The U.S. Department of Energy's In-House Energy Management Program: Meeting the Challenges of Federal Energy Management

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SUMMARY

The U.S. Department of Energy (DOE) is the largest government energy consumer in the civilian (non-military) sector. DOE's In-house Energy Management (IHEM) Program was established in 1975 to implement energy-efficiency improvements at DOE sites across the United States. These diverse sites include power marketing administrations, national laboratories, weapons production facilities, and nuclear reactor facilities, comprising over 14,000 buildings and 120 million square feet of floor area. Energy expenditures at the 62 eligible sites were about $303 million in 1994, 64% of which was for buildings. The IHEM program was funded at $27 million / year in 1995, but is slated by Congress for zero funding in 1996. IHEM buildings-related programs include studies, retrofits, new construction, metering, and energy savings performance contracting. Between 1977 and 1994, $47 million was invested in studies and $290 million in 1100 retrofit projects, with an average payback time of 3 years. This corresponds to an annual savings level of $100 million and a return on investment in excess of 25%. DOE has cost-effectively reduced its energy consumption in buildings by 43% since 1975, surpassing the fiscal year 2000 requirement of the Energy Policy Act of 1992. This article discusses the difficulties in implementing energy management programs in Federal facilities, and how DOE / IHEM is addressing these challenges. This article reviews IHEM's efforts to date, applications-oriented collaborations with DOE R&D programs, institutional and financing issues, and offers some thoughts on future directions.

DOE'S IHEM PROGRAM OVERVIEW & PROFILE

The IHEM program is currently part of the Federal Energy Management Program under the U.S. Department of Energy's Assistant Secretary for Energy Efficiency and Renewable Energy. DOE began its In-House Energy Management (IHEM) program in the mid-1970s and began financing retrofits in 1977. DOE has a diverse set of field sites, including national laboratories, weapons production facilities, and power marketing administrations. Energy use at the 62 eligible sites in 1994 amounted to 39 trillion BTUs of primary energy costing $303 million, including 5 billion kWh of electricity, 98 million therms of natural gas, 394 thousand tons of coal, 15 million gallons of heating oil, and 14 million gallons of motor fuel.

In 1994, buildings represented 64% of the total energy use (costing $194 million / year) at these sites, with most of the balance attributed to various process loads. Some unmetered process energy is counted under the category of "buildings". The nature of these facilities varies widely, from temporary buildings to machine shops, warehouses, laboratories, weapons fabrication, and nuclear reactor facilities. Today there are about 120 million square feet of floor area in about 14,000 DOE buildings. The predominant energy source is electricity (65%), followed by coal and natural gas.

Major IHEM program areas affecting buildings include energy management program planning, energy studies, operations and maintenance procedures, training, retrofits, new buildings, metering, central plant improvements, employee awareness, energy savings performance contracting, and reporting and assessment. Technologies used to achieve energy savings include every category from basic operations and maintenance, through lighting, controls, and motor systems, to sophisticated process modifications. The IHEM program was funded at $25 million / year in 1995, but is slated by Congress for zero funding in 1996.

Since the program's inception IHEM has performed numerous energy management studies, at a total cost of $47 million. About 1100 retrofit projects costing $290 million were funded for buildings and metered processes as of 1994. In the ten-year period of 1975 to 1985, the energy intensity in DOE buildings was reduced by 17.5% (OTA 1991), and by an additional 23% between 1985 and the year 1994 (US DOE 1995). Projected savings are about $100 million / year, corresponding to a 3-year average payback time and a return on investment in excess of 25%. As described below, many projects have been carried out in collaboration with resident DOE energy-efficiency researchers at national laboratory sites.

With intensifying Congressional assaults on DOE's energy efficiency activities, it is a turbulent time for the IHEM program. What makes the Program successful is the group of IHEM energy managers stationed at the many DOE sites. Without a base level of funding support for the IHEM program, it will be difficult to keep these individuals in place to continue the work they have begun. This would constitute a significant loss for American taxpayers, who receive $5 worth of benefits for every $1 plowed into saving energy in DOE facilities.

THE CHALLENGE OF FEDERAL ENERGY MANAGEMENT

The Federal Government spends about $7 billion for energy each year. The government's largest users of energy are the Department of Defense, Department of Energy, Veterans Administration, the Postal Service, and General Services Administration. Defense is by far the largest energy consumer among these. Each of these agencies has an energy-management program of some sort.

For buildings, the savings goals set out for the year 1995 include a 10% reduction per square foot relative to 1985. In 1991, an additional goal of 20% reduction by the year 2000 was set forth (again relative to 1985), a goal already exceeded by the DOE IHEM program (US DOE 1995). In March 1994, Executive Order 12902 increased the goal to 30% reduction below 1985 levels by the year 2005. Such savings are cost-effective and are now being achieved in the field, as illustrated in Figure 1. However, a variety of institutional barriers are encountered in the process.

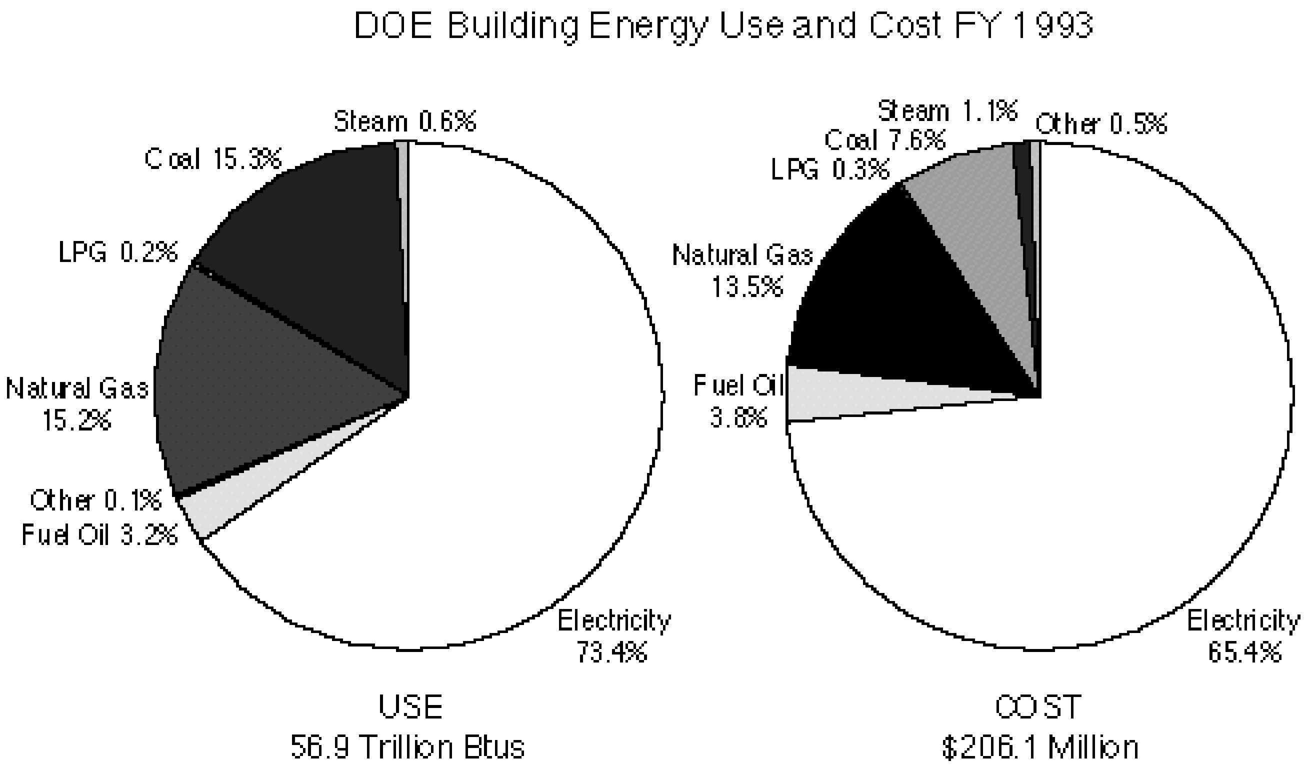

Figure 1. Targets and actual building energy savings achieved during a decade-long In-House Energy Management program at Lawrence Berkeley National Laboratory, a site with 200 buildings.

When it comes to saving energy, public agencies are often not encouraged to take risks. In some cases they lack the technical staff to evaluate the opportunities, and it is not easy for them to balance future operating costs and current capital expenditures. The competition for capital dollars can be so great that energy projects with a 30% or more return on investment go unfunded. Vice President Al Gore, announcing Executive Order 12902, noted that “In the past, Federal facility managers responsible for improving energy efficiency have been hampered by complex and burdensome retrofitting procedures, lack of good information, and a lack of leadership.” Following are some of the barriers that impede Federal agency interest in pursuing energy efficiency, and DOE-IHEM efforts to overcome them (Sartor 1994).

Limited Commitment and Financial Incentives

- **All agencies have conflicting priorities for financial and staff resources.** In many cases, even needs that are considered to be mission-critical or have direct environmental, health, and safety implications go unfunded—leaving little room for energy efficiency investments. IHEM meets this challenge by providing a centralized funding source for energy-saving studies and retrofits, and allowing its individual sites to compete for this funding. Once funding is received by the sites, it can stimulate growth in their energy management programs and the resources devoted to them. IHEM recently raised the acceptable payback period of the retrofit projects that it funds from 5 to 10 years, greatly expanding the range of potential retrofits. However, the effective payback period limit is currently 7 years, given the competition for limited available funds.

- **There are few financial incentives to capture energy management opportunities.** Federal agencies are often blessed with low-cost energy supplies, either as large utility customers, or as preferential consumers of federally produced power. Meanwhile, construction costs are high as a result of procurement requirements (legislated mandates), internal overhead, government bureaucracy, and in some cases extraordinary security requirements. Energy cost savings may lead to budget reductions in subsequent years. IHEM has persistently worked with the Office of Management and Budget to allow all Federal agencies to retain savings from energy savings performance contracts and rebates, but this is not yet allowed.

- **Access to utility rebates is problematic.** Although federal facilities may apply for utility rebates, the long planning cycle of typical projects generally exceeds that of utility rebate program availability. As a result, at the time of project design and financial planning, there is no way for energy project engineers to be certain which rebates may be available to them. In addition, competitive bidding requirements can complicate negotiations between a utility company and Federal facility. Only a small proportion of U.S. utility companies have designed and implemented energy-efficiency programs that are eligible for Federal participation (FEMP Focus 1994), and utility rebate programs are now on the wane. Accounting procedures require the rebates are applied to offset energy costs, providing a disincentive to conserve.

- **Third-party financing can be problematic.** Differences in economic perspective can differ markedly between the Federal facility and a third-party investor. IHEM has advised its sites, based on the work accomplished at the Lawrence Berkeley National Laboratory (LBNL), to keep these projects simple, and is primarily pursuing lighting and cogeneration projects under this financing approach.

- **The lack of metering contributes to both the lack of awareness and the lack of incentives.** *If* energy costs are allocated to end users, it is often done on the basis of average cost per square foot across the entire site—a poor pricing signal, since there is reduced incentive to conserve. IHEM devotes a portion of its retrofit project dollars to metering and encourages all DOE sites to charge their internal customers directly for their energy use.

- **Like their counterparts in the private sector, government building owners and government building users are often not the same entity.** When the building owner does not pay the utility cost, there is diminished incentive to invest in energy-related improvements.

- **Incomplete information makes it difficult to optimize project design.** Standard specifications for types of projects or technologies or authoritative one-stop technical information resources are currently not available. This is especially problematic for small facilities with no ability to maintain their own energy management staffs. IHEM staff are developing mechanisms to facilitate information exchange. For example, Lawrence Livermore National Laboratory has been tasked by IHEM to develop a communications database/network for energy coordinators at DOE sites using existing Internet links as the communication medium. Another mechanism for this exchange is the annual IHEM conference, which facilitates networking between IHEM staff at DOE sites throughout the country.

With conflicting priorities, a general lack of knowledge, and limited economic incentives, inaction is not surprising. Indeed, investments in energy management are perceived as risky by the decision-maker(s). DOE IHEM is addressing these challenges in a pro-active manner.

Funding Constraints

The Federal Government has historically had two funding constraints that challenge investments in energy management: (1) separation of capital and operating budgets and (2) fiscal year spending requirements.

Federal agencies cannot borrow against future cash flows (energy savings) to finance efficiency improvements. However, they can contract with energy service companies to change the "color" of the money and finance energy projects. Some Federal agencies do not have the ability to retain energy cost savings from one fiscal year to another, further limiting the ability to use savings productively. Recognizing that both operating and capital dollars ultimately come from the same source, IHEM has historically met this challenge by implementing cost-effective retrofit projects with separate capital funding, and by providing operating dollars to study and identify future retrofit projects. As of fiscal year 1996, capital and operating budgets are no longer separated.

Competition for capital dollars is strong, and construction projects over certain thresholds require Congressional approval—often creating multi-year funding cycles even for the highest priority projects. The budgets for new building construction are rarely adequate to cover the facilities that meet the programmatic needs of the agency. Therefore, "frills" such as energy efficiency measures are the first to go (if they were considered at all). Tight capital budgets often prevent project compliance with federal mandates to minimize life-cycle cost. IHEM attempts to meet this challenge by requiring that new buildings be designed to meet the Federal energy codes, which require documentation to show that the design has achieved the minimum life cycle cost. IHEM has prepared a manual to guide compliance with the codes, and IHEM personnel are qualified to review the compliance documentation.

The challenge of proper timing adds to the problem of an inadequate budget. Budgets are usually tied to fiscal year spending ("use it or lose it") requirements. The time available to explore innovative solutions is limited, especially if time is needed to involve outside consultants. The frequent lateness of funding authorization exacerbates this problem by reducing the time that agencies have to allocate funds. This remains a challenge for new construction, but IHEM study and retrofit funding can be carried over from one fiscal year to the next. For IHEM retrofits, a $5 million maximum per project—higher than many agencies' limits for construction projects—all but eliminates multi-year funding cycles and the problems they create. IHEM has achieved this by obtaining over $20 million per year for retrofits as a single Congressional budget item, and distributing the money for retrofits according to IHEM priorities.

Staffing and Contracting Capabilities

Even when an agency or a particular facility has made a commitment to energy management and funding is available, staffing and contracting remain two challenges to implementation. Most agencies lack the in-house expertise (and on-call consultants) to implement an energy management program. It can take years to develop the necessary human resources, an achievement that IHEM has realized at many DOE sites.

Any personnel assigned to the energy management function often have other responsibilities, and almost as often, these demands overshadow their energy work. Hiring an energy management staff is challenging. Many agencies have staffing restrictions or hiring freezes or both. Creating or increasing the energy management staff under these conditions is difficult. Furthermore, the potential labor pool is not the best the industry has to offer. This is the case in part because Federal salaries are at least 25% under the market for energy engineers and because preference is given to displaced federal employees who often lack energy management experience. (At many sites, employees are hired by a contractor to DOE and thus are not Federal employees, so these low salary and inexperience problems may not apply.) Also, energy efficiency engineering is a relatively new, specialized practice, with the result that well-qualified candidates are highly prized commodities.

Even the most committed and well-endowed energy management program requires outside resources (i.e. specialized consultants). The inability to retain qualified consultants in a timely fashion can preclude meeting project deadlines. IHEM staff at some sites have pre-qualified consultants who can be hired relatively quickly for specific projects, once the fairly lengthy process of advertising, selecting, and contract negotiating has been completed. Already available (from IHEM staff at the Lawrence Livermore National Laboratory) is franchised energy management services; such franchised assistance will become more available over time.

The effort to assure fair and competitive selection of consultants and construction contractors can cause significant delays in the acquisition of energy savings. The time required to retain and review engineering services at each project stage and to bid a construction contract can take well over a year. Assuming implementation of a project with a three-year payback, the value of energy savings lost during a year of procurement time equals one third of the total project cost.

Another procurement challenge is posed by programs for small and disadvantaged companies. Set-asides and other affirmative action programs, while laudable, can add considerable cost and implementation time to a project. Unfortunately, the intended beneficiaries (e.g. women and minorities) are not well represented in the energy-management industry, and there is no significant program specifically designed to train these groups.

By formalizing the energy management activity, DOE's IHEM program has gone a long way toward meeting the Federal energy management challenge. Other Federal agencies would do well to follow the DOE-IHEM example.

PROGRAM FINANCING OPTIONS AND ISSUES

The IHEM program has been the predominant source of retrofit financing for DOE facilities to date.

Utility rebates are another potential source of funding, but as noted above, the long delays between project inception and implementation make it difficult or impossible to predict what types of utility programs and rebate levels will be available. As a result, project planning and cost-effectiveness analysis are often carried out as though no rebates would be used. However, the IHEM economic analysis for retrofit projects allows engineers to take credit for rebates in their analysis, even though the availability of rebate funds is not assured once the project is completed. The coming years may see new efforts to design special utility programs tailored to the needs of federal facilities. On the other hand, the trend today is towards utility deregulation, which appears to be heralding the end of utility rebates as utilities look to reduce their near-term costs. With increased utility competition, Federal facilities will have new opportunities to negotiate lower utility rates.

Energy Savings Performance Contracting (ESPC) (formerly called shared energy savings) for Federal facilities has drawn considerable interest. In principal, ESPC is best suited for situations where the facility has no in-house financing, project design capability, or project management expertise, but has a good understanding of potential energy savings through independent audits.

DOE presently has two ESPC projects under contract: a laboratory building at the Lawrence Berkeley Laboratory (LBNL) and the Forrestal Building (DOE Headquarters). LBNL's is the first third-party financed retrofit project in the DOE system. The contract was signed October 1991; the retrofits were commissioned January 1994. The project involves a shared energy savings contract to retrofit the 56,000-square-foot Materials and Molecular Research Building. The building contains 56 laboratories, 56 offices, an auditorium, a machine shop, and a small library and has an annual energy bill of approximately $200,000; projected annual cost savings are $60,000. The Forrestal Building contract was signed February 1993; the project is to retrofit the lighting system, projected to save $400,000 per year, and includes a $1 million rebate from the utility company.

As summarized in the following quotation, these projects have manifested technical and financial issues that complicate the prospects for successful ESPC projects at government facilities (US DOE 1994):

> "Developing reliable baselines to measure savings against in these contracts is a formidable task, especially when more than one energy conservation measure will be bid, or when it is not known which energy measures will be used by the shared savings contractor [ESPC]. In order to quantify baseline and post-retrofit consumption, "independent collection and analysis of end-use data was essential to protect the best interest of the Government and to ensure a successful project.
>
> Procurement of these contracts under the Federal Acquisition Regulations (FAR) has been the major obstacle in bringing these contracts to fruition throughout the Federal Government.
>
> There appears to be very little competition in these contracts, and in many cases the Agency may be required to select a firm that does not offer to retrofit all feasible projects in the building. In most cases no projects greater than a four-year payback will be bid, and it is difficult for the government to add Federally funded projects to a building which has been retrofitted under shared energy savings [ESPC]."

In general, the difference in the perspective of the Energy Services Company (ESCO) and that of the facility manager can pose additional major challenges to the successful implementation of energy savings performance contracts.

- The term of the contract is likely to be far shorter than the life of the improvements, but from the ESCO's standpoint, the two are the same. The ESCO's goal will be to maximize net cash flow during the contract term, which may not be consistent with maximizing benefit to the government over the project's life cycle.

- There is an upward pressure on project costs when implementation is negotiated rather than competitively procured. This is especially true for in-house ESCO services or when the ESCO acts as the general contractor rather than a developer/project manager working on behalf of the government.

- ESCOs' cost of funds are significantly higher than the government's. Typically, ESCOs seek an Internal Rate of Return (IRR) of more than 20%. For the government to implement projects with up to a ten-year payback, as mandated by the National Energy Policy Act, the IRR may drop below 10%. Thus "SES should be used [only] when an Agency cannot get Federal funding for doing energy retrofits" (US DOE 1994).

- ESCOs prefer to minimize up-front costs and seek no- or low-cost "engineering" through design-build subcontractors. Unusual or complex opportunities (especially common in government facilities) may not be pursued because their evaluation cost is high. The ESCO's risk is minimized with a diversified portfolio of proven technologies involving few external variables (e.g. human interference). Contracts are structured to provide a significant margin of estimated cash flow above debt service.

These factors can lead to undue bias towards projects with low risk through: (1) high savings-to-cost ratios (known as "cream skimming"); (2) savings that are especially easy to estimate and measure; (3) projects that do not require significant engineering input; and (4) projects with known (or stipulated) savings, not requiring user cooperation. Typical projects that fit this profile include delamping (with or without reflectors), light fixture conversions (e.g. exit sign replacements, compact fluorescent down-lights, exterior light conversions, etc.), and motor replacements. While lighting projects dominate the ESPC industry, even lighting retrofits are often limited to the simpler "first-tier" opportunities. The considerable efforts required for contract management and independent analysis required for these projects suggest that ESPC projects are not the easy answer to energy conservation in facilities lacking in project management expertise. Even given all of the above difficulties, ESPC projects are considered an essential part of the overall strategy to meet energy-saving goals, given that Federal funding is unlikely to be adequate to fund all cost-effective retrofits in all agencies.

SHOWCASING ADVANCED TECHNOLOGIES AND STRATEGIES THROUGH IHEM-RESEARCH COLLABORATIONS

Many IHEM projects have benefited from participation of researchers from DOE's various building energy-efficiency research programs, including windows, ducts, lighting, motors, equipment, appliances, performance monitoring, and energy-use simulation. At the same time, technologies developed by DOE are showcased in DOE's own facilities, making the Department a leader in implementing these new technologies. Appropriately, many of these collaborations between the researchers and the IHEM practitioners are officially "Technology Demonstrations," which are funded by IHEM to enable energy managers in the field to test new ideas for possible broader application. The following examples are from various DOE facilities. They are offered to give a flavor of the wide range of related activities underway at these and other DOE sites, and are not intended to be an exhaustive list. Except as noted, the studies and retrofits were all funded by DOE IHEM.

- At the Brookhaven National Laboratory (BNL), staff from the Department of Applied Science's Building System Division have performed lighting retrofit studies; organized energy-use data and correlated it to weather and other variables; and submitted proposals for central plant studies (Toscano 1994).

- A Building System Division researcher at BNL is currently working on a study of cooling tower performance and BNL's energy awareness programs for building managers and employees in general.

- IHEM funded a $3 million comprehensive lighting retrofit at the Lawrence Berkeley National Laboratory (LBNL). Since unbiased information on lighting technologies was not available, LBNL's IHEM and Lighting Systems Groups tested and evaluated products at LBNL and the Lawrence Livermore National Laboratory (LLNL), scientifically concluding that reflectors are not always a worthwhile measure (Kromer et al. 1991). This study is distributed by IHEM and is used as a reference in evaluating savings claims from proposed lighting retrofits at other DOE sites.

- LBNL's Energy Analysis Program (EAP) researchers completed a study with specific recommendations for purchasers of parts and materiel. For example, incandescent lamps and fixtures will be deleted; fluorescent T-8 lamps and electronic ballasts will become standard items. The study also covered replacement motors; maintenance personnel will be using a computer database to select the most efficient available motor for replacing failed units.

- Working with LBNL's IHEM and Maintenance and Operations staff, an Energy Performance of Buildings Group researcher is currently surveying air balancing and duct leakage throughout the site. One innovative outcome of this work will be a technology demonstration project on demand-based ventilation using CO_2 sensors controlling variable-speed ventilation fans.

- Center for Building Science, Windows and Daylighting Group, and EAP researchers are assisting with end-use tracking, technology selection and building energy simulation on a technology demonstration study at LBNL's Visitor Center. Energy conservation through load reduction and compressor-less cooling strategies (evaporative cooling, e.g.) are being featured.

- Currently, researchers from LBNL's Lighting Systems Group are testing the energy and lighting quality performance of direct and indirect fluorescent fixtures. In addition, a new technology for optimizing the thermal performance of fluorescent lamps is in trial with the goal of collecting field data that can be compared to existing laboratory estimates. The thermal management is expected to yield 10-20% extra light output and a 10% improvement in efficacy.

- At the National Renewable Energy Laboratory (NREL), the Buildings Research Group of the Industrial Technologies program has been instrumental in assisting NREL in its energy-saving efforts. Projects (non-IHEM-funded) have included lighting studies and retrofits; surveys and characterizations of end uses; specifying solar preheating of ventilation air on a new waste-handling building; heat exchangers operated in the summer for "cool recovery" and other operations and maintenance strategies; and thermal imaging of airflow patterns in a new building with an innovative air distribution system (Bowker 1994).

- NREL's Buildings Research Group studied opportunities for night setback strategies in a laboratory building, resulting in IHEM funding for the retrofit.

- As part of a large-scale lighting retrofit at the Oak Ridge National Laboratory (ORNL), the Laboratory's Existing Buildings Efficiency Research (EBER) Program assisted IHEM in an instrumented pilot study to check the accuracy of predicted savings. The researchers performed pre- and post-retrofit measurements and analysis showing the savings to be even larger than predicted (Kuliasha 1994).

- ORNL's Building Thermal Envelopes Systems and Materials (BTESM) Program is working with IHEM to demonstrate the feasibility of installing new roofing over failed (wet) roof systems on flat-roofed buildings. BTESM simulations and mock-ups showed that the old roofs would dry out over time without damaging the building structure, thus adding to the insulation levels, and eliminating the need to demolish and dispose of the old roof prior to adding the new roof system. A Cooperative Research and Development Agreement is in place with a major manufacturer of roofing systems, as well as an IHEM technology demonstration project.

- In developing a CFC replacement strategy for their chillers and other refrigeration equipment, IHEM at ORNL has been assisted by the Laboratory's Building Equipment Research Program.

- ORNL's EBER is assisting IHEM with developing a real-time metering system on the Laboratory's electrical distribution system, using an Energy Monitoring and Control System (EMCS).

- At the Battelle Pacific Northwest Laboratories (PNL), researchers from the Performance Measurement and Evaluation Group (PMEG) of the Energy Sciences Department actively participate in IHEM-funded studies. Recent examples include: a mobile office energy study, which looked at procurement specifications and retrofit strategies to minimize life-cycle costs; monitoring of office equipment, which concluded that at PNL's very low energy costs, there is little that can be done cost-effectively; a CO_2-based office ventilation control (also not cost-effective at PNL); an alternative fuels study, with emphasis on natural gas; and a laboratory building heat recovery study, looking for good and bad examples of the technology and its application (Carroll 1994).

- Another incarnation of PNL's PMEG, the Hanford Energy Management Committee, has used non-IHEM funding to study the energy impact of alternative (non-CFC) refrigerants; the feasibility of occupancy sensors; advanced lighting controllers comprised of "smart" occupancy sensors; and advanced metering for electrical distribution systems.

- Research personnel from PNL assisted in monitoring the DOE pilot ESPC project at LBNL. This work contributed to the development of an industry-standard data logger, which has been commercialized and is now being used by IHEM staff at the pilot building, as well as at building monitoring sites throughout the U.S. and overseas.

LOOKING TO THE FUTURE: OBSTACLES AND OPPORTUNITIES

As noted earlier, DOE facilities are presently operating under an Executive Order to save 30% relative to 1985 by the year 2005. IHEM believes the cost-effective potential for savings in DOE facilities is roughly equal to the goal set in the Order. The opportunity for savings is still large, and there are several reasons why there is so much unmet potential.

- Facilities eligible for IHEM funding are not keeping the spending rate on a par with funding supply, despite IHEM guidelines to complete projects within two years. There are presently unspent funds in the IHEM program due to project delays. Reasons for these delays include insufficient energy engineering staff at some IHEM sites, environmental permitting, safety concerns, and a lack of priority for retrofit projects because of the demands of other facility-related projects (other than those initiated by IHEM). Also, the procurement process is cumbersome, because of the multitude of non-

IHEM regulatory directives, resulting in protracted project execution time.

- Nominal "commissioning" (the process of reconciling as-built performance to that of design) of buildings is being performed to ensure basic functioning of building systems, but there is much room for improvement. Management pressure to finalize construction and close accounts needs to be balanced against requirements to ensure that the buildings perform properly during heating and cooling peak periods.

- Collection and analysis of detailed post-retrofit end-use data could be pursued more vigorously. Comparisons of engineering estimates to measured data is normally very enlightening, and will usually identify the potential for further savings.

- Even though new buildings are required to minimize life-cycle costs, time and budget constraints prevent design teams from ever achieving this goal. Often, retrofit opportunities exist upon completion of the building. One laboratory building at LBNL, completed in 1987, is undergoing a comprehensive retrofit (lighting, controls, motor drives, fume hood controls, etc.) to save an estimated 85% of its gas and 60% of its electricity consumption at a project cost of $710,000, resulting in a 7-year simple payback period. Another LBNL lab building, completed in 1989, is being retrofitted for an estimated 77% gas and 44% electricity savings from a $380,000 IHEM-funded retrofit project (HVAC controls, some lighting and motor drives), plus several operational changes and program-funded modifications, yielding a 6-year payback overall.

One way to increase the effectiveness of the IHEM program is to tap the great pool of experience gained over the last 10 years. Following the directives in Executive Order 12902, the IHEM program is exploring ways to make this resource more widely available to facilities that have been neglected to date, within both DOE and other agencies. One approach being explored: as the study and retrofit backlogs become exhausted at the sites where experienced personnel have been working, they can form teams available to work elsewhere, either as consultants or on-site staff. As noted, such franchising of staff to other sites is already occurring, and will increase over time.

A clear opportunity is more inter-lab / inter-IHEM information exchange and collaboration, in combination with a centralized information / assistance network and source of specifications. While there is some such communication now, it is largely informal, and not extensive enough to prevent "reinvention of the wheel". Many facilities face the same problems dealing with similar technologies, yet they share too few of their solutions. All sites would benefit from the creation of a central repository of information and assistance, including interpretation of energy codes, provision of master specifications for energy-related technologies, and distribution of general information on common problems and their solutions. This service would be especially useful at facilities with limited on-site expertise.

Lastly, we believe that the linkages between research and IHEM groups should be encouraged and strengthened. The success stories described above highlight the clear advantages to all parties. It should be noted that the "real-world" experience gained by researchers is a significant additional benefit to such collaboration. In an effort to move forward in this direction, LBNL has launched an "Applications Team" that will bring the best of IHEM knowledge and R&D to bear on selected efficiency projects in publicly- and privately-owned non-DOE buildings around the U.S. The A-Team supports the deployment of advanced energy-efficient and environmentally friendly technologies in new and existing buildings. It offers expertise in state-of-the-art technologies, financial analysis, and project management, guided by an integrated building lifecycle approach (audits, design, construction, commissioning, measurement and verification, and ongoing operations and maintenance).

EPILOGUE

Congressional budget cutting is an ever present danger, and has resulted in zero funding for fiscal year 1996. The IHEM program's very success makes it vulnerable. There is a feeling by some that the program requires no further funding because it has accomplished its near term objectives. Such attitudes ignore the substantial additional cost savings to the taxpayer that have already been identified, but have not been developed because of lack of resources. Additional investment will be required to harvest those additional savings. A portion of this investment could potentially come from the private sector in the form of energy savings performance contracts or utility company incentive programs. However, for the reasons discussed earlier, there is still a real need for public funding of the IHEM program.

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Further information is available via the World Wide Web: http://eande.lbl.gov/CBS/CBS.html

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