Focusing on Buyers' Needs: DOE's Emerging Technology Program

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Abstract

This paper describes DOE's Emerging Technologies Program, which seeks to increase the speed at which new energy-efficient technologies receive widespread acceptance and adoption in the market place. The Program focuses on technologies in the late stages of commercialization - either the technology exists but energy-efficiency improvements are needed or energy-efficient models have already been produced but have limited market acceptance because of high cost or lack of consumer awareness. ETP uses demonstrations, evaluation and monitoring projects, promotional efforts, and technology procurements to increase market acceptance. The paper describes several completed projects as well as ongoing and planned future projects.

Introduction

Five years ago, highly efficient, apartment-sized refrigerators were impossible to find. But thanks to an innovative program launched by the New York Power Authority, the Consortium for Energy Efficiency, and the U.S. Department of Energy (DOE), new models of high-efficiency apartment-sized refrigerators were developed and introduced into the market, where they were eagerly purchased by public housing agencies and other owners of apartments.

DOE's Emerging Technologies Program has brought about widespread market acceptance of new models of apartment-sized refrigerators and a host of other products and has plans for more to come. Initiated in the Energy Policy Act of 1992 (Sections 127 and 128) and housed in DOE's Office of Energy Efficiency and Renewable Energy, the Emerging Technologies Program has ambitious goals of achieving national energy savings of at least 600 Trillion British Thermal Units (TBtu) per year and introducing 30 or more new technologies and products by 2015.

Approach

The Emerging Technologies Program (ETP) is unique among DOE R&D programs in its approach. Unlike many programs that focus on the technology developers and manufacturers, ETP puts special emphasis on getting to know the buyers, understanding their needs and motivations, and building buyer networks. ETP has formed close working relationships with

- national retailers and large-scale buyers, including Home Depot, Walmart, Costco, Sears, Lowes, McDonald's, and 7-11.
- home builders and home builder associations
- the hotel/motel industry
- the government's largest volume purchaser – the Defense Logistics Agency, and other government agencies, including branches of the military, housing authorities, HUD, and state agencies
- electric and gas utilities
- market transformation organizations, including the Consortium for Energy Efficiency, Northwest Energy Efficiency Alliance, Northeast Energy Efficiency Partnership, New York State Energy Research and Development Administration, and the California Energy Commission.
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ETP focuses on products in the later stages of development (two years or less to commercialization) as well as energy-efficient products that have recently been commercialized but have not yet become established in the market. To be considered, a product has to have the potential to produce significant energy savings within 15 years (savings of at least 0.5 primary TBtu per year) and must show promise of attracting substantial financial and in-kind support from project partners.

ETP uses several approaches to identify new technologies, evaluate their potential for significant energy savings, and speed their market introduction and acceptance. These activities include

1. promoting coherence among state and regional market transformation and demand management programs
2. facilitating access by state and local energy programs to the technology resources of the DOE labs
3. conducting annual solicitations, screening studies, and in-depth studies to identify common needs of energy users that lend themselves to improvements in technology
4. monitoring the media, conferences, and professional networks to identify R&D opportunities
5. evaluating the market potential for emerging technologies
6. late-stage technology development
7. field performance evaluation and verification
8. technology demonstrations
9. technical information and education programs
10. technology procurement
11. business management assistance, via the Commercialization Assistance Program.

Many of ETP's projects use a technology procurement approach, which relies on market forces to *pull* a new product into the market, instead of traditional methods of *pushing* new technologies onto an unsuspecting (and sometimes unwelcoming) buying public or "artificially" boosting sales through reliance on financial incentives and give-aways.

The Emerging Technology Program's technology procurements usually follow these steps:

1. **Develop technical specifications** for new products in cooperation with buyers and review them with potential manufacturers of the products.
2. **Issue competitive solicitations** to potential suppliers that request bids for supplying new products meeting the specifications.
3. **Select one or more winning products** from among these bids and enter into basic ordering agreements with winning suppliers that specify terms and prices under which target buyers can purchase new products.
4. **Promote the winning products** to maximize purchases and help build self-sustaining markets.
5. **Facilitate the sale** of new products at terms and prices specified in the ordering agreement. Suppliers sell directly to target buyers without DOE involvement.

Completed Projects

The ETP has completed a number of projects that have resulted in successful market introduction of new technologies and products or have provided important support to the early market adoption of recently commercialized products. Among those projects are the following.

Red Lion Waste Water Recycling and Heat Reclamation Project

This project, completed in 1997, successfully demonstrated a micro-filtration water recycling/heat recovery system (Figure 1) at a large commercial laundry used by seven hotels owned by Red Lion Inns. It verified a high level of performance (52% water savings and 44% energy savings) and cost effectiveness (reducing water, sewer, and energy bills at the laundry by about $40,000/yr for a simple payback of 4.1 years). The project led to several technical improvements in the technology to both improve its performance and lower its cost. Results were shared with DOE's Hospitality Industry Forum on Energy Conservation, which at the time represented more than 50% of the guest rooms in the U.S. hospitality industry. A large number of microfiltration units were subsequently sold to the hotel/motel industry and the systems are still being sold today.

Apartment-Sized Super Efficient Refrigerator Project

DOE collaborated with the Consortium for Energy Efficiency and the New York Power Authority in a technology procurement aimed at inducing manufacturers to develop and sell highly efficient, apartment-sized refrigerators to the multi-family housing sector (Figure 2). The project succeeded in having Maytag develop and sell a new-to-the-market unit that exceeded

DOE energy standards by 30% and cost about the same as standard efficiency units. More than 100,000 units were sold during DOE's two-year involvement. The units are now well established in the market.

Retailer Program

Working collaboratively with appliance manufacturers such as Whirlpool and Maytag and with major retailers including Sears, Circuit City, and Montgomery Ward (which together represented about 75% of appliance sales at the time), DOE developed a program to promote the sale of high-efficiency appliances and equipment through labeling and promotion on showroom floors. Valuable relationships were developed, and important consumer research was completed. The program eventually became part of the ENERGY STAR™ program and is now highly successful with widespread consumer recognition of the ENERGY STAR™ label (Figure 3).

Appliance Program for Manufactured Homes

DOE worked with manufactured home producers in the Pacific Northwest to promote a suite of high-efficiency appliances in new manufactured homes. After some modest initial success in encouraging home producers and appliance manufacturers to feature high-efficiency appliance options for home buyers, the program was eventually folded into the ENERGY STAR™ Program.

Sub-CFL Technology Procurement

After extensive market research and interaction with the multi-family housing industry and lighting manufacturers, DOE launched a program aimed at speeding commercial introduction of smaller, affordable compact fluorescent lights (CFLs) that met a range of stringent performance requirements. The program succeeded in introducing 17 new sub-CFL models to the market. One of those models beat the program's aggressive price goal of $5 per lamp. By the program's cessation in May 2001, over 3.3 million sub-CFLs had been sold, translating into over $29 million per year in energy cost savings to consumers, and a wide range of non-program manufacturers had commercialized low-cost sub-CFLs as small as those in the program (Figure 4).

High-Efficiency Clothes Washer Projects

The ETP conducted several efforts to help grow markets for high-efficiency, front-loading, horizontal (h)-axis clothes washers. Efforts ranged from working with utility stakeholders to understand the savings potential of high-efficiency clothes washers and potential market acceptability issues, to field evaluations and demonstrations, and to volume procurements. Projects include the following.

The High Efficiency Laundry and Marketing Analysis (THELMA) - This study, initiated in 1995 by DOE, EPRI, the Bureau of Reclamation and 26 major energy and water utilities, surveyed 9,000 homes and confirmed that 1) less than 2% of all homes with washers had a high-efficiency washer, 2) purchasing decisions were driven by manufacturer's reputation, initial cost, washer capacity, and wash time; energy and water conservation were not important factors, and

3) awareness of h-axis washers was very low. The study showed that real-world performance data on h-axis washers was needed and that lack of awareness was the key market barrier to wider adoption of the technology.

The Bern Study - DOE conducted a five-month field study comparing vertical (v)-axis and h-axis washers in the town of Bern, Kansas, a small, rural town with limited water resources. More than 100 homes (most of the town) participated in the study. DOE collected washing machine performance data on the existing machines. Then, all of the participants were given new, h-axis washers and the machine performance evaluation was continued (Figure 5). The changeover produced a 38% savings in water and a 58% savings in energy. Participants reported high satisfaction with the washers' performance. Results of the "Bern" study were published and continue to be cited in a number of consumer publications.

The Tampa Studies - DOE conducted two studies in Tampa, Florida. One was a before/after study of the savings when conventional top loaders were replaced with h-axis washers at a coin-operated laundry room in a Tampa apartment complex. The replacement washers saved 38% of the water and 61% of the energy used by the conventional washers. The second study, an evaluation of several h-axis washers in barracks at MacDill Air Force Base, also produced significant savings. The performance data DOE collected in these studies showed that h-axis (high-efficiency) washers deliver significant energy and water savings in commercial and common laundries.

SWEEP – Saving Water and Energy Education Project - Cooperating with a number of local and state government entities, as well as Portland General Electric, DOE conducted a field study of water (and energy)-efficient appliances and fixtures in Oregon. Water and energy consumption in fifty homes were monitored before and after a retrofit with a suite of efficient equipment donated by manufacturers that included water-conserving clothes washers, dish washers, toilets, and shower heads (Figure 6). The high-efficiency equipment reduced indoor water use by 25% and energy use by 840 kWh per year, yielding annual energy and water savings of $167 per year. A computer model was developed to aid municipal water agencies in estimating operating and capital cost savings from implementing the residential conservation projects. The model and results are now being used to implement water conservation programs in five other Oregon cities.

The Boston Washer Study - A field study in a high-rise residential apartment building with washers/dryers in each unit gathered data before and after existing washers and dryers were replaced with high-efficiency h-axis washers and matching dryers. The energy used by the dryers in the study was measured to determine the impact of the new washer's high-speed spin on dryer energy consumption. Data from the experiment showed that the new h-axis machines saved 50% of the energy and 44% of the water used by the conventional machines and dryer energy savings of 21% were achieved.

How these DOE Clothes Washer Efforts Helped Change the Market - Growth in the U.S. market for high-efficiency clothes washers has outstripped even the most optimistic forecasts done only a few years ago. In 1995, the market for these washers was less than 2% of all residential washers sold in the United States. Presently, that market share is 8.5% and still growing. Over 600,000 high-efficiency washers were shipped in 2000 alone. Moreover, over that short time, the number of major U.S. clothes washer manufacturers who offer a high-efficiency model grew from one to five.

DOE's ETP helped make this success possible by 1) providing independent, objective evaluations of the technology which proved that significant energy and water savings were possible through a changeover to high-efficiency washers, and 2) bringing visibility to the technology and its value in saving energy and water. A number of highly successful outreach activities were conducted as part of these efforts to correct misinformation and to inform stakeholders and consumers of the benefits. Estimates showed that results of the Bern Study alone reached more than 40 million U.S. consumers.

Hotel Lighting

Redondo Beach Crowne Plaza saved approximately $72 per guestroom per year by installing a wide variety of energy-efficient lighting technologies in the rooms, including a unique timer/dimming/occupant sensor bathroom light and CFLs in lamps. DOE researchers monitored the new equipment and estimated that, assuming 90% of the 15 million U.S. hotel rooms already have fluorescent bathroom fixtures, an additional 2 to 3 billion kilowatt hours annually could be saved by installing sensors that automatically turn off the bathroom lights when the rooms are vacant.

Space Conditioning Integrated Water Heating System

As part of DOE's strategy for providing information to help markets for efficient technologies, the Alabama Power Company, Southern Company Services, and DOE, through Oak Ridge National Laboratory, collaborated in a project to evaluate the field performance of a heat pump system that combines space heating, space cooling, and water heating into a single device sized for homes and small commercial buildings. The study, conducted in 1998, showed the integrated design could meet up to 95% of a home's total hot water needs and the integrated heat pump outperformed the combined efficiency of the most efficient heat pump and electric resistance water heater then available on the market.

CFL Torchiere Floor Lamp

When DOE undertook this project with the New York Power Authority and the New York City Housing Authority, there were an estimated forty million halogen torchieres in use in this country, cheap to buy but expensive and sometimes unsafe to operate, burning up 300 to 500 watts a piece at an annual rate of $1.4 billion of electricity each year. ETP conducted a before-and-after study of energy consumption, replacing the halogen torchieres with CFL torchieres developed by Lawrence Berkeley National Laboratory, in 75 New York City apartments. The CFL torchieres consume approximately 40 to 75 watts per lamp, provide more light with

significantly less heat, are dimmable, and last 5 years longer than a typical halogen bulb, yielding a simple payback in about 15 months.

Ongoing Projects

CFL R Lamps

U.S. residential buildings contain at least 200 million recessed downlight fixtures operating with incandescent lamps. While a small fraction of these fixtures have been retrofit with CFLs in the past, users reported widespread dissatisfaction with their operation due to pre-mature failure (from overheating), glare (from over-sized lamps protruding from fixtures), and insufficient light levels (from insufficient light output or poor optical design). This project is designed to help overcome these problems by developing new models of screw-based CFLs that can replace the incandescent bulbs now in place in so many existing fixtures. Working collaboratively with the Northwest Energy Efficiency Alliance, DOE is conducting a technology procurement for CFL R-lamps aimed at bringing to market ENERGY STAR labeled R-lamps that are affordable, bright, durable, short enough to fit in most recessed downlights, and perhaps dimmable. Major tasks include a technical investigation, volume buyer identification and engagement, manufacturer engagement, competitive solicitation, product testing and evaluation, and sales promotion.

Residential Recessed Downlights

Recessed can downlights are the single most popular type of residential lighting fixture. Yet they are one of the least efficient. Almost all use incandescent lamps, and when installed in insulated ceilings, they leak significant amounts of conditioned air into unconditioned attic space (Figure 7). ETP and partners are conducting a technology procurement to develop and introduce advanced versions of air-tight, insulated, ceiling-rated, pin-based CFL recessed downlights to market. Prototype fixtures submitted in response to a request for proposals are undergoing testing and redesign. While laboratory and field testing are completed, ETP will be working with buyers, manufacturers, and program partners such as NEEA, NEEP, the Bonneville Power Administration, the Consortium for Energy Efficiency, the Sacramento Municipal Utility District, and others to ready the market for the products.

Commercial Unitary Air Conditioners

Cooling and heating energy accounts for more than half of the total energy operating cost for commercial and government buildings. Packaged rooftop air conditioning units (Figure 8) dominate the market for small- and medium-sized low-rise commercial buildings, accounting for 60% of cooling energy and nearly one-third of total heating and cooling energy in commercial buildings – over one quadrillion BTus per year. ETP is conducting a technology procurement to help commercialize a new generation of high-performance commercial rooftop air conditioners to provide customers with energy and peak power savings through higher overall efficiency, lower energy consumption over the range of temperatures encountered in typical applications, improved humidity control, and lower initial cost compared to other high-efficiency units. The project has support and involvement from the Federal Energy Management Program and the

Defense Logistics Agency. Other partners include McDonalds Corp., Wal-Mart, Siemens Building Technologies, and 7-Eleven.

Heat Pump Water Heaters

DOE and 18 utility partners are conducting a field test of a 50-gallon residential drop-in water heater. Data collected so far show a 50% reduction in electric water heating energy consumption, yielding a 2-year payback. Feedback from study participants has been used to make design improvements and corrections. Also an evaluation of technical options is being conducted to encourage more manufacturers to produce heat pump water heaters. Two regional pilot studies, a bimonthly newsletter, and new education efforts with utilities are planned to increase awareness of the energy saving potential of heat pump water heaters. A heat pump water heater procurement is planned to begin in 2002.

HVAC Controller

DOE is participating in a project with Digi-Log to evaluate a packaged terminal air conditioning unit (PTAC) HVAC controller for use in the hospitality industry. This controller gives the front desk the capability of thermostat control over all of a hotel's vacant rooms. A field study is being conducted with hotels in Tennessee and Florida to evaluate energy savings of the retrofit devices.

Upcoming Projects

Portable Lamps

ETP is planning a new technology procurement to bring more efficient portable lamps to market. The procurement would target advanced portable lamps using pin-based CFLs. Potential buyers for the products include hotels, consumers, electric utilities, housing authorities, military agencies, and companies seeking an efficient alternative to overhead office lighting in office spaces.

Commercial Water Heating Initiative

Commercial water heating is performed using a range of technologies including gas water heaters, boilers, electric water heaters and heat reclamation from double-bundle chillers, etc. The potential for commercial water heater energy savings is large but the diversity of technologies and wide range of applications makes use of a single new efficient water heating technology unfeasible. ETP hopes to segment the commercial water heating market, look for opportuneities, then apply the best technology to each target market. DOE plans to involve building owners and operators in assessing commercial water heating needs, then to work with building associations and utilities to structure the most appropriate approach to promote the new technologies (e.g., demonstration, evaluation to show proof of performance, etc.). Commercial partners could include such national accounts as health club and restaurant chains and trade associations.

Scotopic Lighting Demonstration

DOE has supported extensive laboratory research to examine the energy use consequences of different lamp spectra for workplace environments. This research has conclusively shown that, when the spectrum of interior lighting is shifted toward the spectra of natural sunlight, light levels can be reduced while maintaining or even improving vision. By taking advantage of the human eye's preference for sunlight-like light, power levels for electric lighting can be reduced 20% or more. Scotopically rich lighting products are already commercially available, but are seldom used because few potential users are aware of them, and because little work has been done to independently verify their benefits. DOE proposes a demonstration project at first one then several sites, which would include before and after monitoring of light levels, light quality, energy consumption, and human factor effects. Potential manufacturers and participants would be invited to visit the test sites and results will be shared.

Other Projects

In addition to these specific projects, ETP will continue to evaluate and identify potential technologies for new projects. ETP intends to form a standing group of buyers interested in energy-efficient products. Past buyers groups have been assembled on an ad-hoc, project-by-project basis. DOE would like to establish an ongoing group of buyers who might be interested in helping select new technologies for investigation and in providing market feedback, as well as participating in volume purchases.

How You Can Participate in ETP's Energy and Cost Saving Technology Projects

ETP invites facility owners and managers to participate as buyers in its technology procurements. To participate in the high-efficiency rooftop air conditioner procurement, see the unitary air conditioner website at http://www.pnl.gov/uac. To participate in the recessed can procurement, see the project website at http://www.pnl.gov/cfldownlights. To locate great deals on sub CFLs, see the sub CFL website, www.BetterBulbsDirect.com.

For more information about all of ETP's completed, current, and upcoming projects, please visit our program website at http://www.eren.doe.gov/buildings/emergingtech. ETP welcomes your suggestions for future projects. Feel free to contact DOE ETP Program Manager James Brodrick, james.brodrick@ee.doe.gov.

Or, contact one of the following managers supporting ETP:

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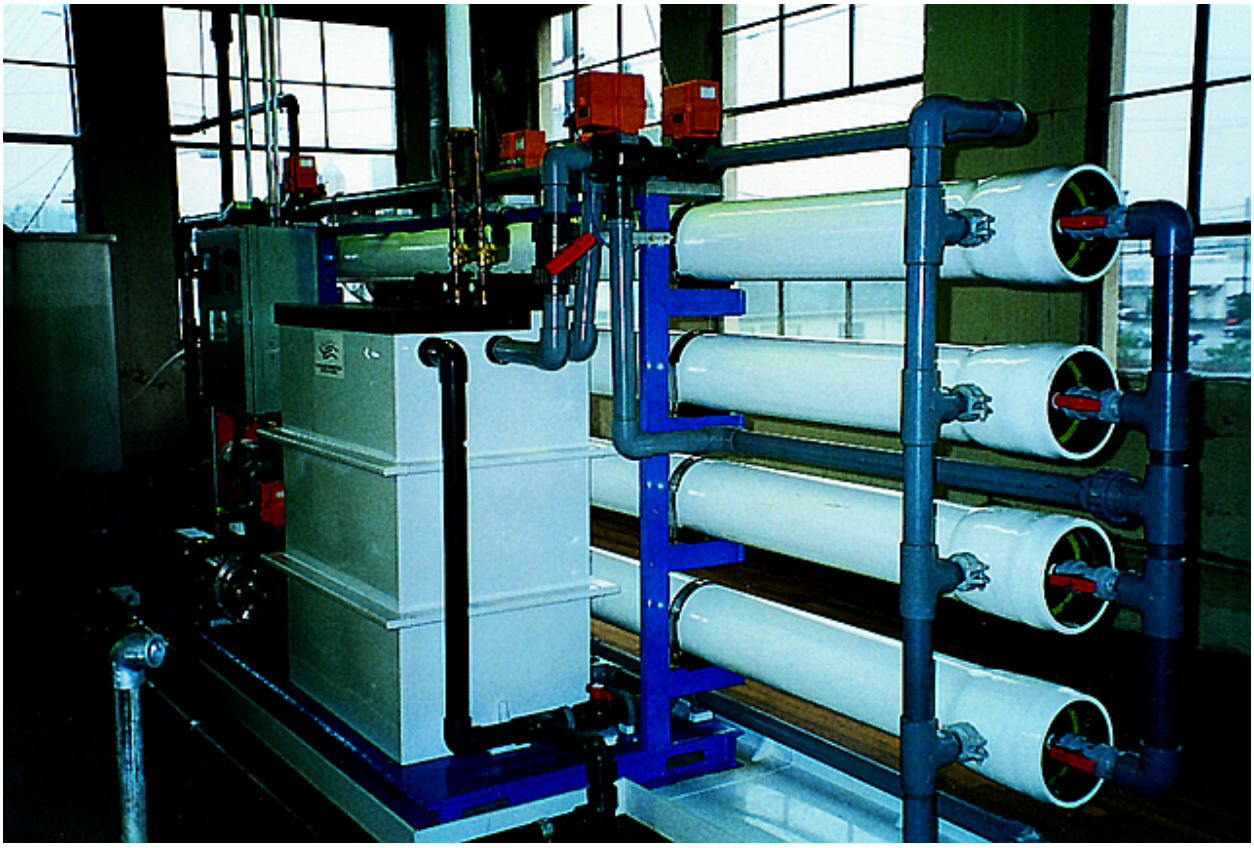

Figure 1. DOE coordinated a water recycling microfiltration demonstration and evaluation at Red Lion Inn's central laundry facility in Portland, Oregon, that verified water savings of 52% and energy savings of 44%, saving the laundry about $40,000 per year in reduced water, sewer, and energy bills.

Figure 2. DOE and partners conducted a technology procurement to develop a new energy-efficient apartment-sized refrigerator. The New York City Housing Authority purchased 20,000 to replace standard units in its apartment buildings. The new refrigerators saved on average 543 kWh/unit/year while giving residents more cubic feet of storage space. (If the new units had been the same size as the models they replaced -15.0 ft^3 instead of 12.7 ft^3 - savings would have been 174 kWh/yr greater per unit.)

Figure 3. The Environmental Technology Program cooperates closely with the DOE-EPA ENERGY STAR™ Program and initiated the nation-wide promotion of efficient appliances in retail stores that is now a core part of the ENERGY STAR™ Program.

Figure 4. Seventeen new models of sub compact fluorescent lights (sub CFLS) were brought to market as a result of DOE's Sub CFL Technology Procurement. During the program, 3.3 million sub CFLs were sold, saving consumers approximately $29 million in energy costs over the life of these lamps.

Figure 5. In Bern, Kansas, (pop. 200) every home in town got a new high-efficiency washing machine as part of a unique study conducted by DOE to evaluate the impacts when a whole town changes over to energy-efficient washers. Detailed energy and water consumption and performance evaluations were conducted before and after the change over. Results showed a 38% water savings and 58% energy savings, with no decrease in consumer satisfaction.

Figure 6. In the SWEEP study, DOE metered water and energy use from household appliances including clothes washers, dish washers, toilets, and showerheads at 50 homes in two Oregon cities. The high-efficiency equipment yielded a 25% reduction in indoor water use and energy and water savings of $167 per home per year.

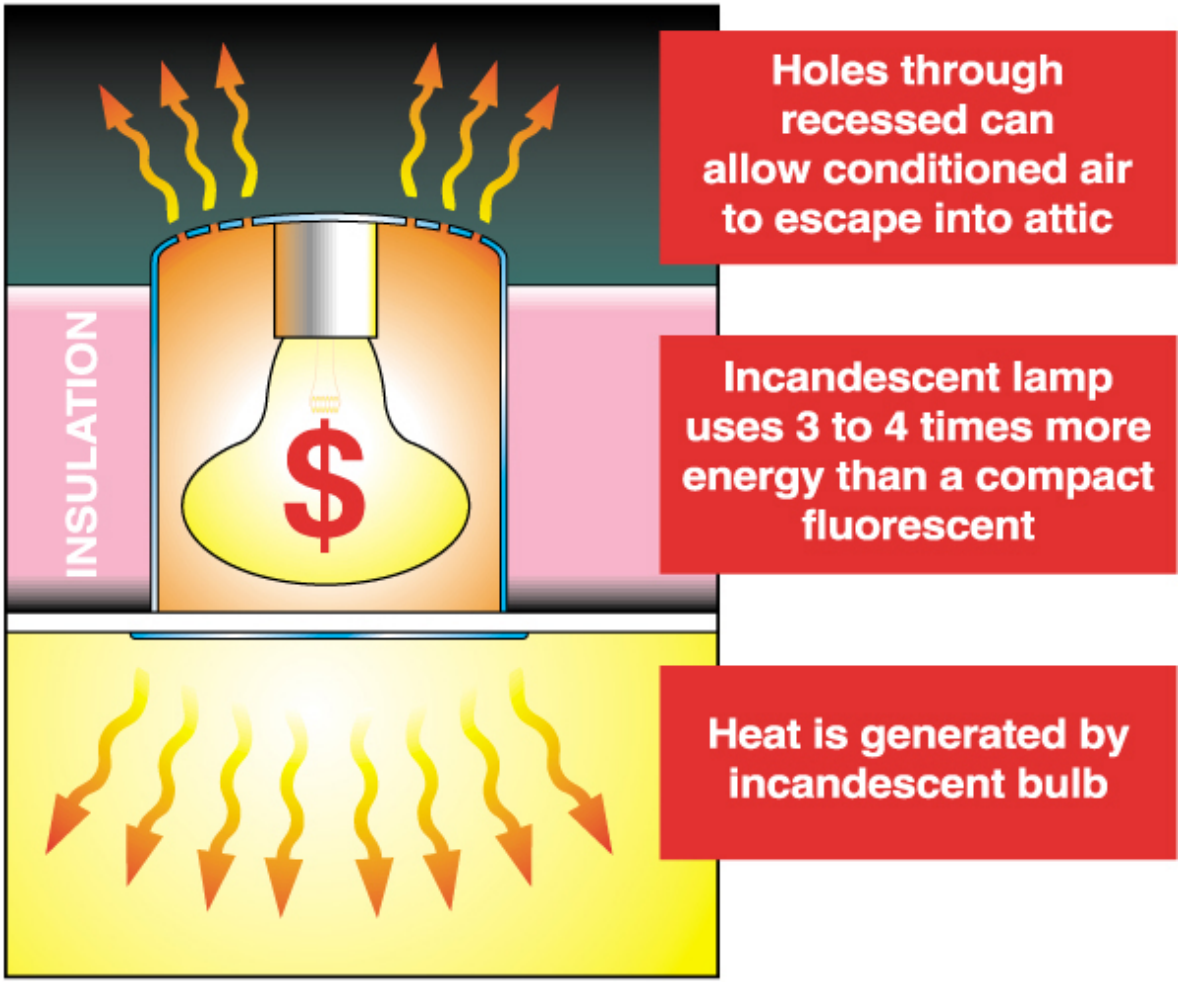

Figure 7. Recessed cans are a popular but inefficient residential lighting fixture. DOE's Emerging Technology Program is conducting a technology procurement to bring more efficient models to market.

Figure 8. DOE is conducting a technology procurement for unitary rooftop air conditioners to increase the availability of affordable, energy-efficient models of these common cooling units for small and mid-sized commercial buildings. DOE developed a cost estimator tool to help consumers determine the life-cycle cost effectiveness of energy-efficient air conditioners for their facilities.