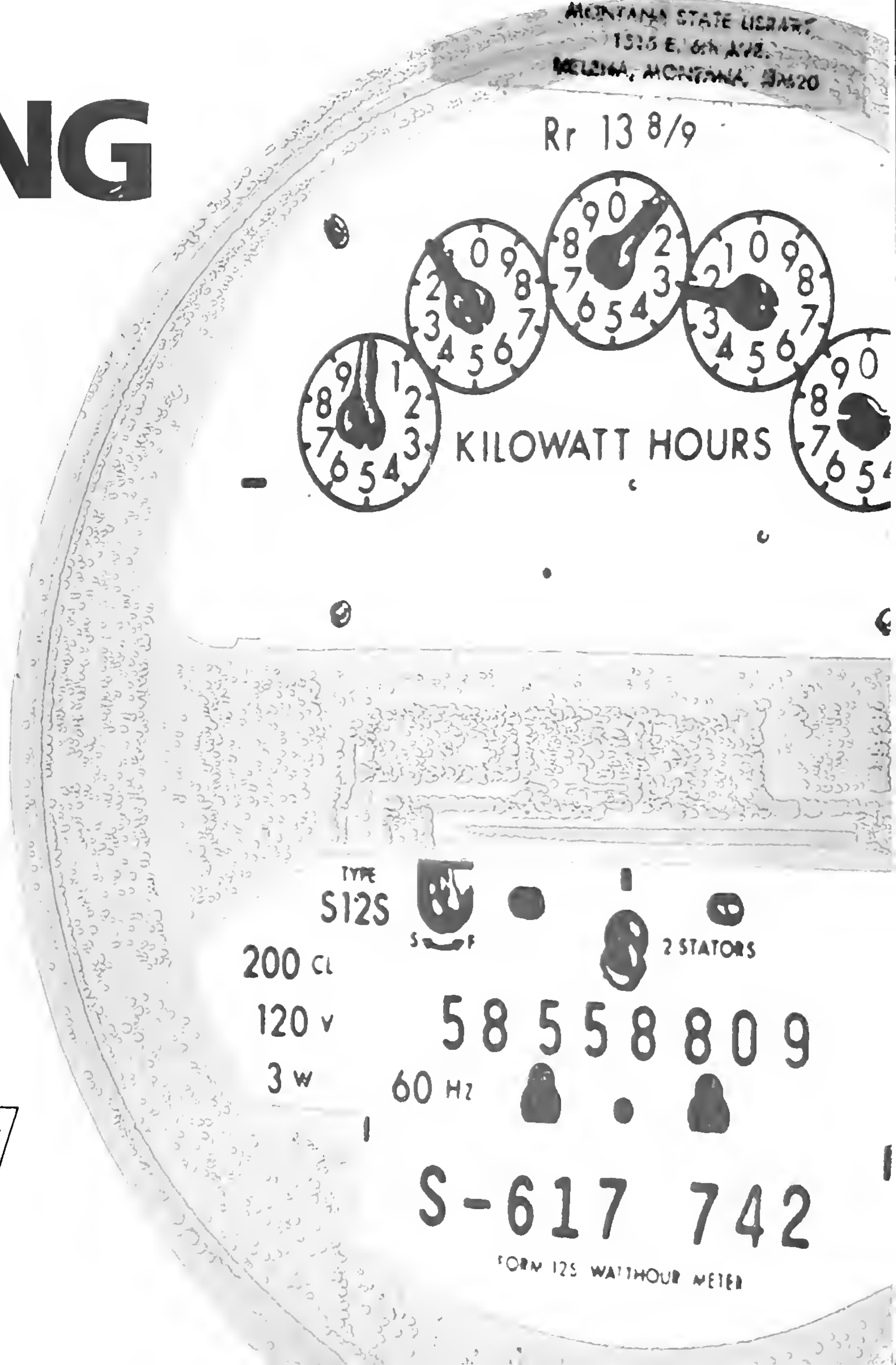
HOW TO REDUCE ENERGY COSTS IN YOUR BUILDING



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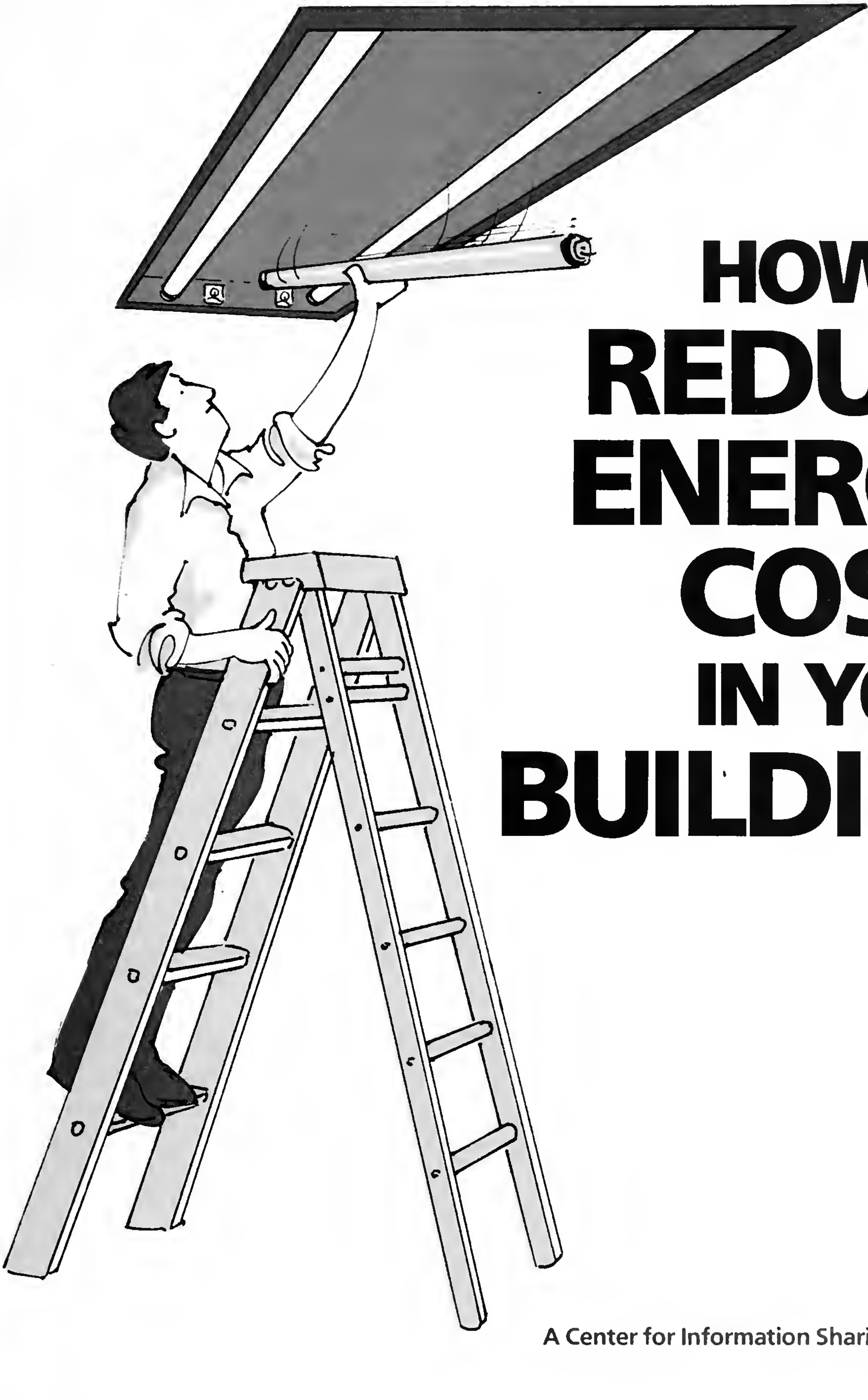

HOW TO REDUCE ENERGY COSTS IN YOUR BUILDING

A Center for Information Sharing Publication

It's easy to save energy dollars

How *you* can save energy dollars

How much energy do you use?
How much are you paying for it?

Take a close look at your building

LIGHTING

ENVELOPE

HOT WATER

HVAC (Heating, Ventilating, Air Conditioning)

MACHINES

Operation and Maintenance: What to do, when

If you use a lot of electricity

Your guide to investing in energy conservation

When you're building or adding on

Energy use/cost record

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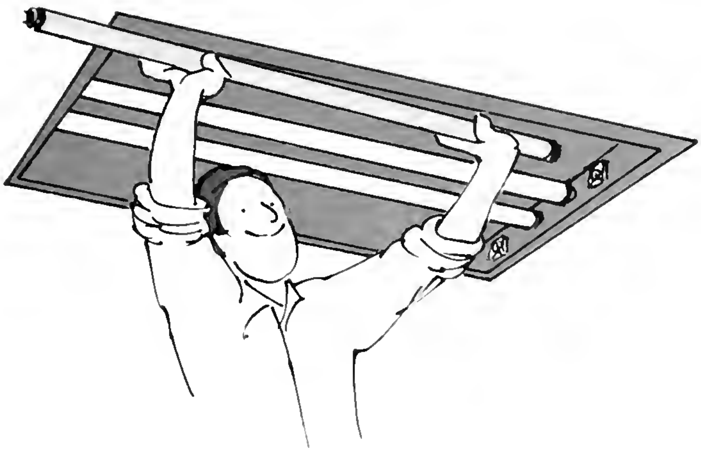
First edition.



Energy conservation can save you hundreds or even thousands of dollars—*every year!* And in many cases the things you need to do are very simple and take very little time. Spend an hour reading this book, and see how many ways *you* can save energy dollars.

Don't Miss the Top 10

Many of the fastest and easiest ways to save energy will also cost you little or nothing to do. In fact, you may get 50% or more of your energy savings by doing these "top 10":

1. **Turn off lights when possible.**
2. **Remove unneeded light bulbs.**
3. **When replacing bulbs, use lower wattage or more efficient ones.**
4. **Lower your heating settings.**
5. **Raise your air conditioning settings.**
6. **Turn off heating and air conditioning at night and on weekends.**
7. **Turn off heating and air conditioning in unoccupied areas.**
8. **Delay turning on heating and air conditioning at the start of the day.**
9. **Turn off heating and air conditioning sooner at the end of the day.**
10. **Lower your hot water temperature.**

Excellent Investment Possibilities

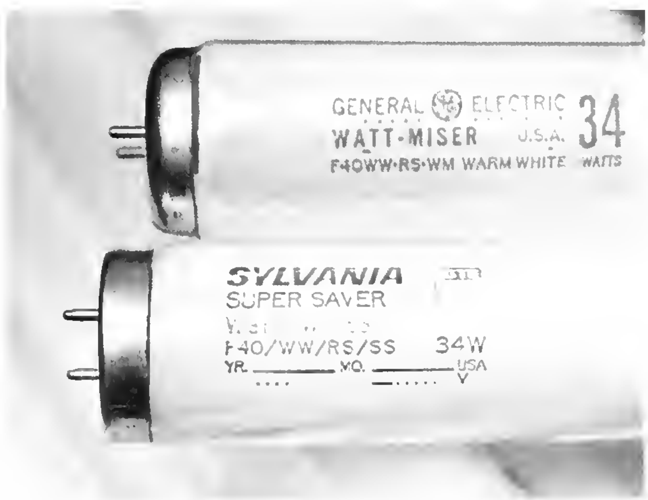
Investing some capital—your own or borrowed—in energy conservation improvements can yield *excellent* returns in the form of energy dollar savings. This book explains many capital investment projects and shows you how to judge whether a particular investment is a good one.

Do you rent your space?

Energy conservation is not just for building owners. If you rent, chances are you pay your own electric bill and perhaps gas or oils bills as well.

When to Use This Book

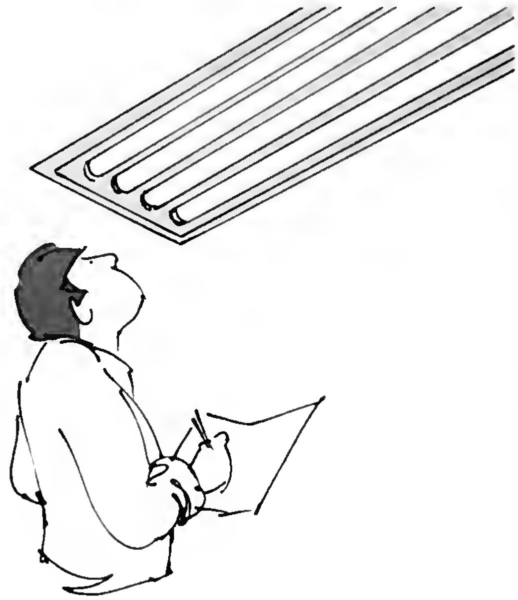
- *Now,* to see what you can do to improve energy use—maintenance and operation.
- *Before you buy* any energy related products—light bulbs, a boiler, etc.—whether replacements or new equipment.
- *Before you remodel, add on to your building, or build a new one.*
- *Just before you do your budgeting* for next year—to see if there are energy-related expenditures you should be making, even borrowing to do. When you evaluate possible projects, remember that some may be *very* good investments.
- *Before you talk to your maintenance personnel.* They should have a chance to read the book, too.



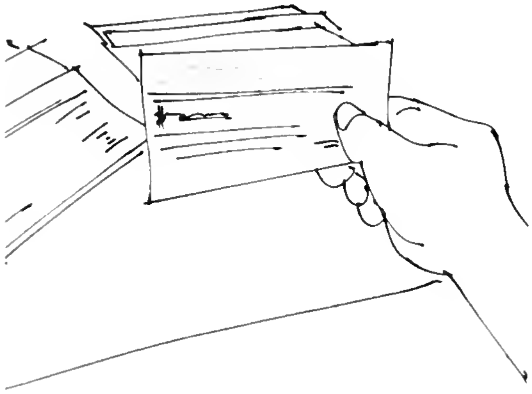
34 watt high efficiency fluorescents, used as replacements for 40 watt lamps.

There are lots of things you can do to reduce energy consumption in your building or in the space you occupy. To get *results*, follow these nine steps:

Take a good look at how and where you use—and waste—energy. Do it systematically to get an understanding of all the places you can reduce energy use.

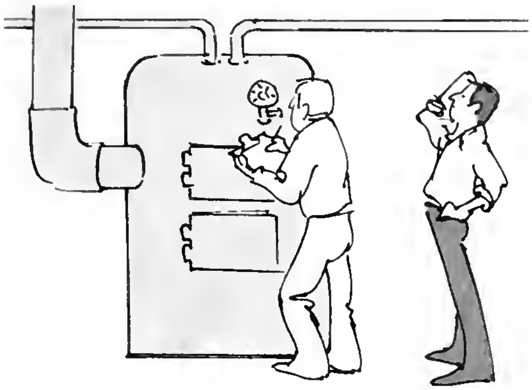


The total amount you've been spending may surprise you, but you can probably save 20-30% with little effort.

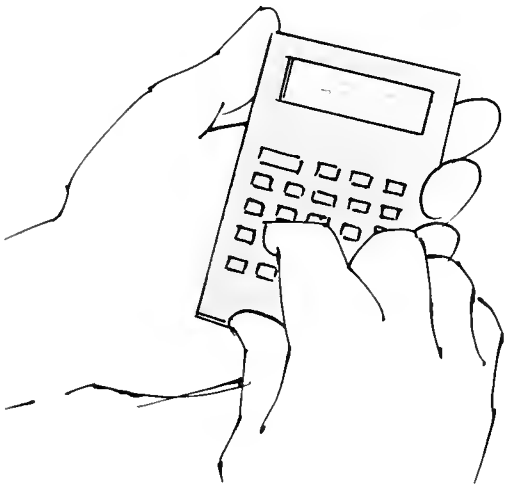


They should be fully involved in your energy conservation efforts and may have some excellent suggestions for ways to save.

If there is a complex heating, ventilating and air conditioning (HVAC) system or something else you can't analyze yourself, get some expert help. Your local utility may be able to advise you.



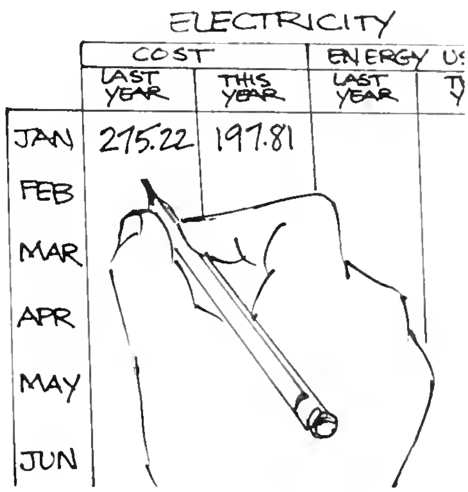
Not all improvements pay—see page 51



Start with the easiest and least costly—some things will cost nothing at all to do. Write your **Energy Action Plan** inside the cover.

The sooner you start, the sooner you start to save.

See if what you've done is working well, how much you're saving, and if some fine tuning is necessary.



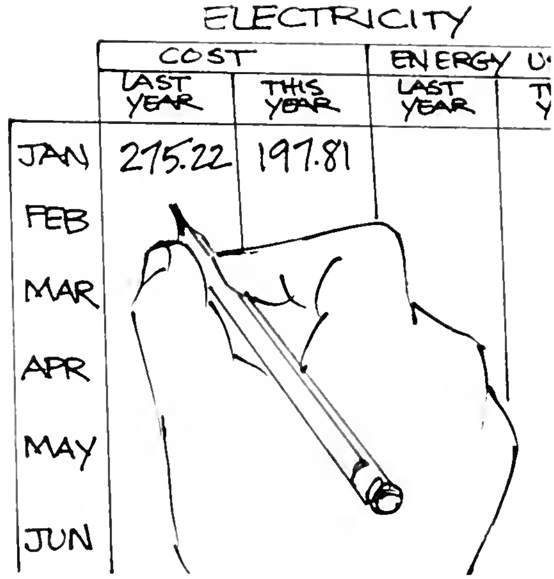
These are important questions, because the answers will give you the "baseline" for calculating potential savings.

To get the figures you need, collect your energy bills for the last calendar year and the first part of this year. Use the worksheet on page 53 (example filled out at right) to record the monthly totals of both the amount of energy used and its cost. For a quick check, or if old bills are not readily available, your utility company and fuel dealer may be able to give you totals from the records for your account.

Fill in the totals in the table below. Also, since energy prices may have changed, you will want to enter the current prices, too, so you can calculate savings as you use this manual. If you pay for electricity at a declining block rate (see p. 47), you will want to note the cost per KWH at the *lowest* rate you pay, since the savings you achieve will usually be at that rate.

* Consult your utility company and fuel dealers.
** The gas unit used by your utility company may be a "therm" or "ccf" (hundred cubic feet) or "mcf" (thousand cubic feet).

If your energy use has been somewhat erratic and you can expect the same kinds of variations to crop up in the future, a 3-year average may be more useful to calculate a "norm." If your operation has been growing or contracting, you may want to pay attention to an average annual use per employee, per square foot of area, per unit of product, per hour of operation, or some other variable that would enable you to relate your energy use to changes in size or level of activity.



Keep track of progress as this year goes by. Use the same worksheet to enter the new figures each month, and see how your conservation efforts are paying off.

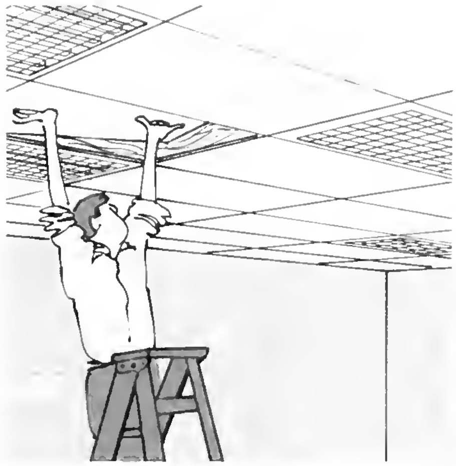
Conservation Pays Even If Energy Prices Fall

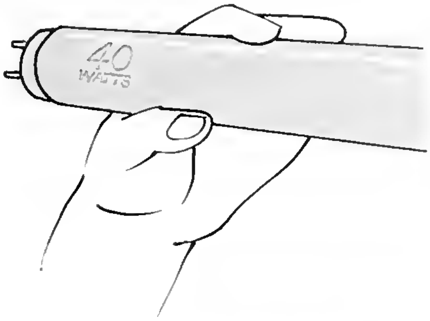
No matter what the unit prices are for energy, it pays to conserve. If prices fall, you may not save quite as much, but it still can be a substantial amount (see examples below). And many conservation improvements produce savings year after year with no additional effort. If prices rise, of course, you stand to benefit even more from your conservation efforts.

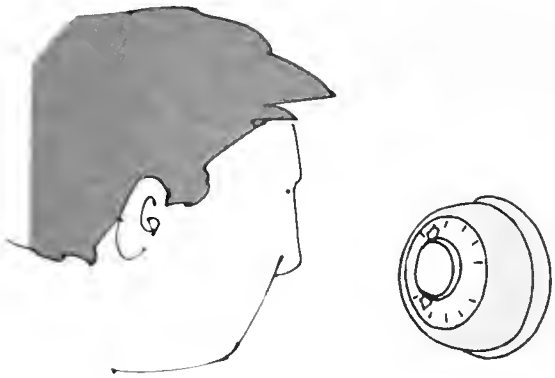
If your energy costs have been running $5,000 a year, and:	Your annual savings if you reduce energy consumption by: 10%	20%	30%
Prices stable	$500	$1,000	$1,500
Prices fall 20%	400	800	1,200
Prices rise 20%	600	1,200	1,800

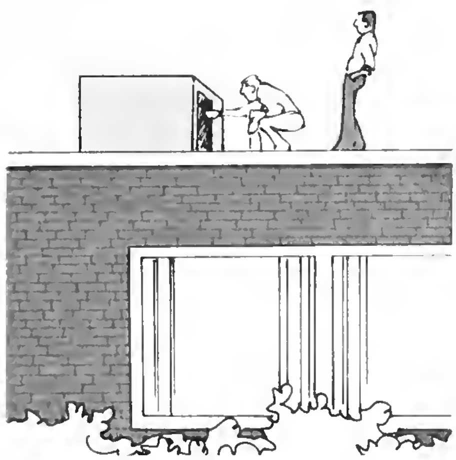
Now that you know *how much* energy you use and what you pay for it, you have to find out *how* it is being used. Taking a close look—or doing an energy "audit"—will reveal ways to cut your energy consumption.

Use this handbook as you walk through and around your building—systematically, energy system by energy system. By following the sequence on this page you'll also be following the sequence of sections in the handbook.

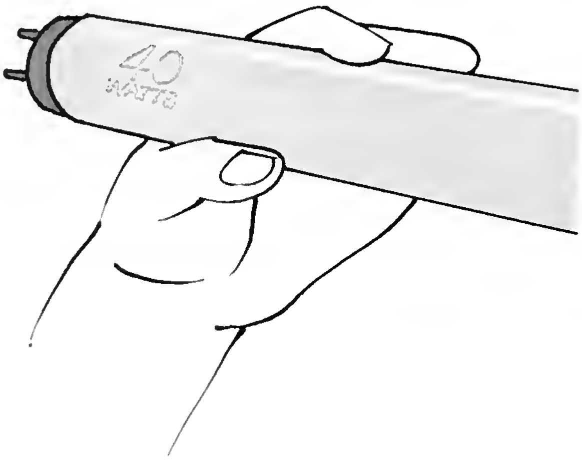








LIGHTING



You need artificial light, inside and outside your building, for a variety of purposes. Whatever your particular needs, you want enough light of the right quality and you want it to be reliably supplied and troublefree in operation.

At the same time, you want the lowest possible electric bills. Reducing the waste of lighting energy is the key to lower electric bills. Lighting energy is wasted in several ways:

- **inefficient sources**—the lamp or fixture is inefficient in converting electricity to light, using more watts (units of electric power) than necessary to produce the lumens (units of light output);
- **transmission losses**—when the light source is too far away from what you want illuminated, or when dirt or some other obstruction blocks off some of the light;
- **overlighting**—when you use more than is needed; when you don't use natural substitutes (e.g., daylight) or reflectors (e.g., light color paint); or when you use lights for no reason (e.g., no one there).

If there is a state lighting code, make sure you meet its requirements. Some states regulate light levels in footcandles, others set limits in terms of watts per square foot of building area.

Save 20% or More with Little Effort

It's very easy to save lighting energy dollars, and savings of anywhere from 20% to 50% are commonplace. For instance, removing *just one* 100-watt light bulb can save over 200 KWH* of electricity every year; removing five such bulbs would save over 1,000 KWH! *Plus* the cost of replacing the bulb twice a year! Check the table below to see what removing those five bulbs—or saving 1,000 KWH in some other way—would save you on *your* electric bill.

Table 1

Yearly Value of Electricity Saved

If your electricity cost per KWH is:	This is the value of the electricity saved if the number of kilowatt hours used per year is reduced by:					
	500	**1,000**	**2,500**	**5,000**	**10,000**	**25,000**
3¢	$15	$ 30	$ 75	$150	$ 300	$ 750
5	25	50	125	250	500	1,250
7	35	70	175	350	700	1,750
9	45	90	225	450	900	2,250
11	55	110	275	550	1,100	2,750
13	65	130	325	650	1,300	3,250
15	75	150	375	750	1,500	3,750

By reducing the amount of lighting energy you use at any one time, you may also reduce peaks and be able to get lower electric *rates* (see p. 48 for more detail). If you have a lot of lighting and you reduce light levels, you may also reduce air conditioning loads, since lights generate heat; but remember that your *principal* savings will come from lower electricity bills for operating the lights themselves.

Table 2

Lamp Life and Efficiency

Life (hours)		Efficiency (lumens per watt)
750-2,500	Incandescent	8-21
4,000	Tungsten-Halogen	18-24
24,000	Mercury vapor	26-50
7,500-20,000	Metal halide	61-100
9,000-20,000	Fluorescent	70-100
16,000-24,000	High pressure sodium	57-125
18,000	Low pressure sodium	150

*Based on average rated lives and mean lumens for typical lamps. Note that ballast losses are not included.

*100 watts × 8 hours a day × 5 days a week × 52 weeks a year equals 208,000 watt hours ÷ 1,000 equals 208 kilowatt hours (KWH).

Remove unnecessary lamps

You can remove unneeded lamps where lighting is too bright, near windows, in hallways and, frequently, in areas with no furniture. To determine the lowest acceptable lighting levels, use your own judgment, or the following table with the aid of a light meter (you might want to ask your lighting supply dealer to lend you one).

Table 3

Recommended Lighting Levels

Lighting Level (footcandles)	Area or Task
5	General public areas, corridors
5-10	Lobbies with signs to read
10-20	Circulation areas and lightly used office areas
20-50	Average office work
50-100	More prolonged or difficult visual tasks (office or shop)
100-200	Especially difficult visual tasks—low contrast, small size

Based on IES recommendations

Removing unneeded lamps will help reduce your lighting bills.

In multiple-lamp fluorescent fixtures, lamps are wired in pairs and therefore must be removed in pairs (both lamps in a pair cease working when one is removed). In four-lamp fluorescent fixtures you have the choice of removing either the two outermost lamps or the inner pair. For aesthetic reasons you may want to try to create some sort of uniformity or even patterns where large numbers of lamps have been removed. Further energy savings are possible by also disconnecting ballasts (see next section).

As you can see from Tables 4 and 7, removing unneeded lamps can be *very* rewarding.

Table 4

Fluorescent Ceiling Fixtures

Savings from Removing 40-Watt Fluorescents

If your electricity cost per KWH is:	Your savings in electricity costs per year if you remove this number of 40-watt fluorescent lamps: 2	8	16	24	48
3¢	$ 6	$ 25	$ 50	$ 75	$150
5	10	42	83	125	250
7	15	58	116	175	349
9	19	75	150	225	449
11	23	92	183	275	549
13	27	108	216	324	649
15	31	125	250	374	749

NOTE: Savings are calculated to the nearest dollar. Assumes lights are used 52 weeks a year, 50 hours a week (5 days a week, averaging 9 hours a day, plus 5 hours for a half-day or for cleaning) Ballasts **not** disconnected (see Table 8 for additional savings from disconnecting ballasts)

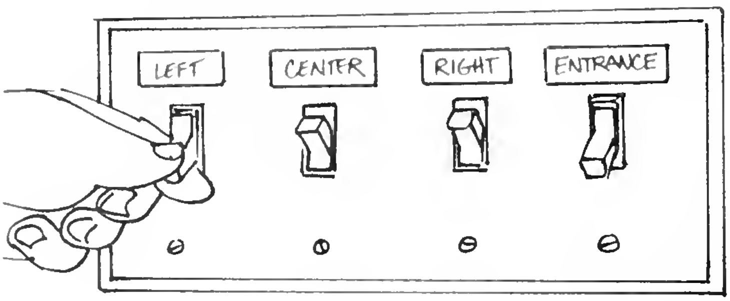
Disconnect ballasts

Fluorescent and HID (high intensity discharge) fixtures have devices called ballasts which provide proper starting and running voltage and current. Ballasts themselves use electricity when the fixture is turned on.

If the lamps are removed but their ballast is not disconnected, the fixture will continue to use some electricity when it is switched on (the fixture may till have some lamps in it, or it may be one of several fixtures operated by the same switch). For maximum energy savings (see Table 8), disconnect the ballast. This is a simple wiring job. Multiple-lamp fluorescent fixtures usually use one ballast for each pair of lamps; there is one ballast in a single-lamp fixture. You do *not* have to rewire ballasts in Instant Start or Slimline fluorescent fixtures (usually identified by 8-foot long lamps marked "IS" at the end), since the ballasts disconnect automatically when the lamp is removed.

Turn off lights near windows

If your lights can be controlled separately, turn off those nearest the windows whenever there is enough natural light. If your present wiring and switches prevent you from doing this, it may pay you to rewire.



If you have shades or blinds that can be opened, the sun they let in will also add warmth and reduce the load on your heating system in winter. On the other hand, this solar heat may be unwanted in summer, but you may find that so much electricity can be saved by switching off lights that it will pay to install special film, shades or blinds to reduce heat transmission yet let the natural light in during the warm months.

Turn off lights when an area is unoccupied

Lights should be turned off whenever an area is left unoccupied for any length of time. Consider using a label or sign next to the light switch to remind people to turn it off.

While the life of a lamp is shortened if it is turned on and off frequently, remember that the cost of the lamp is insignificant when compared to the cost of the energy the lamp will consume during its lifetime. Remember also that mercury, metal halide and high pressure sodium lamps take longer to light than fluorescent and incandescent lamps; this fact must be taken into account when making a decision to turn lights off.

The way your lights and switches are now wired may make it quite easy to control the lights you want to turn off—say, in a bathroom, stockroom or office. If a single switch controls a large number of lights, however, and it is impractical to turn them all off, it may pay you to rewire so you can control the lights area by area.

Re-schedule evening cleaning, reduce or eliminate other evening activities

Cleaning hours are often evening hours, when lights are turned on only for this purpose. Sometimes, because of the wiring and switches, entire floors and even the whole building must be lighted even though only one area is being cleaned at a time.

To the extent possible, re-schedule evening cleaning to times when the lights are on anyway because the area is in use, or to daylight times, such as a weekend day, when the area is unoccupied. You may also want to consider cleaning certain areas less frequently if they now seem to be overcleaned.

In a few cases there may be evening activities such as meetings which can be re-scheduled to daylight hours, but frequently the best that can be done is to switch an activity to an area with fewer lights or where banks of lights can be separately controlled.

If re-scheduling is not possible, you may find that enough electricity is used to justify some rewiring.

Partial lighting before and after "public" hours

There may be times when employees must work in an area but your "public" (e.g., customers) are not in your building. A good example is a store, before and after it is open to the public, when shelves are stocked, merchandise is rearranged, cleaning is done. Employees may need to move freely and safely through the entire area, but full lighting is not needed because it's not selling time.

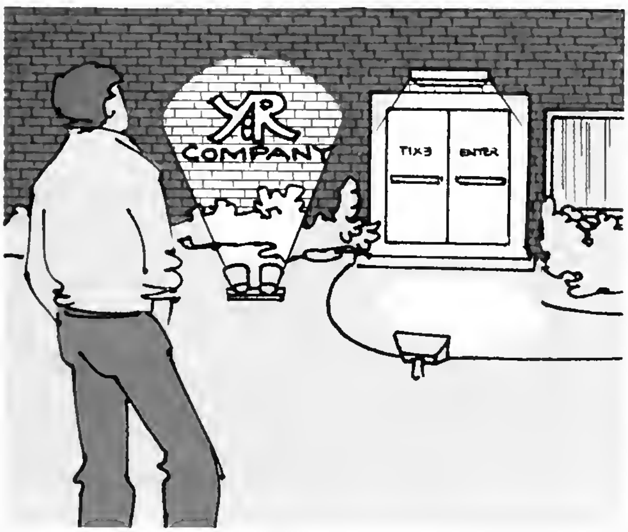
If you have enough control of lights with a bank of switches, you may be able to turn on, say, half the lights and provide enough light throughout the area. If not, you may want to re-wire so this is possible, if you find that enough time is involved to justify the cost. To calculate your lighting energy savings, simply figure the cost of running the lights the way you do now for the total hours of this kind of use per year, and divide by two (for half lighting).

Keep lamps and fixtures clean

Dust, grease, and other dirt accumulations can absorb as much as 30% of the light from lamps and reflecting surfaces. Keeping them clean may allow you to reduce the wattage of the lamps or even remove some of them.

Reduce or eliminate unnecessary outside lighting

Your building may have lighted parking areas, signs, entrances, facade, walls, and landscaping. You may be able to eliminate some of this lighting entirely, use lower wattage or more efficient lamps, or reduce the time the lighting is on—after all, how many people are going to see your signs at 3:30 in the morning?



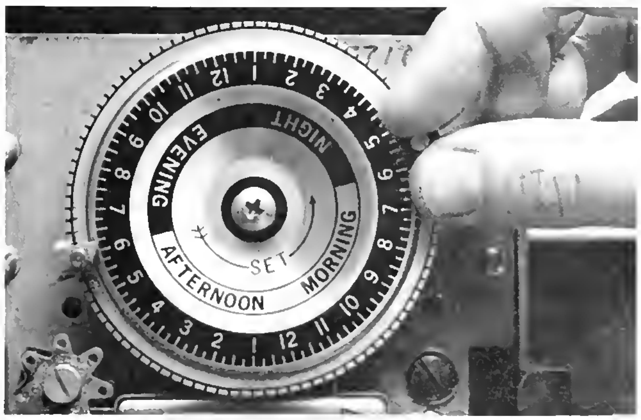
Use only necessary safety and security lighting

Unneeded lights in hallways and other areas can waste considerable energy. Use lower wattage bulbs if appropriate. At night and when areas are unoccupied, make sure the only lights left on are those needed for safety, security, or some other specific purpose. If enough energy savings will result it may pay to do some rewiring so lights can be separately controlled; and if you feel people won't always remember to turn switches off manually, it may pay to install automatic timers to do the job.

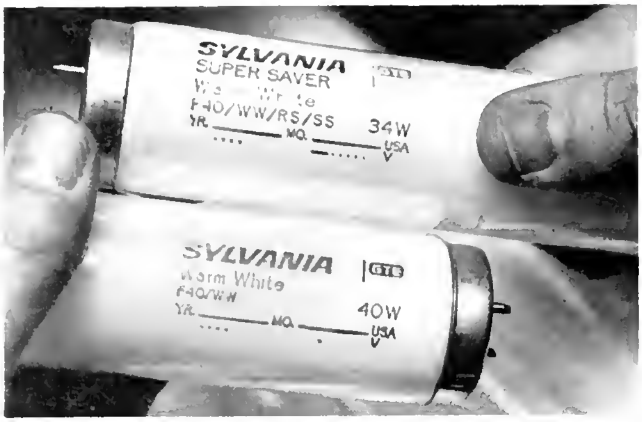
Make sure timers are working and set properly

Many exterior lighting systems and some interior ones, too, are controlled by time clocks which switch the lights off and on automatically. Timers that are activated by photocells will automatically adjust for seasonal variations in daylight. Timers that are set by hand to operate at fixed, pre-determined times must be readjusted seasonally.

If your system has a manually set timer, it may be set improperly, or incompletely if some of the "pins" are missing. A typical seven-day time clock has two movable pins for each on/off cycle; so, properly set for a week it should have as many as seven pairs of pins, each pair in the correct positions to control the lights for one day. Make sure no pin is missing or in the wrong position and that the timer is properly set to take into account seasonal and daylight saving time changes, weekends and holiday closings. If there is a power outage, be sure to reset your timers after power has been restored.



A properly set time clock ensures lights are on only when needed. This model is for lights, such as security lights, used at the same time daily; 7-day models permit daily variations you might need for parking lot lights, other illumination.



34 watt high-efficiency fluorescent uses 15% less energy than 40 watt lamp.

Install high efficiency fluorescent lamps to replace standard ones

In addition to their older lines of lamps, several manufacturers now market slightly lower wattage but more energy-efficient fluorescents. Typically the new lamps draw abut 15% less power yet yield only 10% less light. This loss of light may not be noticed, but if it is not acceptable the loss may be at least partially re-couped when a clean new lamp is installed and the reflecting surfaces of the fixture are cleaned.

When you install these new lamps ask your supplier to make sure they are compatible with the existing ballast (it is not cost-effective to replace both the lamps and the ballast, unless the ballast is burned out — see below).

If your fluorescents are used only infrequently, it probably will not pay to install the new energy-efficient ones until the old ones have burned out. However, *if your fluorescents are used all day, all week, year-round*, your energy costs may be high enough to justify *installing the new lamps and throwing the old tubes out even if they still work*! So much energy may be saved that its value will soon offset the cost of the new lamps. And since the life of a fluorescent is as much as 20,000 hours, it might take you 10 years to wear out a recently installed standard fluorescent, during which time you would use extra electricity worth considerably more than the cost of a replacement lamp.

The Economics of Discarding 40w Fluorescents that Still Work

Old lamp	New lamp
40 watts	34 watts
× 8 hrs/day	× 8 hrs/day
320 watt hrs./day, or 0.32 KWH	272 watt hrs/day, or 0.27 KWH
0.32 KWH	0.27 KWH
× 260 days/yr	× 260 days/yr
83.2 KWH/yr	70.2 KWH/yr
× 5 years	× 5 years
416 KWH	351 KWH

65 KWH saved over 5 years.

Net savings if electricity costs:

5¢/KWH	10¢/KWH	15¢/KWH
$3.25	$6.50	$9.75
– 1.60*	– 1.60*	– 1.60*
$1.65	$4.90	$8.15

* ½ cost of new lamp; assumes lamp lasts 20,000 hours, or 10 years.

This is a simplified example of life cycle costing, which takes into account the cost of equipment, its useful life, energy consumed, and the cost of that energy. This example does not, however, factor in possible *changes* in the cost of equipment or energy, or financing costs if needed.

Install more efficient ballasts when replacing burned out ones

The ballast in a fluorescent or HID fixture provides proper starting and running voltage and current. But some ordinary ballasts may draw over 15 watts of power when the fixture is switched on. For only slightly more than the cost of an ordinary ballast you can get one that uses much less power. Because of the total cost of the ballast, however, it probably will be cost-effective to install the new energy-efficient type in your present fixtures *only* when the old one has burned out. When buying new *fixtures*, make sure they have the new energy-conserving ballasts.

120 watt PAR spots at right have improved lens or reflector design to yield as much light as 150 watt lamp at left.

Relamp with lower wattage incandescent lamps

Where you have more illumination than you need, you may be able to substitute lower wattage lamps. You have a lot of flexibility with incandescent lamps, since there is a wide range of lamps with the same size base.

There are also new high efficiency incandescent lamps you can use as replacements. For instance, a new 67 watt replacement for a 75 watt lamp yields only 5% less light yet uses 11% less electricity.

There are improved design floodlamps (see "Use ER lamps" section) and spotlights available, too. For example, a new 120 watt PAR spot will yield the same amount of light as an older 150 watt PAR. The 30 watt reduction in power consumption will save 20% in electricity costs.

67 watt high-efficiency incandescent uses 11% less energy than 75 watt lamp.

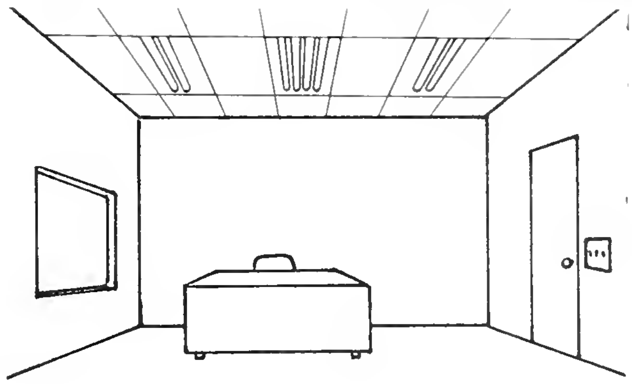
Consider a 12 × 14 foot private office with 12 40-watt fluorescent lamps which consume a total of 480 watts of electricity per hour of operation (.48 kilowatt hours — KWH — of electricity). The lights normally are on 9 hours a day. *Present* annual consumption of electricity is 1,123 KWH (.48 KWH × 9 hours × 5 days × 52 weeks, not including evening cleaning and occasional weekend use), and this might cost anywhere from $34-168 a year. **Three things can easily be done to save electricity:**

- Remove two pairs of lamps. Light is needed most over the desk but less near the window and door. Without doing anything else, this would save ⅓, or 374 KWH each year.
- Turn lights off two hours a day — one hour at lunch and one hour during times when the office is unoccupied. This will save 2/9 (about 22%) of the electricity to run the remaining eight lamps.
- Replace the remaining eight lamps with energy saving lamps which use 15% less electricity.

Annual Electricity Savings:

Present consumption	1,123 KWH
Minus new consumption	– 495 KWH
Electricity saved per year	628 KWH

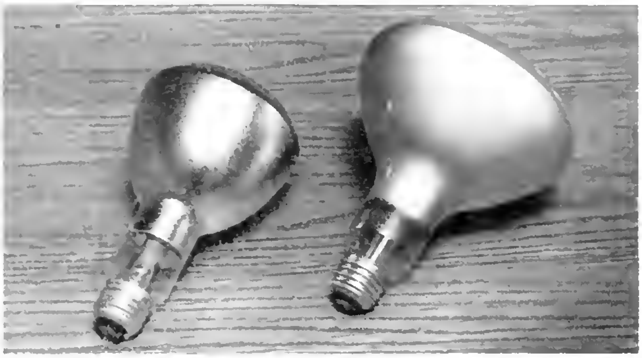
This amounts to a 56% saving worth from perhaps $19-94 *a year*.



The result is an office with adequate lighting consisting of eight 34-watt fluorescent lamps consuming a total of 272 watts per hour of operation (.272 KWH) and used seven hours a day. The *new* annual consumption of electricity is 495 KWH (.272 KWH × 7 hours × 5 days × 52 weeks).

Check Table 1 to see what this saving would be if *you* were paying the electric bill for this office. Once again, this is the saving for *just one office*; using similar techniques throughout your space or building will add up to much larger total dollar savings. While new lamps will cost you money, they will more than repay their cost (depending on the amount you use your lights and the unit cost of your electricity). Further savings are possible by disconnecting the ballasts.

Use ER lamps or extenders in recessed downlights



75 watt "ER" flood (left) is specially designed to project light from deeply recessed downlight fixture, may be used as replacement for 150 watt flood (right).

In a ceiling downlight fixture, as much as 50% or more of the light from a flood lamp may be trapped in the fixture if the lamp is deeply recessed. If the amount of light now being projected is satisfactory, you can save energy dollars by replacing the standard floodlamp with a lower powered ER (ellipsoidal reflector) lamp, which is specially designed to project much more of its light out of such a fixture. In many cases a 75-watt ER used to replace a 150-watt regular flood will yield *more* light with *half* the power. Energy costs saved can be *very* substantial (see Table 5). If you want *more* light, you might want to try a larger ER lamp or a socket extender that will bring the front surface of the lamp closer to the opening of the fixture.

Table 5

Incandescent Recessed Downlight Ceiling Fixtures

Savings from Installing 75-Watt Ellipsoidal Reflector (75ER30) Bulbs to Replace 150-Watt Reflector Floods

If your electricity cost per KWH is:	Your savings in electricity costs per year if you replace this number of bulbs: 2	8	16	24	48
3¢	$ 14	$ 56	$112	$168	$337
5	21	86	171	257	514
7	31	123	246	369	738
9	40	160	321	481	963
11	49	198	396	594	1,188
13	59	235	471	706	1,412
15	68	273	546	818	1,637

NOTES: Savings are calculated to the nearest dollar. It is assumed that: lights are used 52 weeks a year, 60 hours a week (6 days a week, averaging 10 hours a day), R bulbs are replaced when they burn out; both lamps will last about 2,000 hours (about 8 months at 60 hours a week), when purchased in quantity, a 75-watt ER lamp costs 65 more than a 150-watt R-type flood and this cost difference ($1 per bulb per year) is subtracted from the electricity cost savings

Replace two lower-wattage lamps with one higher wattage one

The larger the lamp, the more efficient it is. In other words, the greater the wattage of the lamp, the more lumens of light it produces *per watt*. This is true of all lamps *except* fluorescents.

Where you now use two or more incandescent or other non-fluorescent lamps, try to use a single more powerful lamp. For example, two 60-watt incandescents (total 1,680 lumens) can be replaced with one 100-watt lamp (1,800 lumens). This will yield *more* light but save the cost of 20 watts of electricity. Over the life of the new lamp (750 hours for a regular lamp) 15 KWH of electricity can be saved. Depending upon the cost of your electricity, the value of the energy saved may even justify buying a new lamp and throwing the old one away *before* it burns out. Or you can use the old lamps as temporary replacements for lamps in areas that are now overlighted.

Replace individual incandescents with fluorescents

Fluorescent lamps with incandescent-type screw-in bases are available for use as replacements for incandescents. This makes it possible to replace an inefficient and short-lived incandescent with a more efficient and long-lasting fluorescent lamp *without* changing the fixture itself. For aesthetic or other reasons this may not always be a good choice, but there may be many places where it will work well.

44 watt screw-in fluorescent: the light of a 100 watt incandescent, and much longer life.

Install dimmer switches

Different amounts of light may be needed at different times or in different parts of an area. The simplest way of providing this flexibility may be to install one or more dimmer switches. If you do this, use energy-efficient solid state dimmers and not the old fashioned wasteful rheostat type. If you have old rheostat dimmers and you use them very much, they should be replaced with solid state ones.

Other considerations

Extended life lamps (as distinguished from the new energy-efficient lamps) should be used only in locations where it is very difficult for you to replace burned out lamps. They yield less light (lumens) per watt than regular lamps, and the savings in replacement lamps is completely offset by their higher initial cost.

Many energy conservation projects require only a small amount of capital; in other cases, more substantial investment is needed but savings may be great. Before you invest, you will want to calculate the payback period and consider life cycle costs to see if the project will be a sound investment (see page 50).

New high-efficiency sodium light replaces old light on this parking lot pole.

Sodium lights for parking, other areas

You're probably seeing more and more yellow lights in parking areas and on street lampposts. These are the new, long lasting and highly energy-efficient sodium lamps.

While sodium light makes some colors (blue and red, especially) appear quite different, the very high energy efficiency of these lamps makes them an excellent choice for your parking areas and for other exterior lighting needs. Inside, sodium might be used in a warehouse or in other areas where color rendition is less important than in a store or office.

When switched on, sodium lights do not light up immediately. Where this delay would be inconvenient, you probably will want to choose another type of light.

Other projects to consider

- **Install timer switches** that automatically turn lights on and off; these can be either photosensitive switches that respond to changes in natural light (good for controlling exterior lighting) or timer switches that can be adjusted for desired intervals.
- **Modify the wiring** of the lighting system and **install additional switches** to enable you to turn on only those lights which you need.
- **Lower the ceiling fixtures** so they are closer to the areas which they light; since lighting intensity increases as distance diminishes, this can permit you to remove lamps or use lower wattage ones.
- **Substitute natural light for artificial lighting**, by installing adjustable window blinds, shades or reflective film that will control excessive daylight and glare. You may have to combine this with rewiring and installation of switches to enable you to turn off those lights that are nearest the windows.
- Rather than waiting for lamps to burn out, **replace all inefficient lamps at once** with more energy-efficient ones. Depending in part on your cost for electricity and the remaining life of the existing lamps, energy dollar savings may far outweigh the cost of the new lamps.
- For greater efficiency, **replace incandescent fixtures with fluorescent ones**. This may be a relatively expensive and complex project that you will need to analyze with the help of someone who both knows the installation costs and is up to date on all the latest improvements in the lighting field. If your lights are used a great deal, however, switching to fluorescents may be a very good investment. Fixtures may cost from $25 to $100 each depending on type.
- **Replace yellowed or hazy lenses, diffusers, and globes** with new ones that will remain brighter and clearer. Acrylic is suggested as the best material for the replacement. This will save you energy dollars only if the increased light output enables you to remove some lamps or use lower wattage ones.

- **When you re-paint, use a light color.** Medium and dark colors are poor choices for large areas if you want to keep your lighting bills down. The higher reflective ability of a light color may enable you to reduce the number of lamps you need in the area, so you can remove some lamps or go to lower wattages. Keep this fact in mind when you're going to remodel. The one exception may be the sign area for your building. By using a dark background with light colored letters you should be able to minimize the amount of wattage you need to make your name stand out.
- **Install desk lamps and other types of "task lights"** at work areas such as office desks, drafting tables, product assembly areas. These provide light when and where it is needed, with low wattage lamps, and may permit ceiling lighting to be decreased.

For each area, inside and out, you'll need the following information:

Type of fixture: ______________________
Number of fixtures: ______________________
Type of lamp (brand, wattage, specific
designation or code): ______________________
Number of lamps per fixture: ______________________
Watts per fixture: ______________________
Total watts in area: ______________________
Present light levels
Too bright______ Adequate______ Too dim______
Footcandle level (measured at
surface where light is needed): ________ footcandles
Lights are on: ________ hours/day
________ days/year
Can lights be switched on and off as desired?________
Additional hours per day lights could be turned off:
____
Is there an automatic timer? ______________________
Is it set properly? ______________________

Table 6

Save by Substituting Lower Wattage Lamps

If your electricity cost per KWH is:	Annual Electricity Savings* if each replacement lamp saves: 5w	10w	20w	40w	75w
3¢	$ .31	$ .62	$ 1.25	$ 2.50	$ 4.68
5	.52	1.04	2.08	4.16	7.80
7	.73	1.46	2.91	5.82	10.92
9	.94	1.87	3.74	7.49	14.04
11	1.14	2.29	4.58	9.15	17.16
13	1.35	2.70	5.41	10.82	20.28
15	1.56	3.12	6.24	12.48	23.40

*2,080 hours a year, 8 hours/day, 5 days/week, 52 weeks/year.

Table 7

Save by Removing Lamps

If your electricity cost per KWH is:	Annual Electricity Savings* for each lamp removed: Fluorescent** 40w	Fluorescent** 75w	Fluorescent** 110w	Incandescent 60w	Incandescent 150w *flood*
3¢	$ 2.50	$ 4.68	$ 6.86	$ 3.74	$ 9.36
5	4.16	7.80	11.44	6.24	15.60
7	5.82	10.92	16.02	8.74	21.84
9	7.49	14.04	20.59	11.23	28.08
11	9.15	17.16	25.17	13.73	34.32
13	10.82	20.28	29.74	16.22	40.56
15	12.48	23.40	34.32	18.72	46.80

*Includes electricity but not cost of replacement lamps. Assumes lights are used 8 hours a day, 5 days a week, 52 weeks a year (2,080 hours a year).

**Additional savings will result if ballast is disconnected, too. See Table 8.

Table 8

Save by Disconnecting Ballasts

If your electricity cost per KWH is:	Annual Electricity Savings* for each ballast disconnected when fluorescent lamps are removed: 6.5w ballast for 2 40w lamps	8w ballast for 1 40w lamp**	12.5w ballast for 2 75w lamps
3¢	$ .41	$ .50	$ .78
5	.68	.83	1.30
7	.95	1.16	1.82
9	1.22	1.50	2.34
11	1.49	1.83	2.86
13	1.76	2.16	3.38
15	2.03	2.50	3.90

*Assumes 2,080 hours of operation (8 hours a day, 5 days a week, 52 weeks a year) Also assumes fixtures would be turned on even after lamps have been removed.

**In a single lamp fixture.

ENVELOPE

Your building's "shell" or "envelope" is made up of the windows, doors, walls, foundation, floor, roof and perhaps skylights. The envelope is the *barrier* between the carefully controlled, temperate *indoor* environment in your building and the fluctuating and sometimes harsh *outdoor* environment. The envelope is also a selective "filter" which can be used to make the indoor environment more comfortable, by allowing certain amounts of light, air, heat, and humidity to enter and leave the building.

If the envelope works well as a barrier and as a filter, you will use less energy in your HVAC (heating, ventilating, and air conditioning) system to control the heat, air and humidity levels inside your building.

Even with a very good envelope, your building will lose heat in cold weather and gain it when it's hot outside. Your basic objective is to *minimize* these losses and gains. To do this you will want to:

- **Stop infiltration**—the leaking of cool or warm air into your building, or out of it, through openings such as cracks in walls, around windows, where doors don't fit or close properly; and
- **Reduce conduction**—the transfer of heat through materials, from the warmer side to the cooler side (heat always flows to something cooler). All materials conduct heat, but some, such as a single pane of window glass, conduct it faster than a substance like fiberglass insulation, a poor conductor and therefore a good insulator. "R" value is a measure of the resistance to conduction: the higher the "R" value number, the higher the resistance. There are various ways you can increase the "R" value of your roof, walls, floor and windows, to cut down the transfer of heat from one side to the other.

You'll also want to control humidity levels. A range of 30%-60% will provide satisfactory results in most parts of the country. Drier air may make wood furniture and veneers come apart and can irritate people's lungs. Very moist air can cause mildew and rot, especially if it is trapped behind insulation (this is why insulation should be installed with a vapor barrier on the side facing the heated interior part of your building). Very moist air also retards evaporation of perspiration, one of the ways your body loses heat, and will make people feel warmer; in winter this may be fine, but in summer you may have to turn down your air conditioner thermostat a degree or two to keep people comfortable if humidity is high.

Install or replace caulking to close cracks

Your building may have air-leaking cracks for several reasons: the building was not tightly constructed in the first place; cracks developed as the building aged; or the original caulking has dried out and pulled away.

Walk around the outside of your building to locate cracks and other obvious openings. On the inside look for cracks of daylight and feel for drafts. Ask people who use the building where they notice drafts on a windy day; a piece of tissue paper held at one end is also useful for locating drafts.

Places that may need caulking include:

- around window and door frames
- where the wall meets the foundation
- in the foundation itself
- where walls join at corners
- around window air conditioners and other equipment installed in walls or the roof
- around places where piping or electrical conduits enter the building

Install caulking where there is none, and remove and replace worn out caulking. With many caulking materials the surface temperature must be above 40° to ensure a good seal. If the cracks are large, fill them with glass fiber insulation before caulking. Some masonry cracks will require cement work rather than caulking.

Caulking is generally easy to do, but you may have some trouble reaching high windows in multi-story buildings. Caulking is especially important on the side of your building most exposed to cold or hot winds.

There is a wide variety of caulking materials available. Your hardware or building supply dealer should be able to advise you as to the best ones to use for your particular needs.

Replace faulty or broken window glass

Broken or cracked windows are not only hazardous, they also leak warm or cool air and drive up your energy bills. Missing panes do, too. Check your building and make the necessary replacements. If you need to patch a cracked window temporarily, there are heavy transparent tapes (not ordinary office-type adhesive tapes) that can be used for this purpose.

Tighten up window and door frames; repair, replace, or install weatherstripping

Tighten up window and door frames with screws or nails, and make sure they have weatherstripping, especially between the upper and lower sashes of double hung windows and around all exterior doors. Pay special attention to the "weather side" of your building, where winds usually come from during hot or cold weather.

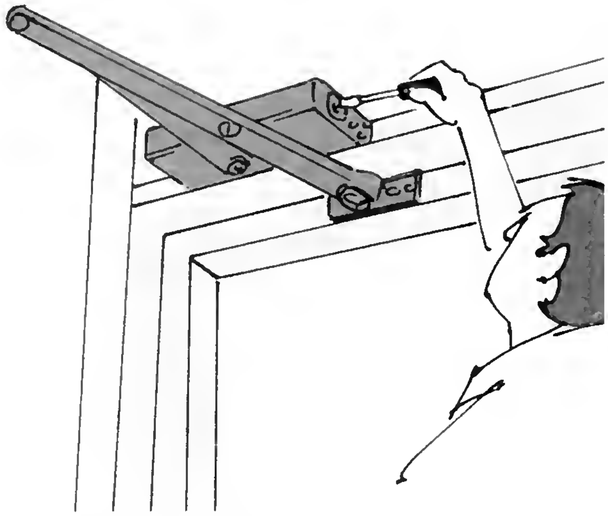
A pair of exterior doors with no weatherstripping can easily have an opening of ¼″ where they meet. While this doesn't look or sound like much, on a 6′8″ high pair of doors it adds up to the equivalent of a *20 square inch opening* (the size of this box)! A similar gap on just two average size double hung windows, where the sashes meet, would add up to the same 20 square inch hole!

If existing weatherstripping is in good condition but has come loose, re-fasten it with an adhesive, nails, screws, or staples, whichever is appropriate. If it has deteriorated, or there is none, install the type that is designed for the particular purpose. There is a special kind for double doors, which often are hung with a substantial gap where they meet so they can swing freely. For the bottom of a door you should use something called a "door sweep."

For economy, doors and windows that do *not* move should be caulked rather than weatherstripped.

Fix doors and windows that do not operate properly

Fix exterior doors and windows that don't fit tightly or close completely; don't forget back doors and loading dock doors. Do the same for any interior doors that separate areas with different temperatures—a door to an unheated storage area, for instance. Some may need to be completely refitted or re-hung; in other cases, simply adjusting the striker plate or planing off an eighth of an inch will do.



Adjust, replace or install automatic door closers

Outside doors are frequently fitted with automatic door closers to ensure that they close completely all the time. Adjust all closers, by turning the adjustment screws, so they operate properly and close the door rapidly enough; slow closing lets cool or warm air escape or enter your building. If the closer is worn out or missing, and the door is on the weather side or is one which people are forgetful about closing behind them, install a new closer and adjust it properly.

Cover window air conditioners in cold weather

In addition to making sure there is caulking around the window openings for window air conditioning units, cover the exterior portion of the air conditioner during cold weather. If left uncovered, even with vents closed these units can let cold air into your building.

Insulate and shield windows better

Single pane window glass conducts a great deal of heat; its thermal resistance (R value) is very low, only 0.9. Single pane "storm" windows that fit over existing windows, and multi-layer "thermal" replacement windows can double or triple the "R" value and resist the passage of a lot of heat.

You may want to consider **storm windows** if your present windows are in good condition and you are interested in maximum transmission of light. If you do not open your windows, large glass storms or single sheet plastic windows that remain in place all season may be a good choice. Plastic exterior windows will also resist breakage. If you have double hung windows that you do open, double hung "triple track" storms with screens may be best.

Replacement **thermal windows** with two or three layers of glass may be appropriate if you are planning to replace existing windows or build an addition. Fixed and movable types are available. In some thermal windows, the space between layers of glass is sealed and filled with a dry gas; this does not necessarily improve the window's insulating ability but does help prevent moisture from collecting between the panes.

Other products that help prevent heat transmission through windows include **reflective film** that can be applied to existing windows to reflect solar heat and retain internal heat within the building. Using this kind of film should be carefully evaluated in relation to your building's characteristics and the climate in your area, since it is permanently applied and does its job year round—reflects heat in summer but blocks helpful solar heat gain in winter. Roller shades of the same material, that can be used flexibly to meet seasonal and even daily needs, may be a better choice.

Since windows not only are the most heat-conductive parts of the building envelope but also greatly affect the comfort of people inside the building, particularly in warm climates, you may want to consider these other ways to shield windows and reduce heat gain in hot weather:

- movable awnings.
- fixed lattice grilles and "brise soleils" (recessed windows to consider if you are building a new structure) that, without any moving parts, block sunlight at certain times of day.
- deciduous shade trees on the east, west and south sides of your building, particularly a low building.

On high school converted to office building, lattices provide horizontal design accent and shield windows from sun's heat

Add building insulation

By adding insulation you can increase your building's resistance to heat loss and heat gain. Depending on the shape of the building it may be more economic to insulate the roof than the walls. This obviously will be the case for one-story buildings where the roof area is a high percentage of the total area of the building envelope. For tall buildings roof insulation is less important.

In a very cold or hot climate, or one with both extremes, insulation can pay very well, because it works year-round—in winter it reduces your heating bill, in summer it cuts your air conditioning bill. In more temperate climates, cost justification may be more difficult.

Roof insulation may be installed inside, under the roof, or outside between the structural roof members and the weatherproofing material. "Batts" or rolls or blown-in insulation are used inside, foam boards outside.

Wall insulation for an existing wall is usually blown in between studs or applied inside (in batts or boards) and then re-covered with some interior wall surfacing material.

Different insulating materials have different properties and "R" values. It is often recommended that roof insulation bring resistance up to R20, wall insulation to R12.5.

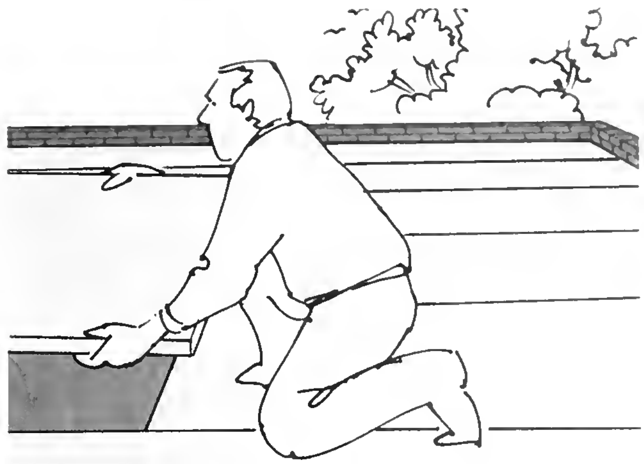
Several important considerations to bear in mind:

- Prevention of moisture build-up. Vapor barriers and adequate ventilation are important to prevent mildew and rot of building materials. But be careful not to add vapor barriers to existing ones; this may cause condensation in the insulation or structure.
- Roof load in cold areas. With adequate roof insulation, snow will melt much more slowly. Make sure your roof is strong enough to support the added weight of snow accumulations.

Table 9

R Values of Some Insulation Materials

Material	R Value per Inch
Glass loose fill	2.5-3.0
Mineral fiber loose	2.5-3.0
Mineral fiber blanket	2.5-3.5
Cellular glass board	2.8
Perlite board	2.8
Fiberglass batt	3.0-4.0
Cellulose loose fill	3.1-3.7
Mineral fiber board	3.5
Fibrous glass board	4.0
Polystyrene foam board	4.2
Polyurethane foam board	6.3
Polyurethane foamed in place	6.7



- Code requirements. Insulation must meet state or local code requirements for fire resistance and perhaps other properties.

Adding insulation can lead to significant reductions in energy bills, particularly if there is no roof insulation at all just now, but it isn't necessarily a good bet in every building. To make sure you make the right decision, get the help of a reliable firm *before* you invest, to inspect your building and give you estimates of both costs *and* savings.

Block up unneeded windows and other openings

Unless a window provides light or air, it may not be needed. For security reasons, it may be *desirable* not to have ground floor windows. Blocking up window openings—with brick or other material that harmonizes with the exterior of your building—will save energy, since solid materials will conduct less heat than leaky windows with single pane window glass ("R" value of only 0.9). You may also want to consider making large windows smaller.

Because of construction costs, however, it probably will not pay in terms of energy savings to block up a window opening—unless the window is badly deteriorated and would have to be replaced anyway. But there may be other reasons, such as a remodeling plan or security needs, which call for eliminating some windows. Or, you may want to use a sheet of insulating material on the inside, such as polystyrene or polyurethane foam board, if interior and exterior aesthetics permit. To be effective, such materials must be carefully cut and fitted to fully close the window opening.

If there is a choice of windows to seal up, you may want to select those on the windy "weather" side of your building.

Ways to keep auto service area doors closed

These large doors may be opened for several reasons: to let vehicles or people pass, or for ventilation. This can result in substantial heat loss or gain. First, as much as possible keep interior doors closed that separate the service area from the rest of the heated or cooled part of your building. Then, in the service area itself, consider the following:

- installing an automatic "electric eye" door opener/closer that keeps the door open only when a vehicle is passing.
- cutting a small, person-size door in the overhead door (many auto service places have these).
- installing an exhaust fan system with hose connections to tailpipes to remove exhaust fumes without displacing the heated or cooled air in the service area.
- wiring heaters or air conditioners in the service area so they turn off whenever the overhead doors are opened.
- if the overhead doors don't fit well around the sides and bottom, install flexible moldings and weather-stripping designed for this purpose or, along the bottom, try using rubber strips cut from an old inner tube. Be sure, however, that there will still be adequate ventilation once these openings are closed.

As with loading dock comfort, the more comfortable you can keep the auto service area the more productive the people working there are likely to be.

Curtain of plastic strips made by wholesale company's owners is used year round, prevents both heat loss and gain while permitting access to loading dock.

Keeping overhead doors closed as much as possible reduces heat loss and gain.

Flexible windbreaks and interior doors for loading areas

At a loading dock there is a very large wall opening, perhaps measuring 100 square feet. You'll want to make sure that exterior doors of loading docks are kept shut as much as possible. But when a truck is being loaded or unloaded, a lot of heated or cooled air can escape or enter your building—through the gap between the truck body and the loading door opening. If the truck backs in at even a slight angle to the loading dock, this gap can be a big one.

To minimize this problem, you'll want to consider doing the following:

- Make sure trucks back up straight and as close to the opening as possible.
- If the opening is larger than needed, make it smaller.
- Install a curtain of plastic strips or a flexible windbreak (dock seal) all around each opening.
- When the exterior door is open, be sure to close the doors that separate the inside of the loading area from the interior of the building. If there are no such doors, you may want to install some.

If your loading dock is exposed to harsh winds, it is more likely you will want to consider installing the flexible windbreaks. Besides energy savings, another advantage is that those doing the loading and unloading will be protected from the weather and the job may get done faster.

Vestibules and vestibule doors

A vestibule with two sets of doors acts as an airlock to reduce the amount of air that can enter or escape from your building as people enter and leave. You may be able to create a vestibule by installing a door or set of doors *inside* your building, or you may have to build it on as an addition. A vestibule does *not* have to be heated or air conditioned (see HVAC section). Whether or not it pays to create a vestibule depends a lot on climate and on the design and orientation of your front entrance. If your entrance is on the windy side, and if you have a lot of very hot or cold weather, it's probably something to consider.

For each area (e.g., front of building):

Are there storm or thermal windows?

☐ Yes ☐ No Describe: ______________________

____

Number/location of broken windows: __________

____

Number/location of cracked windows: __________

____

Description of door or window repairs or replacements needed (including door closers): __________

____

Caulking: _______ feet to replace

_______ feet to install

Weatherstripping: _______ feet to repair;

_______ feet to install

Loading docks and garage doors in need of improvement: ______________________

____

Insulation

Location	Check if not Insulated	Present Insulation Thickness	Type
Ceiling	_____	_________	______
Walls	_____	_________	______
Floor	_____	_________	______
Sills	_____	_________	______

Location of drafts (use tissue to locate): __________

____

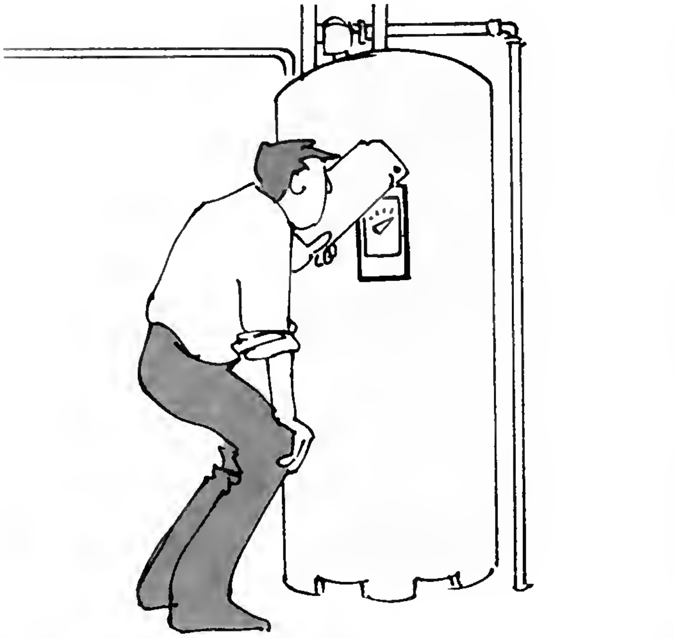
____

____

Location of windows that need shades, blinds or reflective film: ______________________

____

HOT WATER



Hot water may be used in your building for "domestic" purposes—i.e., for showers and baths, washing hands in the lavatory, washing dishes—or for other, more intensive uses such as restaurant or institutional dishwashing (see the Machines section for some of these).

In some buildings, such as motels and apartment buildings, a substantial part of every energy dollar is used to heat water. Whether or not your building uses lots of hot water, there are many ways to cut back on waste. These fall into four basic categories:

- **Reducing the temperature of the hot water;** it often is much hotter than necessary.
- **Reducing the amount of hot water used.**
- **Reducing the heat loss in the system.** Most domestic hot water systems are "stand-by" systems; that is, the hot water is used only infrequently but nevertheless is kept heated, stored and under pressure in the distribution pipes all the time. Making hot water available throughout your building 24 hours a day, seven days a week, whether needed or not, can waste a significant proportion of the energy used, especially if the system is poorly designed and poorly insulated.
- **Using a "free" heat source** to heat the water, including heat reclaimed from some other energy system or atmospheric heat obtained by use of some device such as a heat pump.

Reduce the hot water temperature

Because the temperature control is set too high, many if not most hot water systems waste energy by generating water that is considerably hotter than needed. At the faucet, it ends up being tempered by adding cold water; heat is also lost through uninsulated distribution pipes and inadequate storage tank jackets.

Check the setting on the hot water tank temperature control, and use a thermometer at the faucet nearest the tank and at the dishwasher. Adjust the hot water tank temperature control until the desired temperatures are reached at the points of use. Making this adjustment is usually simple. If the temperature dial on the tank is not visible, you may need to remove a few screws and a cover plate to get at it; if you have an electric water heater make sure you shut off the electric current to the hot water tank before you do this.

Table 10

Hot Water Temperatures
(degrees Fahrenheit)

Handwashing	105°
Showers	105°
Laundry	160°*
Dishwasher rinse	180°**

*Check code requirements. Even lower temperatures may be practical with some soaps and detergents.
**Most diswashers need water to enter at 140 to boost it to 180 Also see machines section.

Repair leaks in the hot water system

It *always* pays to repair leaky hot water faucets, showerheads and pipe joints. And because hot water systems are pressurized, most leaks gradually get worse.

A few minutes, and a few cents for a new washer, are all it takes to fix a leaky faucet.

Repair or replace valves and faucets that don't operate properly, and make sure all joints are tight. Many repairs, such as replacing a sink faucet washer, you can do yourself quickly, easily, and at virtually no expense.

Turn off the water heater, permanently or temporarily

Your water heater may supply only the lavatory sinks. If state or local codes permit, and employees don't mind, you may want to shut off this heater entirely, at least in the summer.

If you normally use a lot of hot water but are closed for two or more days in a row—e.g., weekends or vacation shut-downs—it may pay to shut off the water heater for the unoccupied period, especially if it is an electric heater and your KWH rate is high. It may even pay to install a 7-day time clock so this will happen automatically.

Heat or use hot water during off-peak hours

If your water is heated by electricity, you may be able to take advantage of lower off-peak utility rates and avoid paying extra demand charges. Ask your utility company if this is possible (see page 48).

To benefit, you might have to reschedule your heavy use of hot water (e.g., clothes or dish washing) so machines are used at night, or early in the morning, using water heated at night at off-peak rates and stored in your heater's tank. If you can reschedule adequately, it may be practical to install a timer that restricts operation of your water heater only to off-peak hours.

Eliminate hot water circulation when the area is unoccupied

Your hot water system may include a circulation pump that assures that *hot* water is available at all times at all faucets without delay. An operating pump means that your water heater is heating and reheating water to overcome stand-by heat losses even if no water is being used at the faucets.

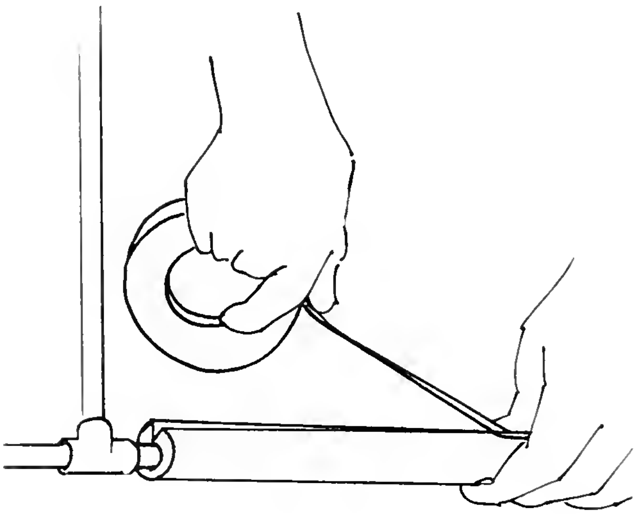
When your space is unoccupied—at night, on weekends, during shut-down periods—hot water is not needed. If there is no timer or switch to de-activate the pump during those periods, consider having one installed; this will reduce the amount of time your water heater will be on.

Test and adjust a fuel-fired heater

A fuel-fired (gas or oil) water heater can waste energy if it is not burning the fuel properly. Have such a heater checked to reveal whether excessive heat is being lost up the stack and whether the fuel is being incompletely burned. Your service technician will be able to make the necessary adjustments to improve the heater's efficiency. If you have a fuel-fired heater, you should have it checked and cleaned at least once a year, perhaps at the same time your boiler or furnace is being tested and adjusted.

Clean out sediment

Any tank-type water heater will lose efficiency if sediment accumulates in the bottom and acts as an internal insulator to inhibit transfer of heat from the heating elements to the water. To make sure these deposits don't build up, periodically open the drain valve near the bottom of the tank and draw off water until it runs clear and the sediment has been removed (probably two to five gallons of water will be enough to drain). Flushing the tank every six months should be sufficient, unless there are higher concentrations of lime and other minerals in the water in your area, which may make it necessary to flush as often as every month. Experiment for a few months to see what the proper interval is, or ask your water company.



Install or repair insulation on your hot water tank and pipes

If you have an uninsulated or poorly insulated storage tank and distribution pipes, adding an insulating jacket to the tank and installing tubular insulation on the pipes should be considered to cut "stand-by" heat losses. If the tank is hot or warm to the touch, it needs insulation. *If you have a gas-fired water heater*, for safety use only a "retrofit kit," which can be obtained from a hardware, plumbing, or building supplier. Repair or replace any existing insulation which needs it.

Install low flow showerheads

Showerheads are now available that provide satisfying showers using only 2-3 gallons a minute, in contrast to the 5 or more gallons per minute used by many older models. Though more expensive, well designed low flow showerheads are to be preferred over inexpensive disk insert flow restrictors which give poorer quality showers. Research shows that user acceptability of the replacement showerheads is extremely high. A low flow showerhead may cost about $10-$15.

Check the flow of the existing showerhead by timing the filling of a bucket of known size when the shower is on at a normal rate of flow.

Install self-closing hot water faucets

A spring operated faucet valve will make sure hot water isn't left on unnecessarily. Where the need for water will vary and may be considerable, such as in a kitchen sink, a foot operated valve may be most useful and will leave the operator's hands free. The type of self-closing valve most frequently used in lavatories operates by means of a hand lever; check to see whether a delay mechanism (e.g., 15-second delayed action) is required by your state or local codes, or whether there are other code requirements which must be met.

Install flow restrictors and aerators in sink faucets

While low flow showerheads will perform better than restrictors in showers, inexpensive and simple disk-type flow restrictors are suitable for sinks. An aerator, which "spreads" the water, can also be installed to assure a satisfactory though lower flow of water from the tap. Flow restrictors for lavatory sinks may be located at the shut-off valve (i.e., below the faucet handle) to prevent loss, or above the aerator. In places such as kitchens or janitors' sinks where speed in filling a container, or force of the flow, would be important to the task, you may not want to install flow restrictors.

Use "Turn Off the Water" labels

We are all creatures of habit. But we can gradually change wasteful habits—such as using more hot water than we need—if we are reminded in a tactful yet forceful way. Try placing a self-stick label on the mirror or backsplash right over each sink hot water faucet, and another near each bath or shower faucet. Your utility company may know where to get these labels.

Microcomputer on newer model clothes washing machine permits precise control of water temperatures, cycles.

Use cleaning materials that save hot water

In washing, your objective is to get things clean. This may require little if any hot water, since cleaning materials are now available that will perform satisfactorily with less hot water than you may have been using. Some of these cleaning materials still require hot water for washing but need less rinsing or may be used with cool rinses.

Replace a tankless coil with a different type heater

In some buildings, water is heated by the central heating system by means of a "tankless coil" installed in a gas-fired or oil-fired boiler, and there is no significant amount of storage. In such a case, the furnace or boiler must operate to heat even a small amount of water. Especially if the boiler or furnace is a large one, this can be a very expensive way to get a small amount of hot water. And in warm weather, when no space heating is needed, the excess heat generated is an added waste. Especially if you have little need for hot water, look into having this coil valved off and replaced with a storage tank type water heater or with small "local" heaters.

Consider changing to gas or to a heat pump water heater

In some areas, it costs more to heat water with electricity than with gas. It may make sense to switch to gas, when it's time for you to replace an old heater, or even before then if you use lots of hot water. You may also want to consider an energy-efficient electric heat pump water heater (see page 26).

Install the new water heater closer to the point of use

If you are replacing an old heater, or installing one for the first time, locate it as close to the major point of use (faucets, washing machines, etc.) as possible. This will reduce potential stand-by heat losses in the distribution pipes.

Switch to "local" storage tank type heaters

A large central heater with long runs of distribution piping can waste a lot of heat energy, particularly if poorly insulated and if there is relatively little need for hot water. Depending on your hot water needs and the age and efficiency of the existing system, it may make sense to abandon the old system and replace it with one or more small storage tank type water heaters very close to the faucets or other points of hot water use (e.g., one in each lavatory).

Saving Energy in Your COLD Water System

Most water coolers use electricity, and your electric costs may amount to several dollars a month for round the clock operation, even though the cold water from the fountain is hardly ever used (another example of stand-by energy losses). You may be able to raise the chilled water temperature or to disconnect the refrigeration unit by removing the cover and disconnecting the compressor. To decrease water waste, if you do leave things hooked up, you may want to install a paper cup dispenser; much of the chilled water from fountains goes down the drain.

Newer Ways to Heat Water

The **heat pump water heater**, one of the most interesting recent developments in energy technology, is an electrical device which can be an add-on to your present water heater or a self-contained unit. Working essentially as an air conditioner in reverse, a heat pump water heater extracts heat from the air outside your building and transfers it to the water you use inside. (For more on heat pumps, see the end of the HVAC section).

Surprisingly enough, heat may be extracted even from air that is quite cold—even 40°F or below—although the efficiency of a heat pump is higher in warmer air. Especially if you have a conventional electric water heater, a heat pump water heater is something to consider, with tests in one area with a moderate climate showing 40-50% lower operating costs.

Solar *space* heating is by no means new, going back to prehistoric south-facing caves and Roman atrium (courtyard) houses. On the other hand, much of solar *water* heating technology has come into use only in the last decade or so. The type most often seen now is the "active" system with solar roof panels that absorb the sun's heat and transfer it to the water. Solar is frequently used to pre-heat water, with a final boost added by another heater which may also provide back-up for cloudy periods. Whether solar would be a good investment for you may depend on many factors, including the availability of federal and state tax incentives.

Heat reclamation systems (see Washing and Drying section) may also be something to investigate, if your building has refrigerating units or houses industrial processes or other activities which throw off excess heat.

Whichever of the newer methods of heating water you consider, be sure to do your analysis in light of your particular needs—amount of water needed now and in the future, temperature required, etc.

Tank location: ____________________

Type of energy: ____________________

Storage capacity: ____________________

Recovery rate: ____________________

°F Temp. setting: ____________________

Age: ____________________

Tank insulation: ____________________

Location of electric booster heaters, if any: ____________________

Length of uninsulated distribution piping: _____ feet

At showerhead: ______ °F

At faucet nearest tank: ______ °F

At dishwasher: ______ °F

At washing machine: ______ °F

Showerheads: Number: ______

Rate of flow: ______ gallons/minute

Average use/day: ______ minutes/shower

Faucets: Number: ______

Rate of flow: ______ gallons/minute

Dishwasher capacity: ______ gallons

Times used/week: ______

Washing machine capacity: ______ gallons

Times used/week: ______

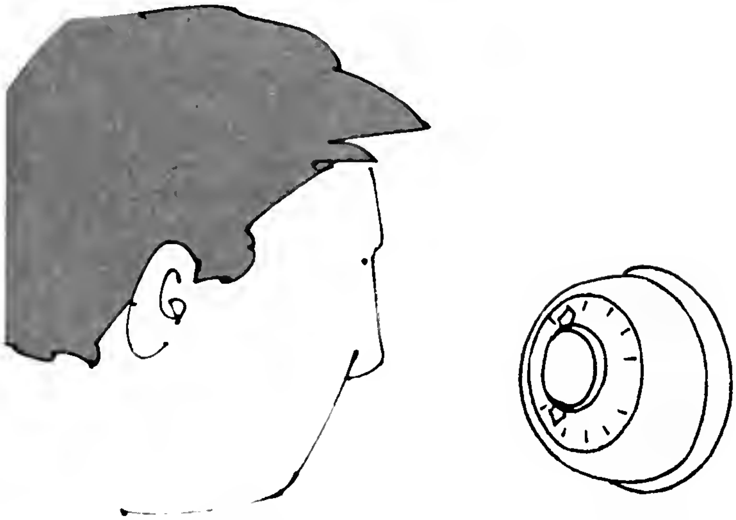
Location/Description of Each

____

____

Calculating savings for hot water systems can be difficult. The text above will give you some pointers. Fortunately, there are many no-cost things which are easy to do. But don't forget to consider investments such as low flow showerheads.

HVAC



HVAC—**Heating**, **Ventilating**, and **Air Conditioning**—may be the biggest user of energy in your building. Fortunately, it's possible to save 30% or even more on your HVAC energy bills.

To trim your HVAC energy bills, most things you can do fall into one of these categories:

- **Turn it off when not needed.**
- **Run it less** (includes using different temperature settings).
- **Make it more efficient.**

The first two you can usually do yourself, the last probably will require some assistance from qualified professionals—your heating oil supplier, gas or electric company, HVAC sales and service firm, or an energy conservation consultant. These people may best be able to help you correct the inefficiencies which can occur in many places in the system—at the primary heating or cooling source (e.g., the burner, boiler or furnace), in the distribution and terminal system (the pipes, radiators, ducts and vents), and in the HVAC controls. They can also help you evaluate potential capital investments, such as a more efficient oil burner, automatic flue damper, or automatic variable aquastat for your boiler.

HVAC Systems

There are many different kinds of HVAC systems. Your building may just have a central heating system and use windows for cooling and ventilation; or, in extreme southern areas, it might just have an air conditioning system. Most frequently there is some combination of heating and cooling apparatus, perhaps including a central system and one or more separate window or area units. Finally, if it is a newer building, it may have a complex, fully integrated "total environment" HVAC system.

There are four basic types of **heating systems:** warm air, hot water, steam, and electric. Electric systems normally have a number of thermostats and create heat in each area served. They offer flexibility of control but if used as the only source of heat for the entire building may be quite expensive to operate, especially if the building is poorly insulated. On the other hand, electricity can be an excellent source of heat for individual areas. The other types of heating systems usually are true central systems, generating heat at a central location and distributing it through pipes (with pumps, in the case of hot water) to radiators or convectors, or through air ducts to registers in different parts of the building.

Air conditioners are mostly of two types: *direct expansion*, in which air is cooled by being drawn past a heat exchanger filled with cooled refrigerant; and *chilled water*, where water instead of air is cooled, and then air is cooled by the chilled water. A unit air conditioner, such as a window or wall unit, is usually the direct expansion type and blows cool air directly into the area to be cooled or into a duct system. Central air conditioning systems use a network of distribution air ducts and registers.

Ventilation and air handling systems can be as simple as your windows or as complex as found in a centralized "total environment" system with variable air volume. Usually the system consists of some ductwork and interior vents, fans, and outside vents with automatically controlled dampers to draw in fresh outside air, mix it with inside air, and exhaust stale air from the building. The system may contain heating or cooling coils to change the temperature of the air. In a system in a building with a warm air furnace and central air conditioner, the ducts of the air handling system probably will be used to distribute the air warmed or cooled by those central sources.

Set thermostats lower during the heating season

During the heating season, keeping the temperature a little lower can really pay. Your savings will depend on how much you lower the thermostat setting and how cold the climate is.

If you make the change gradually, say 1° lower every week or so, it will give employees time to adjust to the new temperatures. Customers, clients, or other visitors may not notice the change at all. Experiment to see how low a setting is still comfortable.

If you have been keeping the setting high to provide heat to a few cold areas, and if your heating system cannot easily be balanced by adjusting warm air registers or radiator valves, you may want to use some supplementary heat sources to provide warmth for people in the coolest areas. This will enable you to set the thermostat lower while keeping everyone comfortable. You may want to consider a through-the-wall (sealed combustion) gas heater if you use gas.

Table 11

Reducing Heating Temperature

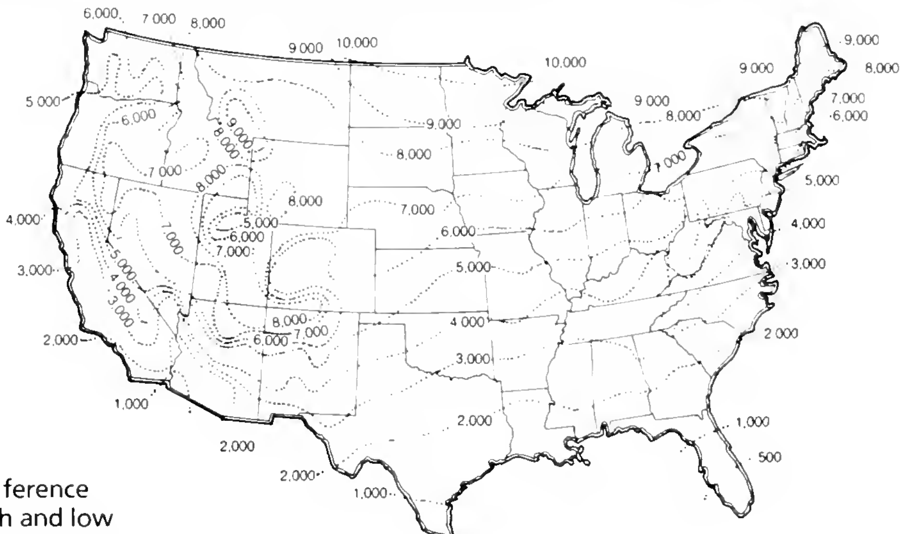
Heating Degree Days	Fuel Savings* if Thermostat Setting Is Reduced By: 3°	5°	7°
1,000	15%	26%	36%
2,000	14	24	33
3,000	13	22	31
4,000	12	20	28
5,000	11	18	25
6,000	10	16	23
7,000	9	14	20
8,000	8	13	18
9,000	6	11	15
10,000	5	9	12

*If temperature is reduced for entire time heating system is in operation.

"Reducing Energy Costs Means a Better Bottom Line", National Frozen Food Assn./U.S. Dept. of Energy

DEGREE DAYS

Normal Number of Heating Degree Days Per Year



What is a Degree Day?

A heating degree day is defined as the difference between 65°F and the average of the high and low temperatures in a given day. The higher the number, the more fuel will be used in heating your building.

Example: On a given day—

High Temperature:	**50°F**
Low Temperature:	**20°F**
Average Temperature:	$\frac{50°F + 20°F}{2} = 35°F$

65°F - 35°F = 30°F

Therefore, the particular day was a 30-degree-day day.

Although the heating degree day reading is useful, keep in mind that other factors such as sun load or excessive infiltration due to high wind also affect the heating requirements of a building and are not taken into account by the degree day calculation.

In addition, it should be remembered that the heating degree day number is not a true average, since only two readings of a 24-hour period are used.

The accumulation of degree days in a given month and year to date should be available from your local weather bureau or utility, or you can use the map above to make a rough calculation.

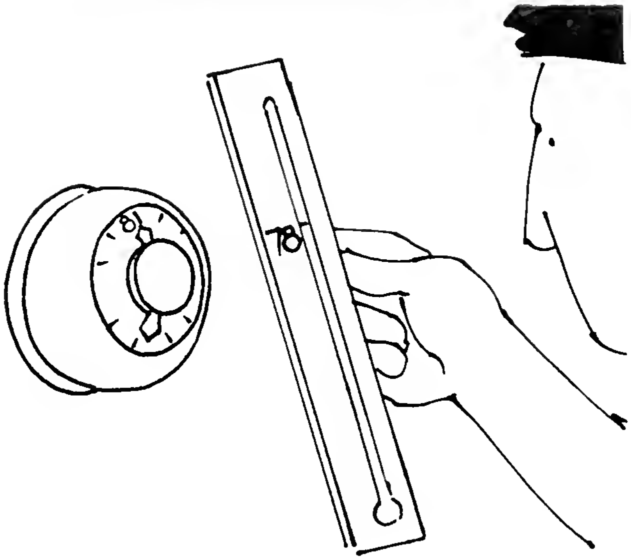
Set thermostats higher during the cooling season

Research indicates that energy savings are even greater, per degree, for raising air conditioner thermostat settings than for reducing heating levels.

As with changes in your heating system thermostats, change the air conditioner settings gradually, perhaps a degree every week or so, so people can get used to the new temperatures over a period of time. Visitors coming in from the warm out-of-doors will still feel a welcome contrast, even though the indoor temperature is somewhat higher than it used to be. Once again, experiment to see how high the settings can be without causing undue discomfort. Particularly if the people who occupy your space are relatively inactive, perhaps sitting at desks or standing behind counters most of the time, considerable changes in the settings may even be *welcome*—recall the times you have seen someone in a supercooled office typing with a *sweater* on.

When you raise the thermostat settings, make sure there is good air circulation. First, it keeps temperatures even and prevents cool air from collecting in a layer near the floor; secondly, it promotes the cooling process of evaporation of moisture from the skin; and third, it

supplies fresh air to counter drowsiness which could occur from a combination of somewhat higher temperatures and stale air. Be sure the air handling part of your HVAC system supplies enough—but not too much (see page 35)—fresh air. And remember, running a fan is considerably cheaper than running an air conditioner. On nice days, open some windows instead of mechanically cooling the air.



Checking your thermostat

People generally are comfortable at temperatures of 68° in winter and 78° in summer. To rely on your thermostats to achieve these temperatures, you have to make sure they are calibrated and adjusted to give *true* readings. Obviously, a thermostat that reads 78° when it is still cooling the air to a real temperature of 75°, is costing you a lot of energy dollars by making your HVAC system run more than is necessary.

Use a thermometer you know to be accurate—buy a good one, if necessary—and check each of your thermostats. First, run your HVAC system until a stable temperature is reached. Then measure the real temperature with your accurate thermometer; take the reading right next to the thermostat. If you are unable to adjust the thermostat yourself, get a technician to do it. In the meantime, make a note of the deviation so you can set the thermostat differently to achieve the actual temperature you want (in this case, you would set it at 81° to get a true 78°).

Lock your thermostats if necessary

Being able to control thermostat settings is crucial if you are going to save energy dollars. While many HVAC controls are hidden from view in boiler or mechanical rooms, thermostats are frequently located where people can see them. If not protected in some way, settings can easily be changed by anybody.

If your experience has been that employees or others tamper with the settings, first talk to people to see if there are any real problems with the settings you have chosen. They may be too high or too low for employee comfort, at least in some areas. If the settings seem reasonable but the tampering still occurs, consider spending the few dollars needed to buy and install a locking enclosure that really works. If you now have such enclosures, make sure they work and cannot easily be tampered with.

Eliminate unnecessary use of HVAC system at night and during unoccupied hours

You may be using energy to heat, cool, or freshen the air in your building when nobody is there to benefit — at night or on weekends, for example. If occupancy hours are different for various parts of your building or area, you can control temperatures for each area only if there are separate heating or cooling units, zones or thermostats (see below). But it may well be that your entire operation works on a regular 8, 10 or 16 hour basis.

Your present temperature controls can be operated manually by a person who has been given the responsibility for seeing that it is done every day. If you feel this may not be a reliable method, you can have a clock thermostat or 7-day timer installed that will turn the system, or some part of it, on and off automatically. You may already have such a device. If so, make sure it is set properly.

Air handling (ventilation) systems, as well as heating and cooling units, should be completely shut down if the building is unoccupied at night or at other times — unless health code provisions require round the clock ventilation. Energy is used to run the circulating fans, and a ventilating system that is working properly will discharge cooled or heated air to the outside and admit cool or warm air that may then need to be conditioned.

Savings can be substantial. For instance, a 14-hour night setback and full weekend setback, from 65° to 50° in the 5,000 degree day St. Louis area, would result in fuel savings of 28%! Use the heating degree day map and the next table to see what *your* savings would be. Contrary to what you may have heard, it is *not* more expensive to turn off the HVAC, let a building cool down or heat up, and then restore it to the desired temperature some time later.

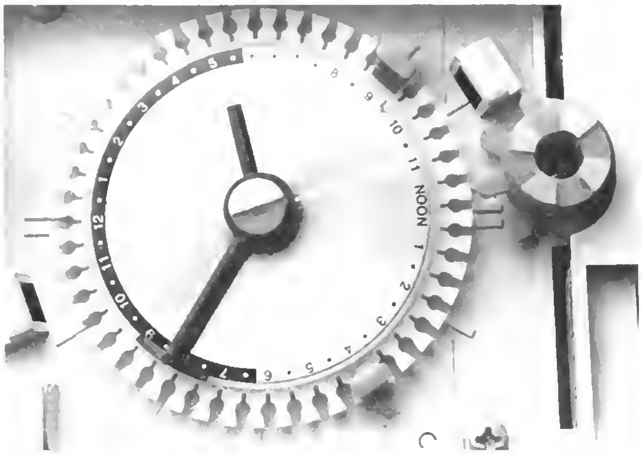
Table 12

Approximate Percent Savings from Setback

Degree Days	Setback Temperature 60°	55°	50°
1,000	13%	25%	38%
2,000	12	24	36
3,000	11	22	33
4,000	10	20	30
5,000	9	19	28
6,000	8	16	24
7,000	7	15	22
8,000	7	13	19
9,000	6	11	16
10,000	5	9	14

Note: Based on 65 F temperature and fourteen hour night setback Assumes full weekend setback.

"Reducing Energy Costs Means a Better Bottom Line", National Frozen Food Assn./U.S Dept. of Energy



Timer inside clock thermostat, set to change temperatures at 9 am and 4 pm.

Turn your HVAC on later, and off earlier, in the day

Turning your HVAC system down, or off, when your building is unoccupied, will save you energy dollars. For even greater savings, lengthen this time period.

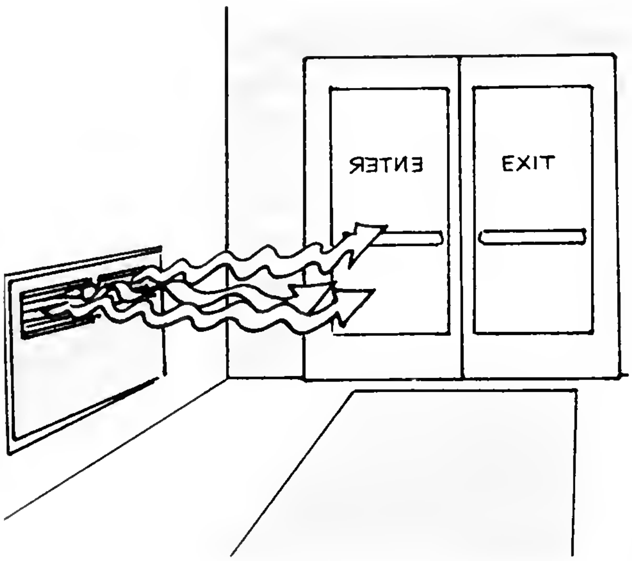
In the morning, use your HVAC controls to make the building reach the desired temperature settings about a half-hour *after* occupants arrive. For short periods of time, when they have just come in from much warmer or colder air outside, occupants usually will be satisfied with the relative warmth or coolness of your building.

At the end of the day or evening, turn off the heat or air conditioning a half-hour to an hour *before* occupants leave. Your building will stay relatively warm or cool for some time after the HVAC is turned off or settings are changed for the night.

A little experimenting will help you determine how long it takes for your space to heat up or cool down and how long it will stay comfortable after the HVAC system is turned off. Times may vary by the season. For instance, in the hottest weather your building may take longer to cool down and will warm up more rapidly. If you have timers or clock thermostats, don't forget to make the seasonal adjustments that may be necessary.

Reduce or eliminate vestibule heating

Buildings sometimes have heaters in the vestibule areas between the street doors and inner front doors. Much of the heat they generate is lost when the outer doors are opened. To save heat energy, try reducing the temperature of these heaters or, better still, turn one or more of them off entirely. The airlock effect of the vestibule itself probably will prevent cold blasts from blowing in. If any employees who stay in the front part of your space might find it too chilly (people at cash registers, for instance) it may be more economical to buy inexpensive individual heaters they can turn on when necessary. If there is no individual control—a valve, for instance—on your vestibule heater, ask your plumbing and heating contractor what it would cost to install one or to tie off the unit entirely.



Reduce or eliminate vestibule air conditioning

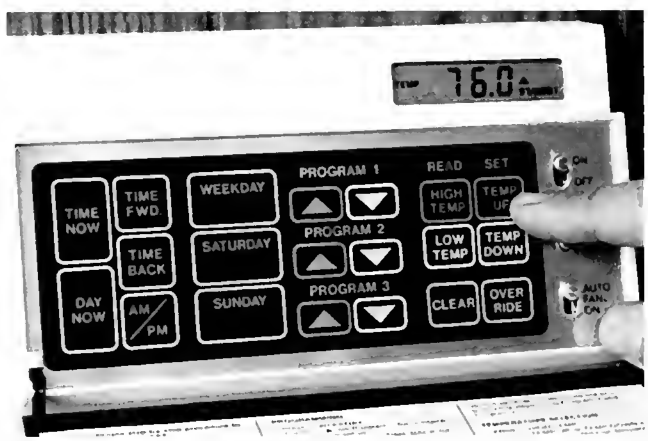
Your building may have vestibule air conditioning which wastes energy in the same way as vestibule heaters do—by losing it to the outside as the outer doors are opened. Chances are you do not have separate air conditioners but rather duct registers which can be partially closed or shut completely. Remember that the airlock effect provided by the vestibule space itself, without air conditioning, will still provide a good transition zone and insulating buffer between the warm outdoors and the cooler interior of your building. If building occupants nearest the front door are too warm, try to adjust the air conditioning vents *in* their area to give them better cooling.

Shut down HVAC systems in unoccupied areas; use local units

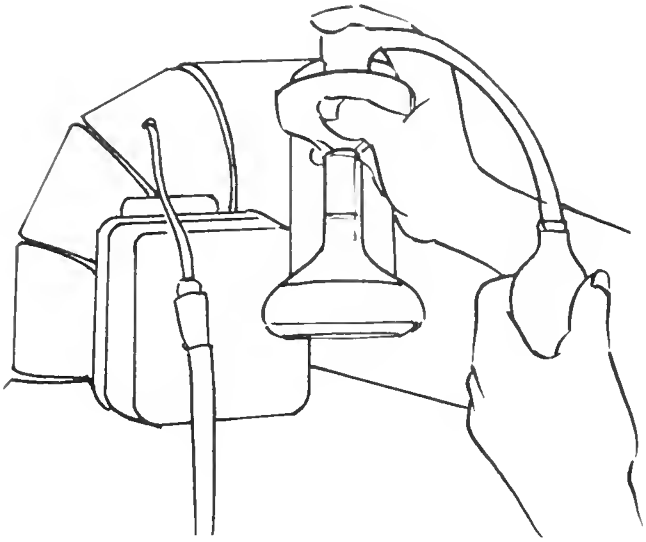
You may be able to turn off the HVAC for individual spaces which are unoccupied while the other areas are still in use. You can do this if you have a multi-zone system with separate controls or if you have separate units, such as window air conditioners or self-contained heaters. You may shut down portions of the system manually or, if there is a regular pattern of use or occupancy, you might want to use a time clock control.

You may have a substantial amount of space that is lightly used—infrequently or for very short periods of time—but is heated or cooled all the time. If you cannot turn off that part of the HVAC system, so much energy may be being wasted that you will want to consider these alternatives:

- Have the system modified and zones and separate controls installed.
- Valve off or otherwise cut off that part of the HVAC system which serves the area, and replace it with individual separately controlled "local" units, such as window air conditioners and area heaters. This may be particularly effective for a seldom used area some distance from the heart of an extensive HVAC system. The effect of this would be to make the main HVAC system more compact and efficient by eliminating long "dead runs" or loops that may have substantial distribution losses as the heat or cool air travels to the remote location.
- Change how the area is used. For instance, storage or some other use that requires little heating or cooling might be switched to an area that is less well served by the HVAC system.



Microcomputer-controlled thermostat provides flexibility in timing temperature changes during weekdays and weekends.



Have someone test, clean and adjust your central heating system

Making sure your heating plant is working efficiently is one of the best—and easiest—ways to save energy dollars. One of the major problems is incomplete combustion of the oil or gas, which wastes fuel and fuel dollars and frequently causes air pollution as well. Testing and tuning your central heating plant may cost less than $100 but can save you many hundreds and even thousands of dollars in a single heating season.

Heating plant efficiencies range from 50%-60% for some older units, to 70%-80% for many of the more modern units, to 90% or more for some of the newest high efficiency equipment. To improve the efficiency of your heating plant may require only an inexpensive part and a few simple adjustments.

In other instances, substantial improvements in efficiency will not be possible because the basic design of the burner is obsolete. If the technician tests your present burner and finds this to be true, you may want to consider installing a modern fuel-efficient burner that will repay its cost in fuel savings in a relatively short time. If the boiler or furnace itself is inefficient, be sure to select an energy-efficient replacement.

When your heating plant is tested and adjusted, any accumulated soot should be removed from boiler tubes and heat transfer surfaces. Soot deposits act as insulators, prevent efficient heat transfer, and require that more fuel be burned to yield the same amount of heat.

A gas burner should be checked and adjusted at least every other year, before the heating season starts. An oil burner should be tested and serviced before the beginning of *every* heating season, to make sure that nozzles aren't clogged or worn, dampers are operating as they should, and the burner is adjusted properly. Some kinds of oil burners must be serviced more frequently—a rotary cup burner, for instance, should be tested monthly. Your technician can advise you and will show you the test results if you ask.

Table 13

Improving Heating Plant Efficiency

If Your Heating Fuel Bill Is:	Approximate Savings If Efficiency Is Improved By: 10%	15%	20%	25%
$ 1,000	$ 100	$ 150	$ 200	$ 250
2,500	250	375	500	625
5,000	500	750	1,000	1,250
10,000	1,000	1,500	2,000	2,500
25,000	2,500	3,750	5,000	6,250
50,000	5,000	7,500	10,000	12,500

Adjust air duct registers

A central air system has registers which let cooled air or heated air into your space. These registers frequently can be adjusted by moving something—a lever, chain, slotted screw, or the louvers themselves. When the heat or the air conditioning is on, see if you can open or close these registers to balance the air flow in the system. Generally, registers farther from the circulating fan or main heating or cooling unit should be more fully open than those nearer the source of heat or cold. This way, you won't overcool or overheat near-in areas just to make sure that more remote areas receive enough cool or warm air. Balancing the system in this way may enable you to adjust your thermostats to more economical settings. Contact your heating and air conditioning contractor if you feel your system is too complex for you to balance without some guidance.

Adjusting air duct registers to balance your system may enable you to re-set your thermostats to more economical levels.

Use exhaust fans as little as possible

Exhaust fans, which transfer interior air to the outside of your building, should be used as little as possible consistent with codes and the comfort and safety of people in your building. In the heating and cooling seasons, whenever an exhaust fan operates, the interior, conditioned air that is exhausted is automatically replaced by fresh air drawn in from the outside, and this new fresh air—cold or hot—will have to be conditioned to an appropriate temperature by your heating or cooling system. If your building has an exhaust system and make-up air heaters that are used to warm this replacement air, you can save some energy if the heaters are wired so they will operate only when the exhaust fans run.

Exhaust fans in restrooms sometimes operate continuously. If codes permit, rewire so that fans operate only when lights are switched on. This will save electricity used to power the fans and will prevent excess loss of interior air that you have paid to heat or cool with your HVAC system. Even if fans and lights are best left on when the building is occupied, you will at least be able to achieve savings during unoccupied hours.

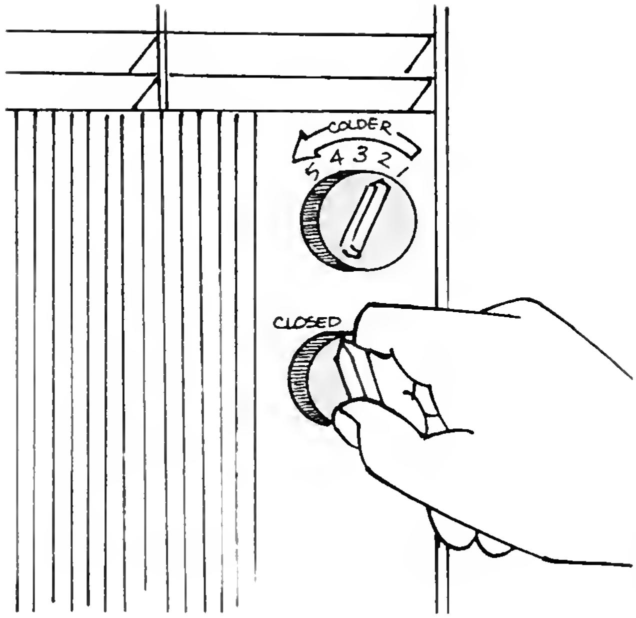
Draw in naturally cool outside air

In hot weather you may be able to open windows to let out warm air and admit cooler air. There may be many times when this very old fashioned method will work quite well for you.

At night, you may be able to pre-cool your building for the next day. If this seems like a good technique for your building and climate, you may want to consider operating or even installing a large attic-type exhaust fan and opening vents or windows on the opposite side of the building, to speed the process of "flushing" the day's accumulated warmth from the building.

Use window coverings to retain heat

In the heating season, closing curtains, shades and blinds at night and during unoccupied periods will help your building retain heat.



Reduce outside air intake to minimum required levels

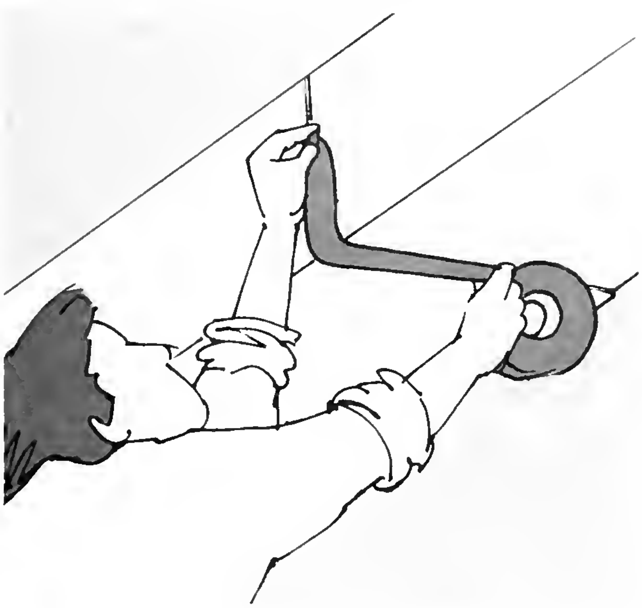
Outside air is needed to remove odors and to ensure an adequate supply of oxygen-rich "fresh" air for occupants to breathe. The more outside air that enters the building, however, the more air there is that must be "conditioned"—that is, heated or cooled—because, for most of the year, either cold outside air must be heated or warm outside air must be cooled. This takes energy, so to save energy the volume of outside air taken in should be reduced.

Outside air enters every building, not only through a mechanical ventilation system but also unintentionally through infiltration leaks around doors and windows, through leaky vents, and through open windows and doors. Because of all these extra sources of outside air, most ventilation systems take in more outside air than is needed. You will want to reduce outside air intake both by preventing infiltration through the building envelope (see the section of this manual on the building envelope) and by reducing the mechanical pulling in of air to the minimum actually needed or to the lowest levels that will satisfy state or local code requirements.

Ventilation rates that are too low are easy to spot; check to see if there are areas which accumulate cigarette smoke or odors or where the air seems stale and the room warm and stuffy. Too little fresh air can make employees lethargic and irritable and can discomfort customers and other visitors.

Central air handling systems may be easy or difficult to adjust. It may simply require adjusting the linkages on dampers, or it may mean altering the sequence of control or reducing fan speeds. You probably would do well to have some expert assistance in determining what needs to be done. Also, be sure to consult applicable codes, since there may be minimum ventilation rates that are required.

Window air conditioning units, on the other hand, are almost always quite easy to adjust. There is usually a "vent" or "ventilation" control, which may be set on "open" or "closed." In the "closed" position, the air in the room is re-cooled; in the "open" position, new warm outside air is drawn into the unit, cooled, and blown into the room. The more often the unit can be operated with the vent in the "closed" position, the less the air conditioning compressor—the main energy-using component—will have to operate and the more energy you will save. During the heating season, the "window unit" is the window itself. Don't open windows to let in cold air to cool superheated rooms—adjust radiator valves, registers, thermostats or some other part of your heating system to prevent the overheating from occurring in the first place.



Replace air filters regularly

A simple maintenance job in air conditioning and warm air heating systems is to replace dirty air filters (most are disposable, although some may be cleaned with water). They not only keep the air smelling fresh, but more importantly they make it easier for the system to work, keep dirt and dust out of fans and motors and prolong their useful life.

Check and repair faulty steam traps

Most steam systems have steam traps, which allow condensate (the water that condenses as the steam cools) to drain from steam-heated devices while preventing steam from escaping into the condensate return system. A steam trap can fail in the closed position, which prevents both steam and condensate from passing (this could mean cold radiators, for example); or a trap can fail in the open position, wasting a lot of steam and energy dollars.

Traps need at least annual maintenance. If there is no test valve, a trap may be checked by listening for its operating sounds or by measuring pipe temperatures on either side of the trap (one side is considerably hotter if the trap is working properly). This is one of the maintenance jobs you may want to have a technician do. If you check the traps yourself, protect your hands with canvas work gloves.

Heat pumps are now in use even in cooler areas (the photo is of a branch bank in Massachusetts). If you have both heating and cooling needs, a heat pump is something to consider when upgrading or replacing your present HVAC system or when constructing a new building or expanding or renovating an old one.

Close duct joints and repair insulation

Make sure heat and cooling are delivered to where they're needed. Don't spend your dollars heating or cooling an unoccupied basement, for instance.

Ductwork in air systems may fit badly at some joints. These gaps can usually be closed quite easily; a roll of duct tape may be all you need. Insulation that is hanging loose from ducts or steam or hot water pipes can also be refastened with tape or strapping.

About heat pumps

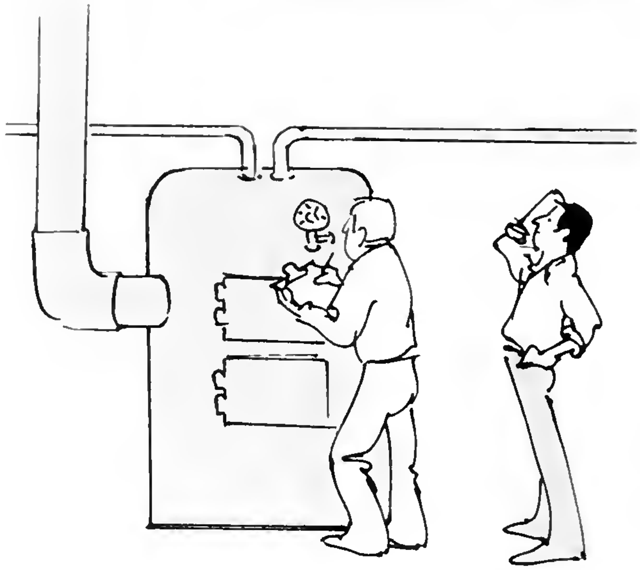
Heat pumps are now in more common use than they were ten years ago. You should know more about them.

The heat pump is aptly named; it is an electrical device which "pumps" or moves heat from one place to another. It may be used both to heat and to cool. In the cooling mode, a heat pump operates like the familiar window air conditioner, removing heat from an interior space and transferring it to the outside; in the heating mode, a heat pump may be thought of as a *reversed* air conditioner which extracts heat from the air *out*side the building and pumps it to the *in*side of the building.

There are two types of heat pumps: air-to-air and air-to-water. The air-to-air uses outside air as both its heat *source* (heating mode) and heat *"sink"* (cooling mode). The air-to-water type acts in the same fashion but uses water as the source and sink. In addition, there are air-to-water heat pump *water heaters* (see end of Hot Water section).

Heat pumps can be ideal for buildings requiring both heating and cooling; the same system does both. In addition to efficient operation, there may be lower first cost, lower maintenance, and space savings as compared to two separate traditional heating and cooling systems. As a heating unit the heat pump works well as long as outside air temperatures do not drop below the mid thirties; below that level the equipment works with lower efficiencies, and its heating effort must be supplemented by other sources of heat, either built-in electric resistance coils or an existing fossil fuel or electric heating system.

This heat pump, installed alongside new branch bank, extracts heat from the air, pumps it into the building; in the cooling mode, it does the reverse.



HVAC adjustments and maintenance jobs for an expert

Many HVAC systems are quite complex, others merely somewhat baffling to people who are relatively unfamiliar with this type of equipment. The following are some energy-conserving changes or adjustments which may require little or no capital investment but which should be undertaken by an HVAC technician who is familiar with the kind of system you have. Also listed are some important maintenance tasks that probably should be done by a professional.

- Adjust temperature of air discharged from air handling units.
- Raise temperature of chilled water supply (if used by your central air conditioning system).
- Lower the boiler steam pressure or hot water temperature.
- Reduce fan speeds and adjust belt drives in air handling systems.
- Turn off water pumps in hot water heating systems when weather is mild.
- Clean refrigeration condenser fins, tubes and coils.
- Check valves, dampers, linkages and motors for proper operation.
- Check and maintain steam traps and vents in two-pipe steam systems.
- Check and repair boiler insulation and any cracks or openings in boiler walls.
- Repair, recalibrate or replace controls.
- Repair vacuum systems in steam heated buildings.
- Shut off unneeded boilers.

With a wide variety of HVAC systems, there is quite a range of possible investment projects.* Some of the things listed here may be appropriate for you to consider, others not. To determine which if any of these you should undertake, and which would be the best investment, you should get the advice of a qualified professional.

Fuel burning and other equipment

- *Add a control to the boiler to provide automatic shut-off* when heat is not needed.
- *Replace an inefficient burner* (such as a rotary cup burner) with a modern, efficient burner of a type suitable to the fuel being used. The capacity of the new burner should be no larger than necessary to carry the present and anticipated load. If possible, a burner with a variable firing rate should be installed.
- *Insulate hot, uninsulated boiler surfaces* with tight fitting, removable glass fiber blankets specially fabricated for this purpose.
- Consider installing an *automatic flue damper* to close the flue when the unit is not firing.
- Consider installing *turbulators* in fire tube boilers to increase turbulance within the boiler passages and thereby improve heat transfer and reduce stack temperature.
- To allow other fuels to be used in place of gas or oil install a *coal, wood or refuse-fired boiler or furnace, or a multi-fuel heating plant.*
- *Consider replacing your existing boiler with a new boiler* of the most efficient design available, if your present boiler is oversized; if it lacks sufficient heat transfer surface to maintain an acceptable low stack temperature when carrying full load; or if it is otherwise inefficient and cannot be brought up to good efficiency in a cost-effective manner by replacing the burner, re-building the combustion chamber, sealing air leaks, installing turbulators, or other measures. Size the new boiler based on the square footage of radiation to be served.
- In large boilers, consider installing *automatic combustion control systems,* which monitor the composition of the exit gases and fine-tune the amount of air taken in.
- If air conditioning is old or if it fails, consider replacing it with a *heat pump* which may also save heating dollars.

*List of projects adapted from "How to Conserve Energy in Your HVAC System," Mass. (State) Office of Energy Resources.

Steam and hot water distribution systems

- *Install controls* to automatically shut off sections of line when not needed.
- *Insulate steam and hot water lines.*
- *Repair or replace defective underground distribution systems.*
- Provide for *lost condensate to be returned* to the boiler.
- *Streamline and simplify the distribution system,* eliminating as much of the existing pipe as possible.
- For hot water systems, calculate the *minimum acceptable flow rate* and modify the system to provide this flow rate. In large systems, consider using several pumps to allow the flow rate to be varied in accordance with the load.

Controls, air handling, cooling

- If your thermostatic controls are electric, install *pre-set solid state electric thermostats.*
- *Separate your controls for cooling and heating* by using a thermostat for each, or a thermostat with separate settings.
- Install *system controls, such as automatic time clocks,* to control all spaces according to usage.
- Consider *load-shedding and peak shaving devices* that will enable you to reduce your demand charges on your electricity bill.
- If your total fresh air intake is large, consider an *economizer cycle with enthalpy control* to optimize use of outside air for cooling.
- Install *control or gravity dampers in the exhaust ducts* that will close when the fan does not operate.
- Consider converting to a *variable air volume air handling system.*
- Install *automatic controls on the hot and cold decks.*
- *Insulate* all cooling ducts, chilled water pipes and heating pipes and ducts.
- Investigate *heat recovery* possibilities wherever excess heat is released from the building if supply and exhaust ducts are close or can be altered.
- Add thermostatic controls and make changes in duct work to *re-zone the building,* enabling more control over unoccupied areas. Changes in duct work will also enable you to return air into the system rather than exhausting it out.

Location: ____________________

Type of fuel used: ____________________

Type of system (e.g., hot water, steam, warm air): ____________________

Number of zones: ____________________

Age of boiler or furnace: ____________________

Age of burner: ____________________

Steam pressure or hot water temperature: __________ °F

If you have a steam system, when were steam traps last checked? ____________________

Type, condition of insulation:

on boiler: ____________________

on air ducts or on distribution piping: ____________________

____

Is domestic hot water heated by the boiler? __________

Date of last test/cleaning: ____________________

Results of test (e.g., combustion efficiency %): __________

Number of units: ____________________

Make, type, size, location of each: ____________________

____

____

Frequency, date of last service: ____________________

Location(s) and description(s) of thermostats: __________

____

____

Location of thermostats that might need to be locked:

____

Location of clock thermostat: ____________________

Cold weather temperature settings: __________ °F

When, how much thermostat is set back:

for the night ____________________

for the weekend ____________________

Hot weather temperature setting: __________ °F

When, how much thermostat is set back:

for the night ____________________

for the weekend ____________________

How many hours a week is system used?

______ hours in hot weather

______ hours in cold weather

Can system be turned down during cleaning hours? ____________________

When is system turned on/off in relation to daily occupancy (i.e., before, after, by how long)? __________

____

Which areas are too hot, too cold?

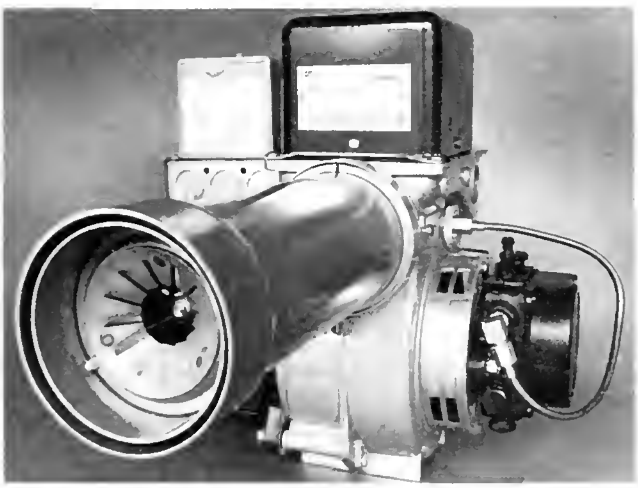
____

____

Are ducts or radiators adjustable? ____________________

Have they been adjusted to balance the system? __________

The tables in the text will help you estimate some savings, while for others you may need help from dealers or manufacturers or from energy consultants or your utility. Of course, there are many no-cost methods, such as choosing different thermostat settings. If you are uncertain about whether or not to buy and install automatic controls, think back over the past heating or cooling season and recall how many times you or someone else has forgotten to re-set the thermostat for the night or a weekend. Then estimate what this has cost you. If the automatic control is no more than a few times this amount, you will have a relatively fast pay-back for your investment.

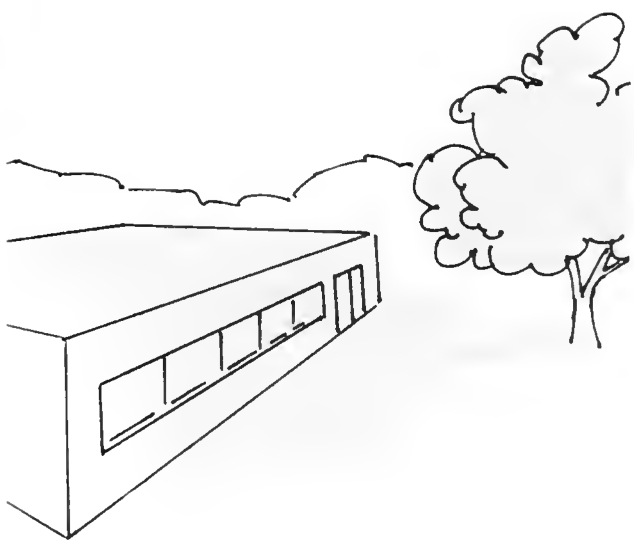


Energy-efficient flame retention head oil burner.

Planning Ahead

Lots of things you do to, in and around your building can affect the load on your HVAC system. Planting deciduous trees—or keeping those you have—can provide warm weather shade, and using light colored roofing material and exterior wall colors will reflect heat. Changing from incandescents to fluorescents will reduce interior heat levels as well as direct use of electricity.

When you build a new building or remodel or expand your existing one, there are many things to do to increase energy efficiency. You'll find some of these on page 52.



MACHINES

There are many kinds of energy-intensive processes, from cooking and cleaning of clothes to welding and painting automobiles, which rely on equipment that transforms or "processes" material in some way or which does some other job that requires the extensive use of energy powered equipment.

In fact, "process" energy may be the *big* item in your total energy expenditures, and your cost for all the other energy uses covered in this manual—heating and cooling your building, lighting, hot water production—may be completely dwarfed by the amount you pay for process energy.

Even if your operation is relatively small in size, as are many businesses such as restaurants, bakeries, automotive paint shops, printing and electroplating plants, your process energy costs may be very important expenditures for you to control.

If your operation relies heavily on heat which is produced by your own heating system, you will want to review the earlier section on boilers, furnaces, fuel burners, and other heating system components. However, many industries use highly specialized heating, cooling and other equipment, the explanation of which is beyond the scope of this manual, and you will want to get more information about how to reduce this type of process energy consumption in your particular operation from your national trade association, a qualified energy consultant, and representatives of equipment manufacturers.

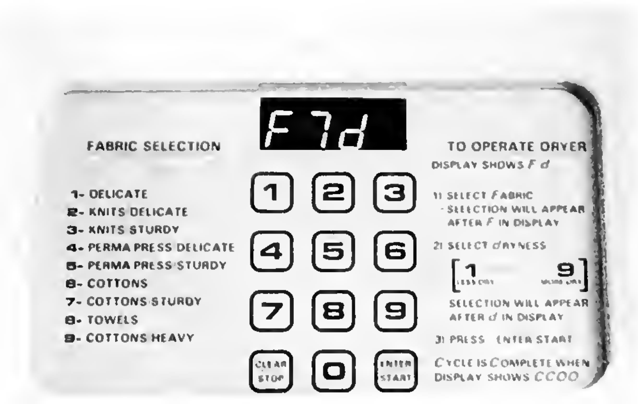
How much do you pay for process energy?

It is important for you to know how much process energy you use, and what it costs, so you will have a baseline for estimating savings and determining whether possible capital improvements would be sound investments.

Basically there are two ways to estimate how much you pay for process energy: estimate how much you pay for *non*-process energy—your lights, heat and air conditioning for instance—and subtract those figures from your total energy bills; or estimate your process energy use directly, either by using meter readings if equipment is separately metered or by calculating hours of operation and energy consumption for each piece of equipment (you may need to note specific model numbers and contact the manufacturers to get some help with this). With energy consumption figures at hand, you can then use unit costs (e.g., cents per kilowatt hour) and multiply to get the answers. In the case of electricity, however, with peak load factors and other possible variables you may want to ask the help of your utility company or an energy consultant.

To give meaning to your figures, you may also want to use one or more of these units of measurement:

- per hour of operation
- per unit of product
- per square foot of building
- per employee



Microcomputer in new clothes dryer permits precise temperature and time control. Machine also has internal heat reclamation device.

12 basic rules for reducing consumption

No matter what the specifics of your use of process energy, the following basic rules may be the key to significant reductions in energy use:

1. Turn it off whenever possible.
2. Adjust the controls to a temperature, speed, pressure, or other setting that uses less energy.
3. Use your equipment more efficiently—for example, load it to capacity rather than do partial loads.
4. Clean, tune and adjust, lubricate, replace worn parts, and otherwise maintain the equipment.
5. Don't create unnecessary problems—for example, don't release process heat inside your building where the air conditioning system must then cool it.
6. Manage your electricity use to avoid high demand charges. This is a very important thing to do if you use lots of electricity for process energy. While it is not truly an energy conservation process, in that you still use the same *amount* of electricity, it *can* decrease your expenditures.
7. When equipment that is worn out must be replaced, choose the most energy-efficient replacement, properly sized to meet the needs of the job.
8. If cost justified, do a major overhaul to make equipment more energy efficient.
9. If cost justified, replace equipment that still operates, with more energy-efficient equipment.
10. Install new automatic controls, if cost justified.
11. Consider using residual heat to advantage—for example, excess process heat may be used to help warm the building or even used to create steam and electricity.
12. Consider using a different energy source. Because of price differences or technological advances in process equipment that meets your particular needs, switching from the energy source you now use—gas, oil, electricity, or coal—to another of these, or to solar, may make sense.

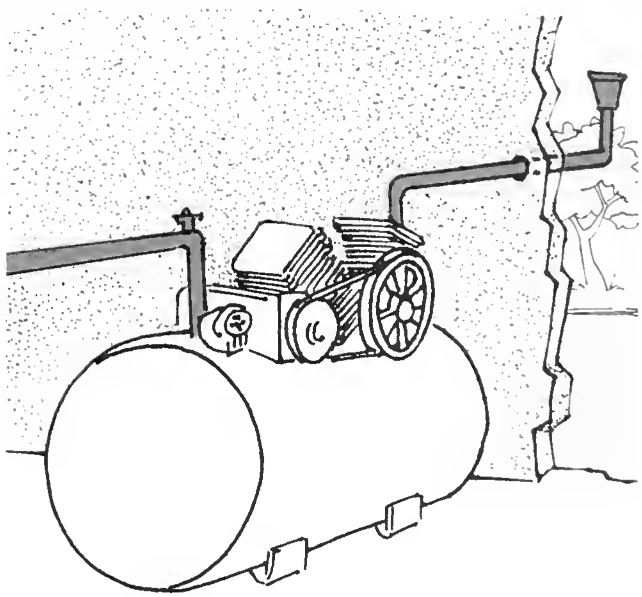
Air Compressors

Many automotive businesses and some industries use compressed air. Like your hot water system, your compressed air system may be costing you energy dollars in the form of "stand-by" losses—keeping air under pressure when it's not needed, or leaking at various points in the system. Or you may be using more than you need to.

Turn off the system whenever possible. And **fix leaks** in hose connections, shutoff valves, pipe connections and flanges, in hoses and clamps, and in worn air cylinders. Your best chance of detecting leaks is when noise levels are low in your building—after work, at lunch or during a coffee break. Many leaks can be fixed easily and inexpensively by repairing seals or replacing gaskets or hoses. Particularly in high pressure systems, leaks can be very expensive.

If you use compressed air to clean or blow away excess material in the manufacturing of a product, make sure you **use a nozzle that concentrates and controls the stream of air.** Using a hose without a nozzle, or a nozzle with too large an opening, will waste lots of compressed air—and energy dollars. Engineered nozzles and fittings can be bought at low cost.

Many air compressors are located in boiler rooms or mechanical rooms and must compress warm inside air. If you **install an outside air intake** in the exterior wall, the compressor will be able to use cool outside air, which takes less energy to compress.



Buy high efficiency electric motors next time

In your building, electric motors may be used to power escalators, elevators, conveyor belts, printing presses, blowers and pumps, and perhaps a variety of manufacturing and assembly processes.

New high-efficiency motors are now available that use less electricity than older standard-efficiency motors and may last longer because they generate less heat to deteriorate the motor windings. A high-efficiency motor may cost 10% more than a standard one, but electricity savings can quickly overcome this cost difference. For example, a high-efficiency motor used 2,500 hours a year with electricity costing .05 per KWH may save enough electricity to pay for the extra cost of the high efficiency motor in about one year.

Unless the motor is used very rarely, it always pays to replace a burned out standard-efficiency motor with a high-efficiency motor rather than buy a new standard-efficiency one. Generally, only burned out motors should be replaced; replacing a standard-efficiency motor that is still functioning usually cannot be justified by the energy savings. Rewinding a burned out standard-efficiency motor is the other choice; generally, the electricity savings over the life of the motor will justify buying a high-efficiency motor rather than re-winding; but the payback period will be longer.

In general, high-efficiency motors pay back more quickly when:

- motor running time exceeds idle time
- motors are larger than 15 HP
- motor loads are fairly constant and electricity costs are high.

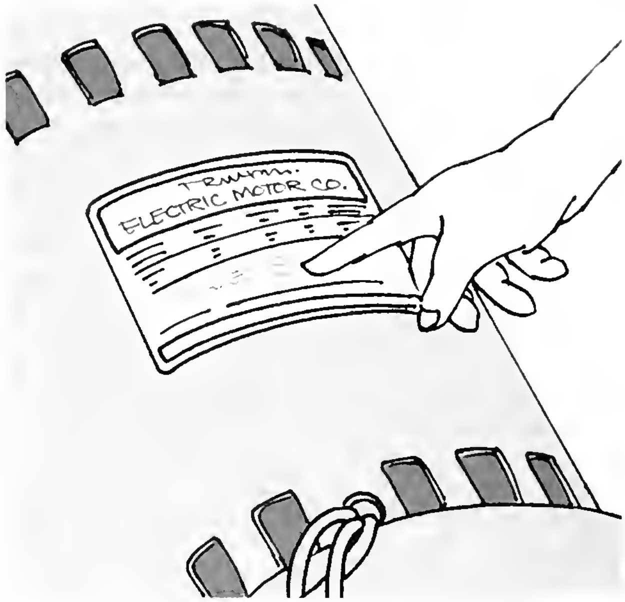
Table 14

Efficiency of Electric Motors

Index Letter	Minimum Efficiency	Index Letter	Minimum Efficiency
A	95.0%	M	75.5%
B	94.1	N	72.0
C	93.0	P	68.0
D	91.7	R	64.0
E	90.2	S	59.5
F	88.5	T	55.0
G	86.5	U	50.5
H	84.0	V	46.0
K	81.5	W	46.0
L	78.5		

Note: When comparing motor efficiencies, use this minimum rating rather than the nominal one, since in many manufacturing processes motors operate at less than their nominal efficiency.

Source: NEMA MG1-12.S3 b Standards.



Electric motor efficiencies vary tremendously. A letter on the nameplate indicates the efficiency rating; the earlier the letter is in the alphabet, the higher the efficiency.

Elevators and Escalators

With large electric motors in many cases operating virtually continually, elevators and escalators can consume significant amounts of electrical energy. To lower operating costs:

- **Operate only those that are needed at any particular time.** There may be some that can be shut down during periods of little or no demand. A stopped escalator still "works" as a flight of stairs. Make sure you or some other responsible person knows how to use the controls.
- **If the motor of your elevator runs continuously, consider having the controls modified** so the motor turns off automatically after a short period of time (say, two or three minutes) rather than remaining in operation in anticipation of need. A control which "puts it to sleep" can be installed by the elevator service people, who may have other ideas for energy savings. With older type elevators, a time clock can be used to shut off the motors during unoccupied hours and other times when the elevators are not needed.

Cooking

Cooking uses a lot of energy even under the best of circumstances. Wasting energy unnecessarily not only costs you energy dollars directly, but the extra heat generated adds to the load of your ventilating, air conditioning, and refrigeration equipment and can increase the fatigue of kitchen employees.

Here are some things you can do to reduce cooking energy waste:

Turn equipment on only when necessary. If you're in the habit of turning on all the equipment first thing, and leaving it on all the time whether or not you're using it, you may be wasting a lot of energy. With the exception of equipment that needs to be preheated, do not turn anything on until you're ready to use it. An open-top range needs no preheating, 10 to 15 minutes probably is enough for a range with a solid top, and 20 minutes should do for a fryer. Make sure that what you're cooking in the oven requires that the oven be pre-heated; it's a waste of energy to turn on an empty oven when you could be using that heat to start the cooking.

If your broiler or griddle has more than one burner, turn on only as many as you need. For your broiler, fryer or griddle, turn the heat down between cooking operations (orders) and turn it off entirely during slack periods. If you have a new infrared broiler you can turn it off between broiling operations because it takes only about a minute to preheat.

Use only as high a temperature as is needed. Temperatures that are too high not only waste energy, they also give poor cooking results—dried out food with poorer flavor. Generally use medium or low heat. It's usually enough for light frying, and in broiling and roasting it will reduce shrinkage and retain juices, flavor and tenderness. High-speed modern fryers usually work best at around 330°, a temperature that will prevent the fat from breaking down. The energy saved by cooking at lower temperatures more than offsets the energy used in the longer cooking times.

Match the equipment to the job. Don't use a utensil that is too small for a burner; excess energy escapes uselessly into the air. For frying, use your fryer, not the range top. On solid top ranges you should use flat bottomed utensils, but on an open top gas range the gas flame will conform to any shape bottom.

Cook as efficiently as possible. On solid-top ranges, when possible group the utensils on one part of the top so you use no more burners than necessary. On open-top gas ranges, adjust the flames so only their tips touch the bottom of the utensil. Try not to open oven doors unnecessarily to check on foods; it lets heat escape. When foods can be baked or roasted at the same temperature, try to cook them simultaneously in a fully loaded oven.

If you can cook things in large volume, it may save energy. Some foods can be cooked partially or completely in advance, then finished or reheated later. If freezing is necessary for preservation, however, by the time you have cooked, frozen, thawed and reheated the food, you may have used more energy than if it were cooked in smaller quantities. And there may be flavor and nutritional losses in some cases.

Control of new high-efficiency fryer, set at economical 330° level

Refrigeration and Freezing

Refrigeration units and freezers can waste energy in many ways, including controls set lower than necessary, doors that don't close completely, overloading, and improper maintenance. Following manufacturers' recommendations is especially important. If you don't have the product literature, contact the manufacturer.

Set controls only as low as necessary. Set temperature levels only as low as you need to preserve the particular type of food or make it appealing to customers. Check present temperature levels with an accurate thermometer. And in the cooler part of the year, make sure to maintain the lowest possible head pressure at which each unit can operate (call in a refrigeration contractor to determine the right settings).

Table 15

Recommended Refrigeration Levels (degrees Fahrenheit)

Frozen food	− 8°
Ice cream	−14°
Delicatessen	35°
Beer, soft drinks	40°

Do not overload. Stocking a case over the load lines can make the unit work harder to cool the extra products and means the other products are over-cooled (if the cooling level were left alone the extra products would deteriorate in quality).

Protect from unwanted heat. This means using night covers (as long as they do not result in frost buildup or compressor damage—consult the manufacturer first). It also means removing as many lights as possible from inside the case, and making sure that units are not located in confined areas where there might be a heat build-up.

Do necessary maintenance. Condensers won't have to work so hard if they are cleaned regularly so that heat transfer surfaces are free of dirt and scale. Coils should also be cleaned and refrigerants checked. For all this, follow the manufacturer's instructions.

Roll-up plastic covers for open refrigerated cases can be used to save energy at night. If needed during store hours as well, strip construction permits access to shelves.

Washing and Drying

Washing and drying, whether of laundry or dishes and utensils, can be very wasteful of energy—because large volumes of water or air are heated, frequently quite high, and then almost immediately disposed of. In addition, hot water systems are often very inefficient. Basic ways to reduce energy waste include:

- Reduce standby losses and system inefficiencies.
- Reduce temperatures and pressure as much as possible.
- Use equipment more efficiently.
- Reclaim heat for use again in the process or for some other use.
- Convert to another energy source.

Reduce hot water stand-by losses and system inefficiencies. The earlier section on hot water contains quite a number of cost-effective suggestions, including:

- repairing leaks
- insulating storage tanks and distribution pipes
- cleaning out sediment
- turning off the water heater when not in use for a period of time
- shutting down the hot water circulation pump when not needed
- testing and tuning up fuel-fired heaters

For these and other suggestions, please refer again to pages 20-24.

Reduce water temperatures as much as possible. Laundry water temperatures should be reduced to 160° unless codes require higher settings. If you can use soaps or detergents that will work in cooler water, you may be able to use even lower temperature settings. Water heaters that supply hot laundry water may have an adjustment knob with "high" and "low" settings. Check the temperature at the washing machine with an accurate thermometer and make the necessary adjustments.

Dishwashers usually use wash water at 140° and rinse water at 180° (using a booster heater) to sanitize and meet code requirements. Some machines can operate at lower temperatures (120°-140°) by using a bleach or sodium hypochlorite to do the sanitizing. Once again, check temperatures with a thermometer and make necessary adjustments.

Maintain the right dishwasher water pressure. Too little pressure means dishes and utensils may not get clean. Too much pressure can waste hot water; you may need an inexpensive pressure reducing valve to correct this.

Run full loads in your dishwasher.

Use equipment more efficiently. This means loading washing machines and dryers fully rather than running partial loads, and spacing tableware closely if a conveyor system is used. Don't run a dryer longer than necessary; for dishes, the residual heat in the machine will continue to dry the dishes after the power is off, and a wetting agent added to the rinse water may eliminate the need to do power drying.

Possible investment projects

A heat recovery system. Dryer exhaust air may be 150° to 190° in temperature. When vented to the outside, this heat is lost. Heat recovery systems can be installed to re-use some of this heat. There are two basic types: *heat exchangers* (rotary and stationary types) which transfer the heat from the exhaust air to the supply air with*out* mixing the two; and *dryer exhaust recirculation* systems which reintroduce into the dryer some exhaust air which still has capacity to absorb additional moisture. Both types of systems can save energy and may have relatively short payback periods; which type is better may depend on the size of your drying operation.

Convert to another energy source. Electricity may be more expensive for drying and for heating water than some other heat source such as gas. Whether to switch may depend on quite a range of factors; for further discussion, see page 51.

Particularly for clothes dryers, converting from electricity to gas can be a particularly good investment. And it may not require buying a whole new dryer. By contacting the manufacturer of your present dryer you can find out if it is possible to replace the electric heating unit with a gas-fired one; this might cost only one-third as much as a new gas-fired dryer.

Is it turned off when possible? ____________

Does the motor run continuously? ____________

How old is the motor? ____________

What is its efficiency letter? ____________

Is it turned off when possible? ____________

Location of leaks: ____________

Is outside air used? ____________

Temperatures now used:

Equipment	Temperature
____________	____________ °F
____________	____________ °F
____________	____________ °F

Are these the lowest possible temperatures? ____________

Is equipment turned off when possible? ____________

Is cooking done efficiently? ____________

Hot water temperatures at the point(s) of use are now:

Location	Temperature
____________	____________ °F
____________	____________ °F

Have you tried to reduce stand-by losses? (See Hot Water section) ____________

Are machines fully and properly loaded?

____

Present temperatures:

Location	Temperature
____________	____________ °F
____________	____________ °F

Are cases overloaded? ____________

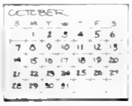
Are night covers used? ____________

Dealers and manufacturers may be helpful in estimating costs and savings if you are considering new motors, equipment or controls.

Timely Adjustments Save Energy

Tuning up your oil burner *after* the heating season has started will cost you energy dollars. So will adjusting your outside light timer weeks *after* daylight saving has started, or checking the settings on your air conditioner thermostats weeks *after* the warm weather has set in.

Doing those important energy-conserving things *at the right time*—the right time during the *year*, *week*, or *day*—will save you the most energy dollars.



At beginning of heating season:

- Inspect, test and tune up heating system—adjust, replace filters, nozzle or other parts
- Turn off heating in unoccupied areas
- Check thermostat accuracy
- Adjust thermostats for desired heating levels
- Adjust outdoor light timers for length of day and/or daylight saving
- Cover window air conditioners

At beginning of cooling season:

- Inspect, test, clean air conditioning system
- Turn off air conditioning in unoccupied areas
- Adjust thermostats for desired cooling levels
- Adjust outdoor light timers for length of day and/or daylight saving

At end of cooling season:

- Caulk, weatherstrip, fix doors and windows
- Inspect, test, clean air conditioning system if used year-round.

At beginning of weekend or other closed period:

- Set back thermostats for heating or air conditioning
- Turn off all lights except safety and security lights
- Turn off hot water (if closed 2 or more days)

At beginning of day:

- Turn off outside safety security lights

During partial occupancy early in day:

- Use only necessary lighting, heating, air conditioning

During full operating hours:

- Adjust thermostats for desired heating or air conditioning levels one-half hour after opening
- Use only necessary lighting, heating, air conditioning, etc.
- Turn off lights where daylight is sufficient
- Turn off lights when areas are not occupied
- Adjust heating and cooling levels for comfort
- Keep doors and windows closed to prevent energy loss
- Set back thermostats for heating or air conditioning one hour prior to closing

During cleaning or partial occupancy at end of day:

- Use only necessary lighting, heating, air conditioning

At closing:

- Turn off all lights except safety and security lights
- In hot season, admit night air if it will cool building

Preventive Maintenance Extends Equipment Life

Equipment operates more efficiently and uses less energy when properly maintained. But timely maintenance also extends the useful life of equipment, reduces the cost of repairs, and prevents breakdowns which generally happen at the worst possible time. Use the schedules on this page, but also follow manufacturers' maintenance suggestions. If your owner's guide is missing, contact the manufacturer with the model number, or call a local repair service for recommendations.

This is a brief explanation of an important subject. If you want to know more about changes you can make that can save you money on your electric bills, get in touch with your electric utility representative.

How Your Utility Charges for Electricity

There are three basic types of charges that you may see on your electric bills: **kilowatt hour (KWH) charges**, which cover the total amount of electricity used during the billing period. KWH charges may be a flat rate, or at a declining block rate (the more you use, the less each KWH costs); **fuel adjustment charges**, for increases in fuel costs (the oil or other fuel your utility may buy to generate the electricity) over some base level, usually added at a flat rate per kilowatt hour; and **demand charges**, for the greatest amount of electrical power (in kilowatts, KW) supplied to you by your electric utility.

Demand charges are the way your utility pays for maintaining the excess capacity it must have to meet peak demands that occur from time to time. The demand charge you pay is calculated on the basis of your highest demand over a short period of time (usually 15 to 30 minutes) during the past month. Your utility then assumes that, during the following month, you are likely to need that amount of peak power again, at some undetermined time, and bills you accordingly for the cost of maintaining extra generating capacity so it can meet your demand at *any* time during the *entire* month. Some utilities use a rachet rate, a charge for the following eleven months which is not reduced even if your actual peak power use goes down during that period.

In addition, your utility may charge for high demand on the basis of "hours use." This can make electricity more expensive on a unit basis for users which have high demand but do not operate continually.

How to Reduce Demand Charges

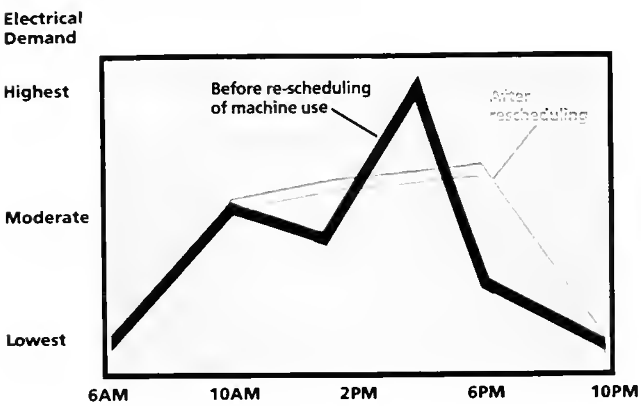
Assuming that you will do everything you can to reduce your *overall* use of electricity, once you have reached a basic level of KWH of electricity needed for your operation you can still work on the demand charge portion of your bill. To reduce peak demand, you will want to do **electrical load planning and management.** What this means, simply, is scheduling the use of electrical equipment to get the work done at the lowest possible electric load at any one time. For instance, if you have electric dryers, electric ranges, parking lot lights, air conditioners, motorized or other electrical equipment *that might be used simultaneously*, you will want to see if you can schedule their use at *different* times of day and night to minimize peak loads. Knowledge of how much each piece of equipment uses, together with some experimentation, should give you some ideas.

If your electricity use is very high, and you have a complex building or operation, you might want to investigate investing in a computerized energy management system and perhaps demand controllers for individual pieces of equipment. Substantial investment is required, but returns can be very high. On the other hand, by pinpointing the major causes of your demand charges, you may find that a major reduction can be achieved just by simple manual rescheduling of the use of a few pieces of equipment.

One other way to lower or eliminate demand charges is to change to another energy source. *One* electrically powered machine which uses lots of electricity may be the primary cause of demand charges that affect your entire electric bill. Replacing this machine at some point, with one that is gas or diesel powered, for instance, could alleviate the problem. Most electric utilities will be happy to advise you on ways to control demand.

Low Power Factor. It is unlikely, but possible, that your facility has a "low power factor"—that is, the equipment draws more in current (KVA) than in power (KW). If the power factor is below 80%-90%, your electric utility company may be billing you extra. If this is so, ask your utility for advice about what to do.

Peak Electrical Demand



Alternative Rates

Your utility may have alternative rates which could save you money on your electric bills. To take advantage of these, you have to work out an agreement with your utility company representative.

First, there may be a **flat rate** which is much higher per kilowatt hour but when used eliminates the possibility of demand charges. If your use of electricity is considerable but infrequent (perhaps totaling less than 100 hours a month), choosing a flat rate may save you money.

If you can schedule much of your use of electricity to occur during "off peak" hours—evening, night or early morning—you may find there are lower **time of use** rates which would be to your advantage. Rates may also vary by season—for instance, electric rates in the South may be lower in the heating season than during the air conditioning season—but you may have trouble doing seasonal rescheduling of electric use to take advantage of lower rates.

Finally, your operation may be flexible enough to allow you to use **interruptible rates.** Your utility company, in return for the right to require that you reduce your use of electricity during peak demand periods, may offer you a rate which sharply reduces demand charges or even eliminates them. If you have high demand charges, interruptible rates can save you a great deal. But you have to carefully weigh the disadvantages. With interruptible service, a utility representative will call you—perhaps only an hour ahead—and ask you to shut down the equipment you have agreed to shut down for the period of time you have agreed on. In the North, some utility peaks occur just before Christmas and on the coldest winter days; others occur during the summer. In the South, peaks occur on the hottest summer days.

To get an alternative rate, ask your utility representative what is available. When the two of you meet, it will be important for you to have with you information about your electric energy consumption—total KWH and KW used per month (your utility may be able to supply a set of figures), how much electricity is used at various times, and what are the time changes or interruptions that would be convenient for you.

Any alternative rates your utility has are advantageous to the utility as well, because they encourage customers to help the utility eliminate the expense and inconvenience of maintaining excess capacity, so you may expect your utility representative to be quite helpful in working out an agreement with you.

If you now pay demand charges, can you reschedule the use of equipment? List the possibilities: ____________

____

____

Should you investigate alternative rates? ____________

Other possible changes: ______________________

____

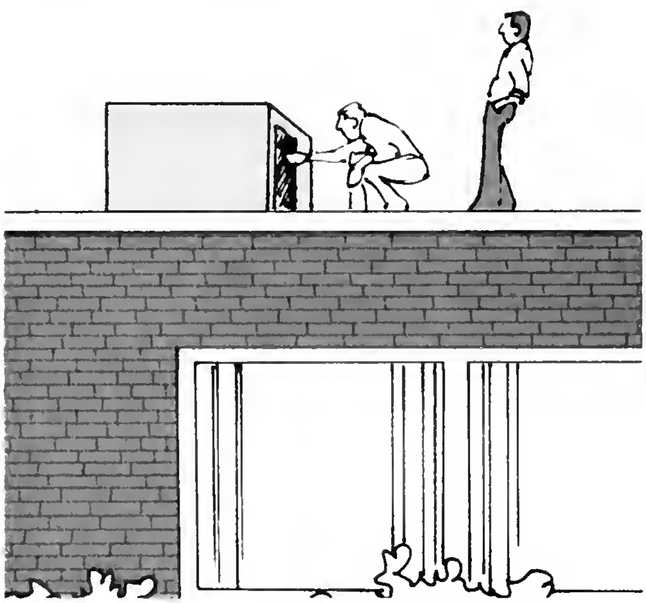
Your utility company can help you determine the possibilities for saving on your electric bills by making various changes.

Some of the ways to conserve energy are no-cost things you can do yourself—resetting thermostats, changing to new energy efficient fluorescent tubes, etc. Other energy saving measures may require some investment for new equipment, some expert help, or both.

Expert Analysis and Adjustment. Probably the best way to spend your investment dollars is to hire an expert:

- to analyze those parts of your energy systems which you don't understand;
- to explain to you possible energy conserving modifications, including changes in control settings, ways to tighten up the building envelope, and new controls or equipment that would be more efficient;
- to estimate potential costs and energy savings; and
- to actually adjust your existing equipment to save you energy, such as reducing unnecessary outside air intake and adjusting other HVAC controls, testing and tuning your oil or gas burner, and balancing air registers or radiators to enable you to reset thermostats without discomforting the occupants of your building.

Experts in the energy conservation field probably will be listed in the yellow pages, or your utility company may be able to make some recommendations. Expect to pay them a lump sum fee, usually a multiple of an hourly charge, and ask them in advance: what, specifically, their services will include; generally what you may expect to save; and whether they will give you a written report (a "must").



The reason that expert analysis and tuning can be so worthwhile is that a few relatively simple adjustments, that *you* wouldn't know how to make, can save you 2%, 5%, 10% or more on your energy bills. This could amount to hundreds and even thousands of energy dollars saved every year, with no investment on your part except the energy expert's fee.

Capital Investment for New Equipment

This manual emphasizes low-cost and no-cost energy saving methods. There are some projects, however, that can be done only with substantial capital investment. These projects are listed at the end of each section and may include your "big" project (for example, replacement of an obsolete boiler) which you should consider most seriously because it *alone* would result in the greatest reduction in your energy use.

As investments go, some energy improvement projects provide *extraordinary* returns. In fact, they may be by far the best use of your available capital and even justify your borrowing in order to undertake them. For example, an investment of $1,000 that yields energy savings of $1,000 a year will pay for itself in one year and by the end of the second year will have netted you $1,000 in energy costs avoided, for a 50% *annual* rate of return over the two years. Over 3 years it would yield $2,000, or 66-2/3% per year; over 4 years $3,000, or 75% annual rate of return; and $4,000 over 5 years, or 80% per year.

The first thing you are interested in is the length of time for an investment to pay for itself in energy savings (or costs avoided). The simplest way to calculate this is the **simple payback method**. Divide the installed cost of the improvement by the annual energy savings; the result is the payback period, in years. For example:

$$\frac{\text{Cost of new oil burner}}{\text{Annual fuel savings}} = \frac{\$450}{\$225} = 2 \text{ years}$$

For more precise figures, first subtract any tax credits from the cost of the improvement and also subtract any operating costs from the annual energy savings.

The **return on your investment** is the energy cost savings (or costs avoided) over and above the cost of the improvement, divided by the total time elapsed. For this oil burner, five years' fuel savings would be $1,125, or $675 more than the cost of the burner. Average annual net savings therefore would be $135, for a 30% annual return on the investment of $450.

If the payback period is long, or if you want to see if a particular energy conservation project would yield as high a return as some other investment, you may want to do a more comprehensive **life cycle/rate of return analysis.**

Here is what you need to know:

- Annual savings (first year)—*conservative.*
- Cost of improvement (including likely maintenance and replacement cost over its useful life).
- The ratio of the cost to the savings (how many times greater the cost is than the savings)—for example, a $500 investment that saves $100 a year is 5:1, or the cost is 5 times the savings.
- How long the improvement will last—conservative.
- What you will assume to be future energy price increases per year.
- What interest rate you must pay if you borrow *or* what rate of return you want if you use your own capital.

Then the calculation is easy:

Example

Annual Savings	**$100**
Cost of improvement	**$600**
Ratio of cost to savings	**6 x 1**
Improvement will last	**10 years**
Energy prices will go up	**0% a year**
My interest rate or rate of return	**10%**

Table 16

Payback Periods
if you assume energy prices *will not change*

If the Cost of the Improvement is ____ times the 1st Year Savings:	Payback period in years if you borrow at, or want a rate of return on your investment of: 10%	12%	14%	16%	18%	20%
1 ×	1.11	1.13	1.15	1.17	1.20	1.22
2 ×	2.34	2.42	2.51	2.60	2.70	2.80
3 ×	3.74	3.94	4.16	4.41	4.69	5.03
4 ×	5.36	5.77	6.27	6.88	7.69	8.83
5 ×	7.27	8.09	9.19	10.84	13.91	never
6 ×	9.61	11.23	13.99	21.69	never	
7 ×	12.63	16.17	29.86	never		
8 ×	16.89	28.40	never			
9 ×	24.16	never				
10 ×	never					
11 ×						

Turning to the table, by going down the left-hand column to 6x and reading across, you can see that the payback period is over 9 years. Your conclusion: a possibly risky investment since the life of the improvement is only 10 years.

Whether borrowing or using your own capital, you may decide on a larger investment than the table would suggest if the conservation improvement has a longer life than the investment period. This is because energy savings are "pure gravy" once the capital is repaid, and this long-term benefit may justify your accepting a lower rate of return during the first few years.

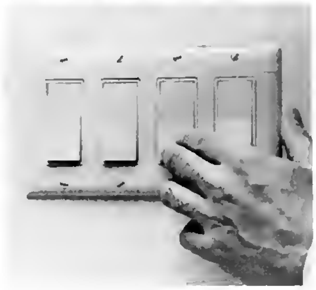
What About Changing Fuels?

It may make sense for you to switch from one energy source to another to save energy dollars.

However, you must take into consideration: the unit price of each energy source; whether you use enough of one form of energy to justify the expenditure for installation and new equipment that may be needed to switch to the new energy source, if your present equipment is not worn out or obsolete; the possibility of future narrowing or widening of the price difference between the energy sources; availability and special characteristics of the different fuels; likely future advances in equipment technology that would make it possible to improve the efficiency of your existing equipment; other expenditures, if your capital is limited, that would yield greater energy dollar returns than switching energy sources.

Tax Aspects

Don't forget to investigate federal and state tax incentives. There may be tax credits or other benefits that can make a conservation improvement more attractive as an investment.



For your present building there may be quite a few energy conservation investment projects that will *not* pay. For example, if your present boiler still works fairly well, replacing it with a new, more energy efficient one may not yield enough fuel savings to justify the investment.

However, when you add on or construct a new building, you are making a fresh start, and it will pay you *very well* to review construction specifications, orientation, design, layout, lighting and equipment to make sure the new building or addition will be as energy efficient as possible. By designing and selecting wisely, at little or no extra cost you may be able to keep future energy bills 30-50% lower than they otherwise would have been.

Also, remember that for new construction your state or local codes may *require* certain kinds of equipment (e.g., self-closing valves on lavatory faucets) or types of construction (e.g., minimum insulation).

Check your plans for these:

- Not too many lights; enough daylight
- Enough switches
- Task lights and minimum general lighting
- Efficient light fixtures
- Energy efficient fluorescents and ballasts
- Few incandescents
- Sodium parking lot lights
- Photo sensitive timers for exterior lighting

- Sufficient insulation for roofs and walls
- Recess building in slope for insulation
- Light colors, both inside and out
- Use land slope to shield building from winds
- Overhangs to shield windows from summer sun
- Adjustable shades, blinds or reflective film
- Thermal windows
- Windows that can be opened
- Caulking and weatherstripping
- In northern areas, thick north wall with few windows for winter, long side of building facing south for winter sun
- Entrance vestibules with revolving or double sets of doors

- Hot water tank near main point of use
- Hot water pipes insulated
- Low flow showerheads

- An efficient HVAC system, with enough zones
- Use of heat pumps if appropriate
- Excellent HVAC controls for all zones
- HVAC pipes or ducts insulated
- Fully adjustable vents
- Heating, ventilating, air conditioning not oversized
- Multi-story, if possible, for insulation and HVAC economy
- Clock thermostats
- Thermostats that go down to 50°
- Exhaust fans in rest rooms wired in tandem with lights
- Adequate wiring and/or gas piping to permit area heaters for remote locations

	COST		ENERGY USE (KWH)		
	Last Year	This Year	Last Year	This Year	% Change
JAN					
FEB					
MAR					
APRIL					
MAY					
JUNE					
JULY					
AUG					
SEP					
OCT					
NOV					
DEC					
TOTAL					

	COST		ENERGY USE (units)*		
	Last Year	This Year	Last Year	This Year	% Change
JAN					
FEB					
MAR					
APRIL					
MAY					
JUNE					
JULY					
AUG					
SEP					
OCT					
NOV					
DEC					
TOTAL					

*Gas unit may be a "therm" or "ccf" (hundred cubic feet) or "mcf" (thousand cubic feet).

	COST		ENERGY USE (gallons)		
	Last Year	This Year	Last Year	This Year	% Change
JAN					
FEB					
MAR					
APRIL					
MAY					
JUNE					
JULY					
AUG					
SEP					
OCT					
NOV					
DEC					
TOTAL					

	COST		ENERGY USE (units)		
	Last Year	This Year	Last Year	This Year	% Change
JAN					
FEB					
MAR					
APRIL					
MAY					
JUNE					
JULY					
AUG					
SEP					
OCT					
NOV					
DEC					
TOTAL					

ENERGY ACTION PLAN

	Top Priority To Do	Location	Approximate Cost (if any)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

HOW TO REDUCE ENERGY COSTS IN YOUR BUILDING

Energy conservation can save your business hundreds or even thousands of dollars every year. And in many cases the things you need to do are very simple and take very little time. Spend an hour reading this book, and see how many ways you can save energy dollars on your electric and gas bills!

In addition to cutting your utility bills, energy conservation can reduce your Montana tax bill. A five percent tax credit, up to a maximum of $300, is given on personal income tax for energy conservation improvements made on commercial, industrial and agricultural buildings; on residential buildings the maximum tax credit is $150. Montana corporate taxpayers can deduct their energy conservation expenditures.

Read this book, take action and watch your tax and utility bills go down!

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