ENERGY FACTS

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Lighting and Energy Conservation

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ABOUT 20% OF THE TOTAL ENERGY used in the U.S. is consumed in and around the home. Two to five percent of this energy is used in lighting. Deciding what you want lighting to do for you, and using only what you need when you need it will help conserve energy and reduce the cost of electricity in your home. Adequate levels of light are important, however, in fulfilling the three basic functions of home lighting:

— local lighting for tasks that require close attention to detail, such as reading, studying, sewing, craftwork, etc.
— general illumination of a room or space.
— lighting to increase safety and security, such as for stairways, walkways, entrances and grounds.

The information in this bulletin is intended to help you eliminate wasteful uses of energy for home lighting without risking an effective seeing environment.

Energy-Efficient Lighting

Light bulbs are rated in both lumens and watts. **Watts** measure the rate of electricity consumption. **Lumens** measure the amount of light output. The higher the lumen output per watt, the more **energy-efficient** the light bulb. For example, a 100-watt bulb that produces 1,585 lumens gives more light for the electricity consumed than a 100-watt bulb that gives 1,490 lumens. Both watts and lumens are indicated on package labeling.

Incandescent bulbs are less energy-efficient than **fluorescent tubes.** Most of the energy consumed by an incandescent bulb is dissipated as heat rather than light. Fluorescent tubes waste less energy in the form of heat, so they give about 3 to 4 times more light per watt than incandescent bulbs. Even though fluorescent tubes cost more to purchase, savings can be realized in replacement costs because they last longer than incandescent lamps. Table 1 on page 2 compares light and life factors for lamps used in home and farm application.

A new electrodeless fluorescent bulb[1] has been developed which fits a standard incandescent fixture. The **Litek** bulb is highly efficient in that it puts out more light than an incandescent bulb while using a third to a fourth as much electricity. Though cost is high, the bulb is expected to give 10 years or longer service. Further development is necessary to reduce noise and static, as well as to lower production costs so that the Litek will have increased potential for the home market.

Long-life bulbs (2,500 to 3,500 hours) burn longer, but produce less light for the amount of electricity consumed. A standard bulb (750 to 1,000 hours) of lower wattage will give an equivalent amount of light for less energy; i.e., a 75-watt standard bulb would

[1] *As of this writing it was not yet on the market.*

Table 1. — Light output, average life, and efficiency for lamps used for home and farm applications.

Type of lamp	Lamp size *(watts)*	Approximate average lumens	Average life *(hours)*	Efficiency *(lumens per watt)*
Incandescent (standard)	25	225	2,500	9
	40	430	1,500	11
	60	810	1,000	14
	75	1,100	750*	15
	100	1,600	750	16
	150	2,500	750	17
	200	3,500	750	18
	300	5,490	750	18
Flood PAR-38	150	1,550	2,000	10
Fluorescent (cool white and warm white)	14	675†	7,500	30‡
	15	870	7,500	34
	20	1,260	9,000	40
	40	3,200	18,000	50
Mercury vapor (color corrected)	40	910	16,000	20‡
	75	2,250	16,000	26
	100	3,560	16,000	31
	175	7,140	24,000	35
	250	10,540	24,000	37
	400	18,570	24,000	42
Metal halide	175	10,800	7,500	54‡
	250	17,000	7,500	59
	400	25,600	15,000	58
High pressure sodium (for use in mercury fixtures)	150	10,800	12,000	63
	215	17,100	12,000	69
High pressure sodium	70	5,220	20,000	65‡
	100	8,550	20,000	74
	150	14,400	24,000	83
	250	24,750	24,000	86
	310	33,300	24,000	93
	400	45,000	24,000	98

*Longer life lamps (2,000 to 3,500 hours) are available at a higher initial cost, and they produce 10-15 percent fewer lumens.

†Fluorescent tube light output is listed as initial lumens by manufacturers. The average light output depends upon many factors, but will be at least 20 percent lower than the initial lumens.

‡The ballast inside a fluorescent, mercury vapor, metal halide, and high pressure sodium lamp fixture uses some electricity in addition to the electrical energy used by the bulb. These lumen-per-watt figures are based upon the average light output of the bulb and the total electrical energy used by the bulb and the ballast in the fixture.

give an equal amount of light as a 100-watt long-life bulb. Since long-life bulbs are not energy efficient, they are recommended for use only in areas that are difficult to reach.

Efficient Seeing Environment

An efficient seeing environment has adequate light for the intended use of the space **and** comfortable balance between high and low illumination. Looking up from a brightly lighted work surface into a dim or darkened room causes eye fatigue and discomfort. Some recommended light levels for specific tasks and general room illumination are given in Table 2. Individual differences must be taken into account. Older people require more light and lower contrast between lighted areas in order to see as efficiently as younger people (5)[2].

The reflectance factor of interior surfaces also affects visual comfort. Walls adjacent to, and opposite, window-walls should have a matte (flat) finish in order to alleviate the potential problem of glare. Similarly, lighter colors on walls with windows will help decrease the contrast between the windows and surrounding surfaces. Table 3 shows desirable reflectance factors for various surfaces in a room.

Choice of color for interior surfaces and furnishings can increase the efficiency of a room lighting system by as much as 15 to 20 percent. Light-colored walls, ceilings, floors, draperies and furniture reflect light, increasing the light level for a given amount of light whether from natural or artificial sources. Lampshades with white liners also increase light reflectance. Table 4 gives typical reflection factors for different colors.

Light quality is also a factor to consider in planning the lighting for home interiors. The concentrated light from incandescent lamps creates highlights and shadows which add depth and warmth to the room atmosphere. Fluorescent tubes give a high-level, diffuse light that, used alone, could give a flat, dull appearance to a room. In areas of the home where color is especially important, **deluxe cool white** tubes are recommended, even though they lose about 20% in light output compared with the more efficient **cool white** and **warm white** fluorescent tubes. Deluxe tubes are more likely to be sold in specialty lighting stores than in other retail outlets that nor-

[2] *Numbers in parentheses refer to list of reading materials on page 6.*

Table 2 — Minimum levels of illumination.
(Recommended by Illuminating Engineering Society)

Specific task	Illumination *(foot candles)**
Reading and writing	
Handwriting	70
Books, magazines, newspapers	30
Studying at desk	70
Grooming	50
Kitchen	
at sink	70
At counters	50
Sewing	
Dark fabrics	200
Occasional	30
Craftwork	
Close work, blueprints, diagrams	100
Rough work	50
General lighting	**Average light in area *(foot candles)****
Any area involving visual task	30
Safety	10
Recreation, conversation	10

*Measured by light meter.

Table 3 — Suggested reflectance factors for home interior surfaces.*

Surface	Reflectance factor
Ceiling	80 to 90 percent
Walls	70
Walls with windows	80
Floor	25

*Recommendations are guides only. Personal taste, individual preference, room location, characteristics, and use also must be considered. Source: Illuminating Engineering Society.

Table 4 — Reflectance factors of colors

Color	Reflection factor
White	80 to 90 percent
Pastel yellow	80
Pastel beige, lilac, rose	70
Pastel blue, green	60 to 70
Mustard yellow	35
Medium brown	25
Medium blue, green	20 to 30
Black	10

*Reflectance values are averages of reflectance to incandescent and to cool-white fluorescent lamps. (Source: General Electric Company)

mally stock standard bulbs and lamps.

When planning a new home, or changing existing lighting, some combination of incandescent and fluorescent lighting would provide a pleasant environment at improved energy efficiency. For example, select fluorescent lamps for long-term, shadow-free use in work areas, and softer, warmer incandescent light sources for general lighting in family-, living-, and bedrooms.

Outside Lighting

Outside lighting is important for safety, security, work, and play. The proper types of lamps and fixtures are important to insure adequate illumination with minimum energy consumption.

High-intensity discharge lamps such as mercury vapor, metal halide, and high-pressure sodium require warm-up periods of one to 10 minutes before reaching maximum light output. Once these lamps have reached operating temperature and then are turned off, one to five minutes cooling-off time is required before the lamps will relight. These lamps, therefore, should not be used in areas where they will be turned on and off frequently. High-intensity discharge lamps are intended for all-night operation, or at least for several hours at a time. They can be operated with a manual switch or a photo control. Incandescent lamps are the best choice for outside areas where the light will be turned on for only a few minutes or an hour or two.

For high efficiency, a lamp should be placed as close as possible to the center of a large outside area. The lamp fixture should be mounted 15 to 20 feet above the ground. If only a low level of light is required, an inexpensive mercury vapor lamp and fixture will be sufficient. The efficient, high-pressure sodium lamp is best for areas where high illumination is required. When the fixture must be located at the side of the area to be lighted, reflector flood fixtures will direct most of the light onto the desired area.

Incandescent outside **reflector flood** and **spot bulbs (PAR-38,** 150 watt) can be used instead of general illumination fixtures with common bulbs to direct light to specific areas around the home. Light escaping to areas where it is not needed is a waste of energy.

Fluorescent light efficiency drops significantly when the temperature around the tube is below 50°F, and the tubes may not start readily. Special fluorescent tubes and fixtures are made for outside use, but they are the expensive instant-start type. Outside fluorescent lamps will operate properly in cold weather, but their light output is lower than when the temperature is above 50°F. Fluorescent lamps should not be used in unheated rooms and basements, garage, outside areas, and cold buildings.

High-Efficiency Lamps for Cold Areas

The **mercury vapor** lamp is a high-intensity discharge lamp (HID) that is widely used for farm and home yard lighting. Its efficiency is not affected by cold weather. Mercury vapor lamps are two to three times as efficient as incandescent bulbs, depending on size, and they generally last 5 to 8 years. Mercury vapor bulbs are available with clear glass or with phosphor coating inside the glass. The clear glass bulbs do not produce red light, and therefore red buildings and red objects appear somewhat brown. The phosphor coating inside the glass bulb of color-corrected mercury vapor lamps produces red light and makes red surfaces appear red. These color-corrected bulbs generally produce slightly more light than clear bulbs of the same wattage.

Harmful ultraviolet radiation is produced inside mercury vapor lamps but is trapped inside the glass bulb and **cannot** pose a safety hazard. However, if the glass bulb is broken and the lamp continues to operate, this harmful ultraviolet radiation can escape. The lamp should be turned off and replaced. New mercury vapor bulbs have a safety device which shuts off the lamp if the glass bulb is broken.

Metal halide is a high-intensity discharge lamp. It is used primarily for sports field lighting and similar applications requiring high illumination and good color balance. Objects appear their natural color under metal halide lamps. Efficiency is three to six times that of incandescent bulbs, depending upon size. Metal halide bulbs, like the mercury, require a special fixture.

The **high-pressure sodium bulb** is the type with the highest efficiency which still makes objects appear nearly their natural color. Efficiency is five to seven times that of the incandescent bulb. The bulb produces an excess of orange light, which makes the bulb appear somewhat orange when viewed directly. High-pressure sodium lamps also require a special fixture. They are recommended for outside areas where high illumination is required. A high-pressure sodium bulb produces two to three times as much light as a mercury vapor bulb of the same wattage. These bulbs are also recommended for general lighting of inside areas such as barns and machinery sheds. Best results are obtained when the fixtures are mounted 15 to 20 feet above the ground.

Another sodium lamp available is **low-pressure sodium.** Its efficiency is about 50 percent higher than the high-pressure sodium bulb. However, the low-pressure sodium bulb has several important disadvantages.

Color is poor for the low-pressure sodium lamp, because it produces only orange light. Some low-pressure sodium lamps are very large which makes the fixtures cumbersome and bulbs hard to handle.

Light output decreases as **all** types of lamps become older. At half the rated life, an incandescent lamp loses about 10 percent of the initial lumens. Fluorescent and high-intensity discharge lamps may lose 20 percent or more of their initial lumens when they reach half their rated life.

Energy Conservation Tips

The key to conserving energy for home light is to **use what you need — but not more than you need.** Start by making use of **daylight** — as much as possible. Place furniture — desk, chair or work surface — near a window (not facing the window) so that light falls across the work surface or your shoulder. On bright or sunny days, use natural light instead of general purpose, artificial light. A white wall facing the window maximizes reflection of daylight; so will mirrors.

Skylights and clerestory windows add to the efficiency of daylight, but this advantage must be weighed against the loss of heat energy at night.

Turn off lights when they are not in use. Separate controls for task and general purpose lighting can provide adequate lighting without waste. Proper placement of switches will reduce the likelihood of leaving lights on in an unoccupied room. Receptacle outlets operated by wall switches provide convenient control for table and floor lamps.

Turning lights on and off can shorten the life of fluorescent tubes, but this does not affect incandescent lamp life. The cathodes at each end of the fluorescent lamp contain a special electron-emitting material necessary for lamp starting. Every time the lamp starts, the initial arc removes some of this material from the cathodes. You see this lost material appearing as dark rings and spots at each end of the tube. When too much of this material is lost, the lamp will no longer light. It will simply blink as it tries to start. Prolonged blinking often results in overheating of the ballast.

To conserve electricity, turn off incandescent lights if you will be leaving the room for 3 minutes or longer; turn off fluorescent lights if you will be gone for 15 minutes or longer.

Solid-state dimmer switches also help conserve electricity. Inexpensive and easily installed, a dimmer will give you lighting flexibility as well as more efficient use of light. Dimmers can lengthen bulb life by op-

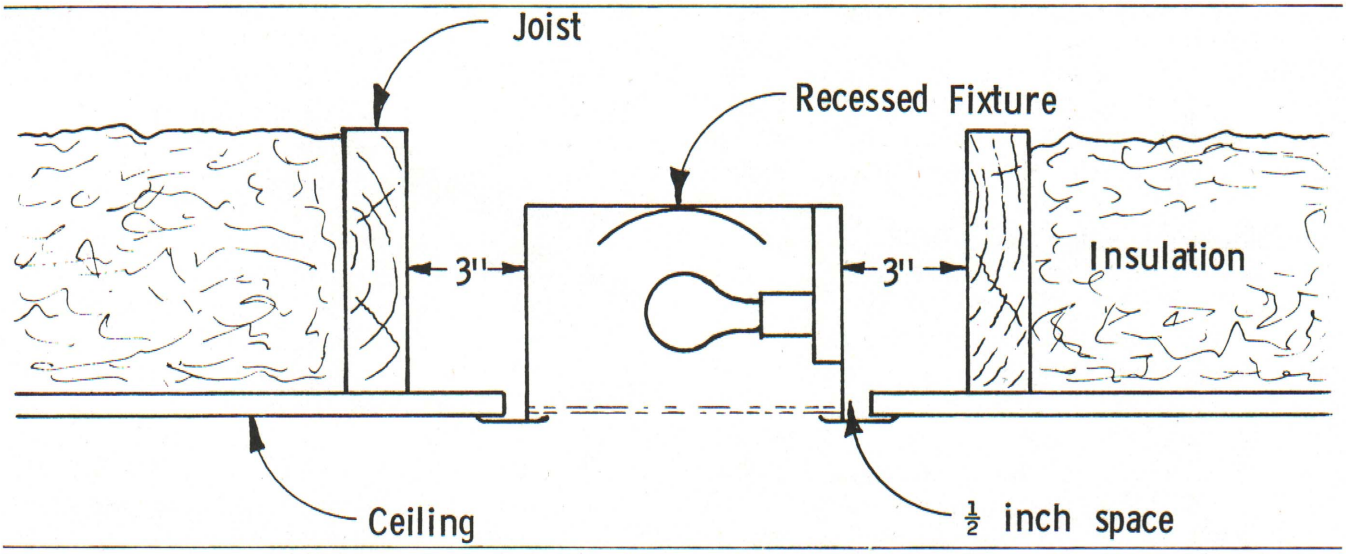

Figure 1. Insulation must not come closer than 3 inches to the sides of a recessed incandescent fixture. Insulation must not be placed over the fixture which may trap heat. If insulation traps the heat, a fire may result.

erating at reduced voltage. **Three-way bulbs** save energy for the same reasons as dimmer switches: they can adjust light output to an adequate but not excessive level. Fluorescent lamps can be put on a dimmer, but this requires a special, costly ballast.

Photo-electric light sensors or timers can also reduce electric lighting usage during periods of sufficient daylight. Timers can switch lights on and off when you are away and limit the use of certain lights to night-time. Light-sensing systems require the added cost of hiring experts to balance the system properly. Other costs have limited interior installation to commercial usage, but the end to cheap energy may encourage development of "over-the-counter" systems which the homeowner can install.

In areas where high illumination is desired, use one high-wattage bulb in place of several low-wattage bulbs — the light output will be higher for the same amount of electricity consumed. A 100-watt bulb gives nearly 50% more light than four 25-watt bulbs.

Clean light bulbs are also more efficient, because dust and dirt absorb light.

Lighting fixtures in barns should be provided with **reflectors** to direct light downward to prevent light from being lost in the roof/ceiling area.

Recessed lighting fixtures should be installed in insulated ceilings only where necessary, because they generally are energy wasters or fire hazards. Insulation must never come in contact with the lighting fixture or cover the lighting fixture. This is a National Electrical Code regulation. The insulation retains the heat of the fixture and may cause a fire. When the insulation is omitted in the area of the fixture, however, heat from the room escapes upward through the uninsulated area.

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