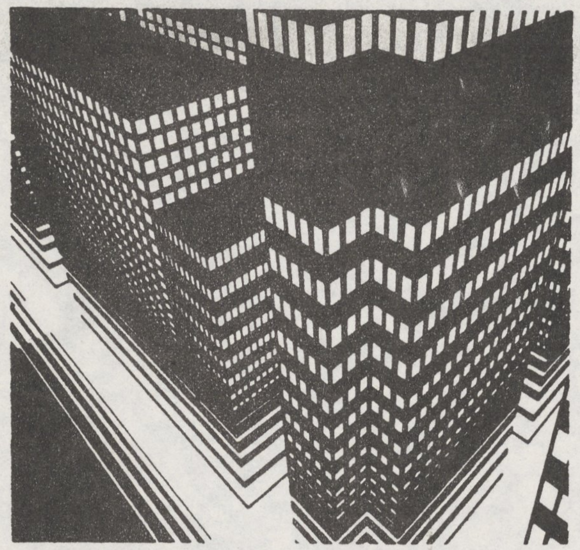
ENERGY YOU CAN BANK ON: SUPPLEMENT III



PRACTICAL ENERGY MANAGEMENT FOR APARTMENTS

JUNE 1983

Prepared by the
Commercial Energy Conservation Program
Colorado Office of Energy Conservation
Denver, Colorado 80203

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Energy **Info**

for Commercial & Institutional Buildings

Office of Energy Conservation
State of Colorado/Office of the Governor
112 E. 14th, Denver, CO 80203
866-2507

Practical Energy Management in Apartment Buildings

Maintaining occupancy rates and keeping an acceptable profit margin are major concerns of apartment managers and owners. Energy conservation can help you achieve these goals as well as save energy. An "average" apartment complex can save up to 25-30 percent on its utility consumption with investments that can pay back within the year. Case studies illustrating this point are mentioned later.

This material was prepared by the Colorado Office of Energy Conservation as a supplement to *Energy You Can Bank On.* The purpose is to provide more indepth information on energy conservation opportunities. It will be particularly useful to directors, maintenance personnel and staff of apartment buildings.

Used in conjunction with *Energy you Can Bank On*, this supplement gives you ideas and techniques for energy conservation that you can put to good use *now.* While energy technology is making rapid advances, we're concerned with the present and the immediate future and with what can be done with currently available methods and materials. You'll find information that will enable you to start reducing your energy consumption quickly.

Studies show that tenants who do not pay their own utility bills consume 30 percent more electricity and 15 to 19 percent more natural gas than those directly billed. Tenants wonder, "I don't pay for the energy; why should I conserve?" Or, "What difference does it make if I conserve when my neighbor doesn't?" Negotiations between landlords need to address problems relating to energy consumption. A variety of solutions exist for billing options for master-metered apartment buildings. But one should keep in mind that, when tenants are billed, they need to know that their conservation efforts are going to be reflected in their bill.

The Residential Utility Billing System (RUBS), developed by the Department of Energy, is one method of charging tenants for energy used. The billing procedure divides the total utility bill by the number of square feet in the building. The common areas are then subtracted from the total square footage and the landlord pays for this area. The tenant is then charged with the amount figured-per-square-foot times the number of square feet in the individual's apartment. This utility amount is then added to the base rent and a monthly bill is presented to the tenant.

With RUBS, the billing system is "up-front" and there are no hidden costs involved; it becomes the tenant's responsibility to reduce his energy consumption and thus reduce his monthly bill. If tenants work together on conserving, all will benefit; and RUBS minimizes rent increases since utility costs are removed from the overhead a landlord must collect. Since all tenants are charged the same amount based on total consumption and the apartment's square footage, tenant's resistance could be reduced if all tenants were made aware of energy conservation techniques which could reduce the overall bill. To make the program most effective, all tenants need to participate in a conservation program or some conscientious tenants will pay for other tenants' wasteful habits.

Another billing option available for master-metered buildings is based on check metering. Check meters are smaller, less expensive, less accurate metering systems. Check meters are placed on hot water pipes running into individual apartments. These meters are read on the same day as the utility company's meter reading day. This information is then plugged into an equitable formula based on apartment size, location and the amount of energy consumed. Apartments on a building's north side will not be required to pay for the same amount of energy as an apartment on the south side, since it will cost more to heat the north-facing unit. Adjustments are made on all apartment dwellers' bills to create a justifiable, equitable billing system. The landlord may or may not pay for the common areas, depending on his perogative. In no case can the tenants be billed more than the actual utility bill plus a small meter-reading charge.

Individual billing for energy used in apartments can be difficult to initiate. An advantage to a central heat and water system is heat recovery systems currently on the market.

A building with central heat and water systems offers some conservation options unavailable for individually-metered apartments. Heat reclaimed from the boiler can be used to preheat the hot water (domestic or boiler) if the stack temperature exceeds 300°, thus reducing the load on the boiler or hot water system.

An apartment building that has a well-equipped laundry room may be able to reclaim heat from the dryers and washers to preheat the water for the laundry facility, or route it to the boiler.

Tenants become frustrated when they are charged for utilities, especially if the landlord does little to help reduce the charges. Insulation, caulk, weatherstripping, insider "storm" windows (if no storm windows exist) are measures easy to install with quick payback and are eligible for tax credits. A swimming pool cover can retain heat in both an inside and outdoor pool. For example, an outdoor pool in Colorado Springs reported that, after being covered each evening, the water temperature rose 7° due to the heat loss associated with evaporation. Pool covers reduce the risk of someone falling in the pool and also help in keeping the pool clean.

Case Studies
Creative Program Spurs Retrofit by Landlords

The landlord's control over increasing energy costs is more important than ever since energy accounts for roughly 50 percent of the operating and maintenance costs in most apartment buildings. As a result, a number of innovative ideas exist to curb energy consumption.

In Colorado, for instance, a workshop series is being designed specifically for apartment building owners. Individual owners and maintenance people can learn about general energy conservation savings, monetary savings, and examples particular to apartment buildings. The Office of Energy Conservation can be contacted for additional information.

In California, the Santa Clara Municipal Utility leased its first domestic solar water heater to a 28-unit building. After paying a $5,500 installation fee, the landlord pays $144 a month for the total heating and hot water costs. Estimating costs over a 10-year period, his monthly heat and hot water costs only $6.78 per unit per month — a savings of about 20 percent from before the solar installation.

In Phoenix, a private company leased a number of solar heating systems to multi-family apartment buildings. The company installed the system for free, and then charged 80 percent of the energy costs based on the previous year's bill.

In New York City, 600 owners responded enthusiastically to a series of "low-cost, no-cost" workshops sponsored jointly by the city and the Apartment House Institution. The workshops emphasized energy-saving options on existing equipment.

Landlord Cuts Winter Energy Costs by $104,200

The 451-unit Phipps Gardens Apartments in Long Island City, New York, cut its fuel bills by $104,200 in 1982 through the installation of a $240,000 multi-fuel heating plant and another $145,000 worth of storm windows, caulk, weatherstripping, and insulation.

The heating plant is capable of burning fuel oil or natural gas; has forced a draft burner; and is equipped with a vacuum pump system. Together, these systems provide an even distribution of heat throughout the apartment building.

The Director of Technical Services for Phipps estimated the payback for all the energy conservation measures 3.7 years. The improvements were originally recommended as a result of a comprehensive energy audit performed in 1977.

Springfield, Massachusetts Landlord Reduces Her Fuel Oil Consumption by 25 Percent

Through the use of several "low-cost, no-cost" conservation techniques, Mary Recchia, the owner of two four-story apartment buildings (16 units) has reduced her oil consumption by 25 percent over previous years. After the city's Multi-family Weatherization Program engineer completed a free energy audit on her buildings, Recchia personally installed aluminum window channels, weather-stripping, insulation in the basement walls, and plywood and insulation over some of the basement windows. She invested a total of $2,000 and expects to see a return on this energy conservation investment in just a year-and-a-half.

Recchia's tenants are pleased with the work she did, since she's passing some of her savings on to them by agreeing not to raise rents for two years.

A variety of energy conservation options exist for the apartment owner. If improvement costs must be obtained from the maintenance budget, a priority system should be established to implement measures with shorter paybacks. One aspect of current commercial workshops deals directly with calculating simple paybacks. Please look for the announcement of upcoming workshops in your area.

We at the Office of Energy Conservation encourage you to read this supplement and *Energy You Can Bank On* thoroughly, and to plan your energy-saving actions now. Remember, saving energy means saving money and that's a wise thing to do.

Please feel free to contact the Commercial Program staff of OEC for further information or questions.

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Establishing a Preventive Maintenance Program

Proper equipment maintenance is the key to energy conservation in your present operation. The more diligently your maintenance program is carried out, the more efficiently all systems will operate, thereby using less energy.

A preventive maintenance program is a systematic approach to equipment operation from a maintenance standpoint. It is the scheduled attention that each and every item of equipment should receive to insure optimum operational efficiency and reduced down-time.

A properly designed and instituted maintenance program can provide considerable benefits to your property. Not only will the equipment last longer, it will use less energy while performing its function, service calls (with their increasing costs) will be reduced, and inventory levels for spare parts will be reduced. Further, property operation will be enhanced since service breakdowns can be largely eliminated because equipment that is beginning to fail (as all equipment will do eventually) can be readily identified and repaired or replaced at such times when its absence will not impair the efficient operation of the property.

The manufacturer's recommendations for equipment maintenance are invaluable since these normally list what must be done to items of equipment and when it should be done. Activities such as oiling, greasing, cleaning, adjusting, etc. are of concern here. Routine inspection of equipment is absolutely necessary. The routine can be designed as daily, weekly, monthly, etc. depending upon such factors as equipment type, function, age, and hours of operation.

Some maintenance, such as cleaning the fins of baseboard radiators or recalibrating thermostats, would not be required as frequently as cleaning swimming pool filters or air conditioner filters and coils.

A list of major maintenance items follows. Use your employee's suggestions to expand this list for your business. Also included is a sample of a preventive maintenance schedule provided by the Hospitality, Lodging & Travel Research Foundation, Inc. Although maintenance and cleaning personnel can efficiently carry out most of a preventive maintenance program, owner-operators may find it worthwhile to learn about the operation of equipment and handle the maintenance of some of them. You should work out a program to suit your business, and then see that it is carried out regularly

Maintenance Schedule

Building

Maintenance Item	Schedule 6 Months	Schedule Yearly
Roof for repairs		*
Exterior walls for caulking		*
Exterior windows and doors for caulking and weatherstripping		*
Exterior wall openings for caulking (louvers, etc.)		*
Interior wall for cleaning		*
Interior ceiling for cleaning	*	
Exterior windows for cleaning	*	
Interior windows for cleaning	*	
Site shading	*	

Maintenance Schedule

Electrical

Maintenance Item	Schedule Monthly	Schedule 6 Months	Schedule Yearly
Check security lighting	*		
Check photo-electric lighting controls	*		
Check dimmer for operation		*	
Check time switches for setting and operation		*	
Clean lighting fixtures			*
Relamp lighting fixtures	As Required		

Maintenance Schedule

Heating and Cooling

Heating-Cooling changeover: Approximately every 6 months

1. Belt tension and alignment
2. Bearings
3. Automatic damper leakage and operation
4. Boiler water treatment schedules
5. Coil surfaces for dust and lint
6. Check intake grills for obstruction
7. Check all equipment discharge air temperature
8. Check circulating pumps
9. Lubricate rotating equipment
10. Check piping for leaks and pipe insulation
11. Check duct connections for leaks and insulation

Heating changeover: Approximately 1 year

1. Boiler efficiency and combustion controls
2. Boiler gas passages
3. Fan blades
4. Check insulation
5. Check burners and nozzles
6. Check and lubricate all equipment
7. Clean cooling tower, condenser, etc.
8. Check and recalibrate controls

Cooling Changeover: Approximately 1 year

1. Chiller efficiency
2. Condenser tubes
3. Refrigerant and oil level
4. Check cooling tower, condensing unit, etc.
5. Check cooling tower or evaporator condenser water chemical treatment.

Maintenance Schedule

Domestic Hot Water

Maintenance Item	Weekly	6 Months	Yearly
Leaks, faucets, piping, equipment	*		
Broken or damaged insulation		*	
Check and adjust gas burners		*	
Check and lubricate pumps		*	
Check pump seals		*	
Flush hot water heater of sediment		*	
Check and clean immersion heater elements			*
Check and clean main hot water mixing valve			*

Maintenance Schedule

Swimming Pool

Maintenance Item	6 Months	Yearly
Check & lubricate pumps	*	
Check pump seals	*	
Check pool heaters for proper operation	*	
Check water heating controls		*
Check and adjust gas burners	*	
Check and clean electric heater elements		*

Maintenance Schedule

Beverage and Food Preparation

Maintenance Item	Schedule: Daily	Weekly	3 Mo.	6 Mo.	Yearly
Food preparation equipment	*				
Leaks, faucets, piping, equipment	*				
Refrigeration pilot lights	*				
Door gaskets: refrigerator, freezer, etc.		*			
Condenser coils: refrigerator, freezer, etc.		*			
Dishwasher drain valve		*			
Filters: kitchen hoods	*				
Defrost cycle: refrigerator, freezer, etc.		*			
Adjust gas burners			*		
Check dishwasher temperature			*		
Clean dishwasher rinse arms and nozzles			*		
Check disposal operation			*		
Check steam traps			*		
Check oven blower fans and motors				*	
Check all thermostats for calibration				*	
Lubricate burner gas valves				*	
Check hot water booster heat coils				*	
Clean light fixtures				*	
Check heating & ventilating unit operation				*	
Check exhaust air quantity				*	
Check steam cookers for lime deposits				*	
Check microwave ovens for operation				*	
Clean walls and ceilings				*	
Lubricate all equipment	Frequency as required by manufacturer				

Maintenance Schedule

Laundry

Maintenance Items	Daily	3 Mo.	6 Mo.	Yearly
Clean lint screens	*			
Check gas burners		*		
Check dryer tumbler speed			*	
Check dryer fan speed			*	
Lubricate equipment	As per manufacturer's recommendation			
Check timers			*	
Check washer water level			*	
Check control valves				*
Check and clean tumbler basket holes			*	

WORK ORDER

No. ________

Requested Service: ____

____

Person Requesting: ____

Nature of Problem: ____

____

____

____

____

____

____

Work Performed: ____

____

____

____

____

Person Completing Work: _______________________________________

Date Performed: ____

Maint. Supv. Signature: _______________________________________

* PREVENTIVE MAINTENANCE SCHEDULE 1982— 1st Half

Description of Work	No. Items	Month	January				February				March				April				May				June			
		Week	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Clean A/C Filters	200 (Room A/C)		■				•				•				•				•				•			
Clean Fan Scrolls	200 (Room A/C)		■				•				•				•				•				•			
Check Refrigerant	200 (Room A/C)		■				•				•				•				•				•			
Check Light Fixture	400 (Room Lights)					•				•				•				•				•				•
Clean Vent Fans	200 (Room Vents)		■				•				•				•				•				•			
Clean Shower Heads	200 (Room Showers)			■								•								•						
Check Tiles	200 (Room Baths)			■								•								•						
Check Fire Extinguishers	20 (Hallway)							•																•		
Check Door Locks	200 (Room Doors)			■								•								•						
Check Circulating Pumps	6 (Central Plant)				•																•					
Check Washer/Dryers	4 (Laundry)					•								•								•				
Adjust Door Closer	200 (Room)																•								•	
Check Boiler Adjustment	1 (Central Plant)																									
Check Window Seals	200 (Room Window)			■								•								•						
Check Security Lights	20 (Building Ext.)								•																	
Check Pool Filters	2 (Pools)				•				•				•				•				•				•	
Check & Clean Ice Mach.	3 (Hallways)					•								•								•				
Check Central Chiller	1 (Central Plant)				•												•								•	
Clean Cooling Tower	1 (Building Ext.)									•								•								•

Section/Person Responsible: ____________________ Signature (When Completed): ____________________

This form is reprinted from material supplied by the Wisconsin Energy Extension Service.

* PREVENTIVE MAINTENANCE SCHEDULE

Description of Work	No. Items	Month																							
		Week	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4

Section/Person Responsible: ______________________ **Signature (When Completed):** ______________________

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Weatherizing the Building

Insulation

Insulation is not always a well-understood subject. Some insulation materials by themselves are not necessarily poor heat conductors — like glass, or mineral fibers. However, these insulation products are made in such a way that the solid material — fiberglass, for example — traps and holds air motionless inside the insulation. Dead air is a very poor heat conductor, and, therefore, a good insulator. Moving air transfers heat by convection. An important characteristic of insulation is that it holds air motionless. Keep this concept in mind as you inspect insulation in your building. Likewise, if you are installing insulation, don't compress it to fit the space. That will decrease insulation value.

Typically, insulation values for the various types available are expressed in terms of R-value per inch of thickness. You can compare R-values and *price* — the price varies considerably — to arrive at the best buy for your particular needs. See Table 1, after the following descriptions of insulation types, for a comparative look at R-values and cost.

Types of Insulation

Fiberglass. Fiberglass is made from spun glass. It is available in several different thicknesses of batts and blanket rolls, much of it cut to fit standard widths between floor joists and wall studs. It also is available in bags of loose fill material for pouring or blowing into cavities. It is relatively inexpensive. Fiberglass is fireproof. However, some batts and blankets do come with heavy paper facing, which is flammable. It also is available with foil-faced vapor barriers attached to batts or blankets. Unfaced batts and blankets are usually used to place over existing insulation. While it is the most popular type of insulation, fiberglass has two chief drawbacks: the tiny glass fibers irritate the skin, eyes and lungs during installation, and the material can develop an odor if it becomes wet. Properly installed, it poses no problems for the building occupants.

Rockwool. Rockwool, also called mineral wool, is made of spun fibers of rock, slag, or other mineral matter. Its features are basically the same as fiberglass, including price and R-value. It is available in batt and loose fill form. Rockwool can cause skin irritation when handled, but it poses less of an odor problem than fiberglass if it gets wet.

Cellulose. Made from ground-up cellulose fibers (usually recycled paper), cellulose is an effective and reasonably priced insulation material. The key with cellulose is to make sure it is properly treated with fire-retardant chemicals. Any you purchase should carry either the Underwriters Laboratories (UL) label or the National Cellulose Insulation Manufacturers Association (NCIMA) label to indicate the material was properly manufactured. While cellulose is available in batts, blankets, and spray-on, its most common form is loose fill. The loose fill material has a very fine consistency, which permits blowing it into cavities through small holes.

Vermiculite. Made from fireproof expanded mineral material, vermiculite consists of small pellets that can be poured or blown into tight cavities. Its main drawbacks include moisture absorption and settling. It is not good for filling wall cavities.

Perlite. Perlite, made from expanded volcanic rock, has similar characteristics to vermiculite with a slightly higher R-value. A common application of perlite is to fill the cavities in concrete block.

Polystyrene. A rigid board insulation made of foamed polystyrene plastic, polystyrene insulation comes in two varieties: extruded and expanded. Extruded polystyrene insulation has a smooth skin surface and an R-value of about 5 per inch. The skin forms an effective vapor and moisture barrier. Expanded rigid board insulation (also known as bead board) has an open surface (no skin) that is composed of small beads of plastic foam. This type of polystyrene board has an R-value of 3.5 to 4 per inch. Expanded polystyrene board is not an effective vapor or moisture barrier. Polystyrene is combustible and must be protected with a fire barrier such as half an inch of gypsum board. The common uses for polystyrene board are wall, basement and foundation insulation. A rather fragile material, it should be handled with care.

Urea Formaldehyde. A foam insulation with high R-value and high fire resistance, urea formaldehyde fully fills any cavity into which it is injected. It also is excellent for absorbing sound. The insulation is expensive and, if installed improperly, can emit formaldehyde gas. This material should be installed only by a professional contractor. Expensive equipment and considerable technological experience are necessary for proper application.

Urethane. Urethane is another foam insulation offering a higher R-value than urea formaldehyde. It is available in rigid boards or foamed in place. The foamed-in-place variety is excellent for filling cavities and has good sound absorbing properties. The key drawback is the fact that the material is not fire-resistant and emits poisonous fumes if it does burn. It should be applied only by an experienced contractor.

TABLE 1
Insulation Materials Comparison

Insulation Type	Form	R-Value Per Inch	Relative Cost (A = least, E = most)	Common Use
Fiberglass	Blankets and Batts	3.3	A	Fitted, secured in open framing: walls, ceilings, floors
	Loose fill	2.2	A	Attic floor framing
	Boards	3.7	A	Wall, ceiling surfaces
Rockwool	Batts	3.7	A	Fitted, secured in open framing: walls, ceilings, floors
	Loose fill	2.9	A	Attic floor framing
Cellulose	Loose fill	3.0-3.7	A	Attics, some walls
Cellulose	Spray	4.7	C	Ceilings, walls
Vermiculite	Loose fill	2.1	D	Small spaces: between ceiling joists
Perlite	Loose fill	2.7	D	Small spaces: concrete blocks
Polystyrene (Expanded)	Boards	3.5-4.0	D	Walls
Polystyrene (Extruded)	Boards	5.0	E	Walls, foundations
Urea Formaldehyde	Foam	4.5	E	Enclosed framing cavities
Urethane	Foam	4.5-6.25	E	Enclosed framing cavities; rooftops; exterior surfaces
Polyisocyanurate	Board	6.25	E	Exterior surfaces; rooftops
Polyisocyanurate	Board	7.2	E	Walls, foundations

Replacing or Adding Insulation

You need to check all the insulation in the building for adequacy and damage, especially water damage. Your goal is to make sure all exterior surfaces of the building are insulated, which includes the roof, walls and, if possible, the floor. If you discover insulation ruined by water seepage, make sure the seepage problem is corrected first.

To begin, determine the type and quantity of the insulation in your building. This won't be easy if all the walls and ceilings are covered with drywall or other coverings, as they usually are. In walls, for example, you can check insulation by removing an electrical wall plate. You may have to remove a piece of the wall covering, or drill a small hole. Use a flashlight to light the area, a small wire or coathanger hook to retrieve a sample, and a measuring tape or ruler to determine insulation thickness. Take similar steps for checking ceiling insulation (in many commercial buildings, however, the insulation is applied to the roof directly under the roofing material). Once you know what and how much insulation you have in the building, you can determine what is required to bring the building up to minimum levels for adequate energy conservation. Check with your local building code officials to find out the insulation recommendations for your building type.

Vapor Barriers

The purpose of a vapor barrier is to prevent the migration of moisture into insulation where it could condense, drastically reducing the insulation's effectiveness. Materials used as a vapor barrier have the additional benefit of reducing infiltration. In drier climates, such as Colorado, where outdoor humidity does not pose a problem, indoor humidity can. This is especially true in commercial buildings which operate laundries, kitchens, or swimming pools.

If there is a potential humidity problem, a vapor barrier should be installed. Some insulation materials come with a vapor barrier attached. If not, a separate one must be provided.

Vapor barriers are rated according to the amount of water vapor passing through them. Some of the materials used include: polyethylene (plastic) film, duplex or laminated papers consisting of a continuous sheet of asphalt between two sheets of paper, and aluminum or other metal foil (usually paperback). Aluminum, asphalt, lead and oil paints or varnishes in sufficient coats (usually two or three) in a smooth glossy finish can provide a reasonably effective vapor barrier.

In Colorado, vapor barriers should be installed on the warm side (the interior-facing side) of the insulation, sandwiched between the interior dry wall and the insulation. Splices or joints should be lapped and folded to properly seal. The vapor barrier must be kept continuous with no holes punched in it during installation.

It is difficult to install a vapor barrier in an existing building. Two or three coats of a good quality alkyd base, semigloss paint, preferably over a base coat of an aluminum paint, will offer some vapor protection.

A second vapor barrier should never be installed near the outside of the walls since it will result in moisture being trapped between the two vapor barriers.

Caulking

Caulking compounds are flexible putty-like materials that are used to plug all the small cracks and holes in buildings. These holes permit air infiltration which robs the building of energy. Caulking compounds should be applied to both the interior and exterior surfaces of the building. Common areas of application are the cracks around doors and windows, any seams in the building surface, and any holes used for utility service entrances. Cracks that develop in the surface also should be plugged with caulking compounds. Caulking compounds are generally not applicable where there is substantial movement between the surfaces.

Types of Caulking

There are a variety of compounds available in tubes that can be installed with the use of a caulking gun. They range in price from a low of about 75 cents a tube to as high as $5 or $6 a tube, depending on the material. Here is a rundown of some of the more common types followed by Table 2, which compares cost and selected features:

Oil Base. The cheapest of all caulking compounds, oil-based caulks are also the least useful, since they have short lives. They adhere to most surfaces, although they are best for porous surfaces which have just been primed. The material will stain unprimed wood. The oil dries out, leaving the material somewhat shrunken and brittle over time. Painting it can prolong its life, which usually is only a year or two.

Latex Base. Latex caulk is easy to apply. It does shrink a bit, but not nearly as much as oil-based material. It is best for narrow cracks. Although it adheres to most surfaces, metal and porous surfaces should be primed first. It can be painted soon after application, and should be painted if used on the exterior surface. It should cure longer if oil-based paint is used (check manufacturer's specification on length of curing time). After the material is applied, the excess can be wiped off with a damp cloth, since the material has a water base. Some manufacturers guarantee a life of up to 20 years. A more realistic expectation is five to ten years.

Butyl Rubber. Priced comparably to latex caulks, butyl rubber caulk is best used on narrow cracks. It does shrink a little with curing. This material is a typical choice for metal or masonry surfaces. It can be covered with any type of paint, provided you wait a week before painting. However, painting is not required. It is cleaned up with paint thinner. You can expect a life of up to 10 years.

Silicone. An excellent sealant which shrinks little and adheres to nearly any surface, silicone can last up to 20 years. It also is the most expensive material. It is highly flexible, making it good for moving joints. Porous surfaces should be primed before application. Clean-up requires paint thinner or naptha on porous surfaces, or just a wipe with a rag on non-porous surfaces, provided the material is still wet. After it is dry, you must cut away the excess.

Nitrile Rubber. Excellent for high moisture areas, nitrile rubber material has a long life (15 to 20 years) and can be painted shortly after application. However, it does shrink. It adheres best to metal or masonry, but doesn't do well on painted surfaces. Painting is not required.

Neoprene Rubber. Another long-lasting material, neoprene rubber is excellent for use on concrete walls or foundations. It does shrink a bit, but can be used on small (less than ¼ inch) moving joints. It can be painted a few hours after application, although painting is not required. Clean-up is done with tolulene.

Polyurethane. Easy to apply, polyurethane shrinks very little and can be used on movable joints. It can be expected to last 20 years, even in harsh climates. No priming is needed, but it is a slow-drying material. Paint thinner or acetone can be used for clean-up.

Rope Caulk. Usually an oil-based material, rope caulk is liked a rolled-up "rope" of thick putty. Since it will last no more than one or two years, it should only be used as a temporary caulk. It is pressed against the surface and remains there until removed. It is most often used as a seasonal caulking when storm windows are applied, and may find little use in the commercial sector.

TABLE 2
Caulking Materials Comparison

Caulking Type	Tack-Free Time	Total Cure Time	Relative Cost (A = least E = most)	Life* (years)
Oil	24 hr.	1 Wk.	A	1-3
Latex	15-30 min.	1 Wk.	C	10
Butyl	30-90 min.	1 Wk.	C	10
Silicone	60 min.	2-5 days	E	20 +
Nitrile	10-20 min.	1 Wk.	D	15-20
Neoprene	60 min.	1-2 Mo.	D	15-20
Polyurethane	24 hr.	2 Wk.	D	20
Rope	—	—	B	1-2

*Expected life, not manufacturer claim or guarantee

Applying Caulking Compounds

The most common approach to applying caulk is with the tube and caulking gun. Make sure you read the instructions for the material you are using. In general, however, just follow these steps:

1. Clean away all old caulking. Scrape or peel it away and then clean the area with a solvent to make sure it is as free of oil and dirt as possible.
2. Either work in warm weather (50° is best), or warm the tube or caulk before use. If the caulk becomes too warm, however, it may become thick and difficult to apply. Store the caulk in a cool area or even refrigerate it for awhile.
3. Cut the tip of the tube off at a 45° angle. Make the hole large enough to give you the size "bead" (the strip of caulk that comes out of the tube) that will overlap the surfaces on both edges of the crack.
4. Hold the gun at a 45-degree angle toward your direction of movement.
5. Apply the caulk by squeezing the trigger on the gun and moving smoothly up or down the crack.
6. When you have completed a section of caulking, twist the L-shaped plunger rod on the gun so that it disengages. That prevents excess caulk from dripping out of the end of the tube.
7. Smooth or push the caulk bead into place. A finger generally works quite well.
8. To seal the tube for later use, plug the hole with a nail or similar object.
9. Large and/or deep cracks pose a special problem, since regular caulking material often will not properly seal them. In general, cracks more than ½ inch wide or ½ inch deep need additional attention. That attention could include the addition of wood or other molding to make the crack smaller. Or, more likely, you need to stuff the crack with material like insulation, sponge rubber, or oakum (a treated hemp rope). Once the crack is mostly filled, apply several beads of caulking compound over it for the final sealing.

Weatherstripping

Properly installed, weatherstripping provides an air-tight seal around movable building components such as doors and windows. Poorly weatherstripped doors and windows are primary paths for air infiltration. The result is considerable energy waste. There are a variety of types of weatherstripping available, including materials designed for specific uses. Each type will have its own installation instruction. To test the adequacy of weatherstripping, close the door or window and feel around all the cracks (from the inside) for any drafts. If you can feel a draft, the seal is very bad. Often, however, significant energy wasting leaks are difficult to detect. A visual aid such as a thin strip of tissue paper or a small smoke source (such as a cigarette or a snuffed-out candle) can be very useful as a leak detector. If you detect drafts, install quality weatherstripping. Also, don't assume that the weatherstripping is adequate just because a door or window is already fully weatherstripped. Check these doors and windows also. Even if there are no broken sections, the existing weatherstripping may be ineffective because of a poor seal. It may be old, or it may have been incorrectly installed in the first place. Here are the basic types of weatherstripping available:

Spring Metal. Usually made of bronze, aluminum or stainless steel, this type of durable weatherstripping provides an efficient seal and is concealed when the door is shut. At times, they can make the door harder and noisier to open and close than other types of weatherstripping. Also, wind may cause it to vibrate. Spring metal weatherstripping is sold in coils and is attached to the door jamb with small nails or screws.

Cushion Metal. Cushion metal, another durable weatherstripping, is also attached with nails, or screws. It is V-shaped and is sold in rigid strips. While it is difficult to move once in place, the seal can be adjusted by increasing the bend of the metal.

Gasket. These are resilient materials, typically made of felt, vinyl, neoprene, or polyurethane foam. There are rigid types available in strips and flexible types available in rolls. The rigid types generally are made from combinations of wood and foam, wood and vinyl, metal and vinyl, and extruded vinyl. They are the most durable of the gasket weatherstripping types. The strips are nailed or screwed to the door jamb so the flexible portion seals against the door when it closes. They are among the most expensive of the gasket types, but they do reduce maintenance time and cost.

Flexible types are installed with nails, screws or adhesive backing. Some are made with reinforcing metal mesh or strips. The reinforced types are the most expensive flexible gasket weatherstripping, but they are the most durable. Some metal door systems incorporate special flexible weatherstripping that fits into a slot on the door or is held in place with metal strips on the door or the jamb.

Interlocking. Made of metal, this type of weatherstripping consists of two interlocking strips, one attached to the door and the other attached to the door jamb. They are either surface-mounted or concealed in special cuts in the door and jamb. When the door closes, the weatherstripping interlocks, creating the required seal.

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Lighting Efficiency

There are three primary factors to consider when choosing a lamp:

- Lamp Efficiency
- Lamp Life
- Color Rendition

The efficiency of a lamp (efficacy) is measured in *lumens per watt* (LPW). The amount of light is expressed in *lumens*, while the amount of energy required is expressed in *watts*. The LPW ratings of different lamps vary significantly from 10 LPW for a low wattage incandescent lamp to more than 180 LPW for a high-wattage, low-pressure sodium lamp. The higher the LPW rating, the more efficient the lamp and the more light produced for each watt of electricity used.

Another important factor in evaluating lamp systems is the life of each lamp. Some incandescent lamps will have to be replaced 20 times before one fluorescent lamp burns out. And the fluorescent lamp provides the same — or better — illumination.

Color rendition is another major factor to consider. The color of a given object is determined in part by the characteristics of the light source under which it is viewed. Color rendition, then, is a relative term describing the extent to which the *perceived* color of an object corresponds to the color of the object under daylight. A lamp that provides good color rendition gives an object a familiar or "normal" appearance.

Usually, incandescent lamps are considered to give the best color rendition because objects appear most "normal" under this yellow-white light which is similar to sunlight. Low-pressure sodium lamps, on the other hand, offer the poorest color rendition, producing an almost pure yellow light which gives objects a very unnatural color. However, these lamps may be acceptable for some uses such as lighting storage areas and warehouses, where color rendition may be of less importance than life span and efficiency, and are very good for lighting t.v.-monitored security systems. There are several light sources between these two extremes which provide both high efficiency and good color rendition.

Types of Lamps

Incandescent

Standard Incandescent. The most commonly used light source, standard incandescent lamps also have the poorest efficiency (lowest lumens-per-watt ratings). As much as 90 percent of the energy consumed by the lamp is released as heat. Incandescent lamps also have the shortest life span of all lamps. Although long-life varieties are available, they cost more and provide even less lumens per watt. They should only be used in hard-to-service areas or where maintenance costs outweigh other factors. The efficiency of incandescent lamps increases as lamp wattage increases. This makes it possible to save on both energy and fixture costs whenever you can use one higher wattage lamp instead of two low wattage lamps. For example, one 100-watt general service lamp produces more light (1740 lumens) than two 60-watt general service lamps (860 lumens each, for a total of 1720 lumens) and saves 20 watts of electricity.

Tungsten-Halogen. Tungsten-halogen (quartz) lamps are a type of incandescent lamp containing halogen gas, which increases their life span by up to four times. They are also more efficient and have excellent color rendition. However, while offering a significent energy savings over the standard incandescent type, they cost more and, compared to other light sources available, have a poor lumens-per-watt rating. In addition, these lamps require a special fixture and operate at very high temperatures, thus limiting their application.

Fluorescent. The second most common light source, fluorescent lamps are four to six times more efficient than incandescent lamps, last up to 20 times longer, and provide good color rendition for most situations. Unlike incandescent lamps, however, the fluorescent lamp requires a ballast, which is a transformer that regulates the flow of current to the lamp. Fluorescents generate less heat and can be used in place of incandescent lamps at a significant savings in cost and energy in most instances. The reduced wattage fluorescent lamps introduced in the last few years use from 10 percent to 20 percent less wattage than conventional fluorescent lamps, depending on size. Fluorescent lamps are made in a wide range of color rendition qualities from good to excellent and many are totally acceptable substitutes for incandescent lamps. In addition, there are new varieties of self-ballasted fluorescents that screw directly into the existing incandescent fixture.

High-Intensity Discharge (H.I.D)

The following lamps are all a type of H.I.D. lamp and, like fluorescent lamps, they all require a ballast to operate.

Mercury Vapor. Mercury vapor lamps were the first of the H.I.D.'s. Of the H.I.D. types they are the least efficient, but also the least expensive. Mercury vapor lamps have found greatest use in industrial applications, indoor arenas and outdoor lighting. They offer very long life (16,000 to 24,000 hours), moderate to good lumens-per-watt ratings, but only fair color rendition. They take several minutes to warm up and restart after being shut off. Mercury vapor lamp sizes range from 40 to 1000 watts.

Metal Halide. The efficiency of metal halide lamps is from 1.5 to 2 times that of mercury vapor lamps, although their life span is shorter. Almost all varieties of available "white light" metal halide lamps produce color rendition which is superior to the standard mercury vapor lamps. Metal halide lamp sizes range from 175 to 1,500 watts. Metal halide lamps take a few minutes to warm up, and much longer to restart. In most cases, ballasts designed specifically for metal halide lamps must be used. However, there are some types of metal halide lamps that can be directly substituted into existing mercury vapor fixtures. Be sure to check with lamp and ballast manufacturers before making any lamp substitutions.

High-Pressure Sodium. High-pressure sodium lamps offer long life, and excellent efficiency, but poorer color rendition than metal halide, casting what is a "salmon pink" to "straw yellow" light. Although the high-pressure sodium lamp first found its principal use in street and outdoor lighting, it is now finding acceptance as a light source in industrial plants. It also is being used in some commercial and institutional applications as well. High-pressure sodium lamp sizes range from 35 to 1000 watts. These lamps also take a few minutes to warm up but less than a minute to restart. Ballasts designed specifically for high-pressure sodium lamps must be used.

Low-Pressure Sodium. The low-pressure sodium lamp is the most efficient of all, providing up to 183 lumens-per-watt. Unfortunately, its use indoors is severely restricted because it has monochromatic yellow light output. Essentially, this means that reds, blues and other colors illuminated by a low-pressure sodium light source all appear as shades of gray, which makes color identification very difficult. These lamps may be acceptable for such uses as lighting storage areas and warehouses and are very good for lighting t.v.-monitored security systems. Low-pressure sodium lamps range in size from 10 watts to 180 watts. The warm-up time for these lamps is several minutes but restart time is less than a minute. Ballasts designed specifically for low-pressure sodium lamps must be used.

Lamp Type	Watts	Lumens	Efficiency (Lumens/Watt)	Life (Hours)	Cost
Incandescent					
Standard	100	1,750	17.5	750	$ .50
Tungsten Halogen	400	7,750	19.9	2,000	$16.25
Fluorescent	40	3,150	78.7	20,000	$ 1.67
High-Intensity Discharge					
Mercury Vapor	400	22,500	56	24,000*	$18.75
Metal Halide	400	40,000	100	20,000	$34.50
High-Pressure Sodium	400	50,000	125	24,000	$64.00
Low-Pressure Sodium	180	33,000	183	18,000	$60.00

*Although manufacturers state life of mercury vapor lamps to be 24,000 hours, actual life is closer to 16,000 due to lumen depreciation.

Measurement of Light Levels

The amount of light falling on a surface can be measured easily by a small, hand-held device called a light meter. The least expensive varieties are available for about $50.00. The result is usually expressed in footcandles. In order to aid you in getting accurate readings, observe the following instructions carefully:

- Readings should not be taken until lamps have been properly seasoned—six hours for incandescent and 100 hours for fluorescent and high-intensity discharge lamps.
- Allow lamps to warm up before taking a reading.
- Take measurements at the work plane (typically, for desks or tables, this is about 30" above the floor).
- Do not shield the meter with your body or allow light-colored clothing to reflect on it.
- For specific task measurements, place the meter at the task.
- For general illumination measurements, take several readings under and between fixtures and average the results.

Minimal Lighting Levels

The following information was developed by the Illuminating Engineering Society as one criterion to use in lighting design. For the proper application of these levels, see the *IES Lighting Handbook, 1981.*

Area	Foot Candles
Hotels	
Bathrooms	
Mirror	30*
General	10
Bedrooms	
Reading	30
Inkwriting	30
Make-Up	30*
General	10
Corridors, Elevators, and Stairs	20
Entrance Foyer	30
Front Office	50
Linen room	
Sewing	100
General	20
Lobby	
General Lighting	10
Reading and Working Areas	30
Marquee	
Dark Surroundings	30
Bright Surroundings	50
Laundries	
Washing	30
Flat work ironing, weighing, listing, marking	50
Machine and Press Finishing, Sorting	70
Fine Hand Ironing	100
Offices	
Auditing, Tabulating, Bookkeeping, Business Machine operation, Computer operation	75-150
General Offices	
Reading poor reproductions, Business Machine Operation, Computer Operation	75-150
Reading handwriting in hard pencil or on poor paper, reading fair reproductions, active filing, mail sorting	50-100
Reading handwriting in ink or medium pencil on good quality paper, intermittent filing	50-75
Building Exteriors	
Entrances	
Active (Pedestrian and/or conveyance)	5
Inactive (normally locked, infrequently used)	1
Vital locations or structures	5
Building surrounds	1
Parking Areas	
Self-parking Area	1
Attendant-parking Area	2
Food Service Facilities	
Dining Areas	
Cashier	50
Intimate Type	
Light environment	10
Subdued environment	3
For Cleaning	20
Leisure Type	
Light environment	30
Subdued environment	15
Quick Service Type	
Bright surroundings	100
Normal surroundings	50
Food displays—twice the general levels but not under	50
Kitchen, commercial inspection, checking, preparation, and pricing	70
Entrance Foyer	30
Marquee	
Dark surroundings	30
Bright surroundings	50

*For close inspection, 50 footcandles. This may be done in the bathroom, but if a dressing table is provided, local lighting should provide the level recommended.

SOURCE: *IES Lighting Handbook, 1972.*

Lamp Replacement Chart[1]

Present Lamp	Replacement Lamp	Replacement Lamp Life (Hours)	Watt Saving Per Lamp	Kilowatt Hour Savings During Lamp Life	Dollar Savings During Lamp Life @$.06/kWh
F40 Fluorescent	F40 energy efficient fluorescent	20,000	5-6	80-96	$4.80-$5.76
F96 Fluorescent	F96 energy efficient fluorescent	18,000	15	240	$14.40
F96 HO Fluorescent	F96 HO energy efficient fluorescent	18,000	14	224	$13.44
60 Watt Incandescent	Fluorescent screw-in[2]	7,500 10,000	38	285 380	$17.10 $22.80
150 Watt R40 Flood Incandescent	75 watt Elliptical Reflector Incandescent	2,000	75	150	$9.00
200 Watt R40 Flood Incandescent	120 watt Elliptical Reflector Incandescent	2,000	80	160	$9.60
500 Watt Incandescent	175 watt Metal Halide	7,500	325	2,437	$146.20
500 Watt Incandescent	Two-F96 fluorescents	18,000	316	5,056	$303.40
175 Watt Mercury Vapor	100 watt High-Pressure Sodium	20,000	75	1,500	$90.00
250 Watt Mercury Vapor	150 watt High-Pressure Sodium	24,000	100	2,400	$144.00
400 Watt Mercury Vapor	250 watt Metal Halide	10,000	150	1,500	$90.00
400 Watt Mercury Vapor	250 watt High-Pressure Sodium	24,000	150	3,600	$216.00

[1]All numbers shown are approximations. Actual results to be derived for any given lamp replacement depend upon factors unique to the installation involved. Consult manufacturers for details, including any ballast or temperature restrictions that may apply. Replacement lamps provide about the same lumen output as the present lamps.

[2]Several types of screw-in fluorescent replacement are available for incandescent fixtures. Figures do not include significant lamp and man-hour savings.

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Heated Swimming Pools — Doing More With Less Energy

Owners and operators of indoor and outdoor swimming pools can significantly cut their energy use and costs by implementing a few energy conservation techniques. Heated pools are tremendous energy consumers. As many as 150 apartment rooms can be heated with the same amount of energy as is required annually to heat one outdoor swimming pool measuring 20'x40'. You could heat three to five homes annually with the energy it takes to heat one residential-sized indoor pool.

Operations and Maintenance

Many things, including weather, equipment, and hours of operation, affect pool energy use. The most obvious and least expensive place to start your energy conservation program is with the implementation of appropriate operation and maintenance (O & M) measures. Begin by establishing a schedule of regular inspections of your mechanical system, including cleaning and preventive maintenance. Ensuring that your equipment is running at maximum efficiency will pay off in both energy savings and repair/replacement costs. Because each system is different, you should consult manufacturer's literature for maintenance suggestions specific to your equipment. Items to consider are cleaning heat exchangers and filters, replacing worn-out equipment with new energy efficient models, and even reducing unnecessary pool and patio lighting.

Another O & M measure with excellent potential for saving energy is reducing the pool water temperature. The greater the temperature difference between a pool's water and the surrounding air or soil, the greater the heat loss through conduction. Replacing that heat takes energy and costs money. Simply turning your heated water temperature down can lower energy consumption from four to ten percent per degree change. The American Red Cross maintains that the most healthful swimming temperature is 78°F. Use an accurate thermometer for checking the temperature.

Pool temperatures should also be set back during periods of non-use, and shut down completely when the pool will not be used for an extended period. Limiting hours of operation can save the additional energy needed to run equipment and reduce the use of costly chemicals needed for water treatment.

Retrofit Options

After having done as many O & M measures as possible, you should consider investing in what is surely the most cost-efficient and effective retrofit available — a pool cover. Unlike your home where heat is lost primarily by infiltration (outside air leaking into the house through cracks and openings) and by conduction (the transmission of heat through a building's wall, roof, etc.) a heated pool loses heat primarily by evaporation. Typically, 50 to 75 percent of a pool's heat is lost through evaporation, and even more during windy conditions. Pools can be sheltered from the wind by using properly placed vegetation, patio structures, enclosures or covers.

Pool covers virtually eliminate evaporation and usually are low cost. They can be equipped with rollers for easy placement and removal or, in smaller applications such as spas and hot tubs, can be manually fitted and removed. Pool covers used indoors provide additional energy saving benefits. Indoor pool areas must be conditioned to prevent damage, such as mold, mildew and efflorescence, resulting from high humidity levels. The humidity is controlled by exhausting the humid air and replacing it with relatively dry outside air. This air is normally heated or cooled and sometimes dehumidified depending on outside weather conditions. A pool cover prevents the evaporation which causes the high humidity. This allows the heating, ventilating, and air conditioning systems to operate much less often when the pool is covered. The energy and dollar savings can be very significant.

Pool covers are made in a variety of materials and colors. The materials can be opaque or transparent. Pool covers can also be made of insulated materials which are especially effective in reducing night time heat loss. Transparent covers, when used with outdoor, unshaded pools, not only prevent evaporation but also have the added advantage of acting as solar heat collectors capable of keeping pool temperatures five to twenty degrees above the ambient air temperature. Often a pool can be kept at 80°F for three to five months of the year without auxiliary heat supplies.

Many sources of energy can be used to heat pool water, including electricity, gas, or geothermal. But it is solar energy which perhaps holds the greatest potential for energy and cost savings. Interestingly enough, a swimming pool will collect an additional five to ten percent of the solar radiation if it is painted a dark color, but the gain collection efficiency is not worth the expense of draining, scraping, repainting, and refilling the pool.

Additionally, active (mechanically operated) solar collector systems can be used to heat both indoor and outdoor pools. Active solar systems are available in a wide variety of styles and prices. Solar panels can be mounted on rooftops or other south-facing surfaces with a relatively flat angle. Pool heating with solar panels is highly efficient and economical due to the low operating temperature required of a solar pool heating system.

As with other solar applications, energy conserving measures such as O & M procedures plus installation of a pool cover should be performed before a solar system is purchased.

For further information you may wish to purchase a copy of *Solar Heating for Swimming Pools,* which can be attained by sending $5.50 to: Environment Information Center, 935 Osage Avenue, Winter Park, Florida 32789.

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How To Read Your Utility Meter

Uncertainty about how to read meters is responsible for most of the difficulties involved in setting up your own energy data base. Meter reading is a tricky matter, because we are accustomed to dials that turn in one direction — clockwise, and read from left to right. Meter dials move in opposite directions, and must be read from right to left — confusing even the experienced meter reader.

The figure below shows a gas meter, easily recognized because it is marked in cubic feet. The top row of dials is the important row — the "half foot" and "two foot" dials are used to calibrate the meter and test consumption of gas-fired appliances — to perform a combustion analysis of the main boiler, for example.

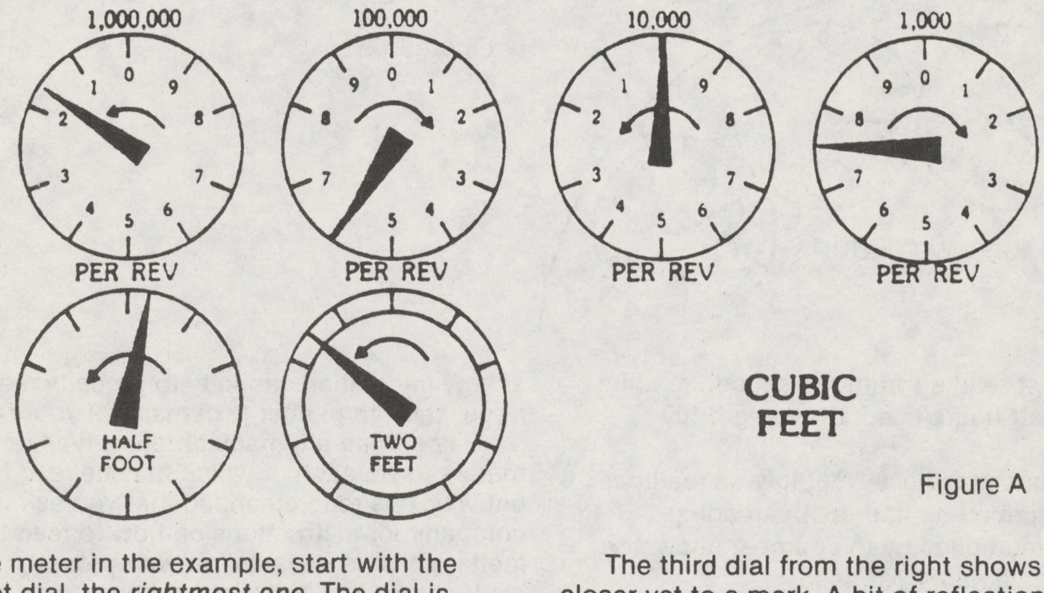

Figure A

To read the meter in the example, start with the 1,000 cubic-foot dial, the *rightmost one*. The dial is between seven and eight, so it is read as *seven*. Always read the lower of the two numbers between which the hand points.

Moving to the next dial, we see that the hand is almost at zero — but not quite. The reading is nine, because the arrow shows that the dial is moving from nine to some higher value — actually ten, and not zero, another trap for the unwary.

It may aid you in understanding how a meter works if you recognize that the hand on the dial at the extreme right completes one full circle, revolving from zero back to zero, while the hand on the dial next to it on the left moves only between two numbers, such as between one and two. The same relationship exists between other adjacent dials.

The third dial from the right shows a pointer closer yet to a mark. A bit of reflection here will suggest that at the exact moment the second dial reaches zero, the third dial will hit a number — in this case six. So the pointer is not yet at six, and the proper reading is five.

The leftmost dial in the example is easy to read. Clearly between one and two, the pointer is read as the lower value, or one. *But be careful here.* This dial is the highest-value dial in the meter so any errors in reading will make the reading grossly inaccurate.

The correct reading for the meter is 1597 — adding the zeros for the tens and digits place, the meter is showing 159,700 cubic feet of gas used. Two zeros are added because the "1,000" above the rightmost meter tells us that one full revolution is 1,000 cubic feet of gas through the meter. Consequently, each value on the dial is 100 cubic feet.

Electric Meters

Electric meters are read in much the same way as gas meters. The figures below show an electric meter for two succeeding weeks. The first meter reads 4519. What is the correct reading on the second meter?

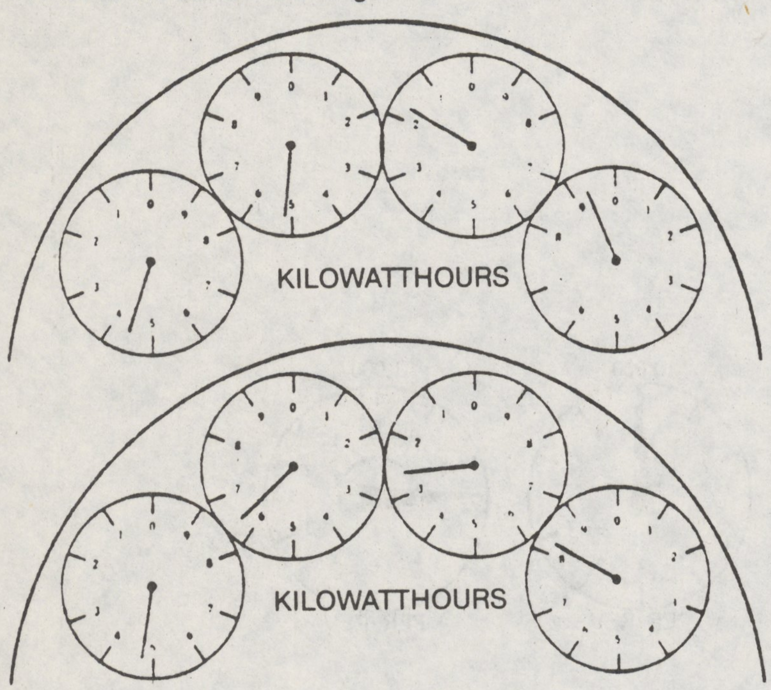

Figure B

Subtracting the first reading from the second reading will give the kilowatt hours used. Do you get 109 kWh?

Note: The meter face may have "multiply all readings by ________" inscribed on it. If so, the reading would have to be multiplied by the number shown on the meter to get the actual kWh used.

Demand and Demand Meters

Demand is a measure of the maximum short-term kilowatt demand of your facility. It is based on your highest usage during a 15-minute interval during the billing period. The greatest level of demand is registered during peak periods when several major pieces of equipment are operated simultaneously. Utility companies base charges on high peak demand to cover the cost to the utility of maintaining sufficient energy-generating capacity to properly meet the large, short-term energy demand of your facility.

Since there are many different types of demand meters used, each of which may be read in a different way, it is recommended that you ask your utility company for instructions on how to read the demand meter which is installed on your property.

If you have a high demand charge on your bills, you might want to consult with your local utility to determine when your highest demand is measured. Once you know when your highest demand is occurring you may be able to schedule equipment start-ups to reduce peak loads.

Once you are comfortable reading your meters, consumption can be recorded on a form similar to the METER READING CONTROL sheet shown on the next page. A typical demand meter is illustrated in Figure C.

Meter Reading Control

Prepared by ____________

	Electricity (Multiplier ______)			Natural Gas		
Reading Date	Meter Reading	Difference from Previous Reading	KWH Used	Meter Reading	Difference from Previous Reading	CCF Used
Total Consumption						

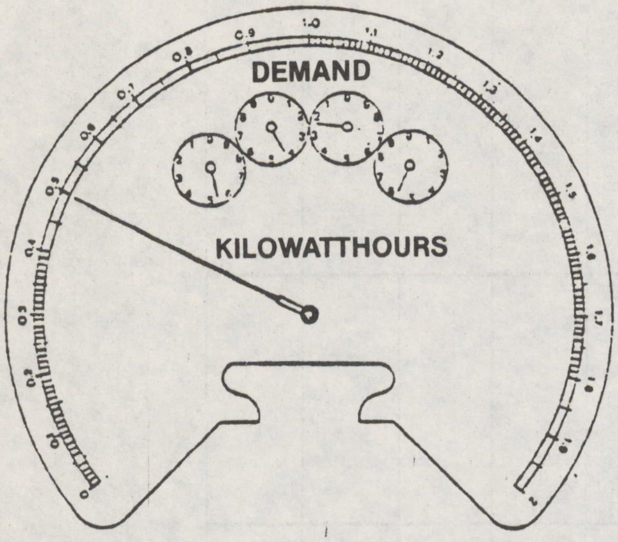

Fig. C-1

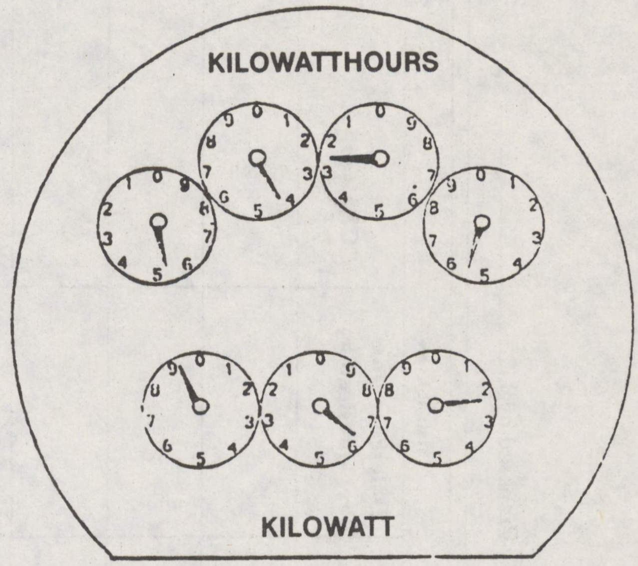

Fig. C-2

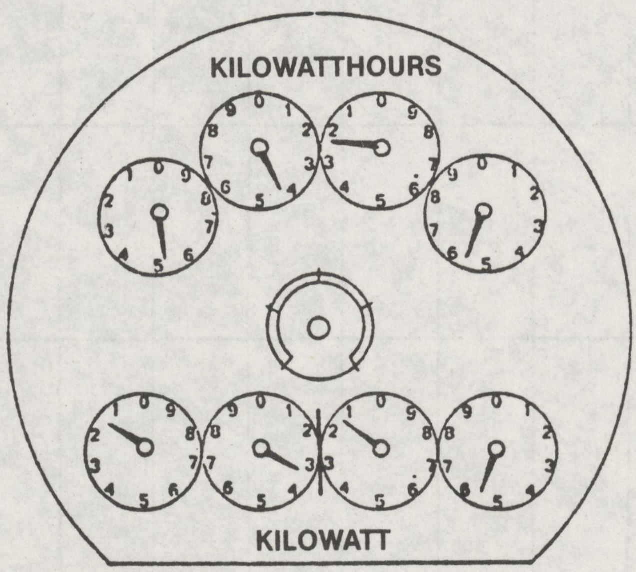

Fig. C-3

Kilowatt Meters With Demand

Figure C

Figure D

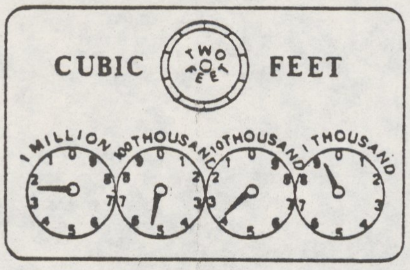

Figure D-1

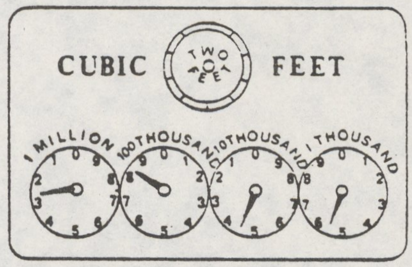

Figure D-2

Gas Meter

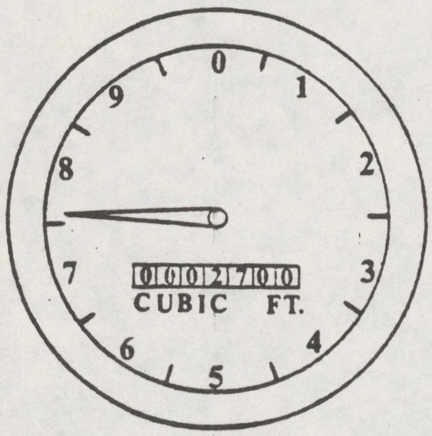

Figure D-3

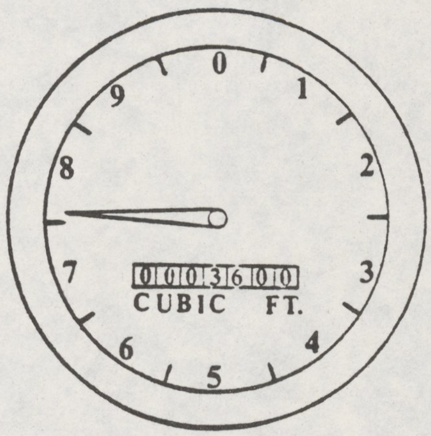

Figure D-4

Water Meter

Water Meters

Referring to Figure D, the numbers which appear at the center of the meter in a row are read to determine the quantity of water used. In the illustration, the quantity read would be 2700, and would be in cubic feet, as marked on the meter. (Other meters may record gallons used, but if so, the meter would be marked to so indicate.) The pointer which moves around the outside circular dial is used only to indicate when water is flowing through the meter. The pointer and circular dial are not used or read to measure the quantity of water used.

Figure D-4 for the same meter reads 3600 cubic feet. By subtracting 2700 from 3600, we determine that 900 cubic feet of water have been used between readings.

This section has been reprinted from the publication, *Stop Throwing Away Energy Dollars, A Notebook of Energy Conservation Techniques for Michigan Restaurants* published by the Michigan Restaurant Association.

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Energy Management Systems

The term "Energy Management Systems" (EMS) is generally used to describe equipment that can monitor and/or control energy use in a particular building or group of buildings. Other commonly used terms for Energy Management Systems are: Energy Monitoring and Control Systems, Utility Control Systems, Utility Monitoring Systems, and Load Management Systems. Energy Management Systems are a tool for conserving energy and reducing energy cost.

EMS generally refer to systems that use programmable computers to monitor and control energy use and equipment operation. However, the range of EMS hardware is very broad. EMS can vary from simple time clocks that control on/off operation to very complex computer systems that also can monitor the performance of specific pieces of HVAC equipment and prescribe both periodic and emergency maintenance (in addition to controlling building temperatures and energy use). As a result, applications of EMS hardware are very specialized and an engineer with experience in EMS should be consulted prior to making any decisions as to whether or not such equipment is needed. The factors that determine the type of EMS to be used at a particular facility are:

- The amount of energy used
- The cost of energy per year
- The degree of monitoring and/or control necessary to operate the facility efficiently

Generally, facilities spending less than $100,000 per year on energy cannot justify the more sophisticated systems because of the relatively high initial cost of the monitoring and controlling equipment. In these smaller facilities, energy conservation emphasis should be placed on operational changes and selected retrofit options.

"On-Off" Operation of Equipment

For buildings containing energy use systems that can be controlled by either stopping or starting them, such as chillers and air handling equipment, the installation of a time-clock system can adequately perform the control function. The following conditions exist in buildings which could benefit from such a system:

- Regular hours of operation
- Known occupancy rates
- Standard equipment for the building environmental conditions, such as air-conditioning, heating, lighting, etc.
- Small operating labor force

For example, such conditions exist in an office building because it is usually occupied during the day and vacant at night. The number of people in the building is fairly constant at any one time and the equipment used for controlling the environment is usually common equipment without complex controls for its operation. Finally, the labor force available for the maintenance of such a facility is usually small. With such conditions, it is feasible for a time-clock system to stop and start equipment at the desired times.

The equipment that can be shut down during unoccupied hours can usually be identified by a visit to the building when unoccupied. Many opportunities for "on-off" controls can be found by looking for lights that could be turned off, and by listening for equipment that is operating. If it is determined that the equipment is not needed during the unoccupied times, a device can be installed to shut the equipment down at a prescribed time. If the only function of an EMS will be to turn equipment on and off, then the capital investment required for a complex EMS system cannot be justified.

An example of the potential magnitude of savings achievable from the installation of time clocks for stopping and starting equipment can be seen from an office building containing 1 million square feet. The annual electric cost to operate the building was $300,000 per year. During a tour of an unoccupied building, it was discovered that most of the fans for the air distribution system were on. Upon investigation, it was learned that they ran 24 hours per day, seven days per week, but the building was only occupied from 7 a.m. to 6 p.m. during the week and not at all on weekends.

An investment of $3,000 was made to install time clocks on the equipment to shut it down during non-use hours. The net result was that cost for electrical energy was reduced by $82,000 per year, a reduction of 26 percent.

Savings of this magnitude are not unusual. A more complex energy management system could have been installed and perhaps increased the energy savings by 10 percent by monitoring and controlling temperatures throughout the building. This would have produced an annual savings of $108,000. However, to obtain the additional $26,000 savings per year, an investment of well over $100,000 would have been necessary. When compared to the actual $3,000 invested, there was no practical way to justify the additional expense.

Given this example, it is advisable to investigate more sophisticated energy management systems for a building or group of buildings when conditions exist which make simple "on-off" operations infeasible because of occupancy rates, required environmental conditions, or the existence of special equipment that cannot be simply turned on or off.

Monitoring and Controlling Equipment

Energy management systems can be designed to include much more sophisticated controls than the simple "on-off" control functions. Some of these functions include:

- Monitoring and/or controlling the temperature and humidity of a designated room or area.
- Monitoring and/or controlling interior air supply systems.
- Monitoring equipment for speed, bearing temperature, pressure differential, etc., so that if a malfunction occurs, it can be acted upon quickly.
- Monitoring and/or controlling the extent to which equipment is loaded.
- Controlling the amount of outside air entering the building and providing the right mix of return air so that the least amount of energy is used in conditioning the air (Enthalpy Control).

There are also cost avoidance benefits possible with the more complex systems. They are:

- The ability of such systems to limit electrical demand to take advantage of electrical rate structures, thereby avoiding costs.
- Providing a record system for equipment maintenance programs.
- Sequentially starting and stopping equipment to avoid system overloads.
- Monitoring and controlling special equipment.
- Monitoring and controlling safety and security functions.

The more complex EMS also provide for the monitoring and controlling of equipment from a central control console. This means that the console operator can monitor and control the status of all equipment from one location. This allows for better utilization of the existing labor force by reducing the amount of time taken to physically check the equipment. Also, maintenance personnel are made aware of potentially large problems with the equipment before they occur.

Aside from the central console provided by the EMS discussed above, there are several other pieces of equipment used to make up the total system. In order for the console to receive the needed information, the desired functions are transmitted from the energy use equipment to data-gathering panels. These panels then transmit the information back to the console. The console operator can then make adjustments to the energy use system by remote control. The more common types of equipment that are avialable for use in such systems are:

- An intercommunications system that allows the console operator to speak to someone at a remote panel location. This allows for direct instruction and/or feedback from the console operator to a mechanic or other person.
- Teletypewriters and printers that log and print operational information for backup data, maintenance, records, or any use requiring a permanent operation record.
- A process controller, or mini-computer, may be added and programmed to start and stop equipment, make adjustments in controls, provide equipment efficiency profiles and a variety of other functions. Software programs for many different functions are commercially available from EMS manufacturers.
- Closed circuit TV can provide visual checks of critical areas of equipment from the central console panel. A graphics display panel can project schematic drawings for any and all systems being controlled so that the operator can display the appropriate system directly on the console.
- A cathode ray tube (CRT) terminal can issue equipment control instructions to other locations and, coupled with a typewriter, can record information sent and received.

Energy management systems can be made simple or complex to match the job as required. Most EMS provide for future addition of equipment as needed and lend themselves easily to expansion. To determine whether or not a particular building or facility would benefit from an EMS with more than simple "on-off" functions, the following questions should be answered:

- Is temperature or humidity monitoring or control needed for certain areas or pieces of equipment?
- Does the building or facility contain equipment too complex to be simply turned on and off?
- Is the building or facility always occupied but at varying levels?
- Is the cost of energy above $100,000 per year?
- Is the monitoring and controlling of equipment necessary to help avoid major maintenance expenditures?

If the answer to any of these questions is "yes," then the building or facility may be a candidate for an energy management system that can perform more than "on-off" functions. A professional engineer knowledgeable about the advantages and disadvantages of EMS applications and with experience in designing them to fit particular requirements should be called in to do a more extensive analysis.

SOURCE: Identifying Retrofit Projects for Buildings
United States Department of Energy
Federal Energy Management Program
DOE/CS-0133

February 1980

Energy Info
for Commercial & Institutional Buildings

Office of Energy Conservation
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112 E. 14th, Denver, CO 80203
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Heating, Ventilation, and Air Conditioning (HVAC)

Heating, Ventilation, and Air Conditioning (HVAC) is by far the biggest energy user in any building. Therefore, it should be the biggest target for your energy conservation efforts. You probably can save up to 30 percent of your HVAC bill, and if your building has older or improperly operated HVAC equipment, that figure could be even higher.

Some modifications in your HVAC system will require expert professional advice to implement. Usually, the more complex the HVAC system is, the more likely you are to need professional help to modify it. But the results of your walk-through audit may show a surprising number of no-cost and low-cost measures that can be achieved by building staff.

This factsheet provides you with a brief overview of heating, ventilation, and air-conditioning systems, and offers some cost-effective, no-cost and low-cost operation and maintenance (O&M) measures.

What Kind of HVAC System Do You Have?

There are many different kinds of HVAC systems. Some buildings just have heating systems and use windows for ventilation. They may also have separate air conditioning units. Other, usually newer, buildings have complex systems that provide heat, air conditioning, and ventilation all in the same system. These are called "total environment systems."

There are different energy saving measures for different parts of your HVAC system. There are possible inefficiencies at the primary heating or cooling source (e.g., the boiler of furnace), in the distribution and terminal system (the pipes, radiators, ducts, and vents), and in the HVAC controls your building has.

Heating Systems

There are four basic types of heating systems: warm air, hot water, steam, and electrically heated systems.

A **warm air system** is the simplest of heating systems. Air is heated in a chamber that encloses the combustion chamber and then rises (or is forced by fans) through air ducts to registers in the area to be heated. In a **hot water system,** hot water is circulated by pipes to radiators in the areas to be heated. A control on the boiler maintains a "stand-by" temperature to ensure an adequate supply of hot water. In a **steam system,** water is heated to create steam, which is circulated through pipes to radiant elements in the areas to be heated. The steam then condenses, and the resulting hot water is piped back to the boiler to be heated again. In **electrically heated** buildings, electricity is converted into heat at the area to be heated, by electrical resistance elements. Some complex "total environment" systems pre-cool air at a central location, and then reheat the same air electrically at the terminal outlet.

Except for electric systems, all of the above systems use the combustion process to heat the air or water. The heat is produced on demand of the thermostats for gas and oil-fired systems, and when "fuel charged" for solid fuel systems such as coal and wood.

How the Combustion Process Works

The **burner** mixes air with fuel and injects this mixture into the **combustion chamber,** where it is ignited by a pilot light or by electrodes to produce a flame. This flame first heats air or water that surrounds the combustion chamber by radiation, then the hot gases from the flame pass through a **heat exchanger** where more heat is absorbed by the heated air or water. The waste gases, containing non-absorbed heat, are exhausted through the **stack** or **flue,** while the heated air, water or steam is distributed through the building.

When a burner is firing, a continuous flow of hot gases leaves the combustion chamber and passes up through the heat exchanger section and then up the chimney. The amount of heat carried away by these gases and the amount absorbed by the air or water depends on the vaporization of the fuel, the oxygen/fuel mix, and build-up of scale or soot on the heat exchanger surfaces, and the amount of insulation. The amount of heat retained by the system represents the system's efficiency.

Stack losses occur when the heat created by combustion is lost up the stack rather than being absorbed by the air or water being heated. Stack loss accounts for a majority of the heat loss from a heating plant. Stack losses can be increased by dirt on the heat transfer surfaces, by excessive firing rates, by improper vaporization of fuel, and by the furnace being adjusted to take in too much or too little air.

Stand-by losses occur when the burner is not firing, and cold air is drawn into the furnace, heated, and passed up the stack. Radiation losses occurring during periods when the burner is off are also considered stand-by losses.

Radiation and convection losses occur when heat passes through the shell of the boiler or furnace. These losses are due to faulty or insufficient insulation and occur whether the burner is firing or not.

Improving the Efficiency of Your Primary Heating System

To improve combustion efficiency, you should:

- keep all heat transfer surfaces clean
- fire the burner at the lowest rate possible while meeting the required heat load of the building
- minimize the air taken in without creating excessive smoke that may foul the heat transfer surfaces.

To minimize radiation losses, you should:

- repair and add boiler insulation where needed
- operate the system at a lower temperature (or steam pressure) during periods when the full operating temperature (or pressure) isn't needed.

To reduce stand-by losses, you should:

- reduce operating temperatures
- shut down the unit whenever possible
- use automatic flue dampers
- be sure all secondary dampers are shut when the system isn't firing.

New Technology in Oil Burners

Many older systems commonly use the **rotary cup burner,** which is recognized by the horizontal, rapidly rotating cup through which the air and fuel are injected into the combustion chamber. These burners can provide reasonably good efficiency, but it is impossible to maintain this efficiency without almost daily cleaning and service. You should consider replacing your rotary cup burners with the more modern flame retention or air-atomizer burners, suitable to the fuel you now use and the capacity your building needs. Be sure that the new burners are no larger than needed to carry the required load and are equipped with a variable firing rate, if possible.

Losses in Heat Distribution Systems

All the heat that is produced in the primary system may not get where it is needed. If your steam or hot water pipes are poorly insulated or not insulated at all, the potential savings from insulating them is substantial and should not be overlooked. Remember that in order to work properly, pipe insulation must fit tightly to the pipe, not allowing air to pass between the pipe and the insulation. Potential savings may also be achieved by "valving off" (closing off with valves) hot water or steam lines that are no longer needed to heat certain areas. Make an effort to shut off any heating lines that are no longer needed. However, be sure to drain the water from any valved-off lines that may be subject to freezing.

Underground distribution lines tend to have severe losses because their insulation is seldom, if ever, inspected. If the insulation becomes wet from ground water, it does not work properly. Also, steam leaks in underground lines may not be noticed unless they are substantial. If several buildings are heated from a central plant, the losses could be considerable.

In steam systems, losses occur when condensate is returned to the boiler in uninsulated lines; when condensate is lost to a drain; and when steam is vented from the system. When condensate is lost from the system, it must be replaced with colder make-up water that must be heated. The quantity of make-up water should be monitored with a water meter to find out how much condensate is lost in the system. Too much make-up water may mean a leak in the system.

Steam Traps — A Special Source of Heat Loss

Steam traps allow condensate to drain from the steam system while preventing steam from escaping into the condensate line. The steam that escapes into the condensate line is not in itself a system loss, for it only increases the temperature of the condensate. The loss occurs if the heat escapes from the condensate line or if the condensate does not reach the boiler. If a great amount of steam escapes into the condensate, steam can actually be seen venting from the condensate receiver near the boiler. When the condensate receiver's temperature is high, or steam "plumes" are observed, the steam traps are probably failing.

When looking at each trap, check the by-pass valve as well, which is used when the trap is being serviced. It may leak or be left in the open position. Most steam traps have a test valve: if the discharge contains droplets of water, the trap is working properly. There are other ways to test traps that require special equipment and training. Be sure to obtain the help you may need for this important job.

Sometimes condensate from a high-pressure boiler is returned through low-pressure lines, and re-evaporates into steam. If this steam is vented off it is wasted; it may be possible to pipe it back into a low pressure line.

Don't Forget to Look at the Water Pumps

Water pumps are frequently overlooked, but a small 20 horsepower pump can cost $5,000 per year to operate. Most pumps used in heating systems can be shut off when the outdoor temperature rises above 60°F; if automatic thermostatic controls are used for this purpose, savings can be substantial.

You may also be able to reduce the flow rate. If the flow rate is reduced without constricting the system or reducing the pump's efficiency, the power needed for pumping would be reduced by the cube (x^3) of the reduction in the flow rate. Reducing the flow rate can be done by reducing pump speed, by trimming the pump impeller, or by installing a smaller pump.

Cooling Systems

If your building is cooled by **local** units (i.e., window or wall air conditioners), the potential for savings lies in proper maintenance and cleaning, monitoring how they are used and in making sure you have efficient equipment of the proper size for the space to be cooled. In **central** cooling systems, there are system efficiencies to be considered.

How Central Cooling Systems Work

In a **direct expansion system,** a refrigerant is passed through a compressor to a condenser where it liquifies and gives off heat. This liquid is then passed through an expansion valve to the evaporator, and as it expands into a gas it absorbs heat from the indoor air. This gas returns outdoors to the condenser, along with the heat it has absorbed.

In a **chilled water system,** water passes over the evaporator and is cooled before being distributed to the conditioned area. The heat from the condenser is absorbed by water from a cooling tower (sometimes direct expansion systems cool condensers with water, too).

A less common system utilizes the **absorption cycle,** particularly found in facilities where waste steam is available. Steam is used to concentrate a solution of lithium bromide. This concentrated solution absorbs water, causing evaporation and cooling of water in the evaporator.

Ventilation and Air Handling Systems

You may have a ventilation system as simple as opening and closing windows or as complex as a centralized "total environment" system with variable air volume. All complex systems can waste energy and are good candidates for some simple O&M (operation and maintenance) measures that can save you money. This fact sheet will help you implement some of these low-cost and no-cost measures.

The air supply in an air-handling unit can be any mixture of outside air and indoor air. This mixture of air is controlled by a series of dampers and is regulated by electronic devices. The air then moves through a series of coils that can provide any combination of heating and cooling. If the outside air is excessively cold, it is often preheated prior to mixing.

• Single Zone Systems

The simplest system is the single zone system. Unit ventilators are single zone air-handling units without exhausts.

With proportional control, as the temperature in the space rises, this is what happens **when the space is occupied:**

1. The heating coil gradually turns off.
2. The dampers gradually take in more outside air if outdoor air is cool enough (in some systems, humidity is also considered to be useful for cooling).
3. The cooling coil gradually turns on.

When outdoor air cannot be used for cooling or when cooling is not needed, the dampers return to their minimum-outdoor-air position.

Tips for Efficient Operation

Even if your single zone air-handling unit is controlled differently, these tips will help save energy:

- The heating coil should never be on while the outdoor damper is open beyond its minimum position. In fact, there should be a "deadband" between heating and outdoor air intake. That is, the temperature at which the outdoor damper begins to open should be several degrees below the temperature at which the heating coil gradually turns off.
- The outdoor damper should be completely closed during unoccupied periods and especially during morning warmup.
- When cooling is required, the cooling coil should be turned on only when outdoor air cannot handle the load. Even when the cooling is on, the outdoor air damper should be open **if outdoor air is easier to cool than return air.**
- During unoccupied periods, the space temperature should be set back, and the fan should run only when heat is required.

To sum up, the system's various functions should never be allowed to fight one another, and the building should use only as much heat or air conditioning as comfort and code regulations require.

• Reheat Systems

A reheat system's major advantage is that it can do an excellent job of providing different temperatures in several different zones at the same time. Its major disadvantage is that it is the most wasteful system in common use. Typically in such systems the cooling coil and dampers maintain the air at a constant cool temperature. This temperature is usually 55°F to assure a relative humidity of no greater than 50 percent at 75°F. The 55°F air is delivered throughout the building to various zones where it is reheated to meet local requirements. Whenever the building's cooling load is less than maximum, this system is simultaneously heating and cooling the same air.

Tips for Efficient Operation

Even a properly operating reheat system is inefficient. However, you can minimize its wastefulness by eliminating the use of the reheat coils as much as possible. Try raising the cooled discharge air temperature gradually over the course of several days. This will reduce the load on the reheat coils. You may find that you can get by with a 65°F unit discharge temperature during the winter while you might still need 55°F in the summer. **Remember, however, that in raising the discharge temperature you are losing control of humidity.**

Further improvements are possible, but require modifications in your controls, especially if humidity control is important.

● Multizone Systems

As its name implies, a multizone system can maintain comfort in several zones simultaneously. While it is not as effective as a reheat system in controlling humidity, it also wastes less energy. With minor modifications, a multizone system can be made to operate more efficiently.

The sketch below shows only one zone.

A typical multizone unit actually has several zones, each with its own thermostat and mixing dampers. If you have a multizone unit which has not been improved since the mid-1970's, it probably operates in the following manner:

The outdoor-air, exhaust-air, and return-air dampers are modulated (gradually change) to maintain a constant mixed air temperature, usually 55°F. The heating coil is regulated to maintain the "hot deck" at a constant temperature, typically around 120-140°F. The cooling coil keeps the "cold deck" at 55°F. Each zone now has hot and cold air available to it. The zone thermostats maintain proper space temperature by controlling mixing dampers which mix the heated and cooled air.

Tips for Efficient Operation

All improvements to a multizone system should be directed toward minimizing air mixing.

1. The mixed-air temperature should be as high as possible to minimize the load on the heating coil.
2. The hot deck temperature should be as low as possible.
3. The cold deck temperature should be as high possible.

In most buildings, it is possible to turn off the heating coil during the summer and the cooling coil during the winter. When this is done, the turned-off deck acts simply as a bypass.

● Other Kinds of Systems

A **dual-duct system** is effectively a multizone system with its hot and cold decks extended by ductworks. Hot and cold air are distributed throughout the building. Mixing takes place in mixing boxes located in or near the areas they serve.

A **variable-volume system** can be very efficient if it is operating properly. Air at a constant temperature is distributed throughout the building. Dampers or air valves controlled by thermostats pass only as much conditioned air as necessary into the areas they serve.

In an **induction system,** a central unit supplies air to terminal units located in conditioned spaces. This air induces an additional flow of room air. The total air flow is heated and/or cooled by coils in the terminal unit. The air from the central unit is often all outside air, which by itself can satisfy the ventilation requirements of the space. In many systems, this air is heated in the winter and cooled in the summer. The temperature of this air should be controlled to minimize the amount of reheating or recooling at the terminal units.

New Technology in Controls

With the rise in energy costs, there has been a rapid evolution in HVAC control systems. New control devices have been developed which can shut down or off parts of your HVAC system when they aren't being used. Some new controls sense outside air temperatures and modify the temperature settings of your primary heating or air cooling systems to suit the weather conditions. Other controls are designed to make energy efficient choices between the temperature and humidity of outside air and inside air, and select whichever is better suited to the needs of the building and its HVAC system.

If your building has a "total environment" HVAC system, your controls are crucial to the efficient use of energy. But no matter what kind of HVAC system you have, controls can make major saving in energy use, often without major modifications in your basic HVAC system. These are the basic types of controls on the market today:

In **electric proportional controls,** the controlled device is usually a motor. The motor can drive a valve, a damper, or a series of cam operated switches. In addition, the motor drives a potentiometer which is balanced against a potentiometer in the thermostat.

More sophisticated control is possible with this system. Controlled devices can be sequenced easily. For example, as room temperature rises, the signal from the thermostat can gradually drive the heating water valve to a closed position. When the valve is fully closed, a further increase in temperature can gradually open the outdoor air damper.

Electronic controls are capable of still further sophistication. Their advantages are that their sensors (thermostats, etc.) have no moving parts, and they have fewer discrete components to be interconnected. Their major disadvantage is that their operation is hidden in "black boxes," and cannot be reached.

Pneumatic controls are the most common in large systems. They operate on the same basic principles as the other control systems and are capable of the same control sequences. Control signals are varying air pressures in place of voltages and currents. Thermostats consist of bimetal strips varying the flow of air through orifices. All controlled devices are bellows or pistons operated against adjustable springs.

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Domestic Hot Water Systems

The Hot Water System

"Domestic" hot water is used in commercial buildings for washing hands, dishes and other "domestic" purposes. Even though the hot water is needed only intermittently, you probably have a water heating, storage, and distribution system designed to ensure that a substantial supply of hot water is available at all times. These same system elements create inefficiencies that lead to energy waste. Additional waste is caused by leaks in the system. As we'll see, it is possible to achieve significant savings by reducing both the quantity of hot water used (or wasted) and the amount of energy required to heat, store, and distribute each gallon.

What Kind of Water System Do You Have?

The differences between hot water systems are found in the method used to heat the water and in where in the system the water is stored. One type of system uses free-standing, tank-type water heaters which may be gas, electric or oil-fired. There also are systems which are boiler-based, in which domestic water is heated by passing it through a heat exchanger which is connected to the hot water supply for the building heating system. This type of system may or may not have a storage tank.

In a system with a single, centralized heating source, after the water is heated, either it is stored in a tank and then distributed through pipes to the end points of the system or it is distributed directly to the end points: the showers, laundries, kitchens and lavatories in the building.

Frequently there are substantial heat losses in such systems because of the long distances between the heat source and the end points. Some centralized systems also have booster heaters at these end points, most often for dishwashing and laundry. Because of the long pipe runs in many central systems, it may take considerable time for the hot water to reach the point of use. To avoid the waiting time, many systems employ a circulating pump which keeps the hot water flowing through the pipes continuously to provide "instant" hot water. These pumps often operate 24 hours a day.

In some domestic hot water systems, the primary heating source and the storage tanks are located very near the end points of the system. This is often true in small buildings with one or two rest rooms or in very large buildings where domestic hot water use is concentrated in a central area. Because there is only a short distance between the heat source and the point of use, in such cases heat losses due to distribution are minimal.

Ways To Save Energy

There are ways to save energy in all components in your hot water system. You can reduce the amount of hot water used at the end points or from leaks, reduce energy use by lowering the temperature of your hot water, and minimize wasted energy by preventing transmission and standby losses in your storage tank and distribution lines.

Leaks and Flow Restrictors

First, all water leaks should be repaired promptly. A single leak, such as that from a faulty valve, can easily squander 50,000 gallons per year. If the water were heated from 55° to 160°F with electricity at 6¢ per kilowatt hour (Kwh), then 12,800 Kwh or $770 would be wasted annually. Water use can also be limited with flow restrictors. In showers and at kitchen and lavatory sinks with controlled flow aerators, water use can be reduced by fifty percent. Auto-shutoff faucets are particularly suitable for public buildings where faucets accidentally can be left turned on. Water conservation not only saves energy costs but can also reduce water and sewer utility charges.

Temperature

The second approach to reducing hot water costs is to reduce water temperature. Free-standing tank-type hot water heaters are often set to heat the water to 150°F, even though a temperature of 105° is adequate for hand washing. The high temperature setting results in increased heat loss from storage and distribution which, in turn, results in increased fuel consumption. The annual energy expenditure for hot water can be reduced by approximately 1½ percent for each degree of temperature reduction over a 20-25°F range. If your hot water comes down from your boiler (a heat exchanger at the boiler), temperature reduction is possible only in the summer when the central heating plant isn't needed to provide space heating for your building.

Generally, reducing the hot water temperature at the main heater makes sense; but not always, since some tasks require hotter water than others. For example, automatic dishwashing requires hotter water (140°F) than washing your hands does. Some dishwashers have a built-in electric booster which will increase the water temperature about 20°F. Without the booster, 140°F water must be supplied by your water heater, so you won't be able to reduce the basic setting to 120°F. Even in the case of a dishwasher that does have a booster, a setback to 120°F may not pay: if most of the hot water is used for automatic dishwashing, the continued use of the electric booster to heat the water to 140°F may more than offset the savings realized by the setback at the main gas-fired water heater.

Check with local health codes for hot water temperature requirements. A very simple rule for hot water settings is: choose the temperature that is required for the major use of hot water in your building.

RECOMMENDED HOT WATER TEMPERATURES

USE	TEMPERATURE (FAHRENHEIT)
Lavatory	
Hand Washing	105
Shaving	115
Showers/Tubs	110
Therapeutic Baths	110
Commercial/Institutional Dishwashing	
Washing*	140
Sanitizing*	180
Commercial/Institutional Laundry	180
Residential Dishwashing/Laundry	150
Surgical Scrubbing	110

*These temperatures are set by health department standards and usually cannot be reduced. Check your local code requirements.

Shutting Down the System Temporarily

Besides reducing the temperature of the hot water, there's another way to save hot water energy dollars. If hot water is used only occasionally, such as to wash dishes after a weekly supper, it will be cost-effective to turn off the hot water heater until perhaps 12 hours before the hot water is needed again. This can be done manually or automatically, depending on your equipment.

In the case of electric tank-type heaters, simply turn off the circuit breaker to the heater (this operation can be automated with a time clock); when it's time to turn the heating element back on, there may be a "re-set" button which must be pushed. A gas-fired heater must be manually turned to the "pilot" or "off" position. If the heater is turned off completely, the pilot will have to be relighted before the burner will fire. Be sure to check your instruction manual and manufacturer's warranty before shutting off the water heater. Whatever type of hot water system you have, be sure to check the system from time to time after turn-off to make sure no leaks develop.

Even though the water heater is turned off for most of the week, tepid or even warm water may still be available for hand washing, depending on the capacity and insulating qualities of the hot water heater tank and whether or not there is a pilot light. If you have a single large water heater near the kitchen and a bathroom some distance away, you may want to consider installing a small water heater right in the bathroom for hot water there, while you keep the larger kitchen heater turned off for most of the week.

ANNUAL SAVINGS FROM
REDUCING HOT WATER DELIVERY TEMPERATURE

ANNUAL FUEL COST($) FOR HOT WATER	AMOUNT SAVED ($) PER YEAR IF TEMPERATURE IS REDUCED BY: 1°	2°	4°	5°	10°	12°	15°
$ 500	$ 7.50	$15.00	$ 30.00	$ 37.50	$ 75.00	$ 90.00	112.50
1,000	15.00	30.00	60.00	75.00	150.00	180.00	225.00
1,500	22.50	45.00	90.00	112.50	225.00	270.00	337.50
2,000	30.00	60.00	120.00	150.00	300.00	360.00	450.00
2,500	37.50	75.00	150.00	187.50	375.00	450.00	562.50
3,000	45.00	90.00	180.00	225.00	450.00	540.00	675.00

Temperatures in Fahrenheit.
SOURCE: XENERGY, Lexington, Massachusetts

System Efficiency Improvements

Long pipe runs that carry the hot water from the heater to other parts of the building should be insulated to reduce distribution losses, if in a circulating type system or in a crawl space. If the pipes are difficult to reach, the energy saved does not pay for itself in time, money and labor. In addition, bare or poorly insulated water tanks should also be well insulated. If you are doing the water tank insulating yourself, care should be taken with gas- or oil-fired equipment to be sure combustion air and exhaust gases are not restricted and that insulation is kept away from ignition sources.

Most water contains a certain amount of impurities and sediment which settle to the bottom of the hot water storage tank. Over time this material builds up and acts as insulation between the tank heater and the cold water. These impurities can be prevented from building up by drawing off a few gallons of water through the tank drain about every six months. If the tank hasn't been drained in several years, it may require extensive cleaning by qualified maintenance personnel.

In larger buildings, the circulator pumps should be controlled with time clocks to further minimize distribution losses and save some of the electricity used to operate the pump. Also, the pipes definitely need to be wrapped on such instances. Lastly, if you have an oil- or gas-fired hot water heater, it should be tuned yearly by trained personnel to insure efficient operation.