The original documents are located in Box 4, folder "Energy - Natural Gas Shortfall (2)" of the Richard B. Cheney Files at the Gerald R. Ford Presidential Library.

Energy
Conservation
Now

energy conservation

Energy Management Case Histories

Conservation Paper Number 1A

Energy Management Case Histories

Office of
Industrial Programs

Energy
Conservation
Now

Federal Energy
Administration

In Cooperation with
U.S. Department
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FEDERAL ENERGY ADMINISTRATION
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OFFICE OF THE ASSISTANT ADMINISTRATOR

The President has established national energy independence as a long range goal for the United States. An important element for the achievement of this goal is the reduction of domestic energy consumption through industrial energy conservation. The experience of many U.S. firms, large and small, has shown that the financial benefits of an energy conservation program can be substantial and that such programs are good business management practice.

This booklet, developed by the Federal Energy Administration in cooperation with the Department of Commerce, illustrates such case experiences by four U.S. firms. It discusses how they organized to achieve results, how they implemented their energy saving projects and what the results of their efforts were.

Great benefits in improved cost control and competitiveness are available to all types of American industry. Improved stability of energy supply is also available through application of some of the practices already identified by pioneering companies.

Take the time to read each case. There are ideas in each that go beyond the specific process and business of the company discussed. Then pass this booklet along to someone who can implement an energy conservation program in your organization or who has energy conservation responsibilities.

Roger W. Sant
Assistant Administrator
Energy Conservation and Environment

Energy Management Case Histories

Contents

RAYTHEON

How one of the Nation's largest manufacturing firms uses a corporate management and technical staff to consult for its plants in an effort to save energy.

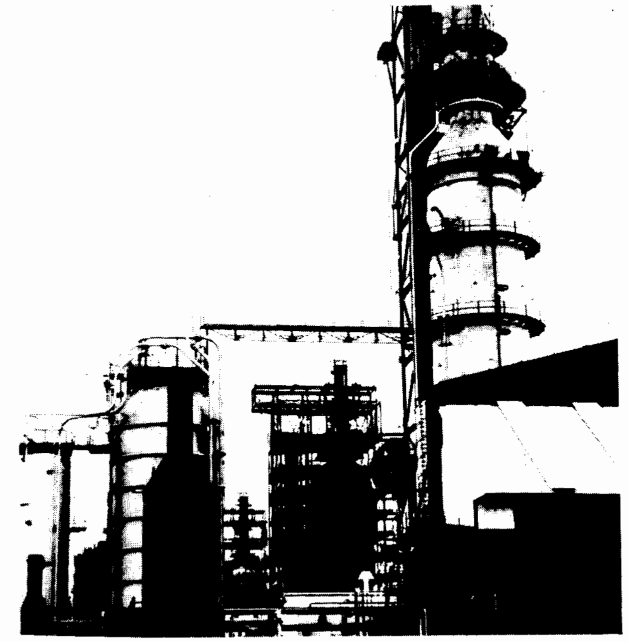
Company Description

Raytheon Company, a diversified electronics manufacturing firm, has annual sales exceeding $1.5 billion and ranks 103d in Fortune's list of the 500 largest U.S. manufacturing companies. The firm is the largest employer headquartered in Massachusetts, with half of the 54,000 employees working in the State. The company has 45 major plants and laboratories nationwide.

Raytheon's traditional product line—military and commercial electronics—makes up over 60 percent of 1973 sales, although significant contributions to overall sales come from the engineering and construction division, major appliances, heavy construction equipment, and publishing subsidiaries. Nearly half of the company's business (48 percent) comes from Government-related work and 20 percent from international operations.

Role of Energy in Company

Raytheon has an inherent interest in the energy business. Three subsidiary companies are benefiting from the mounting demand for new energy sources. As described in the 1973 annual report, the energy-related businesses include: "Design and construction of petroleum refineries and petrochemical plants—the Badger Company, geophysical exploration for oil and natural gas—the Seismograph Service Corporation, and the engineering and building of nuclear and conventional powerplants—United Engineers and Constructors."



The opportunities for cost savings through energy conservation created additional interest within the company and prompted an early look at ways to improve in-house energy management. A company-wide program to conserve energy was established and a full-time manager of environmental and energy conservation was appointed in 1973.

Development of a Conservation Policy

Raytheon is described by one company vice president as "a big company made up of a lot of little companies." Thus each "little company" has its own problems, including energy availability and cost impact, which vary dramatically from plant to plant. For example, the Andover, Mass., plant chose to use only electric power rather than fuel oil or natural gas due to local air pollution concerns, while most of the company's other northeastern facilities are heavy fuel oil users.

It was not corporate citizenship alone that motivated Raytheon to action in the energy area, but savings possible from the high energy costs of the company.

Corporate energy costs exceeded $15 million annually and, the vice president for plant operations explained, "Every fixed cost item in our overhead structure was rising rapidly. We had to do something."

In October 1973, impetus for conservation was provided when D. Brainerd Holmes, executive vice president of Raytheon, made energy conservation a matter of corporate policy. Accordingly, the corporate Office of Manufacturing was assigned overall responsibility for energy-related activities. James K. Rogers, then manager of environmental quality, was assigned the additional job of coordinating energy conservation in the corporation's facilities.

One individual in each division was made responsible for his division's energy conservation, and instructed to submit each month to corporate headquarters detailed statements of energy consumption by source (fuel oil, natural gas, and electricity). The savings in energy consumption resulting from the program are impressive. For example, during May 1974 Raytheon's savings were 46 percent in fuel oil, 11 percent in electricity, and 26 percent in natural gas compared to the previous year. For the period November 1973 through July 1974, the reductions were 30 percent in fuel oil, 15 percent in electricity, and 17 percent in natural gas.

There is a desire to put these savings on a unit-of-production basis, but in Rogers' words, "The product mix in our company is dynamic and changing month to month, making it difficult to get a handle on energy per unit of product. But we're trying."

Actions taken early were largely the common ones—reducing building temperatures, sealing air leaks, improving heating/cooling systems maintenance, and reducing lighting where possible. It was realized, however, that although these techniques are important, a different sort of plan was required if truly innovative measures were to be taken to combat the pressing problem of expensive fuel supplies.

Accordingly, a search was begun in the corporation for a person with strong technical expertise in energy-use management. The man selected was Thola Theilhaber, an engineer who had worked on boiler design for the Raytheon Mini Furnace, a gas-fired heat transfer module for home and commercial heating. Previous experience with high-temperature, hot-water heating systems, boiler design, and combustion systems development provided Theilhaber with a strong background applicable to the corporate energy-saving program. Reporting to energy conservation coordinator Jim Rogers, his job was to act as an energy consultant to the plant engineers and to identify and help implement energy-saving measures at all of Raytheon's plants.

The Conservation Office was to be, in Rogers' words, a "catalyst." And, explains Raytheon's Vice President for Manufacturing: "We decided not to solve their own problems. I'll help move people around who have the specialities to help implement, but that's all." This policy forced each plant to appoint a person to coordinate the individual energy programs.

At the same time, Raytheon's in-house Plant Engineers Council stepped up its energy conservation programs. The group, comprised of plant engineers from 17 Raytheon locations, scheduled meetings and seminars aimed at upgrading skills and disseminating information on energy conservation methods and practices.

Rogers discussed the program further, explaining that a checklist of more than 130 items was prepared and sent around: "The checklist wouldn't have worked, however, unless local plant people cared. Anyone can read checklists, but you need the talent to do things at the plant," he added.

With Theilhaber as a consultant and using individual plant talent, a number of successful energy-savings projects have since been undertaken at various Raytheon plant locations.

Process Changes/Energy Savings

An early assignment began at a plant in California which has several electrically fired processing furnaces. The facility was told by its local power company (Pacific Gas and Electric) that a plan should be developed for a 15-percent reduction in electrical availability in the 1973-74 heating season. It looked for a while as if production would have to be reduced with dramatic effects on the whole plant operation. Theilhaber found, however, that by ducting away hot exhaust gases from the furnaces, providing enclosures at air leakage points, and redesigning the front end of the furnace to reduce radiant energy losses, the air-conditioning load on the area could be reduced by 50 kW.

Another project being studied involves a plant that has a large quantity of dry refuse which is currently removed by commercial waste hauler. The plant also has a large plating department requiring heated water for rinse tanks and steam for heating and air-conditioning (absorption type). Under consideration is a plan to incinerate the refuse and heat the rinse water using a waste-heat boiler on the incinerator effluent. In this case, the installation of incinerator and boiler would have a 3- to 4-year payback.

An example of another important service performed by the conservation group at Raytheon is the review of capital spending for energy-saving plants. At one plant a project was planned to reduce steam distribution losses by closing down the plant's steam boiler in the summer months and using electrical steam generators to service the summer steam demand at a remote part of the plant. By careful analysis, Theilhaber found that the project, although conceived in the spirit of energy conservation, would actually save very little, if any, energy and would never pay for itself. This demonstrates the need for careful consideration and analysis of plans for energy conservation before blindly following recommendations on conservation checklists.

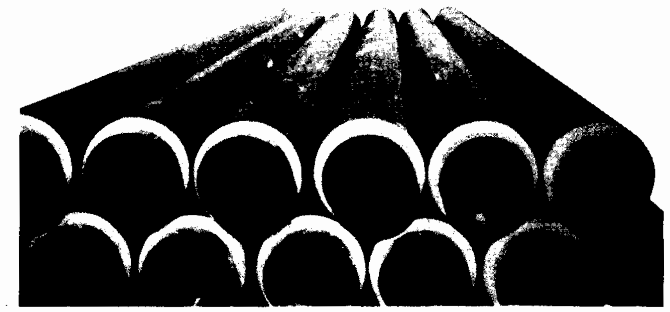
A final example of energy conservation practices at Raytheon may be applicable to a wide variety of industrial plants. One Raytheon facility is air-conditioned and heated by 24 131-ton rooftop units incorporating freon cooling systems and electric resistance heaters. After consulting with the equipment manufacturer, Theilhaber found that it is possible to modify the air-conditioning units to operate as heat pumps in the winter at considerable energy savings. In a heat pump, the energy delivered to the air for heating purposes is greater than the input electrical power. In this case, a coefficient of performance of approximately two will be realized—meaning that for each electrical Btu delivered to the compressor motor, 2 Btu's will be delivered to the air steam being heated. Calculations show that electrical heating will not be necessary until the outside temperature drops to approximately 10°F. At this point the resistance heaters will cut in to augment the heat pump. Costs associated with the conversion are $9,000 for engineering the change in circuit and new controls and $16,000 per unit for modifications required. A total cost for all units is $393,000. Savings anticipated at current electrical rates are $208,000 per year for a simple payback period of under 2 years. Because the units are not originally designed to operate as heat pumps, only one unit will be modified for the 1974-75 heating season. During that period, extensive tests on performance and energy usage will be conducted prior to modifying the remaining units. Needless to say, cost savings of this magnitude are not always possible. This example shows, however, that informed analysis of existing equipment can often result in significant energy and cost savings.

Jim Rogers describes the future programs of Raytheon: "Sure we've made significant reductions already, but we're continually adding to our opportunity list of energy-saving projects. The opportunity list has grown to the point where only the highest priority projects, those with the fastest paybacks, get done first. Naturally, it's impossible to undertake all the worthwhile projects at once."

Raytheon's approach to energy management—having an energy manager with an in-house consultant on energy matters reporting to him—is in many ways well suited to a large corporation with a number of facilities involved in a wide range of manufacturing functions.

CHEMETRON

This manufacturer of industrial products has applied the organization, analysis, and interest of recent cost-cutting programs to its efforts to conserve energy. The company demonstrates the results possible by transferring capabilities of in-house engineering talent to energy conservation problems.



Company Description

The chairman of Chemetron (1973 annual sales of $353 million) describes the company as one with a strong flavor toward "industrial consumables." In his words: "Rarely has more than 25 percent of our sales volume been in capital goods. . . . Rather, the great proportion of our sales was of products that were immediately consumed and then reordered."

The company is divided into three groups: chemicals; gases and related products; and metal products and process equipment. The Metal Products and Process Equipment group includes the Tube Turns Division.

The Tube Turns Division was formed in 1927 to produce welded pipelines and fittings by a process developed in Germany. These fittings were specified for the first major buildings to be constructed using modern welded piping—the Union Carbide Building in Chicago and the Empire State Building and the Waldorf Astoria Hotel in New York. Tube Turns products are produced at three locations: Philadelphia, Louisville, and Houston.

The management's philosophy is to have decisions affecting profitability made as far down in the organization as possible. While the Chicago headquarters house the four corporate vice presidents, the staff activities there are remarkably light. Chemetron has traditionally allowed local managers almost complete authority over local operations.

C. C. Candee, who had been with the company for 18 years, headed the energy effort. He assumed the responsibility in February 1974, to continue until his retirement in October 1974. Candee had the kind of reputation within the company to make novel programs work. When the first of Chemetron's three operating groups was formed in 1968 (the Chemicals Group), it was Candee who was chosen to be the corporate vice president in charge. The designation of a senior executive in Chicago in charge of overall energy matters was contrary to the normal corporate philosophy and seemed to reflect his availability rather than a typical strategy-related decision.

Although other areas of the company have conservation programs, the most intensive one is in the Tube Turns Division.

Energy Conservation in the Tube Turns Division

The Tube Turns mill in Louisville produces steel elbow and tee forgings, gas transmission line elbows, and steam distribution system fittings. In addition, nuclear powerplant penetration seals, forgings for automotive gears, large connecting rods, and other products constitute a line of select products produced on special order. Energy costs at the Louisville plant are 3.1 percent of the manufacturing costs.

The Tube Turns Division has for several years had a major cost-cutting effort under its Profit Improvement Program (PIP). The Division management responded to the energy crisis by establishing an energy task force under the PIP program. The purpose was to improve housekeeping and daily practices and to examine all processes using energy forms; to review and justify all possible cheaper or alternate fuels and processes; then to develop programs, see that they are implemented, and audit the results.

Considerable use is made of a computer system in the overall task force functions. The computer is a key factor in managing the energy audit that is made of all the energy utilized for company operations. All equipment and devices that use energy are accounted for and catalogued as to type and amount of energy used. The objective of the audit is to gather enough data from each product process to compare the energy expended to the product production volume and cost.

An energy audit form has been created to identify each piece of equipment that utilizes energy and the amount it uses. Upon completion of the audit forms, they are catalogued in accordance with equipment type and function. The data provides a categorized baseline of all the major equipment energy users. The sum of the incremental energy functions provides the basis for an energy model of Tube Turns.

"The overall continuing function of the Energy Task Force depends on the exchange of ideas. The composition of the membership lends itself to this prupose," explained task force chairman Bob Benson. "However," he pointed out, "further involvement of all employees is believed to be a necessity, and plans are being made to implement an education program to provide free flow of information and keep energy conservation a prime thought in everyone's mind."

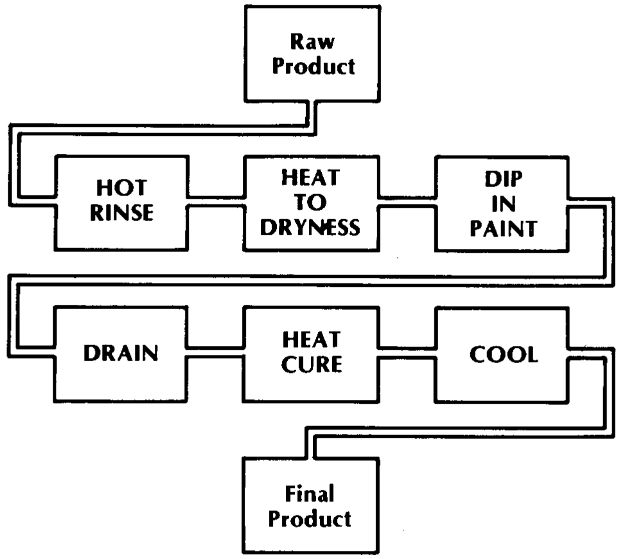
Energy conservation projects are suggested by members of the task force. Each is analyzed as to its payback and then its priority is established. Each project selected for implementation is followed closely during the construction phase. In turn, each project undergoes postauditing to evaluate the original analysis. This is done on an annual basis.

The group reviews two types of programs for energy conservation. In the first category are the housekeeping measures: reducing building temperatures, hot-water service temperature, and lighting levels when appropriate. In the second category are the process-related energy-savings opportunities.

Tube Turns' Vice President David Wyborny indicates that the key question with each process under review is: "Why are we doing it this way?"

One response to this question is to find extraneous processes and thus conserve energy and labor effort. One painting process for small fittings at Louisville is depicted here.

It was believed after analysis that the speed of the conveyor system, the temperature of the



rinse water, and the distance between rinsing and painting stations made the oven no longer necessary for drying the product. On a trial basis, gas to the oven was shut off and the effect on product quality was evaluated. It was found that the parts were completely dry before reaching the paint station and the drying oven could be removed from the process. Natural gas savings by the removal of this process step amount to 4,600,000 cubic feet per year for an annual saving of $3,000.

Some projects in the energy conservation program have also solved other problems, like meeting OSHA standards or controlling air pollution. In the large diameter elbow shop, two car-bottom assembling furnaces have been completely rebuilt. The refractory was stripped away back to the steel frame, and modern insulating firebrick installed. In addition, burners with greater efficiency than those used previously were provided. Before modification it was found that, for some batches requiring a low furnace temperature, an air pollution problem developed due to the formation of aldehydes. Since the furnace was modified, 10,000,000 cubic feet of natural gas is saved per year, with an attendant cost savings of $6,500 per year. In addition, the air pollution problem has been solved, at considerable cost avoidance.

Other changes have improved manufacturing operations as well as saved energy. For example, a simple burner change on one of the small batch-type, car-bottom, heat-treat furnaces in the Louisville plant led to a reduc-

tion in natural gas consumption of more than 4,000,000 cubic feet per year while obtaining an improved temperature uniformity inside the furnace chamber. Previous uniformity had been ±25 degrees. The new system provided ±5 degrees, with a decreased time to bring the furnace to the required operating temperature. The company realized a $2,600 per year direct decreased operating cost of natural gas and has decreased the percentage of heat-treat failures with the improved furnace uniformity.

In another area of the plant, an air curtain was installed to kill the cold air draft caused by building negative pressure and winter air. The principle of this air curtain operation was to warm all incoming air, thereby eliminating cold drafts. This installation would result in $2,000 a year decreased operating costs. This one unit would eliminate several steam heaters presently used to spot heat areas that would have been affected by the cold air drafts. Additionally, decreases in operating costs were expected to result from decreased door repairs in that the door now would stay open at all times. Four more air curtains were scheduled to be installed in other buildings.

One of the more dramatic savings occurred in the engineering department where low light levels had been a morale problem for some time. Recently it became obvious that the air-conditioning requirements for the department exceeded capacity and that a new air-conditioning system might be needed. Instead, the engineers designed a new lighting system which both increased light levels and decreased the heat produced by the lights. The new system raised the lighting level from 25 to 60 footcandles to the 85 to 100 footcandles required by OSHA.

The old system consisted of a suspension ceiling of egg-crate diffusers with bare fluorescent bulbs on 2-foot centers located above the ceiling. Some of the egg-crate sections were replaced with fluorescent panels which were far more efficient in delivering light to the work area. Since the existing wiring was utilized, costs have been $6,000. Direct electrical savings of $860 per year, combined with the cost avoidance of $6,000 for air-conditioning work, made this energy-saving project financially worthwhile.

A water recirculation system was also installed in the Louisville facility which would save both water and energy. Existing equipment used water in large quantities and dumped it directly to sewer after only one use. A study revealed that the facility processed 172,000,000 gallons of water per year. With the proposed recirculation system, sewer charges could be reduced by $41,000 and water costs by $64,000 annually. The total system would cost approximately $120,000. Operating costs were expected to be $10,000 per year. The system would have payback of 2.06 years.

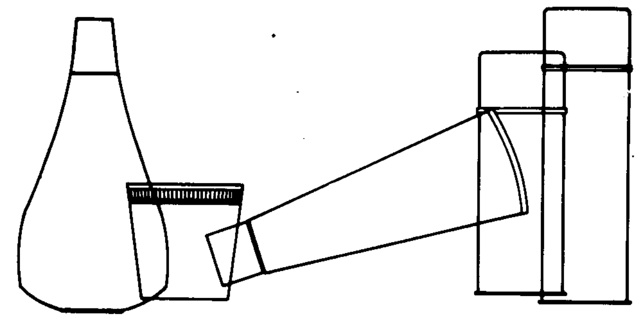
A second water recirculation system has been designed; components will be purchased at a later date. This system for the rotary hearth furnace would consume 82,000,000 gallons of water per year. Savings would be on the order of $8,200. Internal rate of return has been estimated at 162 percent, with a 1.6 year payback.

Another major accomplishment resulted from the operation of one boiler in lieu of two. This was explained by a company spokesman, who stated: "Previously it was felt that two 60,000-pound-per-hour boilers had to be operated to provide the necessary steam for our hammer shop. By study and observation, we found that it is actually only necessary to operate one boiler to supply the necessary steam. The boiler is operating at a more efficient level and the cost of fuel, chemicals, and support equipment as a byproduct have decreased."

These programs were only a few of those undertaken by Chemetron, and as a result, the corporation produced considerably more goods in 1974 for the same amount of energy used in 1973.

The company has decided that energy conservation offers good cost-cutting opportunities. For the long term, management has established a series of research programs to investigate new, less energy-consuming ways to make their products. These include: laser and planar heating, use of induction furnaces, new fossil-fuel burner designs, and new cold-forming techniques including high-strain rate network and hydraulic bulge forming. These programs are expected to continue the substantial energy reductions already achieved by Chemetron.

Chesebrough-Pond's Inc.



In a telephone conversation regarding Chesebrough-Pond's energy conservation program, company president Ralph Ward explained that fuel savings of more than 40 percent have resulted from a combination of process and housekeeping measures. These savings resulted from efforts in a few important energy-consuming areas. Ward simplified the essential part of their effort by saying: "All we did was turn off a few light switches and turn down the thermostats."

Company Description

Chesebrough-Pond's Inc., a diversified consumer marketing and manufacturing company making such well-known products as Vaseline Petroleum Jelly, Pond's creams, Wind Song perfume, Q-Tips Cotton Swabs, Ragu spaghetti sauces, Adolph's meat tenderizer, and Healthtex children's apparel, has earned the description of a "growth" company. Growth in sales, earnings, and dividends has been regular, almost routine. This growth has occurred through both internal and external efforts, including a series of acquisitions beginning in 1955. Company sources indicate that acquisitions routinely have experienced significant sales and earnings growth after joining the Chesebrough-Pond's family.

The company had sales for the year 1973 of $463 million, ranking 313 among Fortune's top 500 U.S. Companies, and earned over $37 million, or 8.1 percent of sales that year. Sales continued to increase in 1974, and during the first 6 months, showed a 16.5 percent increase over the similar period for 1973.

Of Chesebrough-Pond's 22 producing plants in the United States, one of the largest is located in Clinton, Connecticut, a town of 10,000 people located 25 miles east of New Haven. This plant is a key local employer with 800 to 1,000 employees. The Clinton plant dates back to 1873 and was the original Pond's Company which used to make witch hazel from the area's native hazel root. Following the merger with the Chesebrough Company in 1955, the Chesebrough and Prince Matchabelli lines were added to Clinton, so that today the plant produces beauty creams, lotions, powders, and fragrances under such well-known brand names as Pond's, Vaseline Intensive Care, Angel Face, Wind Song, and Cachet. Annual sales of approximately $100 million result from the manufacturing operations at Clinton.

Role of Energy in the Company

The company's internal growth keeps the corporate manufacturing and engineering staffs busy designing and building new facilities. During 1974, operations began at new textile manufacturing facilities in Centreville, Alabama; Cumberland, Rhode Island; and Cabo Rojo, Puerto Rico; and a new Q-Tips Cotton Swabs plant in Las Piedras, Puerto Rico. In addition, construction is underway for a textile facility at Gadsden, Alabama, and a tomato paste plant at Merced, California, has just been enlarged.

Clearly, the Chesebrough-Pond's construction program does not allow much time for nonproduction-oriented activities such as energy conservation programs. Therefore, any programs to be undertaken in the energy area had to be designed in such a way that their administration would not be a problem.

Chesebrough-Pond's Inc. businesses are neither energy nor labor intensive. Energy costs make up roughly $2 million of the domestic corporate expenses.

Process Layout in the Clinton Plant

Clinton plant management has attempted to create a working environment in which employees feel they are members of a team. Communication between management and employees has been viewed as crucial in developing this environment. The Clinton plant manager regularly (once every few weeks) holds a meeting with the personnel manager and one employee from each department. In addition, each month the heads of all departments hold meetings with the department employees. These meetings, an hour in length, are aimed at transferring information and providing a forum for employee complaints. These meetings have existed for some time and are an accepted means of employee communication.

The Clinton plant produces the Prince Matchabelli and Pond's lines of products. Production at the plant has doubled over the past 5 years, primarily due to the introduction in 1972 of Vaseline Intensive Care products, all of which are manufactured at Clinton. This increase has created cramped production facilities, and the result is a production flow not considered adequate by plant officials. New facilities are planned for Huntsville, Alabama, to produce the Prince Matchabelli line, which will relieve some of the pressure at Clinton.

The Clinton plant consists of three floors containing 240,000 square feet, of which 100,000 square feet is manufacturing space and the rest warehousing. At the plant, bulk liquid and powder feedstocks are received, compounded, and proportioned; the products are then prepared and packaged.

Since the product mix is varied, the plant is laid out by function; that is, all compounding of powder is performed in one location, liquid bottling in another.

Utilities provided to the plant's manufacturing areas are low-pressure steam, compressed air, and electricity. In many respects, this plant is typical of numerous light-manufacturing operations in a wide range of diverse industries.

Development of a Conservation Policy

Over the years, energy consumption was never a major concern at Chesebrough-Pond's. For example, the Clinton plant energy bill was $225,000 per year. But 1973 was different. Ralph Ward, Chesebrough's president since 1968, moved quickly to counteract rising fuel costs. On November 13, 1973, he wrote to all employees: "In recent months, we have all become aware of the developing energy crisis in this country, particularly as it relates to petroleum products. This crisis is real, and strong energy conservation steps are required not only by industry, but by each of us individually in our daily lives."

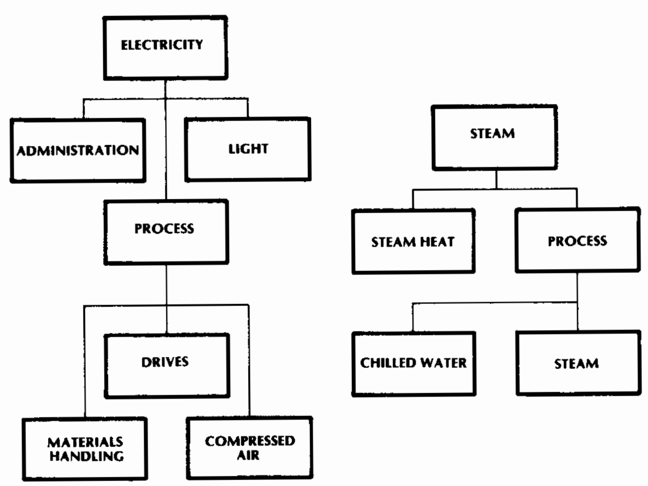
Ward appointed Perry Lindholm, vice president of manufacturing and a 14-year veteran of Chesebrough-Pond's, to head the corporate energy conservation program. Lindholm directed the establishment of Energy Conservation Committees at each company location to develop and carry out local conservation programs.

At Clinton, for example, George Lahn, plant engineer, was named to set up and implement the energy-saving program. As a first step, Lahn organized an energy conservation committee and established a weekly reporting system through the chain of command, to follow up on the steps taken to conserve energy.

Lahn realized that any energy-savings program would require complete cooperation from the employees, and that employees must be kept informed of the energy conservation efforts. By reporting to the employees the effects of their energy-saving ideas, management succeeded in engendering an energy consciousness among the employees. The plant's employee bulletins also played a strong role here, publishing energy saving ideas and accomplishments regularly.

In the beginning, employees were told that some attempts at energy saving could have unforeseen effects and that in no way was it desirable to make working at Chesebrough-Pond's uncomfortable, hazardous, or generally less pleasant. With the preparatory work done, attention was directed toward reducing the plant energy requirements.

Process Changes/Energy Savings



The major sources of electrical consumption were plant lighting and compressed air used in the processes. The plant's energy utilization is illustrated in the chart.

Lighting was studied first. Through a series of gradual changes, light was reduced in the production areas to a point where electric usage was one-third less, with no evidence of employee dissatisfaction. In addition, this reduction was extended to halls, cafeterias, conference rooms, and storage areas.

The night lighting was of special concern since plant security had to be maintained. To solve this problem, switch locks were installed on all lights which were to be left on. All other lights were to be turned off by the employees or the guards. The result was an easily controlled light reduction program with sufficient light still available for the plant guards.

The control of compressed air was more difficult since it was essential for the production of the plant's products. This air is used for a variety of operations, including driving mixer motors in the bulk compounding process, conveying small containers in the packaging process, and the actual bottling of products. The solution to the compressed air usage problem was embarrassingly simple: just to install shut-off valves on the production line machinery so that air could be shut off during work breaks and when otherwise not required. Each production supervisor examined carefully every time the air could be turned off without any adverse effect on production.

In the Northeast, fuel oil was indeed precious during 1973-74 and the Clinton plant's conservation efforts demanded that hard questions be asked about where it was used. First, in the manufacturing and office areas, building thermostats and control valves were adjusted to keep temperatures to 68°F. In the warehouse, even more substantial temperature control steps were taken when half of the steam coil unit heaters were deactivated. Next, questions were asked about temperatures and pressures required in various plant activities. It was determined that steam pressure could be reduced from 125 psig to 100 psig with no measurable effect on the processes. Further, no reason was found why hot water temperatures had to be 180°F., so they were reduced to 140°F. As Lahn explained: "These pressures and temperatures were set years ago and no one ever considered the reasons for them until energy became important." Finally, maintenance efforts were stepped up: faulty steam traps were repaired, new insulation was applied, and faulty automatic door seals and approximately 50 broken windows were replaced.

Employee cooperation, not only in their willingness to accept changes, but also in their initiative in offering their own energy-saving ideas, played a major role in the Clinton plant's energy management success. One employee's idea, which led to substantial heating savings during the winter, will illustrate this cooperation.

The warehouse on the first floor is adjacent to the automatic packaging area. The packaging area uses automatic equipment which generates considerable heat during its operation. During the summer, that area becomes very hot, and the company installed a fan to draw cool air from the outside through the warehouse into the packaging area.

During the process of looking for energy-saving ideas, a woman employee in the packaging area, after noting that the packaging area exceeded 68°F., and that heaters were needed in the warehouse, suggested that the fan between the two areas be reversed in the winter and warm air from the packaging area be drawn into the warehouse. The net result of that effort was that the warehouse required substantially less heat and the employees felt added participation in the save-energy efforts.

In order to assure that savings were obtained, several monitoring procedures were established. Each weekend the plant was inspected to insure that utility usage was at the lowest possible rate. Lighting, compressed air, and temperature levels were checked. Additionally, a weekly report was prepared for top management detailing progress in energy saving during the previous week.

In terms of results, the Clinton plant achieved a total of 40 percent reduction in fuel usage and 20 percent reduction in electrical consumption during the first 6 months of 1974. The company finds it difficult to relate these figures on a unit-of-production-basis, but believes direct-labor man-hours accurately provide a comparison of the 1973 and 1974 energy needs. The direct man-hours for the first 5 months of 1973 and 1974 are almost identical, making direct comparison possible. Despite fuel and electricity prices' nearly doubling, Clinton's energy budget for 1974 is only $284,000,or 26 percent over the actual use in 1973, indicating energy use declined more than 30 percent for comparable levels of production.

The program goes on, despite the reduced publicity about the energy crisis. But Lahn feared a fuel oil shortage this winter and continues to promote plant-wide interest. Under consideration at Clinton is a program to insulate vessels containing heated products. And at the corporate level, energy is a consideration in the engineering of new production facilities. Energy conservation has become an element in the long-range plans of the company—plants which are not moving ahead in the dark.

BEHRENBERG GLASS CO.

How does a company with fewer than 50 employees, 1 graduate engineer, and a 50-year history face a potential allocation of natural gas? The Behrenberg Glass Company, when faced with that set of circumstances, turned to the "gas" company for help.

Company Description

Behrenberg Glass Company, a family-owned business, is located in Delmont, Pa., some 30 miles east of Pittsburgh. The company, founded by the grandfather of the present owners, John and Jim Behrenberg, has been in the "glass bending" business for 50 years in the Pittsburgh area.

The company was one of the early suppliers of the glass logos used in globes that identified gasoline pumps prior to World War II. Since the war, the company has supplied decorative glass to about 50 assemblers who supply a substantial share of the lighting fixtures used in the country. (The firm's sales run about $1 million.) The small industry has only 10 benders. Most of the firm's customers serve the housing industry.

John Behrenberg, 44, a graduate glass technologist, became president of the company when his father retired 3 years ago. John has always been involved in the family business, working the lunch-hour breaks on the furnaces while he was in high school and operating every machine in the plant at some point in his career. After college at Alfred University School of Ceramics, a year with Sylvania Electric, and an Army stint, he then came home to stay at Behrenberg. John runs the production operations while his brother Jim, company vice president, heads the design activities of the firm. John is proud of the fact that, since business regularly comes through the door without a marketing or advertising effort, he need only concern himself with delivering quality products. The company's success is shown by the retention of most of the same customers over the past 20 years.

The company has always been in the Pittsburgh area, moving to Delmont 11 years ago. The Delmont facility, expanded 4 years ago by adding a warehousing area to the basic plant, has changed little of the internally designed equipment over the years.

The company has always designed its own furnaces. John Behrenberg describes the business: "We're in an oddball industry where standard equipment doesn't usually work. We've always had to design for our own purposes. As product demands change, we adjust our speeds and mixture of product accordingly." The company produces no stock items; rather, they are all to customer specifications—as few as 100 at a time.

Behrenberg's Process

Behrenberg produces decorative glass for lighting fixtures from a wide variety of flat glass. Input raw material consists of 90 percent clear window glass and 10 percent colored rolled glass which may have a wide variety of surface patterns.

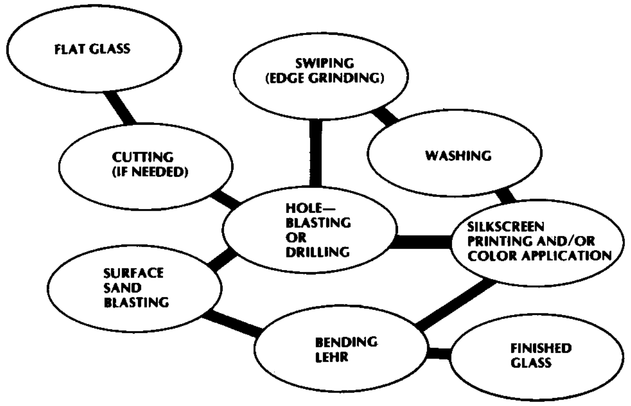
The operations at Behrenberg can be characterized as three types—glass preparation, decoration, and firing.

Glass preparation operations:
- cutting
- hole blasting or drilling
- swiping (edge grinding)
- washing

Decoration operations:
- silkscreen printing or
- spraying
- drying

Firing operations:
- firing in the color
- bending
- annealing

A diagram of the process is shown below:



People's Natural Gas Company—Behrenberg Energy Supplier

During the winter of 1969-70, the local gas distributor, the People's Natural Gas Company, was informed by its parent company and supplier that natural gas might have to be curtailed. People's, through Consolidated Gas Supply Corporation, receives 80 percent of its supplies from the Southwest, where natural gas reserves are declining. At that time, People's began an active gas conservation program among its customers to avoid any interruption or serious curtailment of service.

Initially, the company's efforts were directed at obvious wastes: just getting people to turn off things they weren't using. More recently, People's industrial customer representatives have been more directly involved with 220 industrial customers, helping them identify ways to cut gas consumption. Operating from regional field offices, the industrial representatives provide pertinent technical information on conservation to their customers. If a customer requests guidance or assistance in analyzing his operations for ways to improve energy utilization, People's willingly participates. This is especially true in cases where the allocation of natural gas has hindered the expansion of a customer's business.

The results of People's conservation efforts have been good. Most customers are producing more output than in 1969, but with the same quantity or less of natural gas.

Behrenberg and People's Gas have worked closely many times, although Behrenberg is not the major customer of the gas company. Eight years ago, People's suggested a makeup air system for the plant. Behrenberg used its engineering talents to adapt the suggested system to its site, and the result was cleaner inner-plant air. The plant used to be filled with "blue air," but as soon as the makeup air system went into operation, the air cleared up completely. While OSHA was not in effect at the time, the gas company's suggestion probably prevented violations when the law became effective.

Behrenberg adds: "People's has been very helpful in other ways. For the past several years I haven't been able to add gas connections. It was suggested I add a propane tank for emergencies. I did, and set it up so that connections to propane can occur in only a minute if needed. A conversion to propane is expensive, so while I'm more secure, they've given me more incentive to conserve energy."

According to Behrenberg, "People's Gas has always been promoting energy conservation. Sometimes I think they even promote it too much." Several years ago, the industrial development coordinator for People's suggested that Behrenberg go to a Clarksburg, W. Va., symposium on cost-cutting for glass companies, sponsored by the Consolidated Gas Supply Corporation and West Virginia University. "The symposium was so good I just kept going back. At the 1973 symposium I met an Ohio gas supplier who suggested I look at a new kind of insulation for our furnaces."

Bending Furnace Energy Savings

The bending furnace is the key to the process at Behrenberg. By the time the glass reaches the furnace, all other processing operations have occurred. Therefore, the furnace operation must be carefully managed to assure a quality product with minimal waste. Improper annealing or heating which results in breakage or obvious mold marks reduces productivity and increases operating and raw materials costs.

At the furnaces, flat pieces are placed in or on top of a stainless steel mold which rests on a continuous, flexible chain grating. In the furnaces, the glass is heated by natural gas burners to "fire in" the color and bend the glass to conform to the mold.

The bending operation in the furnace occurs in three successive temperature stages. As the grating moves into the furnace, the glass enters a radiant heating zone in which the temperature is maintained at about 900°F to remove organic color vehicles in the glass prior to softening. Next, the glass passes through a section in which it is heated to about 1,250°F, where it bends under its own weight to conform to the shape of the mold. Finally, the glass passes through the annealing section at 900°F, and subsequently cools to room temperature.

The side walls and suspended crown of the furnaces, or bending lehrs, had been constructed of refractory and red brick to withstand the continuous high temperatures. Although the walls were quite thick, substantial heat losses occurred which Behrenberg believed to be wasteful. After discussions with the insulation supplier, Behrenberg replaced the heavy brick crown of the furnaces with one of sheet metal and the high temperature insulation material described at the West Virginia seminar. Insulation was added to the walls as well. The total cost of modifying two lehrs, 45 feet long by 6 feet wide by 5 feet in height, was about $3,500.

The gas savings were immediate and substantial. Because of the change from massive refractory to light insulation, the daily time required to heat up the one furnace which cycled was reduced from 2 1/2 hours to about 30 minutes. This alone saves over 3,000 cubic feet of natural gas per day. Over the course of a normal 16-hour day, the savings are 4,300 cubic feet per furnace. Annual reduction in total gas consumption is estimated at 1900 thousand cubic feet, for a saving at present cost of about $2,000 per year and a payback of 1 3/4 years if these were the only savings.

Once the changes were complete, intangible economic benefits of the energy saving were more apparent. The comfort of the personnel operating the furnaces improved with the reduction of radiant losses, lowering the ambient temperature near the furnace by 20°F. In terms of operation, temperature uniformity in the furnace improved as well, providing a slight increase in flexibility in the combinations of pieces which could be bent simultaneously. During bending runs of one formerly difficult product, the breakage rate was reduced from 70 percent to 20 percent due to improved heat distribution.

Because of the long heat-up time, one furnace ran on a 24-hour basis and the other only one or two shifts. Thus, the plant had to be open, manned, and illuminated for all shifts. Now both furnaces run on two shifts, saving one full shift of manpower and energy to light the plant.

Reduction in maintenance of the furnaces also was a benefit. Now, when the baffles which control heat distribution must be repositioned or replaced, only a few hundred pounds must be moved instead of the former several thousand pounds. Should the furnace have to be shut down for repairs, the new construction cools faster, shortening the downtime.

While these items cannot be quantified, Behrenberg believes his savings will keep the company's earnings about even this year, even though business has slackened.

Behrenberg continues to believe that People's can help save energy. "People's Gas currently is working on a system which will use furnace waste heat for winter heating. When they get it perfected, we'll have it."

Federal Energy Administration
Office of Industrial Programs
Washington D.C. 20461

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energy conservation

Lighting and Thermal Operations

Building Energy Reports
Case Studies

Conservation Paper Number 4

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Energy Conservation
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Energy
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Lighting & Thermal Operations

ENERGY MANAGEMENT ACTION PROGRAM

Building energy reports

The oil embargo to the United States during the winter of 1973-74, which precipitated the "energy crisis," brought energy management to public view. The roots of our energy troubles, however, go back to trends in production and consumption of energy that have persisted for some time. The most basic energy problem we face is a growing gap between rates in consumption and supply. Energy consumption grew at an average rate of about 3.5 percent per year from 1950 to 1965 and then increased to 4.5 percent annually. Domestic energy production grew at an annual rate of 3 percent between 1950 and 1970, but has been at a virtual standstill since then.

A number of different trends in each energy-use sector—residential, commercial, and industrial—have contributed to rapid U.S. energy growth in the last decade. Commercial energy use has grown at the rate of 5.4 percent per year since 1960—more than any other sector—and now represents almost one-fourth of all electricity consumed in this country.

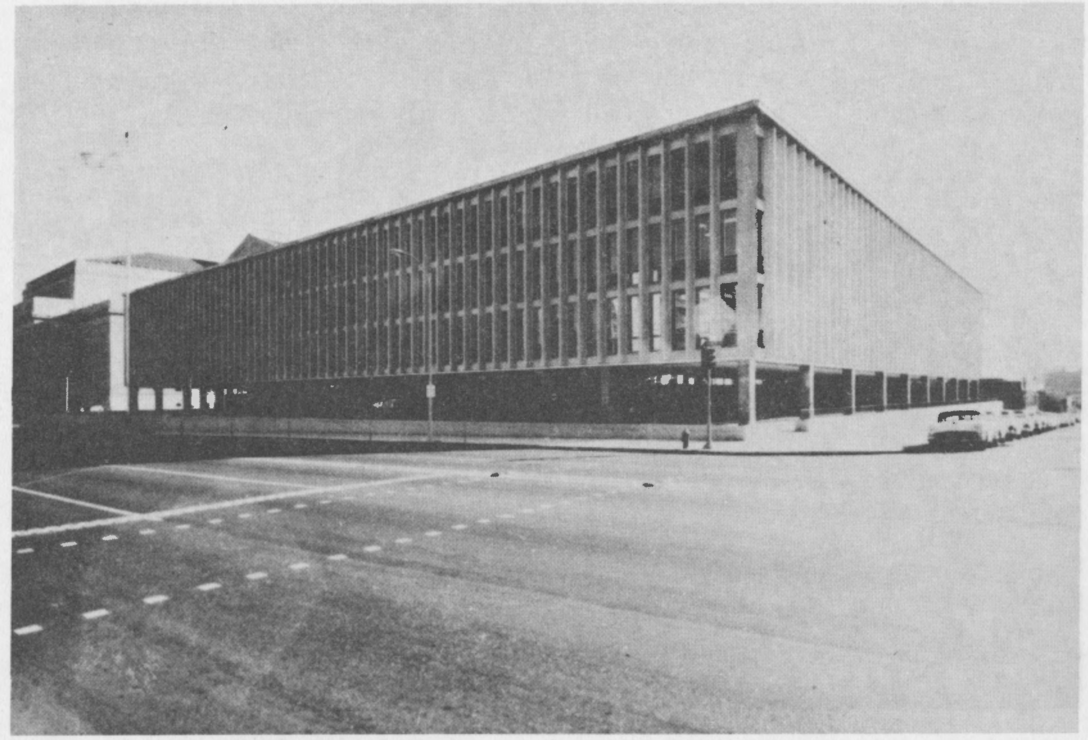
Within the commercial sector, 42 percent of the electricity consumed is used for lighting purposes and 30 percent represents HVAC (heating, ventilating, and air-conditioning) use. Past practices with regard to lighting and building operations have been based on a plentiful supply of cheap energy coupled with a lack of any incentive for conservation. Because of the resulting illumination levels and HVAC operating practices, the potential for saving energy at this time is significant.

In response, therefore, the Office of Energy Conservation and Environment in the Federal Energy Administration has initiated a voluntary Lighting and Thermal Operations/Energy Management Action Program, which seeks the cooperation of the commercial, public, and industrial sectors in instituting energy management programs. Many organizations have already initiated such programs, and the Building Energy Reports in this publication represent a sample of the results achieved in a variety of Federal office buildings. We are indebted to the Public Buildings Service of the General Services Administration for their cooperation and assistance in preparing these Building Energy Reports.

Although in each Building Energy Report the figures have been rounded to make the data consistent, it is significant that in all buildings an appreciable saving in energy resulted from the implementation of a simple energy management program. In fact, the average saving was 27 percent. The changes that produced the savings were made by in-house operating and maintenance personnel. The greatest cost was for lamp removal and this one-time, initial cost amounted to less than 20 percent of the first year savings.

The energy savings, and the resulting cost savings, started as soon as the energy management program began. And the savings are expected to grow each year, increasing as energy costs increase.

Roger W. Sant
Assistant Administrator for
Energy Conservation and Environment



Location: St. Louis, Missouri
Building type: Office
Area: 465,775 ft^2
Height: 6 floors
Built: 1961

		Energy Conservation Program Before (1973)	Energy Conservation Program After (1974)
Illumination			
At work stations	footcandles	60	50
In work areas	do	60	30
In nonwork areas	do	20	10
Lamps	number	24,900	21,050
Thermostat setting			
Summer	°F	74	78
Winter	do	74	68
Building occupancy			
Working	hours	9	9
Custodial	do	+8	+3.5
Fan operation			
Weekday	do	13	12
Weekend	do	0	0

SAVINGS

KWH consumed in 1973	10,795,000	
KWH consumed in 1974	8,284,000	
KWH saved	2,511,000	or 23 percent

2,511,000 KWH saved X 2.1¢/KWH = $52,700 for 1974

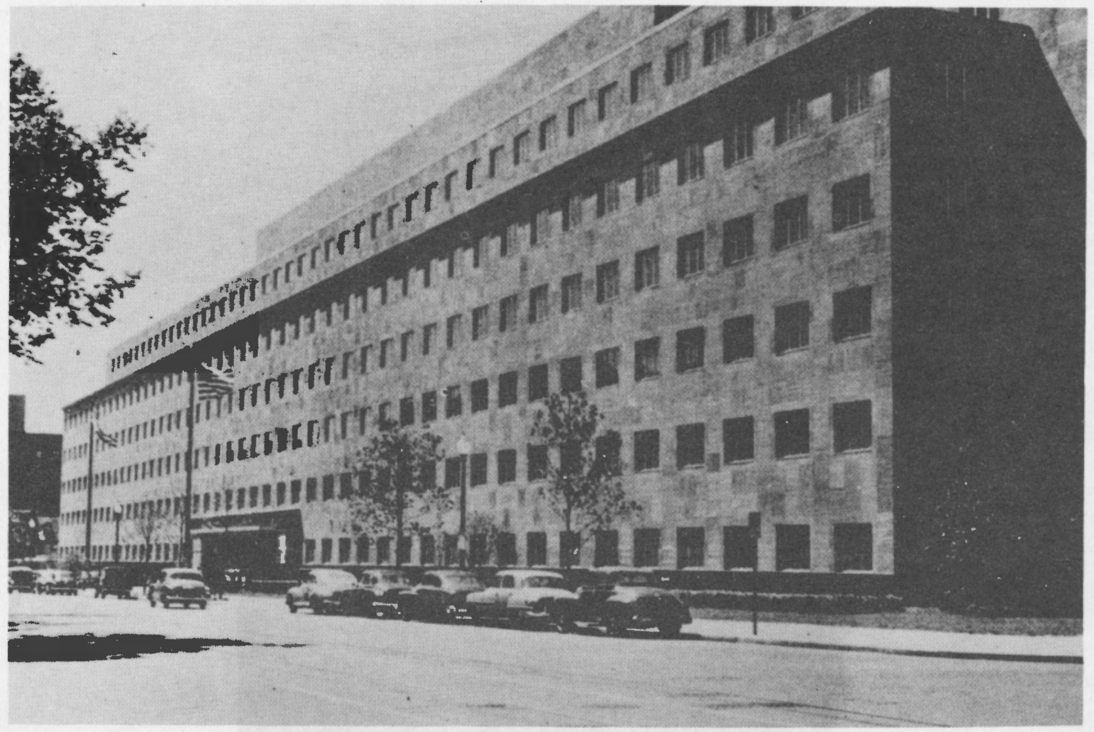
Location: San Francisco, California
Building type: Office
Area: 1,380,820 ft^2
Height: 22 floors
Built: 1964

		Energy Conservation Program	
		Before (1973)	After (1974)
Illumination			
At work stations	footcandles	100	50
In work areas	do	100	30
In nonwork areas	do	30	10
Lamps	number	81,360	62,860
Thermostat setting			
Summer	°F	74	78
Winter	do	74	68
Building occupancy			
Working	hours	10.5	10.5
Custodial	do	+6.5	+2.0
Fan operation			
Weekday	do	24	9
Weekend	do	0	0

SAVINGS

KWH consumed in 1973	29,412,000	
KWH consumed in 1974	21,010,000	
KWH saved	8,402,000	or 29 percent

8,402,000 KWH saved X 1.6¢/KWH = $134,400 for 1974



Location: Washington, D.C.
Building type: Office
Area: 1,844,000 ft^2
Height: 7 floors
Built: 1951

	Energy Conservation Program Before (1973)	Energy Conservation Program After (1974)
Illumination		
At work stations – – – – – – – footcandles – –	60	50
In work areas – – – – – – – – – – – – – – do – –	60	30
In nonwork areas – – – – – – – – – – – do – –	20	10
Lamps – – – – – – – – – – – – – – number – –	67,580	33,080
Thermostat setting		
Summer – – – – – – – – – – – – – – – °F – –	74	78
Winter – – – – – – – – – – – – – – – – – do – –	74	68
Building occupancy		
Working – – – – – – – – – – – – – – hours – –	11	11
Custodial – – – – – – – – – – – – – – do – –	+8	+4.5
Fan operation		
Weekday – – – – – – – – – – – – – – – do – –	12	12
Weekend – – – – – – – – – – – – – – – do – –	0	0

SAVINGS

KWH consumed in 1973	27,029,000	
KWH consumed in 1974	21,336,000	
KWH saved	5,693,000	or 21 percent

5,693,000 KWH saved X 2.2¢/KWH = $125,000 for 1974

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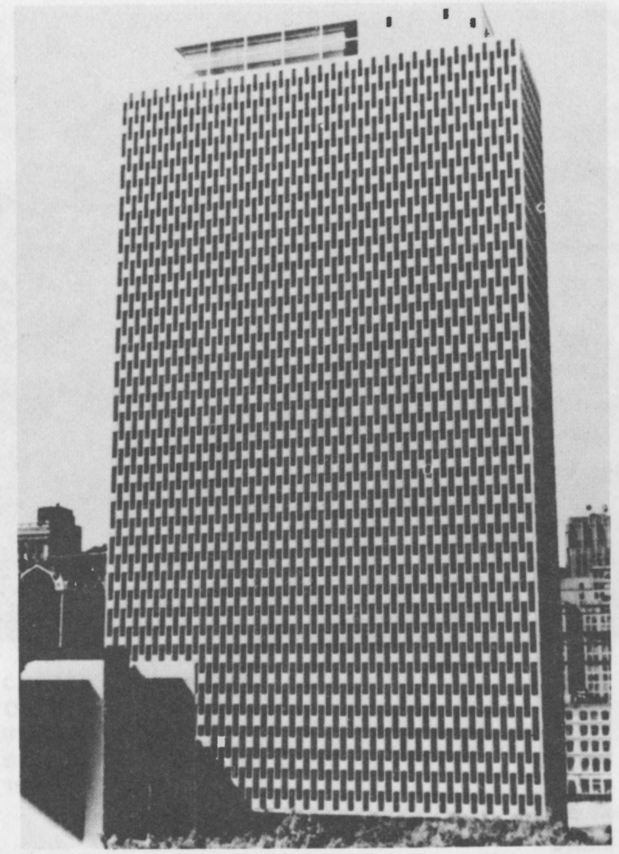


Location: New York City
Building type: Office
Area: 1,782,000 ft^2
Height: 41 floors
Built: 1967

		Energy Conservation Program Before (1973)	After (1974)
Illumination			
At work stations	footcandles	75	50
In work areas	do	75	30
In nonwork areas	do	30	10
Lamps	number	96,500	61,250
Thermostat setting			
Summer	°F	74	78
Winter	do	74	68
Building occupancy			
Working	hours	9	9
Custodial	do	+8	+3
Fan operation			
Weekday	do	24	9
Weekend	do	24	0

SAVINGS

KWH consumed in 1973	32,926,000	
KWH consumed in 1974	24,923,000	
KWH saved	8,003,000	or 24 percent

8,003,000 KWH saved X 4.8¢/KWH = $384,000 for 1974

Location: Columbia, South Carolina
Building type: Office
Area: 97,253 ft^2
Height: 6 floors
Built: 1952

	Energy Conservation Program Before (1973)	Energy Conservation Program After (1974)
Illumination		
At work stations – – – – – – – footcandles – –	100	50
In work areas – – – – – – – – – – – – do – –	100	30
In nonwork areas – – – – – – – – – – do – –	30	10
Lamps – – – – – – – – – – – – – – – number – –	3,260	2,520
Thermostat setting		
Summer – – – – – – – – – – – – – – – – °F – –	74	78
Winter – – – – – – – – – – – – – – – – – do – –	74	68
Building occupancy		
Working – – – – – – – – – – – – – – – hours – –	9	9
Custodial – – – – – – – – – – – – – – – do – –	+8	+4
Fan operation		
Weekday – – – – – – – – – – – – – – – do – –	12	9
Weekend – – – – – – – – – – – – – – – do – –	0	0

SAVINGS

KWH consumed in 1973	1,077,400	
KWH consumed in 1974	911,900	
KWH saved	165,500	or 15 percent

165,500 KWH saved X 2.2¢/KWH = $3,600 for 1974

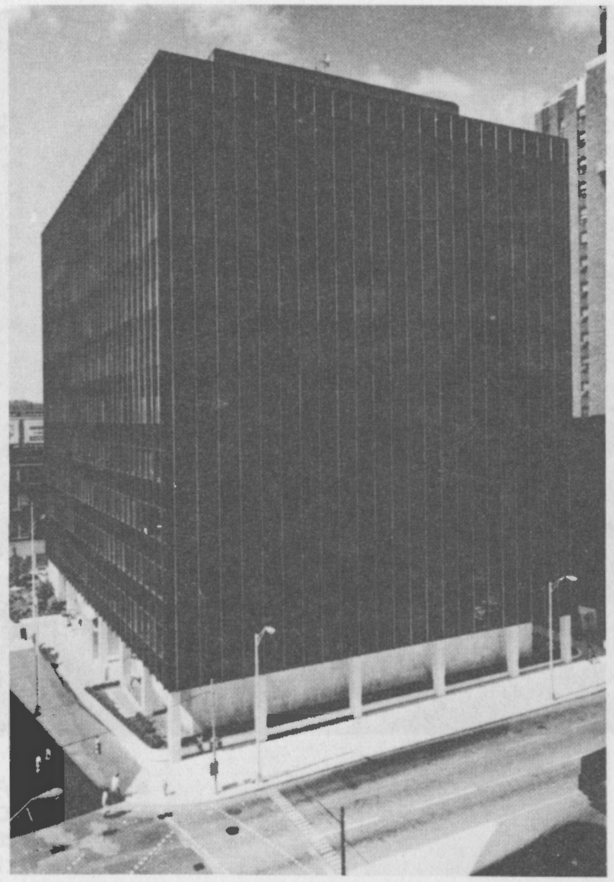
Location: Las Vegas, Nevada
Building type: Office
Area: 201,203 ft^2
Height: 4 floors
Built: 1967

		Energy Conservation Program	
		Before (1973)	After (1974)
Illumination			
At work stations	footcandles	75	50
In work areas	do	75	30
In nonwork areas	do	30	10
Lamps	number	9,250	7,050
Thermostat setting			
Summer	°F	74	78
Winter	do	74	68
Building occupancy			
Working	hours	9	9
Custodial	do	+8	+3
Fan operation			
Weekday	do	24	14
Weekend	do	48	12

SAVINGS

KWH consumed in 1973	3,703,500	
KWH consumed in 1974	2,572,500	
KWH saved	1,131,000	or 30 percent

1,131,000 KWH saved X 1.5¢/KWH = $17,000 for 1974



Location: Harrisburg, Pennsylvania
Building type: Office
Area: 204,300 ft^2
Height: 13 floors
Built: 1967

		Energy Conservation Program	
		Before (1973)	After (1974)
Illumination			
At work stations	footcandles	100	50
In work areas	do	100	30
In nonwork areas	do	30	10
Lamps	number	15,780	8,280
Thermostat setting			
Summer	°F	74	78
Winter	do	74	68
Building occupancy			
Working	hours	9	9
Custodial	do	+8	+3
Fan operation			
Weekday	do	18	12
Weekend	do	0	0

SAVINGS

KWH consumed in 1973	4,180,000	
KWH consumed in 1974	3,010,000	
KWH saved	1,170,000	or 28 percent

1,170,000 KWH saved X 2.8¢/KWH = $32,700 for 1974

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Location: Atlanta, Georgia
Building type: Office
Area: 350,172 ft^2
Height: 13 floors
Built: 1956

		Energy Conservation Program Before (1973)	After (1974)
Illumination			
At work stations	footcandles	75	50
In work areas	do	75	30
In nonwork areas	do	30	10
Lamps	number	14,330	11,460
Thermostat setting			
Summer	°F	74	78
Winter	do	74	68
Building Occupancy			
Working	hours	9	9
Custodial	do	+5	+2.5
Fan operation			
Weekday	do	12	8
Weekend	do	0	0

SAVINGS

KWH consumed in 1973	4,137,000	
KWH consumed in 1974	3,180,000	
KWH saved	957,000	or 23 percent

957,000 KWH saved X 2.2¢/KWH = $21,000 for 1974

Location: Sacramento, California
Building type: Office
Area: 349,530 ft^2
Height: 9 floors
Built: 1961

		Energy Conservation Program Before (1973)	Energy Conservation Program After (1974)
Illumination			
At work stations	footcandles	85	50
In work areas	do	85	30
In nonwork areas	do	30	10
Lamps	number	9,000	3,000
Thermostat setting			
Summer	°F	74	78
Winter	do	74	68
Building occupancy			
Working	hours	9	9
Custodial	do	+8	+3
Fan operation			
Weekday	do	14	8
Weekend	do	0	0

SAVINGS

KWH consumed in 1973	5,035,900	
KWH consumed in 1974	3,728,000	
KWH saved	1,307,900	or 26 percent

1,307,900 KWH saved X 1.5¢/KWH = $19,000 for 1974

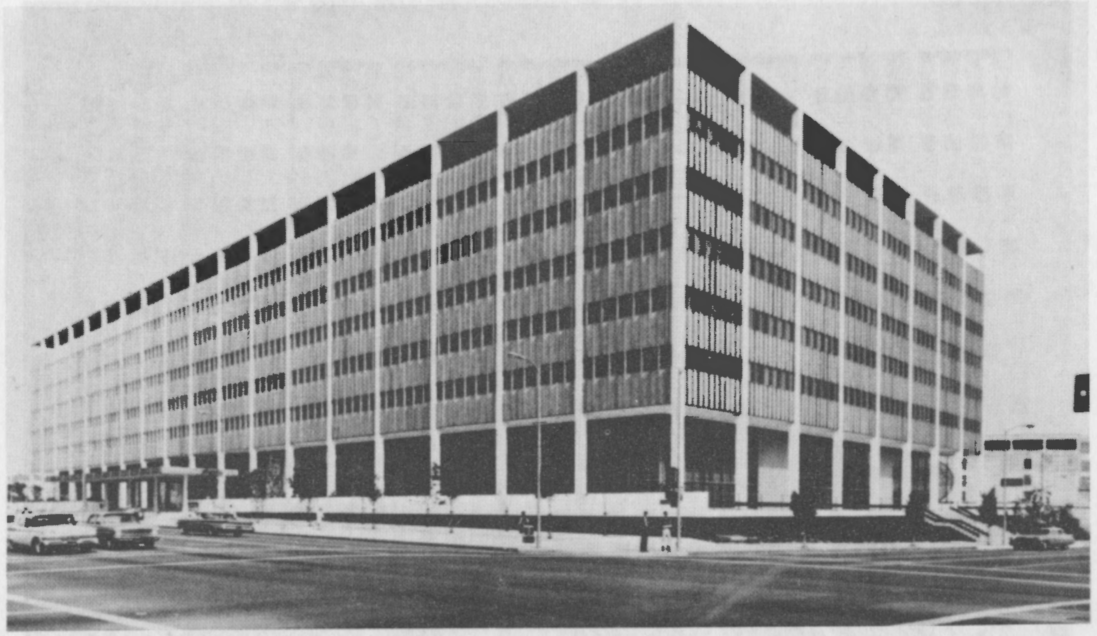
Location: Newark, New Jersey
Building type: Office
Area: 517,551 ft^2
Height: 16 floors
Built: 1968

		Energy Conservation Program	
		Before (1973)	After (1974)
Illumination			
At work stations	footcandles	100	50
In work areas	do	100	30
In nonwork areas	do	30	10
Lamps	number	28,680	23,880
Thermostat setting			
Summer	°F	74	78
Winter	do	74	68
Building occupancy			
Working	hours	9	9
Custodial	do	+5	+3
Fan operation			
Weekday	do	17	9
Weekend	do	0	0

SAVINGS

KWH consumed in 1973	8,957,000	
KWH consumed in 1974	6,385,000	
KWH saved	2,572,000	or 29 percent

2,572,000 KWH saved X 3.0¢/KWH = $77,000 for 1974



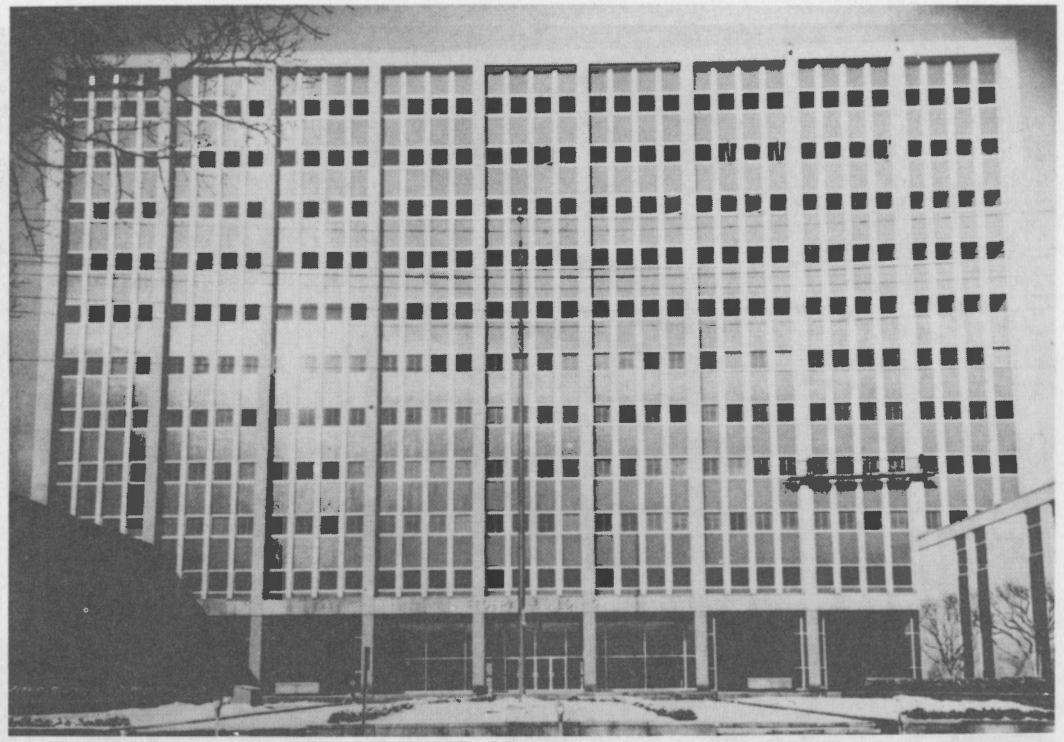
Location: Los Angeles, California
Building type: Office
Area: 1,207,117 ft^2
Height: 8 floors
Built: 1965

		Energy Conservation Program Before (1973)	Energy Conservation Program After (1974)
Illumination			
At work stations	footcandles	100	50
In work areas	do	100	30
In nonwork areas	do	30	10
Lamps	number	90,000	50,000
Thermostat setting			
Summer	°F	74	78
Winter	do	74	68
Building occupancy			
Working	hours	9	9
Custodial	do	+8	+3
Fan operation			
Weekday	do	17	14
Weekend	do	24	0

SAVINGS

KWH consumed in 1973	25,577,000	
KWH consumed in 1974	18,117,000	
KWH saved	7,460,000	or 29 percent

7,460,000 KWH saved X 1.55¢/KWH = $115,400 for 1974



Location: Richmond, Virginia
Building type: Office
Area: 380,310 ft^2
Height: 12 floors
Built: 1962

	Energy Conservation Program Before (1973)	After (1974)
Illumination		
At work stations — footcandles	70	50
In work areas — do	70	30
In nonwork areas — do	30	0
Lamps — number	14,240	11,360
Thermostat setting		
Summer — °F	74	78
Winter — do	74	68
Building occupancy		
Working — hours	9	9
Custodial — do	+8	+4.5
Fan operation		
Weekday — do	16	11
Weekend — do	0	0

SAVINGS

KWH consumed in 1973	5,640,000	
KWH consumed in 1974	4,123,000	
KWH saved	1,517,000	or 27 percent

1,517,000 KWH saved X 1.4¢/KWH = $21,200 for 1974

Location: Charlottesville, Virginia
Building type: Office
Area: 137,731 ft^2
Height: 6 floors
Built: 1965

		Energy Conservation Program Before (1973)	Energy Conservation Program After (1974)
Illumination			
At work stations	footcandles	85	50
In work areas	do	85	30
In nonwork areas	do	30	10
Lamps	number	5,330	2,580
Thermostat setting			
Summer	°F	74	78
Winter	do	74	68
Building occupancy			
Working	hours	9	8.75
Custodial	do	+8	+6.5
Fan operation			
Weekday	do	15	14
Weekend	do	0	0

SAVINGS

KWH consumed in 1973	2,740,000	
KWH consumed in 1974	1,590,000	
KWH saved	1,150,000	or 42 percent

1,150,000 KWH saved X 2.3¢/KWH = $26,400 for 1974

Location: Sacramento, California
Building type: Office
Area: 317,140 ft^2
Height: 2 floors
Built: 1969

		Energy Conservation Program Before (1973)	After (1974)
Illumination			
At work stations	footcandles	75	50
In work areas	do	75	30
In nonwork areas	do	30	10
Lamps	number	18,700	9,500
Thermostat setting			
Summer	°F	74	78
Winter	do	74	68
Building occupancy			
Working	hours	9	9
Custodial	do	+8	+3
Fan operation			
Weekday	do	14	8
Weekend	do	0	0

SAVINGS

KWH consumed in 1973	8,189,200	
KWH consumed in 1974	5,538,200	
KWH saved	2,651,000	or 32 percent

2,651,000 KWH saved X 1.2¢/KWH = $31,400 for 1974

Location: Los Angeles, California
Building type: Office
Area: 568,690 ft^2
Height: 18 floors
Built: 1969

		Energy Conservation Program	
		Before (1973)	After (1974)
Illumination			
At work stations	footcandles	90	50
In work areas	do	90	30
In nonwork areas	do	30	10
Lamps	number	28,850	17,650
Thermostat setting			
Summer	°F	74	78
Winter	do	74	68
Building occupancy			
Working	hours	9	9
Custodial	do	+8	+3
Fan operation			
Weekday	do	24	12
Weekend	do	48	0

SAVINGS

KWH consumed in 1973	17,229,000	
KWH consumed in 1974	11,960,000	
KWH saved	5,269,000	or 31 percent
5,269,000 KWH saved X 1.8¢/KWH = $95,400		

Location: Portland, Oregon
Building type: Office
Area: 148,475 ft^2
Height: 7 floors
Built: 1919

		Energy Conservation Program Before (1973)	Energy Conservation Program After (1974)
Illumination			
At work stations	footcandles	70	50
In work areas	do	70	30
In nonwork areas	do	30	10
Lamps	number	5,160	4,800
Thermostat setting			
Summer	°F	74	78
Winter	do	74	68
Building occupancy			
Working	hours	9	9
Custodial	do	+8	+3
Fan operation			
Weekday	do	12	8
Weekend	do	0	0

SAVINGS

KWH consumed in 1973	1,624,000	
KWH consumed in 1974	1,266,000	
KWH saved	358,000	or 22 percent

358,000 KWH saved X 1.4¢/KWH = $5000 for 1974

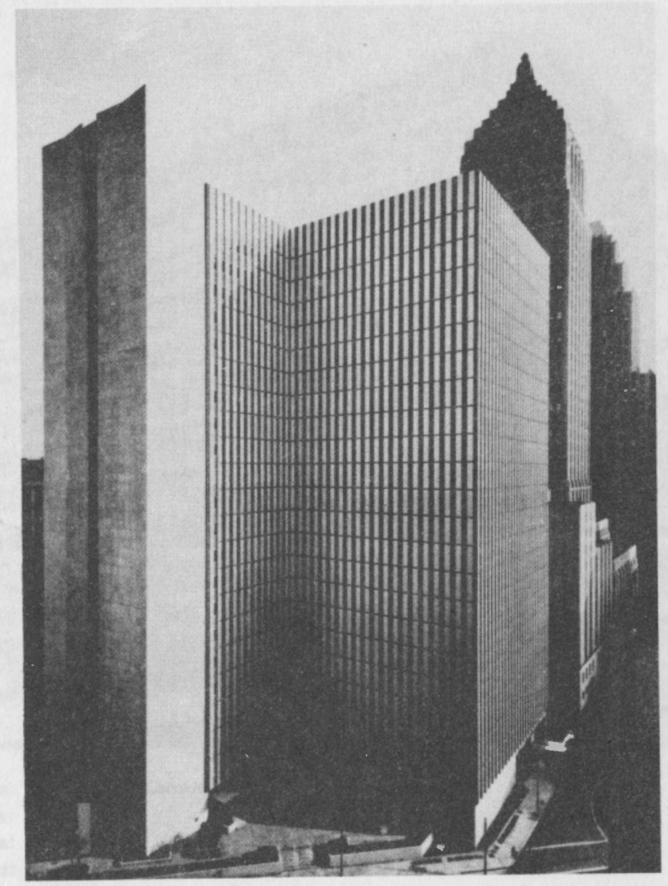
Location: Boston, Massachusetts
Building type: Office
Area: 1,000,000 ft^2
Height: 26 floors
Built: 1966

		Energy Conservation Program	
		Before (1973)	After (1974)
Illumination			
At work stations	footcandles	100	50
In work areas	do	100	30
In nonwork areas	do	30	10
Lamps	number	52,000	41,000
Thermostat setting			
Summer	°F	74	78
Winter	do	74	68
Building occupancy			
Working	hours	9	9
Custodial	do	+7	+3
Fan operation			
Weekday	do	16	8
Weekend	do	48	24

SAVINGS

KWH consumed in 1973	16,998,000	
KWH consumed in 1974	12,650,000	
KWH saved	4,348,000	or 26 percent

4,348,000 KWH saved X 2.6¢/KWH = $113,000 for 1974



Location: Pittsburgh, Pennsylvania
Building type: Office
Area: 781,493 ft^2
Height: 25 floors
Built: 1964

		Energy Conservation Program Before (1973)	Energy Conservation Program After (1974)
Illumination			
At work stations	footcandles	75	50
In work areas	do	75	30
In nonwork areas	do	30	10
Lamps	number	44,060	36,530
Thermostat setting			
Summer	°F	74	78
Winter	do	74	68
Building occupancy			
Working	hours	11	9.5
Custodial	do	+7	+3
Fan operation			
Weekday	do	18	12
Weekend	do	0	0

SAVINGS

KWH consumed in 1973	13,730,000	
KWH consumed in 1974	8,883,000	
KWH saved	4,847,000	or 35 percent

4,847,000 KWH saved X 2.2¢/KWH = $106,600

Location: Louisville, Kentucky
Building type: Office
Area: 447,682 ft^2
Height: 11 floors
Built: 1969

		Energy Conservation Program	
		Before (1973)	After (1974)
Illumination			
At work stations	footcandles	75	50
In work areas	do	75	30
In nonwork areas	do	30	10
Lamps	number	25,050	17,450
Thermostat setting			
Summer	°F	74	78
Winter	do	74	68
Building occupancy			
Working	hours	9	9
Custodial	do	+8	+2.5
Fan operation			
Weekday	do	18	12
Weekend	do	0	0

SAVINGS

KWH consumed in 1973	9,376,000	
KWH consumed in 1974	6,628,000	
KWH saved	2,748,000	or 29 percent

2,748,000 KWH saved X 1.7¢/KWH = $46,700 for 1974

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Federal Energy Administration
Office of Buildings Programs
Washington D.C. 20461

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

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energy conservation

Lighting and Thermal Operations

Guidelines

Conservation Paper Number 3

Lighting and Thermal Operations

Guidelines

Energy Conservation
and Environment

Office of
Buildings Programs

Energy Conservation Now

Federal Energy
Administration

Washington
D.C. 20461

**Conservation Paper
Number 3**

First printing 1974

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Foreword

Today's energy problems, which were intensified by the oil embargo to the U.S. in the winter of 1973-74, have developed from trends in the production and consumption of energy that have persisted for some time. Energy consumption grew at an average rate of about 3.5 percent per year from 1950 to 1965 and then increased to 4.5 percent annually. Domestic energy production grew at an annual rate of 3 percent between 1950 and 1970, but has been at a virtual standstill since then.

Essentially, then, the most basic energy problem we face is a growing gap between growth rates in production and supply. There are two approaches to closing this gap and meeting the Nation's energy needs: First, discovering and developing both new and traditional energy sources (increasing the supply) and, second, decreasing the rate of growth in the demand for energy.

Commercial, public, and industrial buildings, and the people and activities they house, represent the most rapidly increasing demand for energy. In response, the Office of Energy Conservation and Environment of the Federal Energy Administration is working with representatives of this sector to seek their voluntary cooperation in reducing energy consumption. Initially, this effort will address indoor lighting and temperatures and modes of building operation.

This publication contains guidelines which represent desirable targets with regard to illumination levels, efficiency in lighting, and operating heating and cooling systems. Many organizations have attained these levels successfully; others have adapted the targets suggested to meet their unique characteristics and needs. Broad cooperation with the principles of energy conservation represented by these guidelines will have a significant effect on decreasing energy demand and will make a vital contribution to assuring sufficient energy supplies in the future.

Roger W. Sant
Assistant Administrator for
Energy Conservation and Environment

CONTENTS

TABLES

Glossary

Balance temperature	The outdoor temperature at which the internal heat gain of a building (from lighting, people, and machines) equals the losses through walls, roof, and windows.
Ballast	A device used with gaseous discharge lamps and tubes to limit current flow and to provide voltage control at proper design levels.
Btu	British thermal unit, a unit of heat energy. Classically, the heat required to raise 1 pound of water 1°F.
Commercial space	Offices, schools, stores, administrative space, public space, hospitals and other health and laboratory space, and warehouses.
Contrast	The relationship between the luminances of an object and its immediate background.
Footcandles	A measure of illuminance produced on a surface all points of which are 1 foot from a directionally uniform point of 1 candela. That illuminance is 1 lumen/ft^2 or 1 footcandle.
Glare	The sensation produced by luminance within the visual field that is sufficiently greater than the luminance to which eyes are adapted to cause annoyance, discomfort, or loss in visual performance or ability.
Heat redistribution system	A system which transfers excess heat from one zone of a building to another zone which requires heat, as from the interior zone to the perimeter zone. This usually minimizes the total energy required for heating.
Industrial space	Space in buildings or other structures in which fabrication or other manufacturing is performed.
Interior zone	In a multistory building, the interior space beginning about 15 feet from the outside wall and including all floors except the top. This space is not affected by outside temperature.
Lamp	A generic term for a manmade source of light.
Luminaire	A complete lighting unit consisting of a lamp or lamps together with parts designed to distribute the light, position and protect the lamps, and connect the lamps to the power supply.
Lumen	A unit of luminous flux.
Nonuniform lighting	Task lighting only where needed within a space, in contrast to task lighting levels provided generally throughout the space.
Occupied hours	The time when a commercial, industrial, or institutional building is normally occupied by people functioning in their jobs.
Setback temperature (or night setback)	In the interest of economy and energy use, temperature in the winter may be set back to 60°F during the unoccupied hours instead of maintaining 68°F, as during occupied hours.
Static Luminaire	A conventional lighting fixture having no air flow (other than normal convection) through the lamp compartment.
Unoccupied hours	The time when a commercial, industrial, or institutional building is normally empty of people, except for a few attendants or maintenance personnel.
Veiling reflections	A reduction in task contrast due to light rays which are reflected specularly from the surface of tasks rather than absorbed and reradiated diffusely in the observer's eye.
Watt	A unit of electric power or heat power. 1 watt equals 3.4 Btu/hr.
Work area	Circulation area within work space but not at work station.
Work station	Space (such as a desk top) where task is actually being performed.

Lighting & Thermal Operations Guidelines

ENERGY MANAGEMENT ACTION PROGRAM

LIGHTING

Background

Total energy consumption for direct lighting in the United States in 1972 was slightly over 20 percent of the total electricity generated for all uses. This percentage amounts to

360 billion kWh (kilowatthours)
or 3.6 quadrillion Btu's (British thermal units)
or 1.7 million barrels of oil per day
or 5 percent of the total national energy consumed.

Estimates of possible energy savings by implementing energy conservation measures are as high as 43 percent of lighting usage, or about 2 percent of the total energy consumption nationwide.

Because energy for lighting consumes an especially large fraction of electricity and because recent trends in lighting contribute to increased electricity consumption, the Federal Energy Administration is releasing these guidelines for indoor commercial and industrial lighting to encourage efficient lighting practices. The fact that virtually all artificial light is produced by electricity makes efficient lighting practices especially important in alleviating a number of national problems, which include: (a) present and future projected shortages of energy resources generally, (b) special difficulties in providing for increased electricity generating capacity, and (c) problems of additional peak electricity demands created by air-conditioning equipment which must remove waste heat from lighting systems.

Commercial, public, and industrial buildings account for approximately 70 percent of total lighting energy consumption. Energy conservation measures affecting lighting practices in these buildings are therefore likely to be especially important to progress toward goals of energy reduction. Recent lighting design practices have favored higher and higher levels of illumination and have seldom taken full advantage of energy saving opportunities principally because the formerly abundant, economical supply of electricity and fuel provided little incentive to conserve energy.

Energy conservation in lighting systems design and operation

Design, installation, and operation of effective lighting systems have complex scientific, management, engineering, and architectural components. Of the many elements that must be considered in providing an adequate visual environment at acceptable cost, energy conservation is only one, but recent events and future prospects for the demand and supply of energy have underscored the necessity of giving conservation greater weight. Other elements that must be taken into account are the visual tasks to be performed, the physiological state of the observer's eyes, the psychological state and perceptual skill of the observer, the design of task and surrounding areas, the availability of daylight, the level of illumination, and the lighting system quality with regard to spectral characteristics, glare, veiling reflections, and geometrical factors.

These complexities limit the degree to which simple guidelines for energy conservation in lighting can be applied in all cases. However, in most situations they are very useful in providing the guidance necessary to achieve substantial savings in lighting energy and cost while also providing an adequate visual environment.

Variations in visual requirements for different tasks for different observers and other considerations are responsible for some situations where additional analysis is needed. The objective of the guidelines is to provide useful assistance in the design and operation of lighting systems to minimize energy consumption, including direct and indirect effects. There are some situations where measures beyond those specified in the guidelines may result in additional energy savings. The expert assistance of architects and lighting engineers can provide additional guidance.

Illumination levels guidelines

The following illumination levels are recommended as desirable target levels for modifications to existing systems or for design of new ones, under the condition that energy savings are thereby effected. See Tables 1 and 2 and Glossary for details.

Commercial buildings

Office buildings, administrative spaces, retail establishments, schools, and warehouses. During working hours, illumination levels should be reduced to 50 footcandles at occupied work stations, 30 footcandles in work areas, and less than 10 footcandles in areas that are seldom occupied or which have minimal visual requirements such as hallways and corridors. Where needed, because of exceptional individual requirements or because of the difficult nature of a specific task, nonuniform supplemental lighting may be provided for the task duration not to exceed levels indicated in Tables 1 and 2. Individual switches should be provided to permit maximum control over both standard and supplemental lighting when not needed. Lights should be switched off whenever daylight can be used.

Industrial buildings

Factories and plants. For industrial lighting, levels at the work station should be no greater than those recommended by American National Standards Institute Practice for Industrial Lighting A11.1-1973 (June 1973), no greater than 30 footcandles in work areas, and no greater than 10 footcandles in nonworking areas, except in a few special cases specified by the Occupational Safety and Health Administration. Daylight, when available, and switching should be used to the greatest degree possible to reduce energy consumption.

Hospitals

Illumination levels at the task should be no greater than those recommended in Illuminating Engineering Society Lighting Handbook (fifth ed., 1972, p. 84-85) and no greater than 10 footcandles in nonworking areas such as hallways and corridors.

Discussion

No conclusive evidence is available to show harmful effects from either too much or too little light within the range found in commercial and industrial buildings. However, there are differences in lighting requirements for individuals; for example, older people generally need more illumination because of degenerative effects on pupil size, corneal transmission, visual acuity, scattered light, and muscular response. Both level and quality of illumination are important, however, since glare and other factors can make lighting offensive at both high and low levels.

Placement and orientation of luminaires and work stations with respect to each other are important in realizing energy savings. Work stations, places where the principle visual tasks are performed, are to be distinguished from general work areas, which surround work stations and which usually have lower illumination level requirements. Wherever possible, nonuniform lighting that is task oriented, with respect to both placement and illumination level, should be used. Uniform lighting systems which light large general areas independently of the task locations within them do not usually make the most effective use of energy. Coincidentally, the esthetic appearance of indoor space can often be improved by following nonuniform lighting practice.

Guidelines for efficiency in lighting

Selection of efficient lighting equipment

In the design of new lighting systems, and in modifying existing ones, the most efficient light sources that can provide the illumination required should be selected. As a general rule the efficiencies of some available lamp types rank according to the following list, with the most efficient first: high pressure sodium vapor, metal halide, fluorescent, mercury, and incandescent. In many cases replacement of existing low-efficiency lamp types with lower wattage, more efficient types will result in reduced total costs and improved lighting. See Table 3 for detailed examples.

Control and scheduling

Maximum control over lighting systems can be accomplished by having switches to permit turning off unnecessary lighting. Large general areas should not be under the exclusive control of a single switch if turning off small portions would permit substantial energy savings when they are not occupied. Lights should be turned off as a regular practice when buildings are not occupied, such as after working hours or on weekends and holidays. When opportunities for using daylight exist, natural light should be used whenever possible, and artificial lights should then be turned off. Occupants of buildings should be educated and periodically reminded to adopt practices which will save lighting energy, such as turning off lights when leaving a room.

Proper luminaire placement in the design of new lighting systems and the removal of unnecessary lamps in existing installations are examples of energy-saving measures. Luminaires should be positioned to minimize glare and veiling reflections, and work stations should be oriented and grouped to utilize light most effectively. Daylight should be used when available, maximum switching control should be provided to the user, and light colors should be used on walls, ceilings, and floors. Tasks should be designed to present high contrast to the observer.

Deterioration in illumination level due to dirt accumulation on lighting equipment should be prevented by adequate maintenance programs, cleaning lamps and luminaires, and replacement of lamps. As a part of maintenance programs, periodic surveys of installed lighting with respect to lamp positioning and illumination level should be conducted to take advantage of energy conservation opportunities as user requirements change.

Indirect impact of lighting energy on heating and cooling of buildings

The adoption of lighting energy conservation methods should be considered in conjunction with the operation of the heating and cooling systems. As a rule of thumb, when air-conditioning equipment is operating, each watt of lighting causes the expediture of about one-half watt of air-conditioning power. Substantial cooling energy can be saved by reducing electrical lighting loads to a minimum. Moreover, substantial savings in initial cost may be realized by reflecting the reduced heat load from an energy-conservative lighting system in the design of the air-conditioning system. Where possible, heat removal techniques should be considered to conduct waste heat from lighting systems out of the building without imposing an additional load on air-conditioning equipment.

The heat gain from lights should be included in calculating heat load; in addition, schemes utilizing waste heat from lighting are encouraged. Reliance on heat produced by lighting

systems, beyond that produced by systems operated in normal energy-conservative ways, is not generally encouraged.

Measurement of recommended lighting levels

Light levels can be determined with portable illumination meters such as a photovaltiac cell connected to a meter calibrated in footcandles. The light meter should be calibrated to a basic accuracy of ±15 percent over a range of 30 to 500 footcandles and ±20 percent from 15 to 30 footcandles. The meter should be color corrected (according to the CIE Spectral Luminous Efficiency curve) and cosine corrected. Measurements refer to average maintained horizontal footcandles at the task or in a horizontal place 30 inches above the floor.

Measurements of work areas and nonworking areas should be made at representative points between fixtures in halls, corridors, and circulation areas. An average of several readings may be necessary. Daylight should be excluded or corrected for during illumination-level readings for a determination of level when the system is operated without available daylight.

Table 1 shows levels for office work that are recommended when work stations are occupied; otherwise, consideration should be given to turning lights off or to switching to 30 footcandles if other workers remain nearby. For tasks requiring levels higher than 50 footcandles, switching to lower levels is desirable if the work changes to less critical tasks. Illumination at the task should be reasonably free of veiling reflections and body shadows. Refer to Table 2 for guidance in determining visual difficulty of office tasks. Levels for industrial work are from the American National Standards Institute A11.1-1973, June 1973, Practice for Industrial Lighting.

Table 2 may be used as a guide in evaluating the degress of visual difficulty for office work. It is based on the concept that visual difficulty for this kind of work is not only a function of the intrinsic characteristics of the task and the lighting system, but also of the length of time the task must be performed.

To use this table, multiply the difficulty rating, as shown in the table, for each task performed at a given work place by a single worker times the number of decimal hours per day it is performed, for example, 3 hours 15 minutes = 3.25 decimal hours. Add the products for each task. If the sum is greater than 40, provide 75 footcandles on the work station. If the sum is greater than 60, provide 100 footcandles on the work station. Multiply the difficulty factors by 1.5 if the operator is over 50 years of age, or if he has uncorrectable eyesight problems.

Relamping opportunities

Relamping to a lower wattage can save substantial amounts of energy. For example, relamping from a 150-watt to a 75-watt bulb saves 50 percent of previous use, or relamping fluorescents to smaller wattages called "watt misers" or "econo-watt" (industrial trade names) will save energy. Relamping two lamps with one can save also. For example,

Table 1: Recommended maximum lighting levels

Task or area	Footcandle levels	How measured
Hallways or corridors	10 ± 5	Measured average, minimum 1 footcandle.
Work and circulation areas surrounding work stations	30 ± 5	Measured average.
Normal office work, such as reading and writing (on task only), store shelves, and general display areas	50 ± 10	Measured at work station.
Prolonged office work which is somewhat difficult visually (on task only)	75 ± 15	Measured at work station.
Prolonged office work which is visually difficult and critical in nature (on task only)	100 ± 20	Measured at work station.
Industrial tasks	ANSI-A11.1-1973	As maximum.

Table 2: Relative visual task difficulty for common office tasks

Task description	Visual Difficulty Rating
Large black object on white background	1
Book or magazine, printed matter, 8 point type and larger	2
Typed original	2
Ink writing (script)	3
Newspaper text	4
Shorthand notes, ink	4
Handwriting (script) in No. 2 pencil	5
Shorthand notes, No. 3 pencil	6
Washed-out copy from copying machine	7
Bookkeeping	8
Drafting	8
Telephone directory	12
Typed carbon, fifth copy	15

replacing two 60-watt lamps with one 100-watt will save 12 percent of previous usage and will normally provide the same amount of light as before.

Table 3 lists some illustrative examples of changes that can be made in installed lighting systems. They result in roughly the same illumination levels, but reduced energy consumption.

THERMAL OPERATIONS

Background

Of all the energy consumed nationwide 16 percent is used to heat and cool commercial and industrial buildings. Increasing the efficiency of heating and cooling equipment and exercising better control over operating and temperature settings can save significant amounts of fuel oil, natural gas, and electricity.

By adjusting thermostat settings to less energy intensive levels, substantial energy savings can result. In heating, each degree drop in temperature can result in approximately a 3-percent energy savings. In cooling, each degree rise in temperature can result in approximately a 3-percent saving in energy.

The heating and cooling guidelines outline measures that will normally result in appreciable energy savings. Modern heating and cooling systems are complex and interact with other aspects of buildings operations. Therefore, these guidelines can sometimes be supplemented with other measures after a detailed engineering survey of a particular building has been done by qualified experts.

Guidelines for energy conservation in operating cooling and heating systems

Cooling systems

During summer, air-cooling systems should be held at not lower than 78-80°F during working hours. Necessary adjustments should be made to cooling system controls so that space temperatures are maintained at 78-80°F with no reheat.

Humidity control

Humidity control on cooling systems should be eliminated for general office space. Requirements for humidity control in special types of space or locations should be handled on a case-by-case basis by the official responsible for the operation and maintenance of the facility; use of heating energy (other than waste heat) for such cases should be avoided.

Table 3: Relamping opportunities

[All costs are figured at 3 cents per kWh. The annual savings include normal ballast loss]

Change office lamps (2700 hours per year) from	to	to save annually
1 300-watt incandescent	1 100-watt mercury vapor	$14.58 (486 kWh)
2 100-watt incandescent	1 40-watt fluorescent	$12.00 (400 kWh)
7 150-watt incandescent	1 150-watt sodium vapor	$70.80 (2360 kWh)
Change industrial lamps (3000 hours per year) from	**to**	**to save annually**
1 300-watt incandescent	2 40-watt fluorescent	$18.69 (623 kWh)
1 1000-watt incandescent	2 215-watt fluorescent	$48.51 (1617 kWh)
3 300-watt incandescent	1 250-watt sodium vapor	$54.18 (1806 kWh)
Change store lamps (3300 hours per year) from	**to**	**to save annually**
1 300-watt incandescent	2 40-watt fluorescent	$20.55 (685 kWh)
1 200-watt incandescent	1 100-watt mercury vapor	$7.92 (264 kWh)
2 200-watt incandescent	1 175-watt mercury vapor	$20.10 (670 kWh)

Heating systems

In the winter, heating temperature control devices should be set to maintain temperatures of 65-68°F during working hours and should be set to maintain temperatures of not more than 55°F during nonworking hours. During working hours temperatures in warehouses and similar space should be adjusted lower than the 65-68°F range depending on the type of occupancy and the activity in the space. Cooling energy should not be used to achieve the temperatures specified for heating.

Humidity control

The potential adverse effects of very warm room temperatures (78°-80° F.) and the resulting low relative humidity must be considered in the case of older individuals, particularly those who have respiratory disorders, and infants. In addition, the perception of coolness is often more pronounced in rooms that have low humidity levels. For these reasons, the maintenance of practicable humidity levels during the heating season is recommended in buildings whose populations include older individuals, persons who have respiratory disorders, and infants.

Windows

Window draperies and blinds should be used to cut down heat losses by setting them to the closed position during nighttime and on cold, cloudy days and by setting them to the open position during periods of sunshine (subject to control of glare).

Heating blowers, threshold heaters, and portable space heaters

These devices should not be used unless there is no other heating source available.

Outside air intake

Outside air intake during heating and cooling seasons should be reduced to the greatest extent feasible. Under most conditions a 10-percent outside air intake will be adequate for general office space. Under certain outside air temperature and humidity conditions, the use of up to 100-percent outside air will be the most energy economical method of operation. Special purpose space such as laboratories or the like should have the outside air intake reduced to the maximum extent possible consistent with operating requirements.

Interior or core systems

Interior space in office buildings tends to have a heat build-up generated by lights, people, and equipment and does not require an added heat source during the heating season. Systems serving space of this type usually utilize recirculated air mixed with some outside air for ventilation. The amount of outside air should not be increased nor should refrigeration be introduced for the sole purpose of lowering the temperature which might otherwise exceed 68° F. Heat redistributed from the interior zone to the perimeter can be an important factor in energy conservation.

Perimeter zone systems

The function of perimeter zone heating is to offset the heat flow at exterior walls and windows and usually operates independently from the interior systems.

Exceptions

Exceptions to these techniques may be necessary to meet certain specialized requirements, such as for some kinds of equipment or other needs (for example, greenhouses, hospitals, and laboratories).

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Federal Energy Administration
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Washington D.C. 20461

AMERICAN REVOLUTION BICENTENNIAL
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Hit Switch

Energy
Conservation
Now

Empty Rooms
Love Darkness

DON'T
BE
FUELISH!

Hit Me

Energy
Conservation
Now

TIPS FOR THE MOTORIST

30 good ways to make gas go further.

DON'T BE FUELISH.

Energy Conservation and Environment •
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Energy and the Automobile

Passenger automobiles consume about 14% of all the energy and about 31% of all the petroleum used in the United States.

In the 50 states, there are an estimated 100,000,000 registered automobiles. The average car travels approximately 10,000 miles per year and consumes well over 700 gallons of gasoline. The average fuel economy is less than 13.7 miles per gallon.

In this pamphlet are tips on how you can reduce the fuel consumption of your own car. (Owners of the almost 20 million small pickup trucks in the country also can save fuel and money by following these tips.)

If the fuel consumption of the average car were reduced just 15% through better planning of car use, better driving practices, and better maintenance, the nation's consumption of petroleum would fall by over 28,000,000 gallons per day.

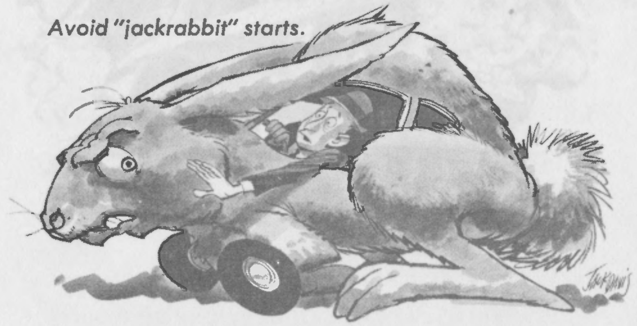
This potential saving in daily fuel consumption is significant from several points of view. It would help stretch America's current fuel supplies further. It would save money and cut pollution. And, it would bring considerably closer America's goal of energy self-sufficiency—Project Independence.

Acknowledgements: The Office of Energy Conservation and Environment, The Federal Energy Administration wishes to express its appreciation to the many organizations, both public and private, which contributed information for the following "Tips for the Motorist" through their publications or exchange of data.

Improve Your Driving Skills

The most important single element in determining fuel economy of a particular car is the driving technique of the individual behind the wheel. One authority declares that a careful driver should be able to get at least 30% better mileage than an average driver, and 50% better mileage than a poor one. Here's our advice:

Avoid "jackrabbit" starts.



1. **Start slowly.** Accelerate gently except when entering high-speed traffic lanes or when passing. Hot rod driving and jerky acceleration can increase fuel consumption by 2 miles per gallon in city traffic.
2. **Avoid unnecessary braking. And try to anticipate the traffic ahead.** When the traffic light far ahead turns red, take your foot off the accelerator immediately. The light may turn green again by the time you reach the intersection. If not, there's still a fuel saving. In coasting, the car's kinetic energy maintains propulsion rather than the burning of additional fuel. There is then less energy to be dissipated in braking. Don't tailgate. This necessitates additional braking too.
3. **Drive at moderate speeds.** As your speed increases, so does your car's wind resistance—a big factor in gasoline mileage. Most automobiles get about 28 percent more miles per gallon on the highway at 50 miles per hour than at 70 and about 21 percent more at 55 than at 70.
4. **Drive at steady speeds.** Hold a steady foot on the accelerator as long as traffic conditions permit. On the highway, "see-sawing" or repeatedly varying the speed by 5 miles per hour can reduce gas mileage by as much as 1.3 miles per gallon.
5. **Save gas when changing gears.** If you drive a car with a manual transmission, run through the lower gears gently and quickly for minimum gasoline consumption, then build up speed in high gear. If you drive a car with an automatic transmission, apply enough gas pedal pressure to get the car rolling, then let up slightly on the pedal to ease the automatic transmission into high range as quickly as possible. More gas is consumed in the lower gears.
6. **Avoid unnecessary use of air conditioning equipment.** When in use, it reduces fuel economy by as much as 2½ miles per gallon.

Hold driving speed to 55 or slower.

7. **Avoid excessive idling.** The average American car consumes a cup of gasoline every 6 minutes when idling. When you stop the car, don't idle the engine for more than a minute. If you are waiting for someone, turn off the engine. It takes less gasoline to restart the car than it does to idle it.
8. **Break gas-wasting habits.** For instance, don't pump the accelerator or race the engine when your car isn't in motion. It wastes gasoline. And use the brake pedal rather than the accelerator to hold your car in place on a hill.

Get car-poolish.

Improve Your Trip Planning

9. **Join a car pool for commuting to and from work.**
10. **Plan short trips carefully.** Short trips are costly in terms of gas mileage. A vehicle started cold and driven four miles may average about 8 miles per gallon. The same vehicle warmed up and driven 15 miles may average nearly 13 miles per gallon. However, don't idle the engine to warm it (a wasteful practice). Drive slowly the first few blocks.
11. **Consolidate your driving.** Combine short shopping and commuting trips to reduce the miles traveled for each action. Patronize shops in your immediate area as much as possible to reduce mileage.
12. **Pre-plan your trips.** Figure out which route will require the least fuel. Allow for the fact that freeway driving is nearly twice as economical as driving in heavy city traffic. Travel during off-

peak traffic times whenever possible. Use routes with a minimum number of traffic lights and stop signs.

13. **Think economically.** If you have more than one car in your family, make the greatest use of vehicle(s) consuming the least amount of gasoline.

Maintenance and Car Care

14. **Get a tune-up.** Keep your car engine tuned according to the specifications given in your owner's manual. If your manual is lost, then follow this plan: Every 10,000 miles a major tune-up should be done. That means:

☐ Install new spark plugs, ignition points, and condenser.

☐ Clean or replace the positive crankcase ventilating (PCV) valve, and remove gum or sludge from the hoses.

☐ Check all electrical ignition circuits and connections for voltage drop and resistance. Clean, tighten, and replace them as necessary.

☐ Inspect the choke for proper operation.

☐ Set the timing to the manufacturer's specifications.

☐ Check the ignition advance mechanism (mechanical and vacuum).

☐ Remove foreign matter from the exhaust gas recirculatory valve and hoses and check the controls following the manufacturer's specifications.

☐ Check the exhaust system for blockage.

☐ Replace air and fuel filter elements.

☐ Check for fuel leaks at carburetor, fuel pump, gas line and gas tank.

About 5,000 miles after the major tune-up, a minor tune-up should be performed. This may involve cleaning the plugs, and adjusting points and timing as necessary.

15. **Check tire pressure at least once a month.** For best gas mileage and for driving

and the motor industry magazines. Generally the best fuel economy is associated with:

Low vehicle weight
Small engine
Manual transmission
Low numerical axle ratio
Low frontal area, i.e., car width times height.

28. **Purchase only the optional equipment and accessories you really need.** Such items as automatic transmission, power steering and air conditioning require considerable energy which must be derived from the gasoline. Other equipment such as power brakes, electric motor-driven windows, seats and radio antenna require little energy for their operation. However, these items as well as a vinyl roof, and a host of other accessories all add to the vehicle weight and thus reduce fuel economy.

29. **In warm climates, select a light-colored vehicle.** Light colors reflect the sun's rays and keep the car cooler.

30. **Look into Local Laws that Save Energy.** State and local laws that help reduce automobile gasoline consumption include: increasing availability of highly energy-efficient public transportation; creating express lanes for carpools and buses during peak traffic hours; establishing a system of one-way streets in heavily used areas; synchronizing lights; permitting right turns on red; banning stopping, standing and parking on arterial streets during rush hours; and providing overpasses at busy intersections.

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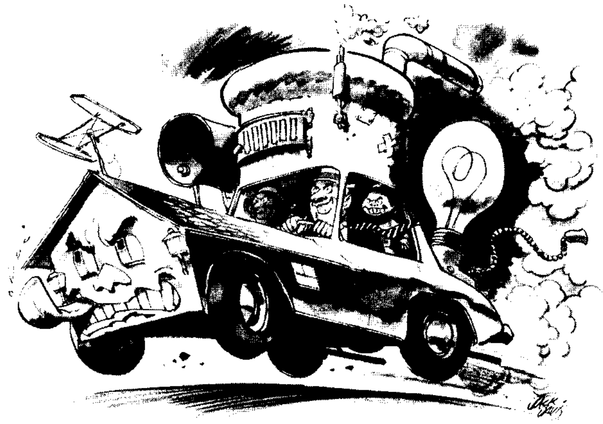
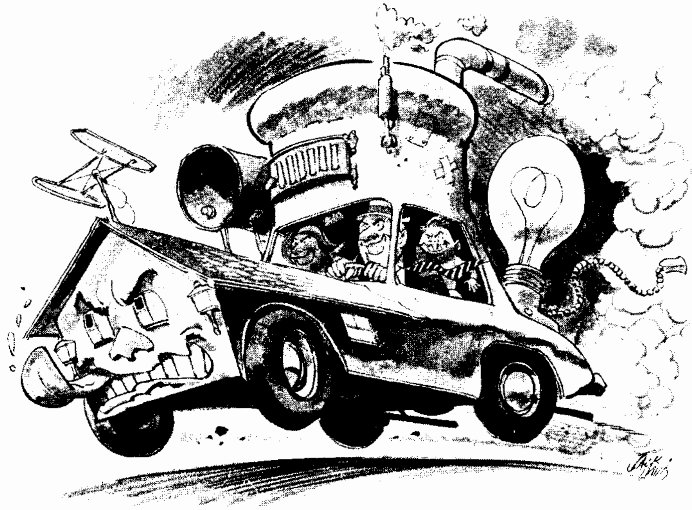


TIPS FOR ENERGY SAVERS

IN AND AROUND THE HOME
ON THE ROAD
IN THE MARKETPLACE



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Federal Energy Administration
Washington, D.C. 20461
Frank G. Zarb, Administrator
Roger W. Sant, Assistant Administrator for Conservation and Environment

THE WHITE HOUSE

WASHINGTON

My fellow Americans:

In no nation in the world do so many citizens enjoy so high a standard of living as in America. Much of this standard of living depends in some way on energy. Consequently, while we comprise only six percent of the world's population, we consume more than one-third of the energy used in the world. In recent years, we have had to rely on increasingly vulnerable foreign sources of fuel to meet our energy requirements.

Today, if we are to maintain our standard of living, we must be far more conscious of the need to use our energy wisely, and to conserve energy wherever possible. The Federal Government has made great efforts to reduce its consumption of energy. But demand for fuel has increased at such a rate that fuel conservation by government alone is no longer enough. Only a truly national effort will meet this critical challenge to our future.

Therefore, as one of my first requests as President, I ask each of you to apply our most abundant natural resource—American ingenuity—toward including energy conservation in your life. The goal is not to change our standards of living, but to ensure that, as we enjoy our American way of life, we are not wasteful and that we use our energy resources wisely. Each person has a part to play in this effort. I ask each of you to play your part.

Gerald R. Ford

FEDERAL ENERGY ADMINISTRATION
WASHINGTON, D.C. 20461

Dear Energy Saver:

The sooner we understand our energy problem, the better we can work at saving our disappearing supplies. I'd like you to help me do that.

We Americans are very productive. We use more than a third of the energy used in the world every year, yet we have only 6 percent of the world's people.

This is our problem:

--Through just plain bad habits, and through careless engineering and design in our buildings and cars, we have been wasting a shocking amount of energy.

--We import about a third of the oil we use, and foreign nations have been able to manipulate the price and supply of that energy.

--In the United States, we use energy faster than we produce it. Our energy needs have been growing 5 percent each year, but our energy supplies have been growing only 3 percent a year. It's obvious that we are slowly running out of the fuel that has made our country so strong.

Here are some solutions you and I can work on together.

--We can start saving energy as if it were money.

--We can drive less and drive more slowly, turn off extra lights, and turn down thermostats.

--We can make energy thrift part of our way of life, simply by starting some good common sense energy habits.

--By working together and working one at a time, we can balance America's energy budget, just as each of us balances our personal checkbooks.

In this little booklet, I point out some simple and practical advice for saving energy. If you, especially, and every other American, follow these tips, the result will be a huge national energy saving. And when we save fuel, we save money. You win--and America wins.

Frank G. Zarb
Administrator
Federal Energy Administration

IN AND AROUND THE HOME

A few basic statistics show how important it is for Americans to save energy at home. Almost 20 percent of all the energy consumed in the United States is used in our 70 million households. That includes more than half of all the space heating fuels used in the country, and about a third of all the electricity.

More than half of the energy we use in our homes goes into heating and cooling. Heating water takes about 15 percent. Lighting, cooking, refrigeration and operating appliances account for the rest. What appear to be small savings in the average household can add up to sizeable savings for the Nation if every family in the country takes part in the effort.

Conserving energy is a relatively new idea for most of us, but today it is as timely for the average family as getting higher interest from the bank—and in a way even more rewarding.

By the judicious use of energy at home, you can save money for yourself and help avert uncomfortable shortages in energy supplies in the years ahead as we develop new technologies to meet our goal of energy self-sufficiency in the next decade.

The money-saving potentials mentioned in this brochure are percentages of current energy costs. They translate into savings at 1974 prices, and should not be confused with reductions in energy bills, which may be higher than they have been in the past.

TIPS FOR YEAR-ROUND ENERGY SAVINGS

Rising energy costs make these ever-more sensible.

Cooling and heating the Nation's households in 1974 is expected to consume about 11 percent of all the energy that will be used in the United States throughout the year. Lighting consumes over 16 percent of all electricity used in American homes.

It is in these energy-intensive household operations where waste often is found, and where you can save considerable amounts of energy and reduce family expenses accordingly. Consider the following all-weather energy conservation measures:

INSULATION—Self-protection against heat and cold

Proper insulation can increase temperature-control efficiency by as much as 20 to 30 percent by reducing the load on both heating and cooling equipment.

Spring, summer, and fall are the best times to insulate, and effective improvements need not be expensive.

☐ **Caulk and weatherstrip doors and windows.**

This inexpensive measure, which can be an easy project for the do-it-yourselfer, could reduce the family's energy costs by 10 percent or more.

If every household were caulked and weather-stripped, the equivalent of 580,000 barrels of home heating fuel could be saved each winter day, thus reducing chances of shortages in cold weather areas of the country.

☐ **Install storm windows and doors.**

Combination screen and storm windows are the most convenient because they do not have to be removed when temperatures are moderate and open windows are desirable. Conventional storm windows cost about $30 each, and storm doors about $75 each. But a sheet of clear plastic film tightly taped to the inside of the frames can be equally effective; and the entire cost for the average home would be around $10. (Renters might prefer this low-cost method.) Either type of protection could reduce individual fuel costs by about 15 percent and make the home more comfortable all year.

If the estimated 18 million single-family homes lacking this protection were so equipped, the Nation's fuel demand would drop the equivalent of 200,000 barrels each day of the winter season (enough to heat 1.6 million homes).

☐ **Insulate the attic and the walls.**

Install mineral wool, glass fiber, or cellulose insulation to a depth of 6 inches in the attic. Heating costs should drop about 20 percent.

If 15 million homes with inadequate attic insulation were upgraded, about 400,000 barrels of heating oil would be saved each winter day—reducing the Nation's demand for residential heating fuels by 4 percent. Installation of insulation in the walls also yields a large energy saving but requires special equipment and professional help in existing homes.

IN AND AROUND THE HOME

ELECTRICITY—The energy that comes to us from generators

Many of the conservation measures contained in this brochure involve saving electricity. But there is one way householders can help save it before it gets to their homes.

During the late afternoon and early evening hours the load on the Nation's electrical systems often reaches its peak. To meet the heavy demand, electric utilities must use back-up generating equipment that is not energy efficient.

- ☐ **Try to use energy-intensive equipment and appliances such as dishwashers, clothes washers and dryers, and electric ovens in the early morning or late evening hours.**

If everyone scheduled household chores so as to lighten the load at the generating plants during peak load hours, fewer inefficient generating units would have to be placed in service, and the utilities' daily fuel consumption would be reduced. So would the possibilities of brownouts and blackouts.

LIGHTING—It's easy to use more than you need

Careful use of lighting provides the homemaker other conservation opportunities.

To save electricity through wise lighting:

- ☐ **Remove one bulb out of three and replace it with a burned-out bulb for safety; replace others with bulbs of the next lower wattage.** But be sure to provide adequate lighting for safety (e.g., in stairwells). Concentrate light in reading and working areas, and for safety.

This should save about 4 percent in electricity costs in the average home.

If everyone took these conservation steps, the Nation's consumption of energy would drop by about 50 million kilowatt hours of electricity per day (enough to light about 16 million homes).

IN AND AROUND THE HOME

- ☐ **Turn off all lights when not needed.** [One 100-watt bulb burning for 10 hours uses 11,600 Btu's, or the equivalent of a pound of coal or one-half pint of oil.]

- ☐ Use fluorescent lights in suitable areas—on the desk, in the kitchen and bath, among others. They give more lumens per watt. One 40-watt fluorescent tube, for example, provides more light than three 60-watt incandescent bulbs. (A 40-watt fluorescent lamp gives off about 80 lumens per watt; a 60-watt incandescent gives off only 14.7 lumens per watt. The lower-watt but higher-lumen fluorescent would save about 140 watts of electricity over a period of 7 hours.)

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☐ Where higher illumination is desirable in areas lighted by incandescent bulbs, use one large bulb instead of several small ones. The larger bulb is more efficient.

☐ Use long-life incandescent lamps only in hard-to-reach places. They are less efficient than ordinary bulbs.

☐ Keep lamps and lighting fixtures clean. Dirt absorbs light.

☐ Reduce or eliminate ornamental lights except on special holidays or festive occasions.

☐ Use outdoor lights only when essential.

☐ Light colors for walls, rugs, draperies, and upholstery reduce the amount of artificial lighting required.

☐ Install solid-state dimmer switches when replacing light switches. They allow more efficient use of light.

ADDITIONAL YEAR-ROUND ENERGY SAVERS

☐ Close off unoccupied rooms and turn off the heat or air-conditioning.

☐ Use bath and kitchen ventilating fans only as needed.

☐ Repair all leaky faucets, especially hot water faucets, as quickly as possible.

☐ Insulate hot water storage tank and piping.

☐ Turn off radio and television sets when not in use.

☐ "Instant-on" television sets, especially the tube types, use energy even when the screen is dark. To eliminate this waste, plug the set into an outlet that is controlled by a wall switch; turn the set on and off with the switch. Or ask your TV serviceman to install an additional on-off switch on the set itself or in the cord to the outlet.

☐ Do as much household cleaning as possible with cold water. This saves energy used to heat water (and some cleaning products work better in cold water).

☐ If you have a fireplace, be sure the damper is closed except when the fire is going, otherwise heated or cooled air goes wastefully up the chimney.

HOT WEATHER ENERGY SAVERS

Some special summer, or warm climate saving tips:

☐ **Set air-conditioning thermostats no lower than 78 degrees.** The 78 degree temperature is judged to be reasonably comfortable and energy efficient. One authority estimates that if this setting raises the temperature 6 degrees (78 degrees vs 72 degrees) home cooling costs should drop about 47 percent. (The Federal Government is enforcing a strict 78-80 degree temperature in all its buildings during the summer.)

If everyone raised cooling thermostats 6 degrees during the summer, the Nation would save more than the equivalent of 36 billion kilowatt hours of electricity, or 2 percent of the Nation's total electricity consumption for a year.

- ☐ Run air conditioners only on really hot days and set the fan speed at high. In very humid weather, set the fan at low speed to provide less cooling but more moisture removal.
- ☐ Clean or replace air conditioner filters at least once a month. Turning the fan requires more electricity when the filter is dirty.
- ☐ If you can confine your living spaces to fewer rooms, close off the rooms that will not be occupied.
- ☐ If rooms are to be unoccupied for several hours, turn off the air-conditioning temporarily.
- ☐ Buy the cooling equipment with the smallest capacity to do the job. More cooling power than necessary is inefficient and expensive. Energy-efficiency ratios (EERs) for most air-conditioning units should be available from dealers, and some window units are labeled to show the EER (the higher the EER, the more efficient the air-conditioner). If you don't see a label in the showroom, ask for the information.

ADDITIONAL HOT WEATHER ENERGY SAVERS

- ☐ Deflect daytime sun with vertical louvers or awnings on windows, or draw draperies and shades in sunny windows. Keep windows and outside doors closed during the hottest hours of the day.

- ☐ Keep the lights low or off. Electric lights generate heat and add to the load on the air-conditioning equipment.
- ☐ Use vents and exhaust fans to pull heat and moisture from attics, kitchens, and laundries directly to the outside.
- ☐ Do as much cooking as possible, and use heat-generating equipment, in the early morning and late evening hours.
- ☐ On cooler days and during cooler hours, open the windows instead of using air-conditioner or electric fans.
- ☐ Turn off the furnace pilot light. But be sure it is re-ignited before you turn the furnace on again.
- ☐ Dress for the higher temperatures. Neat but casual clothes of lightweight fabrics are most comfortable for men and women and are acceptable almost everywhere during the summer.

COLD WEATHER ENERGY SAVERS

To save on heating energy and heating costs:

- ☐ **Lower thermostats to 68 degrees during the day and 60 degrees at night.** If these settings reduce the temperature an average of 6 degrees, heating costs should run about 15 percent less.

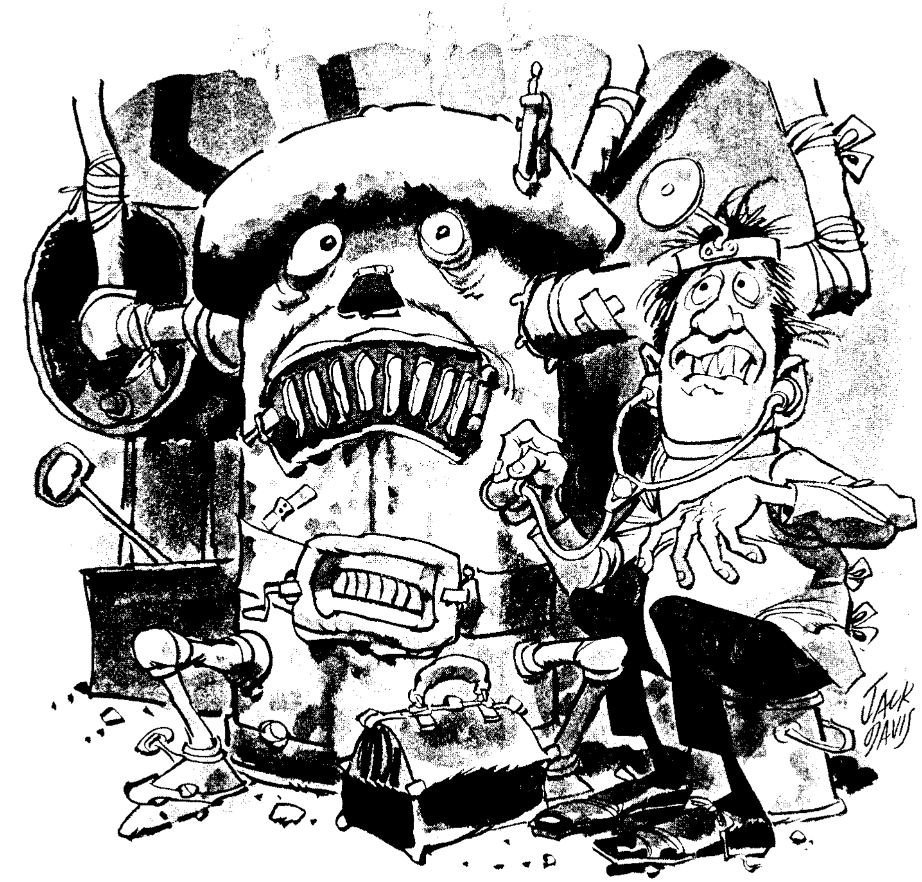
  If every household in the United States lowered heating temperatures 6 degrees, the demand for fuel would drop by more than 570,000 barrels of oil per day (enough to heat over 9 million homes during the winter season).
- ☐ Setting nighttime temperatures back can reduce heating costs significantly. Consider the advantages of a clock thermostat which will automatically turn the heat down at a regular hour before you retire and

turn it up just before you wake.

- ☐ **Have your furnace serviced once a year, preferably each fall.** Adjustment could mean a saving of 10 percent in family fuel consumption.
- ☐ When buying a new furnace, select one that incorporates an automatic flue gas damper, a device which reduces loss of heat when the furnace is not in operation.
- ☐ If you use electric heating, consider a "heat pump" system. The heat pump uses outside air in both heating and cooling and can cut the use of electricity for heating by 60 percent or more.

ADDITIONAL COLD WEATHER ENERGY SAVERS

- ☐ Clean or replace the filter in forced-air heating systems every month.
- ☐ Dust or vacuum radiator surfaces frequently.
- ☐ Keep draperies and shades open in sunny windows; close them at night.
- ☐ For comfort in cooler indoor temperatures use the best insulation of all—warm clothing.



KITCHEN, LAUNDRY AND BATH—
Centers for hot water and electricity savings

Heating water is second only to heating and cooling residences in energy consumption. It accounts for 15 percent of the energy used in the home and 3 percent of all the energy used in the United States. Sensible use of hot water, along with conservative use of electricity, is the basis for the following tips:

In the kitchen...

☐ **Be sure the dishwasher is full, but not overloaded, before you turn it on.** An average dishwasher uses 14 gallons of hot water per load.

If every dishwasher user in the country cut out just one load a week, the country could save the equivalent of about 9,000 barrels of oil each day (enough to heat 140,000 homes in winter).

☐ Scrape dishes before loading them in the washer. Rinsing is seldom necessary, but when it is, use cold water.

☐ Let your dishes air dry. After the final rinse, turn off the control knob of the dishwasher and open the door.

☐ **Use proper defrosting methods for manual refrigerator/freezers.** These appliances consume less energy than those that defrost automatically, but they must be defrosted frequently and as quickly as possible to maintain that edge. Frost should never be allowed to build up to more than one-quarter of an inch.

☐ Most refrigerators have heating elements in their walls to prevent condensation on the outside. These heaters need only be turned on when the air is extremely humid. When buying such a refrigerator, be sure it has a switch to turn off the heaters. Better yet, buy one without heaters.

☐ During holidays or other extended absences from home, empty the refrigerator, disconnect it from the power outlet, clean thoroughly, and leave the door ajar.

☐ Check seals around the refrigerator and oven doors to make sure they are airtight. If not, adjust the latch or replace the seal.

☐ **Reduce energy consumption in cooking.** Use flat bottom pans that cover the burner heating element. More heat enters the pot and less is lost to the surrounding air.

☐ Clean heat reflector below the stove heating element —it will reflect the heat better.

☐ Pressure cookers save energy by reducing cooking time.

☐ When using the oven, make the most of the heat from that single source. Plan all-oven-cooked meals, or fill the oven with other foods that can be used at a later time with a bit of heating. Use small heaters, or small ovens, for small meals.

In the laundry...

☐ **Wash clothes in warm or cold water, rinse in cold.** You'll save energy and money. Use hot water only if absolutely necessary.

If everyone washed clothes in warm or cold water, national fuel savings would amount to the equivalent of about 100,000 barrels of oil a day. That is, 2½ percent of the total demand for residential heating (enough to heat 1.6 million homes in winter).

☐ **Fill clothes washers (unless they have small-load attachments or variable water levels) and dryers, but do not overload them.**

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If every household cut the use of clothes washers and dryers by 25 percent, the Nation would save the equivalent of 35,000 barrels of oil per day (enough to heat over 400 billion gallons of water a day).

- ☐ Remove clothes from the dryer as soon as they are dry. Extra running time is pure waste.
- ☐ Separate drying loads into heavy and lightweight items. Since the lighter ones take less drying time, the dryer doesn't have to be on as long for these loads.
- ☐ Dry your clothes in consecutive loads. The energy used to bring the dryer up to the desired temperature shouldn't be allowed to go to waste.
- ☐ Keep the lint screen in the dryer clean by removing lint after each load.

In the bath...

- ☐ Take more showers than tub baths. Showers use less hot water, hence less energy than tub baths.
- ☐ Consider installing a flow restrictor in the pipe at the showerhead to restrict the flow of water to an adequate 4 gallons per minute. This is easy to do and can save considerable amounts of hot water and the energy used to produce it. The showerhead should unscrew easily, and flow restrictors are available at most plumbing supply stores. In areas where the water pressure remains fairly constant, a washer with a small hole inserted in the pipe should serve nicely.

THE WORKSHOP, THE YARD, THE GARDEN

- ☐ Maintain electrical tools in top operating shape, clean and properly lubricated.

- ☐ Keep cutting edges sharp. A sharp bit or saw cuts more quickly and therefore uses less power. Oil on bits and saws also reduces power required.
- ☐ Buy the power tool with the lowest horsepower adequate for the work you want it to do.
- ☐ Remember to turn off shop lights, soldering irons, gluepots, and all bench heating devices right after use.
- ☐ Use hand tools, hand lawn mowers, pruners, and clippers whenever possible.
- ☐ When using gasoline-powered yard equipment, do not allow it to idle for long periods. Turn off and restart when ready to resume work.
- ☐ Plant deciduous trees and vines on south and west sides of homes to provide protective shade against summer sun.
- ☐ Use manure, or a natural compost from your own yard cuttings, for fertilizer. Petroleum and natural gas generally are used as raw materials (and for fuel) in the manufacture of artificial fertilizers.

HOME-PLANNING—Where energy-wasting mistakes can be avoided

When designing a new house, consider the climate and check local authorities on building codes.

- ☐ A recommended energy-efficient ratio for window areas is no more than 10 percent of the floor area. In cool climates, install fewer windows in the north wall where no solar heating gain can be achieved in winter. In warm climates, put the largest number of windows in the north and east walls to reduce the heating gain from the sun.
- ☐ Install windows you can open, so that you can use natural ventilation in moderate weather.

- ☐ Use double-pane glass throughout the house. Windows with double-pane heat-reflecting or heat-absorbing glass in south and west windows provide additional energy savings.
- ☐ Insulate walls and roof to the highest specifications recommended for your area, but provide a minimum of 6 inches in the attic and 3 inches in the walls. Insulate floors, too, especially those over cold basements and garages.
- ☐ When buying a new water heater, select one with thick insulation on the shell. Avoid purchasing a tank with greater capacity than needed. Have the dealer advise you on the size suitable for the number of people in your family.
- ☐ Install water heater as close as possible to areas of major use to minimize heat loss through the pipes; insulate pipes.
- ☐ Install louvered panels or wind-powered roof ventilators rather than motor-driven fans to ventilate the attic.
- ☐ If the base of a house—especially a mobile home—is exposed, build a "skirt" around it.

WHEN BUYING A HOUSE

- ☐ Select light colored roofing in warm climates.
- ☐ Ask for a description of the insulation and data on the efficiency of space heating, air-conditioning and water heating plants, or have an independent engineer advise you about the efficiency of the equipment provided. It is a good idea to ask to see the heating bills for the previous year, but remember to adjust for current rates and costs.

- ☐ Consider the need for additional insulation or replacement of equipment. If improvements are necessary, you may want to seek an adjustment in the purchase price to cover all, or a reasonable share, of the costs.

USING THE FAMILY CAR

There are more than 100 million registered automobiles in the U.S. A typical car, with an average fuel economy of less than 13.7 miles-per-gallon, travels about 10,000 miles each year—and consumes well over 700 gallons of gasoline.

Altogether, these automobiles consume some 70 trillion gallons of gasoline each year—or about 14 percent of all the energy used in the United States, almost three-quarters of all gasoline used and 28 percent of all petroleum.

The importance of individual gasoline savings cannot be over emphasized. If, for example, the fuel consumption of the average car were reduced just 15 percent through fewer daily trips, better driving practices, and better maintenance, the nation's consumption of petroleum would fall by over 680,000 barrels per day, or about 4 percent of demand.

These individual savings may be accomplished through a combination of the following:

DRIVE LESS

- ☐ **Join a carpool.** About one-third of all private automobile mileage is for commuting to and from work.

If the average passenger load (1.3 people per commuter car) were increased by just one person, each individual's out-of-pocket expenses for commuting would be cut, and the nationwide gasoline savings would be more than 700,000 barrels per day (enough for some 67,000 cars to drive from San Francisco to New York City and back).

☐ **Eliminate unnecessary trips.** Take one less short trip a week. Do several errands in one trip, combine

your trips with those of friends and neighbors.

If every automobile consumed just one less gallon of gasoline a week (an average of about 13 miles of driving) the Nation would save about 5.2 billion gallons a year, or about 7 percent of the total passenger car demand for gasoline.

EMPLOY ENERGY-EFFICIENT DRIVING PRACTICES

The driving technique of the individual behind the wheel is the most important single element in determining the fuel economy of any car. One authority insists a careful driver can get at least 30 percent more mileage than the average driver, and 50 percent more than the wasteful one.

☐ **Drive at moderate speeds.** Most automobiles get about 21 percent more miles per gallon on the highway at 55 miles per hour than they do at 70 mph.

☐ Accelerate smoothly—save engines, tires, and gasoline.

☐ Drive at a steady pace—avoid stop and go traffic.

☐ Minimize braking—anticipate speed changes. Take your foot off the accelerator as soon as you see a red light ahead.

☐ Do not let the motor idle for more than a minute. Turn off the engine. It takes less gasoline to restart the car than it takes to let it idle. Generally, there is no need to press the accelerator down to restart a warm engine.

☐ Do not let the gas station attendant overfill your tank. Tell him to remove the hose when the automatic valve closes. This will eliminate any chance of spillage.

KEEP YOUR CAR IN PRIME CONDITION

Good car maintenance and care in the choice of accessories can mean fuel economy and dollars saved.

☐ **Have your car tuned as recommended by the manufacturer.** Regular tune-ups can save you as much as 10 percent on gasoline costs.

For the Nation, this could mean savings of about 140,000 barrels of gasoline per day... 3 percent of total demand for passenger cars.

- ☐ Keep the engine air filter clean. An air-starved engine wastes gasoline.
- ☐ Use the octane gasoline and oil grade recommended for your car.
- ☐ Check tire pressures regularly. Under-inflated tires increase gas consumption.
- ☐ Consider steel-belted radials when you buy new tires. They give better mileage and last longer. But never mix radials with conventional tires.
- ☐ Remove unnecessary weight from the car. The lighter the car, the less gas it uses.

CHOOSE ACCESSORIES WISELY

- ☐ Don't buy a car air-conditioner unless you really need it.
- ☐ If you have a car air-conditioner, use it sparingly. The cooling equipment reduces fuel economy an average of 10 percent—almost 20 percent in stop-and-go traffic.
- ☐ Purchase only the optional equipment and accessories you really need. Items like air-conditioning, automatic transmission, and power steering require considerable energy, all of which is derived from burning gasoline. Other equipment such as power brakes, electric motor-driven windows, seats, and radio antennas require less energy for their operation—however, all accessories add to the vehicle weight, and this reduces fuel economy.

STUDY THE MARKET BEFORE YOU BUY A NEW CAR

Ask your dealer, or write to Fuel Economy, Pueblo, Colo. 81009 for a free copy of the "*EPA/FEA 1975 Gas Mileage Guide for New Car Buyers.*" Study the fuel

economy figures and tables comparing specifications. Review mileage test results published by Consumers Union and motor industry magazines. Generally the best fuel economy is associated with low vehicle weight, small engines, manual transmission, low axle ratio, and low frontal area (the width of the car times its height).

- ☐ Buy the most energy efficient car of the size and model you want—on the basis of the combination of purchase price and estimated fuel costs for as long as you plan to keep it.

VACATIONING

- ☐ Vacation closer to home this year. Discover nearby attractions.
- ☐ A nearby hotel or campground can often provide as complete and happy a change from routine as one that is hundreds of miles away. Plan to stay in one place instead of "hopping" around.
- ☐ When you travel, take a train or a bus instead of the family car.
- ☐ During your holiday rediscover the pleasures of walking, hiking, and bicycling—the most energy-conserving means of transportation, and the healthiest for most people.

IN THE MARKETPLACE

- ☐ Whenever possible, buy products made of recycled materials or those which offer opportunities for recycling, such as steel, aluminum, paper, and glass, among others. More energy is used in production of products from virgin materials than from recycled or reclaimed materials. For example, producing steel from scrap requires one-fourth less energy than using virgin ores. To make a product from recycled aluminum requires about one-twentieth of the energy needed for the same product made from the ore.
- ☐ When you buy fabrics or garments, try to choose those that require little or no ironing.
- ☐ Try to buy products that will last. More durable products save energy that would be required for their replacement.
- ☐ Purchase equipment such as automobiles, appliances, pumps, fans, compressors, and boilers, on the basis of initial cost *and* operating costs rather than on the basis of purchase price alone. Often products that are more expensive initially but are energy-efficient will cost less over a period of years than lower-priced products that consume more energy.
- ☐ **Ask for information about the energy efficiency of the products you buy.** Under a voluntary labeling program, some motor vehicles and appliances bear labels, developed by the Federal Government, showing their energy consumption. Ask for comparative information if a label does not yet appear on the product you want to buy.

UNDERSTANDING ENERGY—a brief glossary

Chemical energy.
Energy stored in molecules, such as in fossil fuels.

Crude oil or "crude".
Petroleum in its natural state.

Electricity.
Energy derived from electrons in motion. Electrical energy can be generated by friction, induction, or chemical change.

Energy.
The capacity to perform work.

Fossil fuels.
Fuels derived from the remains of carbonaceuous fossils, including petroleum; natural gas; coal; oil shale (a fine-grained laminated sedimentary rock that contains an oil-yielding material called kerogen); and tar sands.

Geothermal energy.
Energy extracted from the heat of the earth's interior.

Hydropower energy.
Energy created by falling or moving water.

Kinetic energy.
Energy possessed by objects in motion.

Nuclear energy.
Energy, largely in the form of heat, produced during nuclear chain reaction. This thermal energy can be transformed into electrical energy (see "Power").

Potential energy.
Energy that is stored in matter because of its position or because of the arrangements of its parts. Examples include the tension of a spring, water stored behind a dam, or chemical energy such as that contained in fuel.

Power.
The capacity to exert energy, usually the rate at which work is done. Power commonly is measured in units such as horsepower or kilowatts. Most bulk electric power is generated in this country by converting chemical energy to thermal, then mechanical, then electrical energy in steam, gas turbine or large diesel power plants, all requiring coal or petroleum resources. A lesser amount is generated by nuclear power.

Solar energy.
Energy radiated directly from the sun.

Thermal energy.
A form of energy whose effect (heat) is produced by accelerated vibration of molecules.

Wind energy.
Energy derived from the wind.

ENERGY CONSUMPTION IN THE UNITED STATES

This nation uses more energy per capita than any other nation in the world. Although we have only about 6 percent of the world's population, we use 35 percent of all the energy consumed in the world.

In statistical terms, we now are using about 77 quadrillion British thermal units (Btu's) of energy per year, derived from coal, oil, natural gas, water and nuclear energy. (This is about the equivalent of 35 million barrels, or 1,470 million gallons, of oil each day.) In recent years, we have produced about 85 percent of our needs, and imported the rest, mainly petroleum.

Our most vulnerable energy source is petroleum. We normally consume about 18 million barrels (756 million gallons) per day. Of this, we produce domestically only about 12 million barrels a day, leaving 6 million barrels a day which must be imported, or done without.

ENERGY MEASUREMENTS

Specific forms of energy are measured in many diverse terms—barrels of oil (42 gallons), therms and cubic feet (natural gas), kilowatts (electricity), tons (coal), and the standard measurement of energy content, British thermal units (Btu's).

Because oil is one of our most common sources of energy, many persons prefer to convert all energy figures to equivalent "barrels of oil per day," particularly when talking about fossil fuels.

FOLLOWING ARE THE MOST OFTEN USED ENERGY MEASUREMENTS:

barrels (bbls)
1 barrel equals 42 gallons.
British thermal unit (Btu)
The energy required to increase the temperature of one pound of water by one degree Fahrenheit.
Watt
The amount of power available from an electric current of 1 ampere (Amp) at a potential of 1 volt.
Kilowatt (kW)
1,000 watts. One kilowatt is the equivalent of about 1⅓ horsepower.
Kilowatt-hour (kWh)
1,000 watt-hours. A unit of electrical energy equal to the energy delivered by the flow of one kilowatt of electrical power for one hour. (A 100-watt bulb burning for 10 hours will consume one kilowatt-hour of energy, or enough to lift a 150-pound person 20,000 feet into the air.) One barrel of oil equals 500 kWh.
Megawatt (Mw)
One million watts, or 1,000 kilowatts.
Mcf
1,000 cubic feet (of natural gas).
therm
A unit of heat equal to 100,000 Btu's.

Frequently energy measurements are expressed in millions, billions, and quadrillions of units, requiring the use of many zeros. A numerical shorthand formula has been devised which indicates multiples of 10. For example, 10^3 represents 10x10x10, or 1,000. 10^6 equals 10x10x10x10x10x10, or 1,000,000. 10^9 equals 1,000,000,000 (1 billion).

Energy units translated into Btu's

1 kilowatt-hour =
3,413 Btu's.
1 ton of coal =
25,000,000 Btu's.
1 bbl crude oil =
5,800,000 Btu's.
1 gallon of gasoline =
125,000 Btu's.
1 gallon of No. 2 fuel oil =
140,000 Btu's.
1 cubic foot of natural gas =
1,031 Btu's.
1 Mcf natural gas =
1,031,000 Btu's.
1 therm of gas (or other fuel) =
100,000 Btu's.

THE ETHICS OF ENERGY CONSERVATION

Most observers view energy conservation as a helpmate to environmental quality. Usually the two go hand-in-hand. It has been extravagant use of energy that has pushed man toward heavy exploitation of his natural resources. Domestic oil shortages are forcing us to turn more to coal as an energy source. Eventually, research will almost certainly lead to development of cleaner ways to mine and burn coal. Research also will lead to greater utilization of energy sources such as geothermal power, solar energy, and others not yet in widespread use and will be both economically and environmentally acceptable. Development of more efficient gasoline engines, improved insulation of buildings, and new industrial processes will enable us to maintain our standard of living with lower energy expenditure. Less energy growth means important environmental savings. Truly, a barrel saved is worth *more* than a barrel found.

**"Nature never gives anything away.
Everything is sold at a price.
It is only in the ideals of abstraction
that choice comes without consequence."**
—Ralph Waldo Emerson

Conservation and Environment
FEDERAL ENERGY ADMINISTRATION
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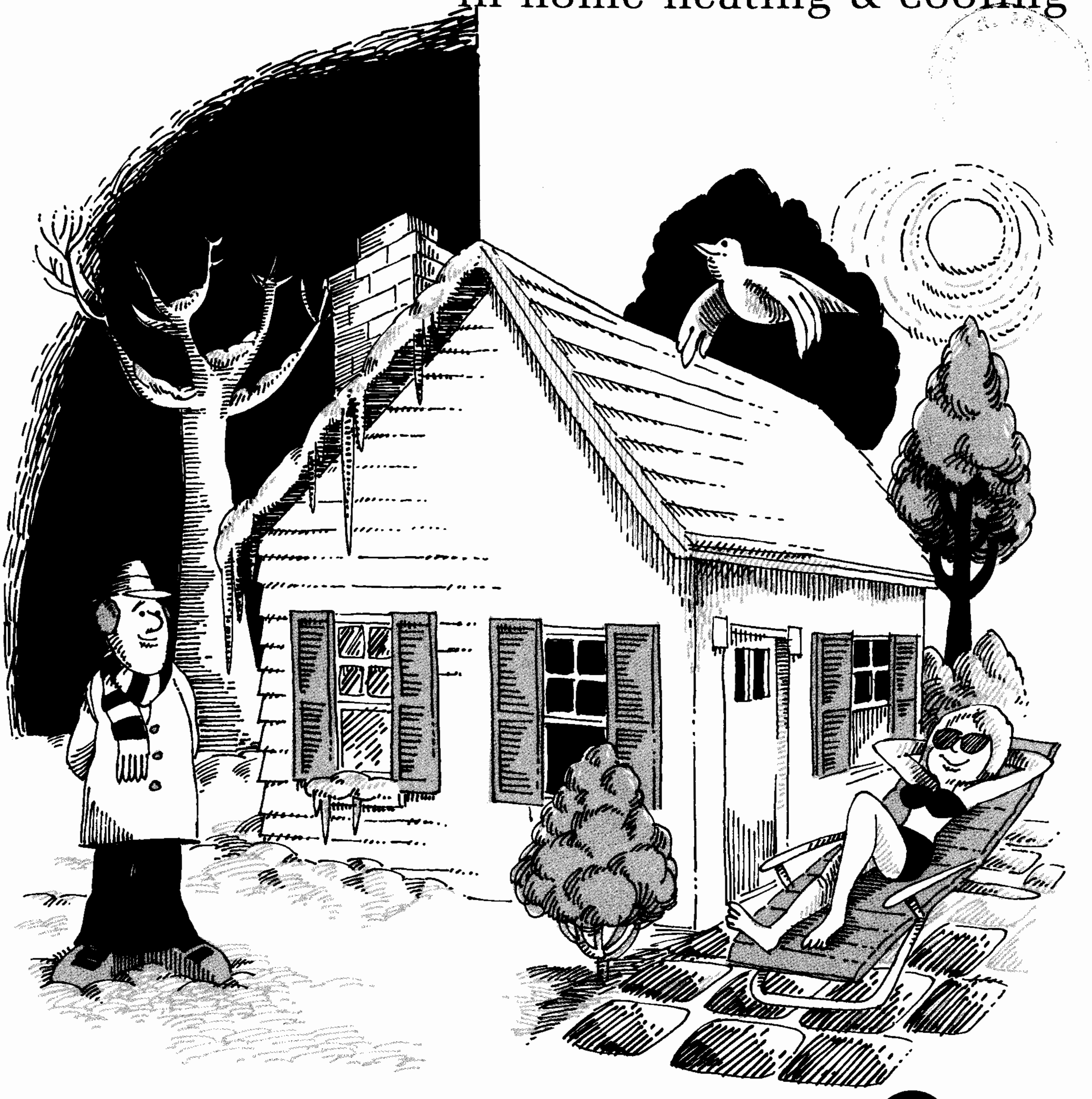
MAKING THE MOST OF YOUR ENERGY DOLLARS
in home heating & cooling



U.S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

Energy Conservation Now

A WORD TO THE READER

During the height of the energy crisis many homeowners turned their thermostats down and wore heavy sweaters in an effort to save fuel. Today, with energy prices on the rise, saving energy also means saving money on monthly heating and cooling bills. As a result, many homeowners are thinking about more permanent ways to reduce their household energy consumption.

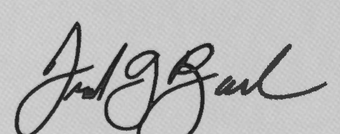
Energy can be conserved by making relatively simple improvements at home. Installing or adding insulation, fitting storm windows and doors and applying weather stripping and caulking are effective energy saving improvements. But many people are reluctant to invest in these improvements because of the cost. In general, homeowners have not been able to calculate the potential return on their investment.

By using this booklet you can determine the best combination of energy conservation improvements for your house—improvements that will give you the largest long-run return on your investment. The booklet also provides information on affording or financing your investment and tips on making the improvements.

This publication is based on the findings and methods presented in a technical report, entitled *Retrofitting Existing Housing for Energy Conservation: An Economic Analysis,* published earlier this year. The report resulted from a joint study conducted by the National Bureau of Standards and the Federal Energy Administration. The report was undertaken to determine what level of investment in home energy improvements would produce the maximum long run savings in home heating and cooling expenses.

This booklet is not a comprehensive "how-to-do-it" book. For more detailed information we recommend a new publication from the Department of Housing and Urban Development, entitled *In the Bank . . . Or Up the Chimney?*

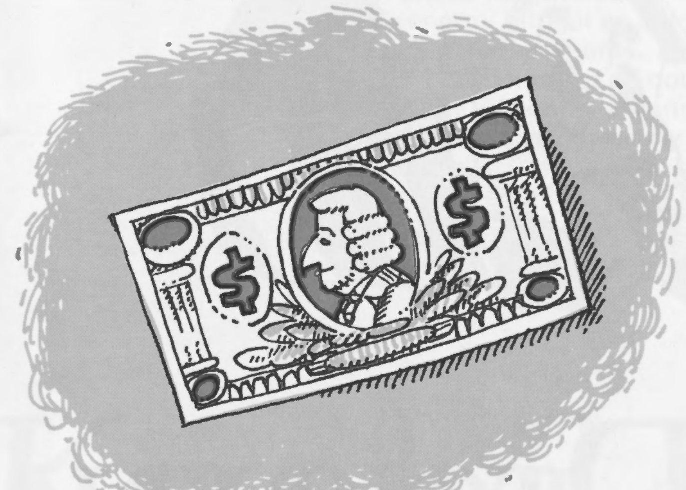
We think *Making the Most of Your Energy Dollars* will convince you that investing in energy conservation improvements can help you offset rising energy prices. And that's good news for you! You'll be saving money and you'll also be doing your part to help conserve our nation's precious energy supplies.



Frank G. Zarb
Administrator
Federal Energy Administration

Richard W. Roberts
Director
National Bureau of Standards

SAVING ENERGY IS SAVING MONEY



If you are a homeowner who wants to save energy and money without sacrificing comfort—this booklet is for you. It is not a "how-to" book, but a "how much" guide to energy conservation investments.

For your climate and the type of energy used to heat and cool your house, this booklet tells what combination of energy conservation improvements to invest in to get the largest, long run net savings in your heating and cooling bills.

Of course, there are many ways to save energy in your house. You can save energy by dialing down thermostats in winter and setting them higher in the summer, turning off lights, shutting drapes, closing off unused rooms, and tuning up your furnace every few years.

But there are other effective ways to save energy and money on your monthly fuel bills—and still keep your house at comfortable temperatures. By investing in the energy conservation improvements described in this booklet, you can *permanently* reduce the amount of energy used to heat and cool your house. These improvements include the installation of insulation in the attic and walls, under floors, and around ducts in unheated areas; storm windows and doors; and weather stripping and caulking.

These energy conservation improvements are wise investments if you can be sure they'll save you enough money on heating and cooling bills to pay for themselves. If you think that doing too much or too little can be a waste of your money, you're right!

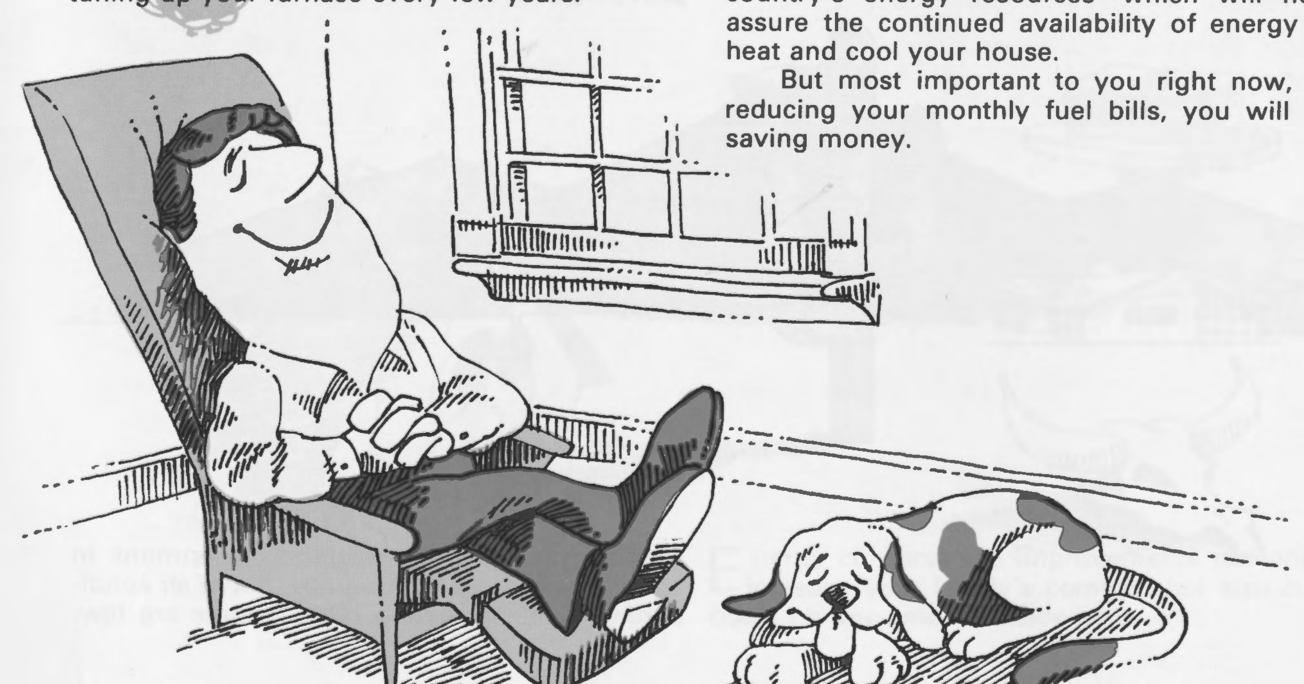
That's why the National Bureau of Standards, in cooperation with the Federal Energy Administration, has published this guide—to help you balance your energy budget and get the most for your money.

You may be surprised to learn how much insulation you should install. In some parts of the country, when higher priced fuels are used, R-38 insulation (about 12 inches of mineral fiber batts) in the attic is recommended to give the best results. Even in milder climates, R-30 insulation (about 10 inches) may be economically justified if you use oil or electric heating at current high prices.

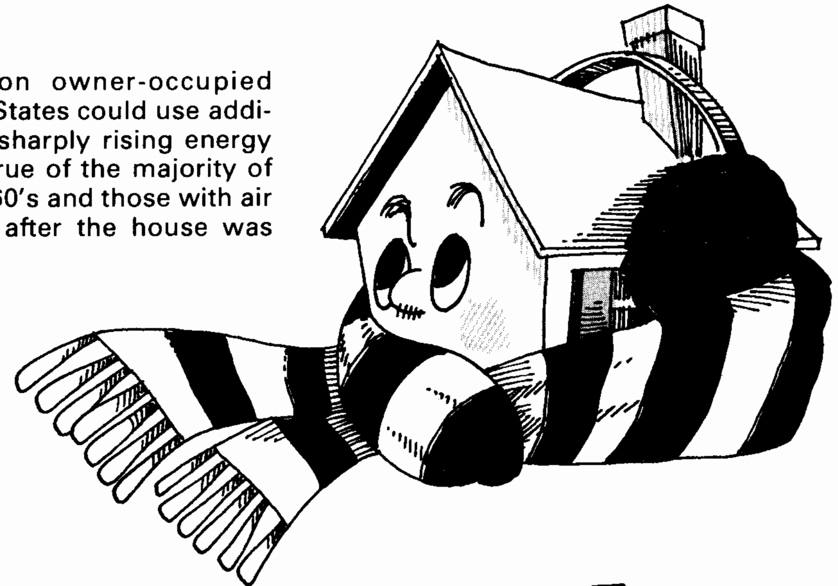
You may be just as surprised to learn that investing in energy conservation improvements now can earn you greater dividends than putting your money in the bank!

By using the guidelines in this booklet, you will be doing your part to help conserve our country's energy resources—which will help assure the continued availability of energy to heat and cool your house.

But most important to you right now, by reducing your monthly fuel bills, you will be saving money.



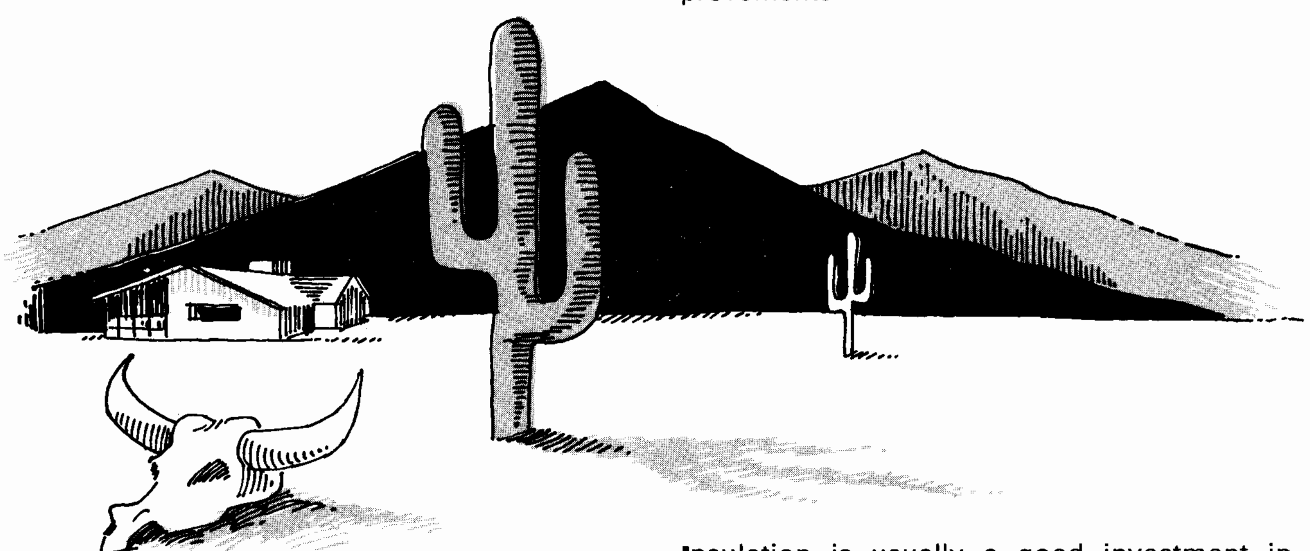
Most of the 40 million owner-occupied houses in the United States could use additional insulation to offset sharply rising energy prices. This is especially true of the majority of houses built before the 1960's and those with air conditioning units added after the house was completed.



Did you Know?

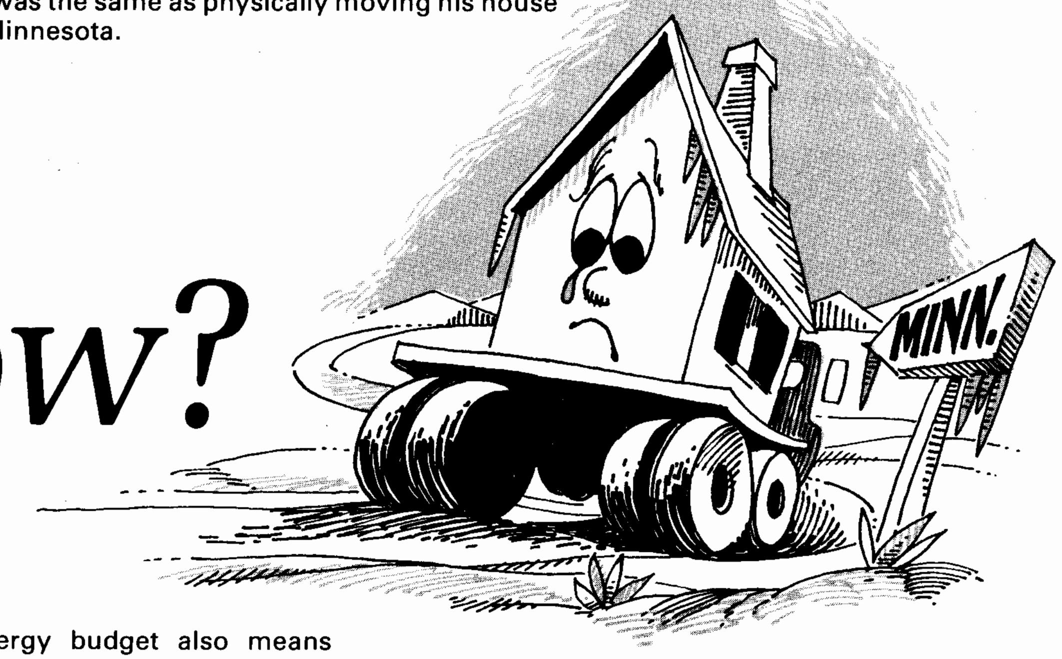
The more you pay for energy, the more you will save from increased investments in energy conservation improvements. Currently, electricity is generally more costly than fuel oil, and fuel oil is more costly than natural gas. As a result, even in the same climate, houses heated and cooled by different energy sources require different levels of investment.

Balancing your energy budget means striking a happy medium between dollars spent on energy consumption and energy conservation improvements. A balanced budget gives you the greatest possible long run net savings on heating and cooling expenses. Your net savings are the total savings on fuel bills less the cost of improvements.

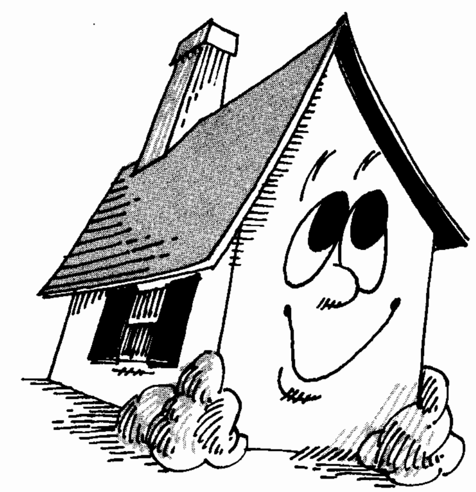


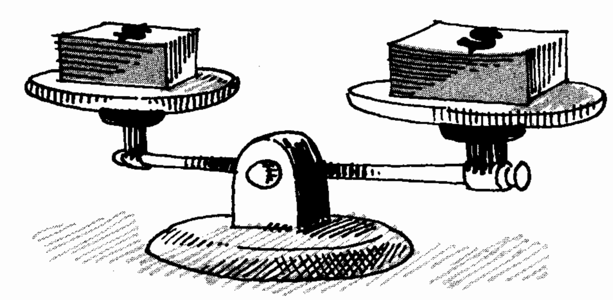
Insulation is usually a good investment in geographic areas that require a lot of air conditioning, even if heating requirements are low.

How much you should invest in energy conservation improvements depends equally on climate *and* energy prices. A doubling of energy prices has the same effect on a homeowner's energy budget as a doubling of heating and cooling requirements. For example, when prices for home heating oil doubled in Washington, D.C., the effect on a homeowner's heating bill was the same as physically moving his house to Minnesota.



Balancing your energy budget also means using a balanced combination of energy conservation techniques. You may not be making the best use of your money if you invest only in attic insulation and neglect the use of storm windows or insulation in floors over unheated areas where these are economical.





Energy conservation improvements not only increase your family's comfort, but also cut down on unwanted, outside noise.

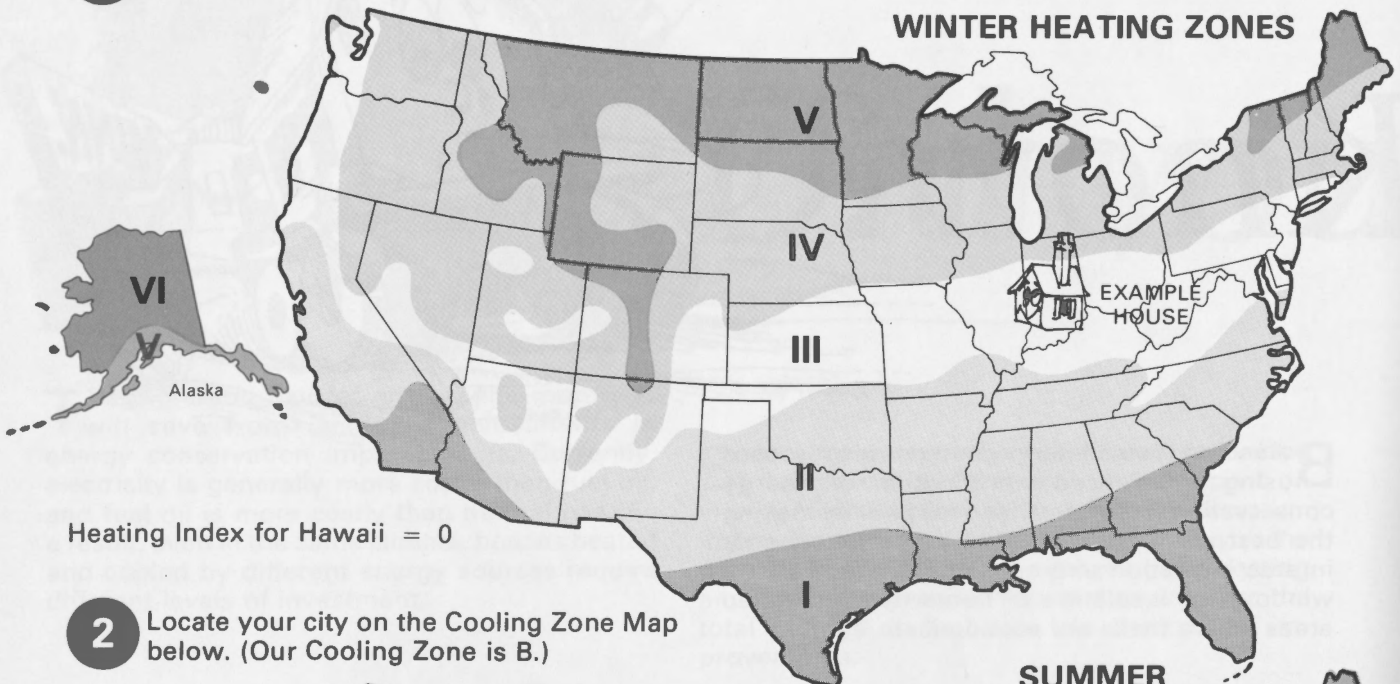
FIGURING YOUR ENERGY CONSERVATION BUDGET

To find the "best combination" of energy conservation measures for your climate and fuel prices, use the tables on the following pages. This best combination gives you the largest, long run net savings on your heating and cooling costs for your investment. By comparing this best combination with what already exists in your house, you can figure out how much more needs to be added to bring your house up to the recommended levels.

The recommended improvements apply to most houses to the extent they can be installed without structurally modifying the house. Recommended improvements are based on sample costs given in Table 7. If your costs are substantially different, see page 9.

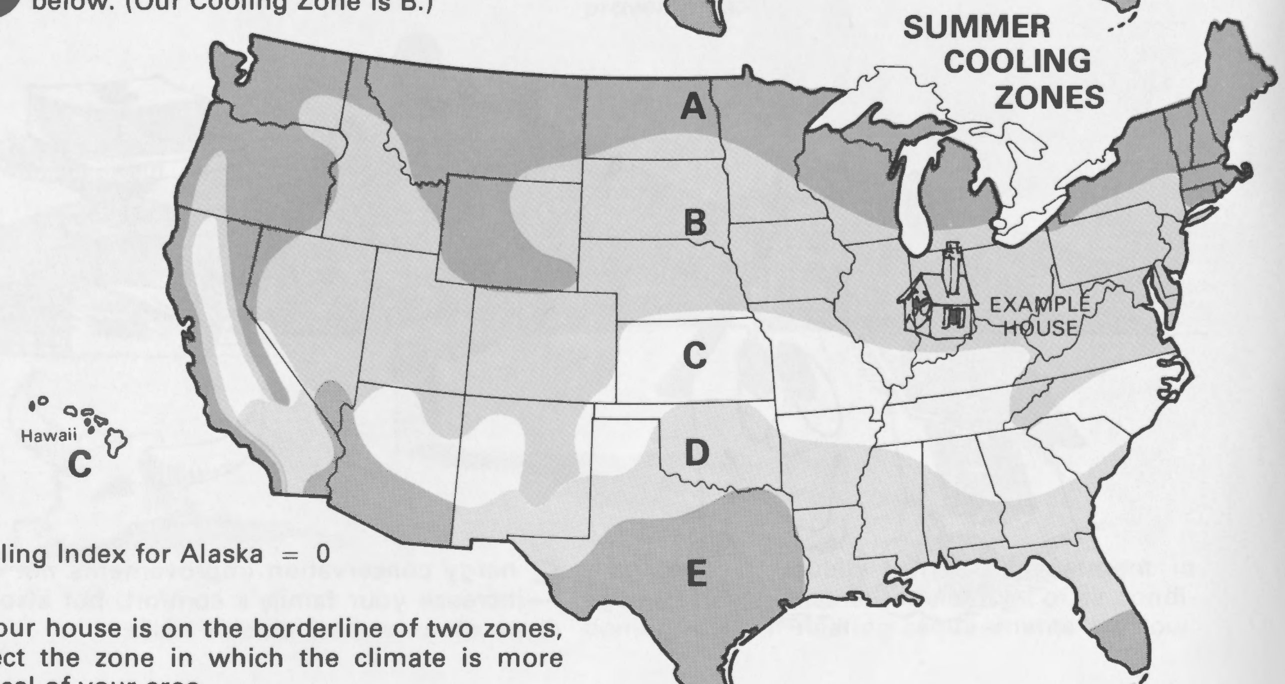
Follow the steps outlined below and fill in the information for your house on Worksheet A. We have filled in the information for a typical house located in Indianapolis, Indiana.

1 Locate your city on the Heating Zone Map below. (Our house is located in Heating Zone III.)



Heating Index for Hawaii = 0

2 Locate your city on the Cooling Zone Map below. (Our Cooling Zone is B.)



Cooling Index for Alaska = 0

If your house is on the borderline of two zones, select the zone in which the climate is more typical of your area.

3 Our house currently uses fuel oil at a cost of 34¢ a gallon to heat. It uses electricity at 4¢ a kilowatt hour to cool. Obtain your unit heating and cooling costs from the utility companies as follows: Tell your company how many therms (for gas) or kilowatt hours (for electricity) you use in a typical winter month and summer month (if you have air conditioning). The number of therms or kilowatt hours is on your monthly fuel bill. Ask for the cost of the last therm or kilowatt hour used, including all taxes, surcharges, and fuel adjustments. For oil heating, the unit fuel cost is simply your average cost per gallon plus taxes, surcharges, and fuel adjustments.

4 Locate your Heating Index from Table 1 by finding the number at the intersection of your Heating Zone row and heating fuel cost column (to the nearest cost shown). (Our house has a Heating Index of 20.)

If your house is air conditioned, or you plan to add air conditioning, find your Cooling Indexes from steps 5 and 6. If your house is not air conditioned and it is not planned, your Cooling Indexes are zero.

TABLE 1 HEATING INDEX

Type of fuel:		Cost per unit*									
Gas (therm)		9¢	12¢	15¢	18¢	24¢	30¢	36¢	54¢	72¢	90¢
Oil (gallon)		13¢	17¢	21¢	25¢	34¢	42¢	50¢	75¢	$1.00	$1.25
Electric (kWh)					1¢	1.3¢	1.6¢	2¢	3¢	4¢	5¢
Heat pump (kWh)		1¢	1.3¢	1.7¢	2¢	2.6¢	3.3¢	4¢	6¢	8¢	10¢
HEATING ZONE	I	2	2	3	3	4	5	6	9	12	15
	II	5	6	8	9	12	15	18	27	36	45
	III	8	10	13	15	20	25	30	45	60	75
	IV	11	14	18	21	28	35	42	63	84	105
	V	14	18	23	27	36	45	54	81	108	135
	VI	22	28	36	42	56	70	84	126	168	210

Note: In Tables 1-3, if your fuel costs fall midway between two fuel costs listed, you can interpolate. For example, if our fuel oil costs were 38¢ a gallon, our Heating Index would be 22.5.

5 Locate your Cooling Index for Attics from Table 2 by finding your Cooling Zone and cooling cost to the nearest cost shown. (Our house has a Cooling Index for Attics of 5.)

6 Locate your Cooling Index for Walls from Table 3 by finding your Cooling Zone and cooling cost to the nearest cost shown in the table. (Our house has a Cooling Index for Walls of 2.)

TABLE 2 COOLING INDEX FOR ATTICS

Type of air conditioner:		Cost per unit*						
Gas (therm)		9¢	12¢	15¢	18¢	24¢	30¢	36¢
Electric (kWh)		1.5¢	2¢	2.5¢	3¢	4¢	5¢	6¢
COOLING ZONE	A	0	0	0	0	0	0	0
	B	2	2	3	4	5	6	7
	C	3	5	6	7	9	11	13
	D	5	6	8	9	12	15	18
	E	7	9	11	14	18	23	27

TABLE 3 COOLING INDEX FOR WALLS

Type of air conditioner:		Cost per unit*						
Gas (therm)		9¢	12¢	15¢	18¢	24¢	30¢	36¢
Electric (kWh)		1.5¢	2¢	2.5¢	3¢	4¢	5¢	6¢
COOLING ZONE	A	0	0	0	0	0	0	0
	B	1	1	2	2	2	3	4
	C	2	2	3	4	5	6	7
	D	3	3	4	5	7	8	10
	E	4	5	6	8	10	13	15

*Cost of last unit used (for heating and cooling purposes) including all taxes, surcharges, and fuel adjustments.

7 Find the sum of your Heating Index and Cooling Index for Attics. (Our sum is 25.)

8 Find the sum of your Heating Index and Cooling Index for Walls. (Our sum is 22.)

Energy savings result from decreasing the heat flow through the exterior shell of the building. The resistance, or "R," value of insulation is the measure of its ability to decrease heat flow. Two different kinds of insulation may have the same thickness, but the one with the higher R value will perform better. For that reason, our recommendations are listed in terms of R values with the approximate corresponding thickness. R values for different thicknesses of insulation are generally made available by the manufacturers.

9 Find the resistance value of insulation recommended for your attic and around attic ducts from Table 4. (For our house the recommended resistance value is R-30 for attic floors and R-16 for ducts.)

TABLE 4 ATTIC FLOOR INSULATION AND ATTIC DUCT INSULATION

INDEX Heating Index Plus Cooling Index for Attics	ATTIC INSULATION R-Value	Approximate Thickness: Mineral Fiber Batt/Blanket	Approximate Thickness: Mineral Fiber Loose-Fill**	Approximate Thickness: Cellulose Loose-Fill**	DUCT INSULATION* R-Value	DUCT INSULATION* Approximate Thickness
1-3	R-0	0"	0"	0"	R-8	2"
4-9	R-11	4"	4-6"	2- 4"	R-8	2"
10-15	R-19	6"	8-10"	4- 6"	R-8	2"
16-27	R-30***	10"	13-15"	7- 9"	R-16	4"
28-35	R-33	11"	14-16"	8-10"	R-16	4"
36-45	R-38	12"	17-19"	9-11"	R-24	6"
46-60	R-44	14"	19-21"	11-13"	R-24	6"
61-85	R-49	16"	22-24"	12-14"	R-32	8"
86-105	R-57	18"	25-27"	14-16"	R-32	8"
106-130	R-60	19"	27-29"	15-17"	R-32	8"
131—	R-66	21"	29-31"	17-19"	R-40	10"

* Use Heating Index only if ducts are not used for air conditioning. ** High levels of loose-fill insulation may not be feasible in many attics. ***Assumes that joists are covered; otherwise use R-22.

10 Find the recommended level of insulation for floors over unheated areas from Table 5. (Our house should have R-19.) Using Table 5, check to see whether storm doors are economical for your home. Storm doors listed as optional may be economical if the doorway is heavily used during the heating season.

TABLE 5 INSULATION UNDER FLOORS AND STORM DOORS

INDEX Heating Index Only	INSULATION UNDER FLOORS* R-Value	INSULATION UNDER FLOORS* Mineral Fiber Batt Thickness	STORM DOORS
0-7	0**	0"**	None
8-15	11**	4"**	None
16-30	19	6"	Optional
31-65	22	7"	Optional
66—	22	7"	On all doors

* If your furnace and hot water heater are located in an otherwise unheated basement, cut your Heating Index in half to find the level of floor insulation.

**In Zone I and II R-11 insulation is usually economical under floors over open crawlspaces and over garages; in Zone I insulation is not usually economical if crawlspace is closed off.

11 Find the recommended level of insulation for your walls and ducts in unheated areas from Table 6. (Our house should have full-wall insulation if none existed previously and R-16 insulation around ducts.) Table 6 also shows the minimum economical storm window size in square feet for triple-track storm windows. (Our house should have storm windows on all windows 9 square feet in size or larger where storm windows can be used.)

TABLE 6 WALL INSULATION, DUCT INSULATION, AND STORM WINDOWS

INDEX Heating Index Plus Cooling Index for Walls	WALL INSULATION (blown-in)	INSULATION AROUND DUCTS IN CRAWLSPACES AND IN OTHER UNHEATED AREAS (EXCEPT ATTICS)* Resistance and Approximate Thickness	STORM WINDOWS (Triple-Track) Minimum Economical Window Size
0-10	None	R-8 (2")	none
11-12	Full-Wall Insulation Approximately R-14	R-8 (2")	20 sq. ft.
13-15		R-16(4")	15 sq. ft.
16-19		R-16(4")	12 sq. ft.
20-28		R-16(4")	9 sq. ft.
29-35		R-16(4")	6 sq. ft.
36-45		R-24(6")	4 sq. ft.
46-65		R-24(6")	All windows**
66—		R-32(8")	All windows**

* Use Heating Index only if ducts are not used for air conditioning. **Windows too small for triple-track windows can be fitted with one-piece windows.

12 Weather stripping and caulking.
Regardless of where you live or your cost of energy, it is almost always economical to install weather stripping on the inside around doors and windows where possible and to caulk on the outside around doors and window frames—if you do it yourself. This is especially true for windows and doors which have noticeable drafts.

REMOVE THIS SHEET FOR YOUR RECORDS

YOU NOW KNOW your best combination of energy conservation improvements. Of course, the size of your investment depends on your existing insulation and the size of your house.

In addition, some of the recommended improvements in this booklet are not appropriate for all houses. For instance, insulation cannot be added under floors in houses built on concrete slabs. In such cases, the other recommended improvements should still be added to the extent indicated in this booklet. Similarly, R-30 insulation may be recommended for your attic although only R-19 may fit at the eaves or in areas where the attic is floored. In this case, you should still put R-30 insulation wherever it fits.

Use Worksheet B and Table 7 (or your own cost information) to calculate how much you need to add to reach your best combination and how much this will cost. We have provided this information on Worksheet B for our example house. Our house only has R-11 attic insulation, some wall insulation, and R-8 attic duct insulation to begin with. To reach our best combination, the improvements would cost about $1200.

WORKSHEET A

	EXAMPLE:	YOUR CALCULATIONS:
Climate:		
Heating Zone	III	
Cooling Zone	B	
Fuel Costs:		
Heating Energy	Oil	
Cost per Unit	34¢/gal.	
Cooling Energy	Electric	
Cost per Unit	4¢/KWH	
Indexes:		
Heating	20	
Cooling (Attic)	5	
Cooling (Wall)	2	
Heating + Cooling (Attic)	25	
Heating + Cooling (Wall)	22	

BEST COMBINATION

	Example	Your Calculations	
Attic Insulation (Batt)	R-30 (10 inches)		FROM TABLE 4
Duct Insulation (in attics)	R-16 (4 inches)		FROM TABLE 4
Insulation Under Floors	R-19 (6 inches)		FROM TABLE 5
Storm Doors	optional		FROM TABLE 5
Wall Insulation (blown-in)	full-wall R-14 (3½ inches)		FROM TABLE 6
Duct Insulation (in unheated crawlspaces, etc.)	R-16 (4 inches)		FROM TABLE 6
Storm Windows (minimum size)	9 sq. ft.		FROM TABLE 6
Weather strip and caulk windows and door frames	all		

See page 12 for recommendations on combining insulation batts to make up greater thicknesses than 6 inches.

WORKSHEET B

OUR EXAMPLE:

ATTIC INSULATION

1. Attic area (sq. ft.)	1200	
2. Recommended level	R-30 (10")	
3. Existing level	R-11 (4")	
4. Add	R-19 (6")	
5. Cost/sq. ft.	$.25	
6. Total cost (1×5)		$300

WALL INSULATION (BLOWN-IN)

1. Wall area (sq. ft.)	900	
2. Recommended level	full-wall	
3. Existing level	some	
4. Add	0	
5. Cost/sq. ft.	$.60	
6. Total cost (1×5)		0

FLOOR INSULATION

1. Floor area (sq. ft.)	1200	
2. Recommended level	R-19 (6")	
3. Existing level	0"	
4. Add	R-19 (6")	
5. Cost/sq. ft.	$.30	
6. Total cost (1×5)		$360

DUCT INSULATION (ATTIC)

1. Length (ft.)	30'	
2. Perimeter (ft.)	2'	
3. Area (1×2×1.5)*	90 sq. ft.	
4. Recommended level	R-16 (4")	
5. Existing level	R-8 (2")	
6. Add	R-8 (2")	
7. Cost/sq. ft.	$.30	
8. Total cost (3×7)		$27

DUCT INSULATION (OTHER AREAS)

1. Length (ft.)	30'	
2. Perimeter (ft.)	2'	
3. Area (1×2×1.5)*	90 sq. ft.	
4. Recommended level	R-16 (4")	
5. Existing level	0"	
6. Add	R-16 (4")	
7. Cost/sq. ft.	$.50	
8. Total cost (3×7)		$45

STORM WINDOWS (over 9 sq. ft.)

size (sq. ft.)	number	cost each	sub-total
20	2	$35	$ 70
15	4	30	120
12	3	30	90
9	2	30	60

Total cost $340

STORM DOORS

1. Doors Needed	1 (Optional)	
2. Cost per door	$75	
3. Total cost		$75

WEATHER STRIPPING (MATERIALS ONLY)

1. Linear feet	200	
2. Cost per foot	$.10	
3. Total cost		$20

CAULKING (MATERIALS ONLY)

1. Variable costs	$20-50	
2. Estimated cost		$33

Total cost of all improvements $1200

YOUR ESTIMATES:

ATTIC INSULATION

1. Attic area (sq. ft.) ______
2. Recommended level ______
3. Existing level ______
4. Add ______
5. Cost/sq. ft. ______
6. Total cost (1×5) ______

WALL INSULATION (BLOWN-IN)

1. Wall area (sq. ft.) ______
2. Recommended level ______
3. Existing level ______
4. Add ______
5. Cost/sq. ft. ______
6. Total cost (1×5) ______

FLOOR INSULATION

1. Floor area (sq. ft.) ______
2. Recommended level ______
3. Existing level ______
4. Add ______
5. Cost/sq. ft. ______
6. Total cost (1×5) ______

DUCT INSULATION (ATTIC)

1. Length (ft.) ______
2. Perimeter (ft.) ______
3. Area (1×2×1.5)* ______
4. Recommended level ______
5. Existing level ______
6. Add ______
7. Cost/sq. ft. ______
8. Total cost (3×7) ______

DUCT INSULATION (OTHER AREAS)

1. Length (ft.) ______
2. Perimeter (ft.) ______
3. Area (1×2×1.5)* ______
4. Recommended level ______
5. Existing level ______
6. Add ______
7. Cost/sq. ft. ______
8. Total cost (3×7) ______

STORM WINDOWS

size (sq. ft.)	number	cost each	sub-total

Total cost ______

STORM DOORS

1. Doors needed ______
2. Cost per door ______
3. Total cost ______

WEATHER STRIPPING (MATERIALS ONLY)

1. Linear feet ______
2. Cost per foot ______
3. Total cost ______

CAULKING (MATERIALS ONLY)

1. Variable costs ______
2. Estimated cost ______

Total cost of all improvements ______

*1.5 is an adjustment factor for increased width of insulation needed to fit around duct.

REMOVE THIS SHEET FOR YOUR RECORDS

TABLE 7 SAMPLE IMPROVEMENT COSTS

These sample costs were used in estimating the best combination of energy conservation improvements for the various climates and fuel prices covered in this booklet. They include an allowance for commercial installation, except in the case of weather stripping and caulking which is considered to be a do-it-yourself project. While these costs are typical of 1975 prices, there may be considerable variation among specific materials, geographic locations, and suppliers. It usually is worth your time to obtain several estimates for materials and installation before making any purchase. Many of these items can be purchased at substantial discounts if you watch the advertised sales. Considerable savings may be made by installing these yourself, where possible.

ATTIC INSULATION (ALL MATERIALS)

Installed cost per square foot of attic:

R-11 = 15¢	R-44 = 57¢
R-19 = 25¢	R-49 = 64¢
R-22 = 29¢	R-57 = 74¢
R-30 = 39¢	R-60 = 78¢
R-33 = 43¢	R-66 = 86¢

WALL INSULATION (ALL MATERIALS)

Installed cost = 60¢ per square foot of net wall area*

FLOOR INSULATION (MINERAL FIBER BATT)

Installed cost:

R-11 = 20¢
R-19 = 30¢
R-22 = 34¢

DUCT INSULATION (MINERAL FIBER BLANKET)

Installed cost per square foot of material:

R-8 = 30¢	R-32 = 90¢
R-16 = 50¢	R-40 = $1.10
R-24 = 70¢	

STORM WINDOWS (TRIPLE-TRACK, CUSTOM-MADE AND INSTALLED)**

Up to 100 united inches (height+ width) = $30.00
Greater than 100 united inches = $30.00+ $.60 per united inch greater than 100"

STORM DOORS (CUSTOM-FITTED AND INSTALLED)**

All sizes = $75.00

WEATHER STRIPPING AND CAULKING

Prices vary according to material used. Use the most durable materials available.

* Price includes allowance for painting inside surface of exterior walls with water vapor-resistant paint.

**Prices may be considerably less for stock sizes, homeowner-installed.

If you find that the costs of any of the improvements to your house are substantially different from the sample costs in Table 7, you can easily compensate for the difference.

Take the Index Number appropriate for the improvement in question, multiply this by our sample cost, and divide the result by your cost. This will give you an Adjusted Index Number with which you can find the best level of investment for that particular improvement.

$$\frac{\text{Original Index} \times \text{Our Cost}}{\text{Your Cost}} = \text{Adjusted Index}$$

EXAMPLE

For our example house, we might find that we can get good quality storm windows for $20 apiece instead of our $30 estimate. Our Index Number for storm windows was 22. Our new Adjusted Index Number for storm windows would be:

$$\frac{22 \times \$30}{\$20} = 33$$

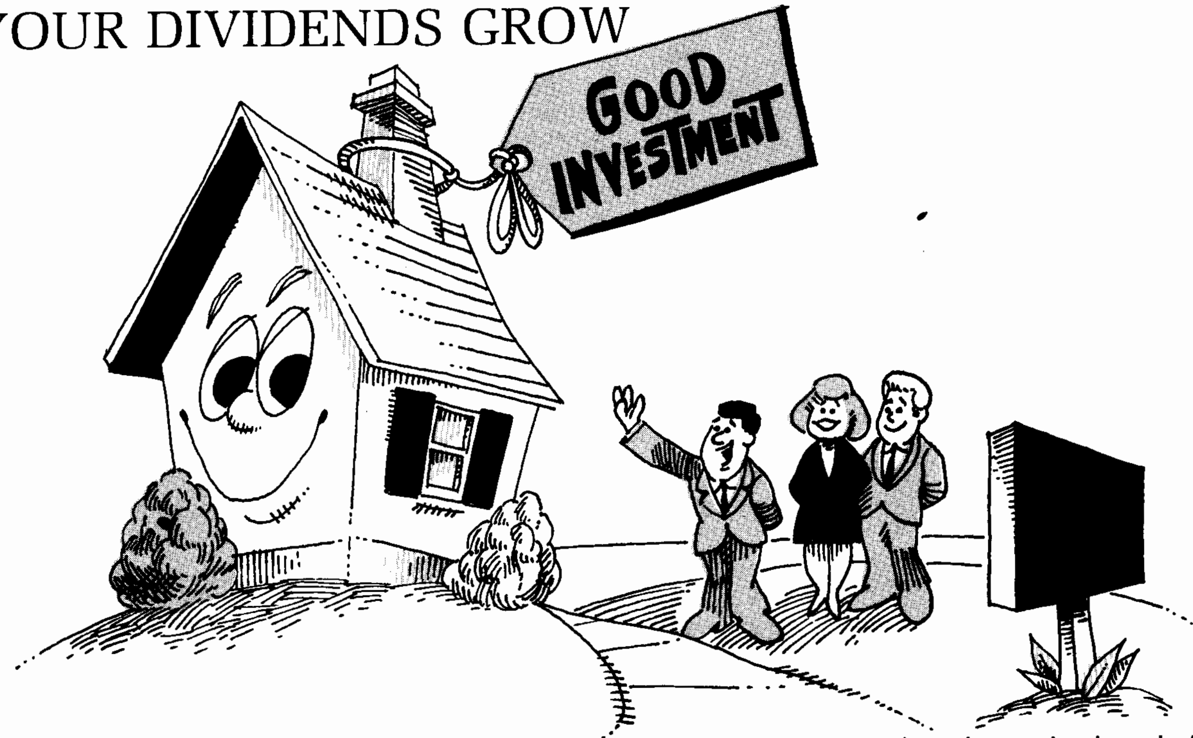
Using our Adjusted Index Number of 33 we find that storm windows are economical on all windows 6 square feet in size or larger, instead of 9 square feet in size. In other words, if your costs are substantially less than ours, you will want to go beyond the recommended level.

Similarly, if R-30 insulation in the attic costs 65¢ per square foot instead of our 39¢ price, the Index Number of 25 for attic insulation would be adjusted to

$$\frac{25 \times 39¢}{65¢} = 15$$

From Table 4 we find that R-19 insulation is now recommended instead of R-30. In other words, if your costs are substantially greater than ours, you may want to use a little less than the recommended level.

YOUR DIVIDENDS GROW



You may not have thought about energy conservation this way, but investing in these improvements is better than most alternative low-risk, long-term investments you can make. When you invest in energy conservation improvements, you immediately begin to earn dividends in the form of reduced utility bills. These dividends not only pay off your investment, but they pay "interest" as well. And unlike dividends from many other investments, these are not subject to income taxes.

At current fuel prices, the recommended improvements will pay for themselves many times over during the life of the house. The energy conservation improvements for a house similar to our example house in Zone III B will pay for themselves in seven to nine years—and even more quickly if the improvements are installed by the homeowner. If the index numbers were higher, the improvements also would pay off more quickly. For example, with a Heating Index of 50, instead of 20, the recommended improvements (R-44 attic insulation, full-wall insulation, R-22 floor insulation, R-24 duct insulation, and storm windows on all suitable windows) would take only three to four years to pay back for this same house. Similarly, the more poorly insulated the house is to begin with, the shorter the payback period.

On the other hand, if the Heating Index number were less than 20 or if the house were better insulated to begin with, the payback period would be a little longer.

More important than the payback period are net savings. In our example house, R-19 insulation in the attic would cost less and pay back faster than the recommended R-30. But the long run net savings are greater with R-30 because each additional resistance unit—up to the recommended level—pays back more than it costs. The best combinations shown in this booklet have varying payback periods, but they always yield the *greatest net savings* over the long run.

Even though utility bills rise as energy prices increase, the rise will be much less than it would have been without increased insulation. In fact, you might think of energy conservation improvements as a hedge against inflation. (Are you beating inflation with your after-tax dividends from other investments?)

Even if you don't plan to live in your house long enough to reap the full return on your investment in the form of lowered utility bills, it will probably still pay to invest in energy conservation improvements now. Because of higher energy prices, a well-insulated house is likely to sell more quickly and at a higher price than a poorly-insulated house that costs a lot to heat and cool. Show your low fuel bills to prospective buyers. They will find the small increase in monthly mortgage payments will be more than offset by monthly fuel bill savings, possibly bringing the cost of living in the house within their reach. The increased value of the house alone might cover the cost to you of making the investment in energy conservation improvements.

CAN YOU AFFORD YOUR INVESTMENTS?
(Can you afford not to invest?)

You may have found that the amount of money needed to finance the best combination of energy conservation improvements is more than you can pay for all at once. If this is the case, you might consider taking a low-cost, long-term home improvement loan.

Whether it is to your advantage to borrow money depends to some extent on the existing condition of your house. A house that is poorly insulated compared to the levels recommended in this booklet requires a greater investment in energy conservation than a house which is close to these recommended levels. However, the poorly-insulated house will yield much greater savings on fuel bills after the improvements are made. This means that your investment will generally pay back fast enough to cover the monthly payments on a long-term home improvement loan. Once the loan is paid off, the additional savings are free and clear!

If you feel you just can't afford to invest in the best combination of energy conservation improvements for your house, you can still make the most of a limited energy conservation budget. Keep in mind the idea of a "balanced" combination—not spending too much on one improvement in relation to the other improvements.

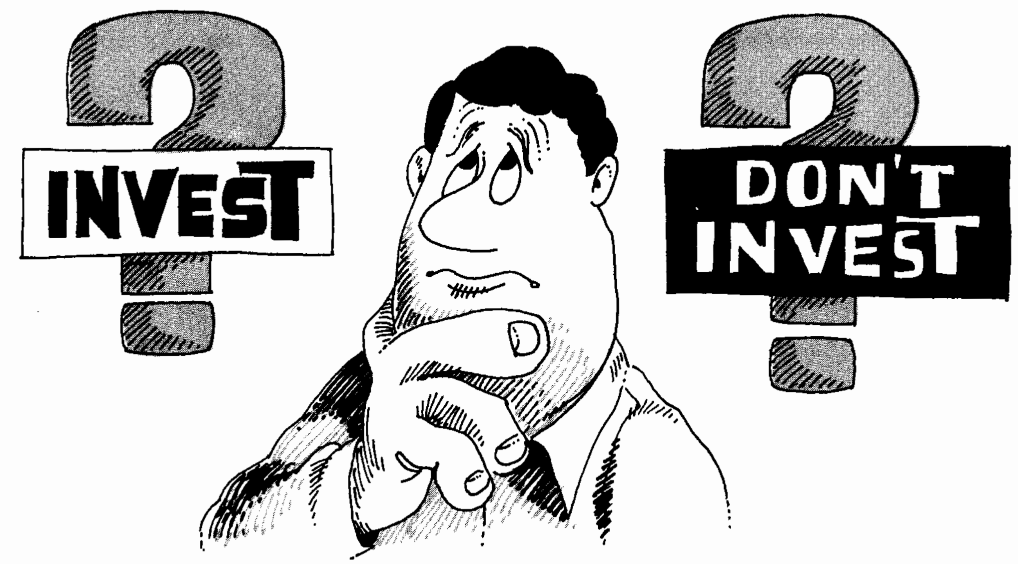
To find this less costly, but still balanced, combination of improvements, decrease each of the index numbers you used in Tables 4, 5, and 6 by the same percentage, say 20 percent. Use the new index numbers to find a new combination of improvements in these tables. Keep reducing your index numbers by the same percentage increments until you reach a balanced combination you can afford.

In the example house, we used index numbers of 25 in Table 4, 20 in Table 5, and 22 in Table 6. Reducing these by 40 percent, for instance, gives us new index numbers of 15, 12, and 13, respectively. Using these numbers gives us the following balanced combination:

	Less Costly Combination	Best Combination
Attic insulation (batts)	R-19	R-30
Duct insulation (attics)	R-8	R-16
Floor insulation	R-11	R-19
Storm doors	none	optional
Wall insulation (blown-in)	full-wall	full-wall
Duct insulation (other areas)	R-8	R-16
Storm windows (minimum size)	12 square feet	9 square feet

Based on our existing level of insulation, this new combination would cost about $750, compared to $1200 for the best combination. If this is still more than we can afford, we might reduce our index numbers by 50 percent or even 80 percent.

On the other hand, if you think that you will eventually add all of the recommended improvements in your best combination, but that it will take a year or two to get them all in, it is usually best to start with those which provide the first level of protection—such as insulation in places where none exists, storm windows, and weather stripping and caulking, where you have poorly fitting windows and doors. Add the others as you can afford them.



Things you should know before you proceed

THE RECOMMENDED levels of insulation and other energy conservation improvements in this booklet will only return the maximum energy and dollar savings if they are properly installed. If you're not a do-it-yourself homeowner, check with several reliable contractors before deciding on a contract. If you plan to make these improvements yourself, always follow the manufacturer's instructions. For a step-by-step description of proper installation procedures, we recommend *In the Bank . . . or Up the Chimney?,* published by the Department of Housing and Urban Development (see inside back cover). But whether you do it yourself or use a contractor, there is some basic information you should know before you invest in energy conservation improvements.

INSULATION RATINGS

It is always best to select insulation on the basis of cost per resistance unit—the so-called "R" value (usually made available by the manufacturer)—rather than on cost per inch. Durability and resistance to flame spread and vermin should also be considered.

Energy savings are provided by resistance to heat flow and not thickness *per se*. Two different kinds of insulation may have the same thickness, but the one with the higher R value will perform better. For example, loose-fill mineral fiber (glass fiber or rock wool) insulation may have an R value as low as 2.2 per inch, while mineral fiber batts have an R value of about 3 per inch. Even if batts cost 30 to 40 percent more than loose fill per inch, they might be a better investment.

Insulation batts are generally available in R-11 (about 4 inches thick), R-19 (about 6 inches), and R-22 (about 7 inches). If more than R-19 is recommended for your house, batts should be combined to make up the desired resistance. For example, R-30 may consist of an R-11 and an R-19 batt. Note that R values are additive.

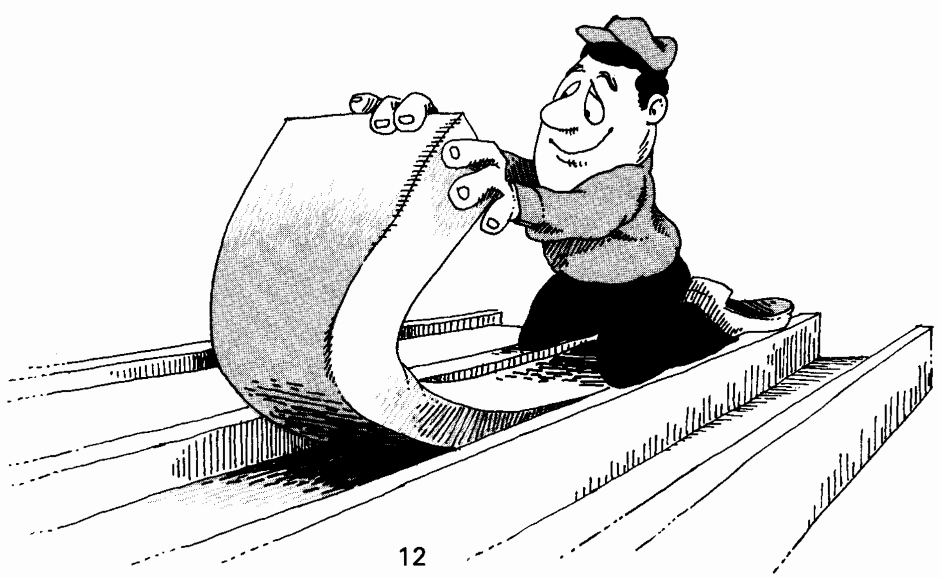
When adding insulation batts to existing insulation, you may not be able to get to our recommended levels exactly. In this case, try to get as close as you can—a little under or over won't make a large difference in your net savings.

MOISTURE CONTROL

Insulation batts can be purchased with or without a "vapor barrier." This is the paper or foil covering on one side of the batt. The barrier retards water vapor, normally present in the house, from passing through or condensing in the insulation. The vapor barrier should face the living quarters of the house, unless a competent air conditioning specialist advises otherwise.

When combining batts or adding batts to existing insulation, additional vapor barriers should not be used beyond the barrier immediately facing the living quarters. If batts without vapor barriers cannot be found or cost more than faced batts, strip off the vapor barrier or slash it to allow any water vapor to pass through freely.

Before you install insulation in closed cavities (such as wallspaces), consult an insulation specialist about possible moisture problems. If water vapor is allowed to condense in the insulated space, it will lower the performance of the insulation and could damage the structure. In general, moisture problems can be prevented with proper installation of vapor barriers and adequate ventilation, but high humidifier settings should be avoided.



INSULATION IN ATTICS AND CRAWLSPACES

Two basic kinds of insulation are available for floors of unheated attics. Both will do the job if they are properly installed. One type is preformed mineral fiber (glass fiber or rock wool) batts or blankets. The other type is cellulose or mineral fiber in loose-fill form.

When installing insulation in attics, you don't have to stop at the ceiling joists if the attic has no flooring, but insulation should not touch the roof at the eaves.

If you have a finished attic, check with an insulation specialist or one of the recommended books on the inside back cover for the proper procedure for installing insulation. In this case there may not be room to use the amount of insulation we recommend.

Preformed insulation batts may be more economical than loose-fill materials in an unobstructed attic area without flooring, if they fit snugly between the joists and you do the work yourself. You can add insulation to your attic in one afternoon using batts—they can be laid out easily and there is no need to staple them down.

Once the area between the joists is fully insulated, the greatest source of heat loss in the attic is through the joists themselves, which may cover as much as 10 percent of the attic. For this reason, when adding insulation batts above the level of the ceiling joists, cover the joists completely if possible.

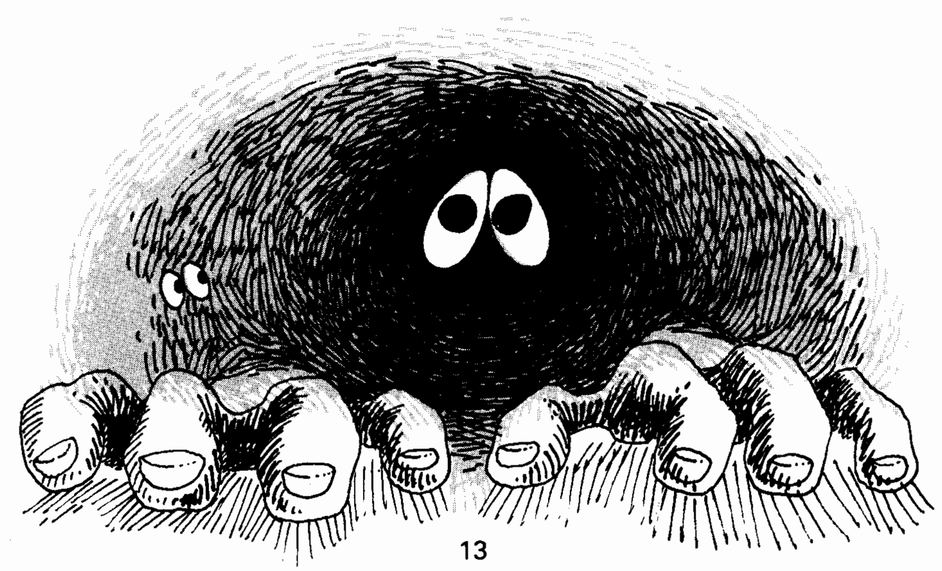
If you want to add R-19 or R-22 insulation to your existing insulation, it is usually best to add R-11 batts up to the level of the joists and cover the entire area with another layer of R-11 batts. Place the batts as close together as possible to prevent air from circulating between them.

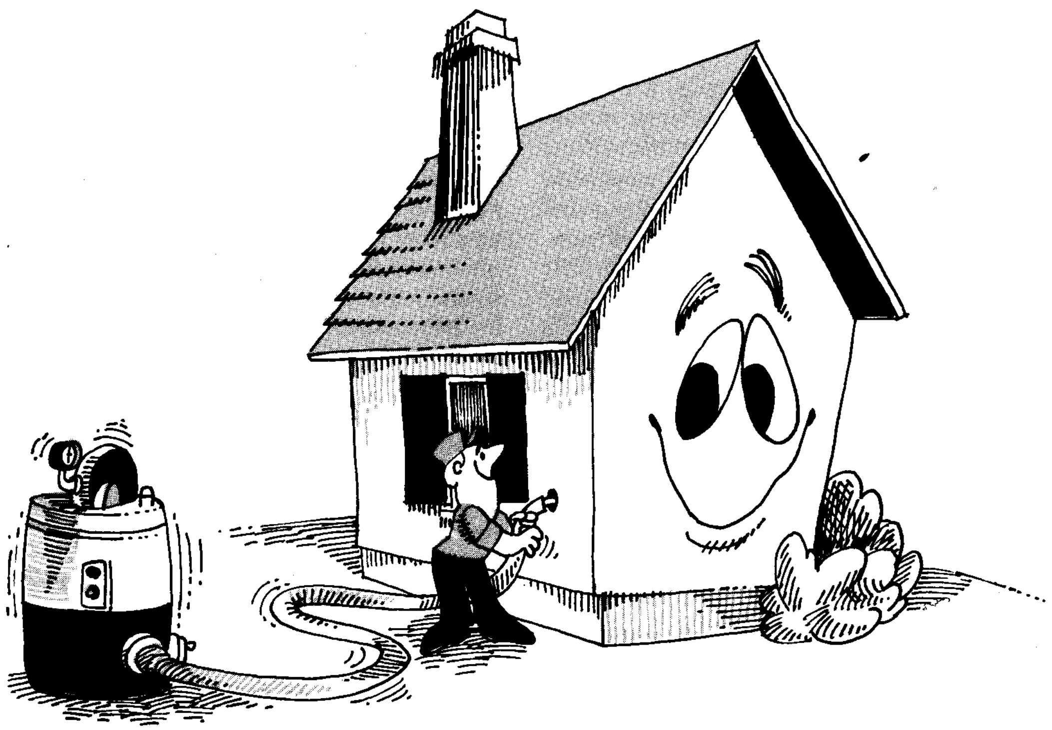
Loose-fill insulation may be better if the access to your attic is difficult or if it has a floor. If flooring is present in an otherwise unfinished attic, you may have to remove some of it temporarily to allow insuation to be blown in. Loose insulation is usually blown into the attic through flexible tubing by a small machine which puffs up the insulation as it pushes it through the tube. This may cause some settling after the insulation is in place so you should take that into account when measuring the depth. Small holes should be drilled into tight fitting flooring at one-foot intervals to allow passage of any water vapor that may rise from the rooms below.

Density of loose-fill insulation is extremely important in assuring the proper resistance to heat flow. The manufacturer will generally specify the number of bags of loose-fill materials needed to achieve a given R value over a specific area. If a contractor is insulating your attic, you should verify that the proper number of bags has been used.

A well-insulated attic should also be well ventilated to prevent moisture accumulation problems. Never block ventilation ports and always provide at least two vent openings, located in such a way that air can flow in one and out the other. A good rule of thumb is to provide at least one square foot of opening for each 300 square feet of attic floor area.

During the inspection of your attic, you may notice interior wall spaces open to the attic, allowing cold air from the attic to fall down into the wall spaces or duct wells. These areas should be sealed off and covered with insulation.





INSULATION IN EXTERIOR WALLS

Three or 4 inches of insulation properly placed in the air space can reduce the heat transfer through the walls by as much as two thirds. The best time to install insulation in the air space is while the house is being built. When the wall is open, it is almost always economical to fill the wall space with batt insulation. For example, unfinished garage walls next to heated areas of the house should be insulated with R-11 batts, except in the mildest climates.

Once a wall is finished off, it is usually difficult to reach the air space and insulation has to be blown or injected into the wall through small holes drilled between the wall studs. (This can be done from the outside or the inside, depending on the ease of sealing the holes and refinishing the surface.) Loose-fill materials, usually mineral fiber or cellulose, are the insulation forms best suited for this job. While this process is much more costly than adding batt insulation during construction, it may still be a good investment in many cases if done properly. Only an experienced contractor should be employed, however, as the process can be quite complicated and poor workmanship will greatly lower the quality of the finished work.

Loose-fill wall insulation is recommended in this booklet only for exterior walls with an air space at least 3 to 4 inches wide and with no existing insulation.

In some older houses, access can be gained to the wall space from the attic. In this case, loose-fill insulation material can be dropped into the space from above at very low cost, making this economical in all but the mildest climates with low fuel prices. (Make sure the insulation doesn't fall all the way into the basement!)

A potential problem with insulation in closed cavities in some climates is the possibility of moisture accumulation. This may be difficult to detect until moisture begins to show through the wall. If moisture problems occur, they can be minimized, however. The interior surface of the wall can be made vapor resistant with a paint or covering that has low-moisture permeability. Cracks around windows and door frames, electrical outlets, and baseboards should be sealed at the surface facing the room. Outside surfaces should not be tightly sealed but allowed to "breathe."

Another potential problem which you may encounter with blown-in insulation is settling or shrinkage. Generally, this problem can be avoided if the insulation is properly installed. Calculating the number of bags of material needed per square foot of wall area and assuring that these have been installed is the best way to avoid this problem.

INSULATION UNDER FLOORS

Floors over unheated areas, such as crawlspaces, garages, or basements, can be a major source of heat loss in an otherwise well-insulated house. Everyone knows that hot *air* rises, but remember, heat flows to cold through solid surfaces in any direction— up, down, or sideways.

Water pipes in unheated areas should also be insulated if there is danger of freezing after the floor insulation has been installed. Crawlspaces can be closed off in winter, but must be well ventilated in summer to prevent the build-up of moisture from the ground and from the rooms above. In many areas it is a good idea to cover the ground under a crawlspace with plastic sheeting to reduce the moisture level in this area.

If your house is built on a concrete slab, it is sometimes possible to insulate around the edges of the slab. Consult an insulation specialist to find the best way to do this.

INSULATION OF HEATING AND COOLING DUCTS IN UNHEATED AREAS

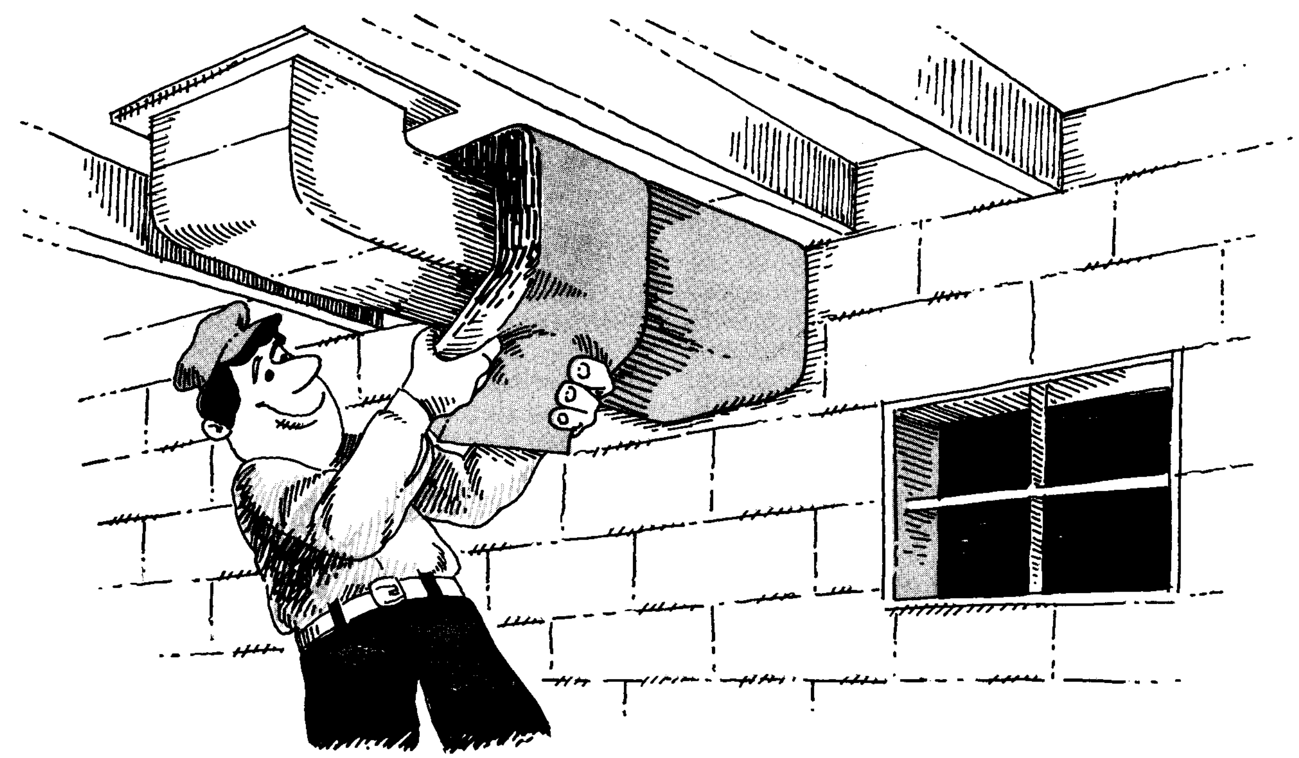
Heating and cooling ducts in attics, crawlspaces, and garages should be well insulated. Even if a sufficient amount of insulation exists, you might want to loosen it temporarily at the joints to check the condition of the ducts. Escaping air indicates the need for retaping of the duct joints.

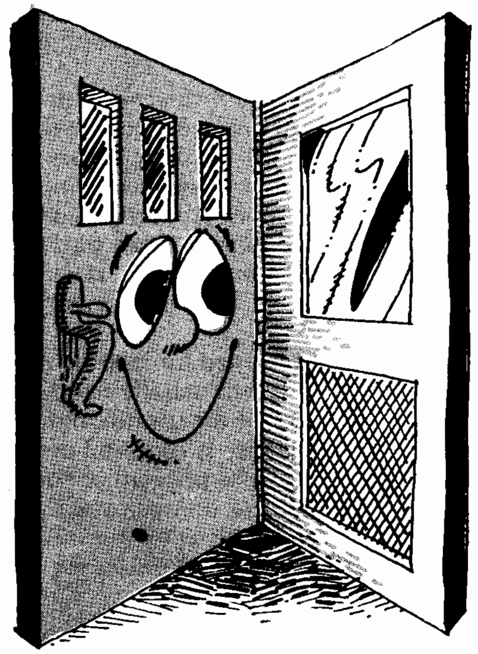
Most houses have no more than 1 or 2 inches of insulation wrapped around ducts in unheated areas. As Tables 4 and 6 show, more is often desirable. Duct wrap in layers of 2-inch thicknesses may be used to insulate ductwork. As an alternative, ordinary mineral fiber batts can be placed around the ducts. Avoid crushing the insulation because this lowers its resistance to heat flow.

Where ductwork is used for heating purposes only, a vapor barrier is not usually needed. However, if ducts are used for air conditioning as well as heating, a vapor barrier is required around the outside of the insulation to prevent condensation on the ducts. In either case, some protective covering should be used. Check with insulation manufacturers for the correct procedure for your climate.

STORM WINDOWS AND DOORS

Storm windows and doors vary widely in basic design, durability, and cost. Storm windows range from single glass panels, that must be put in place each fall and removed each spring, to permanent triple-track assemblies, which include sliding upper and lower windows and a





screen. Triple-track windows can be used both during heating and cooling periods and can be opened for natural ventilation at other times. Because they are left in place permanently, wear and tear and the chance of breakage is minimized.

You should be aware that it is not the storm window itself that keeps the warmth inside in winter and outside in summer. It is actually the dead air space—at least 3/4 inch—between the two windows that saves energy. For this reason a plastic sheet, placed over the window in such a way to create a dead air space, will work nearly as well as more permanent storm windows. If you want to put off buying storm windows for a year or so, you might consider this as a temporary solution.

The size of the storm window is determined by the size of the window frame and not by the glass area. Storm windows should be properly installed and fit tightly to do the most good. To assure a tight fit, permanent storm windows should be sealed to the outer window frame with caulking compound or other sealing material. Storm window frames should have a tiny opening at the bottom to allow water vapor to escape.

Storm windows are generally more economical than double pane windows in existing houses, because they usually cost less to install and they reduce infiltration of air around the window sash. Where double pane windows already exist, it may still pay you to use storm windows over the larger windows (15 to 20 square-foot range) when your Index Number in Table 6 is greater than 50.

Storm doors may not always be economical when considered for winter heating savings alone unless the doorways are frequently used. However, they may still be a good investment, since they can be used as a screen door in the summer months if they have interchangeable glass and screen inserts. If your house already has a screen door, it generally will not pay to replace it with a storm door unless it is shown to be economical for your Index Number in Table 5. Storm doors over doors with inset glass areas save more energy than those over solid doors.

Storm windows and doors vary greatly in price. In general, custom-made windows and doors are more expensive, but they may fit better and last longer.

WEATHER STRIPPING AND CAULKING

In a well-insulated house the largest source of heat loss is from air leaks, especially around windows and doors. Good weather stripping and caulking of exterior window and door frames will not only reduce the heat loss in winter and heat gain in summer, but they will reduce uncomfortable drafts as well.

Weather stripping and caulking are generally economical in all climates, if you install them yourself. This is especially true for drafty windows and doors.

Weather stripping is available in a wide selection of shapes and materials. Caulking materials vary greatly in quality as well. More durable varieties will not have to be replaced as often, which is an important consideration.

When weather stripping, don't overlook hatches to your attic. Even small cracks allow large amounts of warm air to be lost during a heating season.

VENTILATION

Some people think that a tightly sealed, well-insulated house does not allow sufficient air circulation to maintain a healthy environment. In most houses, 70 to 100 percent of inside air is exchanged with outside air every hour. Actually, only a 20 percent hourly air change is needed for normal ventilation purposes. It is most unlikely that an existing house could be sealed up that tightly by these energy conservation improvements alone.

In new houses with tight construction it may be necessary to provide a separate combustion air inlet to the furnace. In both existing and new houses it is more economical to remove moisture and odors from kitchens and baths by localized exhaust fans than to provide continuous, uncontrolled air infiltration.

PLANNING AHEAD

We hope this booklet has provided some fresh insight into energy conservation planning in your house. Our basic purpose has been to save you—the homeowner—the maximum number of dollars in heating and cooling your house. Because energy prices are on the rise, most homeowners can't afford to overlook the potential savings from energy conservation measures over the years to come. Investing in the energy conservation improvements described in this booklet will not only reduce your monthly fuel bills, but will give you the greatest, long run net savings. By planning ahead, you can make the most of your energy dollars.

FOR MORE INFORMATION . . .

General information on energy conservation in home heating and cooling operations

7 Ways to Reduce Fuel Consumption in Household Heating—Through Energy Conservation,	published by the National Bureau of Standards, U.S. Government Printing Office, Washington, D.C. 20402 (C13.2:F95), $0.35.
11 Ways to Reduce Energy Consumption and Increase Comfort in Household Cooling,	published by the National Bureau of Standards, U.S. Government Printing Office, Washington, D.C. 20402 (C13.2:EN2), $0.40.
Energy Efficiency in Room Air Conditioners,	published by the National Bureau of Standards, single copies free from the Consumer Information Center, Pueblo, Colorado 81009.
Tips for Energy Savers,	published by the Federal Energy Administration, free from the Office of Public Affairs, Federal Energy Administration, Washington, D.C. 20461.

Specific information on making energy conservation improvements in existing houses

Insulation Manual, Homes/Apartments,	published by the National Association of Home Builders Research Foundation, Inc., P.O. Box 1627, Rockville, Maryland 20850, $4.00.
In the Bank . . . Or Up the Chimney?	For information write to the Department of Housing and Urban Development, Washington, D.C. 20410.
How to Save Money by Insulating Your Home,	published by National Mineral Wool Association, 382 Springfield Avenue, Summit, New Jersey 07901, $0.30.

For more information on mineral wool insulation write to the National Mineral Wool Association, 382 Springfield Avenue, Summit, New Jersey 07901.

For more information on cellulose insulation write to the National Cellulose Insulation Manufacturers Association, 400 West Madison Street, Chicago, Illinois 60606.

For more information on storm windows and doors write to Architectural Aluminum Manufacturers Association, 35 East Wacker, Chicago, Illinois 60611.

The policy of the National Bureau of Standards is to encourage and lead in national use of the metric system, formally called the International System of Units (SI). For the convenience of the homeowner this booklet uses customary units since building materials in the United States almost always are sold in this manner.

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