RESIDENTIAL LIGHTING IMPROVEMENT OPPORTUNITIES

CALIFORNIA ENERGY COMMISSION

Joint Committee Workshop on Policies to Improve Residential Lighting Efficiency in California

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PURPOSE:

This paper is intended as a plain language, descriptive, qualitative, relative guide to residential general service lighting improvement opportunities as viewed by PG&E; a utility public purpose energy-efficiency program administrator, developer and provider serving gas and electricity to 9 million customers in California.

IMPORTANCE:

Residential lighting constitutes a very significant opportunity for cost-effective energy-efficiency improvement. This is particularly true as society trends towards larger homes in predominantly hot areas, more amenities, and greater home-office prevalence.

SEGMENTATION OF OPPORTUNITY:

Opportunities are *market* related and *technical*. Of these, market related is far more significant. The technology will become available if the market demand is present.

MARKET ISSUES:

Opportunities in new construction (T 24) are associated with *production* and *custom* builders. Of these, production building is far more significant.

Opportunities in retrofit (T 20) are *commodity* or *high-end*. Of these, commodity is far more important.

Opportunities in residences are *portable* and *hard-wired*. Of these, portable is much more prevalent, although hard-wired may have more operating hours.

Opportunities are "*bulb*", and "*lamp or fixture*" related. Of these, "bulb" opportunities are much greater due to the large number of existing sockets.

The retrofit opportunity for bulbs and portable & hard-wired lamps or fixtures is far greater than the new construction opportunity.

Manufacturers and distribution channel participants will act to maximize, and must maintain profitability. Incandescent lamps found at major retail outlets are primarily those of the "big 3" lighting manufacturers. CFLs primarily carry other brands, leading to competitive pressures and shaping business perspectives.

Small differences in the cost of bulbs and lamps or fixtures are not likely to influence individual consumer purchase decisions so much as perceived quality and value. The retail price of all these products varies by wide margins depending on marketing, packaging, and the channel of distribution. These market-related price effects are much greater than the cost of raw-materials or manufacturing. Price is critical to large volume purchasers, such as production builders.

Improved consumer acceptability, CFL market penetration, and energy-efficiency can be realized by increasing the range of product diversity and brand & performance consistency of products routinely found at retail. It is very difficult to routinely find a range of CFLs of reasonable price at retail to fit all common residential applications (A, Reflector, Globe, and cold cathode Candelabra styles). Dim-able, high power quality products are even more difficult to find. If one is replacing a standard incandescent bulb with another, one can be reasonable certain that the replacement will work and look like the original. However, with CFLs, it's here-today, gone-tomorrow. For example, it's very difficult to easily purchase at retail an exact replacement for a burned out CFL lamp in a vanity light bar. Research done in the PEARL program has shown that the quality of CFL products in terms of light output and life, varies widely. Steps should be taken to assure improved production quality control, providing consumers assurance of consistently high product quality which matches specified performance.

"BULB" TECHNOLOGY IMPROVEMENT OPPORTUNITIES:

When considering the energy savings and demand reduction associated with these technologies, lamp lumen depreciation and system efficiency (where ballasts or power supplies are needed) must be considered.

A good measure of efficiency related value is (lumen*hours) / ($ of operating + initial + maintenance *avoided* cost). The term *avoided* cost is used here to reflect the way energy efficiency administrators, providers, and regulators evaluate savings opportunity.

For incandescent lamps, the basic technical efficiency relationship is that the hotter the filament can be, without burning up and sacrificing life, the more efficient the "bulb" is. For example; incandescent bulbs with insulating gasses such as krypton and halogen, filaments operating at higher current and lower voltage, and better reflectors resulting more light directed towards the desired surface, result in improved efficiency.

Bulb improvement opportunities are associated with the following technologies, either individually or collectively, in any bulb shape (although the viability varies), and in no-ballast-required, unitary (self-ballasted) or split-system configurations:

Standard Incandescent
Halogen
Halogen IR
Aluminized or Mirrored Reflector
* Low Voltage
New Ceramic Lattice and Semiconductor Incandescent Filament Materials (least commercialized of the group)
* Probe Start Standard Metal Halide
* Pulse Start Metal Halide (Required in most cases in lieu of Probe Start)
* Ceramic Metal Halide
* Compact Fluorescent
* Cold Cathode CFL (for low Wattage, candelabra like applications)
* Induction CFL (offers longer life with frequent starts and dim-ability)
* Light Emitting Diode

Note: Those with * require a ballast of power supply, where energy savings estimates must be based on system performance.

SPECIAL "BULB" IMPROVEMENT OPPORTUNITY:

The major bulb manufacturers offer a General Service, A Lamp, rated at 130 Volts. This product was developed to provide normal life in applications of high building distribution or utility line Voltage. In practice, high line Voltage rarely exists. PG&E's maximum operating Voltage is 126 (128 under emergency conditions). Normal operating Voltages are more in the range of 116 to 122.

The 130 Volt lamps are actually purchased by consumers that want the very long life of these lamps when operated at normal line voltages. Unfortunately, this very long life comes at the cost of drastically reduced efficacy at normal Voltages. There are now many better choices of products, offering higher efficacy for those desiring long life. The 130 Volt, General Service, A Lamp may have outlived its usefulness in today's era of concern about improving energy efficiency.

THE R LAMP – AN EFFICIENCY IMPROVEMENT OPPORTUNITY MISSED:

The Department of Energy imposed efficiency regulations on the ubiquitous R lamp found in vast numbers in ceiling can fixtures in residences (as well as many commercial buildings). Special variations of this lamp, the ER and BR lamps were exempted because they were represented to serve special applications and represented small quantities in the marketplace. Today, R lamps have virtually disappeared from store shelves, having been replaced with the similar ER and BR varieties. The result is that the energy efficiency opportunity associated with the Federal Regulation was mostly missed due to the substitution of an exempted product for the regulated one. This lapse needs to be corrected.

"LAMP or FIXTURE" TECHNOLOGY IMPROVEMENT OPPORTUNITIES:

Lamp or fixture improvement opportunities depend on whether incandescent type lamps are used directly on line voltage, or bulb types that require a ballast or power supply are used.

In line voltage cases for maximum energy efficiency, lamps and fixtures should be designed to get the most of the lamp's light out of the fixture and directed towards the appropriate surface. This usually involves minimizing the lamp's size relative to the reflector to reduce self-absorption and maximizing the reflectivity of the reflector given its diffuse or specular nature.

In gas discharge lamp cases, such as CFLs and HIDs, burning position and maintaining proper lamp thermal management are important. While burning position with LEDs is unimportant, proper thermal management is extremely important with respect to efficacy, lumen depreciation, and device life.

In low voltage cases, such as low voltage incandescent halogen IR MR and LED, ballast or power supply efficiency is important. Voltage reduction can be accomplished through conventional progressively more efficient laminated core transformers, torrodial transformers, or electronic transformers. It is important from a stand-by energy use and demand reduction perspective to place the on-off switch in the power supply's primary rather than the secondary. Switched primaries reduce standby use to zero.

Important, and often not considered, are power cord and distribution wiring size. The electrical code was written to improve fire safety, not energy efficiency. An additional 5 to 10% of products energy use is lost as heat in wiring. In products with poor power factor, which create additional non-productive electrical current flow, this can be double or more. Energy savings opportunity associated with improved power factor is an opportunity should be considered in energy savings estimates and evaluations.

SPECIAL FIXTURE IMPROVEMENT OPPORTUNITY:

Many homes have illuminated street number signs. These typically use low voltage automotive type lamps of low efficacy, powered through laminated core, impedance protected type transformers. These signs are normally powered 24/7. An opportunity exists to require higher efficacy bulbs, more efficient power supplies, and daylight sensors in these products.

A CAUTION:

Many residences feature “light bar” type fixtures in bathrooms, offering an excellent opportunity for replacement of 40 Watt incandescent lamps with CFLs of similar shape. These “light bars” may have as many as 12 sockets. Placing too many CFLs of poor power quality (high current crest factor) in fixtures served by one “residential grade” switch will cause the switch to eventually suffer an arcing mode failure. Either power quality of CFL products must be improved, or cautions against placing too many such products on one switch or circuit must be provided.

BEHAVIOR & CONTROLS:

Increased use of occupancy sensors in multi-family dwelling common areas, bi or multi-level lighting, manual on, automatic off sensors in living spaces, and motion and daylight sensors for outdoor lighting are all important technologies to minimize burning hours relative to the amount of light and the times that it is actually needed. Many consumer grade photocells have poor precision relative to their on-off light levels. On-off time control precision can be improved by the use of silicon photocell based electronic controls, improving energy efficiency and assuring adequate electric light when needed.

CONCLUSION:

There are many cost-effective energy efficiency improvements associated with residential lighting. These can and should continue to be aggressively addressed through a combination of the methods available to public policy planners (PIER, ET, Information/Education, Incentive, and Codes & Standards Advocacy programs).