INTERNATIONAL ENERGY AGENCY
energy conservation
in buildings and community
systems programme

ANNEX XIII - «ENERGY MANAGEMENT IN HOSPITALS»

A GUIDE FOR ENERGY MANAGEMENT IN HOSPITALS

BOOKLET I

INTRODUCTION TO THE BOOKLETS AND THE MANAGEMENT PERSPECTIVE

PFE
Via Nizza, 128
00198 Roma
Dicembre 1989

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TABLE OF CONTENTS

CONTENT OF THE SIX BOOKLETS

Booklet I

Introduction to the Booklets and the Management Perspective

E

Object of this Booklet is helping Institutions to identify the requirements, fund structures which support the initiatives, carry out certain procedures and ensure that the comfort of the facility is maintained, as well as the proper service, and energy with its associated cost is minimized.

Objectives of an Energy Management Program are reported, with indications for the development of such program.

Practical worked examples for Energy Conservation Opportunities are also included.

Content:

Booklet II

Heat Generation and Distribution
Cold Generation and Distribution

G

The main objectives of this Booklet are to provide a sound basis for the approach of thermal energy management, including both heat and cold generation; it is divided in three main parts: heat generation, heat distribution, cold generation and distribution.

The heating energy may be supplied by means of conventional boilers, heat pumps, or through a district heating system.

The cooling energy is usually provided by chillers equipped with compression or absorption cycles.

E

All systems are described, in order to understand their principles and mode of operation, pointing out how to act on them, in order to attain an energy efficient operation.

Energy Saving Opportunities are reported, mostly with minor changes on existing installations.

Content:

Booklet III

Heating, Ventilating, Air Conditioning
Domestic Hot Water

E

The Booklet focuses on the requirements of the various zones of a hospital, and how they can be met in an energy efficient way, by means of Heating, Ventilating, Air Conditioning systems (**HVAC**).

Detailed description of such systems is reported with indications of the Standards and special requirements specified for hospitals.

Examples of Energy Conservation Opportunities for the management and maintenance of systems are also included.

A chapter deals with Domestic Hot Water (**DHW**) production and distribution, referring to the hospital requirements, pointing out the problems related to an energy efficient operation of this systems.

Content:

Booklet IV

Electrical System

This booklet aims to give practical assistance to the technical hospital staff, with the intent to reduce electricity cost, describing possibilities for an efficient and cost-saving use of electrical energy in hospitals.

E

The electricity supply system from the public grid to the individual users or groups of users within the hospital is examined, specially relating to electricity consumption.

Examples of practical cases are also reported.

Lighting is treated in a separate chapter.

Content:

Booklet V

Services

In this Booklet are considered the auxiliary systems which are generally present in hospitals, such as: hospital medical equipment, laundry, kitchen, sterilization.

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A description of all systems considered is reported, with indication of amount of energy required in each case.

For each system, Energy Conservation Opportunities are included, both in the purchasing phase and during operation, in order to reduce the energy cost.

Content:

Booklet VI

Building Envelope

ℰ

This Booklet treats the problems related to the losses of energy occurring through the building envelope, which includes: walls, windows, roofs, floors, and fresh air intakes.

For hospital buildings, the following items have been considered: air infiltrations, walls, floors, roofs, windows.

Energy Conservation Opportunities are reported, with the aim to attain reductions in the energy required for the operation of HVAC systems in these buildings.

Content:

FOREWORD

The aim of these manuals is to provide hospitals with the methods and procedures to operate their building's systems and equipment efficiently and thereby reduce their energy consumption and cost. The material presented represents the accumulated knowledge and experience of the experts taking part in the work.

The work was started in 1985 based on an agreement among six countries. In total, eight meetings were held of the formal working group.

The names and the affiliation of the experts that have taken part in this work can be found at the end of this Forward. They represent a wide spectrum of backgrounds, from hospital personnel to researchers, educators and consultants.

Effective energy management is a blend of technology, experience, knowledge, operating efficiency and investment. Depending on the mix of these in a particular institution, one can achieve a high degree of energy efficiency, management and cost effectiveness. The key word is management. The operative phrase is cost effective energy management. Inefficient operations leads to wasted energy and monies. It also increases the cost of maintenance.

These books have been written with a view toward helping the institution identify the requirements, fund a structure which supports the initiatives, carry our certain procedures and ensure that the comfort of the facility is maintained, the proper services are maintained and the energy with its associated cost is minimized.

Since many countries participated in the writing of these handbooks, national differences will arise. The reader and practitioner is advised to use due consideration.

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CHAPTER 1. BACKGROUND

1. General

In the wake of the 1973/74 energy crisis twenty-one (21) industrialized countries reached an agreement to cooperate on energy policy. The agreement embodied in an **International Energy Program** is administered by the International Energy Agency (IEA) which was established in Paris as an autonomous body within the Organization for Economic Cooperation and Development (OECD).

One of the basic elements of this program is cooperation among IEA participating countries to reduce excessive dependency on oil through energy conservation.

In a meeting held in Vienna on April 11-12 1983, the problem of energy consumption in hospitals was considered; a second workshop took place in Mülheim (F.R.G.) on October 13-14 1983, where guidelines were settled for the prospective activity in this field.

A committee of IEA on Energy Conservation in Buildings and Community Systems established Annex XIII - Energy Management in Hospitals in 1984 and the first working meeting was held on July 4-5 1985; the goals and objectives of Annex XIII are:

- find appropriate parameters for describing the energy consumption of hospitals
- provide the Participants with generalized information of the energy saving potential of different measures which can be taken in hospital buildings and systems
- define a methodology for estimating the energy saving potential in specific hospital buildings and systems
- compile a "Handbook" for hospital energy managers, directors of physical plant and financial and other management personnel
- provide maintenance directions to assist in operating systems and equipment efficiency.

B

1.1 Booklets

The results of the research, deliberations and cooperation of the Annex XIII participating countries is embodied in six Booklets, each one dealing with a specific subject, according to the previously reported list (see "Content of the Six Booklets").

Annex XI - "Energy Auditing" - produced "Source Book for Energy Auditors" Volume 1 & 2, which provided much useful information and would be of assistance to users of these Booklets.

1.2 Structure of the technical chapters

The structure of the technical chapters in each Booklet can be summarized as follows:

1.2.1 Introduction

A short outline of the subject matter to be dealt with in the Booklet.

1.2.2 Description

Description of the process.

A short description of each system is given, with indication of its functions in the hospital, connections with other systems, level of power, etc. A graphical representation, such as a block or box diagram, is also included, wherever possible. The following information is considered necessary:

- delineation of the boundaries of the system considered in the chapter, as far as energy utilization concerns,
- flow of energy (electrical, chemical, mechanical, thermal) as well as flow of materials, and
- definition of the various components and elements of the systems, with their main characteristics.

Boundaries in a sketch (with comments)

- Energy flows (principle)
- Mass flows (principle)
- Power demand pattern

1.2.3 Strategy

Strategy refers to the organization of an efficient energy management program, and the provision of the means for achieving the objectives of this program.

The strategy must define and specify actions directed to reduce energy consumption to increase the life of the equipment, and to identify the personnel needed to carry out the work. The following four stages are considered:

- measurement
- check with target values
- actions, and
- follow-up

Important parameters for the energy consumption.

Efficiencies (concept, definition).

Target values

Data resulting from measurement must be compared with existing "target values" which represent standard and accepted levels of energy consumption for typical systems or equipment.

In case of ascertained difference actions must be undertaken in order to modify the situation so as to achieve better results from and energy standpoint.

Such actions may be taken in four different categories, with costs and difficulty increasing accordingly:

- maintenance
- operation
- improvement, and
- replacement

Measurement (principle)

Monitoring of each system is necessary in order to ensure that it is operating according to specifications. The following items should be taken into account:

- definition of the concept of efficiency of the particular system considered in the chapter,
- definition of the various quantities which may affect efficiency of the various systems, and whose values must be measured, and
- measurements that must be made in accordance with rules given in paragraphs.

Levels of actions to be taken and monitoring after action.

1.2.4 How to save energy with minor changes

What to do: list of maintenance procedures and tuning techniques which may improve the energy savings.

How to do it: practical details of the best way to proceed, including; instrumentation required, recording of key parameters, etc.

1.2.4.1 Maintenance (tune-up)

- what to do?
- sequence of actions
- how to do it

Details about the procedure.

1.2.4.2 Operational changes

- what to do?
- sequence of actions
- how to do it

Details about the procedure.

1.2.5 How to save energy with modification

When such interventions are necessary, outside consultants and contractors are generally required to support the Hospital staff, and to perform this additional work.

Also, it should be pointed out that improvements or substitutions made in one system can often affect other systems.

At this level of intersystems involvements actions must be considered in a different way, i.e. whether or not they have user interaction. In the one case it is purely a technical matter, in the other it involves both technical and human considerations.

1.2.5.1 Modification

- what to do?
- sequence of actions
- how to do it

Details about the procedure

1.2.5.2 Substitution

- what to do?
- sequence of actions
- how to do it

Details about the procedure

CHAPTER 2. INTRODUCTION

2. Introduction

Energy consumed in the operation of health care facilities including Hospital is subject to market place pressures such as supply and demand, pricing variations and changes in quality. In most cases the impact on end use is to increase the cost of operation of the Hospital. Therefore, there is a need to effect sound resource management programs both economic and technical in nature to ensure that the amount of economic resources which must be devoted to this Hospital department is minimized. This Booklet will deal with the economic or administrative aspects of energy management.

Since it is expected that the cost of all forms of energy will escalate and the availability of various forms will vary, every reasonable effort to reduce energy consumption in hospitals should be pursued. Of course, these efforts should not compromise the high standard of patient care. In most instances, energy conservation programs can improve the environment producing energy and costs savings. Savings which are available for other health care programs.

Energy costs as a percentage of total operating cost in Hospitals varies from country to country and from institution to institution. This variation is dependent on pricing structures, age of facility, availability of supply, form of energy, engineering complexity of the facility, etc. Energy costs currently range from 3 % to 5 % of the total operating budget of Hospitals. For facilities without rigorous energy management programs, the conservation potential is in the range of 25 % - 50 % or 0.75 % to 2.5 % of the total operating budget of the Hospital. To put it another way, energy costs range from 10 % to 17 % of the non salary component of the operating budget. Energy costs will be 2 % to 3 % of the total operating budget of an efficiency Hospital.

The cost of wasted energy is only a portion of the cost of inefficient building systems. The dollars employed in salaries and supplies needed to maintain and repair systems may be equal to or greater than the cost of the energy itself. Thus, one should be sensitive to both the people cost, as well as, the energy (utilities) costs. Monies and people saved in the maintenance area will be available for other needs.

Hospitals are complex, often sophisticated types of buildings, and therefore all engineering systems require special consideration because health care services are provided 24 hours a day, seven days a week, throughout the year.

Every hospital is different in terms of its size, the services it provides, and the specialized functions it performs. The design and operation of the various systems installed in a hospital must take into account this very special environment that must meet the multiple needs of the patient, the staff, and the community.

The primary object of these systems is to provide the best, fastest, most comfortable and cost effective health care available.

In all countries there are strict codes and regulations on hospital design,construction and operation, as well as on the mechanical and electrical systems used in the hospitals.

In all hospitals there are many engineering systems and services related to energy consumption whose management can lead to substantial energy wastes or saving.

This Booklet focuses on better approaches to such management. Examples of economically viable energy management investments are also included.

As buildings age, as systems are modified, energy consumption, added maintenance costs tend to increase. These series of Booklets will, hopefully, assist the institution to bring them in line.

2.1 Use of the Booklets

These Booklets are written to help hospitals who are suitably motivated to embark on an energy management program, or are sufficiently concerned to ensure that their facility is being operated efficiently.

The Booklets are designed to be used to effect reductions in energy consumption and save money. Where does an institution start? One starts where the most effective impact and the quickest results are likely to occur.

Fig. 5.1.I and Fig. 5.1.J show the typical energy consumption for hospitals and nursing homes and can be used to help decide where to start. For example, air circulation with heating and cooling consume a major portion of energy. Thus it might be prudent to begin in this area. Likewise lighting.

The priority for Energy Management Strategies are:

1. analysis of contracts for utilized energy carriers

2. proper operation and maintenance of equipment

3. steady monitoring of the function of the equipment, e.g. through a computer aided system

4. investments for constructional and technical changes

These are in order of least initial cost to most cost for program initiatives, and also from highest ratio of gain to cost.

Once the manager has decided to embark on a program, he should assign the appropriate people to study the relevant systems. The manager's tasks are written in Booklet I. For the staff, the person who is responsible for electricity (or lighting) could be given a copy of Booklet IV. If, on the other hand, a person wants to investigate "boilers", he can go to Booklet II, Chapter 1. The manager should study the Table of Contents carefully, to ensure that this people are directed to the relevant material.

A question often asked is: «But my staff are very busy and do not have the time to do this! How can we begin an energy management program?». Can we really save money and when do we get the money to begin?

First it must be understood that energy management saves money. In the short run the improvements in the maintenance procedures do not require extra staff or money. It only means reorganizing one's thinking and work procedures.

The more detailed and engineering intensive initiatives do require money and people. These initiatives in the long run may save people, they will of course save money (assuming that they have been properly costed and implemented).

We can look at the situation with the framework reported in Fig. 2.1.A.

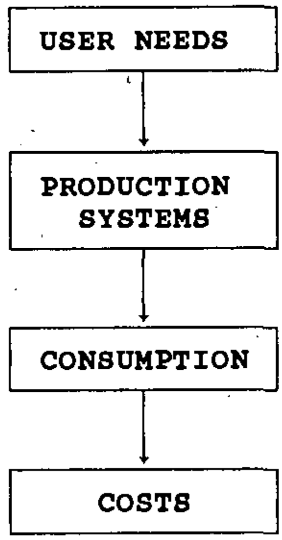

Fig. 2.1.A

First we should be sure that the needs of the users of the facility are properly defined. They should include all the operation requirements but should not include things which are not needed. When needs are overspecified, the cost to provide the services will be higher than necessary.

Having defined the needs, the next job is to design and put in place the production systems, the boilers, lights, operation rooms, offices, etc. Again the opportunity arises to effective efficiency. A good design is an efficient design. If the systems are designed for example such that cooling is used when not needed by users requirement or good design practice, energy and money will be wasted.

The third opportunity for efficiency is in consumption. How you operate the system affects directly the cost. E.g., if you have lights on where they are not needed, than you will be wasting energy and money.

The fourth opportunity is cost directly. Here is meant not only the question of best price for purchasing your energy but also the tariff structure. Often a good management review of the purchasing and financial side of energy acquisition will save significant amounts of money.

The various Booklets cover these topics in greater detail. An energy management program will save energy. The main benefit to the hospital and society is not energy saving (as important as this is), but in a practical sense is money.

When using these Booklets, you should recognize that differences occur between regions within countries and among countries. These differences, arising from cultural and engineering practice conventions, result in design and operation variances. In some countries, hospitals are sealed (i.e. non operable windows). Others will require windows that open as a consequence of cultural aversion to sealed rooms. Likewise engineering design differences occur. For example, air recirculation and forced mechanical air cooling is standard procedure in some areas, while some countries do not permit this practise. Since the Booklets were written as a cooperative effort by a number of countries and as a necessity needed to cover all potential situations, the reader might see described systems which do not seem appropriate. Nevertheless they are important for some other reader.

Thus the user of the Booklets should use these sections which are appropriate for his situation.

Also the education backgrounds of the people who might use these Booklets varies. This variance exists within countries and among countries. The manager might find it useful to work with his staff to ensure that the knowledge base is appropriate and help his staff to understand the complex issues. Indeed people in some countries might not be trained on certain technologies included in these Booklets.

To gain the full benefit from these Booklets a good training program is most important. These programs might be sponsored by the governments, hospital associations or education institutions.

CHAPTER 3. DEVELOPING AN ENERGY MANAGEMENT PROGRAM

3. Introduction

3.1 General

To effectively reduce energy consumption, maintain sound energy resource management and provide the appropriate physical facilities and equipment for health care requires that the institution develop an energy management program which has broad organizational status. The objectives of such an energy management program must be:

- to aid in developing an atmosphere within the facility in which energy management and conservation are acceptable goals.
- to demonstrate the nature of sound energy resource management policies.
- to reduce energy waste and costs.
- to examine the impact on the facility of energy conservation measures.
- to examine the costs and benefits of implementing and incorporating energy conservation measures.
- to facilitate organizational wide input to the energy management program.
- to develop a program for ongoing facility maintenance.
- to ensure that the facilities and equipment provide the needed support to the health care mission of the facility.

The material presented here is intended to:

- be self instructional
- develop the management skills of the administration and technical staff.
- foster the creativity and enthusiasm of all staff.
- convince hospital staff to be responsible and accountable for energy consumption.
- aid in developing a sound energy management program.

While variations in energy use, etc. exist between hospitals, if a standard methodology is followed, energy and cost reductions are most certainly achievable.

A sound energy management program may point out the need for changes in operating and or maintenance procedures. In many cases, minor technical enhancements may be justified. In some cases major capital expenditures may be cost effective.

Monitoring and controlling energy resources and their utilization in a hospital is both an engineering and a management responsibility. Both the engineering and management staff must be sensitive to each others issues and needs.

3.2 Personnel involvement

An energy management program can only be effective if certain key individuals in the organization understand the need for and take the lead in implementing such a program. These individuals might be described or identified using the following title.

- Chief Executive Officer of Administrator

- Assistant Administrator or Director responsible for physical plant operations

- Assistant Administrator or Director of Finance

- Director of Physical Plant

It should be noted that these titles and the suggested organization structure while typical for Canada or the United States might not apply directly to other countries.

In addition to these management positions, every member of the administrative, clerical, maintenance, nursing and medical staff must be sensitized to the issue of resource management and the role they can play. The management personnel should understand the contribution that the maintenance personnel can make to creating an efficient (or inefficient) facility.

3.2.1 Chief Executive Officer (CEO)

In many hospitals, especially smaller ones, the CEO is in the best position to monitor the economic impact of energy consumption, i.e. he will be responsible for reviewing energy consumption statistics and have responsibility for budgeting for energy costs. Of course, in larger institutions, this function may be delegated to an assistant administrator.

In either case, it is essential that the senior executive person have the necessary understanding of the relationship between energy consumption, building operations, end-use and costs. He must also have a commitment to ensuring the hospital is run most efficiently. This includes the lowest energy consumption and cost commensurate with the highest level of patient care.

Not only must the CEO have an understanding of the essential elements he must approach the job of implementing an energy management program with a positive attitude. A positive attitude on the part of the CEO will translate into commitment on the part of the staff at large.

Evolving from an understanding of the issues should be a commitment to sensitizing the institution to the benefits of a program and the role they can play.

The CEO must ensure that a formal auditing and reporting program is in place and that funding is secured for projects which share a positive cost benefit. He must be prepared to seek the advice of outside consultants if necessary. He must be flexible in his approach to facilities operations.

3.2.2 Assistant Administrator - Physical plant operations

If the organizations is large, the senior manager who must take the lead for effective energy management will be the assistant administrator for physical plant operations. The Assistant Administrator should act in consort with the CEO but must devote the time and interest to understanding the administrative ramifications of a sound energy management program.

Also, he must become familiar with the technical operations of the physical plant systems to the degree that he is able to evaluate and document the positive and negative aspects of the operations in such a fashion as to initiate and facilitate the development of asound energy management/building maintenance program.

The Assistant Administrator is in the best position to assist the Director of Physical Plant Operations to prepare various reports, to reflect accurately the energy consumption and conservation potential. He should work with the Director of Physical Operations in the preparation of briefs outlining the time picture of consumption, systems effectiveness, costs, conservation potential, costs of implementation, impact of progress and who should do what.

He must take a leadership role to put in place effective avenues of communications between physical plant operations personnel and other management officers. He must ensure that necessary and influential institutional wide programs are in place to motivate employees positively toward sound energy management practices.

He must ensure that proper audits are carried out and any ongoing adjustments in the program are made.

He must also ensure that the CEO is aware of the positive benefits of the program and that the program has the endorsement of the most senior officer. It should not be seen as a physical plant program, but rather a program requiring involvement of everyone in the organization. The contribution to assisting the hospital meet overall organization goals and objectives should be understood and communicated.

3.2.3 Assistant Administrator for Finance

The Assistant Administrator for Finance is also a key player especially in larger organizations. He can assist the Director of Physical Plant in the preparation of reports of energy costs. He will probably be in a position to provide figures on the cost of the utilities, certain operations and the relationship between consumption and costs. He can also help in the preparation of various briefs by assisting in the compilation of various cost benefit studies and program option.

The Assistant Administrator for Finance should share with the Assistant Administrator for Physical Plant Operation the responsibility for sensitizing senior management toward the value of a sound energy management program. He can also assist in obtaining funding for audits, special studies, or specific programs.

3.2.4 Director of Physical Plant Operations

The Director of Physical Plant Operations must take a leadership role in energy management. This leadership role includes:

(a) being knowledgeable of the energy consuming systems

(b) knowing the amounts and costs of energy consumed

(c) knowing the relationship between consumption and cost

(d) briefing his supervisor on trends in consumption and/or costs

(e) seeking assistance where necessary to study various aspects of energy resource utilization

(f) working with other hospital personnel to effectively reduce energy consumption

(g) maintain a key awareness of the positive aspects of *sound energy management programs*

(h) be receptive to change

(i) recognize that maintenance practices have a major impact on energy consumption and cost and facilities effectiveness.

3.2.5 Other Staff

Sound energy management progress should not be sold on the basis that they are correcting bad practices, i.e. doing things better. Rather, they must be seen to be doing better things, i.e. being innovative. Effective energy management programs benefit the organization as a whole in that "the monies freed up from the energy budget are available for other needs". The staff freed up from maintaining inefficient systems can work on preventative maintenance.

Therefore, every individual in the organization should be willing once the program is in place, to assist in compiling information on energy consuming processes and practices, be diligent in the efficient use of systems and equipment and accept that the program will benefit the organization as a whole and each of them in turn.

The building maintenance staff must be encouraged to take a leadership role. It is they who will contribute most to the efficiency of the systems operations. This contribution must be understood and acknowledged by the senior management of the hospitals.

CHAPTER 4. ENERGY ACCOUNTING TECHNIQUES

4. Introduction

4.1 General

The impact on hospital operations of energy costs makes it imperative that every effort be undertaken to conserve energy and account for its costs.

The corner stone of any energy management program is a good energy accounting system. A proper energy accounting system will provide managers with the appropriate data to formulate, implement and monitor an effective energy management program.

Any good accounting system must be:

- easy to maintain
- effective
- understood and accepted by the key players
- use data which is readily available
- not require large time commitments to complete
- focus on the key variables
- be consistent over time

4.2 Record keeping

4.2.1 Reporting centers

Generally the total hospital is considered in the first instance when defining the area for energy consumption and cost reporting. However, if metering is available it is recommended that more and smaller reporting centers be used - e.g. Laundry. In either case, it is recommended to use energy consumption reporting centers whose boundaries are the same as cost accounting centers. This is particularly important if the process in one area is more or less energy intensive than another area or is occupied for longer periods than the other.

4.2.2 Measurement and timing

Timely and accurate measuring and recording of energy and cost data is critical to the development and monitoring of an energy management program. The data should be collected with sufficient frequency to pinpoint variations, identify seasonal changes in energy consumption, technology changes, additions to facilities, etc. Often it is cost effective to add measurement devices to increase the accuracy and concurrency with cost centre boundaries.

However, any additional measurement devices should be costed and justified on the basis of value of accuracy, performance, etc.

The period used for accounting purposes should be at least one year to account for seasonal variations. It is also important to ensure recording of costs, e.g. opening inventory of say, fuel oil, coincide with the measurement of fuel oil consumption.

Experience has shown that most hospitals tend to start with annual accounting, but then usually increase the frequency of reporting as experience is gained. More frequent reporting generally results in better control and in some cases reporting could even be daily or hourly.

In general, the reporting process should be quarterly or monthly. However, the benefits of more frequent reports should always be weighed against increased data gathering costs and the corresponding benefits. Seasonal or cyclical variations must be taken into account whenever reporting periods are compared.

4.2.3 Base year selection

The Base Year is normally selected as the earliest period for which adequate and reliable information is available. Ideally the Base Year chosen should be one that is considered normal and not significantly affected by unusually high or low occupancy, strikes, new hospital commissioning or shut down of existing facilities. If the Base Year selected has many such abnormalities, then these should be noted for future reference. The intent should be to choose the most representative Base Year so that the comparison of Energy Intensities relative to the Current Year will be meaningful.

4.2.4 Sources of energy

Most of industry's energy needs are currently satisfied by electricity, natural gas and fuel oil. However, this can change as prices and availability vary. Other sources include coal, wood waste, scrap, biomass (wood, peat, etc.), by-products, purchased steam and, in the future, solar energy and wind power.

Petroleum products purchases for non energy uses such as lubrication are not considered to be energy inputs. This is true even if they are reclaimed and burned after being used for lubrication purposes. Thus, they may replace other purchased fuels to constitute an improvement in energy performance. The burning of other wastes such as garbage, cardboard, wood waste, etc. is also not accounted for, as energy inputs.

It is important that all energy inputs be considered, but, this has practical limits. Energy which represents only a small portions (less than 2 %) of the plant's total, and is difficult to determine, may be excluded.

4.2.5 Units of measure

Industrial energy is generally measurable in terms of the physical quantities or by weight or volume in which it is purchased. Typical units include litres, cubic meters, tonnes and kWh. There are units in which these commodities are bought and sold, but, for energy accounting purposes a measure of the energy which each contains is more directly useful. The SI unit in which the quantity of energy is expressed is the joule (J). As this unit is too small for practical use, a megajoule (MJ) which is one million joules is employed. All other measures of energy, such as kilowatt-hours or Btu are readily convertible to megajoules. Appendix B contains a table of energy conversion factors. Once all energy forms are expressed in terms of the energy content they can be combined to account for total energy used.

4.2.6 Energy consumption

Two convenient sources of information on the use of energy are the total energy bills from the various suppliers in the period under study or from a determination of energy actually used by reading the meters at the beginning and end of the period.

Electricity and natural gas are billed on the basis of meter readings. These are frequently made at the convenience of the utility company and do not necessarily reflect the use in one calendar month. However, if records are to be kept on an annual basis, the sum of any twelve consecutive invoices is probably an adequate measure of the year's use. In the case of fuel oil, coal or other sources of energy purchased in bulk, a measure of the opening and closing inventory together with the total delivered amount gives an exact measure of use.

When the accounting period is less than a year, meter reading dates other than at month end can introduce error in the results. In this case, it is preferable to obtain more precise information by reading the meters directly on the period closing date.

Form E-1 (Fig. 4.2.A), the "Energy Accounting Record", can be used to record the basic required information. For

ENERGY ACCOUNTING RECORD
FORM E-1

Company: ______________________ Reporting Centre ______________________

Product: ______________________ Reporting Period ______________________

Prepared by: ______________ Date ______________

DATA SUB PERIODS	ENERGY QUANTITIES (IN PURCHASED UNITS)							
	Fuel Oil Type ___ Litres (1)	Natural Gas m^3 (3)	Electricity kWh (3)	(4)	(5)	(6)	(7)	sq meters (8)
JAN								
FEB								
MAR								
APR								
MAY								
JUNE								
JULY								
AUG								
SEPT								
OCT								
NOV								
DEC								
END OF PERIOD ADJUSTMENT (+/-)								
TOTALS								(9)

Figure 4.2.A

simplicity, the description which follows through to the end of this section is based on the assumption that the hospital has only one building or all buildings are lumped together as one building; that the operation within the hospital is not broken into multiple reporting centers and that reporting is done annually.

Some general comments about the use of Form E-1 are as follows:

a) Fuel Oil Column (1)

The grade of fuel oil should be recorded at the top of column (1). (If more than one grade is used, columns (4), (5), (6) and (7) should be used to record the quantities). The total number of litres delivered during each month would be recorded in this column opposite the appropriate month. Since oil is stored it is necessary to have a year end adjustment for the difference between volume in storage at the beginning of the year versus that at the end of the year. The resulting positive or negative amount should be inserted into the appropriate space. The total fuel oil consumed in the year would then be the total of all purchases plus or minus inventory difference entered in this column.

b) Natural gas column (2)

Although the invoices from the utility company may not quite match consumption on a calendar month basis, over a twelve month period the use of these data may be sufficiently accurate. Thus, the invoiced monthly gas consumption is transferred to this form and the twelve entries in the natural gas column (2) are added to the answer placed on the "Totals" line. If greater accuracy is required gas meter readings should be taken at the end of each accounting period by plant personnel.

c) Electricity Column (3)

Use total billed kilowatt hours in the same way that natural gas billings are employed.

d) Other forms of energy used such as propane, coal, purchased steam, etc. should be identified at the top of blank energy column (4), (5), (6) and (7) and the monthly data entered in the same way as already described.

Purchased steam and other heat streams should be recorded on a heat content basis.

(e) Size of Hospital

The size of the hospital is used only as a reference to ensure that no major physical expansion or construction of the facility took place during the accounting period.

The year end totals of the various forms of consumed energy are now available for further processing. E-1 must be completed initially for the Base Year and annually for the Current Year.

4.2.7 Reporting centre gross energy performance

The gross energy performance is the reduction or increase of the current year energy over the base year equivalent energy. This is expressed as a percentage.

$$\text{Gross Energy Performance} = \frac{\text{Base Year Energy} - \text{Current Year Energy}}{\text{Base Year Equivalent Energy}} \cdot 100$$

If the Gross Energy Performance is positive (+) this means that the performance has improved, but if it is negative (-), this means the performance has deteriorated.

This statistic can be prepared for the institution as a whole or for smaller centers, e.g. Laundry. The use of this statistics, however, is a simple but accurate method for management to ascertain the energy performance of the facility. Of course, more detailed explanations are required when reviewing the reasons behind the changes.

4.2.8 Savings

Management can use the data on energy units saved to calculate the monetary savings for the hospital supply.

$$\text{Energy (monetary units) Savings} = EE_{BY} - EE_{CY} \cdot AC_{CY}$$

where EE_{BY} = Base Year Equivalent Energy in MJ (megajoules)
EE_{CY} = Current Year Equivalent Energy in MJ
AC_{CY} = Current Year Average Cost per MJ (from purchasing records)

A rough calculation of energy savings can be performed by multiplying the energy savings in megajoules by the current average cost of each megajoule of energy. However, in order to yield more accurate results in energy cost savings it is necessary to know the amount of savings for each type of energy and to understand the applicable contract. For instance, a savings in electrical power resulting from shutting down motors during the non-productive periods will have little or no effect on power demand charges.

A similar situation can occur when calculating the dollar value of natural gas energy savings which also may have a built-in demand charge.

In order to correct for these savings and other such influencing factors, each individual energy source must be recorded and a proper unit price applied depending in what period of time the savings is made (i.e. production, non-production or both periods). Total cost savings is then calculated by summing the savings of each individual energy source.

4.2.9 Hospital expansion

When a hospital expands, the extraordinary energy used during construction and start-up should not be allowed to affect the Energy Performance calculations. The additional energy used during the construction and equipment installation is deducted from the annual total. During the start-up phase, the estimated additional energy use for the new equipment is also not included in the annual total. Once the expansion is "on-line" and operating normally, the energy used is then routinely included from that point forward.

4.2.10 New equipment

If significant, the commissioning of new equipment is treated the same way as a plant expansion in the previous section. When a new piece of equipment is installed, the estimated energy used during the start-up phase is deducted from the annual totals until normal operation is achieved.

4.2.11 New hospital or retrofits

New hospitals, retrofit projects, etc., which supplement or replace older areas almost always embody a substantial improvement in energy efficiency. The hospital's energy performance results should reflect these improvements just as they would have if the old plant has been retrofitted to raise energy efficiencies to higher levels. These hospitals may continue to calculate Base Year energy equivalents at the efficiencies that existed prior to the retrofit.

New hospitals account for Base Year Energy in one of two ways:

a) The hospital may choose to use that facilities first full year of normal operation to determine Base Year energy intensity. In the case of a new building, the hospital should recognize that the low level of energy intensity in a new facility will not be credited in the gross energy performance results. Indeed, since the design of a plant will likely embody higher concerns for energy use, future improvements via energy conservation efforts will be harder to achieve and a new plant's gross energy performance improvements will probably not keep pace with improvements at older facilities.

b) Some hospitals may wish to use a constant Base Year for all facilities, or may want to be able to relate the new facilities, or may want to be able to relate the new facilities energy efficiency to that of older ones. If a hospital can credibly assess what the "state of the art" energy efficiency would have been had the new plant been constructed in an earlier Base Year, it may use a calculated Base-Year, equivalent energy use in determining the new facilities energy performance. By constructing such a "state of the art" Base Year, the facilities energy performance results will positively reflect the efficiency improvements that have been designed into the new facility. In such cases energy managers should note that the relatively high energy performance results will be attributed primarily to the efforts of the facilities designers rather than the facilities energy management team. Year-to-year progress comparisons will thus become more useful management tools.

4.2.12 Weather

The effect of weather on energy consumption in a given year is determined primarily by temperature. The Degree Day is the established parameter used to estimate energy usage for heating. This data is available from sources such as Environment Canada and fuel suppliers. The weather adjustment involves identifying the energy required for heating in the Base Year and Current Year as follows:

$$\text{Weather Factor Heating Adjustment (MJ)} = \frac{DD_{CY} - DD_{BY}}{DD_{BY}} \cdot HE_{BY}$$

Where DD_{CY} = Current Year Degree Days
DD_{BY} = Base Year Degree Days
HE_{BY} = Base Year Heating Energy (MJ)

A positive answer means that the Current Year weather conditions were more demanding than the base Year and so for comparison purposes the calculated megajoules should be added to the Base Year Equivalent Energy as if that weather had actually revealed in the Base Year.

Example:

The Base Year energy for space heating was 7 815 000 MJ while Environment Canada Statistics indicate that the heating Degree Days for that year were 4 635. The heating Degree Days in the Current years were 4 146.

$$\text{Weather Factor Heating Adjustment (MJ)} = \frac{DD_{CY} - DD_{BY}}{DD_{BY}} \cdot HE_{BY} =$$

$$= \frac{4\ 146 - 4\ 635}{4635} \cdot 7\ 815\ 000 = -843\ 042 \text{ MJ}$$

This is a negative adjustment since the weather was colder in the Base Year and this will reduce the amount of energy used to compare operation with the milder Current Year. This calculation would be repeated each year unless the Degree Day data for the Current and Base Years were nearly the same.

It is much more difficult and less accurate to derive a cooling weather adjustment due to the effects of humidity, sunlight, etc. and it is recommended that specialists be used for this adjustment in cases where weather affected space air conditioning consumes significant amounts of energy.[1]

---

[1] Each country should refer to their own method of calculating degree days.

4.2.13 Changing types of energy

A change in the type of energy utilized within the plant can distort the energy performance comparisons between the Current and Base Years. When such distortions occur as a result of legislated or involuntary fuel conversions, they should be accounted as base period energy adjustments. Some examples which will help to illustrate this characteristic are as follows:

1. Changing boiler fuels such as natural gas, oil and coal with each having a different heating efficiency or material handling requirements.

2. Changing from electricity to a fuel such as listed in (a) or vice versa.

3. Buying steam instead of generating it or the reverse.

4. A more complex and less frequent possibility would be the situation where electricity is generated at the hospital instead of being purchased from the local utility. Advice on this can be obtained from the local utility or from a consultant.

5. Using renewable energy sources such as: solar, wind, geothermal, etc.

It must be emphasized that these adjustments can be introduced merely to improve the energy accounting statistics, and that once introduced all changes must be accounted for regardless of whether they enhance or penalize the energy performance reporting. Normally the type of energy used might be changed to improve energy supply integrity, to avoid handling problems or for economic benefit. In each case there is no reason why the energy differences should be quantified to change the energy accounting system. The reason why the foregoing example cannot be used for adjustment purposes is that they were acts over which the hospital had full control.

Adjustments to eliminate the impact of energy changes are only to be made when the change was required and was outside the hospital's control, such as when purchased steam might no longer be available or a utility/supplier can no longer supply the company's needs. There are many combinations of circumstances that could merit this type of an adjustment by formula. Thus the Current and Base year energy utilization efficiencies need to be calculated by the application of logic and using the examples which follow as guidelines.

Having calculated the two conditions the adjustment can be expressed as follows:

$$\text{Energy Change Adjustment (MJ)} = E_{CY} - \frac{E_{CY} \cdot U_{NE}}{U_{PE}}$$

Where:
E_{CY} = Applicable Current Year Energy (in MJ)
U_{PE} = Utilization Efficiency of Previous energy source (%)
U_{NE} = Utilization Efficiency of New Energy source (%)

<u>Note</u>:

If steam is sold it should be classified as any other saleable product and calculations of energy input per unit of steam sold would be determined leading to the calculation of energy performance in steam production. If a plant's boiler house is already monitoring and reporting on its energy performance in steam production as a separate reporting centre then the use to which the steam is put once it leaves the boiler houses is inconsequential. Thus, in such a case, the fact that some steam is sold can be ignored when evaluating the boiler house. However, the quantity of steam sold would have an impact when evaluating the total plants' energy performance.

<u>Example of energy change</u>

Steam for Company A's plant heating and process was previously purchased from a neighbouring company. This company now requires all of its steam and can no longer supply steam to Company A. It is now necessary for Company A to generate steam on site by burning oil in the boilers. The previously purchased steam was in a energy form that was 100 % usable, whereas, now oil must be burned and converted to steam with a conversion efficiency of 82 %.

From the records it is determined that the current year 250 000 litres of nº 2 Fuel Oil were burned and that this oil has an energy content of 3 868 MJ/litre.

$$\text{Energy Change Adjustment} = E_{CY} - \frac{E_{CY} \cdot U_{NE}}{U_{PE}} =$$

$$= 250\ 000 \cdot 3\ 868 - \frac{250\ 000 \cdot 3\ 868 \cdot 82}{100} =$$

$$= +1\ 740\ 600 \text{ MJ}$$

The adjustment would have to be reported each year with "utilization efficiency" numbers remaining the same, but, with the volume of oil changing. Note that if it had been #6 oil that was used then the energy required to heat oil storage tanks would have to be included when calculating the new utilization efficiency (U_{NE}). Also any subsequent changes to improve boiler efficiencies would constitute conservation gains (e.g. installing economizers or air heaters). These should not be included when calculating energy adjustments since to do so would remove the benefits from the calculations. Thus, in the above example, the boiler efficiency of 82 % would be used in the calculation of the adjustments for each reporting period even though the addition of heat recovery equipment has improved the boiler efficiency.

Previously, domestic and process hot water were heated by means of electric elements, but the Utility has advised that it can no longer reliably provide electricity for this purpose. With electricity, 100 % of the heat content of the electric sources was converted into water heat, whereas, with natural gas only 80 % of the energy content of the gas is transferred to the water. Again, energy efficiency has suffered.

The natural gas consumption attributable to hot water heating in the Current Year was 4 200 cubic meters with each cubic meter equal to 37.2 MJ.

$$\text{Energy Change Adjustment} = E_{CY} - \frac{E_{CY} \cdot U_{NE}}{U_{PE}} =$$

$$= 4\ 200 \cdot 37.2 - \frac{4\ 200 \cdot 37.2 \cdot 80}{100} =$$

$$= +31\ 248 \text{ MJ}$$

The adjustment would have to be repeated each year with the "utilization efficiency" numbers remaining the same, but, with the amount of natural gas changing.

Note that if the newly installed water heater is subsequently modified to be more efficient through the use of better insulation, for example, the utilization efficiency factor (U_{NE}) should ignore this and the 80 % U_{NE} factor would continue to be used.

4.2.14 Tariffs

As your energy bills come in, record the consumption and cost data for that billing period, or have your energy manager do it. This will allow you to track energy consumption and compare actual consumption with projections as well as your target goals. Two other important issues in review your energy bills are:

a) Is the bill correct?

Are there billing errors due to meter misreading, computer error, double billing, etc.? Compare bills to your base year and target budgets to see if a given bill appears significantly off. If so, check with your staff and your energy supplier to resolve the discrepancy.

b) Are you purchasing energy most economically?

This involves examining such issues as:

- Electric rates:
  Utilities in many localities are creating different rate features, based on time-of-day usage, peak demand, and other factors. Consult your utility or your public utilities commission to learn more about your rate options (see also Booklet IV).
- Gas rates:
  Some gas utilities are offering lower rates to customers who maintain alternate fuel capabilities. This may involve periodic interruptions in gas service, but if you can use an alternate fuel during interruptions, the cost savings may be substantial.
- Fuel purchasing:
  Local governments and other regional groups are beginning to use cooperative purchasing strategies for heating oil. This can offer substantial prices advantages.
- District heating: you should negotiate a most favourable rate.

CHAPTER 5. PHASES OF THE ENERGY MANAGEMENT PROGRAM

5. Introduction

5.1 General

To facilitate the fulfilling of the objective of an energy management program as identified in § 3.1, a five step of phased procedure is recommended.

1. Energy inventory compilation

2. Energy Budget preparation

3. Energy Audit survey

4. Energy program implementation

5. Energy program monitoring

These phases have been organized in such a fashion that if they are followed sequentially, the hospital will be able to develop a sound energy management program that is seen by the staff to be of benefit to them. It is based on sound management principals and is cost effective to operate.

5.1.1 Energy inventory compilation

The first phase of the energy management program is to complete a comprehensive Energy Inventory as outlined on Energy Inventory Forms (1) and (2) - Fig. 5.1.A and 5.1.B. The Energy Inventory will form the basis for future reference and comparison, and can be expedited with the help of engineering maintenance staff and hospital management. The Inventory should, at a minimum, cover the two most recent years. Tables are provided for the necessary conversion purposes (see Appendix A). Another copy of each form should be used for the current year. The forms should be updated each months as utility bills are received and readings are taken.

Energy Inventory Forms (1) and (2), which provide a brief overview of existing conditions, may also be used as attachments to any applications made by the Hospital for government funding of energy conservation projects.

One of the most difficult problems in any energy management program is monitoring energy savings after conservation measures have been implemented. This problem is further complicated by the large number of variables that affect a hospital's energy consumption. Regular monitoring

ENERGY INVENTORY FORM
YEAR
HOSPITAL
GROSS AREA m^2 (SQ.FT.)

ENERGY INVENTORY FORM(1)- FUEL & ELECTRICITY CONSUMPTION

			ELECTRICITY								FUEL								PURCHASED STEAM						TOTAL		WATER	
						KW DEMAND					OIL				GAS							DEMAND kg/h / lb/h						
MONTH	HEATING DEG. DAYS	COOLING DEG. DAYS	KWH	MBtu/h	KWH PER DEG DAYS	ACTUAL	BILLED	POWER FACTOR	TOTAL COST		QUANT. LITRES (GALS)	EMJ / EKWH	TOTAL COST	QUANT. m^3 (MCF)	EMJ / EKWH	TOTAL COST	FUEL PER DEG DAYS		Mkg (M lb)	EMJ / EKWH	M kg (M lb) DEG DAYS	ACTUAL	BILLED	TOTAL COST	EMJ / EKWH	EMJ PER m^2 / EKWH PER FT^2	ML / MGAL	COST
1	2	3	4	5	6	7	8	9	10		11	12	13	14	15	16	17		18	19	20	21	22	23	24	25	26	27
JAN																												
FEB																												
MAR																												
APR																												
MAY																												
JUN																												
JUL																												
AUG																												
SEP																												
OCT																												
NOV																												
DEC																												
TOTAL PER YEAR																												

CONVERSION FACTORS

ELECTRICITY ________ KWH X 3413 = ________ Btu/u

GAS ________ CF X 1030 = ________ Btu/u

OIL ________ GALLONS NO. 2 X 168,000 = ________ Btu/u
________ GALLONS NO. 6 X 182,000 = ________ Btu/u

STEAM ________ lbs X 1000 = ________ Btu/u

NOTE 1) EKWH = EQUIVALENT KILOWATT HOUR = $\frac{\text{Mbtu/u}}{3,413}$
2) M = MEGA = 1 MILLION
3) MBtu/u = 1000 Btu/u

Figure 5.1.A.

ENERGY INVENTORY FORM (2)

SUMMARY AND TARGET

HOSPITAL:______________________________ DATE:______________

GROSS FLOOR AREA:__________________m^2 (__________________$FT.^2$)

__________________m^2 (__________________$FT.^2$)

__________________m^2 (__________________$FT.^2$)

FOR ENERGY CALCULATION:______________TOTAL SQUARE METERS

(__________TOTAL SQUARE FEET)

	TABULATION OF ENERGY CONSUMPTION				
	PAST AND PRESENT				PROJECTED
	YEAR TOTAL	YEAR TOTAL	YEAR TOTAL	YEAR TOTAL	YEAR TOTAL
OIL FUEL LITRES (GALLONS)					
GAS Mm^3 ($MFT.^3$)					
ELECTRICITY EKWH					
AVERAGE DEMAND KW					
TOTAL EKWH					

FUEL $EMJ/M^2/YR.$ ($EKWH/FT.^2/YR.$)					
ELECT. $EMJ/m^2/YR.$ ($EKWH/FT.^2/YR.$)					
TOTAL $EMJ/m^2/YR.$ ($EKWH/FT.^2/YR.$)					

GOAL: 323-538 $EKWH/m^2/YR.$

(30-50 $EKWH/FT.^2/YR.$)

Figure 5.1.B

is important, however, to ensure that the improvements are maintained and that the data is available for additional comparisons.

While not the most influential, weather is the most obvious factor that will differ between two given months, or between the same month in two given years. Energy Inventory Form (1) indicates the heating and cooling degree days, and therefore, allows for a more accurate comparison between given time periods.

Graphs illustrating fuel and electrical consumption can be very useful for identifying trends in energy use and cost projections. (Graph sheets illustrating Total Fuel and Electricity Consumption in EKWH's can be found in Fig. 5.1.C and 5.1.E. Blank copies are found in Fig. 5.1.D and Fig. 5.1.F.

It should be recognized that the energy load is composed of a base or fixed load and a fluctuating or variable load. The former may shift with the seasons and the latter represents changes in occupancy, degree days, procedures, etc.

5.1.1.1 Heating Degree Days

The concept of heating degree days was derived in an attempt to correlate the heating fuel consumed by buildings with the outside temperature. The number of heating degree days recorded for a particular day is the difference between 18 °C (65 °F) and the average outdoor temperature for that day - if the outdoor temperature is less than 18 °C (65 °F). No attention is given to those days for which the average temperature is above 18 °C (65 °F).[2]

Obviously a building will lose heat whenever the outside temperature is less than the inside temperature. The fuel consumed for space heating is generally proportional to the number of degree days recorded in a given month.

Because a great deal of internal heat is generated in hospitals and much of this heat is available 24 hours of the day, the degree-day method is not accurate for estimating absolute values of fuel consumption. However, the method is useful for comparative purposes month by month, and for assessing heat in load factors and fuel consumption over the heating season when the peak heating demand has been independently measured. This descriptions is based on a Canadian model. The amount of internal heat generation means that heat loss will become a concern below the 18 °C (65 °F)

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[2] Some countries use 15 °C.

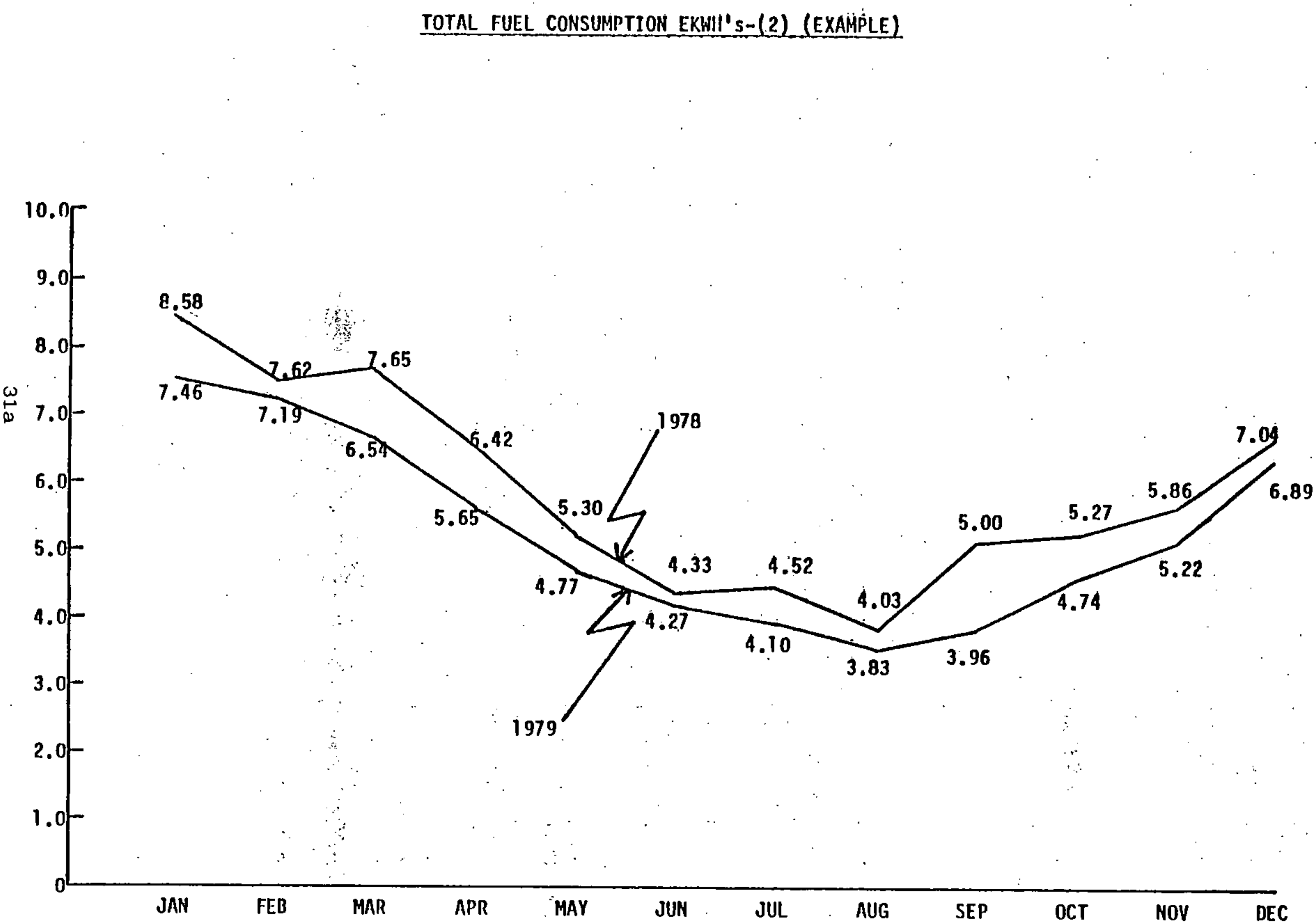

TOTAL FUEL CONSUMPTION EKWH's-(2) (EXAMPLE)
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0
8.58
7.62
7.65
6.42
5.30
4.33
4.52
4.03
5.00
5.27
5.86
7.04
7.46
7.19
6.54
5.65
4.77
4.27
4.10
3.83
3.96
4.74
5.22
6.89
1978
1979
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC

Figure 5.1.C.

TOTAL FUEL CONSUMPTION EKWH's-(1)

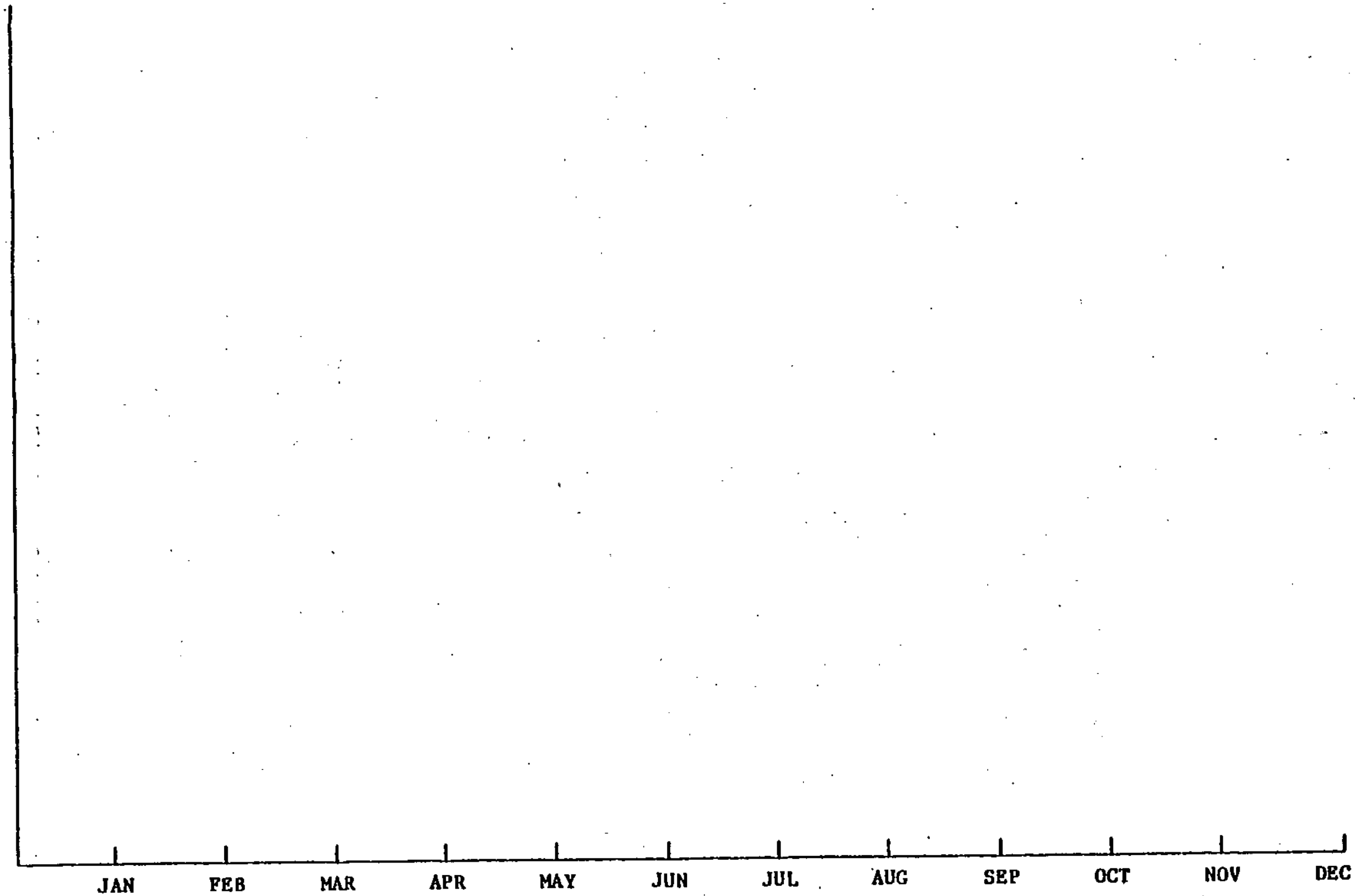
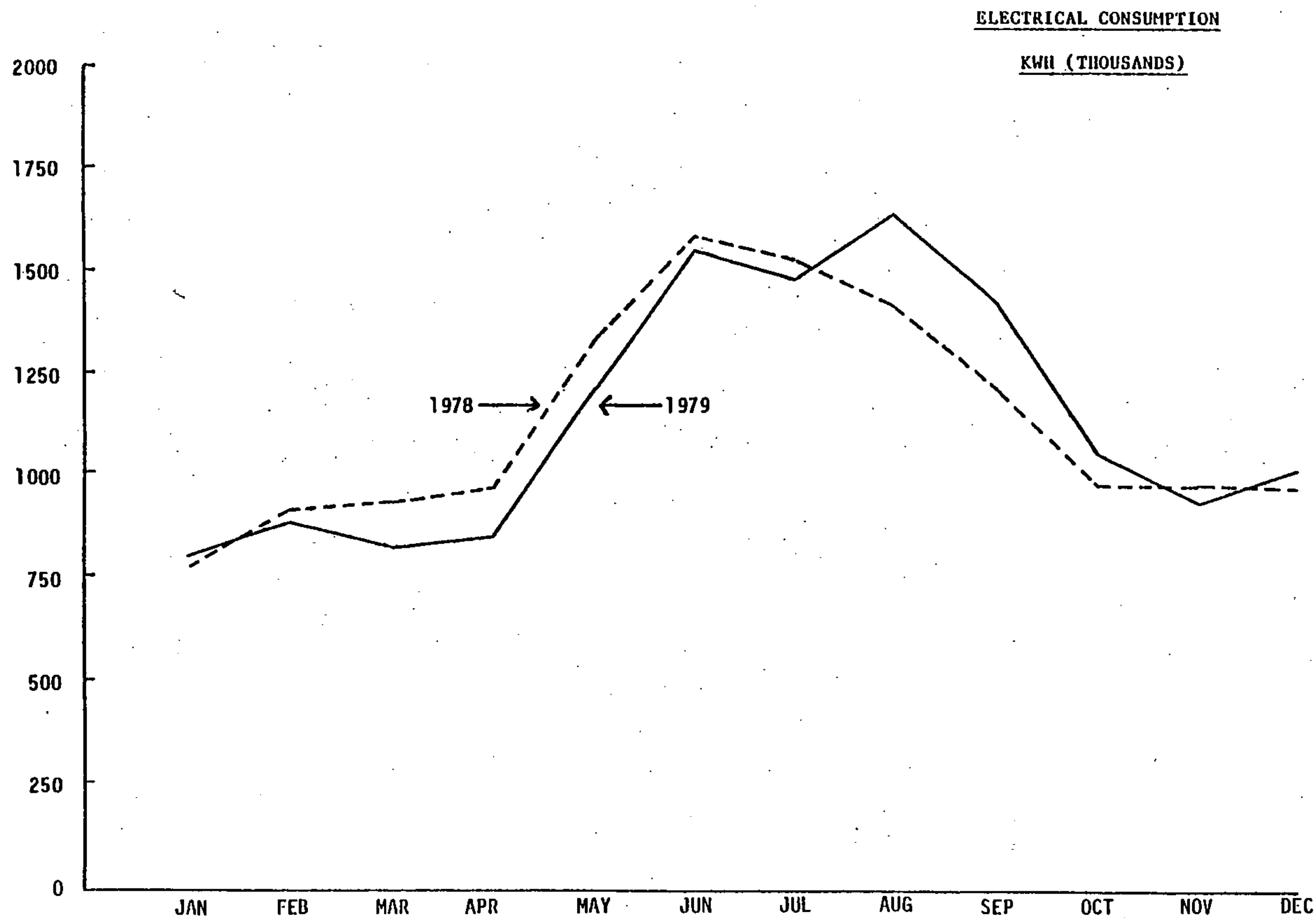


Figure 5.1.D


ELECTRICAL CONSUMPTION
KWH (THOUSANDS)
2000
1750
1500
1250
1000
750
500
250
0
1978
1979
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
Figure 5.1.E

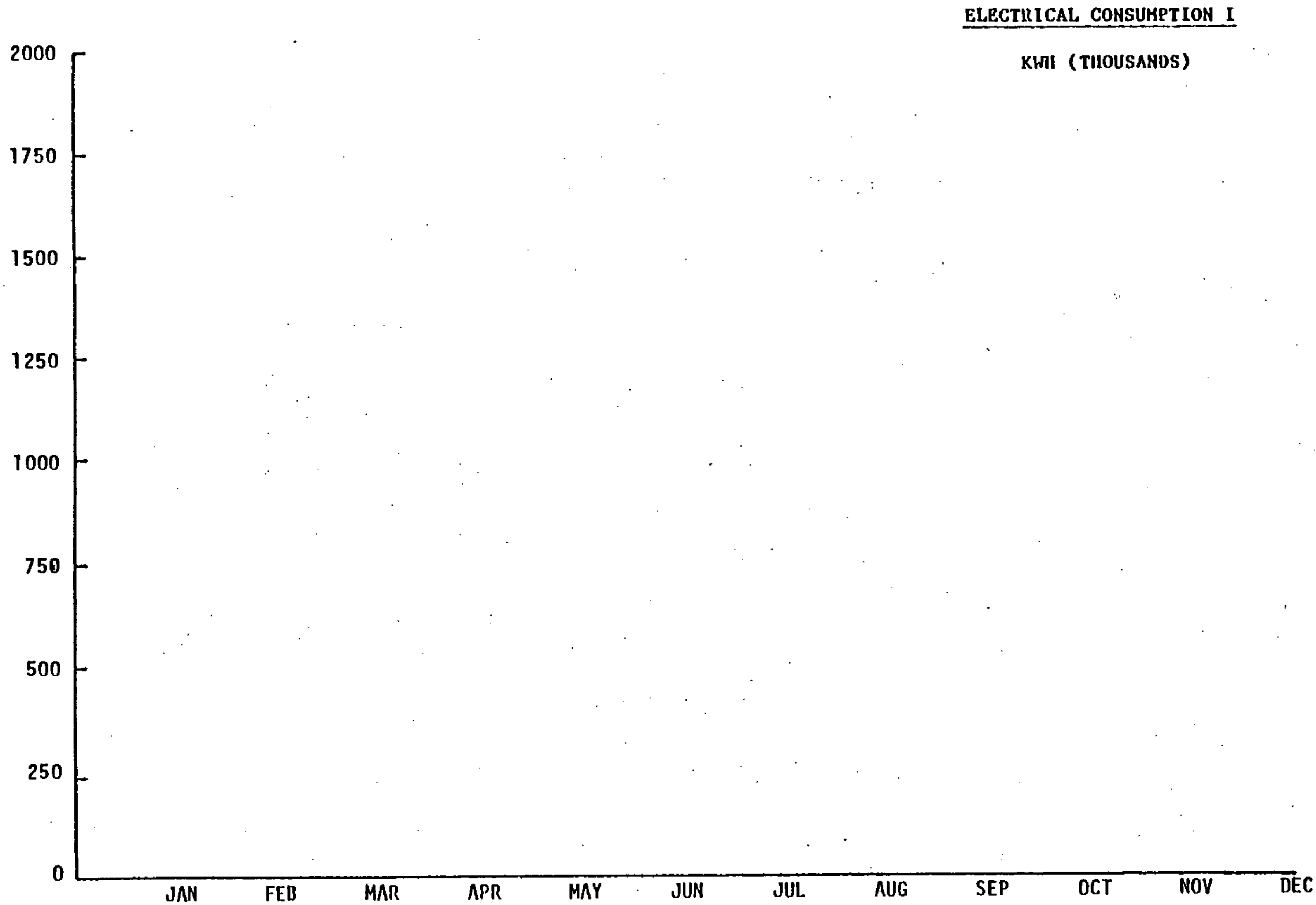

ELECTRICAL CONSUMPTION I
KWH (THOUSANDS)
2000
1750
1500
1250
1000
750
500
250
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC

Figure 5.1.F

point. Once that point is reached, heat loss will increase linearly with lower temperatures. Readers are referred to the model for their own country.

5.1.1.2 Cooling Degree Days (mechanical cooling energy)

In some countries, steam and/or electrical energy is used to drive mechanical cooling equipment to offset high summer temperatures or high building heat gains from room equipment and lighting. In a hospital, "cooling" energy is usually less than 10 % of the total energy consumption but can be difficult to assess accurately without detailed understanding of the building systems and local weather conditions. Unless cooling energy is separately metered, discussion with an experienced engineer will normally be advisable.[3]

To obtain a total picture of fuel use and combined fuel-electric use for a hospital, each form of energy must be converted into common units. Equivalent kilowatt hours are used for this purpose. (Appropriate conversion factors are found in Appendix A).

Typically, the EKWH values arrived at represent the heating value of the fuel, or the amount of heat released when the fuel is consumed.

The unit cost for fuels is also based on the EKWH's calculated for reasons of consistency. The unit cost is determined by dividing the total cost paid for the fuel by the calculated EKWH's. This factor is useful in comparing relative costs when alternative fuels are available.

Depending on a hospital's individual situation, other factors might be sufficiently important to this list.

5.1.1.3 Physical description of building and systems

The forms on Figures 5.1.G and 5.1.H have been included to provide a concise, systematic method of describing the physical condition of hospital buildings and their energy-related systems. The form can be used to establish initial priorities for the hospital's overall energy program. It can also be used as an attachment to any applications that the hospital might make for funding of energy conservation projects, as a brief overview of existing conditions.

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[3] Weather data, including degree days, are published in meteorological reports on a monthly and yearly basis for most locations.

PHYSICAL DESCRIPTION OF BUILDINGS AND SYSTEMS-(1)

HOSPITAL ______________________________

SHEET ____________ OF __________

BUILDING DESIGNATION					
DATE OF CONSTRUCTION					
GROSS FLOOR AREA m^2 ($FT.^2$)					
NO. OF STOREYS					
TYPE OF EXTERIOR WALL					
TYPE OF WINDOW					
TYPE OF ROOF					
TYPE OF HVAC					
TYPE OF LIGHTING SYSTEM					

GENERAL CONDITIONS:

EXTERIOR WALLS					
WINDOWS					
ROOF					
HVAC SYSTEM					
ELECTRICAL					
LIGHT FIXTURES					
ELEVATORS					

Figure 5.1.G.

PHYSICAL DESCRIPTION OF BUILDINGS AND SYSTEMS-(2) (EXAMPLE)

HOSPITAL ANY TOWN GEN. HOSP.

SHEET 1 OF 1

BUILDING DESIGNATION	East Wing	Main Bldg.			
DATE OF CONSTRUCTION	1946	1965			
GROSS FLOOR AREA m^2 ($FT.^2$)	10000 FT^2	15000 FT^2			
NO. OF STOREYS	B/1	B/1			
TYPE OF EXTERIOR WALL	Brick Veneer Wood Frame 2" Batt. Insul'tn	Brick and Steel 3" Batt. Insul'tn			
TYPE OF WINDOW	Alum. Sliding and Fixed Sealed Unit	Alum. Sliding and Fixed Sealed Unit			
TYPE OF ROOF	Sloped Shingle	Flat Built-up			
TYPE OF HVAC	Reheat	Fan Coils			
TYPE OF LIGHTING SYSTEM	Fluor.	Fluor.			

GENERAL CONDITIONS:

EXTERIOR WALLS	Good	Good			
WINDOWS	Good	Good			
ROOF	Fair	Fair			
HVAC SYSTEM	Poor	Good			
ELECTRICAL	Poor	Good			
LIGHT FIXTURES	Fair	Good			
ELEVATORS	Fair	Excellent			

Figure 5.1.H

5.1.1.4 Net versus gross floor area

When dealing with floor areas in buildings, special care should be taken to indicate how the measurements, or "take-offs" were made. The two methods normally used are: net floor area and gross floor area.

Net floor area is calculated using the inside wall-to-wall dimensions of individual rooms, which indicate the actual usable floor space. It does not include the areas occupied by stairs, elevators, shafts, corridors, walls, partitions and so forth.

Gross floor area includes all areas of head-room height within the building. It includes, for example, basements, mezzanines, and penthouses. It is measured from the outside faces of exterior walls or from the centerline of walls separating buildings. A building's gross conditioned area would, however, exclude unheated equipment spaces or parking garages.

The most accurate way of computing gross floor area is from the dimensions noted on architectural drawings used for construction.

5.1.2 Energy budget preparation

The Energy Budget, which provides the energy management team with its optimal goal, is the second phase of qualification criteria which must be completed.

The theoretical Energy Budget is obtained by multiplying the building's gross area by the accepted standard for energy consumption existing in hospitals; for Canada, acceptable values are: 1 548 MJ - 2 322 MJ per square meter per year (40-60 EKWH per square foot per year). The theoretical energy standard is then divided by the cost of the actual utility bills to determine the building's energy efficiency.

This provides the hospital's energy management team with an incentive optimal goal, and with the information needed to determine priorities within the energy management program.

Figure 5.1.I shows a typical budget for a general hospital, with notes which list the explanation for the figure.

Similarly the budget for a nursing home is shown in Fig. 5.1.J, with corresponding explanations.

Budgeting The Energy "Pie" For General Hospitals or, How The Energy Cookie Crumbles!

Energy Component	Design Power Range Equivalent Watts/ft² year	Operating Energy Range Equivalent KWH/ft² year	Incremental Factors Determining Power and Engery
Ventilation preheat	2 to 10	4 to 16	Severe winters. Recirculation rates.
Air circulation reheat	0 to 3	0 to 12	Choice of air systems. Heat pumping and recovery.
Air cirulation pumping	0.5 to 1.5	3 to 16	System air pressure. Circulation rate.
Air humidification	2 to 3	4 to 9	Climatic influences. Patient needs.
Hydraulic Pumping	0.1	1	System design.
Mechanical cooling and dehumidification	2 to 12	1 to 8	Prime power availability. Heat pumping.
Building Envelope heat	1 to 3	3 to 9	Climatic influences. Insulation standards. Appropriate glazing.
Domestic hot water	1 to 2	3 to 7	Low temperature. Heat pump recovery.
Lighting	1.5 to 2.5	8 to 15	Custom task design. Light modulation.
Electro-medical equipment	0.1 to 0.5	1 to 2	Full engineering evaluation including energy.
Laundry Process	0.3 to 2	3 to 8	Heat recovery systems. Recycled water.
Kitchen Process	0.2 to 2	3 to 7	Heat recovery systems.
SPD Process	0.5 to 0.8	1 to 3	Full engineering evaluation including energy.
Elevators	0 to 0.5	1	Energy storage systems. Rate of travel.
NOMINAL TOTALS	15 to 43	36 to 114	
SUGGESTED TARGET 1983 DESIGN:	13 to 20	40 to 50	

Beneficial influences on power and/or energy:

- Early engineering input to planning team.
- Integrated design approach to building planning.
- Scheduled use of high energy systems, e.g. ventilation, lighting.
- Meticulous attention to detail needs and component performance.
- Capital investment in energy engineering.
- Professionally qualified energy manager.
- Commissioning program.
- Performance optimization program.

NOTE: All power and energy units are expressed as equivalent watts or kilowatts.

From a model proposed by E.J. Parker, P. Eng. Chairman, Research Committee Energy Task Force.

Figure 5.1.J

THE ENERGY "MENU"
For Long Term Care Facilities and Nursing Homes

Energy Component	Design Power Range — Equivalent Watts/ft²	Operating Energy Range — Equivalent KWH/ft² year	Incremental Factors Determining Power and Energy
Ventilation preheat	1 to 4	1 to 8	Severe winters. Recirculation rates.
Air circulation reheat	0 to 2	0 to 8	Choice of air systems. Heat pumping and recovery Elderly patient needs.
Air circulation pumping	0.3 to 1	1 to 6	System air pressure. Circulation rate.
Air humidifaction	1 to 2	1 to 5	Climatic influences. Elderly patient needs.
Hydraulic Pumping	<0.1	<1.0	System design.
Mechanical cooling and dehumidification	1 to 6	1 to 4	Prime power availability. Heat pumping.
Building Envelope heat losses	1 to 3	2 to 8	Climatic influences. Insulation standards. Appropriate glazing.
Domestic hot water	1 to 2	2 to 6	Low temperature. Heat pump recovery.
Lighting	1.2 to 2.5	3 to 8	Adequate level for elderly. Custom task design. Light modulation.
Electro/medical	<0.1	<1.0	Some required when separate from General Hospital.
Laundry Process	0.5 to 2	2 to 7	High patient density. Heat recovery systems. Recycled water.
Kitchen Process	0.3 to 2	3 to 8	Heat recovery systems.
SPD Process	0.5	1.0	Full engineering evaluation including energy.
Elevators, Transport Systems	0.5	1.0	Energy storage systems. Rate of travel. Low rise building.
NOMINAL TOTALS	8 to 27	20 to 70	Fully Equipped
SUGGESTED TARGET 1984 DESIGN	8 to 14	23 to 30	Fully Equipped

Beneficial influences on power and/or energy:

- Early engineering input to planning team.
- Integrated design approach to building planning.
- Scheduled use of high energy systems, e.g. ventilation, lighting.
- Meticulous attention to detail needs and component performance.
- Capital investment in energy engineering.
- Professionally qualified energy manager.
- Commissioning program.
- Performance optimization program.

NOTE: All power and energy units are expressed as equivalent watts or kilowatts.

From a model proposed by
John Parker, P. Eng.
Chairman, Research Committee
Health Energy Task Force
June 1984

Reviewed by
George Seely
Harry Callan
and Wes Drodge
of the Health Energy Task Force

NOTES for Figure 5.1.I - THE ENERGY "PIE"

The energy "pie" budget (Fig. 5.1.I) is an electric gathering of observations, experiences and estimations of energy design and usage for Health Care Facilities. The ranges given will be applicable to most localities in Canada and the northern states of the U.S.A. The energy components listed represent discrete elements of design which can be separately extracted from equipment specifications and drawings with the aid of an understanding of building systems.

The lower values of power and of energy are zero-based estimates suggesting the lowest practicable levels of energy use. The upper values have been observed in a number of high energy installations and are included to illustrate where much of the energy is used in such buildings. It can be seen that the four components of ventilation can account for well over 30 % of the total energy used within the ranges given, followed by lighting which often exceeds 20 %. These percentages can increase dramatically, if, for example, a poor lighting design is installed in an otherwise energy-efficient building.

All power and energy figures relate to the gross floor area concerned with patient care and thus exclude areas such as steam plants and air handling machinery rooms, which are not typical of every facility. The figures for domestic hot water and lighting, for example are spread over the entire building area and provide a base load for all functions including special services such as laundries and kitchen. Similarly, the figures for laundry and kitchen processes are also spread over the total building area and are extra-over the base energy provisions given elsewhere. The result is that all energy components and processes can be viewed in proportion to each other and in relation to the building area which, in a general hospital, is usually closely related to building occupancy and number of patients treated.

The use of equivalent watts and kilowatts is a convenient way of comparing power and energy used in quite different buildings. For example, one building may indeed have all-electric energy systems and another may have a more conventional combination of electricity and natural gas or fuel oil. Both, however, may be found to consume similar quantities of equivalent energy when the fossil fuel usage is converted to equivalent kilowatts. During this conversion, allowance should be made for the insufficiencies of a fossil fuel plant so that the energy recorded is that actually used by the building, this being typically about 70 % of the fuel energy received at the boiler plant.

A number of factors which influence a low-energy design are given in the schedule. Of these, three factors are of exceptional importance and are restated for additional impact. These are:

- Early engineering input to the planning process
- Meticulous attention to detail needs and component performance
- Performance optimization program

This latter provision is seldom included in the start-up-commissioning of a new facility and is the reason many otherwise well designed buildings often use a great deal of energy. Gradually, through progressive tune-up and increasing familiarity with the systems, the building staff will achieve improvements in the energy profile but this process may take a number of years following occupation. During this period many avoidable energy dollars will have been expended.

In conclusion, one should be reminded that the figures given are not cast in stone but are a general indication of the energy parameters typically involved. They can provide a useful guide to where the "energy action" might be in a given facility and so suggest priorities for an energy conservation program. The schedule can also suggest energy objectives for a new design. This information will be best utilized, however, under the guidance of a professional engineer who is fully conversant with the complex systems, energy processes and performance requirements of a fully functional health care facility. Some facilities have achieved lower energy consumption figures than those noted.

NOTES for Fig. 5.1.J - THE ENERGY "MENU"

The energy components which comprise the energy "menu" for Long Term Care are similar to those for "The Energy Pie for General Hospitals". The energy value of these components is, however, somewhat changed as the building functions swing from technologically oriented diagnostic and acute care activities to sociologically oriented low technology long term patient care. The concentration of patients per unit area tends to be greater in Long Term Care resulting in similar or higher energy use in components such as Laundry and Kitchen which are related to patient density. Meanwhile, energy components such as ventilation and lighting which are weighted by high technology factors in the General Hospital tend to be significantly reduced in Long Term Care.

The energy components listed represent distinct elements of design which can be separately extracted from record drawings and equipment specifications with the aid of an understanding of building systems. The ranges suggested for power and energy will be applicable to most localities in Canada and the northern states of the U.S.A. Local discretion can be exercised to slightly adjust the "menu" where winter conditions are unusually severe.

The lower values of power and of energy are zero-based estimates suggesting the lowest practicable levels of energy use. The upper values have been observed in a number of high energy installations and are included to illustrate where much of the energy is used in such buildings. It can be seen that the four components of ventilation can account for well over 30 % of the total energy used within the ranges given, followed by lighting which often exceeds 15 %. These percentages can increase dramatically, if, for example, a poor lighting design is installed in an otherwise energy-efficient building.

All power and energy figures relate to the gross floor area concerned with patient accommodations,care and support, and should exclude areas such as steam plants and air handling machinery rooms, which are not typical of every facility. The figures for domestic hot water and lighting, for example, are spread over the entire building area and provide a base load for all functions including special services such as laundries and kitchens. Similarly, the figures for laundry and kitchen processes are also spread over the total building area and are in addition to the base energy provisions given elsewhere. The result is that all energy components and processes can be considered in relation to each other and relative to the building area which, in turn, tends to be a function of patient occupancy.

The use of equivalent watts and kilowatts is a convenient way of comparing power and energy used in quite different buildings. For example, one building may indeed have all-electric energy systems and another may have a more conventional combination of electricity and natural gas or fuel oil. Both, however, may be found to consume similar quantities of equivalent energy when the fossil fuel usage is converted to equivalent kilowatts. During this conversion, allowance should be made for the insufficiencies of a fossil fuel plant so that the energy recorded is that actually used by the building, this being typically about 70 % of the fuel energy received at the boiler plant.

A number of factors which influence a low-energy design are given in the schedule. Of these, three factors are of exceptional importance and are re-stated for additional impact. These are:

- Early engineering input to the planning process
- Meticulous attention to detail needs and component performance
- Performance optimizing program or commissioning

This latter provision is seldom included in the start-up-commissioning of a new facility and is the reason many otherwise well designed buildings often use a great deal of energy, at least during the early years of use. Gradually, through progressive tune-up and increasing familiarity with the systems, the building staff will achieve improvements in the energy profile but this process may take a number of years following occupation. During this period, many avoidable energy dollars will have been expended.

In conclusion, one should be reminded that the figures given are not cast in stone but are a general indication of the energy parameters typically involved. They can provide a useful guide to where the "energy action" might be in a given facility and so suggest priorities for an energy conservation program. The schedule can also suggest energy objectives for a new design. This information will be best utilized, however, under the guidance of an experienced professional engineer who is fully conversant with the complex systems, energy processes and performance requirements of a fully functional health care facility.

5.1.3 Energy audit survey

The third phase of the program is the Energy Audit which consists of a walk-through inspection by hospital and/or consultant engineering staff to identify and determine the energy consumption characteristics of the hospital building(s). These characteristics include building size, type, major energy users, and rate of consumption. The forms provided for this purpose should be used not only to give priorities, but to maintain consistency for review by funding agencies. See also work of IEA Annex XI[4].

If the measuring devices/systems are available a measurement of the energy consumption versus target for each sub system would be useful for pinpointing specified variations which might indicate specific problems.

The energy auditor should produce a detailed cost benefit analysis and potential capital investment for energy conservation considerations.

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[4]Annex XI - "Energy Auditing": Source Book for Energy Auditors, Volume 1 & 2

An in-depth review of the present operating and maintenance procedures will also be required, as well as, suggestions for improving present procedures.

The audit team should make an additional effort to identify potential major cost effective energy options, in addition to potential low-no cost effective energy options.

The purposes of the Energy Audit are:

1. To gather basic information about the Buildings being audited, in order to determine energy consumption characteristics (for example, building size, type and rate of energy use)

2. To identify major energy-using systems, in terms of their fuel source and physical characteristics

3. To determine the extent of previous efforts to conserve energy in buildings being audited

4. To determine who has been designated to monitor and evaluate energy consumption

5. To provide additional information needed for planning purposes

6. To determine appropriate energy conservation operating and maintenance procedures

7. To indicate, using general estimates and approximations, the need for energy conservation measures that will require major capital outlays.

The following information should be gathered under the preliminary Energy Audit.

1. Age and gross square area of building(s)

2. Location of departments and hours of operation

3. Major energy-using systems:
   a) type of heating system and/or cooling system,
   b) type of fuel used for heating and/or cooling systems,
   c) type of fuel used for domestic hot water, such as oil, electricity or natural gas,
   d) type of special energy-using systems, such as food services or laundry, etc.,
   e) type of lighting, such as incandescent or fluorescent, or a combination of both.

4 . Energy use and cost data, by type of fuel, for the preceding 24 month period, by month if practical.

5. Total annual energy used, in terms of EKWH/square meter/year and energy cost per gross square meter, determined by utilizing the conversion factors provided in Appendix A.

6. A brief explanation of the conservation measures already implemented. This explanation should include the following:

   a) whether one person or a number of persons have been designated to monitor energy use,
   b) whether a detailed engineering study has been conducted,
   c) a listing of any major energy conservation measures being considered or implemented.

7. Information regarding site, building orientation and configuration, and heating and hot water systems related to other renewable resource potential.

8. The Energy Inventory report and the Energy Budget

9. Major changes in building use planned over the next ten years.

10. Electrical demands and energy use for building(s)
   a) peak electrical demand (daily and monthly),
   b) annual energy use, by fuel type, for each major mechanical and electrical system, if available or reasonably estimated (see also Booklet IV).

11. Description of terminal heating and/or cooling, for example, radiators, ventilators, fan coil units of dual-duct systems (see also Booklet III).

12. Building site and structural characteristics related to other renewable resource potential, including, but not limited to:

   a) Climatic factors, specifically:
      - average annual heating degree days and cooling degree-days,
      - average monthly wind speeds and directions
   b) Roof characteristics, including:
      - identification of primary structural component, such as steel, wood or concrete
      - type of roofing materials, such as shingles, buildup materials, or insulation.
   c) Availability of well water for cooling purposes.

13. A description of general building design conditions (see also Booklet VI).

For a more comprehensive treatment of energy auditing refer to the report of IEA Annex XI[5].

5.1.4 Energy program implementation

The fourth phase of the energy management program is Energy Conservation Implementation, which includes the purchase and installation of the equipment necessary to expedite energy conservation projects outlined by the audit team.

The following information is necessary for the implementation of this phase:

1. First - indications that appropriate energy conservation operating and maintenance procedures have been implemented for the building. Such indications should be supported by documentation showing that energy use has been reduced in a given year, through changes in operating and maintenance procedures, by not less than 20 per cent from a corresponding base period, having a degree-day variance of less than 10 percent.

2. Second - recommendations for appropriate energy conservation maintenance and operating procedures, developed as the result of an on-site inspection and review of any scheduled preventive maintenance plan, together with a general estimate or range of energy and costs savings. These should include information related to:

   a) Effective operation of ventilation systems and control infiltration conditions, including:
      - repair of caulking or weather stripping around windows and doors
      - reducing outside air and/or shutting down ventilation systems in unoccupied areas,
      - ensuring that central and/or unitary ventilation controls are operating properly.

   b) Changes in the operation of heating and cooling systems through:
      - lowering or raising indoor temperatures,
      - locking thermostats,
      - adjusting supply or heat transfer medium temperatures,

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[5]Annex XI - "Energy Auditing": Source Book for Energy Auditors, Volume 1 & 2

- reducing or eliminating heating and cooling at night or during times when portions of the building(s) are unoccupied.

c) Changes in the operation of lighting systems through:
   - reducing illumination levels,
   - maximizing use of daylight,
   - using higher-efficiency lamps
   - reducing or eliminating evening cleaning of buildings

d) Changes in the operation of water systems through:
   - repairing leaks,
   - reducing the quantity of water used, for example, flow restrictors,
   - lowering settings for hot water temperatures,
   - rising temperature settings for chilled water systems.

e) Changes in the operations and maintenance of the utility plant and distribution system through:
   - cleaning equipment,
   - adjusting air/fuel ratio,
   - monitoring fan, motor, or belt-drive system,
   - monitoring combustion
   - maintaining steam traps,
   - repairing distribution pipe insulation.

3. Third - after one is satisfied that one (1) and two (2) are successfully implemented, then we need an indication of the requirements for the installation of capital energy conservation measures, based upon consideration of one or more of the following:

   a) Energy use index(es) - for example, EKWH per gross square meter (foot) per year
   b) Energy cost index(es) - for example, annual energy costs per gross square meter (foot)
   c) Physical characteristics of the building(s) envelope and major energy-using systems.

Energy management capital investment of a major nature must be subject to vigorous analysis - see Chapter 6.

5.1.5 Energy monitoring

It is critically important that an energy management program be properly monitored. By maintaining an accurate record program, management is able to document such information as: what has been done; the effectiveness of various actions; and the costs and cost savings involved. This kind of information is essential for maintaining a high level of human interest in the program. If people have been asked to help achieve a goal, they will want to know how effective their assistance has been. Monitoring is also essential to determine if correct tasks have been given, if work has been done properly, if changes are required, and to predict the impact of prospective actions. Although monitoring is an extremely important function of the program, it can generally be performed with very little difficulty, and it can in many cases, be incorporated into regular daily, weekly or monthly routines.

Monitoring an energy management program involves two distinct types of effort.

The first type effort consist of monitoring how changes have been implemented. If maintenance schedules call for revisions, the administrator should check with maintenance personnel to ensure that they can handle the revised schedule. Checks on equipment being maintained ensure that maintenance is being performed well. All this means is following procedures of good management; that is, making sure that those responsible for carrying out specific functions are carrying them out in the most effective manner.

The second type of effort concerns monitoring the effectiveness of the program itself in terms of energy consumption. This can be done most easily by using the fuel and electricity consumption forms found in Fig. 5.1.D and Fig. 5.1.F. These forms will provide information on the entire system, and on certain subsystems if the subsystem involved is the only one which utilizes a particular form of energy.

The check metering process, which involves the actual metering of power being supplied by the various electrical feeders to the subsystems, establishes how much energy each subsystem utilizes. In contemporary building where individual subsystems are supplied power independently, such metering is a relatively simply undertaking. For old buildings, which typically have several systems operating from one feeder, the task is far more difficult, if not practically impossible. Even when contemporary buildings are involved, the cost of check metering, which is a relatively simple task, can be very high.

The alternative to check metering is to conduct an empirical survey of the building and its subsystems. This method, being design to provide data on all connected loads, their usage and their load factors, would determine subsystem energy consumption. The larger the building(s) involved, the more difficult and expensive this task becomes.

In certain cases, when a building is heated and cooled by electricity, energy utilized by heating and cooling subsystems is easily obtained by installing separate totalizing and general load meters.

The information yielded by the monitoring process should be utilized to keep the energy management program as effective as possible by: making improvements where data suggest improvements can be made; undertaking alternatives which have not as yet been attempted; revising goals where revision seems warranted, etc. In addition, it is suggested that the program be made a permanent part of the management function if possible. This would include holding periodic meetings with building and management personnel to keep them informed of accomplishments, set-backs and future plans. These meetings would also provide participants the opportunity to request new information and exchange ideas beneficial to the energy management program. Hospital staff should be given the same opportunity. This would help secure their involvement in the program and their continued willingness to make those efforts required to achieve energy conservation goals.

5.2 Energy conservation coordination

A number of hospitals, especially the larger ones, have deemed it cost effective to hire an energy conservation coordinator. The skills for the job include:

a) effective communicator
b) highly self motivated
c) good knowledge of energy systems

This person often reports to a senior administrator and is in a staff position. He works with all parties to develop the energy management program and once it is in place, to carry out the monitoring.

By reporting to a senior person, he has a status of high profile, yet by being on staff as opposed to a line position, he does not appear to be threatening the departmental authority of any department, especially physical plant operations.

In some hospitals (especially smaller ones) the job is performed by a person on a part-time basis while carrying out other line responsibilities.

5.3 Continuing education

Since hospitals are becoming more complex in terms of physical operations systems, continuing education must be undertaken by the key leaders in the energy management program. Knowledge of new products and techniques, and their costs and benefits from the energy perspective is essential.

It is recommended that time and effort be taken to keep up-to-date on the various publications relating to the field, as well as, activities of the appropriate local national and international organizations.

The maintenance personnel must also be kept abreast of the energy consuming influences. They must be kept informed of the successes and failures and encouraged to play an important role.

5.4 Communication and motivation

Since communication and motivation are closely interrelated concerns, they are discussed as a single factor.

Most hospital personnel will first become aware of an energy program during the building survey. Because there may be a substantial time lag between that period and official announcement of the program, it is advisable to issue an "energy update" newsletter regarding progress of the program.

Once a basic energy management plan has been approved, it is appropriate that an official announcement be made by the administrator. The key factors which should be stressed in the announcement relate to:

- increasing cost of energy, and its impact on rates, and its projected impact unless conservation is achieved,
- the potential for energy savings in the first two or three years of an energy management program,
- the amount of money which energy management will save and its impact on employment and related factors,
- the fact that energy and energy cost savings can be attained without adversely affecting the quality of patient care,
- the fact that maintaining a building as an efficient operating system can actually improve the environment and contribute to better health care delivery.

The announcement discussing the general types of energy management options which will be implemented, should appear in the hospital newsletter, if one exists. It can also be distributed directly to employees, or its availability can be made known.

Personnel from each department should be advised of the impact of energy management shortly after the official announcement is made. A meeting format should be used so that each group is addressed by the head of the department and the energy management manager. When appropriate, written material identifying ways to conserve energy should also be distributed.

A newsletter will remind people of the energy conservation effort, as well as, report how the program is operating, who is involved in making it work, and what results have been achieved. Typical information which could be related includes monthly energy cost and consumption data, new programs and ideas, names of people involved, and energy conservation tips which can be put into daily practice.

Whenever possible, each department should be informed of its progress. Bulletins or update notices posted throughout the hospital will remind people that energy conservation is their responsibility. Providing people with motivation to keep up the energy conservation effort is an important aspect of the energy management program.

Since giving praise where it is due is important in gaining and maintaining support, those who have made significant contributions to the program should be congratulated, both in person and by mail.

"Point of use" materials, or labels and signs affixed in appropriate places, can be used as energy conservation reminders. For example, stick-on light switch labels indicate that lights should be switched off when not in use; signs placed on bathtubs and showers encourage less use of hotwater and can inform people that hot water temperatures have been reduced to conserve energy; notices placed on doors will remind people to close them.

5.5 Suggestion program

Establish a suggestion box to encourage energy conservation recommendations. This program should be open to everyone, and worthwhile suggestions should be given recognition. Some of the more innovative ideas could be given special coverage in the newsletter.

5.6 Energy team

Many Hospitals have found that an Energy Team, also called Committee or Task Force, with representation from physical plant, nursing and medical staff, and one senior administrator, where used to implement and energy management program, helps to gain Hospital wide acceptance. The Team can continue to function in a monitoring role once the program is in effect.

The energy conservation program benefits from everyone's involvement. Each member is able to bring to the table issues and functions which affect energy end use and cost and valuable ways to reduce energy consumption.

CHAPTER 6. ENERGY MANAGEMENT INVESTMENTS

6. Introduction

6.1 General

An effective energy management program may include the investment of financial, as well as, human resources. While significant energy conservation may be effected by sound management and maintenance practices, certain programs may require investing in retrofits to existing technologies or in new technologies.

In any case, sound investment practices must be adhered to before embarking on such projects. A thorough investigation of the economic and operational costs and benefits must be undertaken followed by the preparation of a specific proposal to the funding authorities. If the project is approved and implemented, constant monitoring of the project is needed, including proper commissioning to ensure that the perceived benefits are realized.

6.2 Making the proposal

Once an energy audit has been carefully prepared, the Director of Physical Plant Operations and/or the Assistant Administrator for Physical Plant Operations, perhaps with the assistance of the Assistant Administrator for Finance, should prepare the proposal. Alternatively, the Energy Audit Team (or consultant) can prepare the brief.

The document should clearly identify:

- technical merits of the project
- the total cost including design, acquisition, implementation and commissioning
- the benefits, both technical and financial
- the impact on the organization and facilities
- the length of time required to carry out the project

The proposal may require approval of the Chief Executive Officer and the Board of Trustees. This depends on the size of the investment, as well as, the organization's policies.

6.3 Implementation

Once the project has been approved, careful attention must be given to implementation. This includes:

- sticking to the original concepts
- monitoring costs
- monitoring progress
- ensuring correct and timely completion
- monitoring the ongoing costs

6.4 Retrofits versus new development

In many cases newer facilities have greater amounts of energy consuming technologies. Thus, the opportunity exists when building new hospitals to put in place major energy consuming systems. To retrofit an older facility may require shutting down of parts of the building or replacing major engineering systems.

In most cases when building new facilities, the cost of energy efficient design systems and equipment may, in fact, be less than the alternate approach.

Since most of our Hospitals last for 50 years or more and a great deal of investment is made in redeveloping these facilities for new or revised health care programs, an opportunity exists to invest in energy management as part of the redevelopment.

In many cases the savings from investing in energy management which is independent of other projects more than exceeds the costs.

6.5 Examples

The following examples show the value of careful investment/operation and the resultant savings. These examples are not worked out here in detail but rather are taken from actual worked examples and recounted here to show that the payback on even a small investment can be quite significant in seemingly unimportant conditions.

6.5.1 Repair leaks

Four (4) small air leaks were noted in an air system. This system was operating for approximately 9 000 hours per year and when it was analyzed it was found that, for a cost of 275 $ for labour and materials, the annual dollar savings resultant from repairing the leaks amounted to 5 400 $ or a simple payback of 19 days. Additional benefit of reducing the leakage was that additional compressed air was now available for other uses and consequently the purchase of another compressor for additional air capacity might not be required if additional tools or equipment were to be installed requiring compressed air.

6.5.2 Repair water leaks

If two 12 mm wash down hoses are left running, it will result in a water loss of approximately 0.5 million litres per annum. Assuming that water costs 0.41 $/m^3$, the dollar savings would be 2 200 $ per year.

6.5.3 Reduce hot water temperature

When reviewing hot water usage with a steam fed heat exchanger, it was found that the wash water could be reduced from 60°C to 48°C with no effect on the rinse operation. Assuming that the washer was in operation 800 hours per year, and the water flow rate was 1 litre per second, it was found that this reduction in temperature could save approximately 1 700 $ per year. Not only saving money, but ensuring that there was more steam available for other productive capacity.

6.5.4 Monitoring and control equipment calibration

Many facilities monitoring and control equipment receive little attention until a problem develops. Consider a flowmeter indicating the flow of cooling water to a process operation. If the flowmeter goes out of calibration and indicates lower flow than it is actually taking place, the equipment operator will, unknowingly, increase the cooling water flow beyond the required rate. Pumping energy would thus be required to provide the additional cooling water. In analyzing one such operation, it was found that, due to equipment being out of calibration, approximately 22 000 $ per year could be saved by ensuring that the meter read the actual cooling water pressure.

6.5.5 Tank surface installation

In another case, management was concerned about the surface heat loss of an otherwise well insulated open top tank containing 2 900 kg of sodium dichromat solution at 94°C. The steam flow to the tank was metered establishing the steam required to maintain the tank at the correct temperature. By adding 50 mm polypropylene balls to the top of the tank to cover the liquid surface, and thus reducing the steam flow readings, it was found that, for an investment of 3 000 $ in polypropylene balls, a saving of 51 600 $ was realized or a simple payback of 22 days on the investment.

6.5.6 Energy efficient design

Pumping systems have not always been designed to minimize the use of energy. Consider the example of a water pump which was designed to delivery 320 litres per second at a discharge head of 134 m. The pressure was measured at several points in the system to provide that the pump discharge head could be reduced by 12 m. The savings in pumping energy amounted to 2 300 $ per year at a cost of 500 $ to trim the pump propeller. A simple payback of 3 months.

6.5.7 Statistics

The forgoing examples show the value of small investments with significant payback. However, this is not the only type of investment. Time invested in preparing statistics on energy consumption is of significant value. For example, by plotting monthly and yearly statistics, one can identify trends in energy consumption from changes in energy conservation programs. If one is able to see a trend of energy increasing without a reasonable explanation about the use of the facility or an expansion, then one has a reasonable argument to investigate why this is happening. Even crude statistics are useful to highlight trends from year to year or month to month. Only by understanding our energy consumption will be in a position to judge whether the consumption is reasonable for any particular facility.

6.5.8 Conclusion

These examples are typical only. The other Booklets (II to VI) give a more detailed engineering approach to energy savings technology and the various systems. These examples show the value of diligent record keeping and a detailed analysis of the operating conditions, maintenance standards and performance criteria of a facility.

CHAPTER 7. CONCLUSION

7. Introduction

7.1 Keep the energy management program going

There is a natural tendency to assume that once the last bolt is tightened on an energy project, the job is done and your attention can go to other things. Though this is true to an extent, in another sense the job has just begun. Energy "dollars" are saved over months and years, and savings require regular attention in order to continue at their expected rate. Concerted action is needed to counter the tendency to "return to normal" that so often follows a period of innovation. This section suggests some practical means of keeping your energy savings on target.

The ideas in this section should become part of your energy manager's routine, with assistance from your accounting and maintenance staff. As a manager, your role should be to see that these practices are adopted and kept up, so that your time is not consumed with too much details.

7.2 Monitor energy performance

Ongoing monitoring of energy consumption provides the basis for evaluation of the success of an institution's energy conservation program. Reviewing and comparing monthly fuel bills and adding equipment metering are two effective methods for identifying the areas of potentially greatest savings, as well as, quickly pinpointing consumption-increase problems.

7.3 Make a target energy budget

Your energy analysis should produce projected energy and cost savings from each of the energy measures you install as well as the combinations of measures, to provide a basis both for estimating total savings potential, and for subsequent monitoring. By subtracting the savings projections from your base year consumption levels you can establish a target energy budget, that can then be used to track energy performance.

7.4 Review energy bills

Make sure that you are receiving all the energy you are purchasing. Make sure that you meter the consumption to ensure that it agrees with that indicated on your bills. Make sure that you are receiving the most favourable tariff rate. This latter case can be a significant source of savings.

7.5 Evaluate energy performance

Recording energy data each month is one thing; using it to assess your facilities performance is another. The real value of doing energy accounting is to measure - with the hope of improving - energy efficiency. How do you measure energy performance? One of the simplest ways is to keep a chart of your year-to-date consumption. If your consumption is increasing, consider the following factors:

a) Has the weather been more severe than in the base year?
b) Have the hours of operations, the floor surface in use, or the number of people using the facility increased?
c) Has energy-using equipment such as computers, medical equipment, etc. been installed?

7.6 Investigate problems

Assuming that you have implemented a comprehensive conservation program in your facility, identifying problems should be relatively easy. However, even when your energy manager and maintenance staff are conducting an excellent program, consumption data may inform you that expectations are not being met. Some complex ECMs (e.g. computer systems, boiler interconnects, heat recovery) may require the attention of the installer, manufacturer, or service contractor. The fact that you have been tracking energy performance and are aware of the problems when they occur will prevent both energy and dollar losses over the long term.

7.7 Monitor program upkeep

Though you may have spelled out O&M procedures for your staff, and arranged for service for ECMs, it is nonetheless important to check to see that the orders are being carried out. The energy performance review process using energy bills is one way to see if things are working, but it is not a substitute for a more "hands-one" assessment of what's going on in the boiler room. You may want to ask your energy manager to do spot checks or quarterly reports on both internal staff adherence to O&M procedures and external service contractors' adherence to specified requirements.

7.8 Support energy performance

Even with the best physical plant, your facility is not likely to maintain the energy efficiency it is capable of unless the people who use and maintain it are properly motivated toward that end. While motivation is essentially a quality within individuals, there are several ways management policies can encourage individual support of institutional goals. Energy management goals can be supported through such means as:

a) Reporting systems

Receiving useful information that relates to an individual's energy conservation efforts on a regular basis can be a motivator. If, for example, you see monthly reports on your building's energy performance, you have a basis for continuing or improving your efforts and sharing the good news (assuming it is good). If not, you can take corrective action.

b) Publicity

Success should be highlighted in the institution's regular communications media, such as staff memos, newsletters, posted announcements, etc. Individuals who have contributed to improving energy performance could be recognized, through special mention, formal or informal awards, or just personal appreciation.

CHAPTER 8. CHECKLIST

8. Introduction

Often a simple list of items, which can be carried out as a part of the normal practise of doing one's job, can be very effective in accomplishing energy savings. Such a list of management and operations items follows.

8.1 Checklist for managers

- Conduct a seminar for all building maintenance people on energy management policies and needs. Establish prior a year as a base year to compare future records of energy consumption in areas such as heating and lighting costs.
- Form an Energy Action Committee with representatives from as many areas as possible. Send members to energy management seminars.
- Establish short term goals and give frequent progress reports. Conduct an energy awareness campaigne. Include the following:
  - . post reminders on equipment and light switches
  - . develop a slogan, e.g. "Turn it off if not in use"
  - . use bullettin boards to illustrate energy waste
  - . develop a newsletter to communicate progress and give recognition to personnel who have made good suggestions or departments that have achieved savings
  - . remind everyone to report problems and malfunctioning equipment, e.g. dripping taps
  - . assign responsibility to individuals for an area or task
- All promotion and recommendations concerning energy management should seek to develop a team spirit.
- Involve people in changes in their work areas.
- Building committees of the Board of Trustees can hold intensive seminars for maintenance staff using specialists on energy management. Board members should be present.
- Publications documenting comparing consumption, records of oil and electricity for similar facilities can be used as part of an incentive program by the Board of Trustees.
- Boards and managers could adopt a regulation for administrative manuals, that has the objective of instilling in the mind of staff that we live in a finite world. Today's energy manager is essential for tomorrow's generations.

- Trustees, administrators and other managers should demonstrate their own commitment to energy management and set a good example.
- All programs undertaken should be widely publicized in the community to encourage others to give leadership to energy management.
- Persistence is important. Old habits die hard. Costly programs are not needed as much as people involvement.
- Energy management is essentially creating the awareness that we must conserve energy followed by a dedicated effort to do so.
- Encouragement and recognition stimulates people to become involved.

8.2 Checklist for Nursing staff

- Report overheated or overcooled rooms rather than opening windows.
- Remove furniture or any other obstruction such as magazines, plants, over or in front of heating or cooling vents.
- Open curtains for natural light rather than using electricity.
- Turn off unused lights, T.V. or radio.
- Report electrical or plumbing deficiencies, such as leaking taps or showers or toilets that run continuously.
- Close drapes in unused rooms to prevent loss of heated or cooled air.
- Encourage patients to use bed lighting for reading.
- Turn off coffee warmers when not being used.
- If natural light is adequate, turn off or reduce corridor lighting during daylight hours.
- Spread patient bath times throughout the day. This will reduce peak water requirements.

8.3 Checklist for repair and maintenance staff

- Check doors to ensure they close quickly and completely.
- Use automatic door closers on all exterior doors.
- Leave storm windows and doors in place during the summer.
- Install vestibules or revolving doors at all major entrances.
- Install a vestibule with enough space so that outside doors are closed before inside doors are open.
- Install solar screen on south, east and west windows to reduce incoming heat loads.
- Limit hot water for general use to 60°C. Lower temperatures may cause the spread of Legionellae. Ask your infection control officer to advise you in this area.

- Install spring shut-off devices on hot water faucets in public washrooms.
- Arrange for a system that will turn off direct hot water recirculation pumps manually or by a time clock.
- In new installations, specify "water saver" type toilets that use only about 12 litres per flush rather than the usual 20 litres or more.
- Place appropriate conservation stickers in every bathroom.
- Reschedule operations to take advantage of off peak periods. For example, water could be heated electrically in off peak periods and then stored for use when needed.
- Investigate the installation of thermal storage capability.
- When deciding on light levels, check with people working in each area. Light requirements will vary (see recommended lighting levels provided by national Standards).
- Institute a preventive maintenance system.
- Mark each fixture with plastic tape indicating proper Wattage lamp to be used.
- Reduce lighting in lobby, lounge areas and hallways during daylight hours.
- When replacing fixtures, purchase the most energy efficient system that is appropriate.
- When replacing ballasts for fluorescent tubes, choose those with the best (highest) power factor rating.
- Replace reflector floor lights with parabolic lights. They will use about half the energy and give you a comparable amount of light.
- Convert incandescent lamps to small fluorescent fixture which use less electricity with a small increase in illumination.
- Put courtesy lighting around overhangs, etc. on a light sensor.
- Use personnel sensor to activate lighting in specific areas.
- Install twist on door jam switches for areas such as storage, closets, walk-in coolers where lights may be left on by mistake.
- Consider installing load stabilizers to lower peak power demands.
- Put outside lighting and building illumination lights under a computer control system for turning on and off lights to ensure minimum usage which compensates automatically for time of the year and weather conditions.

- Remember that dark buildings are less reflective and will need more light than light buildings.
- Introduce load monitoring and scheduling to reduce or eliminate high peaks and hence havy power demand charge. Schedule starting of motors and fans at different times.

8.4 Conclusion

The checklist is a guide. Many items are similar to operation of other systems. You are encouraged to develop your own checklist.

CHAPTER 9. ACKNOWLEDGEMENTS

9. Acknowledgements

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- "Task Force on Energy Managements in Health Care Facilities in Canada". Administrative and Technical manuals, Technical Reports #'s 4 & 5. Ottawa 1982;
- "Lo-No-Cost Hospital Energy Management Options", prepared by Hospitals and Medical Care Alberta, Canada;
- "Total Energy Management for Hospitals", prepared by the U.S. Department of Health, Education and Welfare;
- "Management of Energy in Health Care Facilities", prepared by Hospital Programs Planning and Construction Division, British Columbia, Canada;
- "Energy Conservation in Hospitals", prepared by the Ontario Ministry of Health, Planning Branch, Toronto, Ontario, Canada;
- "First steps to Energy Conservation", prepared by the Office of Energy Conservation, Department of Energy, Mines and Resources Canada, Ottawa, Ontario;
- Supply and Services Canada, Ottawa Cat. # M91-6/12E, ISBN 0-662-14164-4, Ottawa, Canada.

APPENDIX A

10. Conversion Factors

The following typical values for conversion factors may be used when actual data are unavailable. The MJ and Btu equivalencies are heat of combustion. Hydrocarbons are shown at the higher heating value, wet basis. Some items listed are typically feedstocks, but are included for completeness and as a reference source. The conversion factors for coal are approximate since the heating value of a specific coal is dependent on the particular mine from which it is obtained.

Consistent factors must be used when calculating Base Year and Current Year Energy usage.

ENERGY TYPE	**METRIC**		**BRITISH**		
COAL					
- metallurgical	29 000	MJ/t	25.0	$\cdot 10^6$	Btu/ton
- anthracite	30 000	MJ/t	25.8	$\cdot 10^6$	Btu/ton
- bituminous	32 100	MJ/t	27.6	$\cdot 10^6$	Btu/ton
- sub-bituminous	22 100	MJ/t	19.0	$\cdot 10^6$	Btu/ton
- lignite	16 700	MJ/t	14.4	$\cdot 10^6$	Btu/ton
COKE					
- metallurgical	30 200	MJ/t	20.0	$\cdot 10^6$	Btu/ton
- petroleum					
- raw	23 300	MJ/t	20.0	$\cdot 10^6$	Btu/ton
- calcined	32 600	MJ/t	28.0	$\cdot 10^6$	Btu/ton
PITCH	37 200	MJ/t	32.0	$\cdot 10^6$	Btu/ton
CRUDE OIL	38 500	MJ/l	5.8	$\cdot 10^6$	Btu/bbl
No. 2 OIL	38.68	MJ/l	5.88	$\cdot 10^6$	Btu/bbl
			0.168	$\cdot 10^6$	Btu/IG
No. 4 OIL	40.1	MJ/l	6.04	$\cdot 10^6$	Btu/bbl
			0.173	$\cdot 10^6$	Btu/IG
No 6 OIL (RESID.BUNKER C)					
- 2.5% sulphur	42.3	MJ/l	6.38	$\cdot 10^6$	Btu/bbl
			0.182	$\cdot 10^6$	Btu/IG
- 1.0% sulphur	40.5	MJ/l	6.11	$\cdot 10^6$	Btu/bbl
			0.174	$\cdot 10^6$	Btu/IG
- 0.5% sulphur	40.2	MJ/l	6.05	$\cdot 10^6$	Btu/bbl
			0.173	$\cdot 10^6$	Btu/IG
KEROSENE	37.68	MJ/l	0.167	$\cdot 10^6$	Btu/IG
DIESEL FUEL	38.68	MJ/l	0.172	$\cdot 10^6$	Btu/IG
GASOLINE	36.2	MJ/l	0.156	$\cdot 10^6$	Btu/IG
NATURAL GAS	37.2	MJ/m^3	1.00	$\cdot 10^6$	Btu/MCF
PROPANE	50.3	MJ/kg	0.02165	$\cdot 10^6$	Btu/lb
			0.1145	$\cdot 10^6$	Btu/IG
ELECTRICITY	3.6	MJ/kWh	0.003413	$\cdot 10^6$	Btu/kWh

COMMON CONVERSIONS:

1 ton (2000 lbs)	=	0.9072	tonnes (Metric tons)
1 lb	=	0.454	kilograms
1 Imperial Gallon	=	4.547	litres
1 US Gallon	=	3.785	litres
1 Barrel (35 Imp Gals)	=	159.1	litres
(42 US Gals)	=	0.1591	m^3
1 Btu	=	1 055	Joules
	=	1.055	kilojoules
	=	0.001055	megajoules
1 Cubic Foot (at STP)	=	0.028317	m^3
1 Horsepower	=	0.75	kW

Watt hours and kW hours are commonly used in practice.

1 Whr	=	3 600	Joules
	=	2 655.4	ft·lb.
	=	860.5	g-cal
	=	3.413	Btu
	=	0.00134	Hp·hr
1 Joule	=	0.009484	Btu

SI PREFIXES:

Multiplying Factor	Prefix	Symbol
1 000 000 000 000 000 000 = 10^{18}	exa	E
1 000 000 000 000 000 = 10^{15}	peta	P
1 000 000 000 000 = 10^{12}	tera	T
1 000 000 000 = 10^{9}	giga	G
1 000 000 = 10^{6}	mega	M
1 000 = 10^{3}	kilo	K

11. Bibliography

11.1 Canada

- Technical Report #1, "Energy Management Manual" (1981)
- Technical Report #2, "An Assessment of Energy Management Within Health Care Facilities in Canada" (July, 1981)
- Technical Report #3, "National Energy Index Survey"
- Technical Report #4, "Energy Management in Canadian Health Care Facilities - Administrative Manual" (July, 1982)
- Rapport technique #4, "Gestion de l'Energie dans les Etablissements de Services de Santé du Canada - Manuel Administratif" (Juillet, 1982)
- Technical Report #5, "Energy Management in Canadian Health Care Facilities - Technical Manual" (July, 1982)
- Rapport technique #5, "Gestion de l'Energie dans les Etablissements de Services de Santé du Canada - Manuel Technique" (Juillet, 1982)
- Technical Report #6, "Energy Use Index of a Sample of Health Care Facilities in Canada" (1982)
- Technical Report #7, "Proceedings of Workshop Energy Management Strategies for Health Care Facilities" (October 18 - 19, 1983)
- Technical Report #8, " Budgeting the Energy "Pie" for General Hospitals (January, 1984)
- Technical Report #9, "The First Five Years" (June, 1984)
- Technical Report #10, "Budgeting the Energy "Pie" for Nursing Homes" (in preparation)
- Technical Report #11, "Towards Energy Self Sufficiency" (September, 1984)
- Technical Report #12, "Proceedings of EnerHealth '84 Workshop - Winnipeg" (October, 1984)
- Technical Report # 13, "Proceedings of EnerHealth '85 Workshop - Back to Basics, Halifax" (October, 1985)
- Technical Report # 14, "National Energy Index Resurvey" (March, 1987)
- Technical Report # 15, "Proceedings of EnerHealth '86 - Energy Trusteeship: A Need for Leadership" (October, 1986
- Technical Report # 16, "Long Term Care Facilities in Canada: A Sector Profile"
- Technical Report # 17, "Energy Survey of Long Term Care Facilities in Canada" (April, 1987)
- Technical Report # 18, "Winners of the 1985 Energy Conservation Awards" (1987)
- Technical Report # 19, "Checklist of Energy Management Ideas for the Canadian Health Care Industry" (June, 1987)
- Technical Report # 20, "Energy Costs as a Component of (Physicians) Practises Operations" (1987)

- Technical Report # 23, "Winners of the 1986 Energy Conservation Awards" (1988)
- Energy Mines & Resources Canada through Minister of Supply and Services, Ottawa, Canada 1985 Cat.nº M91 - 6/12E, ISBN 0-662-14164-4
- Energy Management/Employee Participation
  Conducting an Energy Audit
  Financial Analysis
  Energy Accounting
  Waste Heat Recovery
  Process Insulation
  Lighting
  Electrical
  Energy Efficient Electric Motors
  Combustion
  Boiler Plant Equipment
  Thermal Storage
  Steam and Condensate Systems
  Heating & Cooling Equipment (Steam & Water)
  Heating Ventilating and Air Conditioning
  Refrigeration and Heat Pumps
  Water and Compressed Air Systems
  Fans and Pumps Compressors and Turbines
  Measuring, Metering and Monitoring
  Automatic Controls
  Materials Handling and On-Site Transportation Equipment
  Architectural Considerations
  Process Furnaces, Dryers and Kilns
- Canada. Department of Energy, Mines and Resources. Second Annual Energy Management Industry Conference and Exhibition. May 12-14, 1986. Addressing Energy User Needs and Concerns -- New Techniques and Trends.
- Canada. Department of Supply and Services DSS Requisition nº 23216 6 2115. Proceedings from the March 24, 1986 Seminar on the Networking of Energy Management Control Systems. Available from:
  Shawinigan Lavalin
  330 - 90 Sparks Street
  Ottawa, ON
  KIP 5B4
  (613) 236-0438
- "Lo-No-Cost Hospital Energy Management Options", prepared by Hospitals and Medical Care, Alberta.
- "Healthy Building Manual" - Systems, Parameters, Prblems and Solutions (May 1988) - Coordinating Council Energy Management Task Forces, 17 York Street, Ottawa, Ontario, Canada, KIN 9J6
- "Management of Energy in Health Care Facilities", prepared by Hospital Programs Planning and Construction Division, British Columbia.

11.2 United States of America

United States Department of Energy. Institutional Manager's Guide to Energy Conservation. Washington D.C. Available from:
U.S. DOE-TIC
P.O. Box 62
Oak Ridge, TN 37830

Association of Energy Engineers. Energy Auditing. Atlanta; The Fairmont Press, 1980. Available from:
The Association of Energy Engineers
Atlanta, Georgia 30324
(404) 892-1784

Blue Cross of Greater Philadelphia. Final Report of the Philadelphia Hospital Energy Conservation Program. Philadelphia, 1979. Available from:
Blue Cross of Greater Philadelphia
1333 Chestnut Street
Philadelphia, PA 19107
Blue Cross of Greater Philadelphia. Practical Energy Management in Health Care Institutions. Philadelphia, 1977. Available from:
(see above)

Brown, Robert J. Life-Cycle Costing: A Practical Guide for Energy Managers. Atlanta: The Fairmont Press, 1980. Available from:
The Fairmont Press, Inc.
P.O. Box 14227
Atlanta, Georgia 30324

Dubin, Fred S. How to Save Energy and Cut Costs in Existing Industrial and Commercial Buildings. Park Ridge, NJ: Noyes Data Corporation, 1976. Available from:
Noyes Data Corporation
Noyes Building
Park Ridge, NJ 07656

Minnesota Department of Energy Planning and Development. Energy Accounting Procedures Manual for Local Governments and School Districts. 1981. Available from:
Minnesota Department of Energy Planning and Development
St. Paul, MN
(612) 296-8899

National Society of Professional Engineers. Guide to a Successful Project: Energy Conservation and Management. Available from:
National Society of Professional Engineers
2029 K Street, NW
Washington DC 20006

National Society of Professional Engineers. Model Competitive Procurement Procedure. Available from:
(see above)

Southeast Georgia Planning Commission. Energy Conservation and Management Guide for Small Municipalities and School Districts. Available from:
Southeast Georgia Planning Commission
P.O. Box 14227
Atlanta, Georgia 30324

Thumann, Albert. Handbook of Energy Audits. Atlanta: The Fairmont Press, 1979. Available from:
The Fairmont Press, Inc.
P.O. Box 14227
Atlanta, Georgia 30324

U.S. Department of Energy. Energy Audit Workbook for Hospitals. 1978. Available from:
NTIS
U.S. Department of Commerce
Springfield, Virginia 22161
Document #: DOECS-00412

U.S. Department of Energy. Energy Efficient Hospitals: DOE-Assisted Retrofit Projects. Office of Institutional Conservation Programs. 1981. Available from:
U.S. Department of Energy
Technical Information Center
P.O. Box 62
Oak Ridge, TN 37830

U.S. Department of Health, Education and Welfare. Public Health Service. Health Resources Administration. Criteria for Design Review and Licensure Surveys of Solar Systems in Health Care Facilities. DHEW Pub. #HRA/79-617
Energy Issues in Health. DHEW Pub. #HRA/79-14510
Energy Management in Health Care Institutions. USGPO #017-022-0046508
Solar Energy for Health Care Institutions. DHEW Pub. #HRA/78-613
Available from:
Health Resources Administration
Division of Energy Policy and Programs
5600 Fishers Lane
Rockville, MD 20857
(301) 443-6652

"Total Energy Management for Hospitals", prepared by the U.S. Department of Health, Education and Welfare.

11.3 Belgium

- Energy Savinggs, J. David, Building Services - May 1984
- Integriertes Energieversorgungskonzept für ein Krakenhaus Studie für das Universitätsklinikum Berlin - Steglitz, Esdorn und Jahn, H.L.H. n°34 1983 - n°9 sept.
- Subventions de l'A.F.M.E. pour les audits
- Energy Management in Hospitals, M. Libert, Minutes of the Workshop held in Mulheim (RFA) 13 and 14th.10.1983
- Les économies d'énergie dans les établissements de soins hospitaliers, J-C Menn, Promoclim E Tome 12 E n°1 - Février 1981
- Saving Energy in Health Buildings, Croome et Sinclair, Building Service Engineering Research and Technology Volume 4 n°4 1983
- Le Conditionnnement d'Air pratique - § 3.4. Les Hôpitaux, A. Libert, Chaud - Froid - Plomberie n°358
- Production d'e.c.s. par panneaux solaires, Serv. Communal de Belgique, (CPAS de Rixensart) août 1981
- Energiebeheer in Openbare Gebouwen - Case Study - A.Z. St. Jan (Brugge), L. Wullart
- A.R. du 15 déc. 1978 (MB du 4 juillet 1979), Normes spéciales pour Hôpitaux et service universitaire
- Energy Target: 68% Cut G. Cundall, Building Service sept. 1984
- Réflexions sur les solutions à énergie complémentaire - 2) l'Hôpital, Ch. F. Pb. n°431
- La pompe à chaleur enn relève de chaudière dans le secteur hospitalier, M. Gaussin (E.D.F.), Techn. Hosp. n°459 déc. 1983
- Energy Audit for Health Care Facilities, Nick Choski, H.P.A.C. - déc. 1978
- Anatomy of an Ennergy Management Program, Grumman and Butkus, ASHRAE Journal - June 1983
- Energie - onderzoek in het Diaconessenhuis te Eindhoven, Lenders en Kersten, Klimatbeheersing 13 (1984) n°12 (december)
- La production d'e.c.s. dans les hôpitaux belges: étude des systèmes et possibilités d'économie d'énergie, V. Terlinden, Trav. de fin d'études en vue de l'obtention du grade de licenciée en Sciences, Techniques et Gestion de l'Energie - ULB 1984
- Reducing energy consumption at a major Midlands Hospital, Building Services and Environmental Engineer - August 1984
- Programme de travaux en faveur des économies d'énergie dans les établissements hospitaliers, Circulaire (française) du 3 janvier 1980
- Lüftungstechnische Anlagen - Lüftung in Krankenanstalten, DIN 1946 Blatt 4 Juni 1974 (Entwurf)
- Berechnung der Kosten von Wärmeversorgungsanlagen Dampfebard in Wirtschaftsbetrieben, VDI 2067 Blatt 5 Dezember 1982

- Energiebesparing in instelingen voor intramurale gezondheidszorgg, J. De Vries, National ziekenhuisinstituut Utrecht - January 1984
- Guide pour une meilleure utilisation de l'énergie dans les établissements de santé, Ministère (français) de la Santé, Mai 1982
- Récupération d'énergie à l'hôpital Lapeyronie Montpellier, Cazal et Gras, Techniques hospitalières n°469 - octobre 1984
- Personeel ziekenhuis Dijkzigt bespaart evenveel elektriciteit als de uitgevoerde maatregelen, W. Van Blaricum, Energiebesparing 9/84
- Beyond the Nucleus (How to reduce the energy used by building services in hospitals), J. Ellis, Building Services - June 1982
- Le Centre hospitalier Bichat à Paris - Récupèration et économie d'énergie, J. R. Weill, Chaud - Froid - Plomberie n°414
- Möglichkeiten der Einflussnahme auf den Energiebedarf in Allgemeinkrankenhäusern, A. Hiergeist, H.L.H. 31 (1980) nr 7 Juli
- Solar Powered Hospitals: Cost Effective Solution to Rising Costs, R. A. Padillo, ASHRAE Journal August 1981
- L'utilisation de l'énergie solaire à l'hôpital du Pays-d'Enhaut, Chuard et Kleiber, Techniques hospitalières n°419/420 août - septembre 1980
- Filterklasse, Aussenluftrate und Luftwechselzahl
- Performance Characteristics of an Energy Recovery System, Sadler and Campbell, ASHRAE
- Evaluate Cogenerationn package for hospitals, ASHRAE Journal February 1985
- A report of the proceedings of the final symposium on the low energy hospital design study held on 27th October 1982 at DHSS, Low energy hospital study team, DHSS - Hannibal House - London SE 1 February 1983
- Light sources, Building Services Volume 3 n°6 June 1981
- Cutting light, J. URE, Building Services Volume 3 n°8 August 1981
- Energy conservation through lighting controls, R. Loury and M. Rea, Lighting Design and Application - sept. 1981
- The need for high-pressure sodium ballast classification, M. C. Unglert, Lighting Design and Application - March 1982
- Light switching for Energy Conservation in an office environment, W. Robertson, Lighting Design and Application - February 1984
- Energy Conservation in the Built Environment, Proceeding of CIB W67 Third International Symposium - Dublin 1982 (5 vol.)
- Controlling the lighting, J. Warrington, Building Services - August 1983
- User friendly lighting Control, Building Services - August 1983

- A cool look at lighting control, Building Services - January 1984
- Innovations '83 - 1983 IES Progress Report, Lighting Design and Applications - January 1984
- CIBS Code for Interior Lighting, CIBS 1984
- Office Lighting, ANSI/IES RP-1-1982
- Low energy office Lighting, L. Bedcocs, Lighting Journal 1981 n°24
- Lighting for Health Care Facilities, IES Trans.,Lighting Design and Applications - June 1978 and July 1978
- CIBS Lighting Guide Hospitals and Healthcare Facilities, 1979 - The Chartered Institution of Building Services. Publication n°12

11.4 Federal Republic of Germany

- ERIK - Energierationalisierung im Krakenhaus

  Bundesministerium für Forschung und Technologie
  Forschungsbericht T 86 - 189, Teil 1 und Teil 2,
  Dezember 1986

- ERIK2 - Energierationalisierung im Krakenhaus

  Praxisnahe Fallstudie Städtische Kliniken Kassel
  Bundesminister für Forschung und Technologie
  Der Hessiche Minister für Wirtschaft und Technik
  Forschungsbericht Projekt 03E - 5340 - A, August 1988

- ERIK3 - Energierationalisierung im Krakenhaus

  Praxisnahe Fallstudie am Beispiel des Katharinenhospitals in Stuttgart,
  Anwendung der seitherigen Forschungsergebnisse durch Fachingenieure,
  gefördert vom Bundesminister für Forschung und Technologie,
  dem Land Baden-Württemberg und der Landeshauptstadt Stuttgart

- H. Blank und L. Rouvel

  Cogeneration of Electricity, Heating and Cooling in Hospitals and Similar Buildings
  Proceedings of ENERHEALTH '87, Toronto/Canada,
  October 5-6-7, 1987

- M. Joeschke und L. Rouvel

  Mindestausstattung an Meßmöglichkeiten für den Versorgungsbereich im Krakenhaus
  H. Apel
  Energieflüsse im Krakenhaus: Anfall, Beurteilung, Wirtschaftlichkeit, Management, Technische Ver - und Entsorgung im Krakenhaus
  Hospi Tech '87, 13. - 15. Okt. 87, Hannover, S. 115/135,
  Herausgeber:
  Prof. Dr. C. Hartung, Prof. Dr. O. Anna

- DIN 1946, Teil 4: Raumlufttechnik (VDI-Lüftungsregeln), Raumlufttechnische Anlagen in Krankenhäusern, Dez. 1988

- A. Dütz und A. Le Marié

  Energieeinsparung in Krankenhäusern
  Deutsche Bauzeitschrift 12/1986, S. 1605/1615

- R. Krawinkel

  Betriebskoten - und Wirtschaftlichkeitsberechnungzur Verringerunng des Primär-Energieverbrauches durch den Einbau eines Hochheizkraftwerkes
  TAB 7/81, S. 573/594

- Neue Wege in der Gestalgungg von Bau und Betrieb des Krankenhauses

  12. Internationales Krankenhaussymposium 19. bis 22. Februar 1986
  Institut für Technische Betriebsabteilungen Bayerischer Universitäten)
  München, 30 Juni 1984

- D. Klaus und W. Schemkes
  Energiehaushalt in neuzeitlichen Krankenhäusern

  K. Nietsch
  Zentrale Leittechnik - ein Instrument zur Kostenoptimierung elektowärme international, Heft 5, S. A 113/A 132

- H. Esdorn und A. Jahn

  Integriertes Energieversorgungskonzept für ein Krankenhaus, Studie für das Universitätsklinikum Berlin-Steglitz
  HLH 34 (1983), Nr. 9, S. 361/368

- T. Pinter
  Verbrauch und Einsparung von Energie in Krankenhäusern
  Fachzeitschrift "das Krankenhaus" 5/1983, S. 214/219

- P. Renger
  Energieeinsparung durch Umluftbetrieb von Klimaanlagen im Operations-raum-Bereich
  HLH 35 (1984), Nr. 11, S. 532/536

- H. Schaefer (Hrsg.)
  Messen in der Energieanwendung
  Springen Verlag Berlin, Heidelberg, New York, London, Paris, Tokyo 1989

11.5 Switzerland

- Veska/Sorane SA, Lausanne /E+V Ingenierbüro für Energie und Verfahrenstechnik AG, Zurich: L'énergie dans l'hôpital, Enquête sur les hôpitaux suisses. Série de publications de l'OEN, étude n°32.
- D. Chuard, Sorane SA, Lausanne: Indices de dépense d'énergie des hôpitaux suisses, Schweizer Ingenieur und Architekt, 49/86
- P. Chuard, P. Jaboyedoff, F. Vuille, Sorane SA, Lausanne: Manuel de gestion d'énergie dans les hôpitaux, 1987
- Sorane SA, Lausanne: Hôpital de Payerne, Economie d'énergie, Bilan global, 1981
- Office fédéral des questions conjoncturelles, Programme d'impulsion pour l'amélioration thermique des bâtiments: Manuel "Etudes et projets", 1983
- E+V Ingenierbüro für Energie und Verfahrenstechnik AG, Zurich: Bericht n°3, Konzept der Energierationalisierung und Sanierungsvorschläge im Heizwerk 04 und Betriebsgebäude 05, 1983
- Institut Suisse de la Santé Publique et des Hôpitaux, Cahiers d'études de l'ISH n°35: Directives pour la construction, l'exploitation et la surveillance des installations de ventilation mécaniques des hôpitaux
- Kanton Basel-Landschaft, Kantonsspital Bruderzholz: Energiesparmassnahmen im Kantonsspital Bruderholz, 1985
- Kantonsspital Baden, Technischer Dienst: Effizienter Energiehausalt mit Gebaüdeleisystemen, Schweizer Energiefachbuch, 1989

11.6 Italy

- CTI, Calcolo per la qualificazione energetica degli edifici e degli impianti di riscaldamento. Progetto di Norma 9/124b
- CTI, Impianti di condizionamento dell'aria. Norme per l'ordinazione, l'offerta e il collaudo. Progetto di Norma 8/32 bis E 02.08.032.0
- CTI, Calcolo del fabbisogno termico per il riscaldamento

di edifici, Norma UNI 7357-74
- E. Cirillo - R. Lazzarin - F. Piccininni - R. Caliari. Alcuni problemi connessi alla produzione centralizzata di acqua calda sanitaria, "Condizionamento dell'aria", Dicembre 1988
- M. De Renzio, La Cogenerazione nelle Centrali Termiche degli Ospedali, "Condizionamento dell'aria", Gennaio 1987
- E. Cirillo - R. Lazzarin - F. Piccininni - R. Caliari, Analisi sperimentale sull'impiego di caldaie a condensazione per la produzione centralizzata di acqua calda sanitaria, "Condizionamento dell'aria", Nov. 1988
- R. Caprio, Recuperatori di calore in centri di cottura, "Condizionamento dell'aria", Sett. 1986
- M. Strada - R. Zecchin, Le Centrali di produzione del caldo negli Ospedali, "Condizionamento dell'aria", Dicembre 1986
- R. Borchiellini - A. Marano, Il recupero di calore in condizioni di ventilazione meccanica secondo la Legge 373 del 30.4.76, "Condizionamento dell'aria", Sett. 1987
- P. Brunello - A. Rieppi, Effetti degli scambi termici per radiazione e convezione all'interno degli ambienti sul calcolo delle dispersioni degli edifici, "Condizionamento dell'aria", Nov. 1987
- S.J. WOZNIAK, La malattia dei legionari, implicazione nella progettazione e nella utilizzazione degli impianti di produzione di acqua calda, "Condizionamento dell'aria", Gennaio 1986
- A. Boeche - A. Cavallini, Gli impianti di condizionamento dell'aria per sale operatorie e reparti speciali, "Condizionamento dell'aria", Gennaio 1986
- S. La Mura - L. Stefanutti, Quattro tubi ed aria primaria, o pompe di calore acqua-aria? Un raffronto tecnico amministrativo, "Condizionamento dell'aria", Ottobre 1987
- B. Lewis, Combustione efficiente e caldaia pulita per un alto rendimento, R.C.I., Marzo 1982
- G. Moretti - E. Segalini - S. Tallon, Il recupero delle acque di raffreddamento, "Il Progettista", Settembre 1975
- WOODS, Guida pratica alla ventilazione, PEG Editrice, 1976
- D. Guarino - M. Minischetti, Caratteristiche e consumi energetici nei servizi, ENEA, 1987
- C. Taddia - M. de Renzio, Studio di fattibilità di un impianto di cogenerazione di energia elettrica e termica "Ospedale S. Martino di Genova", "Condizionamento dell'aria" n°9/10, "Tecnica ospedaliera" n°7/8/9, 1981
- CNR - Progetto Finalizzato Energetica, CNR -PFE- LB6 - Libro bianco sulle ricerche condotte in materia di risparmi energetici del Sottoprogetto "Risparmio di energia nel riscaldamento degli edifici" del Progetto Finalizzato Energetica del CNR, Febbraio 1982