The Modern History Of Energy Conservation: An Overview for Information Professionals

Donald R. Wulfinghoff
Wulfinghoff Energy Services, Inc, USA

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Energy conservation is one of the critical issues facing society today. Our civilization runs on energy. However, energy resources are finite. Increasing demand is being made for diminishing supplies. The cost of energy is enormous, and the cost is rising. Utility bills account for much of the cost of housing, and they are a major cost of business. A large hotel or hospital spends millions of dollars for energy each year. Some steel mills pay hundreds of millions of dollars annually for energy. This consumption brings a host of environmental dangers. Fossil fuels dump carbon dioxide into the atmosphere, accelerating the greenhouse effect. Air conditioning systems release gases that destroy the earth's ozone layer. Discarded lamps contribute to mercury pollution. Energy consumption depletes not only the fuels themselves, but also a spectrum of other resources. A fundamental issue today is providing information about energy conservation. It is a special challenge for information professionals because:

Energy conservation relates to many areas of human activity, so the original information about efficiency is scattered throughout the literature of many fields.

By the same token, information about energy conservation is often subsidiary to other topics.

Energy conservation is still evolving as a distinct field of knowledge. Therefore, even modern information about it is scattered.

The best information often comes from sources that are unconventional for librarians.

Information about energy conservation varies widely in quality and credibility.

Attempts to create directories of information about energy conservation have failed to keep up with the quantity and variety of information.

The information client often has no clear idea of what he wants to learn.

There is a vast sea of information about energy conservation. From the standpoint of the information professional, this sea is still largely uncharted and full of strange hazards. The purpose of this article is to help everyone to navigate this sea and find needed information. The present organization of information about energy conservation has been shaped by the way that energy conservation has evolved. Therefore, the author discusses the historical currents of information about energy conservation and stresses the modern era, which began in 1973. Then he views the overall geography of energy conservation information, followed by field trips to the most important groups of information. Finally, to avoid giving misinformation to information clients, the author examines some of the strange customs and beliefs that exist in the lands of energy conservation. At the end of this guide he includes a selective list of Internet sites.

WHAT IS ENERGY CONSERVATION?

"Energy conservation" can mean a variety of things, and the most common meanings are:

using less energy in a particular application

finding ways to purchase particular forms of energy at lower cost. This is usually accomplished by negotiating with energy providers or by using energy under less costly conditions. (Paradoxically, the latter method may increase energy consumption considerably.)

shifting to different energy sources of lower price

using "free" or "renewable" energy sources (Paradoxically, this is often expensive.)

shifting to energy sources that are considered to be more desirable, or less undesirable, with regard to non-efficiency concerns such as availability and pollution. Such shifts typically involve serious compromises.

conserving water and materials, as well as energy sources

Information about energy conservation is not usually grouped in ways that distinguish between these meanings. In this article the author will treat all of them under the mantle of "energy conservation," "energy efficiency," and "energy management," and use similar terms interchangeably. These terms

have no standardized meanings at the present time. Energy conservation is now widely recognized as a fundamental strategy for protecting the environment. Therefore, expect to find more and more information about energy conservation under the heading of "environmental protection" and related terms.

THE EARLY HISTORY OF ENERGY CONSERVATION

The imperative to conserve energy is as old as the use of energy. For most of human history, use of energy was limited to the amount of work that could be done by human beings, usually alone, but sometimes in large groups. Later, humans learned to use animals and teams of animals to do the tasks requiring heavy lifting and hauling. Neither humans nor animals like hard work. Aversion to work strongly motivated energy conservation from the beginning. Energy conservation first consisted of doing less. Then, as intelligence evolved, it included finding easier ways to get work done. For example, the invention of the wheel was an early advance in energy conservation. Fire is the oldest major source of energy, other than muscle, that is controlled by humans. Since prehistory, fire has been used for cooking, heating of dwellings, hardening spear points, clearing land, smelting and casting metal, baking pottery, and other applications. Controlled fires require a considerable amount of effort for gathering fuel, so efficiency arose in the use of fuel. For example, the kilns and ovens of many early cultures were quite efficient in their use of fuel. Also, North American Indians devised ways of using far less fuel for comfort heating than European immigrants.

Wind power is the oldest major source of mechanical energy, other than muscle. Its earliest major application was ship propulsion, which began perhaps five to ten thousand years ago. This made possible the trading of large tonnages of goods throughout the known world. Moreover, wind power expanded the boundaries of the human world and it was an essential factor in the development of many civilizations.

Land-based rotary wind machines have been used in a limited number of cultures for over two millennia. Efficiency evolved by trial and error. The Dutch style of wind machine used for pumping water and grinding grain five hundred years ago achieved a large fraction of the theoretical maximum efficiency. However, usage is limited by the localized and irregular nature of wind.

The energy of falling or flowing water has been used to a significant extent for over two millennia, becoming a major energy source in the Middle Ages. Unlike wind, which is a nuisance in itself, water is desirable for many

important purposes. As a result, many cultures settled near water supplies, which they learned to exploit for power. Well designed "overshot" water wheels built 500 years ago have efficiencies that approach the theoretical maximum. Water power is limited by the amount of stream flow and by the height of the fall that is readily available. The technology of building dams tall enough to augment power production was not highly developed until the 19th century.

Steam machinery is another application of fire. It was first put into practical application during the 18th century. Its development was revolutionary for several reasons. It enables fire to produce mechanical work. It was the first invention capable of producing mechanical power in any locale, on land or sea. Virtually any amount of work can be done by building larger machines. Steam engines can operate whenever work is needed, independent of climate. To a large extent, steam power created modern civilization. However, steam machinery requires fuel, unlike wind and water power. The ability of mechanics to build large steam engines, and the growth in applications for such engines, led to rapidly increasing demand for fuel, which could no longer be satisfied by whatever excess wood happened to be in the vicinity. Fuel cost soon emerged as a dominant limitation to the application of steam machinery.

In response, efficiency also emerged early as a fundamental issue in the design of steam machinery. In fact, during the 18th and 19th centuries, what we now call mechanical engineering was largely a search for higher efficiency. James Watt and many other engine builders improved efficiency on an empirical basis, while attempting to understand the underlying physics. Sadi Carnot created the first solid theoretical understanding of energy efficiency. During the early 19th century, Carnot explained the Second Law of Thermodynamics, which places a severe theoretical limit on the efficiency of converting heat to mechanical work.

New fuel sources were discovered and developed in parallel with the development of power producing machinery. This was largely a fortunate coincidence. It was not primarily a matter of new machinery creating a demand for new energy sources. On the contrary, from the beginning of the 19th century, new sources of fuel were developed or discovered in advance of demand. Steam machinery made coal mining much more productive. The extraction of petroleum in quantity was developed in the middle of the 19th century, before people knew what to do with large amounts of petroleum. The development of internal combustion engines soon provided a large market for petroleum, which later found application as a primary fuel for steam machinery. With petroleum came natural gas, initially a dangerous waste product. Its discovery in quantity again motivated people to develop

uses for it.

Electrical power first emerged in the late 19th century, specifically for lighting. Electrical power was produced by increasingly efficient engines. However, lamps remained inefficient until the commercialization of fluorescent lighting, shortly before World War II. The development of practical electric motors, largely by Nikola Tesla, occurred toward the end of the 19th century. This enormously expanded applications for mechanical power. It freed the individual energy user from the need to have his own steam plant. Mechanical power could now be used anywhere, even in very small applications. The invention of innumerable small machines and labor saving devices made "energy" a ubiquitous commodity by the beginning of the 20th century.

Unlike the evolution of mechanical equipment, the development of electrical equipment was largely based on theory. All practical electrical motors are efficient, at least in comparison with combustion-driven machinery. However, the efficiency of applications served by inexpensive alternating-current motors is often limited by the fact that these motors are single-speed devices. Efficient variable-speed motors were developed early, but they had serious cost and maintenance limitations.

By the beginning of the 20th century, energy consumption *per capita* was accelerating, while the energy-consuming population of the earth also grew rapidly. Appliances displaced muscle power at home. Machines increased production in factories and in agriculture. Automobiles made transportation a major new consumer of fuels. Fuel replaced wind for the propulsion of ships. Air travel became another user of fuel. All the while, the available supply of energy continued to grow comfortably ahead of demand. Huge hydroelectric generation plants were built to provide jobs during the Depression. Electricity generation by nuclear fission arose as a byproduct of nuclear weapons, becoming another major source of energy from the 1950’s onward.

Until the early 1970’s, there was a popular conception of continually diminishing energy prices. For example, nuclear power advocates spoke of electricity that would be "too cheap to meter." As a result, efficiency ceased to be a major concern of the engineers who designed energy-using equipment, and efficiency faded as an issue with the public and the government.

THE MODERN ERA OF ENERGY CONSERVATION

The Big Bang that started the modern era of energy conservation was the

"energy crisis" that erupted in 1973. This resulted from an embargo of oil that was directed primarily against the United States by Arab oil producing countries in reaction to U.S. policy in the Middle East. Energy prices in the United States rose dramatically, mainly for petroleum. Far more compelling, there were actual shortages of petroleum, mainly in the form of annoying lines at gasoline stations. And, there were threats of insufficient heating oil.

In fact, petroleum prices in the United States never reached the levels that had long been routine in other countries. The big change introduced by the 1973 "energy crisis" was the realization that energy sources might not keep pace with mankind's ability to use energy. This was not a new concept for specialists in energy resources, but it was new as a popular idea. Stated differently, the supply of energy was no longer viewed as something that was always ahead of demand. Instead, the supply of energy, although still vast, was now viewed as lagging demand.

Previously, energy efficiency had been a technical aspect of designing equipment, systems, and buildings. In 1973, efficiency metamorphosed into "energy conservation," which emerged as a distinct field of interest, rather than continuing to be a subsidiary engineering issue. Energy conservation became a single freestanding issue, independent of the many technical areas to which efficiency applies specifically. This single-issue nature of energy conservation became a dominant factor in information about energy conservation from that time until the present.

The differences between the new era and the early era of energy conservation are so important that we will summarize them:

Old Energy Conservation	**New Energy Conservation**
Energy sources are discovered ahead of demand.	Energy sources are being depleted, without replacement.
An issue for individual parties.	A societal issue.
A technical aspect of individual machines and processes.	A freestanding issue, struggling to become technically integrated.
Perceived by everyone as an issue of labor requirements and fuel costs, to be addressed by technical and economic means.	Perceived mainly as a resource conservation and/or environmental issue. Distinct interest groups variously seek to address it by economic, technical, political, social, and/or metaphysical means.

The Major Currents of Modern Energy Conservation

Energy conservation is an issue with many aspects that continue to evolve. There have been major areas of technical improvement. There are also important areas in which there has been virtually no improvement, and hence, most of the potential of energy conservation still remains to be tapped. In the architectural arena, there has been serious efficiency regression, primarily related to the use of glass box exterior design.

The United States was the primary target of the oil embargo, and in the United States, popular opinion drives politics. As a result, there were many government initiatives toward energy conservation, including massive spending on research, major new laws, and incentives for favored energy conservation activities. Energy conservation continues to be a national imperative.

These are significant generalizations that we can make about the modern era of energy conservation, thus far:

The 1970's were a time of great ferment and rapid learning. The 1980's was a period in which many bad ideas from the 1970's collapsed. The 1990's was a time of stagnation and information loss. The new millennium restores interest in energy conservation, largely under the banner of environmental protection.

By far the greatest advances came from equipment manufacturers. Most new concepts were introduced during the 1970's. By the 1990's, the equipment had become reliable. Remaining technical development is slow.

Architects have disregarded efficiency in building design. Engineers, who are subordinate to architects in building design, continue to improve efficiency in a desultory manner.

Most government programs failed. Important exceptions were information programs and equipment efficiency standards.

Energy conservation codes for construction were enacted into law, but they remain widely ignored.

The industrial sector achieved much better efficiency improvement than the commercial sector, achieving most improvement during the years 1974 to 1985. Progress since then has been minor.

Facility owners and managers do not yet recognize energy efficiency as a normal aspect of management, but as an episodic issue.

During the first part of the modern era, energy conservation was independent of environmental protection. Then, they were seen as conflicting issues. Now, they are seen as complementary issues.

Information mushroomed during the 1970's, and slowed substantially thereafter. The *Energy Efficiency Manual* (see the review of the book in this issue) finally appeared at the beginning of the new millennium, filling the

need for a complete and easily usable guide to the main areas of energy conservation.

All this development and turmoil has created strong currents of issues within the modern era of energy conservation. These are summarized in Figure 1.

THE GEOGRAPHY OF ENERGY CONSERVATION INFORMATION

It helps to view information about energy conservation in these groups and sub-groups:

the primary grouping is by energy end-use sector
within each end-use sector, there are sub-groups of information that are targeted to the practitioners in those sectors
also within each end-use sector, there are sub-groups of information that relate to the equipment and materials used in that sector
a separate body of policy and advocacy information exists largely in isolation from the technical literature.

Understanding this large-scale geography helps to start searching for information by sailing in the proper direction. Below one can examine each of these groups in greater detail.

Information Grouped by Usage Sectors

Energy usage by humanity is divided into three large sectors, each of approximately equal size. One third of the world's energy is consumed in the buildings where we live, work, and congregate. Another third is used in the factories and plants that produce our needs. The remaining third is used in transportation.

The term "energy conservation," as it is generally used, applies to the first two end-use sectors, buildings and industry, but not to transportation. (Energy conservation in transportation is considered an integral part of the engineering of the vehicles, or it is a social discussion about different modes of transportation.) The buildings sector is divided into residential and commercial buildings. (The latter includes all large buildings that are intended primarily for human occupancy, regardless of whether the activity is "commercial" or not.) Residential buildings account for about 80% of energy consumption in the buildings sector, primarily because of their great number.

Energy conservation in the industrial sector falls into two distinct groups: conservation methods that are common to most industrial facilities and

efficiency improvements to specialized industrial processes. One is likely to find information about the common processes under the heading of "energy onservation." Only a fraction of industries, such as paper making and primary metals, have specialized energy processes. However, some of these are very energy intensive. One will find most information about conservation in the specialized processes within the literature of the particular industry.

In summary, there are four archipelagos of information about energy conservation based on the sectors in which the energy is used:

residential buildings
commercial buildings
the common uses of energy in industry
improvement of specialized industrial processes

These archipelagos have virtually no professional or technical connection with each other. There is little commonality in the information sources for them. However, they may share some islands of information about particular topics, such as lighting.

Note that this classification does not include energy that is consumed by the energy or utilities industries. These comprise an intermediate step on the way to the end user of energy. A large amount of energy is lost in energy industries, primarily in the production of electricity by burning fuels. (The laws of physics impose a severe and unavoidable efficiency penalty on this conversion process.) Energy industries tend to be operated as efficiently as possible. Energy conservation is considered an integral part of design, as in the transportation sector. Energy conservation in certain common components of the energy industry, such as cooling towers and lighting, falls within the category of common industrial energy uses.

Information Oriented to Practitioner Groups

Within each of the four end-use archipelagos, there are islands of information that are intended for the different practitioner groups who work in each end-use sector. The information for each practitioner group is produced primarily by the practitioners themselves and by the manufacturers of the equipment with which the practitioners work. Academic sources may produce the educational or theoretical components of practitioners' literature.

The main practitioner groups who influence energy efficiency are:

facility owners, including homeowners

facility operating staffs
facility administrative managers
architects
HVAC design engineers (called "mechanical engineers" in commercial sector)
electrical power engineers
lighting designers (often a sub-group of architects or electrical engineers)
industrial process specialists
builders and contractors
energy conservation specialists

Practitioner groups with similar titles may have different bodies of knowledge in different end-use sectors. For example, "mechanical engineers" in the commercial sector are involved exclusively with heating, ventilating, and air conditioning ("HVAC"), whereas "mechanical engineers" in industry may be involved with machine tools, conveyor belts, air compressors, and a wide variety of other matters.

Practitioners in different groups typically do not communicate with each other effectively. As a result, the information for each group may be ineffective or even incomprehensible to the other groups. Therefore, when your client appears with an information request, attempt to find out whether your client belongs to a particular practitioner group, or wants the viewpoint of a particular group. An important exception to the segmentation of literature by practitioner group is the *Energy Efficiency Manual*, which was designed to be comprehensible to readers of all backgrounds. This publication is discussed below.

Information about Equipment and Materials

The energy consumption of a facility is determined largely by the equipment and materials used in it. Fortunately, there are highly developed islands of information related to virtually all types of equipment and materials. In particular, the energy efficiency characteristics of equipment and materials for all end-use sectors are usually well documented. Manufacturers are the primary producers of information about equipment and materials. The information appears first in their catalogs. We discuss this important source below.

There is a great deal of overlap between information sources that are related to professional groups (discussed previously) and information sources that are related to materials and equipment. This is because manufacturers produce their information primarily to induce practitioners to purchase or

recommend their products. Professional and academic information sources are also important. Professional literature is more likely to address application problems that manufacturers have not yet solved. Academic literature is closer to the truth about efficiency performance.

Equipment efficiency ratings are another important information source. Efficiency ratings are easy to understand, if you spend a few moments learning how the rating factors are defined. Federal law requires efficiency ratings to be published for major residential energy-using equipment, including heating, cooling, and water heating equipment. Certain states, especially California, have efficiency standards for this equipment that are more stringent than the federal standards. Federal law also requires efficiency ratings for certain common types of equipment that are used primarily in the commercial and industrial sectors. Examples are efficiency ratings for particular types of fluorescent lamp ballasts and for the most common types and sizes of electric motors. The Energy Star Program of the U.S. Environmental Protection Agency labels a wide category of products for efficiency.

Trade associations and others may compile equipment efficiency information. For example, the Air Conditioning and Refrigeration Institute compiles efficiency ratings for all air conditioners and heat pumps below a certain size that are made in the United States. The list of Web sites at the end of this article includes a large number of sites that provide equipment efficiency ratings.

Some government agencies perform an important function in disseminating technical information that has been prepared by others, including many technical studies funded by the government. For example, the U.S. Department of Energy Office of Industrial Technology (OIT) has information programs devoted to specific industries. The OIT also produces a comprehensive computerized tabulation of electric motor efficiency that is called MotorMaster.

Information Related to Energy Policy

The previous sources are located in the ocean of technical information. There is another archipelago of information that lies in the ocean of energy policy. The people who inhabit the two oceans come from different backgrounds, and they have different viewpoints and agendas. They communicate with each other poorly, if at all, and there is tension between the two groups. Many people within each archipelago are virtually unaware of the existence of the people and information in the other. There are several important groups of people who deal primarily with the policy aspects of energy

conservation, rather than the technical issues. These include government, lobbyists, and advocacy organizations.

In the United States, the federal government and some state governments exercise initiative in energy conservation. Legislation is the primary form of government policy information. Legislation arises in ways that are generally not well documented before the legislation appears. Industry newsletters and the popular media may be the best source of information about pending legislation. Although laws are developed as a policy matter, they commonly produce mandates that are technical in nature. For example, an important group of laws create energy conservation codes for building construction and efficiency standards for equipment. The U.S. federal government also makes laws that dictate the selection of fuels in many applications, largely in response to environmental concerns.

Lobbyists typically represent particular industries that may be affected by energy conservation legislation. These parties are generally not a primary source of information about conservation, although they may compile information in a manner that favors their cause. For example, energy industries are a source of such information.

A growing number of advocacy organizations have become involved with energy conservation. A few of these organizations, such as the Alliance to Save Energy and the American Council for an Energy Efficient Economy, have energy conservation as their primary issue. In recent years, the major environmental advocacy groups, such as the Natural Resources Defense Council and the Sierra Club, have embraced conservation as a primary means of environmental protection. Energy conservation may become entangled with other issues, including political, social, or commercial agendas, or some combination of these.

Information that is produced by advocacy organizations is usually derivative. In fact, some organizations make an important contribution by compiling and analyzing existing information. Their output is commonly in the form of articles, conference proceedings, and "white papers." Expect this class of information to be heavily flavored to advance the various agendas of the organization, not all of which may be apparent.

On the positive side, compared to other sources, information from advocacy sources tends to be more forward-looking, and it encompasses a broader range of issues. For example, it tends to be the first to raise alarms about environmental dangers. On the negative side, advocacy sources tend to be technically naive and oblivious to practicality. A common example is promoting the installation of wind generators without regard to the

availability of wind. Advocacy sources may display little sense of balance, either between conservation and other issues, or between different methods of conservation (see more about this at the end of this article).

THE MAIN INFORMATION SOURCES

Comprehensive Energy Conservation References

Each well developed field of endeavor has a comprehensive reference that functions as a repository of the information of the field, and it often serves as the textbook of the field. In fact, the appearance of such a reference is often the first step in the emergence of a field as an area of human competence. For example, the advance of medical practice from quackery to an effective science had the publication of major books as its milestones. Similarly, the consolidation of each branch of engineering has been marked by the emergence of a primary reference book in that field.

During the 1970's "energy crisis" years, there were several important efforts to produce comprehensive energy conservation manuals. Hindsight reveals these efforts to have been fragmentary, but they were major advances in making energy conservation a rational subject area. Most of these earlier efforts are classified under the Library of Congress classification TJ163. Unfortunately, there is no corresponding Dewey Decimal Classification number for energy conservation as a whole.

The first truly comprehensive guide to energy conservation arrived at the beginning of the new millennium. It is the *Energy Efficiency Manual* by Donald R. Wulfinghoff, published by Energy Institute Press. It was written explicitly to serve as a comprehensive store of knowledge, and to be user-friendly for anyone involved with energy conservation. To achieve both breadth and depth, the *Energy Efficiency Manual* is big. It has 1,536 pages and 830 illustrations. It presents two types of information. The first 1,200 pages present 400 energy conservation measures, with a variety of aids to make the information quickly and easily accessible. These are written in conversational style, at a "Consumer Reports" level of detail. The last part of the book explains the most important general topics of energy conservation, ranging from brief explanations of terms to in-depth coverage of emerging technologies.

The *Energy Efficiency Manual* does not duplicate extensive engineering design information. For activities where this is needed, the book dovetails with the major professional references. For example, it tells the reader how to improve the efficiency of air conditioning, but it refers the reader to the *ASHRAE Handbook* for design data. The *Energy Efficiency Manual* covers

three of the four energy end-use sectors described previously—residential, commercial, and common industrial uses. It does not cover specialized industrial processes. For example, in a paper mill, it covers the motors, pumps, fans, and lighting, but it does not cover the specialized paper making equipment. For the specialized processes, one needs to be refered to the literature of the particular industry.

Books on Individual Energy Conservation Topics

Books are available about nearly every aspect of energy conservation, except for the most recent developments. Their quality ranges from excellent to fair. Books are the best source of aggregated information, for the reasons that we discuss below. A main challenge will be finding the best books for the needs. We discuss general methods of searching for books below.

There are several publishers that specialize in books about energy conservation, and these are good places to start. The Association of Energy Engineers is the most prolific of these. It is wise to keep a copy of their catalog on hand. There are several vendors that specialize in selling conservation books produced by a variety of publishers. For example, Iris Communications has a fairly good selection of books about residential construction, a large fraction of which involve naturalistic construction methods and renewable resources. The Internet sites of these and other sources are listed at the end of this article. These collective sources account for only a fraction of the energy conservation books that one may wish to find. We will explain below how to search for the energy conservation books individually.

Remember that energy conservation is not clearly distinct from the equipment and processes in which it is applied. This increases the range of sources that you should consider. For example, the famous book *Steam* is not an energy conservation book, but it is a fundamental source for learning about the efficiency aspects of boiler design.

Energy Conservation in the Major Professional References

Despite the emergence of energy conservation as a separate field, efficiency will remain an integral part of engineering, architecture, and management practice. Therefore, one will continue to find much important information about efficiency in the various specialized references used by professionals in those fields.

The *ASHRAE Handbook*, published by the American Society of Heating,

Refrigerating, and Air Conditioning Engineers, Inc., is the world's definitive reference for heating, ventilation, air conditioning, and refrigeration. This reference covers the majority of the equipment and materials that determine energy consumption in the commercial and residential sectors, and in refrigeration applications. It is also the primary source of information related to the architectural aspects of building design. Energy efficiency is a major issue throughout the *Handbook*, but energy conservation measures are not presented explicitly.

The *ASHRAE Handbook* belongs in every reference collection that provides information about energy consumption in building construction and refrigeration. Its coverage of topics is thorough, and it is extraordinarily well organized. The depth of treatment varies among the topics, from thorough in many areas to superficial in a few. It is published in four volumes, each volume being revised annually on a four-year cycle through the work of many ASHRAE technical committees. This keeps it exceptionally current, in comparison to other major references. The two volumes dealing with systems and applications, respectively, are easy to read. The volume dealing with industrial refrigeration is detailed, but easy to read by specialists in that field. The volume dealing with the principles and theory of HVAC (called "Fundamentals") has come under criticism from practitioners for poor organization and increasing remoteness from practicality. Unfortunately, the indexing of the four volumes is weak.

For electric lighting, the prime reference source is the *Lighting Handbook*, published by the Illuminating Engineering Society of North America. This beautifully rendered book is a fundamental source of information about the technical details of lighting, including the efficiency characteristics of lighting equipment. It covers the field completely, it is well organized, and it is easy to read. Unfortunately, it is updated only at long intervals, and lighting technology is presently evolving rapidly at the level of detail covered by the book. Therefore, its information about specific equipment is likely to be dated (the current edition was published in 1999). Lighting design practitioners do not yet have a doctrine of lighting design that stresses efficiency. This defect is reflected in the *Lighting Handbook*. (The *Energy Efficiency Manual*, which also covers lighting extensively, threw down that gauntlet by discarding conventional lighting design methods and introducing a radically different approach that emphasizes efficiency.) Aside from failing to deal with efficiency, lighting design in the commercial and residential sectors is oriented heavily toward the use of light for cosmetic purposes, which increases energy consumption. Another factor that makes efficiency an orphan in lighting design is that responsibility for lighting design wanders between architects, electrical engineers, and anyone who wishes to call

himself a lighting designer.

The *ASHRAE Handbook* and the *Lighting Handbook* are the primary design references used by the practitioners who determine most of the energy consumption in the commercial and residential sectors. It is noteworthy that architects have not produced a reference that deals adequately with energy efficiency in architecture. (The *ASHRAE Handbook* is a prime reference for the energy aspects of architectural design, but architects do not appear to use it.)

In the industrial sector, there are major references oriented toward mechanical engineers and electrical engineers. There are also major references oriented toward particular industries. *Marks' Standard Handbook of Mechanical Engineering*, published by McGraw-Hill, first appeared in 1916. Its audience is "heavy" mechanical engineering. Unfortunately, its age shows, and it has become a grab bag as mechanical engineering has diversified far beyond the content of the book. Efficiency is not a primary theme, and information related to efficiency tends to be intermingled with other issues. The latest edition is copyrighted 1987.

The *Standard Handbook for Electrical Engineers*, published by McGraw-Hill, is the original comprehensive reference for electrical engineers. The latest edition is copyrighted 1991. It has little to say about energy conservation, in the sense that we defined it previously. Electrical engineering has diversified to the point that a single reference can no longer cover all aspects of it. There are now major references that deal with individual areas of electrical engineering. The design of electrical machinery is the aspect of electrical engineering that most affects energy conservation, and it is determined largely at the time the equipment is made.

Along with these general handbooks, there are major references dealing with particular industries. Perhaps the largest of these is the 25-volume *Kirk-Othmer Encyclopedia of Chemical Engineering*, published by John Wiley & Sons (1991-1997).

Professional and Trade Association Materials

A variety of professional and trade associations produce information that relates to energy conservation. Examples are the National Electrical Manufacturers Association (NEMA), the Association of Physical Plant Administrators of Universities and Colleges (APPA), the Electrical Power Research Institute (EPRI), and the Sheet Metal and Air Conditioning Contractors' National Association (SMACNA). In some cases, associations produce the primary information in their fields, which may have major

relevance to energy conservation. Notable examples are the *ASHRAE Handbook* and the *Lighting Handbook*, which are both produced by engineering societies. Some trade associations produce consolidated information about the equipment and materials that their members manufacture. An outstanding example is the Air Conditioning and Refrigeration Institute, which publishes directories that give the efficiency characteristics of all packaged air conditioning equipment and heat pumps made in the United States.

Manufacturers' Catalogs and Training Materials

Most advances in the efficiency of equipment and materials are made by manufacturers. Therefore, manufacturers' literature is usually the first source of information about product efficiency that appears in a useful form. The best product information usually comes from one or a few manufacturers in each product area. These manufacturers assume the role of educator within their markets. Their goal is to influence the engineers, architects, contractors, and others who purchase or recommend products.

Manufacturers' best information may be contained in their catalogs, and also in pamphlets, design manuals, training aids, technical bulletins, and so forth. For example, Armstrong International and Spirax Sarco, two major manufacturers of equipment related to steam plant efficiency, offer excellent design guides for steam systems. One should be aware that manufacturers' literature tends to exaggerate efficiency performance. There is little outright lying in the catalogs of major manufacturers. However, it is a common practice to state equipment efficiency under ideal conditions, which may differ radically from typical operating conditions. For example, manufacturers of air conditioning equipment typically quote efficiency under full load, but the equipment operates at substantially lower average efficiency under typical load conditions. Another caution is that problems related to particular types of equipment and systems are swept under the rug. Adverse side effects are a general problem of energy conservation, but manufacturers avoid mentioning them, at least initially. For example, electronic motor speed controls are an important new product that can create serious electrical problems. Denial of the issue continues until a manufacturer can gain a competitive advantage by claiming the ability to tame the problem.

Magazines and Journals

There is little "scholarly literature" in energy conservation. Advances are made primarily by manufacturers, who keep their information proprietary until they are ready to release it. At that point, advances are announced in

the manufacturers' own promotional literature, and in magazines of the respective trades and professions. The majority of magazines read by practitioners are free. These magazines earn their income by advertising, and the influence of advertisers is strong. The better magazines provide some degree of quality control. Others rigorously avoid subject matter that might offend anyone, especially advertisers. This is a serious defect because progress in energy conservation is now largely a matter of recognizing and solving problems.

A large fraction of magazine articles are written by manufacturers' marketing people, so the articles have the same credibility concerns as manufacturers' literature. Another fraction of articles are written by practitioners who are promoting their own successes. A related weakness of all magazines is a hankering for "success stories," to the point of censoring anything that sounds negative. This tendency makes magazine information misleading and incomplete. For example, the author once wrote an article for the journal of a major professional society to explain solar control films for windows. This technique has great appeal, but also serious deficiencies. Without informing the author, the editor deleted all reference to the deficiencies, turning the article into a puff piece. There are magazines and journals devoted specifically to energy conservation. Examples are Energy User News and Energy Manager. Magazines in this group tend to suffer from the "success story" fixation.

Valuable information about energy conservation appears in certain industry magazines. The trick is to know which magazines are the best in each field. For example, *Heating, Piping, and Air Conditioning* is perhaps the best in the field of commercial sector HVAC. It has a large editorial board of leading professional engineers, a quality control device that is virtually unique among the free magazines. More specialized information may be found in odd places. For example, *Store Equipment and Design*, which serves the food store industry, has an interesting monthly section that deals with energy conservation in food stores. The subject matter of magazines tends to appear in waves, as editors seek to exploit interest in current topics. The downside of this is that a good article about a topic that is not current may not appear in magazines for several years.

Conference Proceedings

Since energy conservation is an evolving field, a variety of conferences are held at which information is presented. Most of the conferences that produce good information occur annually. Leading examples of conferences devoted specifically to energy conservation are the World Energy Engineering Conference and the Industrial Energy Technology Conference. Many

conferences oriented to specific industries produce information that relates to energy efficiency. A leading example is the semi-annual meetings of the American Society of Heating, Refrigerating, and Air Conditioning Engineers.

Conferences are organized by trade associations, universities, and companies that specialize in arranging conferences. Conference funding typically is provided by combinations of sponsors, typically associations and government agencies. Exhibits at conferences provide revenue from vendors, as well as attracting participants. A conference may have a dominant theme, or a variety of themes. Presentations are grouped into sessions. Session chairmen select speakers, who write the papers. The papers typically are written by practitioners, manufacturers' representatives, and academics. The major conferences archive their papers, and some conferences collect all the presentations into bound volumes that are called "proceedings."

The average quality of conference information is good. Topics are treated in greater depth than in magazines. Speakers have considerable latitude to express their opinions, and there is no opportunity to escape from probing questions. The author of a paper faces personal exposure to a large number of peers, which is strong motivation to provide information that is relevant and credible. As a result, conference proceedings are a source of information about practical issues that may not be discussed candidly elsewhere. Conference proceedings tend to age well. This is because most energy conservation technology is not advancing rapidly, and because the same problems keep arising year after year. For this reason, you may find good information in conference proceedings that are several years old.

Newsletters

As the name implies, newsletters tend to be oriented toward news. Newsletters typically do not have advertisers, so they will tackle issues that magazines avoid. The most candid are produced by private individuals. Newsletters are also produced by universities, government agencies, associations, and others. Such newsletters tend to be more inhibited, or more selective, about controversial issues. The information in newsletters tends to be fresh because newsletters require considerably less preparation than other print sources. They are short, usually plain, and few people are involved. In fact, commercial newsletters (on all topics) may be produced by one person. By the same token, newsletters are narrower in scope than almost any other type of information source. Newsletters tend to be free or very expensive. Free newsletters must be subsidized in order to function. Commercial newsletters are expensive because of a lack of advertising revenue and a limited subscriber base. For example, the monthly *Energy*

Design Update costs $337 per year, and *Environmental Building News* costs $179 for ten issues per year.

Government Sources

An enormous amount of information about energy conservation has been produced over the years by government agencies. The quality is variable. Most of the better information was produced by the U.S. federal government. State governments have sponsored much information, but typically it is derivative. The largest group of government information is consultant studies, which were produced in great quantity during the 1970's, and in reduced numbers thereafter. Many of these are available from the agencies who sponsored them, and from the National Technical Information Service (NTIS).

For the past two decades, the primary federal government source of information about conservation has been the U.S. Department of Energy (DOE). The DOE component primarily responsible for energy conservation is the Office of Energy Efficiency and Renewable Energy. (The name has changed over the years). Information produced by the DOE reflects the organization of the administrative groups within this Office. The various groups produce information related to all the sectors of conservation that we described previously. For example, one group deals with specific industries and specific energy-using equipment, such as electric motors and air compressors. Another group deals with the residential and commercial issues that cover a much broader range of issues. A sub-group of the latter develops energy efficiency standards in response to federal law. And so forth. The Energy Information Administration (EIA) is part of the Department of Energy. The EIA is oriented primarily toward energy supplies, rather than conservation. Internet queries about energy conservation are diverted out of the Web site to a general search engine.

The U.S. Environmental Protection Agency (EPA) is primarily a regulatory agency responsible for enforcement of environment laws. Because fuel consumption is a major cause of air, water, and ground pollution, EPA has become aggressively involved with energy conservation, increasingly taking the initiative for energy conservation away from the Department of Energy. As a result, EPA is becoming a source of information about conservation. An example is the equipment efficiency information resulting from the Energy Star program. The list of Internet sites at the end of this article leads to the important government sites.

THE BEST WAYS TO SEARCH FOR INFORMATION

At the present time, there is no comprehensive index to information about energy conservation that is similar to *Index Medicus* for medicine or *Lexis/Nexis* for law. Therefore, you may have to invest significant effort to find the best sources. Exploit the aggregations of information that we have explored. Here are some tips for organizing the search. First, one should try to judge what kind of information source will satisfy one's requirement best. See Figure 2, Comparison of Energy Conservation Information Sources.

Books are Usually Best

There are good reasons why books have been the primary medium for information throughout human history. In contrast with other media, books provide information in finalized form. They present a broad view of a particular subject. A book usually organizes information well. It has a table of contents and an index, making the information within the book quickly accessible. The investment required to produce a book and the exposure that a book provides to the author motivate the best possible job in presenting the information. During production, a book is refined by passing through the hands of people with skills in various aspects of communicating knowledge. One can find books that cover almost any specific energy conservation topic exhaustively or one topic in context among related topics. Even if the topic is highly specific, it is usually best to learn about it in a book, which will provide the context that surrounds the topic.

There is a current viewpoint that the Internet has made the book obsolete as a source of information, or that the Internet makes books a secondary source. In fact, the Internet challenges none of the advantages of books, and it is an excellent way to find books. Books are usually easier to find than other sources of information, especially if one is new to the world of energy conservation. Therefore, we will first examine the ways to search for books about energy conservation.

Internet Book Dealers

Internet book dealers are good places to find books, provided that you know the title and/or the author. They are much less reliable when searching by subject matter. Even so, one may have better success searching "energy management" on a large book dealer's site than one will searching "energy management" on the Internet as a whole using a search engine. A serious weakness of Internet book catalogs (and other catalogs) is finding a particular topic within books that cover many topics. Such books may be the best source. However, book dealers typically provide an inadequate number of key words for searching comprehensive books. For example, a subject search for "cogeneration" in Amazon.com yielded mostly books in which that

word appears in the title. Two thirds of these books were out of print, and most of the remainder were special orders. Thus, one would miss many readily available books that address this popular topic.

Defective cataloging is another weakness of Internet booksellers. Books may be classified incorrectly, or they may be listed in categories that are not expected by people making searches. As of now, the major Internet dealers do not offer extensive descriptions of books. Limited information, such as tables of contents and reviews, may be provided. Be aware that "book reviews" on dealer sites are often written by claques. However, these may be the only reviews for an energy conservation book that one will be able to find.

Publishers' Web Sites and Catalogs

Once one finds a particular book that looks promising, one will get the most complete information about it from the publisher. Most catalogs list the publisher's name, but not all do. If the catalog does not list the publisher, it may list the ISBN. In any case, one can use an Internet search engine with the title of the book and/or the name of the author to find the publisher's Web site quickly. For example, by going to the Energy Institute Press Web site, **http://www.energybooks.com/**, you can view extensive information about the *Energy Efficiency Manual*, including the table of contents, the entire 40-page index (as a searchable PDF file), and extensive extracts from the book.

Book Catalogs Specializing in Energy Conservation

A few catalog booksellers specialize in books about energy conservation. In addition, catalog booksellers who specialize in related topics, such as construction or environmental protection, may carry a limited selection of books about conservation. Such catalogs are offered by commercial booksellers (e.g., Iris Communications), professional and trade associations (e.g., AEE and ASHRAE), advocacy groups, and others. An advantage of these catalogs is that they are small enough to be examined in their entirety, so you can gain a good overview of what the catalog offers. Typically, a catalog offers brief descriptions of the books, making it easier for you to judge their relative merits. A disadvantage of specialty catalogs is that they offer only a fraction of the books that are available about their subject. The catalog may be produced by a publisher that sells only its own books. Or, the catalog may offer only the books of a limited number of publishers. Given their lack of completeness, why bother with specialty catalogs? Because not all good books about energy conservation are sold by the major booksellers. General booksellers may not want to carry books that

are considered to be of limited interest. Or, the publishers of the books may lack the sophistication to make their books available through the major booksellers.

Book Reviews

Judging the quality of a book by reading the publisher's description in a catalog is almost impossible. One may not even be able to judge the potential audience of the book. Independent book reviews are the time honored solution to this problem. Unfortunately, only a fraction of books about energy conservation ever receive serious reviews. Some review publications, such as *SciTech Book News*, announce the arrival of most books that are submitted to them. Unfortunately, such review publications tend to report contents in a bland manner that does not say much about the quality of a book. Also, most reviews do not tell you the relative merit of a book compared to other books on the same subject. There are databases of book reviews that you can use. These are generally subscription services. Searching the Internet yields spotty results for book reviews.

Literature Databases

Librarians are being inundated by vendors of literature databases. It is unlikely that any of these can do a good job of leading you to the best energy conservation books. It would take the entire population of a small country to generate a database that would allow one to find the best literature on any topic. And, as we said before, there are no databases that deal comprehensively with the subject of energy conservation alone. A database is no better than the people who do the indexing, and this function tends to be sloppy. Descriptions, if any, tend to be perfunctory. Even the mainstream directories, like *Books in Print*, are disappointing. For example, the *Energy Efficiency Manual* is listed under the single classification of "energy production," which is incorrect [this has since been corrected and the *Manual* has been given the subject "energy conservation" in the online version of *Books in Print*]. There are exceptions in some areas that are distantly related to energy conservation. For example, *Petroleum Abstracts* is excellent, but does not tell much about conservation.

Tips about Searching the Internet

The Internet has become a popular tool for finding books, articles, or almost any other form of information. One should know how to use it, and be alert to its weaknesses. The Internet is not yet a well organized source of information, and it is far from complete. It is a huge, growing dump into which information of differing quality and relevance is mixed

indiscriminately. The Internet has no magical ability to capture information. In order for information to appear on the Internet, someone must create a Web site and put the information on the site. Much good information does not appear on the Internet. Even if information is located on the Internet, it may be difficult or virtually impossible to find. To find information, one must know the address (URL) of a particular Web site beforehand, or one must use search engines. Keep a record of URL's that have proven useful. Often, one good URL will link to others. Knowing the right URL for a topic may radically shorten the search time (see the list of Web sites at the end of this article).

The Internet is handy when searching for information about an unfamiliar subject. One can use a search engine, the tool that allows one to find the gems that are scattered throughout the Internet's information dump. A search engine is a computer program that matches search words that you specify against the vast amount of information on the Internet. There are several major search engines. They are offered free to Internet users. Each search engine operates somewhat differently, so each will yield different results in a search. However, the same search engine may be licensed under different names, so you may get identical results from search engines that you think are different.

How do search engines work? Each search engine continually sends out a search program called a "spider" that looks at the text of all Web sites. Using various criteria, the spiders decide whether or not a site is worth cataloging. If a site is deemed worthy, the spider will store fragments of text from various pages of the site, usually the home page. Some search engines use humans to refine the selection of sites and the information that is collected. This prior indexing is what allows search engines to find information with a speed that seems magical. Later, when an Internet user requests a search, the search engine scans its own catalog for a match and presents you with the corresponding Web page fragments.

Search engine spiders look for two kinds of text entities on a Web site, the visible text and invisible "tags." If the text on the Web site does not match your search words, the search engine cannot lead you to that site. Poor search response for a particular Web site is often the fault of deficiencies in the site design. Tags, which are a part of the hidden background (HTML) code of the Web site, are critical for most search engines. Many Web sites have no tags, or the tags are poorly selected. In addition, the visible text of the Web site plays a major role in getting hits. There are other limitations that Web site developers may overlook, or they may be impractical to address. For example, important text that is displayed inside graphics boxes may not be seen by search engines. Also, search engines typically do not

enter PDF files, which may contain the most relevant information on a site. To get a better understanding of how search engines look for Search Engine Watch: Tips About Internet Search Engines and Search Engines Submission <**http://www.searchenginewatch.com/**>.

There is a serious flaw in the present Internet system for tagging and searching Web sites. The present system limits the number of topics that can be listed in the invisible tags. And, if a topic is listed among many other topics, it gets lower search priority than the same topic would receive if it were the sole subject of a Web site. As a result, search engines often miss the best information sources, especially comprehensive books and conference proceedings. For this reason, one needs to know which are the best references in each subject area that you are searching. Understand that a search engine finds only content that is contained on a Web site. It rarely provides you with primary content, except for samples. For example, a Web search may lead one to a particular book, but it will not give the content of the book to download. Information is a valuable commodity, and little is given away. Assuming that a reference to good information is present on the Internet, how well one finds it depends on two factors: which search words you use, and how cleverly the search engine matches your search words to the information that is posted on Web sites.

One fundamental problem of search engines is an excessive number of hits. One faces a needle-in-a-haystack problem, which is that good sources are lost among many irrelevant or low-quality hits. You can narrow your search by using more specific search words, but this may cause you to miss a valuable Web site because the site does not contain all your search words in proximity to each other. One can reduce the number of extraneous hits by using the "advanced" search features that search engines offer. These comprise various ways of combining and limiting search words. Each search engines provides easy directions for using these search features.

The following table is an example of the number of responses that one will get from typical searches. It illustrates how variations in search word inputs have a major effect on the results that one gets. (These searches were done with the search engine, northernlight.com.)

Search Words, Exactly as Written	Number of Hits
Industrial Energy Technology Conference	131,660
"Industrial Energy Technology Conference"	187
heat pumps	208,353
"heat pumps"	54,073

ground source "heat pumps"	11,054
geothermal "heat pumps" [Note: "geothermal" is a synonym for "ground source" in this context, but the hits obtained were substantially different.]	7,700
geothermal "heat pumps" principles	741
book reviews	3,522,494
"book reviews" AND "energy conservation"	615
Energy Efficiency Manual	47,673
"Energy Efficiency Manual"	50
book reviews AND "Energy Efficiency Manual"	9
"book reviews" AND "Energy Efficiency Manual"	none
"Energy Efficiency Manual" AND Wulfinghoff	8

Good search engines automatically search for variations of a word. So, if you search for "pump," the search engine will recognize "pump," "pumps," "pumped," and "pumping." However, do not expect search engines to recognize related concepts. For example, "energy efficiency" will turn up many books that do not appear in response to "energy conservation," and vice versa. Some search engines sort hits into labeled groups. This may radically improve your ability to find the most relevant hits. For example, in a search for information about heat pumps, one search engine divided the hits into fourteen groups. However, the grouping depends on the information contained in the individual Web sites, so it is no more reliable than the search itself.

In summary, the Internet is an excellent resource, and it is certainly the easiest. One does not have to get out of the chair to use it, and it provides information immediately. But, do not be seduced into using it exclusively. Only rarely will the Internet be your actual source of information about an energy conservation topic. It will fail to tell you about some of the best sources.

How to Get Information from Manufacturers

Manufacturers have a strong interest in being found, so there are many directories of manufacturers that are indexed by the types of equipment they offer. Some directories, such as the *Sweet's Catalog*, include the manufacturers' own catalogs for a fee. For the larger manufacturers, these are only small extracts. Expect to go directly to the manufacturer to find out what is offered. The question is, which manufacturer should one approach? Usually, only one or two manufacturers of each type of equipment offer good explanatory information. To identify the manufacturers with the best

information, contact a leading practitioner in a related field. For example, to find out which manufacturers offer the best information about pump efficiency, contact a mechanical engineer who designs pumping systems. It may take a series of telephone calls to find such an individual. Or, if you are lucky, your information client may steer you to a good contact.

There have been attempts to produce directories of manufacturers who produce equipment and materials related to energy conservation. These directories are not complete, and they do not tell you who offers good information, but they may be a good place to start. Iris Communications offered one of the better directories of this type, but they appear to have abandoned it. Most major manufacturers now have Web sites, which a good search engine may find when you search for a particular product. The Internet may be the quickest way to identify a relevant manufacturer. However, the manufacturer's Web site is unlikely to have the information you need. For that, pick up the telephone and call the manufacturer. Whom should you contact when you call a manufacturer? Your best bet is usually the engineering department, or "applications engineering," which is a sales department that is composed of technical people. Odd as it may seem, corporate marketing departments are often surly and uncooperative, and many have little knowledge of their own products.

Use the PER Division Discussion List

The Petroleum and Energy Resources (PER) Division is the component of the Special Libraries Association (SLA) that is intended to serve librarians involved with energy conservation. The PER Division maintains an active "discussion list," which is a forum for posting e-mail messages. The list puts you in direct contact with a large fraction of the members of the PER Division. If you post a question on the list, you are likely to get a useful response within a day or two. This is a good way to start if you are stymied by an unusual question. At present, you do not have to be a member of the PER Division, or even a member of SLA, to use the discussion list. To join the list, go to the SLA PER Division Web site, **http://www.sla.org/division/dper**, click "Discussion List," and follow the simple instructions.

PROVIDE INFORMATION, AVOID MISINFORMATION

Progress in energy conservation has been crippled by misconceptions and misinformation. You are likely to encounter these in many of the requests for information that you receive. You can provide an important service to your client, and to society as a whole, by dealing professionally with these problems. You not only want to provide good information, but you want to

avoid propagating misinformation.

What Does Your Client Really Want to Know?

As a provider of information about energy conservation, you often need to take a leadership position in guiding and formulating your client's request. This can be the most challenging aspect of your job. You will have to judge when to simply give your client what he requests, and when to probe to find what he really wants. As a rule, if your client comes to you with a very specific question, you are safe in proceeding directly to that information. An example is a question like, "Please find information about the relative efficiencies of single-stage and two-stage absorption chillers." In cases like this, just ask the client to explain his terms so that you search more intelligently. On the other hand, if your client comes to you with a question that sounds vague or general, he probably does not know what he wants. He may not even have a clear idea why he is seeking the information. He may be implicitly asking you to help define his request.

For example, during my career as an energy efficiency specialist, people have repeatedly approached me with the question, "Do you deal with solar energy?" In the end, it turned out that they did not have a specific interest in solar energy, but they were using the term "solar energy" as a surrogate for energy conservation in general. Usually, they really wanted to figure out how to make their facilities more efficient in a broad sense. When making the original request, they were fishing. If it is not clear what your client really wants to know, work with him to answer this short series of questions:

What is your motive for making the request? Help the client to define his purpose. Is he trying to understand basic principles or to make improvements? For example, if your client is seeking information about geothermal heat pumps, does he merely want to know the principles of operation, or does he intend to install one? Information about the principles of geothermal heat pumps is widely available. However, you will have to search longer to discover that geothermal heat pumps are plagued by problems, and you will have to search even longer to learn how to minimize the problems. Or, was your client's interest in heat pumps recently stimulated by seeing a television program, reading an article, or attending a conference? In that case, the client's potential interest may be much broader than heat pumps.

What is your background? Provide information that is appropriate for your client's ability to understand. Is your client an architect, a homeowner, an equipment manufacturer, or a college professor? Is your client a facility engineer trying to lower energy costs, or a student writing a

term paper? Each of these clients is best served by a different selection of information sources.

Have you considered all your options? The client typically focuses prematurely on a particular energy conservation activity. Make an effort to find the range of approaches that apply to your client's situation. For example, if your client asks about solar energy because he wants to reduce his heating costs, suggest that he consider all the other ways of reducing heating cost. Some of these methods may complement each other, and others are mutually exclusive.

How do your options compare? Energy conservation activities differ widely in the benefit they provide, their cost, their reliability, and how easy they are to accomplish. For example, adding a geothermal heat pump to reduce the heating and cooling costs of a new house is expensive, and the system is likely to be unreliable. The same saving in heating and cooling cost may be possible by increasing the amount of insulation, which is simple, reliable, and inexpensive. Or, the same saving may result from upgrading to conventional equipment having higher efficiency.

Gadgets are Not Energy Conservation

A common misconception, even among energy professionals, is that energy conservation consists of installing the latest gadgets. Actually, effective energy conservation consists mostly of applying conventional equipment and materials reliably, and following efficient operating practices. Gadgets appear from time to time, but most of them prove to be impractical, riddled with problems, or pure snake oil. Some examples of questionable or useless gadgets include fluorescent fixture reflectors, fuel oil additives, and electrical power surge suppressors. Some gadgets, such as turbulators to improve the efficiency of old boilers, may be legitimate, but they typically claim much larger benefits than the laws of physics allow. If you recognize that your client is treating a gadget as a surrogate for serious energy conservation, help your client to broaden his view to include the broad range of possibilities that may apply to his situation.

Deal with Novelty Appropriately

An issue that is related to fascination with gadgets is the appeal of novelty for its own sake, which is commonly expressed as "innovation." More generally, there is a fascination with energy conservation measures that are novel, expensive, and complicated. You can help your client by pointing out that these three characteristics correlate to failure. In terms of achieving success, innovation is a serious liability. Things never work well at first, in

any field of endeavor. The way to achieve successful conservation is to use methods that are well proven. There are a few areas where energy conservation is still awaiting major developments, but not many. Even in these areas, the prudent course is to wait until those developments have been well tested. Unfortunately, innovation has a powerful appeal, so your client may not be happy to hear you counsel against it. If your client requests information about emerging technology, find out whether he wants to understand the principles of the technology or to apply the technology. If your client's objective is to achieve reliable energy conservation, suggest that he skip the literature that is devoted to innovation.

Part of the appeal of innovation is the misconception that energy conservation is advancing at a blinding pace. This is not true. Most of the modern advances in equipment efficiency appeared during the 1970's. Most of the equipment available today settled into its present form during the 1980's. Equipment efficiency advanced radically during those two decades, and it is now largely stabilized. In most cases, your client does not have to worry about being left behind if he uses the best conventional technology. Most of the important development continuing at the present time is related to improving the reliability of energy-related equipment and to reducing adverse side effects. For example, electronic variable-speed drives for motors are one of the most important new advances in energy conservation. However, using them has the potential for creating serious problems in a facility's electrical system. There are various ways of dealing with these problems, which may be the most important information that you can provide about this technology.

In contrast with equipment evolution, which is largely complete and stable, design practice is still primitive with respect to efficiency. There is opportunity for radical improvement in all aspects of design practice, especially in architecture and lighting. Unfortunately, the information about efficient design in these areas is fragmentary and largely unsatisfactory. This is because the information is written largely by the people responsible for the problems.

Be Cautious with Advocacy Literature

Energy conservation is a technical subject with a strong emotional appeal for many non-technical people. This stems from the subject's novelty, its naturalistic aspects, a doomsday threat in the event that conservation fails, the intervention of government, and confusion of issues. As a result, information about energy conservation is an odd mix, ranging from serious professionalism to virtually religious beliefs. This diversity creates many niche markets for information, and advocacy groups compete to enter these

markets. At the extremes of energy conservation are the professionals and the enthusiasts. Roughly speaking, the professionals are those with technical training, who treat energy conservation as primarily an engineering issue. Enthusiasts commonly lack technical understanding, and they view energy conservation as a social and political activity. For some enthusiasts, energy conservation has become virtually a cult, especially when it is associated with environmental protection.

Carl Sagan once lamented that ten times more people are interested in astrology than in astronomy. A similar ratio applies to energy conservation. However, practitioners of astrology and astronomy isolate themselves from each other, and there is little confusion between the two interests. In contrast, professional interest and enthusiast interest overlap widely in energy conservation. Professionals generally cluster within professional organizations, out of public view. In contrast, enthusiasts tend to be represented by advocacy organizations, which strive for publicity. The information produced by advocacy organizations is heavily flavored for publicity. As a result, advocacy dominates the public discussion of conservation, and thereby the political action. Increasingly, the heads of government agencies involved with energy conservation and environmental protection are enthusiasts rather than professionals.

Most serious books about energy conservation are written by technical professionals, because they have enough knowledge to write good books. However, there is a substantial body of advocacy literature that is written by people with a weak grasp of the technical issues. Advocacy literature is characterized by blindness toward the practical issues that determine whether conservation will succeed. In advocacy literature, favored solutions to energy and environmental problems will work without question, if only obtuse and reactionary people would recognize their virtues. Scrutiny of actual energy savings and concern about cost and reliability are dismissed as resistance to progress. Enthusiasts favor certain esthetic characteristics. Favored methods tend to be unusual, small, local, and highly visual, with a rustic and residential flavor. Examples are solar systems, little wind generators, and straw bale houses. Things involving soil or mud are highly favored.

In these subject areas, much of the useful literature has been written by enthusiasts, who typically are specialists seeking to promote a particular type of energy conservation to which they have devoted a large part of their careers. The information tends to be technically correct, and it may be the best that is available. However, candor about critical shortcomings tends to be inversely proportional to the enthusiasm of the author. You will avoid giving misinformation if you recognize advocacy literature for what it is. At

best, its technical validity is questionable. Be aware that advocacy sources commonly include energy conservation as part of a broader agenda, or they may use it as bait to attract support for an agenda that is not overtly stated.

INTERNET SITES

This is a selected list of Internet sites to get you started in searching for information about energy conservation. These comprise only a small fraction of the sites that may contain information useful to you. However, they are likely to satisfy your requirement, or to lead you to other sites that may do so.

Note that the prefix "http://" has been omitted from all Web site addresses for brevity and clarity.

PUBLISHERS OF BOOKS AND MONOGRAPHS RELATED TO ENERGY CONSERVATION

The following are some of the most important publishers of information about energy conservation, along with a sampling of general publishers of information in related fields. This list is far from complete, especially for books on individual topics.

Publisher	Web Site	Products
Energy Institute Press	www.energybooks.com	*Energy Efficiency Manual*, the primary reference and how-to guide for energy conservation
Association of Energy Engineers	www.aeecenter.org	Many books about different aspects of energy conservation. Also some general construction topics.
American Society of Heating, Refrigerating, and Air Conditioning Engineers, Inc. (ASHRAE)	www.ashrae.org	*ASHRAE Handbook*, the primary design handbook for HVAC, refrigeration, and the energy characteristics of building architectural features. Also, books on related topics and primary standards.
Air Conditioning and Refrigeration Institute	www.ari.org	Directories of air conditioning and refrigeration products with efficiency ratings. Standards and guidelines. Training publications.
Illuminating	www.iesna.org	*Lighting Handbook*, the primary

Engineering Society of North America (IESNA)		handbook of lighting technology. Monographs on many aspects of lighting.
Electric Power Research Institute (EPRI)	www.epri.com	Many monographs related to the electric utility industry, including related energy conservation technologies
International Energy Agency	www.oecdwash.org	Reports on world energy supplies and related environmental issues
McGraw-Hill Inc.	www.mcgrawhill.ca	Primary engineering references, including *Marks' Standard Hanbook for Mechanical Engineers*, *Standard Hanbook for Electrical Engineers*, many energy-related books
Prentice Hall	www.phdirect.com	Many energy-related technical books
John Wiley and Sons	www.wiley.com	Many energy-related technical books
National Technical Information Service (NTIS)	www.ntis.gov	Publications produced by the U.S. government, including studies.
Sheet Metal & Air Conditioning Contractors' National Association	www.smacna.org	Primarily publications and standards related to duct design. Some books related to energy conservation.
Air Conditioning Contractors of America	www.acca.org	Primarily training publications related to air conditioning.

BOOKS CATALOGS SPECIALIZING IN ENERGY CONSERVATION AND RELATED TOPICS

Very few catalogs specialize in energy conservation. A larger number of catalogs include energy conservation books, but usually not as a clearly identified category.

Organization	Web Site	Products
Association of Energy Engineers	www.aeecenter.com	Lists only books published by AEE.
Iris	www.oikos.com	Books related primarily to

Communications, Inc.		residential construction using efficient and renewable techniques.
American Society of Heating, Refrigerating, and Air Conditioning Engineers, Inc.	www.ashrae.org	*ASHRAE Handbook*, ASHRAE books on HVAC and building envelope topics, ASHRAE standards, conference proceedings, major books by other publishers
Illuminating Engineering Society of North America	www.iesna.orge	*IESNA Lighting Handbook*, IESNA technical monographs, books by other publishers on related topics
Construction Book Express	www.constructionbook.com	Many books about all aspects of construction. Does not identify the publishers.

APPLIANCE AND EQUIPMENT EFFICIENCY DATABASES

The following Internet sides provide immediately useful information about the efficiency of a wide range of commonplace energy-using appliances and other products. [These sites were compiled by David Scott Smith, Executive Director of the White House Interagency Environmental Technology Office.]

American Council for an Energy Efficient Economy (ACEEE) Appliance Information

These are listings of the most efficient models of common types of appliances, compiled by the
American Council for an Energy Efficient Economy.

Web Site	Appliance or Topic
hes.lbl.gov/hes/ACEEE/intro.html	General information about appliance efficiency standards, utility rebate programs, etc.
www.aceee.org/consumerguide/topfridge.htm	Refrigerators and Freezers
www.aceee.org/consumerguide/topdish.htm	Dishwashers
www.aceee.org/consumerguide/topwash.htm	Clothes Washers
www.aceee.org/consumerguide/toprac.htm	Room Air Conditioners
www.aceee.org/consumerguide/topcac.htm	Central Air Conditioning Systems
www.aceee.org/consumerguide/topwater.htm	Water Heaters

www.aceee.org/consumerguide/topgboil.htm	Gas Fired Heating Boilers
www.aceee.org/consumerguide/topoboil.htm	Oil Fired Heating Boilers
www.aceee.org/consumerguide/topfurn.htm	Forced Air Heating Furnaces
www.aceee.org/consumerguide/topcashp.htm	Air-source Heat Pumps
hes.lbl.gov/hes/ACEEE/post.html#info	Information about the ACEEE *Consumer Guide to Home Energy Savings*

California Energy Commission Database of High-Efficiency Appliances

This group of sites lists categories of high-efficiency appliances that EXCEED BY AT LEAST 15% current California and Federal appliance efficiency standards. In each listing, the models are listed in order of decreasing efficiency.

Web Site	Type of Appliance
www.energy.ca.gov/efficiency/appliances/conditioners/CENA.HTM	central air conditioners
www.energy.ca.gov/efficiency/appliances/roomair/ROOMAIR.HTM	room air conditioners
www.energy.ca.gov/efficiency/appliances/heatpump/HPMP.HTM	heat pumps
www.energy.ca.gov/efficiency/appliances/furnaces/FURNACE.HTM	central gas furnaces
www.energy.ca.gov/efficiency/appliances/refrig-freezers/refrig-freezers.html	refrigerators, refrigerator-freezers, freezers, and wine cellars

California Energy Commission Appliance Efficiency Database

www.energy.ca.gov/efficiency/appliances

This is the main California Energy Commission database, of which the previous items are parts. The main database lists appliances that are certified to the CEC by their manufacturers to MEET (rather than exceed) the current energy efficiency standards. These appliance types are included:

A. Refrigerators, refrigerator-freezers, freezers, & wine chillers (3,700+ models)
B. Plumbing fittings and fixtures (10,000 models)
C. Central air conditioners and heat pumps (13,500+ models)
D. Room A/C, package terminal A/C, package terminal heat pumps (3,700+ models)
E. Spot air conditioners and computer room air conditioners (600+ models)
F. Cooking and washing appliances (1,200+ models)
G. Central fan type furnaces (11,700+ models)
H. Gas space heaters (3,000+ models)
I. Boilers (7,200 models)
J. Pool heaters (200+ models)
K. Lighting and ventilation control devices (1,000+ models)
L. Fluorescent lamp ballasts (450+ models)
M. Water heaters (gas) (5,800+ models)
N. Water heaters (electric) (2,500+ models)

Currently, there are more than 65,000 individual products in this database. The file size exceeds one megabyte, so the download time could be prohibitive. To make it possible to view the database, database viewers (for computers using Windows operating systems) are available at an FTP site:

ftp://energy.ca.gov/pub/efftech/appliance (Note that the prefix is "ftp", rather than "http".)

If you elect to use the "ftp" site, be sure to read the "read-me file" FIRST!

U.S. Department of Energy Lawrence Berkeley Laboratory Product Information

This group of sites comprises the "Home Energy Saver Library: Product Information". It includes even more categories of appliances and equipment than the previous California Energy Commission site. These products are labeled in the "Energy Star" program. This site includes a limited amount of narrative about the types of equipment, as well as describing the ratings.

Web Site	Type of Equipment
hes.lbl.gov/hes/prodinfo.html	Index page for Energy Star products and links to ACEEE product ratings
www.epa.gov/appdstar/hvac/prodfur.html	Furnaces

www.epa.gov/appdstar/hvac/prodcac.html	Central Air Conditioners
www.epa.gov/appdstar/hvac/prodghp.html	Geothermal Heat Pumps
www.epa.gov/appdstar/hvac/prodcac.html	Electric Air-Source Heat pumps
www.epa.gov/appdstar/hvac/prodgas.html	Gas-fired Heat Pumps
www.epa.gov/appdstar/hvac/prodthem.html	Programmable Thermostats
www.epa.gov/appdstar/hvac/prodblrs.html	Heating Boilers
www.epa.gov/appdstar/esoe/database/clist.htm	Computers
www.epa.gov/appdstar/esoe/database/mon.htm	Computer Monitors
www.epa.gov/appdstar/esoe/database/plist.htm	Computer Printers
www.epa.gov/appdstar/esoe/database/flist.htm	Fax Machines
www.epa.gov/appdstar/esoe/database/xlist.htm	Copiers
www.energystar.gov/products/clotheswashers/	Clothes Washers
www.energystar.gov/products/dishwashers/	Dishwashers
www.energystar.gov/products/refrigerators/	Refrigerators
www.energystar.gov/products/roomair/	Room Air Conditioners
www.epa.gov/appdstar/home_electronics/products.html	Television Set and VCR's
www.epa.gov/appdstar/fixtures/products.html	Residential Light Fixtures
www.energystar.gov/products/windows/climate.html	Windows (best choices by climate)
www.energystar.org/partners.asp	Manufacturers, Retailers, and Utilities who participate in the Energy Star program

ENERGY CONSERVATION ADVOCACY AND GOVERNMENT ENERGY ORGANIZATIONS

These organizations are devoted primarily to promoting energy conservation. Their information products change with time. The products listed here are their primary ones at present. Energy conservation is also promoted by many other organizations, not listed here, who are primarily

concerned with other issues, such as environmental protection, property management, etc.

Organization	Web Site	Present Information Activities
Energy Institute	www.energy-institute.org	Publication of books, papers, and other media about primary technical and management issues of energy conservation.
Alliance to Save Energy	www.ase.org	Topical news, newsletters, position papers
American Council for an Energy Efficient Economy	www.aceee.org	Appliance efficiency ratings, legislative alerts, press releases, position papers, LINKS to other sites, etc.
Energy Efficient Building Association Inc.	www.eeba.org	Conferences related to residential construction.
International Institute for Energy Conservation - U.S.	www.cerf.org/iiec	Newsletters, press releases, articles related to energy conservation in developing countries
Export Council for Energy Efficiency	www.ecee.org	international market assessments, international events calendar, LINKS to other sites, etc.
U.S. Business Council for Sustainable Energy	www.bcse.org	Reports, quarterly newsletter
The Results Center	www.crest.org/efficiency	discussion groups about various topics, LINKS to other sites, etc.
U.S. Department of Energy Office of Energy Efficiency and Renewable Energy	www.eren.doe.gov	"access to 80,000 documents and more than 600 LINKS" about conservation and renewable resources

U.S. Department of Energy Office of Industrial Technologies	www.oit.doe.gov	Newsletter, press releases, conferences, conservation programs for specific industries, telephone inquiry line, etc.
U.S Department of Energy Energy Information Administration	www.eia.doe.gov	A wide variety of information energy supplies, but not much about conservation.
International Energy Agency Energy Technology Data Exchange	www.etde.org/edb/energy.html	"contains the world's largest collection of energy literature, with more than 3.8 million abstracted and indexed records … updated twice monthly"

AND, FINALLY …

A site that will link you to many other sites related to energy conservation is the U.S. Department of Energy's Energy Crossroads:

eande.lbl.gov/CBS/eXroads/EnergyXroads.html

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Donald Wulfinghoff <dw@energybooks.com> is the president of Wulfinghoff Energy Services, Inc., Wheaton, Maryland, USA. TEL: 1-301-946-1196.

Figure 1. MAJOR CURRENTS THROUGH THE MODERN ERA OF ENERGY CONSERVATION

ISSUE	the 1970's	the 1980's	the 1990's	2000 and after
Who Takes Initiative	Federal governments leads, States follow. Architects attempt to seize leadership, then abandon field. ASHRAE gains initiative.	Federal government backs out. State governments force DSM on utilities. ESCO's exploit DSM pressure.	Utilities attempt to benefit from DSM, but concept fails. Federal government regains interest, primarily as environmental issue.	Leadership vacuum at beginning of millennium. Fuel prices and shortages will increase action.
Legislation	Flurry of Federal laws, especially fuel selection, building efficiency codes, and appliance efficiency.	Expansion of previous Federal laws. Reversal of fuel selection laws for environmental reasons.	Expansion of previous Federal efficiency laws.	Unpredictable.
Efficiency Codes & Standards	ASHRAE commences Standard 90. Federal BEPS fails. Federal law establishes equipment efficiency standards.	ASHRAE works interminably on Standard 90. Most states enact variations, which are widely ignored.	Federal equipment efficiency standards become significant. Building codes still ignored.	No major changes in sight.
Equipment Development	Many types of efficiency equipment introduced. Failure prevalent.	Snake oil mostly disappears. Efficiency improves. Reliability evolves.	Mechanical and electrical equipment is mostly reliable. Fenestration evolves.	Efficient, reliable equipment available in most areas. Major areas of development remain.
Design Practice	Architects fail to grasp theory, mostly abandon interest. Engineers expect to solve problem. Efficiency features selected haphazardly.	Glass-box buildings spread, major step backward. Engineers advance in some areas, complain they are not paid for efficient design. VAV disappoints.	Stagnation. Designers lose interest, fail to specify efficient equipment. Fast-track construction interferes with efficient design.	Structure of design professions continues to inhibit progress. Owners fail to create motivation for efficient design.
Construction Practice	Wasteful construction practices identified, especially insulation.	Wasteful practices largely continue.	Minor improvement.	Wasteful construction practices still prevalent.
Management Practice	Fascination with gadgets dominates management response.	Profit-center approach formulated, but not adopted.	Still unfocussed. Disillusioned by failures. Shared-savings deals become evasion.	Still need to take initiative and learn how to exploit efficiency as economic asset.
Energy Audits & Retrofits	Energy audit concept is born, but without disciplined approach. Retrofit options not enumerated.	Many audits are done. Quality is generally poor. Little retrofit action results.	Energy audits die out, reappear sporadically. Still no systematic approach.	*Energy Efficiency Manual* enables rational, complete energy audits and retrofit.
Relationship to Environmental Protection	Not seen as related issues. Conflicts occur in fuel selection.	Still not seen as related issues. Conflicts alleged in indoor air quality.	Global warming concern makes energy conservation an environmental protection issue.	Energy efficiency becomes a primary part of environmental protection. Conflicts continue.
Knowledge Base	Little understanding of efficiency in buildings sector. Many studies sponsored by government.	Buildings sector knowledge continues to grow.	Knowledge regresses as previous experience is lost. DOE sponsors information programs.	Old lessons are learned anew.
Publications	Many books and articles. Government sponsors many publications; *ECM-1&2* are best.	Government ceases funding. Private publications at slow pace.	More private publications, some popular, increasingly stress environmental connection.	*Energy Efficiency Manual* is primary reference, provides structure for other information.

Figure 2. COMPARISON OF ENERGY CONSERVATION INFORMATION SOURCES

Source	Quality	Freshness	Ease of Finding	Speed of Access
Books	Usually the best source. Most thorough, best organized, most candid.	At least one year old, often many years old.	Typically easy to find.	Immediate, if you have the book. Otherwise, several days to several weeks.
Catalogs	Where technical information first appears in useful form. Selective. Heavily biased.	Freshest available for commercial products.	Takes effort to find the best manufacturers	Several days to several weeks, unless catalogs are on the Internet.
Training Material	Often superb. Depth and thoroughness vary. More candid than catalogs, but biased to producers' interests.	Less fresh than catalogs, but often appears soon after.	Takes effort to find who produces the best material.	May be difficult to acquire without contacts.
Magazines & Journals	Good for quick introductions to topics. Easy to read. Narrow in scope. Tend to avoid critical issues.	At least several months old, often several years old.	Takes effort to find the appropriate magazines. They may lack cumulative indexes.	Typically takes weeks to acquire back issues, if available. Some articles are archived on the Internet.
Conference Proceedings	Broader subject areas covered in fragmentary format. Candid. Generally good quality.	At least six months old at time of publication.	Conferences that produce good proceedings are few and usually well known by specialists.	Printed proceedings available in about one week. Some papers are archived on the Internet.
Newsletters	Candid, but often opinionated. Easy to read. Limited in scope. Subject matter tends to be randomly selected.	One to four months old at time of publication.	Takes effort to find relevant newsletters.	By subscription only. Individual issues may be sold.
The Internet	Not primarily an information source, but increasingly the primary way to find information.	Up to date, but only for those sources that post information.	Information is vast but fragmentary. Much information is difficult or impossible to find.	Immediate!