7	24.1	9	31.0	8	3.14	4	0.91
8. Solar	4	13.8	8	27.6	5	17.2	2	6.9	10	2.26	2	0.93

N = 29

TABLE IV-7

RANK ORDERING OF THE VARIABLES IN THE PERCEIVED EFFECTIVENESS, ADMINISTRATIVE (PEA) AND PERCEIVED EFFECTIVENESS, TECHNICAL (PET) SCALES, BY SUM OF VARIABLES SCORES, ON DATA OBTAINED FROM ACUHO RELATED INSTITUTIONS IN THE SPRING OF 1978

PEA		PET	
Element	Sum of scores	Element	Sum of scores
1. Executive support	89	Improved systems	85
2. Evaluation system	80	2. Preventive maintenance	76
3. Conservation officers	78	3. Thermal insulation	75
4. Checks and controls	74	4. Life-cycle costing	69
5. Energy objectives	71	5. Installed meters	69
6. Cost data	69	6. Efficient HVAC equipment	66
7. Conservation incentives	69	7. Waste heat	54
8. Conservation committee	51	8. Solar energy	43

$\overline{X} = 72.6$ $\overline{X} = 67.1$

The PEES institutional scores ranged from a low of 2 to a high of 62. The mean score for all institutions was 41.4 with a standard deviation of 14.13. The range for the PEA and PET sub-scales was 31. The mean score for the PEA was 21.57 with a standard deviation of 7.14. The mean score for the PET was 19.89 with a standard deviation of 8.42. Table IV-8 shows the frequency distribution of institutional scores on the PEES, PEA and PET.

Discussion

The average mean response for the five PEA variables, "executive support," "conservation officer," "energy objectives," "checks and controls" and "evaluation system" was 3.21. The rather high average mean response suggested that the five variables were perceived to be, at least, very important as effective energy conservation program elements. Three of the variables "conservation incentives," "energy objectives" and "cost data" had standard deviations greater than .90. Standard deviations of this magnitude indicated that there was a lack of consistency as to the perceived importance of the three elements as effective elements in a conservation program.

On the basis of mean scores, five of the PET variables, "life-cycle costing," "thermal insulation," "improved system," "preventive maintenance" and "efficient HVAC equipment," were perceived to be, at least, very important as effective elements of an energy conservation program. The average mean response for the five variables was 3.22. With the exception of "installed meters," "solar energy" and "waste heat," the responses had a moderately high degree of homogeneity. The high degree of homogeneity suggested that the respondents were fairly

TABLE IV-8

NUMBER AND PERCENT OF INSTITUTIONAL SCORES OBTAINED ON THE PERCEIVED ENERGY EFFECTIVENESS SCALE (PEES) AND ITS PEA AND PET SUB-SCALES BY ACUHO RELATED INSTITUTIONS IN THE SPRING OF 1978

PEES			PEA			PET		
Score	N	%	Score	N	%	Score	N	%
2	1	3.4	0	1	3.4	0	2	6.9
6	1	3.4	6	1	3.4	2	1	3.4
21	1	3.4	12	1	3.4	9	1	3.4
28	1	3.4	14	1	3.4	12	1	3.4
29	2	6.9	15	1	3.4	14	1	3.4
32	2	6.9	16	1	3.4	15	1	3.4
39	1	3.4	19	3	10.3	16	2	6.9
42	1	3.4	20	2	6.9	19	1	3.4
45	3	10.3	22	1	3.4	22	2	6.9
46	3	10.3	23	6	20.7	23	6	20.7
47	3	10.3	24	1	3.4	24	2	6.9
48	3	10.3	25	2	6.9	25	3	10.3
49	2	6.9	26	1	3.4	26	1	3.4
54	1	3.4	28	3	10.3	27	1	3.4
55	1	3.4	29	2	6.9	28	2	6.9
56	1	3.4	31	2	6.9	29	1	3.4
58	1	3.4		29	100.0	31	1	3.4
62	1	3.4					29	100.0
	29	100.0						
Mean 41.41		SD 14.13	Mean 21.51		SD 7.14	Mean 19.89		SD 8.42
Median 46.00		Mode 45.00	Median 22.91		Mode 23.00	Median 22.91		Mode 23.00

consistent in rating the importance of the variables as effective energy conservation elements.

On the average, the PEA variables had a higher total score than did the PET variables. Institutions tended to perceive administrative elements (PEA) as more effective than technical elements (PET). The data showed the PEA variables "executive support," "evaluation system," "conservation officer," "checks and controls" and "energy objectives" to be the top ranked elements with minimum scores of 70. Only three PET variables, "improved systems," "preventive maintenance" and "thermal insulation" had scores greater than 70. "Conservation incentives" with a score of 69 and "conservation committee" with a score of 51 were the lowest ranked PEA variables. The lowest ranked PET variables were "waste heat" with a score of 54 and "solar energy" with a score of 43.

Item Analysis of the Variables Comprising the Perceived Energy Effectiveness Scale (PEES) Variables

The means and standard deviations for each PEES variable were obtained through an item analysis (Kohr, 1974). The statistics were computed for each item by comparing the scores of the highest 27% of the respondents (high "contrast" group) versus the scores of the lowest 27% of the respondents (low "contrast" group). The low "contrast" group which contained seven scores had a mean of 42.00, whereas the high "contrast" group, which contained six scores, had a mean of 55.83. The average item mean for the PEES was 3.022. The means and standard deviations for the PEES variables are shown in Table IV-9.

TABLE IV-9

MEANS AND STANDARD DEVIATIONS DERIVED FROM AN ITEM-ANALYSIS OF THE PERCEIVED ENERGY EFFECTIVENESS SCALE VARIABLES, BASED ON HIGH-LOW CONTRAST GROUPS' SCORES ON DATA OBTAINED FROM ACUHO RELATED INSTITUTIONS IN THE SPRING OF 1978

Element	Group	Mean	SD
1. Executive	Low	3.000	.816
	High	3.667	.516
2. Committee	Low	2.143	.378
	High	3.000	.632
3. Officer	Low	3.000	.577
	High	3.833	.408
4. Incentives	Low	1.714	.756
	High	3.667	.516
5. Objectives	Low	2.714	.756
	High	3.667	.516
6. Checks	Low	2.571	.535
	High	3.833	.408
7. Data	Low	2.571	.976
	High	3.500	.548
8. Evaluation	Low	2.714	.488
	High	3.500	.548
9. Costing	Low	3.000	1.155
	High	3.667	.516
10. Insulation	Low	2.857	.690
	High	3.167	.753
11. Meters	Low	2.571	1.134
	High	3.667	.516
12. Improved	Low	3.143	.690
	High	4.000	.000
13. Maintenance	Low	3.143	.378
	High	4.000	.000
14. Waste	Low	2.286	.488
	High	2.500	1.049
15. Efficient	Low	2.571	.787
	High	3.667	.516
16. Solar	Low	2.000	.816
	High	2.500	1.049

N = 20 N of item = 16 N of response categories = 4

Discussion

The PEES was designed to ascertain the perceived effectiveness of specific conservation elements. A high degree of variability in the response of either the high or low "contrast" group indicated a lack of consensus as to the degree of importance of the element as an effective conservation practice. Low variability in the scores of the contrast groups indicated homogeneity of response as to the effectiveness or non-effectiveness of the element in a conservation program.

Seven of the eight PEA high "contrast" group items had standard deviations of less than 0.550. "Committee" was the only item in the PEA high "contrast" group that had a standard deviation above 0.630. There was greater variability among the standard deviations for the low "contrast" group items, with standard deviations ranging from 0.378 ("committee") to 0.976 ("data") than there was, as indicated, among the high "contrast" group.

Two of the eight PET high "contrast" group items ("waste" heat and "solar" energy) had standard deviations of 1.0 or higher. Two of the low "contrast" group items (life-cycle "costing" and installed "meters") had standard deviations of 1.0 or higher.

The data indicated that although there was some variability in the responses of the "contrast" groups, the groups tended to be consistent in rating the elements as either effective or ineffective. When the PEES elements were analyzed in relation to their inclusion in the sub-scales (PEA and PET), the data indicated that there was greater agreement among the PEA "contrast" groups than there was among the PET "contrast" groups.

Question Three: What are the Types and Characteristics of Residence Hall Energy Conservation Programs?

The data showed that only 11 or 37.9% of the responding institutions reported the existence of a formalized residence hall energy conservation program. Nine of the institutions had residence hall energy conservation programs which were implemented during the years 1972-77, with three each in the years 1973 and 1975. Residence hall conservation programs at two other institutions were implemented prior to 1972.

Three types of conservation programs were identified: Quick-fix, Refit and Systems-convert. When categorized according to type of program, the data showed that 5 or 45.4% of the housing departments had implemented Quick-fix programs, 2 or 18.2% Refit programs and 4 or 36.4% a combination of Quick-fix, Refit and Systems-convert. Three or 27.3% of the institutions indicated that administrators were the primary group of individuals involved in the establishment of objectives for the conservation programs. The combination of administrators, staff and students formed the second largest group of people involved in establishing program objectives. There was no faculty involvement in the establishment of objectives. Table IV-10 shows the response data for groups involved in the establishment of program objectives and types of programs implemented.

The combined factors "ease of implementation" and "minimum cost," were the factors which influenced the majority (27.3%) of the housing departments in the selection of a particular residence hall conservation program. Two or 18.2% of the respondents indicated that the combined factors of "trained personnel" and "little or no cost to

TABLE IV-10

NUMBER AND PERCENT OF CONSERVATION PROGRAMS, BY TYPE AND GROUPS INVOLVED IN ESTABLISHING PROGRAM OBJECTIVES OF RESIDENCE HALL CONSERVATION PROGRAMS, OBTAINED BY ACUHO RELATED INSTITUTIONS IN THE SPRING OF 1978

Types of programs	N	%	Groups involved in establishing objectives	N	%
1. Quick-fix	5	45.5	1. Administrators	3	27.3
2. Refit	2	18.2	2. Administrators and staff	1	9.1
3. Quick-fix and refit	3	27.3	3. Administrators, staff and students	2	18.1
4. Quick-fix, refit and systems-convert	1	9.1	4. Administrators and engineers	1	9.1
	11	100.0	5. Administrators and students	1	9.1
			6. Maintenance department	1	9.1
			7. Administrators, staff, students and in-house energy teams	1	9.1
			8. Missing	1	9.1
				11	100.0

implement" were the major determinants in the selection of the department's program. Two other respondents indicated that all four factors were determinants which influenced the selection of the department's program. "Long-term maintenance" was identified by one respondent as an additional factor which influenced the selection of the department's program. Another respondent indicated that "moral implications" was a major factor.

The data showed that 6 or 54.5% of the respondents provided estimated cost figures incurred with the development of residence hall conservation programs. The range of cost estimates was from "small or minimal" to $300,000, with the majority (27.3%) designated as small or minimal. Table IV-11 shows data on the factors and costs involved in the selection and development of the programs.

Data were also gathered on the estimated annual savings attributable to the conservation programs during the years 1972 to 1977. The amount of savings ranged from unknown to $1,300,000 which were cumulative savings during a three-year period. Given the type of data responses, no attempt was made to provide additional measures of central tendency. Table IV-12 illustrates the data pertaining to estimated savings per year for the nine institutions with residence hall energy conservation programs.

Discussion

The existence of only eleven specific individual residence hall energy conservation programs suggested that the majority of housing departments, for one reason or another, relied on institutional conservation programs to reduce energy consumption in the residence halls.

TABLE IV-11

NUMBER AND PERCENT OF FACTORS AND COSTS WHICH INFLUENCED THE SELECTION OF RESIDENCE HALL CONSERVATION PROGRAMS BY ACUHO RELATED INSTITUTIONS IN THE SPRING OF 1978

Factors	N	%	Costs	N	%
1. Ease of implementation	1	9.1	1. Small/minimal*	3	27.4
2. Little or no cost	1*	9.1	2. $5,000	1	9.1
3. Availability of technology and equipment	1	9.1	3. $15,000	1	9.1
4. Ease of implementation and no cost	3	27.4	4. $20,000	1	9.1
5. Availability of technology and trained personnel	2	18.1	5. $300,000	1	9.1
			6. Missing	4	36.2
				11	100.0
6. Ease, technology, no cost and personnel	2**	18.1			
7. Missing	1	9.1			
	11	100.0			

One respondent added:

*An additional factor of "long term maintenance"

**An additional factor of "moral implications"

*Less than $3,500

TABLE IV-12

ESTIMATED ANNUAL SAVINGS FROM RESIDENCE HALL ENERGY CONSERVATION PROGRAMS BASED ON DATA OBTAINED FROM NINE ACUHO RELATED INSTITUTIONS IN THE SPRING OF 1978

Institution	Years 1973	1974	1975	1976	1977
1				$20,000	$20,000
2			*	*	*
3	**	**	**	**	**
4		***	***	***	
5			10%	20%	5%
6	$12,000	$11,500	$13,000	$14,500	$16,000
7		*	*	*	*
8		*	*	*	*
9			$11,191	$47,757	$21,457 (6 mo.)

* = unknown
** = not applicable
*** = cumulative cost avoidance $1,300,000

Cost undoubtedly was a major factor in the decision as to whether or not to implement a program. The majority of institutions which did implement programs utilized a Quick-fix (low or no cost) program. Responses to the question of which factor(s) most influenced the selection of a program reinforced the finding that cost was a major factor. The data suggested that those administrators who were energy conscious did establish conservation program goals and objectives and, in some instances, involved other campus groups in the establishment of those goals and objectives. The small number of institutions (4) which reported actual cost avoidance figures suggested that the majority were still in the process of developing data collection and analysis procedures.

Question Four: What Types of Incentives are Incorporated in Residence Hall Conservation Programs?

Four or 36.3% of the respondents reported that the funds saved by the department's energy conservation efforts were available for use in other budgetary categories within the department. Of those four, only 3 or 27.3% reported that money was available for departmental awards or incentives to conserve energy. The amount of money available ranged from $300 for a contest budget to $5,000 which was available for the entire campus. The data showed that no departmental funds were available for departmental awards or incentives at the seven other institutions.

Data on the types of acknowledgement of efforts to conserve energy were examined. With respect to efforts by housing and residence hall staff, 2 or 18.2% received a departmental "pat on the back" and 2 or 18.2% received institutional recognition as well as a departmental "pat on the back." One respondent reported that the department received extra "funds for departmental use," while another reported institutional "recognition of the manager for a reduction in operating costs." Four or 36.3% of the respondents indicated that no acknowledgements were accorded.

Four or 36.3% of the respondents indicated that the major acknowledgement of student/residence hall efforts to conserve energy was in the form of "no or minimal increases" in housing fees. One respondent indicated that specific prizes or dollar amounts were awarded to individual residence halls. Another reported that in addition to minimally increasing housing fees and awarding specific prizes,the department was able to "process some (residence hall student) projects that otherwise might not have been funded." None of the respondents indicated that students received a reduced housing fee as a form of acknowledgement. Table IV-13 illustrates the types of acknowledgement accorded to residence hall staff and students.

Discussion

The literature indicated that successful conservation programs, particularly those of a voluntary nature, generally required the use of some type of inducement or incentive to encourage people to conserve. The data showed that of the four housing departments that had funds available for conservation efforts, only three utilized the funds as incentives or awards in programs involving students. This finding suggested that those departments which did not have either departmental staff or student oriented incentive programs were less likely to have staff or student participation and consequently less student involvement and motivation to conserve energy.

TABLE IV-13

NUMBER AND PERCENT OF TYPES OF ACKNOWLEDGEMENT EFFORTS TO CONSERVE ENERGY BY HOUSING STAFF AND RESIDENCE HALL STUDENTS BY ACUHO RELATED INSTITUTIONS IN THE SPRING OF 1978

Housing and residence hall staff	N	%	Students/residence halls	N	%
1. Recognition of departmental accomplishments by the institution	0	0	1. Reduced housing fee	0	0
			2. No or minimal increase in housing fee	4	36.3
2. Recognition of individual efforts--"pat on the back" at evaluation time	2	18.2	3. Specific prizes or money is awarded to individual hall(s)	2	18.2
3. Merit raise or financial award to individuals	0	0	4. Institutional or local recognition of efforts (no monetary awards)	0	0
4. Combination of 1 and 2 above	2	18.2	5. Combination of 2, 3 and 4	1	9.1
5. Other: A. Received money for department use in other categories B. Recognition by manager for reduction in operating costs	2	18.2	6. Combination of 2, 4 and 7A	1	9.1
			7. Other: A. Individual recognition of residents B. Processed some projects that otherwise might not have been funded	1	9.1
6. No acknowledgement	4	36.3			
7. Missing	1	9.1	8. No acknowledgement	2	18.2
	11	100.0		11	100.0

The data, which indicated that the major acknowledgement of student/residence hall efforts to conserve energy was in the form of "no or minimal increases" in housing fee, suggested that although there was a departmental or institutional commitment to conserve energy, the immediate and direct impact on students was absent. Those housing departments which utilized contests, conservation awareness and educational programs that were incentive oriented were more likely to have greater student participation and ultimately the conservation of larger amounts of energy.

CHAPTER V

SUMMARY, FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

The stated purposes of this study were threefold. The first purpose was to identify and determine the effectiveness of elements of established energy conservation programs. The second purpose was to systematically examine the development, cost and incentive features of existent residence hall energy conservation practices and programs. The third purpose of this study was to develop a set of recommendations for implementing a residence hall energy conservation program. The study asked:

1. What are the major elements or components of established and effective energy conservation programs?
2. How effective are the previously identified conservation elements or components in a college or university energy conservation program?
3. What are the types and characteristics of residence hall energy conservation programs?
4. What types of incentives are incorporated in residence hall conservation programs?
5. What recommendations could be advanced to improve the utilization of energy in college and university residence halls?

The major elements or components of energy conservation programs were identified in a review of the literature. The sixteen-item Conservation Program Elements Index (CPEI) was used to assess the extent to which the elements were utilized or incorporated in college and university energy conservation programs. The effectiveness of the conservation program elements in a collegiate setting was assessed through the Perceived Energy Effectiveness Scale (PEES). Identification of the development, cost and incentive features of existent residence hall energy conservation programs was accomplished through the use of data obtained from Section III of the Residence Hall Energy Conservation Questionnaire (RHECQ).

A review of the literature revealed that since the 1973 Arab oil embargo all segments of the U.S. economy were confronted with the task of paying and budgeting for rapidly escalating energy and utility costs. Because of limited or restricted budgets, educational institutions, with limited cost-pass-through capabilities, were particularly hard pressed to absorb rapidly increasing energy costs. Concern over the impact of rising energy costs on operating budgets, prompted a number of educational institutions to seek ways to reduce energy costs and consumption. The effect of this concern resulted in the development and implementation of energy management or conservation programs.

The literature, unfortunately, revealed little research on the application of energy conservation programs on college and university campuses in general and residence halls in particular. This study represented a response to that perceived need and was designed to identify and analyze the major elements and features of institutional and residence hall energy conservation programs.

The thirty-five institutions listed in the Association of College and University Housing Officers' "1976-77 Room and Board Survey" comprised the population for this study. All of the institutions were affiliated with ACUHO and maintained on-campus residence hall facilities. An original survey instrument, the Residence Hall Energy Conservation Questionnaire (RHECQ), was mailed to the chief housing officer at each of the listed institutions. Twenty-nine or 83% of the questionnaires were returned.

Validity for the RHECQ was established through a process outlined by Dillman (1978). Reliability for the instrument was determined through the use of Kuder-Richardson's formula, KR-20. Summary statistics, such as means and standard deviations, were computed. An item-analysis (Kohr, 1974), using high and low scoring of "contrast" groups was performed on the PEES.

Findings of the Study

The purposes of this study were achieved by: (1) identifying major elements of energy conservation programs and testing the degree to which the elements were utilized in selected institutional energy conservation programs through the use of the CPEI; (2) testing the perceived effectiveness of specific elements or conservation practices through the use of the PEES; and (3) expanding the field of knowledge by analyzing and presenting data on the development, cost and incentive features of college and university residence hall energy conservation programs. The results and implications derived from the analysis of the data are limited to the ACUHO related institutions surveyed in this study.

Question One

The first question posed by this study focused on the identification of the major elements of established and effective energy conservation programs. Sixteen elements were identified in the review of the literature as important or essential to an effective energy conservation program. The elements were categorized as either administrative or technical in nature and used to form the sixteen-item Conservation Program Elements Index (CPEI). The CPEI was composed of two sub-indices, the elements of which are listed below.

ADMINISTRATIVE ELEMENTS INDEX (AEI):

1. The support of the institution's chief executive,
2. An energy conservation committee with campus-wide representation.
3. A designated energy management/conservation officer.
4. Built-in conservation incentives/rewards.
5. A set of institutional energy objectives.
6. Checks and controls to assure that objectives are achieved.
7. A system for collecting and analyzing actual energy consumption and cost data for all divisions/departments.
8. A continuing and on-going evaluation system.

TECHNICAL ELEMENTS INDEX (TEI):

1. Utilization of a life-cycle costing approach in the design of new facilities and/or purchase of new energy consuming equipment.
2. Improvement in the thermal insulation of existing walls, ceilings, windows, doors, pipes, etc.
3. Installed meters to measure energy consumption in each building.
4. Updated and improved mechanical, electrical and lighting systems.
5. Instituted a comprehensive preventive maintenance program.
6. Installed waste heat reclamation equipment or systems.
7. Installed more efficient mechanical/electrical HVAC equipment.
8. Utilized solar energy for heating or cooling.

When the AEI elements were ranked on the basis of the number currently utilized in an institutional conservation program, the data showed that "executive support," "conservation officer," "evaluation system," and "cost data" were, respectively, the highest ranked elements. "Energy objectives," "checks and controls," "conservation committee" and "conservation incentives" were respectively the lowest ranked elements.

When the TEI elements were ranked on the basis of the number currently utilized in an institutional conservation program, the data showed that "improved mechanical, electrical and lighting systems," "thermal insulation," "comprehensive preventive maintenance" and "life-cycle costing" were, respectively, the highest ranked elements. The next highest ranking elements were "installed meters" and "efficient HVAC equipment" which had the same number of responses. "Waste heat" and "solar energy" were, respectively, the least utilized elements.

Question Two

The second question asked, "How effective are the previously identified conservation elements in a college or university energy conservation program?" The findings showed that the mean score for all of the elements in the Perceived Energy Effectiveness Scale (PEES) was 2.99 which indicated that all of the elements were perceived to be important as effective energy conservation program elements. Based upon the sum of institutional ratings for each of the elements, "executive support," "evaluation system," "conservation officer," "checks and controls," "collection of cost data" and "energy objectives" were, respectively, the PEA elements perceived to be the most important as effective conservation elements. "Conservation incentives" and "conservation committee" were, respectively, rated as the least important.

The PET elements perceived to be the most important as effective conservation elements were, respectively, "improved mechanical/electrical systems," "preventive maintenance," "thermal insulation," "life-cycling costing," "installed meters," "efficient HVAC equipment" and "life-cycle costing." "Waste heat reclamation" and "solar energy" were, respectively, rated as the least important.

Caution needs to be exercised in interpreting the item-analysis results due to the small N and the fact that answers to the PEES items were based upon the respondent's perception as to the degree of effectiveness of the elements. It was recognized that answers to the items were contingent upon the degree to which the respondent had access to accurate energy conservation data, correctly interpreted the data, and understood the principles upon which the various conservation technologies were based.

The data indicated that although there was some variability in the responses of the "contrast" groups, the groups tended to be consistent in rating the elements as either effective or ineffective. When the PEES elements were analyzed in relation to their inclusion in the sub-scales, the findings indicated that there was greater agreement among the PEA "contrast groups" than there was among the PET "contrast" groups. The data also indicated that the respondents perceived the administrative elements in the PEES to be more important as effective energy conservation elements than they did the technical elements.

In the judgment area of rating effectiveness, there was greater agreement on the effectiveness of some elements than other elements. Four of the PET elements, "life-cycle costing," "meters," "waste heat reclamation" and "solar energy," had standard deviations of 1.0 or higher. Due to the higher degree of response variability or lack of consensus, the four elements did not appear to be effective discriminating items in the PEES scale.

Question Three

Question three of this study asked, "What are the types and characteristics of residence hall energy conservation programs?" Three types of residence hall energy conservation programs were identified: Quick-fix, Refit, and Systems-convert. Residence hall energy conservation programs were characterized largely by low cost or Quick-fix programs that were easily implemented. Administrators were the individuals primarily responsible for establishing the program's objectives. The typical program was implemented at a cost of less than $3,500 and, generally, did not provide departmental funds to be used as incentives or awards. Departmental efforts to conserve energy were generally acknowledged in the form of a departmental or institutional "pat on the back."

Question Four

Question four of this study asked, "What types of incentives are incorporated in residence hall conservation programs?" The general nature of the type of incentives incorporated in residence hall conservation programs was in the form of contests. The contests involved competition against a hall's prior energy consumption record or against other halls in the area. The incentives generally were in the form of cash prizes which were awarded to the hall(s) which had the largest decrease in energy consumption during a specified time period. Other incentives included the awarding of specific prizes, such as recreational equipment or the undertaking and funding of a student project or program that otherwise would not have been funded.

Summary of Findings

The following findings are derived solely from the presentation and an lysis related to the data obtained from the twenty-nine ACUHO related institutions surveyed in this study. The reader, therefore, should exercise caution in interpreting the results and making generalizations to institutions other than those actually surveyed.

1. There was a difference between the number of elements considered essential to an effective energy conservation program as recommended by energy experts and the extent to which the elements were actually incorporated in institutional programs.

2. Institutions which were committed to the concept of energy conservation implemented more of the sixteen CPEI elements than did those that were less committed.

3. Based upon the degree of utilization, colleges and universities accorded a lesser degree of importance to the conservation program elements, "conservation incentives," "waste heat" and "solar energy" than did energy experts. The same conclusion could also be reached with respect to the variable "conservation committee" but to a lesser extent.

4. Colleges and universities tended to attach a higher degree of importance to administrative as opposed to technical program elements.

5. Respondents were not in general agreement as to the effectiveness or non-effectiveness of all the PEES elements.

6. Eleven institutions had implemented conservation programs that were designed to reduce energy consumption in residence halls above and beyond the goals prescribed by an institutional program. However, only two had student incentive related conservation programs.

7. Residence hall conservation programs tended to be of the low cost Quick-fix variety.

8. Residence hall administrators tended to include in the formulation process of residence hall energy conservation goals and objectives only those individuals who, of necessity, were required to be involved.

9. Exact data on residence hall conservation program development costs and "cost avoidance" figures were minimal or not available.

Conclusions

1. College and university institutional and residence hall energy conservation programs were, for the most part, in an initial evolutionary stage of development.

2. The majority of colleges and universities which had conservation programs relied on institutional programs to meet their established enargy conservation goals and, therefore, apparently did not perceive a need to develop independent residence hall conservation programs.

3. Respondents were more consistent in reporting what conservation elements had been implemented than in the perceived effectiveness of the elements.

4. As a whole, institutions did not foster an environment that provided incentives for either administrators, managers or consumers to conserve energy.

5. Student involvement in formalized residence hall energy conservation programs was exceedingly small.

Recommendations

Two sets of recommendations are offered. The first set of recommendations involves a response to question number five of the questions which directed this study. The second set of recommendations pertains to areas of future research studies.

Recommendations Pertaining to Question Five of the Study

Question five of this study asked "What recommendations could be advanced to improve the utilization of energy in college and university residence halls?" The following recommendations are offered:

1. Develop a research project that can effectively assess residence hall students' concerns or lack of concern regarding energy conservation and ways to motivate students and staff.

2. Appoint a departmental energy coordinator to collect and analyze all residence hall energy consumption and cost data and coordinate the department's program with other campus offices. The energy coordinator should know and understand the institutional energy conservation plan.

3. Organize a residence hall conservation committee consisting of students, an energy coordinator, the chief housing officer and representatives of the maintenance department. The function of this group would be to develop goals and objectives for the residence hall program.

4. Launch an energy conservation campaign or energy education program.

5. Develop an incentive based program that would motivate students to conserve energy. A certain fixed amount or percentage of the "cost avoidance" money could be utilized to fund or support various conservation efforts. Such incentive based programs could take the form of:

   a. competition among halls or buildings;

   b. competition among areas;

   c. competition against a hall's previous year's energy consumption record; and

   d. idea generating contests on the best way to conserve energy (or other resources).

6. Recognize and reward conservation efforts by students. Awards for conservation efforts could take the form of:

   a. specific cash prizes to the residence hall winner(s) of various contests;

   b. large ticket items such as color TV's, pool tables, movie projectors;

   c. special student oriented projects or programs that would not ordinarily be funded;

   d. "free snack night," special dinners and pizza parties; and

   e. publicly recognizing individual student and residence hall accomplishments.

7. Recognize residence hall staff, maintenance personnel and administrators for their conservation efforts by:

   a. publicizing individual or departmental accomplishments; and

   b. merit raises to staff who did an outstanding job in conserving energy (pay raises could be awarded in relation to a percentage of the costs avoided or saved).

8. Install meters in all residence halls to accurately measure the amount of energy actually being consumed in each hall.

9. Develop an understanding of, and utilize, life-cycle costing when considering the replacement or purchase of equipment.

10. Encourage the institution (if it has not already done so) to:

   a. conduct a campus-wide energy audit;

   b. organize a comprehensive preventive maintenance program;

   c. install thermal insulation in the roof, walls and energy distribution network of pipes and ducts;

   d. install more efficient mechanical/electrical HVAC equipment where possible; and

   e. update and improve mechanical, electrical and lighting systems.

11. Strive to utilize an evolutionary approach to energy conservation and ensure that each phase is thoroughly evaluated by an

on-going evaluation system. Shape the conservation program according to the needs and reasonable constraints of the department.

Recommendations Regarding Areas of Future Research

The value and specific technologies associated with energy conservation have received a lot of attention in recent years. With energy prices predicted to continue their upward spiral, energy conservation represents a feasible and practical way of addressing the present energy crisis. However, additional research efforts on the most effective ways to conserve and utilize energy in college and university residence halls is needed. Recommendations regarding future areas of research pertaining to energy conservation and college and university residence halls are posed in the form of the following questions.

1. To what extent have conservation programs reduced energy consumption in the residence halls?

2. To what extent is there congruence between the conservation elements residence hall administrators perceive to be effective and the actual effectiveness of the elements?

3. What impact have residence hall conservation programs had on Housing Department operating budgets?

4. Is there a difference in the amount of energy saved or conserved between those residence halls which utilize a passive (purely technical or automated) conservation program than those which include the active participation of the energy consumer?

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APPENDICES

APPENDIX A

SURVEY QUESTIONNAIRE

RESIDENCE HALL ENERGY CONSERVATION QUESTIONNAIRE

This questionnaire is designed to identify institutional and residence hall energy conservation practices, programs, and costs related to energy consumption.

For purposes of this survey, significant terms are defined as follows:

Energy Conservation Practice - a singular action or measure designed to conserve energy (may or may not be a part of a formal program).

Energy Conservation Program - a coordinated group of energy conservation practices organized in a systematic manner so as to constitute a formal program.

Residence Hall - campus facility consisting of rooms or suites, designed to house resident students; excludes apartments, suites, etc. where utility costs are individually metered and charged separately to the occupant.

Life-cycle Costing - an evaluation technique that considers the sum total of all costs associated with an expenditure during its expected life span.

HVAC - Heating, ventilating and air conditioning systems.

Directions: Please circle or complete the appropriate response(s) to each question. Please note that several questions may require multiple responses. Y = Yes, N = No

SECTION I - Institutional Data and Energy Conservation Programs

1. The institution has:

   a. A centralized heating and power system for more than 60 percent of campus buildings. . . . . Y N

   b. Had a campus-wide energy audit. . . . . Y N

   c. Had an infrared survey of the campus. Y N

   d. A computer-centralized HVAC control system. . . . . Y N

   e. A fully implemented energy conservation program. . . . . Y N

In questions 2 and 3, please indicate whether or not the stated element is a designated part of the institution's energy conservation program. Then, utilizing the scale provided, rate each statement according to the degree of its importance as an effective conservation element in an overall program: 1 - unimportant, 2 - moderately important, 3 - very important or 4 - extremely important.

2. The institution's energy conservation program has:

   a. The support of the institution's chief executive. . . . . Y N 1 2 3 4

   b. An energy conservation committee with campus-wide representation. Y N 1 2 3 4

   c. A designated energy management/conservation officer. . . . . . . Y N 1 2 3 4

   d. Built-in conservation incentives/rewards. . . . . Y N 1 2 3 4

   e. A set of institutional energy objectives. . . . . Y N 1 2 3 4

   f. Checks and controls to assure that objectives are achieved. . . . Y N 1 2 3 4

Code: 1) Unimportant, 2) Moderately Imp., 3) Very Imp., 4) Ex. Imp.

g. A system for collecting and analyzing actual energy consumption and cost data for all divisions/departments. . . . . Y N 1 2 3 4

h. A continuing and on-going . . . . Y N 1 2 3 4

3. The institution has:

a. Used a life-cycle costing approach in the design of new facilities and/or purchase of new energy consuming equipment. . . . . Y N 1 2 3 4

b. Improved thermal insulation of existing walls, ceilings, windows, doors, pipes, vents, etc. . . . . Y N 1 2 3 4

c. Installed meters to measure energy consumption in each building . Y N 1 2 3 4

d. Updated and improved mechanical, electrical and lighting systems. Y N 1 2 3 4

e. Instituted a comprehensive preventive maintenance program. . . . . Y N 1 2 3 4

f. Installed waste heat reclamation equipment or systems. . . . . . . Y N 1 2 3 4

g. Installed more effecient mechanical-electrical HVAC equipment. . . Y N 1 2 3 4

h. Utilized solar energy for heating or cooling. . . . . Y N 1 2 3 4

SECTION II - Residence Hall Data

4. For each of the years listed below please indicate the number of residence halls in operation and the total square footage for all halls.

	No. of Residence Halls	Total Sq. Ft.		No. of Residence Halls	Total Sq. Ft.
1972			1975		
1973			1976		
1974			1977		

5. Number of residence halls, as of July 1, 1972, utilizing centralized heating and/or cooling ______________; as of July 1, 1977 ______________.

6. Residence halls are individually metered to record consumption of a. electricity b. gas c. other (please specify) ______________ d. fuel/electricity is not metered.

7. Year in which meters were installed to record consumption of a. electricity ________ b. gas __________ c. other (please specify) ______________________.

8. Primary energy/fuel for heating ____________; for cooling ________________.

SECTION III - Residence Hall Conservation Programs

9. Does the housing office have a formal energy conservation program (this may or may not be a part of an institutional program) a. yes b. no.

10. If the answer to question 9 is No, are identifiable energy conservation practices utilized in the residence halls? a. yes b. no.

If your answer to question 9 is No, please go to SECTION IV, below.

11. Date the residence hall energy conservation program was first implemented ______ ______.
month year

12. Which people were involved in establishing objectives for the program a. faculty b. administrators c. staff d. students e. others (please specify) ________________

13. Which definition best describes the residence hall energy conservation program: a. Quick Fix - consists of energy reduction measures that achieve rapid and significant savings at negligible cost b. Refit - consists of energy reduction measures requiring moderate capital investment c. Systems Convert - consists of a major change in system design; requires a large capital expenditure.

14. Aside from reduced operating costs and/or the conservation of energy, the factor(s) which most influenced the selection of your particular program was a. ease of implementation b. availability of trained personnel c. little or no cost to implement d. availability of technology and equipment e. other (please specify) ____________________ ____.

15. Estimated cost to develop and institute the program including energy audits, consultants, publicity, equipment, installation, etc. ________________________.

16. Funds saved by the department through energy conservation are available for use in other budgetary categories within the department. a. yes b. no.

17. What dollar amount is available for departmental awards, incentives, etc. ____________.

18. Acknowledgement of housing and residence hall staff efforts to conserve energy include a. recognition of departmental accomplishments by the institution b. recognition of individual efforts in annual personnel evaluations (no financial reward, just a pat on the back) c. merit raise or financial award to individuals d. other (please specify) ____.

19. Acknowledgement of student/residence hall efforts to conserve energy include a. reduced housing fee d. no or minimal increase in housing fee c. award or specific prizes or dollar amounts to individual halls d. institutional or local recognition of efforts (no monetary awards) e. other (please specify) ________________________________ ____.

20. What are the estimated annual savings attributable to the conservation program in each of the following fiscal years.

1972 __________ 1974 __________ 1976 __________

1973 __________ 1975 __________ 1977 __________

SECTION IV - Institutional/Residence Hall Written Conservation Policies

It would be immensely helpful if you would return, with your questionnaire, any written materials pertaining to institutional and/or residence hall energy conservation programs.

May I express my appreciation for your cooperation in this effort by extending a hearty Thanks! If you would like a summary of the results, please indicate your name and school here ____.

Please use the enclosed return envelope or return to: R. Doran
BERS, College of Education
University of Tennessee
Knoxville, TN 37916

APPENDIX B

LIST OF THE THIRTY-FIVE INSTITUTIONS INCLUDED IN
ACUHO'S 1976-77 ROOM AND BOARD
SURVEY RESULTS

INSTITUTIONS INCLUDED IN ACUHO'S 1976-77 ROOM AND BOARD SURVEY RESULTS

1. Massachusetts Institute of Technology
2. Brandeis University
3. New York University
4. Princeton University
5. Hofstra University
6. Boston University
7. Stanford University
8. Northwestern University
9. University of Southern California
10. University of Miami
11. University of California (Berkeley)
12. Duke University
13. University of Denver
14. University of Wisconsin
15. Rhode Island University
16. University of Maryland
17. University of Michigan
18. University of California (Davis)
19. Ohio University
20. University of Minnesota
21. University of New Hampshire
22. Trenton State College
23. Southern Methodist University
24. Penn State University
25. Ohio State University
26. University of Cincinnati
27. University of Illinois
28. Michigan State University
29. University of Houston
30. Purdue University
31. San Francisco State University
32. University of Iowa
33. University of Connecticut
34. University of Tennessee
35. Indiana University

APPENDIX C

SURVEY LETTER

February 12, 1978

Dear ACUHO Member:

Enclosed is a questionnaire designed to survey the types of energy conservation practices and programs currently utilized by college and university residence halls. The instrument will be used to determine the effectiveness of specific energy conservation practices and ways in which residence halls can utilize energy more effectively.

I would greatly appreciate any effort you could devote to completing this questionnaire and returning it on or before February 27, 1978. This research project is integral to my doctoral dissertation and has been endorsed by the ACUHO Research and Information Committee.

Any questions pertaining to this project, along with the completed questionnaire should be directed to:

Robert J. Doran
BERS College of Education
University of Tennessee
Knoxville, TN 37916

I will be happy to provide you with a summary of the results if you so indicate on the questionnaire. Lastly, thanks ever so much for your invaluable help.

Sincerely,

Robert J. Doran

APPENDIX D

FOLLOW-UP LETTER

March 16, 1978

Dear ACUHO Member:

This is a follow-up letter to my initial request for your help in completing a doctoral research project on energy conservation programs in college and university residence halls. I recognize that because of time constraints and the adverse weather conditions,you may not have had time to complete and return the questionnaire by the requested date.

Since my survey is limited to thirty-five ACUHO related institutions, your cooperation and input are extremely important. This is particularly relevant given the current energy situation. The data collected in this survey may be quite beneficial to any institution considering implementation of a residence hall conservation program. I might add that this project has been endorsed by the ACUHO Research and Information Committee.

Your help in completing and returning the questionnaire by March 28, 1978 will be greatly appreciated. I will gladly forward a summary of the results, if you so indicate on the questionnaire. Any questions pertaining to this project, along with the completed questionnaire should be directed to:

Robert J. Doran
BERS College of Education
University of Tennessee
Knoxville, TN 37916

Please accept my sincere thanks for the time and effort you have devoted to this endeavor. Your help will certainly be invaluable.

Sincerely,

Robert J. Doran

VITA

Robert J. Doran was born on July 17, 1942 and reared in the city of Pittsburgh, Pennsylvania. He was the second oldest of eleven children and attended parochial schools throughout his formative years. He was graduated from St. Conice High School, Pittsburgh, Pennsylvania, in June 1960.

He attended St. Andrew's, Rochester, New York, and St. Vincent's, Latrobe, Pennsylvania, seminaries and received a Bachelor of Arts degree in philosophy from St. Vincent's in June 1967. He received a Master's of Science degree in Student Personnel/Counseling from Indiana University, Bloomington, Indiana, in June 1970.

He was accepted into a doctoral program at the University of Tennessee in the spring of 1974 and received the Doctor of Education degree with a Major in Educational Administration and Supervision in August 1981. He is a member of the American College Personnel Association and the National Association of Student Personnel Administrators. He is currently employed as an Assistant Director of Residence Life Programs at The Pennsylvania State University.

He is married to Jamie L. (Trainer) and is the father of two beautiful daughters, Jacquelyn Ann and Jennifer Lynn.