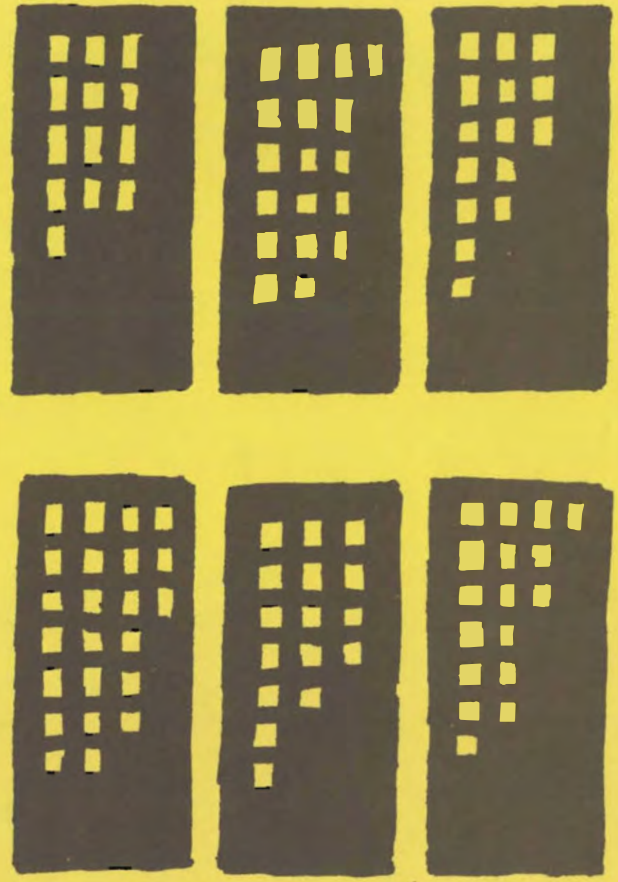

AN ENERGY PROGRAM FOR TENNESSEE CITIES

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THE NEED FOR ENERGY MANAGEMENT

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Energy, according to Webster, is "the capacity to do work." In the home, energy works in dozens of ways to make life comfortable and convenient. Business and industries depend heavily on various types of energy to keep machines and systems operating. Municipalities depend on energy to provide services to the community. Without energy, transportation is at a standstill.

The truth is, the present and future standard of living, the state's economy, your municipality's future, and life in general all are directly related to vast and increasing demands for energy.

The public must come to understand that energy supplies are rapidly being used up and energy itself is becoming a precious commodity. Yet little has been done to manage energy efficiently in order to help assure that the supplies will go further. Energy management must be an integral part of daily life and business.

For the short-term, to weather the transition period before the long-term possibilities become widely practical, our best option is energy conservation. In one sense, using energy more efficiently is a major potential energy source. By conserving our scarce resources of oil and natural gas, we make them available for uses for which they are uniquely suited.

Although our economic growth has been linked historically to rapidly increasing demand for energy, conservation does not have to adversely affect our economy. In fact, using energy more efficiently can have a positive economic impact. Furthermore, we have almost endless opportunities for conservation. As much as one-third of the United States' energy consumption may constitute recoverable waste, simply because our buildings, factories, and automobiles are geared to the era of cheap energy. The United States consumes more energy per dollar of gross national product than any other industrialized nation, and twice as much energy per capita as West Germany, which has a similar standard of living.

According to the American Institute of Architects, the improved design of new buildings and modifications of old ones could save an amount of energy roughly equivalent to twice our oil imports. Recovery of waste heat from electrical generating plants, improved industrial process efficiency, and more efficient automobiles also offer substantial conservation potential.

These problems and opportunities require informed and coordinated action by individuals, private-sector organizations, and all levels of government. For the State of Tennessee, this Conservation Plan is a first step toward meeting that need.

LEADERSHIP BY ELECTED MUNICIPAL OFFICIALS

The leadership of the elected municipal official is important to the success of every program in the community, but it is particularly important in the development of a successful community energy conservation plan. Aside from being a national problem, the energy situation is first and foremost a local problem. The most effective means for conserving our scarce energy resources is for each community in the United States to initiate and implement a comprehensive conservation effort right in its own back yard.

The energy situation is a local problem and it affects every person in the community. For this reason it is necessary that elected officials confront the problem on the local level. It is the responsibility of every elected official to understand the seriousness of the energy shortage and roll up sleeves and go to work in his or her community directing an effective energy plan. The local official cannot take the attitude that the energy shortage is a national problem that must be solved in Washington. It is a national problem, but it is also a local problem that concerns every person in the community. Any national solution to the energy problems facing our nation today must be directed back to the local level because that is where the energy is ultimately consumed.

Every community is unique and has its own singular problems. This is particularly true with respect to the energy shortage. Each community consumes energy in a different manner and has its own particular problems to solve. For this reason each community must develop its own unique energy plan and implement it if efficient energy usage is to be realized within the community. Any local energy plan developed in Washington cannot possibly reflect the consumption patterns and problems encountered in each community across the nation.

The vital role the elected official plays in developing an energy plan for his or her community can be underscored by asking, who, if not the elected official, has the ability and resources to accomplish the task? The answer is simple—no other individual in the community has the responsibility or capability to direct a community-wide conservation effort. Each citizen in the community looks to the elected official for leadership in this vital area. It is the elected official who can initiate action in the community to alert the citizenry, develop an energy plan, and pass the necessary laws upon which an effective conservation effort can flourish. In essence, the elected official has the ball with respect to the energy situation. He or she must pick it up and run with it.

AN ENERGY PROGRAM FOR TENNESSEE CITIES

This Energy Program has been designed and developed to provide specific guidance to cities in implementing an energy management program. Much information is produced today from a myriad of sources on the need to conserve our energy resources, but little information is given on how to systematically deal with the problem. What follows is intended to be an outline of "how to do it."

The program is relatively simple in its design. Just as is true in the old adage, "you have to spend money to make money," you will have to spend a little energy to save a lot of the city's energy. The requirements are:

1) A commitment by elected officials to carry out an effective energy management program. This requires certain skills by city employees which can and will be developed in workshops located within easy commuting distance of your city.

2) The assistance of citizens is equally important to build a community-wide interest in energy conservation. These citizens, appointed by the Mayor and governing body to a commission on energy, also must become knowledgeable about what can be accomplished in the community. A workshop for the commission's members and elected officials will provide basic information on community awareness activities, information sources and energy planning.

3) The need to monitor progress is self-evident. Without basic data the program cannot measure the effectiveness of the city's efforts. Two tools should be used for measurement purposes:
   a) An energy budget for all city facilities and departments.
   b) A monthly management report.

GOALS

The overall goals of the program are to make cities energy efficient and to raise the level of awareness in the community of the need to conserve energy. The goals are translated into specific results which are measurable:

a) To reduce the level of energy consumption in municipal activities by at least 15%.
b) To reduce the per capita level of energy consumption in the total community by at least 5%.

The target date for these reductions will be the end of 1981, or earlier if possible.

Realistic and achievable goals are key components to a successful program. Studies by the Tennessee Energy Authority have determined the goals for this program to be practical and well within the resources of participating cities to accomplish.

OBJECTIVES

The objectives necessary to achieve the goals are the heart of the program. They are:

I. METHODOLOGY—To establish a methodology and organization within cities for an energy management program. Everyone concerned recognizes the increasing cost of energy, but getting organized to deal with the problem is difficult. This program is designed to help your city by providing guidance in organizing an effective program.

II. TECHNICAL ASSISTANCE—To provide needed technical assistance to cities in four areas:

a) Identification of energy saving opportunities.
b) Development of management skills.
c) Providing solutions to problems.
d) Establishing a record-keeping system.

Such assistance may be obtained from electric and gas systems, private consultants (architects, engineers, etc.) who are specializing in the energy field, and university faculty personnel. MTAS consultants will provide limited assistance in the planning phase. The Center for Government Training will conduct seminars and workshops for personnel involved in energy conservation programs.

III. ENERGY BUDGET—To establish the principle of budgeting energy in city departments and operations. Budgeting dollars for energy used by a city does not provide an adequate management tool because the cost of energy keeps going up. By establishing a budget on the basis of usage, the city can control energy expenditures more effectively and can budget dollars more intelligently for new facilities and equipment.

IV. COMMUNITY-WIDE CONSERVATION—To encourage energy conservation throughout the community. Through the creation of a Commission on Energy, an awareness program in each community can be undertaken. Its members will be able to develop a program based on information in the materials to be given out at the workshops.

V. PLANNING—To provide a planning process for the community to follow in assessing present and future energy needs and alternatives. Energy is the lifeblood of a community. If the supply of any forms of energy is interrupted, it can be extremely disruptive to a local economy. The dependency upon various energy sources in each community must be established and alternatives planned in order to provide a stable economic base. Future development in the community also must be carefully planned to minimize energy consumption. A basic planning process will be included in the materials distributed at the workshops.

VI. ANTICIPATED PROBLEMS—To overcome anticipated problems in city government and throughout the community. These include:

a) The burden of adding responsibilities to existing job requirements, because keeping track of energy consumption is a new function.
b) Changing established habits; e.g., driving at 55 MPH.
c) Lack of cooperation by various groups and individuals.

City officials and members of energy commissions will have to overcome these problems with strong leadership and enthusiasm.

VII. MONITOR PROGRESS—To determine the effectiveness of the program it is necessary to monitor progress made. To accomplish this objective, the municipality must establish a simple recordkeeping system. The Commission on Energy will have to use other techniques and rely on data supplied by the various energy suppliers.

ROLE AND COMMITMENT OF MAYOR AND COUNCIL

Effective conservation means changes in long-established habits, attention to detail, and sometime long-range planning and capital investment. Leadership is essential. To be successful, local comprehensive programs must have the active backing of the highest elected and appointed officials.

The following is an outline of the commitments needed on the part of the local elected officials and the program elements to be adopted and implemented by a city government.

REDUCE ENERGY CONSUMPTION

As stated previously, one goal is to reduce total community energy consumption by 15% by the end of 1981. This goal must be taken seriously in order to assure success of the program. Once achieved, a new goal should be adopted; e.g., additional reduction or maintaining the existing reduced level of energy consumption.

POLICY STATEMENT

To launch the program, the Mayor and governing body should adopt a resolution declaring that it is the policy of the city to encourage energy conservation both inside and outside of government, and outlining various objectives of the program.

Appendix I is a Model Statement of Policy on Energy Conservation.

ENERGY MANAGER

If the program is to be anything besides a council resolution, it will require some resources from the city. The most important resource, of course, will be staff time, and the most effective way to run the program is to provide it with a full-time staff. In governments too small for this to be feasible, a specific person should still have responsibility for the program, where possible. This "energy conservation manager," working with department heads, should be given the resources and powers to act and assigned the duty of producing energy savings.

Staff time can easily be compensated for in savings in energy. For instance, a $20,000 energy bill reduced by 15% will save $3,000. In large cities, such savings could surpass the expense of added full-time staff for the sole purpose of conserving energy. But a break-even, or a small net-loss, operation may be justified to conserve scarce natural resources.

A number of city governments have taken a committee approach to energy savings. An energy conservation committee may be composed of concerned department heads from public works, police, fire, maintenance, schools, inspections, engineering, and public transportation, along with other interested parties. The committee should meet periodically to review the energy conservation performance of each department and to develop targets and new programs.

The detailed responsibilities of an energy conservation manager or committee will be discussed in the workshop for city employees.

COMMISSION ON ENERGY

For outreach programs, to promote and assist energy conservation outside the local government, a Commission on Energy should be established. Members should include a representative from the city, representatives from citizen groups, the chamber of commerce, and local organizations, firms and individuals with interests in energy conservation. This commission would develop and review strategies for implementation by the local government, volunteers, and private firms. It provides a way to involve the community directly in the programs and make them more effective.

There will be workshops for elected officials and members of the Commission on Energy to provide basic information on conducting an energy conservation program in communities. The workshops will be in regional locations, to minimize travel time, and will be free. The co-sponsors of the program will provide the workshop leaders. All involved personnel should make maximum use of these training opportunities to increase the effectiveness of the program.

The Commission on Energy will generate a small amount of clerical work which the city should provide: typing minutes, mailing notices, filing, occasional correspondence, etc.

ENERGY BUDGETING

Just as a city adopts a financial budget, it also should adopt an energy budget. Energy is too important and costly to leave to guesswork. The budgeting process represents a constructive step toward understanding energy usage in the city and, therefore, a sound basis for decision making.

Briefly, the budgeting system has been designed to project the expected energy usage of every facility and operation of city government. Initially this will be based on available historical information of consumption of energy by the city and a pragmatic forecast of anticipated potential reduction.

The system will require the collection of energy consumption information on a month-by-month basis to monitor performance. From this information, management decisions and inferences may be made of potential areas where steps may be taken to conserve and reduce usage. Future facilities and operations can be evaluated clearly on the basis of energy usage.

The energy budget concept also is designed to assist cities with the information required by the Department of Energy under the grants program for schools, hospitals, local governments, and public care buildings.

ENERGY PLANNING

Cities can deal with the future cost and limited supplies of energy by preparing plans which optimize community development and energy conservation. The city needs to collect information on energy usage patterns in the community and develop plans to provide alternate fuels or courses of action in times of energy shortages. In its land use and transportation planning, the community should consider the impact of any development project or transportation corridor on the overall energy efficiency within the community. Facilities should be located and built with future energy costs and conservation in mind.

The program provides a planning process which is simply designed. This is deliberate in order to give the city a logical and effective approach to energy planning that recognizes the limited resources a city may have for this purpose and to permit the Commission on Energy to prepare the plan. The process also can be related to existing planning efforts in the community.

BUILDING CODES

Most existing building codes do not incorporate many of the potential opportunities for energy conservation in new construction. To correct this situation, cities should consider adopting "Energy Conservation" Appendix "J" to the Standard Building Code (available from the Southern Building Code Congress International). Also, as new technology, materials and methods for energy conservation develop over the ensuing years, changes in building codes will be inevitable. The city needs to monitor such developments and make whatever changes are necessary to encourage energy efficient buildings.

DEMONSTRATION PROJECTS

Demonstration projects stimulate action throughout the community, region and state. To the extend that resources are available, the city should pursue energy conservation demonstration grants such as solar heating and cooling for a new building. Or the city should encourage, through the Commission on Energy, other agencies to undertake projects, e.g., the construction of energy efficient homes by local builders.

LEADERSHIP

The elected officials in a community are its leadership. What they do influences others. To stimulate interest in energy conservation, the elected officials and city employees should practice and encourage energy conservation at every opportunity. By evaluating city facilities for energy saving opportunities, buying the most efficient vehicles for each function, formulating energy plans for the community, proclaiming an energy week and otherwise speaking out on energy management, much can be done to reach and influence the energy-consuming public.

ENERGY MANAGEMENT IN MUNICIPAL OPERATIONS

As the "energy crisis" unfolded, municipal governments experienced shortages in supplies following the oil embargo in late 1973, the quadrupling of fuel prices that occurred in 1974, and a persistent but less rapid rise in fuel prices since that time. While these events are beyond the control of local government, and their impact on the cost of local government services is severe, cities cannot choose to forego providing critical services. Often, a generalized feeling of helplessness has led to acceptance of steadily rising energy costs as a fact of life that must be absorbed in the municipal budget either at the expense of other services or by raising additional revenue.

This need not be the case. Although the price of energy is largely beyond the direct control of municipal government, the amount it uses is not. In most cities energy use in buildings comprises about 70 per cent of the total energy used in all municipal services, including fueling vehicles and lighting streets. Because energy was cheap when the existing physical plant was developed, most buildings use much more energy than is required to perform their functions. Substantial savings can be made without reducing the level of services offered in these facilities or imposing hardships on their users and occupants. The U.S. Department of Energy has determined that it is practical to cut energy use by 15 per cent in existing municipal buildings and operations. Achieving this result requires that energy use be managed and controlled to eliminate the margin of waste and inefficiency that exists.

As the mayor and council consider whether to organize a program to save energy in municipal buildings, the real nature of the energy crisis should be kept in mind. The fundamental cause is the depletion of domestic petroleum and natural gas supplies that must be replaced at significantly higher prices. Rising energy prices will be a fact of life over the next quarter century. If energy costs rise by an annual rate of 6 per cent, within 12 years the price of fuel will double. Similarly, the energy "saved" each year will increase in value by 6 per cent. Many municipalities that manage their cash reserves would be pleased with a 6 per cent return on these assets. A Municipal Energy Management Program will yield a similar return.

This program is designed to enable local decision makers and operating personnel who do not have extensive technical training to organize, implement, and sustain an energy savings program in municipal operations. The emphasis on "energy management" rests on the principle that a significant portion of energy costs is in fact "controllable." An effective program addressing the causes of waste and inefficiency will pay for itself many times over in savings of local tax dollars. This Energy Management Program introduces the tools that are the foundation blocks of a successful program.

RESPONSIBILITIES OF THE ENERGY CONSERVATION MANAGER OR COMMITTEE

Management is organizing resources and directing people toward a goal. The chief executive of a city government must focus the responsibility for coordinating and accomplishing the tasks of an energy management program. The options for organizing this management function can vary widely from city to city depending upon the local mix of talent and resources as well as the amount of expected dollar savings in a given community. The program can be managed by a committee of relevant department heads and technical personnel, by an individual who may already have substantial responsibilities in city government, or by an individual hired specifically for this purpose.

The functions of the Energy Conservation Manager (ECM) or Committee are broad and, therefore, the support of the mayor and council and the cooperation of other city employees are necessary. Outlined here are some of those responsibilities and duties which must be carried out or coordinated by the energy manager.

Energy Audits. Conducting energy consumption audits of city facilities or arranging for such audits to be made within a given period of time is a primary responsibility of the Energy Conservation Manager. The purpose of an energy audit is to identify the sources of waste and inefficiency in city facilities and operations. It is a physical survey leading to the establishment of an energy management program based on the energy conservation opportunities (ECO's) identified in the audit. Experience in using this approach has shown that significant (usually greater than 15 per cent) savings can be achieved with implementation of the audit recommendations involving minimal cost to the city.

It is important for the city to establish a specific, realistic date for the completion of the energy audits or the program will lag behind. Since the initial auditing procedure is a one-time task, the city should devote whatever manpower is needed to the project. The savings in energy costs which will accrue to the city frequently compensate for the effort required.

Energy Budget. The energy budget should address the goal of meeting the 15 per cent reduction in energy consumption in existing city facilities and operations. The budgeting technique is relatively simple in its approach and deals with the purposes for which energy is purchased by the city.

The Energy Conservation Manager will be responsible for preparing or coordinating the preparation of the energy budget. This will require gathering data on energy consumption for each facility and operation for the past year. This can be prepared by a clerk going through the accounting records or utility bills. The budget will be based on last year's energy consumption less whatever per cent reduction can be determined (through energy audits or other means) to be realistic for each facility or operation, including vehicles. Each month, the ECM should compare actual energy consumption against the budget and the previous year's consumption. Such a comparison will be of direct assistance to the ECM in meeting the budget and effecting an overall energy conservation goal of 15 per cent.

• **Energy Advisory Committee.** Building operators and department managers should be used on an energy committee chaired by the Energy Conservation Manager. Procedures for the operation of facilities should be developed by the committee. These procedures should then be implemented in all of the city's facilities. Monitoring the results can be accomplished through monthly energy consumption reports, but periodic spot inspections are necessary to find non-adherence to the proper operation of the various facilities.

Another important function of the energy conservation committee is to give proper recognition where due. Some program to reward departments that show positive results should be implemented so that support for the program will be maintained.

Results of successful energy savings efforts should also be communicated to other departments. If personal pride is instilled into individuals involved in the program, greater results should be anticipated.

• **Energy Workshops.** A major part of a continuing energy conservation program is the proper education of the people involved. The Energy Conservation Manager should encourage attendance at educational workshops on conservation techniques so that the latest information and ideas can be used.

Various publications carry many examples of case histories and programs to save energy. Helpful suggestions should be referred to the responsible building operators and managers so that they can use ideas appropriate to their facilities.

City employees may be an excellent source of information for conservation ideas. They work in city facilities daily and are most familiar with energy conservation opportunities which they encounter. Employee suggestion boxes or other suggestion systems should implemented where possible. Suggestions which cause significant savings should be recognized and/or rewarded.

ENERGY BUDGETING: CONCEPT & APPLICATION

Dollars are spent for energy in the form of a varied mix of fuel supplies to heat, light, and power a diverse group of municipal facilities. Compiling the total annual costs by building and by department for all energy used from all sources — whether gas, oil, or electricity — provides a municipality with a useful insight into the structure of its energy uses and costs.

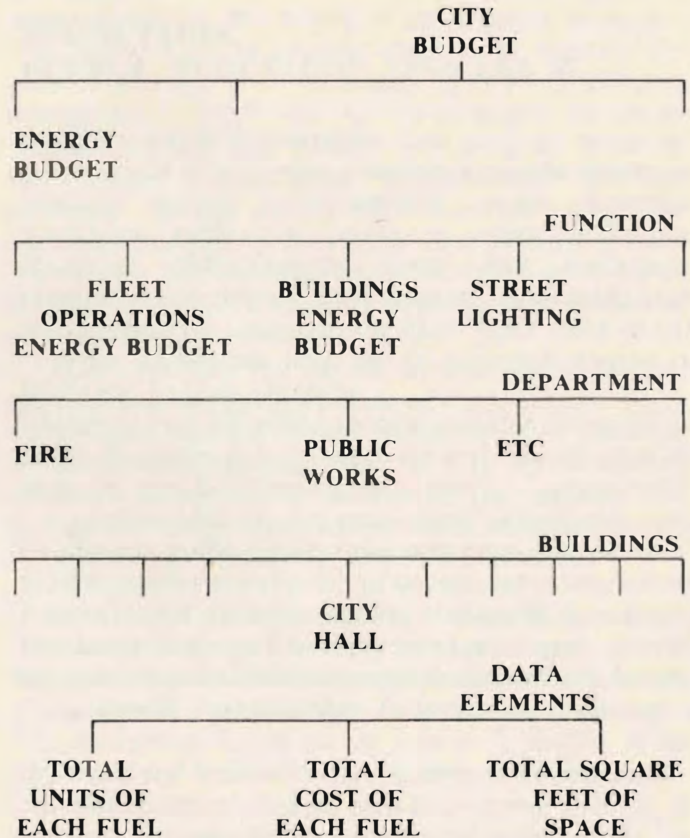
The cost of energy will generally increase with the size of the community, with a corresponding increase in the potential annual dollar savings through energy conservation. Larger cities have greater flexibility to consider changes in the organization of their building management function, including the addition of specially skilled personnel, in order to achieve their full annual savings potential.

A municipality beginning an energy conservation program may encounter some difficulty in retrieving and presenting energy cost data for specific buildings within a department. As part of a long-term energy management program, the municipality should consider modifying its budgeting and accounting procedures where necessary to build an information system that will support management action to reduce costs in buildings. Figure 1 illustrates the organization of a building management information system. This type of system ultimately would enable a municipality to identify total building energy cost as a line item in its municipal budget with back-up accounts on a departmental and building basis, including data on the cost and units of fuel consumed during a fiscal year.

Data will need to be gathered for each of the city's utility accounts and for fleet vehicles. Billing and energy consumption (i.e., KWH usage, therms, or cubic feet) for each building will need to be obtained

FIGURE 1

ENERGY BUDGET INFORMATION SYSTEM



and posted for the most recent 12 months, or for the same series of months as the city's fiscal year, whichever is preferred. Each month, current energy purchases will need to be added to the history and will be compared to the purchases last year. The Energy Manager, with this information, will be able to determine where more effort needs to be exerted to obtain the goals established.

In order to fully develop a standard by which one building can be compared to another, more information that is contained in the basic report should be collected. The basic report provides information on the amount of energy purchased in various forms (electricity, natural gas, fuel oil, gasoline, etc.), and the cost of each month's purchase. Each building must be analyzed to determine its square footage so that a measure of the energy used per square foot per year can be determined. This standard is called an Energy Utilization Index (EUI) and will provide a common base for comparing the overall energy efficiency of one building to another.

WATER SUPPLY AND WASTE TREATMENT CONTROL FACILITIES

Energy conservation opportunities vary considerably with the many different systems in use. In general, the systems are designed to provide water service for peak use periods, and are operated on that basis. Consequently, peak KW demand loads are often created for short time periods which may result in billing demand charges which could be avoided. Each type system must be analyzed to determine the potential savings in operating costs through more prudent operation and control.

More efficient design of systems should be utilized in all expansions and newly developed facilities. These newer facilities should consider use of better monitoring of power usage, water flow, and in treatment plants, the condition of processed water. High efficient motors and drives should be incorporated, along with maximum use of gravity flow and water storage capability.

Utility rates should be examined annually to assure that the most economical rate is employed at each service point. Riders, such as off-peak, may allow for additional cost savings by changing the operation schedules. Consolidation of service points, if feasible, may result also in cost reductions in some cases.

Water System Recommendations — (a) Water storage offers savings in electricity demand costs associated with pumping by allowing water to be pumped during off-peak hours.

(b) Each system operation should be studied to assure efficient operation of facilities. Sometimes, due to system designs, operation of two pumps on a system does not double water output. It would be more efficient to use one pump for longer periods in these instances.

(c) Filter plant installations should use KW demand monitors and peak demand controllers to allow better scheduling of operations. Some functions may be deferred, and used to level the electrical loading at the facility.

(d) Fuel-fired pumps, which exist in many installations as back-up units, may reduce annual cost if used to lower peak demand on the facility.

Sewerage System Recommendations— (a) Sewage lift stations typically operate to handle peak water flow requirements. Many storm sewers dump into sanitary systems, and infiltration from sewage covers and system leaks cause unneeded peak loads and KWH consumption on the system. These storm water sources should be eliminated.

(b) Water storage in wet wells and/or allowing water to back up into lines for controlled storage can reduce peak demands.

(c) Aerators at treatment facilities are major energy consumers. These often are allowed to run with little or no attempt from operators to minimize electrical demand or usage. Operators should be provided metering information from effluent quality and electrical consumption in order to level the electrical demands while maintaining acceptable effluent quality.

(d) Waste sludge pumping and incineration may allow demand control by rescheduling these operations to off-peak hours.

Overall, most water and sewage treatment facilities offer some potential for energy cost savings. Reviewing energy consumption patterns, and studying rate schedules and operations may result in savings through reduced energy consumption. Some inefficient operations may be discovered through energy audits. Each individual system should be studied with emphasis placed on conservation of energy instead of peak water flow only.

OUTDOOR LIGHTING

Outdoor lighting of streets, parks, and walkways cannot be considered solely an energy problem since lighting has been related to crime levels, especially in urban areas. Because street lighting uses only three-quarters of one per cent of all energy used nationwide, safety and energy conservation both should influence street lighting decisions. Some communities responded to the energy crisis of 1973-1974 by deactivating portions of their street lighting; however, safety factors and the low level of energy savings caused most of the lighting to be reactivated within a short period of time. Although turning off lights is an effective means to dramatize the need to conserve energy, a more practical approach would be to design and install a system which efficiently meets lighting requirements, and maintains the system properly.

General guidelines for communities seeking energy conservation opportunities in their street lighting include:

- Consider public safety factors as well a energy savings before deactivating any street lighting. Consult with police and citizens in any decision.

- Improve or replace older, obsolete, or inefficient lighting.
- Use efficient light sources for replacement.
- Design future street lighting for maximum energy efficiency.
- Maintain the lighting system properly to realize maximum illumination from equipment.
- Work to convert to efficient systems on an accelerated schedule, where possible, but consider the costs of replacing existing systems.

The basic resource for designing street lighting to meet community needs is the American National Standard Practice for Roadway Illumination, sponsored by the Illuminating Engineering Society (IES) and the American National Standards Institute (ANSI). This standard includes recommendations of minimum levels of illumination for many different classifications of public streets. The energy use characteristics of the particular type of equipment used to meet the desired level of illumination must also be carefully considered. For example, mercury vapor lamps use about half as much energy as incandescent lamps, while high pressure sodium vapor lamps use about one-quarter as much to produce the same lighting levels. Since incandescent street lights represent about one third of the power usage of street lighting nationwide, there is a significant opportunity to both improve lighting and conserve energy. However, care must be taken since simply putting in brighter luminaires could lead to more variations in lighting levels and less safety. The uniformity (ratio of average illumination to lowest) should be less than 6:1 on residential streets and 3:1 on arterials.

Lighting decisions should not be made solely on the basis of the highest lumens per watt of the light source. The lamp and luminaire should be considered as a single unit since the efficiency ratio changes under some conditions from that of the lamp alone. Another factor to consider is the use of control equipment which is capable of dimming or deactivating some portions of the lighting system during off-peak hours. For nighttime recreation sites, such as tennis courts, light dimming equipment can reduce energy use when the site is not in active use. Playground lights can be coin-operated so that users can activate them.

The illumination level produced by the lighting system is greatly affected by maintenance, since dirt can reduce the light output of a luminaire. Luminaires also are affected by wind and rain, and should be cleaned regularly. Lamps should be replaced regularly to maintain lighting levels.

Other specific suggestions for more efficient lighting are listed below:

- Phase out inefficient incandescent systems. Convert to mercury, metal halide and sodium light sources.

- Replace old poles with more efficient higher poles. This also increases uniformity.
- Replace ornamental lanterns or globes which have no optical distribution system. These units direct only 11 per cent of the light to the street while the remaining illumination causes glare or merely lights up the sky.

REPORTING RESULTS AND RECOGNITION

One of the most important functions of the overall energy management program is the reporting system. All information should come through the Energy Conservation Manager's office from all sectors of the city's operation: department heads, accounting staff, maintenance personnel, and building occupants.

A monitoring system will need to be established to audit energy purchases on a monthly basis. Posting of the billing data will allow each department head the op-

COMPARISON OF TYPICAL LAMPS AND LUMINAIRES UTILIZED IN STREET LIGHTING

OPERATING CHARACTERISTICS	MERCURY VAPOR	METAL HALIDE	HIGH PRESSURE SODIUM	LOW PRESSURE SODIUM
Rated watts	400	400	250	135
Total watts input (typical)	460	454	307	196
Mean lamp output (lumens)	17,200	24,100	23,200	21,500
Mean lumens per watt	37	53	76	110
Light on street*	1.00	1.26	1.32	.70
Light behind curb*	1.00	.98	1.15	1.79
Light diffused upward*	1.00	1.14	1.02	1.35
Color of light	Bluish White	Pinkish White	Golden White	Yellow (monochromatic)

*Mercury vapor output used as base for comparison portunity to note unusual demands or consumptions appearing on their monthly statements. When approved, the information should be forwarded to the Energy Conservation Manager's office.

In analyzing the billing data, it is essential that information reflecting weather conditions be considered. This information is available from the weather bureau as degree-day information. Other data, such as operating procedures and maintenance schedules, is needed to evaluate the cause of changes observed in the energy usage of a given building. Any unexplained increase often may be traced to a maintenance problem which should be corrected.

The energy manager should use positive results in the energy reports to promote and emphasize the conservation program. An award system can have financial awards or plaques and trophies given to the winners. When a building meets its energy conservation goal, everyone who had a part in attaining this goal should get the deserved credit. The initial announcement of the program and the rules and guidelines should be publicized wisely through in-house publications, staff meetings, and bulletin boards. Also, every community resource should be used to make the program highly visible to the general population. To be successful, the program needs to give publicity to not just the community, but the individual buildings and the particular persons instrumental in reaching these desired results.

COMMISSION ON ENERGY

A Commission on Energy should be created as an official arm of the city government by resolution of the governing body. Appendix II is a model resolution for this purpose.

The members of the Commission on Energy should be appointed for a term of at least one year, and preferably no longer than three years (to involve more people), should number at least five but no more than fifteen, and should be representative of the community. It is extremely important for the members to be interested in and enthusiastic about energy conservation. It also is recommended that some members have technical background, such as plant engineers, science teachers, heating and cooling dealers, so that technical problems can be better understood and dealt with by the commission.

The general objective of the Commission on Energy is to encourage the community to reduce energy consumption, perhaps by a stated percentage on an annual basis. Because of the general increase in economic activity each year such reductions may be difficult to measure except on a per capita basis. Most utilities are able to provide data in this manner (e.g., average annual KWH consumption by residence).

Summarizing the broad functions of the Commission on Energy:

1) To establish specific energy conservation objectives for the community.
2) Develop community awareness in energy conservation.
3) Study energy consumption patterns and problems affecting the community.
4) Recommend local energy policy and programs.
5) Monitor the city's energy management program.

Specific details of the responsibilities and proposed activities of such commissions will be explained further in workshop materials.

WORKSHOPS AND TECHNICAL ASSISTANCE

The purpose of the workshops is to provide local officials with an overview of energy conservation programs and their relationship to the State Energy Conservation Plan and national energy efforts, and to provide local officials with information on energy conservation opportunities in municipal facilities and operations and the community in general.

Regional workshops will be conducted in selected locations around the state within convenient commuting distance of the participating cities. They will be less than one day in length and should not require any overnight travel by participants.

There will be two types of workshops:

1) **For elected officials and members of energy commissions** (dealing generally with the objectives of an energy program at the community level and the particulars involved in implementing the program).

2) **For city employees** (more technical in nature —on such matters as auditing and management of specific city facilities and operations).

These workshops will be conducted by the University of Tennessee's Center for Government Training and an effort will be made to obtain workshop leaders who will be competent to answer technical questions. By attending the workshops and using the printed information, city officials will be assisted significantly in implementing an effective energy management program.

APPENDIX I

MODEL STATEMENT OF POLICY ON ENERGY CONSERVATION

BACKGROUND

Prior to 1973, citizens of the City of ______________ enjoyed plentiful and inexpensive energy supplies. Since then, our dependence on foreign energy supplies has grown while the assurance of meeting our needs for energy has diminished. It has, therefore, become increasingly important to optimize the use of existing supplies of energy as well as to seek alternate energy sources.

PURPOSE

The citizens of the City of ______________ require an adequate and reliable supply of energy. Shortages of energy, such as have been experienced recently, wil undoubtedly be repeated in the future and may become more severe. Such shortages negatively affect the local economy and hamper the delivery of essential public services. It is therefore necessary that guidelines for the conservation of energy be established by the City, within the areas of its authority, so that optimum use is made of available energy supplies.

POLICY

The extent of the City's impact on energy conservation varies with the degree of its authority in specific areas of energy consumption. The policy of the City in these areas is as follows:

A. City Operations

1. **Budgeting**
   It is the policy of the City to budget the amount of energy for each facility, department, and operation at the beginning of each fiscal year.
2. **Purchasing**
   It is the policy of the City that in the purchase of equipment and materials, the long-range potential for energy savings shall be evaluated in addition to the initial cost.
3. **Construction**
   It is the policy of the City that specifications for public facilities be continually reviewed so that the most current energy conservation techniques, materials, and appliances are utilized in their construction.
4. **Building Maintenance and Operations**
   It is the policy of the City that all its buildings will be maintained and operated in such a fashion that the minimum amounts of energy are consumed. Buildings should not be heated above 68 degrees F, nor cooled to reduce the temperature therein below 78 degrees F.
5. **Vehicles**
   It is the policy of the City to utilize vehicles which consume the least amount of energy for the nature of work they are to perform, and to maintain and operate these vehicles in such a manner as to insure maximum energy conserving performance. To the extent practically feasible, City employees will utilize alternatives (telephone, mail, etc.) to vehicles in the performance of their work.
6. **Solid Waste Management**
   It is the policy of the City to actively promote solid waste energy conservation systems.

7. **Innovative Projects**
It is the policy of the City to pursue the innovative application of new energy sources (e.g., solar energy) and techniques in the provisions of its regular municipal functions.

B. City Regulated

1. **Urban Development**
It is the policy of the City to foster patterns of urban development that minimize vehicular travel generated without significantly impairing the City's ability to function, or the quality of life presently experienced by residents and visitors.

2. **Transportation**
It is the policy of the City that programs be developed in cooperation with other governmental agencies, as well as the private sector, that will provide safe and energy-efficient transportation within the region. These programs shall consist of, but not be limited to, the following:
a) Carpool programs
b) Non-motorized transportation programs
c) Traffic signal coordination programs
d) Elimination of energy consuming traffic flow restrictions
e) Applications of innovative traffic operation techniques
f) Reduction in street lighting energy consumption without detrimentally affecting public safety
g) Transit development programs

3. **Building Code Revisions**
It is the policy of the City to continually evaluate and update the Building Code so that the most current energy conservation techniques, materials and appliances are utilized in the construction of buildings by the private sector, keeping in mind the goal of providing housing at the lowest possible cost.

C. Indirect Influence

1. **Legislation**
It is the policy of the City to support state and federal legislation to conserve energy, while at the same time attempting to preserve the quality of life of the citizens of the City.

2. **Lighting on Private Property**
a) Signs
It is the policy of the City to encourage the moderate use of sign illumination.
b) Ornamental
It is the policy of the City to encourage reduced use of ornamental lighting.

3. **Heating and Cooling**
It is the policy of the City to urge citizens not to heat homes or buildings above 68 degrees F, nor to provide cooling to reduce temperatures therein below 78 degrees, F, except where other temperatures are necessary for health or safety reasons.

4. **Automobiles**
It is the policy of the City to encourage its citizens to limit the non-essential use of automobiles and to use mass transit or other forms of energy-efficient transportation whenever possible. In lieu of vehicles, alternate modes (telephone, mail, etc.) also should be considered.

5. **Public Education**
It is the policy of the City to create a Commission on Energy to actively promote the dissemination of energy conservation information to the citizens of the City and to encourage implementation of energy savings programs.

APPENDIX II

MODEL RESOLUTION

WHEREAS, the citizens of ______________________ require a reliable and adequate supply of energy, and

WHEREAS, the conservation of energy is a matter of urgent concern at the local, state and national level of government, and

WHEREAS, the Mayor and governing body of __________ wish to take necessary and practical steps to conserve energy,

NOW, THEREFORE, BE IT RESOLVED that:

1. A Commission on Energy shall be appointed by the Mayor, to be confirmed by the governing body, to:
   a) Establish energy conservation goals for the community
   b) Develop community awareness in energy conservation
   c) Study energy consumption patterns and problems affecting the community
   d) Recommend local energy policy and programs
   e) Monitor the city's energy management program.

   The Commission shall report on its activities on a quarterly basis to the Mayor and governing body.

2. The Commission on Energy shall consist of __________ members who will be appointed for a term of __________ years. The Mayor shall establish a pattern of staggered terms by initial appointments for variable years so that as nearly as practicable an equal number of terms will expire each year. The Commission shall elect a Chairman, Vice Chairman and Secretary from among its members.

BE IT FURTHER RESOLVED that the City requests other organizations, such as the Planning Commission, the Industrial Development Corporation, Civil Defense, educational institutions, and other agencies to cooperate fully with the Commission on Energy in developing an effective conservation program for ______________ , and that all appropriate organizations be advised of the creation of the Commission and the policies of the City on energy by copies of this Resolution.

APPENDIX III

DIRECTORY OF FEDERAL AGENCIES RELATED TO ENERGY CONSERVATION

Regional Office
U.S. Department of HUD
Room 211 Pershing Point Plaza
3171 Peachtree Street, NE
Atlanta, GA 30303
404/526-3521

Southeastern Federal Regional Council
101 Marietta Tower Suite 2121
Atlanta, GA 30323
404/221-4162

U.S. Department of Energy
1655 Peachtree Street, NE
Atlanta, GA 30309

Economic Development Administration
1365 Peachtree Street, NE
Atlanta, GA 30303
404/656-3545

Environmental Protection Agency
Resource Recovery Division
1835 K Street, NW
Washington, DC 20006
202/386-6102

Federal Power Commission
Union Center Plaza, 825 N. Capitol St NE
Washington, DC 20426
202/386-6102

General Services Administration
Federal Supply Service
18th and F Streets, NW
Washington, DC 20406

General Services Administration
Public Buildings Service
18th and F Streets, NW
Washington, DC 20406

Department of the Interior
Office of Coal Research
2100 M Street, NW
Washington, DC 20027
202/343-5594

Department of Transportation
400 Seventh Street, SW
Washington, DC 20590

Energy & Environment Division
202/427-2022

Urban Mass Transportation Adm.
Research Dev. & Demonstration Programs
202/426-4043

Urban Planning Division
Federal Highway Administration
202/426-0210

National Science Foundation
1800 G Street, NW
Washington, DC 20550

Office of Public Technology Programs
202/632-4175

Division of Advanced Energy Research
& Technology
202/632-9793

Office of Systems Integration & Analysis
202/632-4032

Law Enforcement Assistance Administration
Emergency Energy Committee
633 Indiana Avenue, NW
Washington, DC 20530
202/386-4551

National Bureau of Standards
Center for Building Technology
Building 226, Room B-244
Washington, DC 20234
301/921-3377 (Gaithersburg, MD)

National Bureau of Standards
National Conference of States on Building
Codes and Standards
Building 226
Washington, DC 20234
202/921-3447

Oak Ridge National Laboratory
Energy Division
Post Office Box X
Oak Ridge, TN 37830
615/483-8611

Community Services Administration
Southeastern Regional Office
101 Marietta Building
Atlanta, GA 30303

APPENDIX IV

GLOSSARY OF TERMS

AIR ECONOMIZER—A simple device that improves system operations; it continuously monitors the outdoor comfort zone by drawing air into the mechanical unit from the outside instead of through the return air system.

BALLAST—A device used in a starting circuit for fluorescent and other types of lamps.

BARRELS (BBLS)—One barrel equals 41 gallons.

BIOMASS—The total mass or amount of living organisms in a particular area or volume.

BOILING-WATER REACTOR (BWR)—A type of nuclear power reactor in which the steam produced by water flowing through the core is used to drive a turbine directly.

BRITISH THERMAL UNIT (BTU)—The amount of energy necessary to raise the temperature of 1 pound of water by 1° Fahrenheit at or near 39.2°F.

BUILDING ENVELOPE—The exposed surfaces of a building except openings for windows, skylights, and doors.

COAL—A solid, combustible, organic material formed by the decomposition of vegetable material without free access to air.

COAL GAS—An artificial gaseous fuel produced by heating coal in the absence of oxygen. This fuel, known as town gas, can supply about 450 BTU per standard cubic foot. Use of coal gas in the United States ceased when inexpensive natural gas became widely available.

CRUDE OIL—Petroleum liquids as they come from the ground. Petroleum liquids were formed from animal and vegetable material which collected at the bottom of ancient seas.

DEGREE DAY—A unit representing one degree of declination from a standard temperature on the average temperature of one day, used in determining fuel requirements.

DEHUMIDIFY—To remove moisture from the air.

ENERGY—Energy is the capacity for doing work, and therefore, energy and work are measured in the same units. Commonly used units of work and energy are the joule, BTU, calorie, foot-pound, electron volt, watt-hour, and kilowatt-hour (kwh).

ENERGY EFFICIENCY RATIO—Operating efficiency of the equipment (EER).

FLAT PLATE COLLECTOR—Used for the collection of solar radiation; consists of an absorber plate and working fluid which passes through or near the absorber plate and then is transported to points of use or storage.

FOOTCANDLE—A measure of illumination produced on a surface all points of which are one foot from a directionally uniform point.

FOSSIL FUELS—Fuels dug from the earth, i.e., coal, petroleum, and natural gas.

FUEL CELL—A device in which hydrogen is fed to an electrode where it is catalytically converted to hydrogen ions, releasing electrons to flow through an external circuit (the load). The electrons flowing through the external circuit constitute an electronic current. When they return to another electrode in the fuel cell they combine with oxygen atoms which in turn migrate to the first electrode and unite with hydrogen ions to form water. The process is, essentially, the reverse of electrolysis.

FUEL OILS—Fuel oils are the petroleum fractions with a higher boiling range than kerosene. They are generally classified as distillates or residuals. Distillates (Nos. 1, 2, and 4) are the lighter oils used primarily for central heating of homes, small apartment houses, commercial buildings, and for transportation. Residuals (Nos. 5 and 6), often called bunker oils, are heavier, high viscosity oils which usually need to be heated before they can be pumped. They are used in industry, large commercial bulildings, and for the generation of electricity.

GEOTHERMAL ENERGY—Heat energy in the crust of the earth believed to have been produced by natural radioactivity. The thermal gradient of the earth's crust is such that the temperature in a deep well or mine increases by about 1°F for each 100 feet of depth. At a place where the average surface temperature is 50°F a temperature of about 212°F could be expected at a depth of about 16,000 feet.

HEAT EXCHANGER—A device for transferring heat energy to a cooler medium from a warmer one.

HEAT PUMP—Utilizes refrigeration equipment to achieve desired temperature level; removes heat from outdoor (indoor) air to heat (cool) the indoor environment.

HEAT REFLECTIVE GLASS—Glass coated with a metallic film. Heat reflective glass can reduce solar gains by as much as 90 per cent over ordinary glass.

HVAC—Abbreviation for heating, ventilating, and air-conditioning system.

HYDROELECTRIC—Producing, or having to do with the production of electricity by water power or by the friction of water or steam.

INFILTRATION—The leakage of air into a building through cracks around doors, windows, etc. (usually undesirable).

INSULATING GLASS—Glass composed of double panes sandwiching an air space. Insulating glass has approximately twice the thermal resistance of single pane clear glass.

KEROSENE—The petroleum fraction containing hydrocarbons that are slightly heavier than those found in gasoline and naptha, with a boiling range between 180 and 300°C. Used today as fuel for gas turbines and jet engines.

KILOWATT (KW)—The unit of power equal to 100 watts. Roughly a power of 1 kw is capable of raising the temperature of a pound (pint) of water 1°F in one second.

KILOWATT-HOUR (KWH)—The amount of work or energy delivered during the steady consumption of 1 kilowatt of power for a period of 1 hour.

LIFE CYCLE COSTING—The analysis of an investment over its economic or useful life, based on the present value concept.

LIQUEFIED NATURAL GAS (LNG)—Natural gas that has been cooled to about -160°C for storage or shipment as a liquid. Liquefaction greatly reduces the volume of a gas and, thus, the cost of shipping and storage is reduced.

LIQUEFIED PETROLEM GAS (LPG)—Consists of propanes and butanes recovered from natural gas and in petroleum refining. Its energy content ranges between 2,000 and 3,500 BTU per standard cubic foot. Sometimes called "bottled gas." Used widely as a fuel for internal combustion engines when pollution must be minimized and as a substitute for natural gas in areas not served by pipelines.

MEGAWATT (MW—A unit of power equal to 1000 kilowatts or 1 million watts.

NAPTHA—A petroleum fraction with a boiling point ranging from 125° to 240°C. Its principle uses are in solvents, paint thinners, and as a raw material for the production of organic chemicals. It is expected to be used more and more as a raw material for the production of synthetic natural gas.

NATURAL GAS—A gaseous fossil fuel usually found associated with oil. It is made up of about 60% to 80% methane, 5% to 9% ethane, 3% to 18% propane, and 2% to 14% heavier hydrocarbons. Some nonhydrocarbons such as nitrogen, carbon dioxide, and hydrogen sulfide are sometimes present. Propane and the heavier hydrocarbons are usually removed and sold as liquefied petroleum gas. Pipeline natural gas is principally methane and has an energy content of 980 to 1050 BTU per standard cubic foot.

OIL SHALE—A sedimentary rock which contains an oil-yielding organic material called kerogen. When heated, oil shale may yield as much as 60 gallons of oil per ton of rock.

PASSIVE SOLAR SYSTEM—Uses solar energy alone for the transfer of thermal energy.

PHOTOSYNTHESIS—The process in which sunlight falling on green plants causes carbon dioxide and water to be converted into more complex organic materials such as glucose.

PHOTOVOLTAIC CELL—A type of semiconductor device in which the absorption of light brings about a separation of electric charges. Such a separation produces a voltage which can be used to set up an electric current in an external circuit, thus, directly converting radiant energy to electrical energy. Materials which can be used in the construction of photovoltaic cells are silicon, cadmium sulfide, and gallium arsenide.

POWER—The rate at which work is done; therefore, the rate at which energy is transferred. Power is measured in units of work per unit of time. Typical units are the watt and the horsepower.

PUMPED HYDROELECTRIC STORAGE—The only means now available for the large-scale storage of electrical energy. Excess electricity produced during periods of low demand is used to pump water up to a reservoir. When demand is high the water is released to operate a hydroelectric generator. Pumped energy storage returns only about 66% of the electrical energy put into it, but costs less than an equivalent generaating capacity.

QUAD—Quadrillion Btu; one million billion; 10^{15}.

R VALUE—The resistance of a material to heat transfer.

RETROFIT—A change in design, construction, or equipment already in operation, in order to incorporate later improvements.

SOLAR WINDOW—The sun's path between certain hours that forms limits for useful solar collection.

STANDARD CUBIC FOOT (SCF)—The amount of gas contained in a volume of 1 cubic foot under a pressure of 1 atmosphere (14.73 pounds per square inch) at a temperature of 60° F.

SYNTHETIC NATURAL GAS (SNG)—A gaseous fuel manufactured from naptha or coal. It contains 95% to 98% methane, and has an energy content of 980 to 1035 BTU per standard cubic foot, about that of natural gas.

THERMAL INSULATION—Resistance to heat flow; material used to resist the flow of heat through a building's walls, floor, and roof.

THERMAL RESISTANCE—The ability to resist the flow of heat.

WATT (W)—A unit of power equal to the transfer of 1 joule of energy per second. The watt is the unit of power most often associated with electricity (1 horsepower = 746 watts).

COMMONLY USED ABBREVIATIONS

bbls—barrels (a barrel contains 42 gallons)
kw—kilowatt
kwh—kilowatt-hour
mcf—1,000 cubic feet (of gas)
mw—megawatt, 1 million watts
Btu—British Thermal Unit
therm—a unit of energy used for natural gas equal to 100,000 Btu

Numerical abbreviation: Very often you will see energy expressed in numerical form—e.g., 10^6 Btu. This is a convenient way of expressing the large numbers such as millions, billions, or even quadrillions involved in measuring energy, instead of using many zeros. It is in a formula which indicates the multiples of 10 used to arrive at these large numbers. For example:

$1{,}000 = 10 \times 10 \times 10 = 10^3$

$1{,}000{,}000 = 10 \times 10 \times 10 \times 10 \times 10 \times 10 = 10^6$

ENERGY CONVERSION TABLE

To Convert From	To	Multiply by
kilowatt-hour	Btu	3,412.8
1 ton bituminous coal	Btu	26,200,000
1 bbl crude oil	Btu	5,600,000
1 bbl residual oil (No. 5)	Btu	6,290,000
1 gallon gasoline	Btu	125,000
1 gallon No. 2 fuel oil	Btu	138,800
1 cubic foot natural gas	Btu	1,031
1 Mcf natural gas	Btu	1,031,000
1 therm natural gas	Btu	100,000
1 Btu	Kwh	0.000293

APPENDIX V

HISTORICAL ENERGY CONSUMPTION PATTERNS

YEAR	PER CENT FUELWOOD	PER CENT COAL	PER CENT NATURAL GAS	PER CENT HYDROPOWER	PER CENT NUCLEAR
1860	83.5	16.4	0.1	—	—
1880	57.0	41.1	1.9	—	—
1900	21.1	71.3	5.0	2.6	—
1920	7.5	72.8	16.1	3.6	—
1940	5.3	50.1	40.9	3.7	—
1950	3.3	36.7	55.9	4.1	—
1969	—	22.8	73.5	3.7	—
1970	—	18.9	76.8	4.0	0.3
1975	—	18.2	74.6	4.6	2.6
1976	—	18.6	74.5	4.2	2.7

Sources: Bureau of Census; Bureau of Mines.

DOMESTIC ENERGY CONSUMPTION BY ECONOMIC SECTOR

PER CENT OF TOTAL

YEAR	COMMERCIAL/ RESIDENTIAL[1]	INDUSTRIAL[1]	TRANS-PORTATION[1]	ELECTRICITY GENERATION	MISCELLANEOUS & UNKNOWN[1]
1950	22.3	36.3	25.3	14.7	1.4
1955	21.6	35.2	24.8	16.6	1.8
1959	22.8	32.9	24.3	18.5	1.5
1961	22.9	32.3	24.2	18.8	1.8
1962	23.1	32.2	24.0	19.2	1.5
1963	22.3	32.3	24.3	19.6	1.5
1964	21.7	32.6	23.9	20.3	1.5
1965	22.2	32.2	23.8	20.8	1.0
1966	22.0	32.0	23.6	21.4	1.0
1967	22.3	31.3	24.1	21.8	0.5
1968	21.2	31.4	24.5	22.5	0.4
1969	20.9	30.9	24.3	23.5	0.4
1970	20.8	30.1	24.6	24.2	0.3
1971	20.7	29.1	24.8	25.1	0.3
1972	20.3	28.5	25.1	25.8	0.3
1973	19.1	28.6	25.3	26.6	0.4
1974	19.1	27.9	25.3	27.4	0.3
1975	19.2	25.4	26.3	28.7	0.4
1976	20.2	25.4	25.6	28.8	(2)

[1]Does not include electricity.
[2]Distributed throughout other sectors.
Sources: Bureau of Mines, 1950-1975; FEA, 1976.

TOTAL DOMESTIC ENERGY PRODUCTION

PER CENT OF TOTAL*

YEAR	CRUDE OIL[1]	COAL	MARKETED NATURAL GAS[2]	HYDROELECTRIC POWER	NUCLEAR POWER
1950	33.3	42.7	19.9	4.1	—
1955	37.0	32.6	26.9	3.5	—
1960	35.3	26.8	34.0	3.9	(3)
1961	35.9	25.4	34.8	3.9	(3)
1962	35.3	25.5	35.0	4.1	0.1
1963	34.2	26.5	35.4	3.8	0.1
1964	32.9	27.0	36.0	4.0	0.1
1965	32.4	27.3	36.0	4.2	0.1
1966	32.6	26.7	36.6	4.0	0.1
1967	33.0	25.9	36.6	4.3	0.2
1968	32.9	24.7	38.1	4.1	0.2
1969	32.2	24.2	38.9	4.5	0.2
1970	31.9	24.5	38.9	4.2	0.4
1971	31.7	22.4	40.7	4.6	0.6
1972	31.2	23.4	39.9	4.6	0.9
1973	30.6	23.3	40.1	4.6	1.4
1974	30.3	23.9	38.7	5.2	2.0
1975	29.5	25.6	36.6	5.3	3.0
1976	28.8	26.4	36.3	5.1	3.4

[1]Includes lease condensate, excludes natural gas plant liquids.
[2]Wet natural gas.
[3]Less than one-tenth of one per cent.
*Numbers will not add up to 100 due to rounding.
Source: Department of the Interior.

U.S. OIL IMPORTS

YEAR	TOTAL[1] IMPORTS (MBBL/D)	TOTAL CRUDE (MBBL/D)	TOTAL[2] PRODUCT (MBBL/D)	TOTAL (PER CENT OF DEMAND)	OPEC IMPORTS[3] (% OF ALL IMPORTS)	ARAB OPEC IMPORTS[3] (% OF TOTAL IMPORTS)	PAYMENTS FOR IMPORTS[4] (MILLIONS OF DOLLARS)
1960	1.8	1.0	0.8	19.8	71.9	16.0	1,543
1961	1.9	1.0	0.9	19.5	67.0	14.8	1,674
1962	2.1	1.1	1.0	20.3	60.7	11.5	1,810
1963	2.1	1.1	1.0	20.2	60.4	12.0	1,824
1964	2.3	1.2	1.1	20.9	60.2	13.0	1,904
1965	2.5	1.2	1.2	21.8	59.2	12.5	2,095
1966	2.6	1.2	1.3	21.7	58.0	11.8	2,124
1967	2.5	1.1	1.4	20.2	49.5	6.9	2,091
1968	2.8	1.3	1.6	21.2	45.8	9.5	2,384
1969	3.2	1.4	1.8	22.4	42.2	8.7	2,649
1970	3.4	1.3	2.1	23.3	37.8	5.7	2,929
1971	3.9	1.7	2.2	25.8	43.2	8.9	3,649
1972	4.7	2.2	2.5	29.0	43.6	11.2	4,651
1973	6.3	3.2	3.0	36.1	47.6	14.6	8,414
1974	6.1	3.5	2.6	36.8	53.3	12.2	26,592
1975	6.0	4.1	1.9	36.8	59.5	22.9	27,018
1976	7.3	5.3	2.0	42.0	67.2	32.1	34,643

[1]Numbers will not add up due to rounding.
[2]Includes unfinished oil, natural gas liquids, and plant condensate.
[3]Excludes indirect imports; includes imports from sources that were included in OPEC and Arab OPEC memberships as of December 31, 1976.
[4]Figures for 1960-66 exclude imports into U.S. territories and associated areas; all figures exclude military grant shipments.
Sources: Bureau of Mines; Department of Commerce for payments.
MBBL/D = millions of barrels per day.