U-C Energy Task Force

INTERVENTION STRATEGIES for ENERGY EFFICIENT MUNICIPAL BUILDINGS:
Influencing Energy Decisions Throughout Buildings' Lifetimes

Hetch Hetchy Water & Power
Bureau of Energy Conservation
City & County of San Francisco, California

BACKGROUND AND ACKNOWLEDGMENTS

Public Technology, Inc. (PTI), is the non-profit technology organization of the National League of Cities (NLC), the National Association of Counties (NACo), and the International City/County Management Association (ICMA). PTI's mission is to bring technology to local governments. Through collective research and development efforts in its member jurisdictions, PTI creates and advances technology-based products, services, and enterprises for all cities and counties.

Four active task forces, each composed of members of PTI's Urban Consortium (UC)—which represents fifty of the nation's largest and most progressive cities and urban counties—drive PTI's research and commercialization efforts. One of these task forces is the Urban Consortium Energy Task Force (UCETF), which was established a quarter of a century ago to address critical energy needs of urban America.

About The Urban Consortium Energy Task Force

The UCETF is the nation's most extensive cooperative local government program to improve energy management and technology applications in local governments. Its membership is composed of local government officials from America's large urban centers. The four major goals established by UCETF members are to:

1. Act as the premier advocate group for local governments on energy technology;
2. Improve energy efficiency, reduce costs and develop revenue from local energy assets;
3. Address the overlap between energy and environmental policy issues; and
4. Act as the implementation arm for NLC and NACo policies.

Under an annual program sponsored by the U.S. Department of Energy (USDOE), the UCETF provides funding for a number of city and county projects that propose to meet these objectives. Projects selected for each year's program are organized in thematic units, such as Transportation, Sustainable Communities, Buildings, and Technology Transfer, to assure effective management and ongoing peer-to-peer exchanges. The results of these research projects are documented in reports such as this one, and made available for broad dissemination by PTI among other local governments.

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Intervention Strategies for Energy Efficient Municipal Buildings:

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**Energy Task Force of the
Urban Consortium for Technology Initiatives**

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**Hetch Hetchy Water & Power, Bureau of Energy Conservation
City & County of San Francisco, California
1993**

John F. Deakin, Director

Danielle Dowers, Project Manager

**Terrence O'Sullivan
Doug Johnson
Calvin Broomhead**

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TABLE OF CONTENTS

ABSTRACT

CHAPTER 1: OVERVIEW

1.1 Project Concept	1
1.2 Background and Purpose	4
1.3 Project Design	10
1.4 Report Organization	10

CHAPTER 2: THE BUILDING LIFETIME

2.1 Building Lifetime Model	13
2.2 Research Methodology	15
2.3 Access Points for Intervention	18

CHAPTER 3: PILOT PROJECTS

3.1 Pilot Project Selection	23
3.2 Pilot Project Implementation	25
Pilot 1: Bond Guidelines	26
Pilot 2: Energy Efficient Design Practices	33
Pilot 3: Commissioning	39
Pilot 4: Motor efficiency	47
Pilot 5: Facility Condition Monitoring Program	50

CHAPTER 4: CONCLUSION

4.1 Findings & Lessons Learned	55
4.2 Evaluation & Plans for Future Action	59

BIBLIOGRAPHY	63
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RESOURCE TOOLBOX

T.1 Tools	T1
T.2 Distributors	T11
T.3 Internet Resources	T21

APPENDICES

Appendix A: Institutional Barriers and Proposed Solutions	A1
Appendix B: EMAP List of Institutional Barriers	A7
Appendix C: CEC Hospital Design Energy Efficiency Guidelines	A15
Appendix D: Draft Bond Report Language	A23
Appendix E: Energy Efficient Lighting Design Practices excerpt	A25
Appendix F: BPA Commissioning Guidelines excerpt	A33
Appendix G: <i>Motormaster</i> software sample printout	A39
Appendix H: Motor Equipment Manufacturers and Software Suppliers ...	A41
Appendix I: Guideline for energy efficient FCMP lighting upgrades	A51
Appendix J: <i>Energy News</i> newsletter	A57

FIGURES

Figure 1.1 Lost Opportunities and Incomplete Actions	2
Figure 1.2 Balanced Approach for Successful Programs	5
Figure 2.1 Building Lifetime Model	14
Figure 2.2 Lifetime of a San Francisco Municipal Building	17
Figure 3.1 Potential Actions	24
Figure 3.2 Project Selection Criteria	24
Figure 3.3 Utility Commissioning Programs	45
Figure 4.1 Strategies for Access points	56
Figure 4.2 Potential Actions	62

ABSTRACT

In order to realize our vision of the ideal energy efficient city building process, we must first describe the problem. The current energy-related decisionmaking processes that take place during the lifetimes of municipal buildings in San Francisco do not reflect our ideal picture of energy efficiency as a part of staff awareness and standard practice. Energy is often not on priority lists and is not perceived as an important issue. Energy efficiency issues are not part of the vocabulary of many City staff associated with decisions that affect energy use in city buildings.

Two key problems that undermine the success of energy efficiency programs are *lost opportunities* and *incomplete actions*. These problems can be caused by technology-related issues, but often the causes are *institutional barriers* (organizational or procedural "people problems"). Energy efficient decisions are not being made because of a lack of awareness or policy mandate, or because financial resources are not available to decisionmakers.

The Bureau of Energy Conservation (BEC) is working to solve such problems in the City & County of San Francisco through the *Intervention Strategies* project. In the first phase of the project, using the framework of the building lifetime, we learned how energy efficiency in San Francisco municipal buildings can be influenced through delivering services to support decisionmakers at key points in the process of funding, designing, constructing and maintaining them. Through identifying and describing *steps, access points, decisionmakers, and actions*, we formed a picture which describes pathways for influencing decisions throughout the building process to incorporate energy efficient practices in our municipal buildings.

The second phase of the project involved choosing and implementing five pilot projects. Through staff interviews, we learned how decisions that impact energy use are made at various levels. We compiled information about city staff and their needs, and resources available to meet those needs. We then designed actions to deliver appropriate services to staff at these key access points. BEC implemented five pilot projects corresponding to various stages in the building's lifetime. These were: *Bond Guidelines, Energy Efficient Design Practices, Commissioning, Motor Efficiency, and Facilities Condition Monitoring Program*.

During the course of the project, we made progress toward integrating energy efficiency into the practices of in San Francisco through filling in gaps in our understanding of the processes, fostering relationships with decisionmakers, and by providing them with tools. We found that to have successful programs requires looking at energy efficiency in the context of the entire lifetime of a building, and designing energy services that are timely, relevant to staff, and balanced in approach.

In addition, BEC has developed a *Resource Toolbox* to provide other local government energy offices with a list of useful tools and information sources. This *Toolbox* is included as part of this report.

The work described in this report was funded in part through a grant awarded by the Energy Task Force of the Urban Consortium for Technology Initiatives.

CHAPTER 1: OVERVIEW

Chapter 1 presents the origins of the *Intervention Strategies* project and describes:

- ❑ the *Intervention Strategies Project Concept* (**Section 1.1**), including the problems identified, proposed solutions, and the underlying goals of the project;
- ❑ the **Background and Purpose** (**Section 1.2**) of our work, including a discussion of common institutional barriers facing energy offices; current San Francisco Bureau of Energy Conservation programs; and a description of the roots of the project;
- ❑ our **Project Design** (**Section 1.3**), which presents an outline of the project methodology, including research and implementation tasks; and
- ❑ the **Report Organization** (**Section 1.4**), which provides descriptions of chapters 2, 3, and 4, and of the *Resource Toolbox*.

1.1 PROJECT CONCEPT

The problem

In the ideal city, all facility staff -- architects, engineers, facility managers, purchasers -- would make energy efficient choices as a matter of course. Managers and administrators would put into practice suggestions from operations and maintenance staff to improve energy efficiency. Energy efficiency would be a required element in the curricula of all architecture, engineering, city planning, and technical schools' programs. Energy savings dollars would be returned to departments or facility managers to spend on their needs. Design and maintenance purchasing decisions would be based on lowest lifecycle cost. In the ideal city government, *all staff associated with buildings at key steps where energy-related decisions are being made would practice energy efficiency.*

In the *real* city, we have problems like a stock of older, inefficient buildings, and an entrenched bureaucracy which presents barriers to the introduction of the necessary policy, budget incentives, education, and coordination required to successfully integrate energy efficiency into standard practices.

In order to realize our vision of the ideal energy efficient city building process, we must first describe the problem. The current energy-related decisionmaking processes that take place during the lifetimes of municipal buildings in San Francisco do not reflect our ideal picture. Energy efficiency is often not part of people's awareness and standard practice. Energy is often not on priority lists and is not perceived as an important issue. Energy efficiency issues are not part of the vocabulary of many City staff associated with decisions that affect energy use in city buildings.

Two key problems that undermine the success of energy efficiency programs are "lost opportunities" and "incomplete actions". These problems can be caused by technology-related issues, but often the causes are **institutional barriers** (organizational or procedural "people problems"). Energy efficient decisions are not being made because of a lack of: awareness, policy mandate, or financial resources available to decisionmakers.

Lost opportunities are missed chances to incorporate energy efficiency into our buildings. These lost opportunities translate into wasted energy and wasted taxpayer dollars. Energy efficiency opportunities are being lost due to gaps in the services we as energy offices are able to deliver. Our effectiveness to influence decisions that impact energy use in our buildings is limited in part by our level of knowledge of what these key decisions are, who makes them, and when they occur.

Incomplete actions are energy efficiency measures that have been initiated, but not successfully brought to fruition. The eventual results of these energy efficiency actions often do not reflect the original savings estimates. We must look for ways to prevent incomplete actions by anticipating the needs of decisionmakers, and by monitoring progress on our previously initiated actions.

Fig. 1.1(below) shows how these factors can block full energy savings potential from being realized.

Figure 1.1 Lost Opportunities and Incomplete Actions for incorporating energy efficiency

Solving the problem

The best way to address these problems, and to move towards our ultimate goal of incorporating energy efficiency into the standard practices of city staff, is to understand the process, so we may more appropriately and effectively intervene. The need is clear. We must take a broader view of the problem, looking at energy efficiency in terms of the whole building lifetime. Taking such a holistic view of the process is a fundamental first step towards addressing the problems of lost opportunities and incomplete actions. If the appropriate actions are carried out in the early steps of the process, then the need for intervention will decrease down the line. If energy is specified as a priority in the initial bond report, for example, then it is less likely that we will have to lobby later to keep energy efficiency measures in the project.

Our ideal would be to influence all key people at all key stages on all buildings. In reality, we influence some buildings at some stages and affect some people. Being aware of the whole process enables us to see where all the opportunities are, and to therefore better choose strategies for acting on these opportunities most effectively.

The intent of the *Intervention Strategies* project is to address these opportunities by looking upstream and downstream from the work we have historically done. We analyzed the whole building timeline, looking for opportunities to integrate energy efficient practices. Our goal was to find and tap into opportunities and to get initiated actions back on track. This goal can only be accomplished by knowing more about the system in which we are trying to intervene, and anticipating the institutional barriers that we may encounter. We must become aware of the key players and decisions involved within the steps of the overall process of funding, design, construction, and maintenance over the lifetimes of city buildings, and design programs to influence them.

A range of different types of intervention are required at the different stages of a facility's life time: from administrative or policy changes to provide for the additional incremental costs of efficient design and construction, to specialized technical advice and support for building architects and design engineers, through to training on efficient equipment operation for facility maintenance staff. Through the *Intervention Strategies* project, the Bureau of Energy Conservation (BEC) has developed and begun implementing strategies that will influence municipal policy makers, designers, building operators and other decision makers to create and maintain buildings that will perform efficiently throughout their lifespans.

Our underlying goal is to integrate energy efficiency into standard municipal operating procedures and practices. This requires that we influence people, who will in turn make better decisions. Improved decisionmaking will affect the process, which will lead to energy efficiency in City buildings. Towards that end, the goals of the *Intervention Strategies* project were:

- ▶ to gain a better understanding of the overall process of funding, designing, building and maintaining a municipal building in San Francisco.
- ▶ based on this understanding, to take action by designing, targeting and implementing pilot projects to improve the performance of the City's facilities.

1.2 BACKGROUND AND PURPOSE

Common issues facing cities and energy offices

Nationwide, the government sector is one of the largest energy consumers. The energy bills paid by city and county government agencies are typically the second largest item (behind personnel) in their respective budgets. In California alone, local governments spend \$1.2 billion annually to light, heat and cool their buildings. Meanwhile, research by the California Energy Commission has shown that savings on the order of 25% are readily achievable.

Potential efficiency improvements are being missed, not because better technologies do not exist, but because those technologies are not getting out of the laboratories and into local government facilities. Clearly, if we are to solve this problem, we must examine organizational as well as technical systems.

Energy offices working to improve the efficiency of local government facilities face not only technical tasks, but systemic limitations due to institutional barriers. Our key objective is to make energy efficiency a part of City staff's standard operating procedures. In working towards this objective, institutional barriers often impede our progress.

Institutional barriers have been recognized as a widespread problem. The U.S. Office of Technology Assessment (OTA)¹, American Council for an Energy-Efficient Economy (ACEEE)², and National Research Council (NRC)³, have identified common institutional barriers, such as a lack of institutional incentives and information constraints, that impede efficiency in government and commercial buildings. They have recommended actions, like rewarding agencies and individuals for energy and cost savings, to address these barriers. The findings of these studies are summarized in Appendix A.

The Bureau of Energy Conservation has worked to remove such barriers in the City and County of San Francisco through the development of an *Energy Management Action Plan*, (EMAP)⁴. Through the EMAP project, we identified and described 37 institutional barriers that inhibit progress of energy conservation projects, and analyzed the interrelationships among them. These barriers include purchasing policies based only on minimizing initial cost, budget structures that do not reward efficiency, and general low awareness of energy

¹ U.S. Congress, Office of Technology Assessment, *Energy Efficiency in the Federal Government : Government by Good Example?*, OTA-E-492 (Washington, DC: U.S. Government Printing Office, May 1991).

² ACEEE/Western Area Power Administration, *Energy Efficient Motor Systems: A Handbook on Technology, Program and Policy Opportunities*, 1991.

³ National Research Council, *Pay Now or Pay Later: Controlling Cost of Ownership from Design Throughout the Service Life of Public Buildings*, National Academy Press, 1991.

⁴ City and County of San Francisco, *Energy Management Action Plan; Developing a Strategy for Overcoming Institutional Barriers to Municipal Energy Conservation*. Urban Consortium/Energy Task Force, 1992.

issues (see Appendix B for descriptions of these barriers and proposed solutions). The *EMAP* work led to the development of a methodology for energy offices to use in designing programs which address these barriers.

An important insight we gained through analyzing institutional barriers was that they tend to fall into three major areas -- **awareness, policy, and budget** -- and that to have success in overcoming them requires a holistic approach that addresses barriers in all these areas. A fourth component is **coordination**, which insists that clear communications between people and agencies is essential to effective operation.

These approaches -- awareness, policy, budget and coordination -- work together and have a reinforcing effect upon each other (see **Fig.1.2**). Education to increase awareness of the benefits of energy efficiency can help make energy issues a higher priority. As energy efficiency becomes a higher priority, policies may be implemented to ensure that funding and incentives are available to support staff in making the most energy-efficient choices. The presence of incentives to conserve creates an environment where more information and training are sought, thus completing the circle.

Figure 1.2 A balanced approach for successful programs

For example, our lighting retrofit program became more effective once we had publicized the program in a newsletter and put into place a specialized term contract to supply efficient lighting products. Through these steps we were able to foster sufficient buy-in so that some facility managers have begun to incorporate compact fluorescents and other efficient lighting equipment as standard equipment. Together these steps were able to influence staff behavior.

We embraced this principle of comprehensiveness and balance of approach and integrated it into the design and implementation of our *Intervention Strategies* pilot projects.

The San Francisco context

The BEC operates within the City and County of San Francisco's complex bureaucracy (with some 40 departments, 500 municipal buildings, and 25,000 employees) attempting to provide a broad range of public services to its 750,000 citizens. In addition to police, fire, libraries, parks and other services provided by most cities, San Francisco also operates an airport, a professional sports stadium, convention centers, public hospitals and health centers, a mass transit system, wastewater treatment plants, a municipal water utility and Hetch Hetchy Water & Power, the City's hydroelectric utility.

The BEC is part of Hetch Hetchy Water & Power (Hetch Hetchy), which provides electricity to San Francisco's municipal buildings. Commercial and residential electricity is provided by Pacific Gas & Electric Company (PG&E), an investor-owned utility. Natural gas is provided to smaller municipal buildings by PG&E. Natural gas for the seven largest municipal facilities is purchased through a broker, with transportation provided by PG&E.

The electricity generated at Hetch Hetchy is delivered to City facilities by PG&E. PG&E meters the facilities and provides bills to Hetch Hetchy, which in turn bills City departments. "General Fund"-supported departments such as the Department of Public Health are billed at the cost of producing power (about \$.03/kwh). "Revenue-generating" departments (such as the Airport) are billed by Hetch Hetchy at the higher PG&E rates (about \$.09/kwh) and the costs are passed on by the departments to the tenants and users.

San Francisco's total annual municipal energy use is about 650 million kwh, with a demand of 100 MW, at a cost of about \$30 million per year. The gas use is about 20 million therms per year at a cost of \$9 million. Assuming a conservative 10%⁵ savings can be realized, the City could be saving over \$4 million per year in energy costs alone (excluding maintenance savings). The utility recognizes that it is a cost-effective endeavor to promote energy efficiency. It costs Hetch Hetchy less to save a kilowatt-hour than to buy one (from PG&E or on the spot market) and the City can sell a kilowatt-hour for more than it costs to generate one. Electricity saved through conservation is sold by Hetch Hetchy to California central valley irrigation districts.

Energy efficiency directly benefits the City because it lowers longterm operating costs. The energy and demand charges and the associated maintenance costs avoided through efficiency translate into a source of revenue for the City. San Francisco is in the midst of a national economic recession, a large city deficit, and a general anti-government climate. This situation has resulted in layoffs and severe cuts in departments which can least afford it, yet are vulnerable because they do not generate revenue for the City. With the constant tightening of the budget belt, there is a general incentive to be more efficient, to save money in every possible area. Our challenge is to convince decisionmakers to see energy efficiency as an investment rather than as a cost.

⁵ Various studies estimate an energy savings potential of anywhere between 15% and 75% nationwide. see Komor, Paul and Moyad, Andrew, 'How Large is the Cost-Effective Energy Savings Potential in U.S. Buildings', *ACEEE* 1992; Rosenfeld, et al. 'Conserved energy supply curves for U.S. buildings', *Contemporary Policy Issues*, Vol. XI, January, 1993; and Nadel, Steven, 'Electric Utility Conservation Programs: A Review of the Lessons Taught by a Decade of Program Experience', *Proceedings of the American Council for an Energy Efficient Economy*, Volume 8, 1990.

Bureau of Energy Conservation's role

The Bureau of Energy Conservation (BEC) works to integrate sustainable, energy efficient practices into the operations of the City and County of San Francisco. According to the Energy Element of the San Francisco General Plan, the central objective of the BEC in relation to municipal buildings is to "establish the City and County of San Francisco as a model for energy management" by implementing programs that:

- ▶ incorporate energy management practices into facility operations,
- ▶ integrate energy cost reduction measures into the budget process, and
- ▶ investigate and implement techniques to reduce municipal energy requirements.

Over 200 municipal capital improvement projects, totaling approximately \$800 million are now in progress in San Francisco. For a small energy office such as ours in a City as large as San Francisco – 8 people need to influence 25,000 – with several multimillion-dollar capital projects on line simultaneously, we cannot directly impact every aspect of every project. Our most appropriate role is that of *facilitator*. Our ultimate goal is not to micromanage each project, nor to create unnecessary layers of bureaucracy, but rather to provide support services to specific groups of decisionmakers to enable the incorporation of energy efficient practices into their current work.

Roots of the Intervention Strategies project

At the root of this project was an evaluation of our ongoing work on City buildings through BEC's existing retrofit and design review programs. These programs seek to save energy through increased efficiency, to reduce longterm operating costs and to improve comfort and productivity through better quality lighting and HVAC systems. BEC has invested about \$1 million in these programs over the past five years with estimated lifetime savings exceeding \$5 million.

In recent years, however, we have recognized that while the office was running successful energy efficiency programs, we were still missing energy efficiency opportunities. These opportunities occur at several points throughout the lifetime of municipal buildings and affect all of the stages that follow. The point at which a bond report is being written, for example, is the most opportune time to incorporate energy efficiency as an explicit priority and to ensure that money is earmarked to support it. If this opportunity is missed, it becomes more difficult to ensure that energy is included on the list of priorities for a project. Similarly, if energy issues are not introduced until midway through the design process, it may be too late to incorporate efficiency recommendations that could provide substantial savings.

We as energy managers have focused our thinking mainly on retrofit projects for addressing the problem of inefficient buildings. The *Intervention Strategies* project took a broader view. It is not enough to just fix buildings now; we must look upstream and downstream on the building timeline. If we fail to introduce energy issues upstream, the policy and funding decisions will not be in place to support effective energy efficiency. If we ignore what is downstream, then what we do now can be undone later. It is important to recognize that whatever we do (or fail to do) at one step will have consequences that affect all the steps that follow. Investment of time and money resources may be wasted if

mechanisms are not in place for followup and monitoring of results.

Below are descriptions of some of BEC's programs, and some problems we discovered that led to the development of *Intervention Strategies* pilot projects.

Retrofit programs

The *Simplified Energy Conservation Measures Program* performs small-scale lighting retrofit projects citywide, and promotes the use of efficient technologies such as compact fluorescent lamps and electronic ballasts in City facilities through a newsletter and an energy efficient lighting materials contract.

The *Boiler Efficiency Program* promotes boiler efficiency through funding preventative maintenance, producing a Boiler Improvement Guidebook, providing training for maintenance staff, and identifying and implementing heating system retrofits in City facilities.

The *Electricity Efficiency Program* performs retrofits in larger facilities. These retrofits include improvements in the HVAC systems as well as lighting systems. Measures include controls on valves to prevent unnecessary heating and cooling, variable speed drives on motors to match load requirements, fluorescent conversion of incandescent lights, and occupancy sensors to turn off lights when offices are unoccupied.

We asked ourselves what might keep energy efficiency measures from being fully realized, and what additional opportunities we might be missing. We found some answers to these questions through looking at some of the problems we had encountered in the course of running these programs. For example,

- ▶ After BEC had installed efficient lighting at a recreation facility, we learned that facility staff had begun to leave the new metal halide lights on all the time (as opposed to their previous practice of turning lights off when not in use). This was based on a misconception that leaving the lights on would actually save energy. This pointed out a need for follow-up training for facility staff on proper operation of the new equipment in order to realize estimated savings.
- ▶ After a retrofit project had been completed at a city facility, we learned that a renovation project was in the planning stage for the building. This experience showed us the need for better coordination between and within departments in order to facilitate cost effective projects and prevent waste.
- ▶ The City's Department of Public Works runs a program that inspects City buildings for a range of deficiencies, including those in lighting and HVAC systems. Repairs are performed by in-house staff according to a policy that requires "in kind" replacement equipment. As a result, out-of-date, inefficient equipment continues to be specified and installed. There is a need for an expanded definition of "in kind" replacement equipment that includes equivalent *function* to allow efficient equipment to be installed. We have begun to tap in to this opportunity for energy savings through one of the *Intervention Strategies* pilot projects (see section 3.2, pilot project #5, FCMP).

Design Review and Assistance Program

The *Design Review and Assistance Program* makes efficiency recommendations for HVAC, lighting, and envelope systems in new construction and major renovations; and funds the incremental cost of the recommendations. The program has recently recommended design improvements for the new sheriff's facility, the new main library, and several police stations and fire stations.

We realized that while the funding that was available to us did help by financing energy efficiency measures (EEMs) on a case-by-case basis, the program's effectiveness was limited, because we were coming into the process too late to affect certain decisions. For example:

- ▶ While participating in design team meetings on a bond-funded public library project, we were told that the scope of the bond did not explicitly include energy efficiency. Although there was agreement that energy efficiency was an important issue, any additional costs would have to come from another source. It became clear that in order to be effective, energy issues needed to be included at the earliest stages of new capital improvement projects.

This experience led us to look for opportunities *earlier* in the process where we might make a more significant impact. This search led us to investigate opportunities for influencing the City's bond funding and bond writing processes (section 3.2, pilot project #1, Bond Guidelines).

We also realized that in some cases we were not continuing far enough to ensure the complete success of our efforts. For example:

- ▶ An energy-efficient variable frequency drive (VFD) had been specified in the design of a remodel project. The equipment was installed, but because the maintenance staff were unfamiliar with its operation, the VFD was disconnected, thus nullifying the potential energy savings. This showed the necessity for training for facility maintenance staff on new equipment installed in buildings for which they will be responsible. (See section 3.2, pilot project #4, Motor Efficiency)
- ▶ BEC provided energy-efficient design recommendations to the City's new Sheriff's Facility. We planned to discontinue our involvement in the project after confirming that our recommendations had received funding. Later reports from the construction site, however, suggested that one of the recommendations, efficient lighting equipment, was not being incorporated. The project had suffered the misfortune of a change in the architectural firm of record at the commencement of construction; the death of the lead design engineer; and a corporate takeover of the general contractor firm. All this suggested that the energy recommendations had been lost in the shuffle. The need to get "in the loop" during the construction stage of projects became apparent. Through subsequent communication with the construction management subcontractor, we requested that the energy items be placed on the contractor's final "punch list," and that BEC staff be included in the project's walk-through inspection with the client and project engineer in order to confirm the proper installation of the recommended equipment.

We looked for opportunities to follow up our design recommendations at later steps in the building development process. We knew that there were many steps that took place between the preparation of design drawings and completion of the finished product, and we had learned that some energy efficiency measures were falling through the cracks and not being included in completed projects. This knowledge spurred us to investigate the construction process to look for opportunities to ensure that proposed designs become fully functional systems (see section 3.2, pilot project #3, Commissioning).

1.3 PROJECT DESIGN

The principal task of the *Intervention Strategies* project was to look comprehensively at energy efficiency within the lifetime of a building -- "cradle to grave". The purpose of this research was to develop efforts that would influence decisionmaking processes at the maximum number of stages throughout the lifetimes of City buildings. The project had two major phases; a research phase, followed by an implementation phase.

Research phase: We created a model based on the lifetime of a City building. The research tasks were to:

- 1) Describe steps in the process
- 2) Identify opportunities for incorporation of energy efficiency
- 3) Identify key decisionmakers and determine their needs
- 4) Design actions to address opportunities

Implementation phase: We implemented several identified actions as pilot projects. The implementation tasks were to:

- 1) Identify potential pilot projects
- 2) Select pilot projects
- 3) Implement pilot projects

1.4 REPORT ORGANIZATION

Chapter 2 describes the research phase of the project, including:

- ▶ an explanation of our *methodology*, which describes how we studied the system in order to design services for city decisionmakers;
- ▶ the results of our research shown in a *timeline diagram*, which describes the process of funding, designing, constructing and maintaining a San Francisco municipal building; and
- ▶ a description of key *access points* for intervention.

Chapter 3 explains the implementation phase of the project by describing the selection, design and implementation of our five pilot projects -- Bond Guidelines, Energy Efficient Design Practices, Commissioning, Motor Efficiency, and Facility Condition Monitoring Program.

Chapter 4 summarizes the conclusions of the project by discussing what we learned from the *Intervention Strategies* project; the findings, lessons learned, project evaluation and plans for the future.

The **Resource Toolbox** lists tools (such as reports, guidelines, and software) and distributors (such as government agencies and trade organizations) that energy managers, designers and facility managers can use to inform their projects.

CHAPTER 2: THE BUILDING LIFETIME

Chapter 2 describes the research phase of the *Intervention Strategies* project. This chapter presents:

- ❑ the **Building Lifetime Model (Section 2.1)**, a conceptual framework for describing events over the lifetime of a city building and paths to influencing energy-related decisions during that lifetime;
- ❑ the **Research Methodology (Section 2.2)**, a description of the process leading to the *San Francisco Municipal Building Lifetime Diagram*, which describes a typical building's lifetime and opportunities for intervention; and
- ❑ **Access Points For Intervention (Section 2.3)**, descriptions of selected steps in the building's lifetime and how they present key opportunities for influencing energy-related decisions.

2.1 THE BUILDING LIFETIME MODEL

The *Intervention Strategies* project is based on a model which describes energy efficiency opportunities in terms of efforts to influence people at key steps throughout the lifetime of a municipal building. We used this model to look upstream and downstream of our current efforts in order to find effective ways to integrate energy efficiency at all points in a building's lifetime.

The building lifetime model describes the lifetime of a municipal building as a series of chronological **steps** within the major **stages** of Funding, Design, Construction, and Operations & Maintenance. These steps define the processes that take place over the building's lifetime.

Some of these steps may present opportunities for an energy office to influence the energy efficiency of a building. At some of these steps, key energy-related decisions are made, or transitions between responsible agencies occur. These key steps present **access points** where we can act most effectively to incorporate energy efficiency into existing processes.

At each of these access points, there are key individuals or groups making decisions that have a great impact on the building's energy efficiency. Influencing the practices of these **decisionmakers** by raising their awareness of energy issues and providing them with appropriate tools, is essential to successful intervention.

The pathway to effectively influence these decisionmakers and their choices is through **actions** that provide the necessary information, funding or policies to enable them to incorporate energy efficiency into their daily tasks.

The relationship among these elements of the building lifetime model -- steps, access points, decisionmakers, and actions -- is shown schematically in **Fig. 2.1**.

Figure 2.1 Building Lifetime Model

2.2 RESEARCH METHODOLOGY

This section outlines the process we used to fill in the building lifetime model with information. The results of this research are outlined in the *San Francisco Municipal Building Lifetime Diagram* (Fig. 2.2). Our research methodology was to:

- 1) Describe the *steps* in the process
- 2) Identify *access points* for incorporation of energy efficiency
- 3) Identify key *decisionmakers*
- 4) Formulate *actions* to effectively address opportunities

This process is described below:

1) Describe steps in the process

What does the current process of funding, designing, building and maintaining a municipal building look like?

In order to construct a "before" picture of the existing process, we investigated the series of steps that take place within the major stages -- Funding, Design Construction, and Operations & Maintenance -- of a municipal building's lifetime. To do this we interviewed staff within various city agencies who helped give us a clearer picture of how the system works. The purpose of these interviews was to learn from staff's knowledge of existing processes, to hear about the barriers they face to making energy-efficient decisions, and to solicit their ideas on improving these processes.

For example, by interviewing a member of the city's Capital Improvement Advisory Committee, we learned how capital bonds evolve from departmental requests, through bond reports, approval, and on to the design stage. This knowledge enabled us to describe in detail the steps in the early stages of a building's lifetime and to begin work to impact the bond report process through a pilot project (discussed in section 3.2).

2) Identify *access points* for incorporation of energy efficiency

Which of these steps present good opportunities for integrating energy efficiency into the process; and which steps involve decisions likely to affect long-term energy use?

We chose some steps in the process where we believed we could appropriately intervene and have an impact. While other steps may offer potential for intervention, we considered this set of access points to be the most likely for successful implementation due to factors such as timing, existing relationships, and available staff resources. (These access points are discussed in greater detail in section 2.3).

3) Identify key *decisionmakers*

Who are the key staff associated with these access points?

These are the people we wish to influence. They are the individuals in charge of decisions regarding bond scope, technology choices in design, purchasing criteria, contractor management, and maintenance practices. While some early steps in the development and management of a building may involve a relatively small number of key decisionmakers (making them extremely important people to influence), most steps have many players.

Through researching civil service lists, studying organizational charts, and interviewing departmental staff, we compiled a database of key staff to target for future actions. The citywide database contains over 800 city staff, including: architects, engineers, construction managers, building inspectors, purchasers, departmental administrators, and maintenance personnel such as electricians, stationary engineers, maintenance supervisors and lamp changers. With this comprehensive list of virtually all San Francisco staff (other than end-users) involved in making decisions related to energy-consuming equipment, we could target key departments, projects and individuals on which to focus our efforts. Through interviews, we gained a better understanding of "who does what", and the duties, responsibilities, and roles of these city staff.

4) Formulate *actions* to effectively address opportunities

How can we best address these decisionmakers' needs? What tools and resources will enable them to integrate energy efficiency into their practices?

Our goal was to design actions that would effectively inject energy efficiency at each of the selected access points, would provide decisionmakers with practical resources, and would help foster relationships with them and among them.

Target decisionmaker groups may range anywhere from a department such as Parks and Recreation, to an employee class such as architects, to a working group such as a design team or a maintenance crew, to individuals such as a department head or a facility manager. Through interviews, we learned more about the kinds of tools they might need.

We identified available resources such as technical expertise, staff, materials, and funding. We investigated ways to capitalize on our partnerships with Lawrence Berkeley Laboratory and Pacific Gas & Electric Company. These partners helped generate project ideas including technical workshops for San Francisco staff (for instance, on high-efficiency motors/variable frequency drives, or commissioning). Other resources, such as Washington State Energy Office's *Motor Master* software, were studied for possible inclusion in pilot projects. (Information on these and other resources are assembled in the *Resource Toolbox* found at the end of this report).

We formulated a list of possible actions, including classes, guidelines, rebates, and design assistance, that could be undertaken to address identified opportunities to motivate and equip decisionmakers to make energy-efficient decisions.

Major **Stages** in Building Lifetime

Steps in the process

Access points

Decisionmakers

Potential energy office **Actions** to influence decisionmakers

[**Actions** shown in bold type were implemented as pilot projects]

Figure 2.2 LIFETIME OF A SAN FRANCISCO BUILDING

→ CONSTRUCTION → OPERATIONS & MAINTENANCE →

Guide to the Building Lifetime Diagram

The *San Francisco Building Lifetime Diagram (Fig. 2.2)*, is a picture of the major events in the lifespan of a typical municipal building in San Francisco, as well as a plan for focussing energy programs on key access points. It describes the overall process of Funding, Design, Construction and Operations & Maintenance by showing a chronological listing of the steps that take place over the building lifetime (read left to right). It also shows pathways by which the energy office may influence the process through actions designed for key decisionmakers (read bottom to top).

The steps described here may not have exact parallels in all cities, since every city has its own unique organizational structure, processes, resources, and energy office roles. However, the components presented here should generally apply.

Definition of terms

Stages: major phases that characterize the lifetime of a municipal building.

Steps: events or milestones that take place within these stages.

Access points: selected steps along the lifetime where there are opportunities for effective intervention.

Decisionmakers: key city staff we need to influence.

Actions: initiatives to incorporate energy efficiency into the process at these access points. (Five of these actions – those in **bold type** – were implemented as pilot projects undertaken this year, and are discussed in Chapter Three).

2.3 ACCESS POINTS FOR INTERVENTION

This section describes selected steps in the San Francisco municipal building lifetime, and how they present key opportunities for influencing energy-related decisions.

We used the *San Francisco Building Lifetime Diagram* to help us determine where and when to best allocate our resources. It informed our program development efforts by filling in gaps in our understanding and showing us where in the "big picture" the opportunities for influencing the process lie.

We examined all the steps along the lifetime, looking for opportunities to effectively intervene in the overall process. Through considering a combination of factors such as availability of our staff and financial resources, cost effectiveness, good timing, our relationships with decisionmakers, and our own past experience, we arrived at steps where we believed we could most effectively intervene.

The nine access points described here were chosen because they present appropriate and significant opportunities, and because they represent a cross-section of steps on the lifetime. Other steps may also provide access points through which to influence key decisions affecting the current or future energy use of city buildings.

1) Bond Report Team Selection

Once needs have been identified and a project has been deemed viable, a team is put together to prepare the bond report. This team usually includes a Department of Public Works project manager, a departmental representative, a value engineering consultant, and a member of the city's Capital Improvement Advisory Committee (CIAC). The bond report describes the needs and scope of the project in detail, and attaches general estimates of \$ per square foot and long-term operating costs. Some possible actions that energy staff can undertake here to introduce energy issues are: providing lifecycle cost information and/or training; preparing general bond guidelines for energy efficiency; reviewing energy aspects of a specific bond report; and doing a cost-benefit analysis of proposed energy efficiency measures.

Working to include energy efficiency explicitly within the scope of the bond is the earliest action we can take to influence energy use in a municipal building. If we can introduce energy issues into projects from the beginning, we can help make energy efficiency a design priority, and thus impact energy usage for the rest of the building's life. If energy issues are overlooked at this step, it will be more difficult to insert and fund them later.

2) Project Management Agency is Chosen

Once the issuance of the Bond has been authorized, and staff may proceed with the project, the client department and the CIAC determine the appropriate agency -- usually the Department of Public Works/Bureau of Architecture -- to oversee the project, and a city project manager is assigned. An appropriate energy efficiency action at this step is writing a

commissioning requirement into the design contract.

By getting a commissioning process included in the project, we can help ensure that building performance meets design intent and thereby maximize energy efficiency. If we are unable to influence the project management agency, we will have missed an opportunity to include energy efficiency as an issue for the duration of the project.

3) Design Teams are Selected

The project manager is responsible for assembling design teams made up of architects and electrical, mechanical and structural engineers; and for setting priorities for the design team. Often the same design team will work together on several projects within a single bond focussed on a particular department or need (such as seismic upgrades). Possible actions to take here are: offering design review and technical assistance, providing training on energy efficient design practices and technologies, and offering classes on state energy code compliance.

Convincing project managers to include energy efficiency as a priority will encourage energy efficient design and will set the tone for the design teams. It is more cost-effective to specify efficient equipment in the original design than to retrofit later. If energy efficiency is not incorporated in the design, many opportunities for efficiency may be lost.

4) Construction Documents/Plancheck

Once design is complete, construction drawings are submitted to the City's Department of Building Inspection for approval. At this step, plan checkers review the drawings for compliance to codes such as structural, electrical, and safety.

Providing training in state energy code compliance for staff will enable them to become familiar with energy efficient design technologies and practices. If plan checkers are unfamiliar with energy codes, they will not recognize inefficient designs or specifications and may then pass them through to construction.

5) Client Department Approval

The client department must accept the final design before bid selection. An important activity to be undertaken at this step is lobbying to keep energy efficiency measures in the project should they be threatened (by, for example, budgetary problems).

Any previous agreements regarding funding of energy efficiency measures between the energy office and the design agency should be revisited. Also, decisionmakers should be reminded of the advantages of investing in energy efficient design: lower long-term energy and maintenance operating costs. Failure to monitor this step could result in wasted effort.

6) Contractor Submittals

The construction manager reviews bid submittals from contractors and consults with design engineers on the acceptability of equipment substitutions ("or equals"). Managers might be unaware that a product which provides equivalent function in terms of output may not provide equivalent function in terms of energy efficiency. Actions at this point could include advising construction managers on appropriate energy-related equipment substitutions.

Providing on-call technical assistance for construction managers can help prevent energy efficiency measures from being lost during contractor submittals.

7) Building Startup

During startup, the checking, testing, balancing and calibrating of installed equipment and systems is performed in preparation for occupancy. This access point provides several opportunities, such as: working with the commissioning agent to oversee and document equipment testing, verifying that appropriate manuals and documentation are in place, training operations and maintenance (O&M) staff on installed systems, and setting up end-use monitoring of the building to measure actual versus estimated energy use.

This is the key transition point between the construction phase and the O&M stage and is an opportunity to anticipate and prevent future problems with building performance before they occur. Without proper testing of installed systems and training for O&M staff, energy efficiency features will not operate at their optimum levels.

8) Replacement Equipment

Ongoing maintenance and repair require the purchase of HVAC and lighting replacement parts and equipment (eg. lamps, ballasts, motors). There is an opportunity here for influencing and enabling staff to purchase the most appropriate and efficient replacement equipment. Potential actions include providing efficient technologies training on for O&M staff and equipment specifiers, lifecycle cost training for specifiers and purchasers, rebate incentives; and the development of streamlined purchasing procedures for buying efficient equipment.

Because the Operations and Maintenance stage covers the longest period of a municipal building's 50+ year lifetime, choice of energy-using replacement equipment specified and purchased over time can result in significant potential energy savings (or waste).

9) FCMP Inspections

The Facilities Condition Management Program (FCMP) is an ongoing audit program within the Department of Public Works. The program inspects City facilities for "deficiencies" in various areas including HVAC and lighting as well as seismic, asbestos and disabled access needs. It assesses these deficiencies, estimates dollar amounts required to correct them, prioritizes the deficiencies, and enters this information into a central database. The FCMP then contracts work to be done by city staff (small-scale projects) or uses the data as the basis for future bond proposals (large-scale projects).

Energy-related actions focusing on the FCMP are: funding an energy specialist on the inspection team; providing training and technical support for inspection team members; and funding incremental equipment costs for FCMP-generated repair projects.

By coordinating with this existing City-wide auditing program, we can not only influence small-scale retrofit projects, but can also help identify and document energy efficiency work as an important infrastructure improvement need; thus completing the cycle back to the funding stage. By missing this opportunity, we allow cost-effective energy efficiency projects to remain untapped, and planned work to proceed without an energy component.

Summary

Through the research phase of the *Intervention Strategies* project, we created a conceptual model of a building lifetime (Fig.2.1); gathered San Francisco-specific data about access points and their associated decisionmakers in order to fill in this model (Fig. 2.2); and targeted areas where we thought we could integrate energy efficiency into the overall process of funding, design, construction, and O&M of a City building (section 2.3, access points). Through development of these tools, we were able to get the much needed view upstream and downstream from our existing projects.

We now had a picture of the building lifetime; and a list of some of the mechanisms for influencing this process. The next step was to use this information to act on these ideas to capture lost opportunities and prevent incomplete actions. We did this by implementing some of the identified *actions* as pilot projects. Chapter 3 describes these pilot projects.

CHAPTER 3: PILOT PROJECTS

Chapter 3 describes the implementation phase of the *Intervention Strategies* project. This chapter covers:

- ❑ **Pilot Project Selection (section 3.1)**; which describes the process of identifying candidates, choosing selection criteria and selecting projects; and
- ❑ our efforts at influencing energy efficiency over the building lifetime through the implementation of five **Pilot Projects (section 3.2)** - Bond Guidelines, Energy Efficient Design Practices, Commissioning, Motor Efficiency, and Facility Condition Monitoring Program.

3.1 PILOT PROJECT SELECTION

The central theme of the *Intervention Strategies* project was concerned with how to target our efforts towards energy efficiency in a systematic way, through projects based upon the needs of decisionmakers, over the lifetime of a municipal building. The implementation phase of the project comprised identifying, selecting, and implementing five pilot projects towards this end.

First we brainstormed a list of pilot project ideas we would like to undertake. These project ideas ranged from providing HVAC system workshops, to design guidelines, equipment subsidies and policy recommendations. Then, through our research of the building lifetime (section 2.2), we listed potential actions we might take and organized them chronologically by access point (**Fig. 3.1**). This formed a menu of potential pilot projects.

We then formulated a set of criteria to use in narrowing the list down to a few pilot projects(**Fig. 3.2**). We found that two criteria were key; 1) the pilots should represent a cross-section of the overall building lifetime, and 2) opportunities to influence decisions on specific work in progress should be available. Choosing a pilot from each of the major building stages (funding, design, construction, and operations & maintenance) would help us gain a better understanding of the overall building process. Also, in order to test the ideas, projects needed to be matched with specific work that was underway. We used the selection criteria to choose five pilot projects. Pilot project implementation, strategy, and results are discussed in section 3.2.

<u>Bond report team selection</u> Provide lifecycle cost classes Provide Bond guidelines Review bond report Provide Cost estimate of energy-related measures	<u>Contractor Submittals</u> Track energy efficiency measures funded by energy office Advise construction managers on equipment substitutions, review alternate specifications
<u>Project Management agency is chosen</u> Write commissioning into design contract	<u>Building Start up</u> Liaison with commissioning agent on oversight of energy elements testing and balancing Provide training for O&M staff on installed systems, verify manuals, documentation in place Monitor end-use
<u>Design Teams are selected</u> Advise and assist design team Fund incremental equipment costs Provide energy efficient design practices classes Provide efficient technologies training (eg. lighting, HVAC, motors) Provide Title 24 (California state energy code) training for designers	<u>Replacement equipment</u> Provide efficient technologies training (eg. lighting, HVAC, motors) Provide lifecycle cost training Offer rebates on efficient equipment Streamline purchasing of efficient equipment
<u>Construction Documents/Plancheck</u> Provide Title24(California state energy code) training for building inspectors	<u>FCMP Inspections</u> Fund energy specialist on inspection team Provide training, technical support for inspection team Fund incremental equipment costs
<u>Client Department Approval</u> Lobby to keep energy efficiency measures in project	

Figure 3.1 Potential Actions

<p>The project is representative of a cross-section of the overall building lifetime. The timing is good for the action to be effective. Sufficient resources are available. The project has transferability potential – it is generally applicable and repeatable. There are significant potential energy savings. The project will yield good, user-friendly tools for inclusion in the "resource toolbox". Research requirements are manageable. The scale is manageable. The complexity of the project is manageable. Personalities are manageable.</p>
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Figure 3.2 Project Selection Criteria

We chose the following pilot projects:

- ▶ **Bond Guidelines**, addressed the funding stage of the building lifetime. A major hospital project was a candidate for bond funding, and we participated in the bond report process.
- ▶ **Energy Efficient Design Practices**, targeted City architects and engineers working in the design stage of the building lifetime. Several capital improvement projects were in progress, and we provided workshops and guidelines on efficient lighting design.
- ▶ **Commissioning**, addressed the construction stage of the building lifetime. While there was no existing commissioning process that we knew of to use as a test case, we were interested in the potential for continuity that commissioning represents. We explored the field for its potential application in San Francisco.
- ▶ **Motor Efficiency**, represented a step in the operations and maintenance stage of the building lifetime. Replacement motors were being purchased at a wastewater plant and a hospital, and we had an opportunity to open a dialogue with specifiers and provide them with information on premium efficient technologies.
- ▶ **Facilities Condition Monitoring Program**, addressed the operations and maintenance stage of the building lifetime. The San Francisco *Facilities Condition Monitoring Program (FCMP)* inspects City facilities for "deficiencies" in various categories, including HVAC and lighting. Our pilot project was a test case of how to integrate energy efficiency into the FCMP.

3.2 PILOT PROJECT IMPLEMENTATION

The purpose of the pilot projects, and the *Intervention Strategies* project in general, was to lay the groundwork for influencing city decisionmakers to view energy efficiency as a component of their jobs, and to change their practices accordingly. Our goal for the pilot projects was to begin to integrate energy efficiency into standard practice by:

- ▶ introducing energy efficiency as an issue.
- ▶ raising city staff's awareness of energy efficiency.
- ▶ providing technical support.
- ▶ promoting self-reliance of staff.
- ▶ providing funding for incremental equipment costs.

In undertaking the pilot projects, we were careful that they be limited in scope due to time and staffing limits. At the same time, they needed to be comprehensive in design and to include a balanced, thorough approach so we could form a solid foundation for future program expansion and effect lasting changes in the process.

For each of the five pilot projects discussed below, we cover background, goals for the pilot, action undertaken, and results of the project.

Pilot Project # 1: BOND GUIDELINES

Background

Bond report team selection is the earliest access point (see Fig. 2.2) that we have discovered to influence energy-related decisions. Introducing energy as an issue at this point can have a major impact because it will form the basis for all the steps that follow. If energy is explicitly stated as a priority in the bond report, then it is much more likely to be included in the design and more likely to be acknowledged during construction. The presence of an early, written mandate means energy efficiency will more likely remain a priority throughout design and construction.

Establishing energy efficiency as a priority before beginning building design provides access to the greatest possible energy savings potential, and to the most cost-effective interventions by energy management staff. A sample of recent DSM literature provides examples of efficient building designs yielding significant savings through establishing an energy efficiency intent in the building's capital funding and priority setting stage. These examples include: a commercial office design which yields 36% energy savings versus typical design, with a 4.7 year payback; a building remodel which saves 50% over typical existing construction with a 5.5 year payback; and another building renovation which achieves 75% energy savings versus the pre-design base-case, with a 5.3 year payback (2.7 years when including utility rebates).^{1, 2, 3}

Decisions made in the funding stage affect building energy efficiency throughout the remainder of a building's useful life. When decision-makers determine a building's purpose and capital budget, these decisions, either implicitly or explicitly, then set the building's design priorities.

In San Francisco, although municipal bonds fund the majority of major City construction projects, the bond approval process generally does not mention either energy efficiency or long-term operating costs. This pilot project seeks to address this gap.

A bond report describes a bond proposal's rationale and capital budget. The key decision-makers to influence here are the bond report writing team, usually consisting of the client department's representative, an architectural or engineering (A/E) project manager, and often a planning programming A/E consultant. By reviewing a bond report and making recommendations, this pilot project has been designed to motivate and equip the bond-writing team to establish an energy efficiency priority.

Two anecdotes from BEC's recent history illustrate the importance of including energy efficiency in the bond report. In one case, the design team for a series of seismic retrofit

¹ Hepting, Curt, 'An Energy Responsive Building Application for New Commercial Construction,' *Proceedings From the American Council for an Energy Efficient Economy (ACEEE) Summer Session on Energy Efficient Buildings*, 1992.

² Watson, Robert, 'Case Study in Energy Efficient Office Renovation; NRDC's Headquarters in New York City', *ACEEE Proceedings*, 1990.

³ Watson, et.al., 'Office Building to Produce Energy Savings of 75%', *ACEEE Proceedings*, 1992.

projects in branch libraries declined advice about energy efficient lighting because energy conservation was not explicitly within the scope of the bond. On the other hand, a bond report writer for a municipal steam loop renovation project contacted BEC for advice, and ended up including an additional \$100,000 for building heating controls in the bond proposal. These cases reinforce our belief that actions taken in the funding stage can help make energy efficiency a design priority, and thus impact energy usage for the rest of the building's life.

The project team used an upcoming \$500 million hospital bond proposal as a pilot to explore what form a bond guideline could take, and how much extra financing would be necessary to build projects to a more energy efficient standard than minimum code requirements. Based on the pilot project's results, we hope to apply these guidelines to other bonds, and eventually to institutionalize them.

Goals

The key challenge for this pilot project was developing meaningful guidelines and enforceable requirements for building energy efficiency before a project has even begun its initial design study. We then needed to discover how to translate these energy provisions into language acceptable to bond writers. Our eventual goal is to package these provisions as a guideline for all future bond proposals.

The project team's goals for the Bond Guideline pilot project were as follows:

- ▶ Incorporate energy efficiency as a priority at the earliest point in the life of a sample building project by including language in the appropriate documents (the bond report, bond language, etc.);
- ▶ Raise the awareness of funding stage decision-makers (bond-writers, Bureau of Architecture project managers, department administrators) on energy issues and the benefits of energy efficiency.
- ▶ Learn from the process to be able to improve and repeat it later with other bond proposals.

Action

Taking action on these goals required first gathering information on key decisionmakers in the bond approval process. From the decisionmakers we believed we would learn of upcoming candidate bond proposals that we might work with on a pilot basis. We would also come into direct contact with the people who actually write the bond reports.

Once we found a bond proposal team willing to work with our project, we would explore bond guideline strategies which incorporated the four project approaches developed during BEC's *EMAP* project (see section 1.2). Specifically, to be successful, the pilot project's bond guidelines must provide a guiding *policy* statement; they also must provide the *budget* resources with which to take action; they must raise decisionmaker's *awareness* of energy issues to know which action to take; and finally they must designate a *coordinator* to carry the message around the loop. For the pilot project the project team tried to design bond

report language with all four elements for an upcoming proposed bond.

Research on Key Decision-makers

The project team discovered that, due to San Francisco's decentralized administrative structure, key decisionmakers exist in every department. We discovered that many of the City and County's departments develop their own bond proposals. Further, we learned that departments often hire consultants to write the bond reports. We realized that instituting a new set of bond guidelines would be far more difficult than simply advising a centrally located small group of specialized bond report writers which we had imagined existed.

Nonetheless, members of bond writing teams did share common concerns. These were 1) meeting the client department's needs; 2) characterizing the bond's benefits in terms compelling enough to be supported by the voting public; 3) controlling the initial cost of the project - recognizing that bond proposals would be reviewed by the City's Capital Improvement Advisory Committee (CIAC) with an eye toward their impact on the City-wide debt ceiling; and 4) assessing the project's subsequent impact on the City's General Fund, (for costs not covered by the bond, such as staffing and operations). Within this context, BEC reasoned that decision-makers would be susceptible to long-term operating cost arguments.

Choosing a Bond

Of the three bond reports being written this year in various City departments, we chose to work with a proposed \$500 million replacement to the City's long-term health care facility, Laguna Honda Hospital. We chose this proposed project based on: the openness of the client department to our participation; the growing importance of health care facilities, in both public finance and utility planning; and the potential for energy savings in such an energy-intensive building type.

Project Description.

Laguna Honda Hospital serves as San Francisco's primary long-term health care facility. Built more than 70 years ago, the facility is now out of compliance with current health care standards, such as lack of positive air-flow ventilation for disease control. Seismic safety, as is usual in older San Francisco buildings, is also a concern. In addition, the city's aging population, the increasing need for long-term care for AIDS patients, and soaring health care costs make this public long-term care facility an essential public service.

The hospital prepared a 1992 draft bond report proposing a \$500 million replacement of the existing facility. During 93-94 the bond team hopes to develop a less expensive alternative; it hopes to complete the review process by the Board of Supervisors in time to be put on the Fall 1994 ballot. (In California, state law requires all new taxes or bonded indebtedness to be approved by a 2/3 vote of the electorate).

Energy Efficient Hospital Design Research

We supplemented our in-house expertise in energy-efficient design with research specific to hospitals, and in particular with research on the question of what extra costs to associate with an energy efficient hospital.

Research included contacts with the California Energy Commission, the Pacific Gas and Electric Company's New Construction program, as well as the new construction programs for Southern California Edison, the Sacramento Municipal Utilities District, and San Diego Gas and Electric Company. We also collected information from Kaiser Permanente HMO, Montgomery County, MD, and a local engineering consultant firm.

The jewel found in BEC's hospital design research was a list of hospital energy efficient design recommendations compiled by the California Energy Commission's Local Assistance Office. CEC staff developed this list based on its provision of technical assistance to public hospitals, both major renovations and new construction. The list appears in Appendix C.

As a result of this research our recommendations for Laguna Honda Hospital's bond proposal were as follows:

- ▶ voluntary compliance with the state energy code whenever possible to establish an efficient base case (the code implicitly includes an energy budget)
- ▶ provision of a capital fund specifically for "beyond code" design and construction
- ▶ inclusion of an energy design consultant as part of the design team to provide detailed awareness of energy issues throughout design
- ▶ requirement of design studies for major system choices to identify the lowest life cycle cost building energy systems, and to guide the building design as a whole
- ▶ inclusion of a building commissioning process
- ▶ reference to hospital-specific energy design guidelines

These recommendations employ a variety of "tools" or strategies to help the design team achieve building energy efficiency. These tools can help satisfy the following central requirements for successful incorporation of energy efficiency into a bond proposal:

- ▶ budget incentives (such as access to design fees and the "beyond code" capital fund);
- ▶ energy awareness on the part of the design team (through the design team energy consultant); and
- ▶ policy (through an explicit reference to energy efficiency by the Board of Supervisor's when placing the proposed bond on the ballot).

Appendix D contains the draft Laguna Honda Bond Report language currently under review by the design team, along with BEC's memo supporting each recommendation.

The following recaps several issues considered in developing this proposed language:

Bond Writing Team's Needs

The Bond writing team provided essential feedback on what form of energy guidelines would be useful at this early stage of a building's life. First, the bond team asked BEC to review the draft bond report and to identify "only the major energy issues" for the project. Second, the team asked for an estimate of how much extra capital the project should seek in order to address these issues and to make the hospital energy efficient. Implicit in any recommendation for additional capital, was that BEC would need to project enough energy savings to justify the added expense.

Non-Specific Bond Report Language

The bond team specifically requested broad bond report language. Although in favor of making energy efficiency an explicit part of the bond's scope, the bond team did not want energy efficiency recommendations which were more detailed than the project proposal itself. Specific language, they said, would overly restrict designers; e.g. "We don't want the requirement of an atrium if the designer later determines that an atrium would disrupt a building's function."

BEC balanced this desire for broad language against the need to establish specific minimum requirements to constrain designers who might later be pressured to cut energy efficiency features because of cost-over-runs elsewhere. So BEC presented the desired one-sentence general policy statement for energy efficiency, while supporting this language with more specific requirements (See Appendix D).

Energy Savings Potential

Our research indicated that the new hospital would use significantly more energy than the existing facility, due primarily to HVAC system changes required by modern State hospital regulations. Current energy costs of \$800,000 per year would likely increase to \$2 million per year. An *energy efficient* hospital could reduce these costs by at least 15-20%, according to the California Energy Commission (CEC). 20% savings on a \$2 million annual utility bill would be \$400,000 per year. These savings could be used to repay the bond, fund patient services, subsidize maintenance activities, offset General Fund Transfers, etc.

Efficiency Contingency Fund

BEC research indicated that building an "energy efficient" Laguna Honda Hospital would cost \$2-to-5 million more than standard practice⁴. BEC recommended setting these funds aside within the design/construction budget to cover design fees and construction features beyond what state building efficiency codes would require.

⁴ BEC research indicated that energy efficiency is not standard practice in new hospital design; the City therefore should not assume that efficiency measures would be included under the hospital construction costs estimates being used in the bond report.

Offering a precise "energy efficient" construction cost estimate proved to be problematic. Each engineer we contacted offered the same advice of creating a computer model of the hospital as it is likely to be built (the base case); and creating another computer model of the building if designed for efficiency; and calculating the construction costs of each. Although BEC indicated to the bond team a willingness to pursue this method, we made clear that the quality of the results rested heavily on the quality of hundreds of assumptions made about the yet-to-be-designed "base case".

To develop the cost-estimate BEC used three techniques offered by efficiency design experts for estimating the additional cost of constructing an "efficient" hospital⁵. One reality check for this construction cost estimate is that energy savings of \$400,000 per year would appear to justify the additional bond payments of even the full \$5 million: a 30 year bond, at 5% interest, would have annual payments of about \$320,000.⁶

On this question of "how much more capital": Some experts argue that it need not cost anything extra to build an efficient building. Proponents of this position note, for example, that very efficient windows and wall insulation can help decrease the size requirement of the heating and cooling system. HVAC equipment savings could therefore help offset the added costs of the efficient windows.⁷

Ultimately construction savings may in fact offset all additional costs; however, through our municipal design review and assistance program, we have found designers to be unwilling to even initiate an extra efficiency design study unless capital is in place to implement the resulting recommendations. Setting aside capital funds for "beyond code" studies and implementation can protect against designers fear of "futile" design studies.

As a compromise for the cost-conscious hospital project team, BEC suggested taking part of the "contingency fund" (for beyond code energy efficiency) from the existing construction budget. This idea uses the rationale of construction cost "windfalls" to minimize the absolute increase in construction costs, while preserving the special fund for "beyond code" design studies and construction.

⁵ Method # 1: \$0.50-to-\$2 per sq. ft. for commercial buildings, with hospitals at the high end: \$2/sq.ft. X 1 mill sq.ft. = \$2 million

Method # 2: 1-to-2% of total project costs (based on San Joaquin County hospital renovation); 1% X \$500 mill project costs = \$5 million.

Method # 3: Assuming efficient design can cut energy use by 15-20%, and pays back additional capital costs in 5 years (using typical utility costs):
"Typical" utility costs of \$3 per sq. ft. x 1 mill. sq.ft. X 20% savings X 5 years = \$3 million initial investment.

⁶ This raised the issue of whether savings in operating costs could be applied either directly or indirectly, to bond payments. BEC is pursuing this issue with the city Chief Administrative Officer's office.

⁷ For example, Montgomery County, MD's efficient design program is founded on this idea of offsetting first costs.

Voluntary Compliance with State Energy Code.

Faced with conflicting expert opinions about whether the State Hospital regulations preempt California's state energy code (Title 24)⁸, BEC recommended voluntary Title 24 compliance for the project. In doing so, BEC simultaneously: referenced a familiar, comprehensive, cost-effective minimum efficiency standard; established a baseline energy use for the project against which to judge the designer's efforts as well as our own (e.g. 10% beyond Title 24 requirements); and provided a threshold of "standard construction practice", beyond which designers could tap into the "Efficiency Contingency Fund" budgeted in the bond. Appendix D discusses some additional issues regarding energy code compliance for hospitals, which we incorporated in our recommendation.

Results

Through this pilot BEC has developed a model for a citywide bond guideline. We have based this model on the needs of key decisionmakers and bond-writers in City departments, and on knowledge of the bond-writers' institutional context.

Specifically, in this pilot we have obtained buy-in from key departmental and Bureau of Architecture personnel on the Laguna Honda bond-writing team. We have drafted bond report language establishing energy efficiency and lower long-term operating costs as explicit goals within the bond project's scope. We have identified key pre-design decisions and researched energy efficiency strategies for inclusion in the bond report. And we have proposed provisions which will provide not only policy guidance, but the budget, informed awareness, and overall coordination needed to facilitate an energy efficient design process.

⁸ California's Building Energy Efficiency Standards, "Title 24", similar to ASHRAE's Standard 90, is among the nation's most comprehensive building energy codes. BEC believes that Laguna Honda's economic interests are best served by exceeding Title 24's minimum requirements in non-patient-care areas (such as offices and cafeterias).

Pilot Project # 2: ENERGY EFFICIENT DESIGN PRACTICES

Background

Clearly, incorporating energy efficiency into the initial design of a building is significantly more cost effective than retrofitting the building down the road⁹. It is not a question of whether to do it, but how.

In San Francisco, an early access point for influencing design priorities is when ***design teams are chosen*** (Fig.2.2). If designers are convinced of the economic, environmental, and comfort advantages of energy efficient design, and are provided with design tools to facilitate energy efficient design, then they will be more likely to act to incorporate energy efficiency into their designs. There are several benefits of this approach. It helps further our goal of raising energy awareness; it multiplies the effect of case-by-case design review, and it encourages designers' self-reliance. Greater awareness leads to more designers practicing energy efficiency, which leads again to greater awareness.

BEC, through our *Design Review and Assistance Program*, has provided energy efficiency design consulting services for a number of recent capital improvement projects. Through the program, a consulting engineer attends design team meetings and makes recommendations on the technical and economic effectiveness of various energy efficiency measures. BEC will then subsidize the incremental cost of the cost-effective EEMs.

In the course of reviewing these projects, we found that we had recommended the same general efficient lighting technologies on several different projects. While many energy efficiency measures are building-specific and must be analyzed on a case-by-case basis, some measures, like specifying T8 lamps and electronic ballasts, are generic enough to be included in a general guideline format.

While working with us on past projects, some designers had expressed the need for a "cookbook" approach to incorporating these technologies into their designs. It became clear to us that designers needed "user-friendly" tools in order to regularly incorporate energy efficiency into their designs. Therefore, we designed a pilot project which would work towards making efficient lighting design practices standard practice for City construction projects.

Goals

One of BEC's goals is to *sustain* energy efficient practices, so energy efficiency decisions continue beyond our one-time involvement. In keeping with this goal, one of the goals of this pilot project was to help make City designers more confident in independently

⁹ "...it is generally easier and less expensive to incorporate energy saving measures at the time of building construction than to retrofit a building after it is completed. Costs per kilowatt saved can be as much as 80% lower when measures are incorporated into new construction instead of being retrofit." Vine, Edward and Crawley, Drury, ed., *State of the art of energy efficiency - Future directions*, American Council for an Energy Efficient Economy, 1991.

including energy efficient elements in their designs. The objectives of the ***Energy Efficient Design Practices (EEDP)*** pilot project were to:

- ▶ provide a guidebook for straightforward energy efficiency measures.
- ▶ conduct workshops to present the guidebook.
- ▶ work towards making efficient design practices standard design policy for all City construction projects.

Action

Guidebook Design

Our objective was to present a list and description of sample recommendations from several past *Design Review and Assistance* projects. We wanted the contents to be relevant to engineers, architects and building operations staff (who are sometimes *de facto* designers on small scale projects). We also wanted the guidebook to be as practical as possible to encourage people to use it independently. The guidebook was to include lighting and HVAC components and be general enough to apply to most municipal building types.

The original idea of focussing on sample recommendations from past projects evolved into the idea of presenting a few cost-effective measures we knew would be relatively straightforward and generally applicable. The workbook became *technology* specific rather than *project* specific, because we believed this would best meet our goal of integrating the measures into as many projects as possible. We decided to cover lighting only, with the intention that this become the first chapter of an expandable, comprehensive energy efficient design practices guidebook.

In conjunction with our consultant, *Brown Vence and Associates*, we produced the *Energy Efficient Design Practices for San Francisco Municipal Facilities (EEDP)* guidebook. The guidebook provides concise information and step-by-step instruction on how to incorporate five reliably cost-effective lighting practices into new construction and renovation projects. These practices are:

- 1) Design to IES Recommended Light Levels
- 2) Specify Fixtures with T8 lamps and Electronic Ballasts
- 3) Specify Compact Fluorescent Fixtures
- 4) Specify High Pressure Sodium or Metal Halide Outdoor Lighting
- 5) Specify LED Exit Signs

The guidebook includes a brief description of each practice or technology, typical applications, rules of thumb, case studies from San Francisco municipal buildings, and a step-by-step approach -- including sample specifications -- to incorporating the technology into designs. The guidebook also contains sections explaining these recommended practices within the San Francisco context (cost effectiveness, BEC funding criteria, and Title 24 code requirements). Appendix E contains an excerpt from the guidebook.

Workshops

Our plan was to train architects, engineers, and selected maintenance personnel using the guidebook as the class text. We also included overheads, demonstrations, and a question and answer session to encourage participation.

We presented a 3-workshop series in which a total of 75 people participated. The invitees were chosen based upon a strategy of targeting design teams associated with upcoming capital improvement projects. We made a conscious effort to include people from all points in the buildings' lifespans (architects, electrical engineers, client department facility managers, and O&M staff). By following the format of the guidebook, and answering people's concerns, the workshops focused on enabling participants to confidently recommend, specify, use, and maintain the technologies. In preparing for the workshops, we:

- reviewed San Francisco's five year Capital Plan to identify potential projects to target with workshops. San Francisco currently has approximately \$800 million in active capital projects, funded mostly through bonds.
- gave a presentation to the senior architects at the Bureau of Architecture (the group overseeing most Capital Improvement Projects in the City) outlining BEC's services, previewing the upcoming workshops, and inviting them to participate. This was a step towards our goal of persuading the Bureau of Architecture to adopt the EEDP as their standard practice for all projects.
- interviewed Project Managers in charge of upcoming capital projects in order to determine their needs, concerns, priorities and interest level in energy efficiency and to solicit their ideas on appropriate people to attend the workshops.
- compiled a database of City architects, engineers and facility managers. This helped us to identify key people to invite to the workshops. Including facility managers and maintenance staff in the classes offered the benefit of fostering acceptance of the technologies and dialogue between maintenance and design staff. With all concerns heard, efficient equipment is more likely to be designed, installed and maintained properly. As a result, estimated energy savings are more likely to be realized.
- designed the workshops, structuring them to allow for student participation.
- completed logistical tasks, including invitations and confirmation, room reservations, and audiovisual and props procurement.

Results

Adhering to the principles learned from the *EMAP* project (discussed in Chapter 1), we endeavored to use a balanced approach in developing the EEDP pilot project.

The main focus of this pilot was in the *awareness* area. We designed and presented the workshops and guidebook keeping in mind our goals of providing user-friendly materials that staff would actually incorporate into their designs. In the *budget* area, we were able to support our recommendations in the guidebook and workshops with capital to subsidize the incremental costs of energy efficient technologies. This capital resides in a fund earmarked

specifically for upgrading specifications in City new construction and major renovation projects to more energy efficient equipment. *Policy* work included giving a presentation for the senior City architects. At the presentation, we outlined our design review and retrofit programs and invited these influential decisionmakers to the upcoming workshops. In preparing the class lists, we *coordinated* our recruitment efforts with current and upcoming bond-funded capital projects by targeting staff associated with those projects.

The EEDP pilot project resulted in:

- ▶ production of the *Energy Efficient Design Practices for San Francisco Municipal Facilities* guidebook, which provides concise information and step-by-step instruction on how to incorporate five reliably cost-effective lighting practices into new construction and renovation projects;
- ▶ presentation of the first workshop series;
- ▶ adoption of the guidelines by the Fire Department for upcoming projects. The Fire department has informally made the EEDP their standard practice on all current and upcoming projects as part of a \$40 million seismic capital improvement bond; and
- ▶ laying of the groundwork for further adoption of the practices. Because designers on upcoming projects (like City Hall and the Opera House) have already attended the workshops, they will already be familiar with the practices.

Evaluation

Savings estimates

The workshops presented simple design elements that will increase the efficiency of most lighting systems that the designers specify. While estimating the dollar value of training is not so obviously quantifiable as a retrofit project, savings estimates based on conservative assumptions are surprisingly large.

If the workshops result in half of the attendees implementing the recommendations in the designs for which they are responsible, the improved efficiency is worth \$380,000 (present value) in avoided energy costs (at the city's rate of \$0.05/kWh) over a 15-year equipment lifetime. This savings accumulates with each year's work, so over the next five years of designs, the lifetime savings approach \$2 million.

The workshops themselves cost about \$5,000 each, after an initial investment of \$20,000 to develop the materials. While the BEC is often called upon to pay the incremental costs of more efficient equipment, the benefit/cost ratio is still quite high. Our experience with these workshops and others (for instance, boiler efficiency workshops for maintenance personnel) have impressed upon us the value of educational efforts; our programs are shifting to reflect our understanding of this potential. This is part of the overall process of putting energy efficiency on the agenda of more city staff.

Workshop Follow-up Survey

Six months after the workshops, BEC surveyed a ten percent representative sample of the workshop participants, in order to measure the effect of the workshops on design projects during the intervening months. Our purpose was to assess participants' level of satisfaction with the workshops, impact of the EEDP guidebook and workshop on their daily work, and to solicit suggestions for improvement. We included architecture, engineering, maintenance and administrative representatives. We purposely biased our sample toward in-house design staff, since they have the best chance of re-using the material on City facility projects.

Engineers and outside consultants appeared to have had the most previous contact with the material, while architects and in-house staff appeared to have had the least exposure, due to a lack of training opportunities. Reactions about the workshop were universally positive. In addition to exposure to the technologies, respondents liked learning more about BEC's resources to assist designers. For workshop improvements, respondents requested more demonstrations, additional details on technologies, historic building applications, and more time to discuss their individual projects.

When asked about the guidebook distributed at the workshop, all those interviewed claimed to still have it. Respondents complimented the Guidebook for being very practical for the design process, well-organized with tabs for the various technologies, and useful for showing outside consultants exactly what technologies the City recommends.

When asked about design activity since the workshop, respondents answered either that they had not yet had a project to which to apply these lighting techniques; or that projects they worked on "sometimes" incorporated efficient lighting. All respondents claimed either to have used the Guidebook in recent small applications, or to be planning to do so in their upcoming designs (which tended to be larger applications.)

Finally the survey asked who on the design team the respondents felt had responsibility to make sure efficient lighting gets incorporated; and when not incorporated, how much certain factors contributed. Responsibility tended to be passed either up or down the chain of command: either up to the Lead Architect or his/her supervising Project Manager, or down to the Electrical Engineer. This confusion was perhaps best summarized by one response that the Lead Architect has the responsibility to remind the Electrical Engineer to include efficient lighting. Two thoughtful respondents, however, claimed that "no one" on the project team had this responsibility, and that this absence was a barrier to efficient lighting in new design.

All respondents agreed that the one factor that contributed to efficient lighting not being included in new designs was "lack of a clear policy" to do so. Some respondents clarified that the client departments, rather than the designers, set the design criteria, and thus need to be setting this policy. The respondents generally agreed that aesthetic considerations were "sometimes" a barrier to including efficiency, and that downstream maintenance concerns were not a barrier to efficient design. There was also tepid agreement that lighting designers' lack of familiarity with efficient technologies contributed to the problem. Interestingly, the respondents were about evenly split on the question of whether the extra cost of efficient equipment contributed to inefficient designs, with most answers being either strongly yes or no.

The results of the survey indicated that the materials we presented were worthwhile and worth repeating to more designers, largely unaltered. Future workshops would benefit from a longer question and answer period, and more discussion at the workshop as to what the responsibility of each team member is toward energy efficient lighting design. The results of the workshop would also be greatly improved by eliciting a policy for energy efficient lighting design from the departments who serve as the client base for the participants of the workshop. We are planning to repeat this lighting workshop several more times during 1994.

The next step towards our goal of integrating energy efficiency into standard practice is to promote wider adoption of the *Energy Efficient Design Practices*, by:

- ▶ repeating the lighting workshops
- ▶ presenting HVAC workshops with a companion guidebook
- ▶ continuing followup interviews with participants
- ▶ coordinating trainings with upcoming bond-funded projects

Pilot Project # 3: COMMISSIONING

Background

Commissioning is defined as:

"the process of ensuring that a building's design intent is implemented during the construction process and is carried through to building operation." ¹⁰

or, more specifically,

"a systematic process of assuring by verification and documentation, from the design phase to a minimum of one year after construction, that all building facility systems perform interactively in accordance with the design documentation and intent, and in accordance with the owner's operational needs, including preparation of operation personnel." ¹¹

Commissioning is facilitated by introducing a *commissioning agent* into the design and construction process, who is responsible for preparation and completion of a *commissioning plan*. The commissioning agent acts as a liaison among all the groups associated with design, construction, and operation of the building. The responsibilities of the commissioning agent are typically to:

- ▶ work with the owner and the design team to make sure the design intent is clearly stated
- ▶ ensure that the documented design criteria are followed throughout the course of construction
- ▶ review and functionally test all dynamic systems
- ▶ train O&M personnel and ensure that all procedural manuals and documentation are in place for occupancy

"An important link exists between the commissioning agent and design professionals. A commissioning agent provides technical assistance to help the designers and contractors integrate accessible, energy efficient systems into their building plan." ¹²

Potential for Commissioning in San Francisco

In San Francisco, the City is owner, project manager (and often also the designer), building manager and occupant. It is ultimately the City who funds the project and the City who must live with the results. Because the City will also be the operator and the occupant, the City bears all long-term operating costs of energy and maintenance associated with the building's energy using systems. Commissioning can help lower these operating costs by

¹⁰ Energy Simulation Specialists

¹¹ *National Conference on Building Commissioning, Summary Report*, April 28-30, 1993, Portland Energy Conservation Incorporated (PECI).

¹² Peci, op. cit.

ensuring that these systems are operating as efficiently as possible.

The building commissioning process best exemplifies the "cradle to grave" idea because it bridges the design, construction and operations and maintenance stages of a building. It connects steps, and their associated decisionmakers to achieve realized energy savings through functioning systems, operating as designed. The goal of commissioning, as it relates to energy, is to translate estimated savings into *actual* savings.

The effect of commissioning on the building timeline is the realization of design intent through verification and testing of systems after installation. Commissioning also helps to ensure longterm energy savings through inclusion of requirements for O&M training and support. A key access point for introducing commissioning into the municipal building process are when the ***project management agency is chosen*** (Fig.2.2).

This pilot project focussed on the Bureau of Construction Management (with over 100 staff) within the San Francisco's Department of Public Works. In the past, BEC has made energy efficiency recommendations on several capital improvement projects by providing energy expertise through participation in design team meetings, but has had no role in the construction stage. Through this pilot, we hoped to learn more about the construction stage, and how we might integrate commissioning into it.

Clearly, the construction stage is where many important energy-related decisions get made. It is where designs get translated into functioning systems. It is often a time where budget and schedule are major concerns, and as these parameters are pushed, a kind of triage may come into play which results in energy systems being given a lower priority.

Energy issues currently do not have an official advocate in the construction stage and are therefore in danger of being neglected. There are different variations on this theme. The problem could be as simple as a construction manager being unfamiliar with a technology that a designer has specified, so that a part or brand substitution may appear to be equivalent in terms of function, but may not be in terms of energy efficiency (eg. the difference between a magnetic and electronic fluorescent ballast, or a standard and premium efficiency motor). In other cases, the technical aspects may be clearly understood, but the relative importance assigned to energy aspects of the project are low, and therefore considered expendable in favor of higher priority features. These priorities could be driven by code requirements (eg. disabled access) or client-preference (eg. aesthetic or department-specific equipment needs).

Another significant energy-related issue that comes up at the end of the construction stage is: once the building is complete with equipment installed, does this equipment perform as designed? In order to ensure that it does, some kind of testing and balancing is required. This step can range from simple on/off static testing to a fully documented commissioning process. Interviews with selected construction management staff revealed that there is no true commissioning process for San Francisco municipal buildings. In terms of function, there only appear to be some cursory checks. Code compliance is the main focus of current inspection practices.

One important component of the commissioning process is the inclusion of information and training for O&M staff by manufacturers and contractors on HVAC and lighting systems. We have heard complaints from O&M staff of being handed the responsibility for a facility without sufficient training on the newly installed systems. Ongoing support is even more

rare. Some staff feel they are on their own to figure out how to troubleshoot and repair these systems when they fail.

Goals

Because commissioning was new territory for us, this pilot focussed on research. Before undertaking a commissioning program in San Francisco, we had to learn what is currently being done in the commissioning field, and which tools and resources we can provide for City staff to enable them to incorporate commissioning into their projects. The goals of our commissioning pilot project were to:

- ▶ investigate what has been done elsewhere
- ▶ determine if and how commissioning might be included in future contracts on San Francisco municipal construction projects.

Action

We investigated some of the needs, costs, guidelines, case studies and utility programs associated with commissioning. Through our research we found the following:

The Need for Commissioning

At the 1993 National Conference on Building Commissioning, several utilities, government agencies and engineering firms shared information on current efforts in the field:

*"Over the years, commissioning has been a neglected element in the design, construction, and operation of buildings....Ideally, the commissioning process extends through all phases of a project, from conception to occupancy and operation. Inspections and startup tests alone are not comprehensive enough to reveal the design and operational problems occurring in complex buildings. When commissioning becomes an integral part of the design, construction, and operation process, buildings will operate more sufficiently and function according to original design intent."*¹³

*"The diversity of professionals involved in design, construction and installation are not responsible to each other, and integration of systems often is not achieved."*¹⁴

There are many benefits to building commissioning. Through commissioning, systems and equipment are dynamically tested in "real world" conditions. As a result, building operation is improved and equipment lasts longer. Because building systems are then operating as designed, persistence of energy savings is increased, occupant comfort is improved, maintenance costs are lowered, and call-backs are avoided.

¹³ Bonneville Power Administration, *Building Commissioning Guidelines*, 1992
BPA pub. # DOE/BP-1574

¹⁴ PECL, op.cit.

Because dialogue among the various players is built in to the commissioning process, there are opportunities for better communication leading to greater continuity and fewer change orders.

Cost

Estimates of the cost of commissioning range from 1% to 4% of the cost of the systems or facility to be commissioned. The low end figures apply mainly to mechanical system only, with the upper range referring to "whole building" commissioning.^{15, 16} Other cost/benefit estimates say benefits can range from \$1 to \$3 per square foot at costs of \$0.20 to \$0.70 per square foot. Still others show 2 to 3 year simple paybacks.¹⁷

Commissioning experts often stress the costs of *not* commissioning. Without a commissioning process, even well-designed buildings may operate inefficiently.

*"Without commissioning, everyone pays. Some who share the highest stakes in building performance - owners, architects and engineers, utilities - are already paying for commissioning as a preventative measure against call-backs, construction delays, unbridled energy use and lawsuits."*¹⁸

One expert estimates a 10% and 20% energy savings potential from commissioning, and reminds us that 10-20% waste is inevitable without commissioning¹⁹. Another warns that the loss incurred for not commissioning can be \$4-\$8 per square foot per year.²⁰

Typical problems found through commissioning include system operation and design problems; comfort and air quality problems; and higher operation and maintenance costs. Some examples are:

- ▶ lack of control schematics (leaving control engineering in the hands of the installers)
- ▶ Energy Management System (EMS) not coordinated with the HVAC plant and systems
- ▶ EMS points not wired to hardware
- ▶ missing water treatment system for cooling tower and hydronic loop, resulting in fouled coils
- ▶ daylighting controls improperly installed or not hooked up to circuits
- ▶ no as-built documentation

¹⁵ NVT Technologies

¹⁶ British Columbia Building Corporation

¹⁷ Northeast Utilities case studies

¹⁸ PECL, op.cit.

¹⁹ Herzog, Wheeler and Associates

²⁰ NVT Technologies

- ▶ no operation and maintenance documentation
- ▶ building operators who do not understand the design intent for system operation (although they make their best efforts to operate systems to minimize complaints)²¹

According to Tamblyn, a successful handoff to O&M personnel must include:

- ▶ documentation of building systems
- ▶ definition of O&M responsibilities
- ▶ standards of performance for building systems
- ▶ training for O&M personnel

Guidelines and Case Studies

▶ Bonneville Power Administration's (BPA) *Building Commissioning Guidelines* ²² includes discussions of the goals and strategies of commissioning, the roles of team members, the commissioning process (pre-design through occupancy), the commissioning plan (scope, scheduling, testing, monitoring, training), and test plans. The guidelines include a sample commissioning specification, commissioning agent qualifications, O&M manual criteria, and design intent documentation. (See Appendix F for a sample summary of the tasks and responsibilities performed by the members of a commissioning team).

▶ Montgomery County Department of Facilities and Services' *Commissioning Program, Guidelines and Specifications* ²³ is a detailed guideline that provides a description of participants in the commissioning process and their responsibilities, sample commissioning statements for inclusion in mechanical and electrical specifications, design narratives, and an O&M instruction manual and training requirements.

Montgomery County's stated goals are to:

- ▶ turn over to the facility owner a complete set of documentation on the design intent of each of the systems involved in the commissioning process.
- ▶ turn over a system which functions in accordance with the design intent.
- ▶ have operators who fully understand the design intent and the operations of this system.

Field experience has shown that the commissioning process can be very cost-effective. A school district in Canada commissioned 120 existing buildings²⁴, integrating documentation and training. The project involved commissioning the building systems,

²¹ Tamblyn, B.T., 'Commissioning: An Operation and Maintenance Perspective', *ASHRAE Journal*, October 1992.

²² BPA, op.cit.

²³ Montgomery County Department of Facilities and Services, *Montgomery County Commissioning Program, Guidelines and Specifications* 1991

²⁴ Tamblyn, op.cit.

providing building operation manuals, training operators, installing direct digital control (DDC) systems, making minor HVAC modifications, and monitoring end-use. The payback period was less than 5 years (including interest costs for capital invested) and the owner realized a 20% return on investment. Additional savings were achieved in reduced maintenance, though these costs were not measured.

The *Advanced Customer Technology Test for Maximum Energy Efficiency (ACT²)* is a demonstration project managed by the Pacific Gas & Electric Company (PG&E). A key idea behind the project's approach is to consider a building as an integrated system, and focus on what can realistically be achieved in the area of energy efficiency.

One of the ACT² test sites is a PG&E office building, where several energy efficient measures were installed. These involved retrofitting the air distribution system, chilled water equipment, chiller unit, and lighting equipment, and installing an evaporative condenser and direct digital control (DDC) system. The savings estimates for the project are up to 75%. In order to realize such savings, a commissioning process was included as an integral part of the project.

*"Before installation began, the design firm prepared a detailed commissioning plan to ensure that the newly installed equipment would perform as designed. This plan was provided to installation contractors as part of the bid specifications. It describes the design intent for each energy efficiency measure (EEM) and all of the measurable aspects of EEM performance. It also details commissioning procedures, which include instrument calibration reporting, static tests, functional performance tests and recommissioning procedures."*²⁵

Commissioning Programs

Our research on current work in commissioning has yielded a list of relatively new programs around the country.

- ▶ Utilities and governments are developing programs that incorporate commissioning requirements and incentives as part of their Demand Side Management programs (**Fig.3.3**). They include guidelines, advice on Request For Qualifications (RFQs) for commissioning agents, and cash incentives.
- ▶ Pacific Gas & Electric's program offers 2% of a project's HVAC budget (up to a \$50,000 limit) for commissioning.
- ▶ The University of Washington is including commissioning in the workplan for all new construction (2 million square feet will be added to the campus over the next several years).

²⁵ *Facts on ACT²*, Issue 13, May-June 1993.

Sacramento Municipal Utility District, *New Construction Services*
New England Electric System, *Design 2000*
Pacific Power, *Energy FinAnswer*
Northeast Utilities, *Energy Conscious Construction*
Los Angeles Department of Water & Power, *Design Advantage*
Baltimore Gas & Electric, *Comprehensive Commercial Construction*
Pacific Gas & Electric, *Building Commissioning*
Bonneville Power Administration, *Energy Smart Design*
Potomac Electric, *Commissioning Pilot Program*

Figure 3.3 Utility commissioning programs

In order to determine if these models are applicable to San Francisco, it is necessary to identify the possible barriers to implementation. Money is usually the most prominent issue. The question that usually comes up early on is, "Who is going to pay for it?"

Different commissioning programs have used different approaches to funding. One option, used by Montgomery County, is to build commissioning into the initial funding for the project. The entity given responsibility for carrying out the commissioning varies from program to program. In some, the contractor hires and manages the commissioning agent, while in others the owner is in this role.

Results

Through our research, we learned that commissioning is an ongoing process that ideally begins at predesign and continues through occupancy. In the context of the timeline diagram (**Fig. 2.2**), commissioning is an action that affects several access points along the building timeline, and is therefore extremely valuable. Through this pilot project, we :

- ▶ gathered commissioning resources to offer to decisionmakers (see **Resource Toolbox**).
- ▶ attended a commissioning seminar, presented by Pacific Gas & Electric Company; we plan to offer a tailored version of this class to city staff.
- ▶ created a database of City construction managers to target for future action.

Because this pilot was research-oriented, the primary focus was on raising our own *awareness*. Plans for future action include:

- ▶ presenting construction project managers with information on the benefits of commissioning (using case studies, results of utility programs), with the goal of instituting a *policy* to include commissioning in future design and construction contracts.
- ▶ working to include a provision for a commissioning *budget* in a bond report, or initiating a commissioning incentive program through our municipal utility.
- ▶ continuing to familiarize ourselves with the steps and players involved in the construction stage so we may better *coordinate* with appropriate decisionmakers on these actions.

Implementation of a commissioning process is challenging because it requires decisionmakers to work together in new ways. We are continuing to look at what is being done around the country in terms of guidelines and utility incentive programs, and how best to incorporate commissioning into San Francisco's municipal building process.

Pilot Project # 4: MOTOR EFFICIENCY

Background

Influencing the choices of City staff who specify or purchase **replacement equipment** (Fig 2.2) is an important strategy towards affecting long term energy efficiency in City buildings. It is a key access point because at this time staff often make decisions that become templates for future decisions which may remain in place for a long time.

A list of decisionmaker's criteria related to a hardware purchase might look like this:

- ▶ Is it dependable?
- ▶ Is it cheap?
- ▶ Is it low maintenance?

The question, "is it energy efficient?" is not often asked. Thus, "is it cheap?" refers to lowest first cost rather than lowest lifecycle cost. Our goal is to introduce energy efficiency into the equation. City staff who buy replacement equipment may also make recommendations to design staff during **design team meetings**, and thereby affect multiple energy-related technology decisions. Many small decisions, such as inefficient motor specifications, can have the cumulative effect of large amounts of wasted energy.

A study by the American Council for an Energy-Efficient Economy (ACEEE) asserts that 9-23% of U.S. electricity could be saved by installing efficient electric motors and motor systems (their associated wiring, power conditioning equipment, controls, and transmission components)²⁶. An efficient electric motor can operate consistently at 90% efficiency. Variable frequency drives (VFDs), electronic devices that control a motor's speed, can replace older throttling and control technologies, and can save 15-40% of a motor's energy use. A heavily used motor can cost *ten times* its purchase price in electricity *each year*, yet efficient motors represent only 3% of existing motor stock due to market and institutional barriers. ACEEE identified the following common barriers to the use of efficient motors:

- ▶ "Payback gap": emphasis is placed on simple payback vs. lifecycle cost criteria.
- ▶ Lack of information: specifiers have inadequate technical and economic information on which to base decisions.
- ▶ Limited access to capital: decisionmakers may be convinced of the advantages, but lack the resources for the initial investment.
- ▶ Lack of institutional incentives: facility managers are not allowed to retain savings.
- ▶ Market structure: original equipment manufacturers (OEMs) have a disincentive to buy efficient motors.

²⁶ ACEEE/Western Area Power Administration(WAPA), *Energy Efficient Motor Systems: A Handbook on Technology, Program and Policy Opportunities*, 1991.

- ▶ Aversion to downtime and innovation: facility managers are wary of unfamiliar technology that might be unreliable.
- ▶ Repair shops compete on speed and price: motor repair shops may sacrifice quality in favor of reduced downtime and price.
- ▶ Standardized inventories: distributors often do not keep a full range of efficient motors in stock.
- ▶ Purchase decision criteria: purchasing staff are typically uninvolved and untrained in the energy-use consequences of their choices.

ACEEE's recommendations for overcoming these barriers include:

- ▶ Improved quality and availability of information from utilities, energy agencies, manufacturers, universities, and private organizations
- ▶ On-site technical assistance
- ▶ Improved engineering curricula
- ▶ More accurate labeling of equipment
- ▶ National minimum efficiency standards
- ▶ Testing programs
- ▶ Financial incentives and utility rebates
- ▶ Allowing individuals and departments to keep a share of their energy savings
- ▶ Promotion of new technologies through demonstrations and case studies
- ▶ Simplified energy analysis tools

In San Francisco, most equipment specifying and purchasing decisions are decentralized. In order to integrate efficient motors into City facilities, we needed to find the people who were making these decisions, and provide them with practical tools.

BEC had been working with the Water Department and a public hospital as part of our *Electricity Efficiency Program*. A component of this work is the specification of new equipment, including pump and fan motors. We saw an opportunity here for a pilot motor efficiency program.

Goals

Our goal was to raise awareness of City staff on current efficient motor technologies and to integrate these technologies into City facilities. The objectives for the pilot project were to:

- ▶ Distribute technical information
- ▶ Investigate incentives
- ▶ Facilitate training

Action

Our first task was to research and compile some appropriate resources to distribute to staff. Two such tools we found were the Washington State Energy Office *Motormaster* electric motor selection software, and the American Council for an Energy Efficient Economy *Energy Efficient Motor Systems Handbook*.

We previewed the motor selection software and, using San Francisco-specific inputs, checked for cost-effective applications. (A sample *Motormaster* printout is shown in Appendix G).

The handbook, a comprehensive treatment of the subject of motors, includes extensive information on efficiency, applications, economics, and physics of motors, as well as appendices listing resources such as manufacturers, modeling software distributors and trade organizations. (Appendix H lists some of these resources).

Next we met with City wastewater plant staff, to whom we distributed information on the software and copies of the handbook. We presented ideas for a pilot incentives program, including rebates for installing premium efficient motors. We described what resources we had available, and explained that our projects must meet certain cost-effectiveness criteria (such as lowering peak demand). The wastewater plant staff expressed interest in the program and agreed to gather specifications and usage data on motor replacement upgrade candidates at the plant.

In order to determine a target group for training efforts, we compiled a list of key City staff (eg. facility managers, stationary engineers, maintenance staff) who are involved in the specification, purchase, and maintenance of motors and VFDs.

We began planning workshops for these staff, to be presented in conjunction with Lawrence Berkeley Laboratory (LBL) and Pacific Gas & Electric Company's (PG&E) *Pacific Energy Center*. The workshops will include a walk-through of *Motormaster*, an overview of technical aspects of motor systems and applications, presentation of case studies, and a question/answer session.

Results

BEC has distributed practical tools to facility managers at the wastewater treatment plant and the hospital in conjunction with current retrofit projects going on there. We plan to distribute these resources to facility managers and specifiers in other City departments.

A \$100,000 capital fund has been earmarked for subsidizing incremental costs of premium efficiency motors. We are researching existing utility motor rebate programs, hopefully leading to our own program. City staff have expressed interest in the program and are particularly interested in the proposed rebate program. Some scheduling and administrative hurdles remain in putting on the workshops, but interest remains high and the workshops should be offered this year.

Pilot Project # 5: FACILITY CONDITION MONITORING PROGRAM

Background

The San Francisco *Facilities Condition Monitoring Program* (FCMP), inspects all City facilities for "deficiencies" in various categories. The program assesses these deficiencies, estimates costs required to correct them, enters this information into a central database, and contracts work according to a priority system as the budget allows. For small-scale needs, these jobs are contracted to in-house crews within the City's Department of Public Works. For large-scale needs, data is compiled for future consolidated capital requests.

FCMP is managed by the Department of Public Works (DPW)/Capital Resources Management office. The FCMP mission is to:

- ▶ inventory and assess the condition of the City's general fund supported buildings.
- ▶ identify current and potential "deficiencies" within city buildings.
- ▶ develop cost estimates to address these problems (over \$80 million in deficiencies have been identified to date.)
- ▶ assist in developing capital improvement plans to address facility repair and rehabilitation needs.²⁷

The FCMP influences three steps on the timeline: ***FCMP inspections, Small-scale retrofits***, and when ***Needs are identified*** (Fig. 2.2). It plays a dual role, assessing both current and potential problems in city facilities. The FCMP program identifies deficiencies deemed to be operations and maintenance-related. Current standard operating procedure entails replacing old equipment with a new piece of *inefficient* technology. By replacing this practice with a new procedure -- replacing old equipment with a new piece of *efficient* technology, -- energy efficiency will be cost-effectively incorporated into the existing process.

FCMP inspections are also used to identify long-term facility capital improvement needs. This information is often used to justify future bond measures. If energy issues are integrated into the FCMP database, then they will more likely be included in large-scale capital improvement requests. Our pilot project was an investigation of how to integrate energy efficiency into the FCMP.

Inspections are done by teams made up of representatives from DPW bureaus of Architecture, Engineering, and Building Repair (BOA, BOE and BBR).

During the inspections, the teams look for deficiencies under six "system groups":

- ▶ architecture
- ▶ building repair
- ▶ structural
- ▶ mechanical
- ▶ electrical
- ▶ specialized

²⁷ source: *Facilities Condition Monitoring Program (FCMP) report*, 1991

The *specialized* group includes asbestos, seismic, disabled access, high-rise fire protection and, energy conservation (BEC had previously worked with FCMP to include energy conservation as an element in the FCMP database). Specialized areas are not assessed by the team directly, but are contracted out as "special studies".

Reports are produced on a weekly and monthly basis to reflect the results of inspections entered into a database by the inspectors. These reports are available to departments (Appendix I).

Unfortunately, there have been insufficient FCMP staff resources to inspect for energy-related deficiencies. Thus, the energy conservation field in the FCMP database remains empty. There appear to be three levels of need: 1) to identify the energy deficiencies, 2) to do the special studies, and 3) to fund the incremental costs of energy efficient equipment. A number of options were considered for addressing these needs:

- ▶ Train current FCMP inspectors in energy assessment
- ▶ Hire a consultant to train inspectors and/or to do the special studies
- ▶ Create a FCMP or BEC staff position to do assessment
- ▶ Create a fund for subsidizing incremental equipment costs.

Obtaining funding for subsidizing incremental equipment costs has been relatively straightforward. An ongoing barrier to meeting the other needs is the difficulty of securing service-related resources (eg. training, auditing). Because of this, the FCMP has a bottleneck at the point of identifying energy efficiency measures. They must borrow engineers from other jobs to staff their inspection teams. Because of these constraints, the teams have limited time to complete their inspections.

Although we realized these problems were substantial and would take some time and effort to overcome, we saw great potential for strengthening both BEC and FCMP programs by working together.

Goals

- ▶ Work with the Capital Resources Management office to test integrate energy efficiency into a portion of the FCMP.
- ▶ Further investigate how we might incorporate energy efficiency into the existing FCMP mission.

Action

The pilot project comprised inspection team technical support and funding for incremental equipment costs on small-scale lighting repairs. The focus was on supporting inspectors by providing practical guidelines, and then providing funding to subsidize the incremental costs of the efficient equipment.

Through interviewing three members of the FCMP team -- the program manager, an

electrical inspector, and a Bureau of Building Repair (BBR) representative -- we gained insights into their needs and concerns. The program manager was interested in getting training to his inspectors, but was concerned about the additional time required for energy-related tasks. The electrical inspector was concerned that the incremental equipment funding levels might not be sufficient. The BBR representative expressed interest in sharing information between our agencies through coordinating our databases, and believed it was a good time for this cooperation, because a new cycle of inspections was about to begin. BEC prepared sets of support materials for the FCMP team including:

- ▶ a 1 page "cookbook" guideline for simple one-to-one lighting retrofits.
- ▶ sample specifications and cut sheets
- ▶ a copy of the *Energy Efficient Design Practices* guidebook.

(See Appendix I for examples).

We presented a proposal to the FCMP team along with support materials for their review. The idea was to alter the current practice of requiring "like with like" equipment replacement specifications. Our goal was to expand the definition of "like" equipment to include "like function". This would, for example, allow for the installation of LED exit signs instead of less efficient incandescent signs.

Results

- ▶ BEC has provided specifications and support materials for inspectors. In addition, FCMP inspectors will be included in upcoming rounds of BEC's *Energy Efficient Design Practices* workshops (see pilot project #2 for discussion of these workshops).
- ▶ An initial fund of \$50,000 was set aside for subsidizing incremental equipment costs. This fund will be managed by FCMP, and used according to mutually agreed upon guidelines.
- ▶ The proposal to substitute efficient equipment specifications was well received, and the program manager has agreed to direct inspectors to specify energy efficient equipment for all future identified small scale lighting deficiencies.

The work the BEC is doing in coordination with the FCMP is a good example of how intervening at key access points increases the cost-effectiveness of energy efficiency work. By providing supporting information and funding, the BEC is convincing the auditors and installers to substitute efficient alternatives when replacing non-functional equipment (instead of the current practice of installing identical inefficient equipment).

Estimated Savings

By affecting the steady stream of small repairs of broken equipment, we estimate we can access about 200 fixture repairs and lamp replacements each month. Replacing these fixtures with newer efficient models is extremely cost-effective (paybacks average 2 years) since the only cost is the incremental expense of this newer equipment, typically \$15 to \$30 per fixture. These 200 fixtures per month amount to an annual expense of roughly \$48,000 each year to achieve an estimated lifetime savings of \$264,000.

Future Work

BEC and FCMP are discussing plans for future cooperation including the following:

- ▶ BEC supplies FCMP with information from our existing energy audits, and usage data from our municipal energy usage database.
- ▶ FCMP supplies BEC with reports of their existing information such as square footage and previously identified energy-related deficiencies (eg. HVAC, lighting).
- ▶ Facilitate information exchange by creating a common building numbering system to coordinate databases.
- ▶ Review options for funding and staffing energy special studies.

CHAPTER 4: CONCLUSION

Chapter 4 describes the results of the *Intervention Strategies* project.

- **Findings and Lessons Learned (section 4.1)** presents our insights gained, and intervention strategies conceived, including locating access points and designing and delivering energy actions to influence energy efficiency;
- **Evaluation and Plans for Future Action (section 4.2)**; presents our pilot project results and savings estimates, and plans for future work.

4.1 FINDINGS AND LESSONS LEARNED

At the outset of the *Intervention Strategies* project, we believed that gaps in our understanding of the steps and players involved in energy-related aspects of funding, design, construction, and maintenance of city buildings contribute to the problems of lost energy efficiency opportunities and incomplete energy efficiency actions.

Through first analyzing these processes and then undertaking pilot project work, we confirmed our belief that only by looking at energy efficiency within the context of the building lifetime could we make lasting change. By using the framework of the building lifetime, we described how the San Francisco municipal building process can be influenced through focussing actions on decisionmakers at key access points (**Fig. 2.2**).

We are convinced that the best way to move towards incorporating energy efficiency into the standard practices of city staff is to examine the entire building lifetime in order to learn where and how to most effectively intervene. With this improved awareness of the overall process, we are designing more effective programs that provide more useful and timely energy efficiency services to city staff.

Over the course of the project, we discovered new opportunities to influence energy-related decisions by finding city staff involved in these decisions and learning what support they needed. By providing customized support to staff -- like tailored language for inclusion in a bond report -- we laid the groundwork for influencing city decisionmakers to make energy efficiency a component of their work.

Partially as a result of the *Intervention Strategies* work, city staff are now calling us to ask for design advice, to inform us of upcoming projects, and to invite us to participate in current projects.

Intervention Strategies

The strategies BEC conceived for finding and taking advantage of energy efficiency opportunities fall into three categories: locating *access points*, i.e. selected steps along the lifetime where there are opportunities for effective intervention; designing energy *actions*, i.e. initiatives to incorporate energy efficiency into the process at these access points; and then delivering these actions effectively.

Access points

In identifying opportunities for improved energy efficiency, we asked ourselves which of the steps in the San Francisco municipal building lifetime involved decisions that would likely affect longterm energy use, and which presented possible opportunities for integrating energy efficiency. *Access points* (see section 2.3 for more detail) are steps we found which present key opportunities for influencing energy-related decisions. It is at these access points that key decisions affecting the current or future energy use of city buildings are made.

Below is a list of the possible relationships an energy office may have to these access points and corresponding recommended strategies:

Energy office relationship to access point	Strategy
1. None-not aware of access point.	Study the process; identify key access points and associated decisionmakers.
2. Aware of access point, but insufficient resources to pursue.	Prioritize and target most important ones.
3. Aware of access point, has designed actions to address it.	Implement actions as resources allow.
4. Has implemented action at an access point, but results are incomplete.	Look for opportunities to "get in the loop" to ensure completion.
5. Has successfully implemented actions.	Evaluate why successful , try to duplicate.

Figure 4.1 Strategies for Access Points

Action design

Our goal was to design actions which would motivate and equip decisionmakers to incorporate energy efficiency into their standard operating procedures; to make energy efficient practices the path of least resistance. A key component of the project was formulating *actions* to address identified energy efficiency opportunities. In order for an

action to be successful, we found it must have certain attributes. A well-designed action should be both *relevant* and *balanced*.

The action should be relevant in that it should be customized for the target audience in order to address their specific needs. Tools should be tailored to the user (eg. consulting prospective students when designing workshops and guidelines). We learned that city decisionmakers need support in certain forms in order for it to be useful to them. For example, bond report writers wanted general language for the bond report, and specific background information like cost estimates to support it.

An energy efficiency action should be balanced among each of four approaches -- awareness, policy, budget, and coordination--in order to be successful. A balanced project provides information, support from management, funding, and coordinated planning (see section 1.2 for further discussion).

For example, we wanted electrical engineers to specify an efficient T8/electronic ballast instead of the standard T12/magnetic ballast they normally would. Specifying the standard equipment is the path of least resistance, the easiest thing for them to do. It is cheaper, they have already got the part numbers in front of them, and it is a proven technology. They have no reason to change their standard practices. If we expect them to change their practices, we need to make specifying energy efficient technologies the path of least resistance. We must not only provide them with an alternative equipment specification, but we must also convince them it is a better choice through training, provide economic incentives through subsidizing incremental costs, and direct them to do it through administrative policy or legislation. If we are able to put all of these components in place, energy efficient practices will be sustained.

We learned that taking such a broad approach does indeed strengthen our efforts. Because of the support solicited from upper level managers and funding provided for incremental equipment costs, the *Energy Efficient Design Practices* workshops enjoyed good attendance and a high level of interest.

By providing tools that specifically addressed staff's needs (like energy efficient motor specifications and lighting design guidelines), and by using a holistic approach in designing those actions (balanced between policy, budget, and awareness-related aspects of a given problem), we were able to foster staff buy-in. This approach is helping move staff towards independent energy efficient practices.

Action delivery

In delivering energy services the action must be provided in the right place in the organizational structure and at the right time in the building process.

We saw that it was necessary to take both top down and bottom up approaches to targeting our efforts. In a top down approach, information is provided to upper level policymakers, such as department heads or managers, showing the fiscal advantages of energy efficiency (eg. through lifecycle cost analysis). Because we are operating in a hierarchy, a top down approach has a trickle down effect and there are fewer people to convince. In terms of cost-effectiveness, we've learned the earlier in the process, the better.

In a bottom up approach, we target the facility O&M staff; the people with their hands on the equipment; the people who make things work. Their actions directly affect energy use in City facilities. Supplying them with appropriate training and tools will go a long way towards affecting the efficiency of City buildings. Soliciting staff's opinions and advice, and learning from their practical experience as we design programs makes these programs more effective.

An action should also be introduced at the appropriate time in order to influence the right people. Some opportunities for introducing energy efficiency are ongoing while others may be time-critical. Training in lifecycle cost analysis or energy efficient maintenance practices, for example, can be applied ongoingly. Writing commissioning into a design contract or including energy efficiency in the scope of a bond report, on the other hand, are time-critical actions.

Lessons Learned

Through our experience researching the building lifetime and implementing pilot projects, we developed the following general advice for successful programs:

- ▶ Minimize reaction time: put mechanisms in place (such as easily accessible funding sources) in order to deliver the service quickly as the need arises. Make sure resources are in place before making commitments.
- ▶ Be proactive rather than just reactive: propose efficiency projects at facilities where there may be no planned work. If there is planned work, try to adjust timing so that efforts coincide, resulting in a more cost-effective project.
- ▶ Be aware of potential institutional barriers: even a well-designed action will inevitably encounter barriers to implementation (for suggestions, see *Energy Management Action Plan; Developing a Strategy for Overcoming Institutional Barriers to Municipal Energy Conservation*. Urban Consortium/Energy Task Force, 1992).
- ▶ Research scheduling of upcoming design and renovation projects for possible coordination. Get involved in discussions with decisionmakers as early as possible.
- ▶ Research what is being done in the field. Learn from other government agencies and utilities who have implemented similar programs. Facilitate connections between energy efficiency experts and facility staff.
- ▶ Look for opportunities to foster buy-in eg. selling energy efficiency in terms of existing priorities such as a department's need to lower annual operating costs.
- ▶ Make training convenient.
- ▶ Bring designers together with operations and maintenance staff to discuss issues. Interview staff in their working environment to get a picture of what their jobs are like.
- ▶ Preview tools for applicability before distributing to staff.

4.2 EVALUATION AND PLANS FOR FUTURE ACTION

Our objectives for the *Intervention Strategies* project were the following:

- 1) **Describe the lifetime of a San Francisco municipal building.**
- 2) **Implement actions to influence energy decisions through pilot projects.**
- 3) **Create a toolbox of useful resources for energy offices.**

Below is a discussion of the results of our work on each objective.

1) **Describe the lifetime of a San Francisco municipal building.**

By researching the process and developing and filling in a conceptual model of a building's lifetime, we found avenues for influencing energy decisions at certain access points. Developing and using the *San Francisco Building Lifetime Diagram (Fig.2.2)* to look at the problem of incorporating energy efficiency into our municipal buildings has informed our program development efforts by showing us where and when in the process to best allocate our resources.

By selecting some of these access points and delving further into them, we discovered some of the particular needs of city staff involved in duties that affect the current and future energy use of city buildings. For instance, we are now more aware of designer's needs for specifying lighting equipment.

2) **Implement actions to influence energy decisions through pilot projects.**

We chose five pilot projects that were representative of a cross-section of the overall building lifetime, and that presented opportunities to influence decisions on specific work in progress. Our goal for the pilots was to begin to integrate energy efficiency into standard practice by first raising awareness of city staff about energy efficiency, and then promoting self-reliance of staff by providing technical, financial, and policy support. Below are brief summaries of these pilot projects (see Chapter 3 for detailed discussion of the pilot projects).

Bond guidelines

Bond report team selection is an early (and thus key) access point in the building lifetime. If energy efficiency is explicitly stated as a priority in the bond report, it will more likely remain a priority throughout design and construction.

Through this pilot, BEC developed a model for a citywide bond guideline. We based this model on the stated needs of bond-writers and thereby were able to gain buy-in from key departmental and Bureau of Architecture personnel on the Laguna Honda Hospital bond-writing team. We drafted bond report language establishing energy efficiency as an explicit goal within the bond project's scope. If these recommendations are adopted and carried through successfully, the initiative could save \$10 million over the facility's lifetime.

Energy Efficient Design Practices (EEDP)

An important access point for influencing energy decisions is when *design teams are chosen*. If designers are convinced of the advantages of energy efficient design, and provided with design tools and incentives to facilitate it, then they will be more likely to consistently incorporate energy efficiency into their designs. Incorporating energy efficiency at the design stage is "doing it right the first time". This is more cost-effective than retrofitting later.

This pilot resulted in the *Energy Efficient Design Practices for San Francisco Municipal Facilities* guidebook, presentation of workshops, and adoption of the guidelines for several upcoming projects. Including facility managers and maintainers in classes with designers encouraged dialogue and helped foster buy-in of the technologies. Estimated lifetime savings from the energy efficient lighting design practices workshops is \$2 million.

Commissioning

Client department approval is a key access point for introducing commissioning into the municipal building process. Commissioning bridges the design, construction and O&M stages. The effect of commissioning on the building lifetime is the realization of design intent through verification and testing of systems after installation. Including requirements for O&M support is also a good investment in insuring long-term energy savings.

Through this pilot project, we researched guidelines and utility incentive programs in order to present project managers with information on the benefits of commissioning. We attended a commissioning seminar, and created a database of city construction managers to target for future action. Savings estimates for commissioning one 100,000 square foot building are about \$2 per square foot, or \$200,000 in lifetime avoided costs.

Motor efficiency

Influencing the choices of City staff who specify or purchase *replacement equipment* is an important strategy towards affecting long term energy efficiency in City buildings. It is a key access point because at this time staff make decisions that often become templates for future decisions which may remain in place for a long time. The goal is to introduce energy efficiency and lifecycle cost into the equation.

Through the motor efficiency pilot, BEC distributed motor specification software and a motor efficiency handbook to facility managers in city departments in conjunction with retrofit projects currently underway. A \$100,000 capital fund has been earmarked for subsidizing incremental costs of premium efficiency motors. The installation of 50 motors @ 75 horsepower would yield an estimated lifetime savings of \$350,000.

Facilities Condition Monitoring Program (FCMP)

The FCMP affects several steps on the timeline, but we concentrated on the *small-scale retrofits* access point. If we can change the current procedure of replacing old equipment with a new piece of inefficient technology to a new procedure where we replace old

equipment with a new piece of efficient technology, then energy efficiency will be cost effectively incorporated into the existing process.

Through this pilot, BEC provided specifications and support materials for FCMP inspectors, set aside a \$50,000 fund for subsidizing incremental equipment costs, and got agreement from the program manager to direct inspectors to specify energy efficient equipment for all future small-scale lighting repairs. Estimated lifetime savings for this measure are \$250,000.

3) Create a toolbox of useful resources

The *Resource Toolbox* is a compilation of practical guidelines, reports, software, and information resources that can be used by energy managers, designers and facility managers to help incorporate energy efficiency into their projects.

The *Toolbox* provides access to selected tools that BEC found useful over the course of the *Intervention Strategies* project, and presents sources of additional tools.

Plans for Future Action

BEC plans to continue and expand the pilot project work begun this year. This work includes:

- ▶ continuing support of the Laguna Honda Hospital bond proposal, developing general guidelines for including energy efficiency in future bonds, and providing lifecycle cost analysis training for city staff.
- ▶ developing an HVAC component for the *Energy Efficient Design Practices for San Francisco Municipal Facilities* guidebook and workshops, and facilitating Title 24 training and other technical training for Department of Public Works design staff.
- ▶ participating in the commissioning process of a current construction project, facilitating training, and developing commissioning guidelines for San Francisco leading to a policy to include commissioning in all future design and construction contracts.
- ▶ developing a motor rebate program, technical training for city facility managers and purchasers, and further distribution of software and reference tools to city staff.
- ▶ managing energy audits triggered by FCMP inspections; training electrical and mechanical inspectors to identify energy-related deficiencies; and integrating the FCMP and BEC databases.

We are also planning a training program to serve the broad cross-section of City staff in need of information on technical specifications for energy efficient HVAC and lighting equipment, lifecycle cost analysis, and Title 24 energy codes. Resources and training on these subjects is available through utility DSM programs, professional associations and other government programs, but often not accessible because of budget or administrative constraints.

BEC is setting up a fund to help subsidize city staff to attend energy-related classes. This fund is being created in order to provide training opportunities for architects, maintenance staff, plan checkers and purchasers as well as engineers. The fund will be administered centrally from the Personnel section of the Department of Public Works so that any staff member from the DPW Bureau's of Architecture, Engineering, Building Inspection, or Building Repair may have access to these training opportunities. The program will provide outreach to targeted staff in the form of announcements and class descriptions as well as payment of class fees. Additional outreach will be provided by continuation of our *Energy News* newsletter (see Appendix J).

We intend to implement more actions as resources allow. Below is a list of potential Bureau of Energy Conservation actions, organized chronologically by access point (Fig. 4.2). This list will serve as a "menu" from which to choose projects.

<u>Bond report team selection</u> Provide lifecycle cost classes Provide Bond guidelines Review bond report Provide Cost estimate of energy-related measures	<u>Contractor Submittals</u> Track energy efficiency measures funded by energy office Advise construction managers on equipment substitutions, review alternate specifications
<u>Project Management agency is chosen</u> Write commissioning into design contract	<u>Building Start up</u> Liaison with commissioning agent on oversight of energy elements testing and balancing Provide training for O&M staff on installed systems, verify manuals, documentation in place Monitor end-use
<u>Design Teams are selected</u> Advise and assist design team Fund incremental equipment costs Provide energy efficient design practices classes Provide efficient technologies training (eg. lighting, HVAC, motors) Provide Title 24 (California state energy code) training for designers	<u>Replacement equipment</u> Provide efficient technologies training (eg. lighting, HVAC, motors) Provide lifecycle cost training Offer rebates on efficient equipment Streamline purchasing of efficient equipment
<u>Construction Documents/Plancheck</u> Provide Title24(California state energy code) training for building inspectors	<u>FCMP Inspections</u> Fund energy specialist on inspection team Provide training, technical support for inspection team Fund incremental equipment costs
<u>Client Department Approval</u> Lobby to keep energy efficiency measures in project	

Figure 4.2 Potential Actions

Overall, the *Intervention Strategies* project was successful in achieving its objectives. We researched and described the process, initiated efforts to influence it, and compiled practical resources to share with others. Examining the problem of energy efficiency in buildings within the context of the building lifetime has allowed us to better target our efforts towards the goal of integrating energy efficiency into standard practices of city staff.

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Vine, Edward and Crawley, Drury, ed., *State of the Art of Energy Efficiency - Future Directions*, American Council for an Energy Efficient Economy, 1991.

RESOURCE TOOLBOX

The **Resource Toolbox** is a compilation of "tools"; guidelines, reports, software, and information resources that can be used by energy managers, designers and facility managers incorporating energy efficiency into their projects.

This compilation is by no means exhaustive. Its purpose is to aid access to selected tools available to energy offices that the Bureau of Energy Conservation (BEC) found useful over the course of the *Intervention Strategies* project, and to present sources of additional tools.

The **Resource Toolbox** is divided into two sections:

Section 1: *Selected Tools* is an annotated list of specific "tools" (such as design guidelines) discovered or developed during the *Intervention Strategies* project. This section is divided into two subsections: A) published tools developed by government agencies and trade organizations, and B) unpublished tools developed by BEC for internal use. The entries are organized by building stage (eg. DESIGN). Each entry gives a brief description of the tool and how to obtain it.

Section 2: *Distributors* is a list of tool *sources* (such as federal laboratories). The entries are organized alphabetically. Each entry gives a description of the range of services and publications available, and how to obtain them.

Section 1: *Selected Tools*

A) *Published Tools*

FUNDING

Financing Options for Energy Efficiency Projects in Public Agencies

This report investigates financing options available to local public agencies interested in pursuing energy efficiency projects and provides information and guidance in securing low-cost project financing. It includes: a discussion of financing and project factors that affect the costs and terms of project financing; descriptions of different financing mechanisms available and their requirements and terms, questions decisionmakers must answer to determine the most appropriate course of action, and identification of barriers to obtaining financing and suggestions on how to eliminate or avoid them. [1992, 30 pages].

Source: California Energy Commission (CEC)

1516 Ninth Street
Sacramento, CA 95814-5512
☎ (916) 324-3000

Contact: Daryl Mills (916) 654-5070

NIST Lifecycle Cost Classes

The U.S. General Services Administration and Department of Energy have developed this training program to provide a formal standardized methodology for lifecycle costing that can be applied throughout the public and private marketplace. The companion videos, *Introduction to Life-Cycle Costing*, *Uncertainty and Risk*, and *Choosing Economic Evaluation Methods*, cover the fundamentals for applying the life-cycle cost method to decisions affecting the energy consumption of buildings. [1990, videos, 60, 36, and 35 minutes]

Source: National Institute of Standards and Technology
Office of Applied Economics
Computing and Applied Mathematics Laboratory
Building 226, Room B226
Gaithersburg, MD. 20889
☎ (301) 975-6132

Contact: Harold E. Marshall (301) 975-6131

DESIGN

Advanced Lighting Guidelines

Detailed sourcebook of energy efficient lighting technologies. This comprehensive reference provides descriptive information on the latest lighting technologies and offers advice on how to apply that information in lighting design practice. Separate guidelines address lighting design practice, luminaires and lighting systems, energy - efficient fluorescent ballasts, full-size fluorescent lamps, compact fluorescent lamps, tungsten-halogen lamps, metal halide and high-pressure sodium lamps, daylighting and lumen maintenance, occupant sensors, time scheduling systems, and retrofit control technologies. For each technology, a description of the product or strategy under consideration is provided, along with suggested applications and specifications. [1993, 197 pages]

Source: California Energy Commission
1516 Ninth Street
Sacramento, CA 95814-5512
Publications MS-13
☎(800) 772-3300 or (916) 324-3000

Energy Efficient Building Design: Guidelines for Local Government

This 1989 Energy Task Force project focused on implementing a local ordinance calling for energy efficiency in new municipal facilities. The project used the following strategies for influencing building design: Energy Budgets (BTU per square foot); Life Cycle Cost Analysis of major building systems; reference to voluntary Public Standards; Building Energy Codes; and Standard Equipment Specifications. A binder titled *Energy Design Guidelines for Local Government Buildings* accompanies the final report. This document provides a very complete design guideline, including sections on energy analysis, thermal envelope, lighting, HVAC, and more. [1989, report, 125 pages, binder, 44 pages plus appendices]

Source: Montgomery County Department of Facilities and Services
Capital Projects Management Division
110 North Washington Street, 3rd Floor
Rockville, Maryland 20855

Contacts: Ron Balon, Paul Tseng ☎(301) 217-6091

General Energy Efficiency Guidelines for the Design of New Hospitals

Energy efficiency design guidelines for hospitals based on staff's experience of providing design assistance to several new and remodeled public hospital projects. Although not intended as an exhaustive list, the guidelines offer recommendations for building envelope, lighting, HVAC, and service hot water systems in hospitals. [1993, 6 pages]

Source: California Energy Commission
1516 Ninth Street MS#26
Sacramento, CA 95814-5512

Contact: Bruce Cenicerros ☎(916) 653-1590

CONSTRUCTION

Montgomery County Commissioning Program, Guidelines and Specifications

Description of participants in the commissioning process and their responsibilities, sample commissioning statements for mechanical and electrical specifications. Design narratives. O&M instruction manual parameters. [1991, 133 pages]

Source: Montgomery County Department of Facilities and Services
Capital Projects Management Division
110 North Washington Street, 3rd floor
Rockville, Maryland 20855

Contact: Ron Ballon ☎ (301) 217-6091

Building Commissioning Guidelines

Discussion of goals, integrating commissioning into building projects, roles of team members, the commissioning process(pre-design through occupancy), the commissioning plan, (scope, scheduling, testing, monitoring, training), test plans. Includes sample commissioning specification, commissioning agent qualifications, O&M manual criteria, and design intent documentation. [1992, 141 pages]

Source: Bonneville Power Administration
P.O. Box 3621
Portland, Oregon 97208-3621
publication # DOE/BP-1574

Contact: Corinn Castro Boyko ☎(503) 230-5870, (800) 622-4520

National Conference on Building Commissioning, Summary Report

Reports on an April 1993 meeting in Sacramento, CA. of utilities, researchers, trade organizations and engineering firms involved in the field of building commissioning. Discusses current issues such as standards and guidelines, roles and responsibilities of the commissioning agent, and who should pay for commissioning. Session topics include costs and savings/benefits of commissioning; retrofits, recommissioning and operations and maintenance; and utility commissioning programs. [1993, 48 pages.]

Source: Portland Energy Conservation Incorporated (PECI)
921 SW Washington, Suite 840
Portland, Oregon 97205

Contact: Debbie Dodds ☎(503) 248-4636

OPERATIONS & MAINTENANCE

Motormaster Software/Guideline

Software tool and accompanying guideline for evaluating and specifying premium efficient motors. Includes database of standard, efficient, and premium efficient motors by various manufacturers. Database of several utility rebate programs and their requirements. [1993, diskette]

Source: Washington State Energy Office
P.O. Box 43165
Olympia, WA. 98504

Contact: Billie Quinn-Russell ☎(206) 956-2215, (206) 956-2057

Energy Efficient Motor Systems: A Handbook on Technology, Program and Policy Opportunities

Covers motor technologies, systems, controls, applications, motor population and use, national savings potential, the motor market, motor efficiency programs, and policy recommendations. Appendix on economics, manufacturers and software suppliers lists. [1991, 300 pages]

Source: American Council for an Energy-Efficient Economy (ACEEE)
2140 Shattuck Avenue, Suite 202
Berkeley, CA 94704

Contact: Fawn Smiley ☎(510) 549-9914

Variable Frequency Drives, Saving Energy!

Shows how to use VFDs to use less energy on systems that are subject to fluctuating demand; lower maintenance and repair costs of motors, pumps and fans; allow for precise speed control, and reduce noise. Case studies, interviews with design and facility engineers. [1992, video, 16 minutes, VHS]

Source: Urban Consortium, Energy Task Force
Public Technology Incorporated (PTI)
1301 Pennsylvania Ave., NW
Washington, DC 20004-1793

☎ (202) 626-2400, (800) 852-4934, FAX (202) 626-2498

Section 1: Selected Tools

B) BEC Tools

The tools listed in this section were designed primarily for the Bureau of Energy Conservation's internal use. They generally have minimal documentation and in some cases they contain San Francisco-specific information. We believe, however, that these items may be useful and would like to share them with other energy offices. We welcome feedback on how we may improve these tools.

All of the resources listed in this section are available from:

**Hetch Hetchy Water and Power
Bureau of Energy Conservation
1155 Market Street , 4th floor
San Francisco, CA 94103**

(415) 554-3180 (Specific contact people are listed at the end of each entry).

FUNDING

Bond Report Language Proposal

Draft language and background information for incorporating an energy efficiency commitment into a municipal construction project proposal. Includes supporting arguments for each energy efficiency provision in the proposed bond report language. Example is a one million square foot public hospital. [1993, 6 pages]

Contact: Terry O'Sullivan (415) 554-3184

DESIGN

Energy Efficient Design Practices for San Francisco Municipal Facilities

Guideline for lighting designers, architects and electrical engineers, outlining several energy-efficient lighting technologies and design practices. Describes how to incorporate electronic ballasts and T8 lamps, compact fluorescent lamps and fixtures, occupancy sensors, LED exit signs, high-pressure sodium and metal halide outdoor lighting, task/ambient lighting, appropriate IES light levels, lumen-efficient fixtures. Includes appropriate applications, sample specifications, cost-effectiveness calculations, and California Title 24 code requirements. [1992, 150 pages]

Contact: Terry O'Sullivan (415) 554-3184

Energy Efficient Design Guidance for San Francisco Fire Stations

An energy efficient design checklist; lighting, HVAC and building envelope design recommendations; and a case study for applying energy efficient design principles to San Francisco fire stations. BEC staff provide these design guidelines to architects and engineers for all new and remodeled fire stations. The guide addresses some of the unique characteristics of this municipal building type, which includes both residential and commercial elements. The guideline builds on design assistance experience with several fire stations undergoing complete seismic renovations. [1992, 43 pages + appendices]

Contact: Terry O'Sullivan, (415) 554-3184

Quick Interior Lighting Calculation Spreadsheet

One-page worksheet and accompanying computer spreadsheet for calculating uniform light levels in standard rectangular rooms. This tool boils down approximately 30 pages from the Illuminating Engineers Society's Lighting Handbook to a basic cookbook methodology. The tool helps designers and reviewers calculate what light levels would result from a proposed lighting design. [1993, 1 page plus diskette, written in QuattroPro for DOS, v.4.0. Requires basic familiarity with spreadsheets]

Contact: Terry O'Sullivan, (415) 554-3184

An Energy Plan for Mission Bay

As part of an Urban Consortium Energy Task Force project, the Bureau of Energy Conservation worked with the San Francisco Department of City Planning to prepare recommendations for the design and construction of an energy efficient community at the Mission Bay redevelopment area in San Francisco. The project developed and tested a methodology for establishing appropriate energy efficiency design measures for new high density urban communities.

The Energy Plan contains 18 energy planning design recommendations developed specifically for use at Mission Bay and based on California's Title 24 energy code. These recommendations include efficient equipment, energy management systems, solar design, recycling, and building system operation and maintenance. [1988, revised 1992, 139 pages]

Contact: Christine Vance (415) 554-3185

OPERATIONS & MAINTENANCE

FCMP Lighting Retrofit Guideline

Simple reference sheet for small-scale lighting equipment retrofits developed for facility inspectors unfamiliar with efficient lighting technologies. A simple "cookbook" approach for straightforward, one-to-one equipment replacement. [1993, 1 page]

Contact: Danielle Dowers (415) 554-3183

Liteval Spreadsheet

Spreadsheet for assessing cost-effectiveness of lighting retrofit projects. Inputs include existing and proposed equipment, hours of use, labor rates, energy and demand rates. Outputs include annual and lifetime savings for energy and maintenance, simple payback, and benefit-to-cost ratio. Includes a "lookup table" of existing and proposed retrofit equipment. [1992, diskette, written in QuattroPro for Windows, v.5.0]

Contact: Danielle Dowers (415) 554-3183

Boiler Improvement Guidebook

This guidebook describes over 20 energy conservation measures for boilers in the areas of combustion efficiency, thermal efficiency/heat transfer, reduction of standby losses, systems controls, load matching, and end-use and distribution losses. [1992, 33 pages]

Contact: Christine Vance (415) 554-3185

Facilities Condition Monitoring Program Description

This summary report provides a comprehensive introduction to the foundation of San Francisco's Facilities Condition Monitoring Program. It is written to inform policymakers, administrators, and technical persons (architects, engineers and building maintenance specialists) about the philosophy, strategy, ideas, and concepts that have gone in to building this program.

The basic premise of the program is that decisions about infrastructure planning and budgeting should be based on systematic physical inspections of the city's capital assets rather than guesswork. [1991, 15 pages]

Contact: Danielle Dowers (415) 554-3183

Energy Management Action Plan (EMAP) Strategy Guide

As part of an Urban Consortium Energy Task Force project, the Bureau of Energy Conservation developed this planning tool with which energy offices can develop programs to address institutional barriers to energy conservation in municipal facilities. Each jurisdiction can adapt the scope and approach of this generic process to suit their own situation. The Guide describes specific tasks and goals, gives tips from the BEC's experience, and provides examples of the BEC's work. [1992, 30 pages]

Contact: Danielle Dowers (415) 554-3183

Section 2: *Distributors*

This section of the **Resource Toolbox** contains listings of sources of information on building energy efficiency, such as government and trade organizations. The list is organized alphabetically. Each entry gives a description of the organization, the range of services and publications available, and how to find them.

American Council for an Energy-Efficient Economy (ACEEE)

1001 Connecticut Avenue N. W. Suite 801
Washington, D. C. 20036
☎ (202) 429-8873

A non-profit organization, the American Council for an Energy-Efficient Economy collects, evaluates and distributes information to stimulate greater energy efficiency and to make such information available to all interested groups. The ACEEE conducts studies, publishes topical, timely books and reports, provides expert testimony and sponsors conferences to facilitate the exchange of information between individuals working on new energy efficiency techniques and those who can put new ideas to work.

Examples of recent publications include: *ACEEE Summer Study of Energy Efficient Buildings, Industrial Demand-Side Management Programs: What's Happened, What Works, What's Needed; Emerging Technologies to Improve Energy Efficiency in the Residential and Commercial Sectors; Regulatory Incentives for Demand-Side Management; Energy Efficient Motor Systems: A Handbook on Technology, Program and Policy Opportunities.*

❖ To obtain a list of publications or to purchase a report, contact:

American Council for an Energy-Efficient Economy (ACEEE)
2140 Shattuck Avenue, Suite 202
Berkeley, CA 94704
Fawn Smiley ☎(510) 549-9914

Association of Energy Engineers (AEE)

4025 Pleasantdale Road, Suite 420
Atlanta, Georgia 30340-4278
☎ (404) 447-5083

The Association of Energy Engineers, consisting of more than 8,000 individual members and some 42 local chapters, is the largest association in the country designed specifically for professionals in the energy and environmental fields. The Association provides numerous benefits for its members, including energy certification programs (e.g. Certified Energy Manager Program, Certified Lighting Efficiency Professional); continuing education programs; publications; annual conventions; professional awards

and scholarships.

Members receive subscriptions to *Energy Engineering*, *Strategic Planning for Energy and the Environment*, *AEE Energy Insight*, and *Energy User News*. The AEE also provides such specialized divisions as The Cogeneration and Competitive Power Institute and The Environmental Engineers and Managers Institute (EEMI).

The American Institute of Architects

1735 New York Avenue, NW
Washington, D. C. 20006
☎ (202) 626-7427

The AIA is the largest organization of architects in the world. It is dedicated to providing architects and other design professionals with information they need to practice their profession. The AIA is committed to encouraging stronger public advocacy for quality design and to increasing public awareness of the value of architects in improving the quality of life. The AIA publishes a variety of books, literature, reference manuals, videotapes and software applications for the benefit of architects, designers and interested groups. These publications include: *The AIA Energy Design Handbook*, *Designing Healthy Buildings*, *Design and the Environment*, and *Energy, Environment, and Architecture*.

❖ For a free copy of the AIA catalog, *AIA Press*, call (800) 365-2724.

American Public Power Association (APPA)

2301 M Street, Northwest
Washington, D. C. 20037-1484
☎ (202) 467-2900

The American Public Power Association is a national organization representing 1,750 publicly owned electric utilities. APPA provides a range of information resources and free services to member utilities and their consumers including an Energy Services Database; Information Services; Library and Information Center; Energy-Efficient Lighting Packet; Demand-Side Management Information Services and Database; Utility Education Courses; and a Publications Catalog. The Energy Services Database is a free service containing information on more than 3,000 public power energy services programs.

Publications: weekly newsletter, bimonthly magazine, and *Electric Utility Guide to Marketing Efficient Lighting*

❖ For information on publications and other services, contact Sonia Serrano (202) 467-2926.

❖ To access the Information Services Hotline and Database, call (202) 467-2957.

***American Society of Heating, Refrigerating and Air-Conditioning Engineers
(ASHRAE)***

1791 Tullie Circle Northeast
Atlanta, GA 30329
☎ (404) 636-8400

ASHRAE is a technical society of heating, ventilation, refrigeration, and air conditioning engineers. ASHRAE, in conjunction with the Illuminating Engineering Society (IES) has developed standards for energy efficiency in new and existing buildings. These standards have been the basis for most energy codes and regulations in the United States. The organization sponsors numerous research programs on such subjects as environmental studies, air conditioning, air quality, heat transfer, flow and cooling processes. ASHRAE's research and technical programs are handled through ninety technical committees organized in eleven sections.

- ❖ For information on ASHRAE publications, resources, committees, call (404) 636-8400.
- ❖ For technical inquiries on appliances, buildings and standards, ask for Randy Ward.

Bonneville Power Administration (BPA)

905 NE 11th Avenue
P. O. Box 3621
Portland, Oregon 97208-3621
☎ (503) 230-7334
☎ Document Request Line (800) 622-4520

The Bonneville Power Administration is a federal agency that distributes electricity throughout the Pacific Northwest. The BPA publishes numerous reports on energy alternatives and supports energy conservation projects in its service area. The BPA funds a regional resource center, known as the Electric Ideas Clearinghouse, for issues related to commercial and industrial energy use. This free service is for utility professionals, engineers, architects and designers located in the Northwest region seeking information and solutions on a wide range of topics. The Clearinghouse has three regional toll-free services: a technical assistance "hotline" number, a fax line and a computer bulletin board system.

- ❖ Electric Ideas Clearinghouse
1925 Plum Street SE Bldg. 4
P.O. Box 43171
Olympia, WA. 98504
☎ (206) 586-8588
Hotline: ☎ (800) 872-3568

Staff experts can answer questions related to such topics as energy-efficiency technologies, products, or programs; environmental issues; electric systems; HVAC; motors; insulation; process equipment; computer simulations; boilers; pumps; lighting;

refrigeration; renewable resources; and specific products.

- ❖ Bulletin Board: ☎(800) 762-3319, 24-hours a day via computer modem

To check resources on the referral directory, review upcoming training programs or network with other energy peers. The referral directory contains the names of individuals and companies listed under areas of expertise such as lighting, HVAC, and program design and implementation. The Bulletin Board maintains a database of training programs throughout the Northwest.

- ❖ Fax Line: ☎(800) 872-3882, 24-hours a day.

The fax line is available to order technical information, articles, reports and product literature and also to send project details to staff experts.

California Energy Commission (CEC)

1516 Ninth Street
Sacramento, CA 95814-5512
☎ (916) 324-3000

The California Energy Commission manages a broad scope of energy efficiency programs. Among the CEC's areas of responsibilities are promoting energy conservation, developing and maintaining building and appliance energy efficiency standards, providing assistance to local governments for energy efficiency improvements, and developing renewable energy resources and alternative technologies. The CEC's building and appliance efficiency standards have served as national models for energy efficiency. Other achievements are the implementation of the state's Title 24 State Building Code and the adoption of fluorescent lamp ballast standards. The CEC has created a wide variety of programs for the public sector and local governments.

Energy efficiency services for public sector schools, hospitals and other buildings include an Institutional Conservation Program; Energy Conservation Assistance Act Loan Program; Small School District Program; Community Colleges Program; and Title 24 Building Energy Efficiency Standards Training. Programs for local governments include the Energy Partnership Program; Water Energy Efficiency Program; and Energy Facilities Siting and Permit Assistance; and New Construction Design Assistance Program.

- ❖ Contact (916) 654-5200 to request the publications catalog or the Energy Hotline at (916) 654-5106 or (800) 772-3300 for technical assistance. For municipal utility issues, contact Melinda Merritt at (916) 654-4829.

California Institute for Energy Efficiency (CIEE)

Lawrence Berkeley Laboratory
1 Cyclotron Road, MS 90-3124
Berkeley, CA 94720
☎ (510) 486-5380

The CIEE is a unique collaboration of California's largest utilities, energy agencies, the University of California and other research organizations. This partnership was created to develop new energy-efficient technologies drawing on the combined scientific and technological capabilities and know-how of the state's universities, colleges and research laboratories. Some research projects include: Analysis of Energy Efficiency and Air Quality; Building Performance Measurement, Operation and Control; and Efficient Systems for Thermal Distribution. The CIEE achieves its goals by funding and implementing research projects, demonstrations and field tests, co-funding workshops and meetings, and publishing an annual report, a quarterly newsletter (the *Research News*) and a journal (the *Journal of Energy Efficiency*).

- ❖ To obtain a list of publications or purchase a report, contact the Communications Office at (510) 486-4322.

Electric Power Research Institute (EPRI)

3412 Hillview Avenue
Palo Alto, CA 94303
☎ (415) 855-2000

The Electric Power Research Institute is a member-supported research institute dedicated to applying advanced science and technology for the benefit of more than 660 member utilities. The institute's work covers a wide range of research activities related to the generation, delivery and use of electricity. More than 350 scientists and engineers manage some 1,600 ongoing research projects throughout the world. Areas of research include environmental issues, transmission and distribution issues, new generation technologies, customer systems, planning tools and exploratory research. EPRI has 23 regional offices and technology centers in 13 states to assist utilities in technology transfer and offer solutions to technical problems. Member benefits include products, services and information for direct application by electric utilities and their customers.

Publications: *EPRI Journal*, *End-Use News*, *Ready Now*, *Host Utility*, *Innovators*, *Events*, *Announcing*, *Technical Brief*.

- ❖ EPRINET: on-line network enables utilities to communicate electronically with EPRI's staff and member utilities and access to EPRI's resource database. EPRINET provides newsboards (Daily Utility News, The Energy Daily), topical forums and database libraries. Utilities communicate with other utility staff members from around the country to share information, discuss concerns and issues and have at their fingertips information from a single source.

- ❖ For assistance in locating research projects, published technical reports, computer programs, and conferences and workshops, use the EPRI HOTLINE (415) 855-2411. To order copies of technical reports, reference manuals, technical papers, databases, brochures, slides, and videotapes, contact the EPRI Distribution Center (510) 934-4212. To order software and hardware, contact the Electric Power Software Center (214) 655-8883.

Energy Information Administration (EIA)

United States Department of Energy
1600 Independence Avenue SW
Washington, D. C. 20585
☎ (202) 586-8800

The Energy Information Administration is the Department of Energy's independent statistical and analytical agency. The EIA is mandated to collect and publish data and prepare analyses on energy production, consumption prices, resources, and projections of energy supply and demand. The EIA produces a variety of publications, periodicals, products and services such as *Architect's and Engineers Guide to Energy Conservation in Existing Buildings*. Both the *Publications Directory* and the *Energy Information Directory* are available free of charge from the National Energy Information Center by calling (202) 586-8800. Call the National Energy Information Center for more information about how to order various free publications.

Environmental Protection Agency-Green Lights Program

Green Lights ,U.S. EPA
401 M Street, SW(6202J)
Washington, D.C. 20460
☎ (202) 775-6650, FAX: (202) 775-6680
Technical Hotline: (703) 934-3150

Green Lights is a voluntary program that encourages the widespread use of energy-efficient lighting. Green Lights participants include corporations, environmental groups, electric utilities, and state and local governments. Participants become Green Lights "partners" by signing a Memorandum of Understanding with EPA to survey their facilities and upgrade 90% of their square footage, where it is profitable and where lighting quality is maintained or enhanced. EPA provides partners with software assessment tools, financing program databases, and technical support.

Illuminating Engineering Society (IES)

345 East 47th St.
New York, NY. 10017-2377
☎(212) 705-7925
FAX (212) 705-7641

IES is a professional group of lighting designers, architects, interior designers, consultants, utility professionals engineers, facility managers, specifiers, researchers and educators. They put out several publications including the *Lighting Handbook*, and various recommended practices, design guides, energy management tools, lighting measurement guides, and *Lighting Design and Application (LD+A)* magazine. IES also offers courses on topics such as lamps and luminaires, lighting economics, and lighting efficiency.

Lawrence Berkeley Laboratory (LBL)

Technology Transfer Department
1 Cyclotron Road, MS90-1070
Berkeley, CA 94720
☎ (510) 486-6467

Lawrence Berkeley Laboratory is a national laboratory managed by the University of California for the U. S. Department of Energy. LBL conducts a wide range of research activities in three program areas: energy sciences, biosciences, and general sciences. Each program area is divided into several divisions. Of special interest is research conducted by the Energy and Environment Division for the Energy Sciences program. The Energy and Environment Division's research areas include building energy efficiency, indoor air quality, solar energy for heating and building cooling systems and the environmental effects of technology.

The role of the Technology Transfer Department is to make technology and expertise developed at LBL available to industry. The Technology Transfer Department helps to move technology and ideas to the marketplace and to handle research requests.

Publications: *Energy Analysis Program Annual Report*; *Building Technologies Annual Report*

- ❖ For copies of energy efficiency publications, contact Jane Dunbar at (510) 486-7574.

Lighting Design Lab

400 East Pine Street, Suite 100
Seattle, Washington 98122
☎ (206) 325-9711

The Lighting Design Lab is a regional resource center primarily set up for commercial designers with an interest in the latest, most energy efficient lighting applications. The Lab offers consulting services, classes, technology displays, lighting design tools, hands-on facilities, a lighting library and more. The Lab is connected to the Bonneville

Power Administration's Electric Ideas Clearinghouse and can be accessed by modem or fax. In addition to the Bonneville Power Administration, the Lab's other sponsors include the California Energy Commission, Washington State Energy Office, University of Washington, Idaho Power Company, and Washington Water Power.

- ❖ For additional information about the Lab's services, contact Dianna Campbell, Project Manager (206) 325-9711.

Lighting Research Center (LRC)

School of Architecture
Rensselaer Polytechnic Institute
Troy, New York 12180-3590
☎ (518) 276-8717

The Lighting Research Center is committed to changing architecture through efficient lighting that is responsive to human needs. It is dedicated to promoting state-of-the-art lighting technologies, developing new technologies and communicating this information to consumers, manufacturers, research organizations, utilities and lighting decision-makers. LRC's interests include DSM, technology transfer, design and analysis tools, performance evaluation and lighting product information.

In addition, LRC created the National Lighting Product Information Program to provide an objective source of information on manufacturer's energy efficient lighting products. To help close the gap about specific products and performance data, the Program provides information in useful formats to guide lighting decisions. The Program provides numerous publications as well as various research center technical reports and documents to interested groups. Publications: *Specifier Reports*, *Lighting Answers*, *Guide to Performance Evaluation of Efficient Lighting*

- ❖ Contact: Robert Davis, Head, Efficient Lighting Program (518)276-8717

Office of Applied Economics (OAE), National Institute of Standards and Technology (NIST)

Computing and Applied Mathematics Laboratory
Building 226, Room B226
Gaithersburg, Maryland 20899
☎ (301) 975-6132

The Office of Applied Economics is a part of the National Institute of Standards and Technology under the United States Department of Commerce. The OAE conducts research and provides technical assistance in the field of microeconomic analysis. It provides information to both the public and private sectors about new technologies and policies relating to manufacturing, industrial processes, the environment, energy conservation, construction and safety. Life-cycle costing, risk analysis and benefit-cost analysis are some of the techniques used to evaluate new technologies, processes, programs, codes, standards for the purpose of determining efficient alternatives.

OAE products include reports on findings; standard methods and guidelines for making economic evaluations; audiovisuals that teach and illustrate methods in practice; and software.

Publications: *Life-Cycle Costing for Energy Conservation in Buildings: Student's Manual*; *Simplified Energy Design Economics*; *Hospital Energy Analysis Toolkit: User Manual*.

- ❖ For more information about OAE publications, contact Dr. Harold E. Marshall, Chief of the Office of Applied Economics, (301) 975-6131.

Pacific Gas and Electric Company's Energy Center

851 Howard Street
San Francisco, CA 94103
☎ (415) 973-7268

The *Energy Center* is Pacific Gas and Electric Company's energy efficiency showcase. Its purpose is to help building and design professionals learn how to save energy through the use of energy-efficient technologies and design technologies. The Center is a flexible, interactive environment with full-scale working displays featuring such technologies as advanced lighting, air conditioning, glazing, and building controls. The Center includes: a lighting classroom/demonstration lab; HVAC classroom/demonstration lab; lighting mock-up lab; daylighting lab; heliodon station; advanced products gallery; a "Challenge 2000" house; and a commercial design and residential systems exhibit area.

The *Energy Resource Center* supports the *Energy Center* with resource specialists who supply technical information and research assistance to building and design professionals. The Center has a collection of material on such topics as daylighting, energy management, glazing, retrofitting, solar control, adjustable speed drives, building controls, building and construction, architecture and thermal storage.

- ❖ PG&E Energy Resource Center: (415) 972-5930 or 972-5927; fax number (415) 896-1290.

Portland Energy Conservation, Inc. (PECI)

921 S W Washington, Suite 840
Portland, Oregon 97205
☎ (503) 248-4636

Portland Energy Conservation, Inc. is a non-profit corporation using a diagnostic approach to achieving sustained energy savings for its clients through building commissioning programs. PECI's goal is to design programs that assure facilities perform efficiently in accordance with design intent and the owner's operational needs. PECI works with utilities and related industries to design commissioning programs; add commissioning and O&M components to existing programs; customize commissioning guidelines; consult with and train utility staff and commissioning agents; and develop

evaluation plans to measure commissioning and O&M effectiveness.

- ❖ To find out more about commissioning and building energy savings, contact Debbie Dodds, Program Consultant (503) 248-4636

Public Technology Incorporated (PTI)

1301 Pennsylvania Ave.,NW
Washington, DC 20004-1793
☎(202) 626-2400, (800) 852-4934
FAX: (202) 626-2498

PTI is a nonprofit institution whose mandate is to create and disseminate new technology in society, responsive to the needs of local governments. PTI uses a consortium of entrepreneurial and innovative cities and counties to provide an effective and coordinated urban laboratory in the technology research, development and commercialization cycle. PTI's work is conducted through three task forces, Energy, Environmental, and Telecommunications and Information.

Western Area Power Administration (WAPA)

1627 Cole Boulevard
Golden, CO. 80401

Powerline
c/o ERG International Inc.
13949 West Colfax Avenue Suite 140
Golden, CO. 80401-9894
☎(800) 769-3756

Powerline is a service of WAPA that offers information on lighting, Demand Side Management, SCADA, cogeneration, life-cycle costing, heat pumps and more. *Powerline* offers four main services: a national listing of events, seminars and workshops; technology transfer packets, a peer match program, and a test equipment loan program. These services are geared mainly for utilities, but information is available to government agencies in WAPA's service territory throughout the West and Midwest.

Energy sites on the World Wide Web:

American Council for an Energy Efficient Economy (ACEEE)
<http://solstice.crest.org/efficiency/aceee/index.html>

Association of Energy Services Professionals
<http://www.dnai.com/AESP/>

Austin Green Builder Program
<http://www.ci.austin.tx.us/EC/ECHSSAVE.HTM>

California Energy Commission(CEC)
<http://resources.agency.ca.gov/cehomepage.html>

Center for Building Science News
<http://eande.lbl.gov/CBS/NEWSLETTER/CBSNEWS.html>

EPA - Energy Star Buildings program
<http://www.epa.gov/docs/GCDOAR/esb-home.html>

**Energy Crossroads (this site lists, describes, and points to many energy related sites on the world wide web)*
<http://eande.lbl.gov/CBS/eXroads/EnergyXroads.html>

Energy Efficiency and Renewable Energy Network (EREN)
<http://www.eren.doe.gov/>

Energy Yellow Pages
<http://www.ccnet.com/~nep/yellow.htm>

National Renewable Energy Laboratory (NREL)
<http://www.nrel.gov>

Public Technology Incorporated (PTI)
<http://pti.nw.dc.us/>

Rensselaer Lighting Research Center
<http://www.rpi.edu/dept/lrc/LRC.html>

Solstice - Center for Renewable Energy and Sustainable Technology
<http://www.crest.org/>

Washington State Energy Office - Energy Ideas Clearinghouse
<http://www.eicbbs.wseo.wa.gov/>

Appendix A

Institutional Barriers and Proposed Solutions

The U.S. Office of Technology Assessment, American Council for an Energy Efficient Economy, and National Research Council have described various institutional barriers to energy efficiency and recommendations for overcoming them. Appendix A contains summaries of these descriptions and recommendations.

The U.S. Office of Technology Assessment (OTA) has identified the following common institutional barriers that impede energy efficiency in Federal buildings, and policy options for change.¹

Resource Constraints

- ▶ *Priorities favor other agency needs:* Energy efficiency is not central to most agencies' missions and is a small component of most agencies' expenditures. There is little senior management interest.
- ▶ *Many measures require initial capital spending:* Despite opportunities for high returns on investment, Federal agencies have not sought and have not received stable sources of funding for energy efficiency projects.
- ▶ *Many measures require personnel:* Many facilities defer or delegate maintenance functions and have no energy coordinator.

Information Constraints

- ▶ *Opportunities have not been systematically assessed:* There are no government-wide estimates of potential and little analysis of results of different measures.
- ▶ *Agencies are uncertain of technical and economic performance:* Does this technology really work? There is a lack of detailed energy use metering. Would the facility be better off waiting for next year's model? There are too few demonstration programs and too little information sharing between agencies.
- ▶ *Energy-use decisions are dispersed, made by thousands of individuals:* Implementation requires coordinated effort from diverse parties and there is too little training and education of these diverse parties.

Lack of Incentives

- ▶ *Dollar savings often do not accrue to energy savers:* Energy costs are readily passed through budgets. Cost savings are often not retained at a facility, and thus incentives for facility staffs are often indirect.
- ▶ *Federal procurement policies often favor status quo:* Procurement practices are complex and often restrictive.

¹ Office of Technology Assessment, *Energy Efficiency in the Federal Government : Government by Good Example?*, OTA-E-492, GPO, May 1991.

The OTA recommends the following policy options for change:

Dedicate resources

- ▶ *Increase funds for investment.* There are several billion dollars worth of highly cost-effective investment opportunities in federally owned and assisted buildings.
- ▶ *Support an adequate staff.* It is important to have a trained, competent, and motivated staff to determine which measures are most likely to succeed.

Encourage agency efforts

- ▶ *Set standards for performance.* These include lifecycle costing, energy efficient design criteria, appliance and vehicle efficiency standards, and energy consumption reduction targets.
- ▶ *Reward agencies and individuals for energy and cost savings.* Raise the priority of energy efficiency by creating incentives for agencies and individual facilities. Provide incentives to individuals in the form of awards or bonuses.
- ▶ *Revise procurement:* Improve information on energy using goods, increase the use of life-cycle costing, and simplify procurement of energy efficient products.
- ▶ *Follow through and enforce policies.* Request regular reports by inspectors evaluating success.

Promote research, development, and demonstration

- ▶ R&D is vital to innovation and practical application of new energy efficient technologies. Close cooperation between R&D and manufacturers is critical to ensuring that useful concepts proceed .

The American Council for an Energy-Efficient Economy (ACEEE), identified several barriers to incorporation of efficient motors². These barriers could be applicable to any new efficient technology. Common barriers to the use of efficient motors(equipment) include:

- ▶ *Payback gap:* Organizations typically require a simple payback of less than 3 years before they will invest in energy efficiency projects, even though longer-payback investments can yield significant life-cycle savings. This gap in payback requirements causes too little investment in savings and too much in power supply.
- ▶ *Lack of information:* Specifiers don't have adequate awareness of either the technical or economic advantages of efficient equipment.
- ▶ *Limited access to capital:* Decisionmakers may be convinced of the advantages, but lack the resources for the initial investment.
- ▶ *Lack of institutional incentives:* Often, the person in the best position to implement an energy-saving program has little to gain from doing so. Facility managers whose energy bills are treated as a flow-through operating expense are less likely to invest in efficiency improvements than managers who can retain some share of savings in their budgets.
- ▶ *Market structure:* 75% of electric motors are purchased by original equipment manufacturers(OEMs), who in turn build them in to their equipment for sale. They have a disincentive to buy efficient motors because the higher cost would result in higher prices on their products.
- ▶ *Aversion to downtime and innovation:* The first priority of facility managers is to keep the building up and running. They are wary of new, unfamiliar technology that might be less reliable than the equipment they are used to.
- ▶ *Repair shops compete on speed and price:* In an effort to reduce downtime and save on price, quality may suffer, leading to greater expense later.
- ▶ *Standardized inventories:* Facility managers often stock a few standard motor sizes to serve a wide range of loads. This can lead to installation of motors inappropriate for the task. Also, distributors often do not keep a full range of efficient equipment in stock.
- ▶ *Purchase decision criteria:* Purchasing personnel are typically uninvolved and untrained in the energy-use consequences of their choices.

ACEEE's recommendations for overcoming barriers include:

- ▶ Improved quality and availability of information from utilities, energy agencies, manufacturers, universities, and private organizations.
- ▶ On-site technical assistance.
- ▶ Improved engineering curricula.
- ▶ More accurate labeling of equipment.
- ▶ National minimum efficiency standards.
- ▶ Testing programs.
- ▶ Financial incentives and utility rebates.
- ▶ Allowing individuals and departments to keep a share of their energy savings.
- ▶ Promotion of new technologies through demonstrations and case studies.
- ▶ Simplified energy analysis tools.

² ACEEE/Western Area Power Administration, *Energy Efficient Motor Systems: A Handbook on Technology, Program and Policy Opportunities*, 1991.

The **National Research Council (NRC)** studied barriers to integration of lifecycle cost decisions in the management of public buildings.³ Their conclusion was that *"..these mechanisms are essential to the management of long-lived facilities in a setting characterized by responses to short-term issues."* NRC recommends a broad range of actions that each agency responsible for these buildings should take:

- ▶ *Formally recognize control of lifecycle cost as an essential and effective element of the agency's mission.*
- ▶ *Include explicit assessment of design alternatives that influence lifecycle cost as an element of the scope of work and fees of agency designers.*
- ▶ *Assure that value engineering programs and construction contract incentives and other procurement mechanisms demonstrate savings in expected life cycle cost rather than construction cost only.*
- ▶ *Direct designers to document clearly their design decisions in expected lifecycle cost and the subsequently expected operating consequences for each facility.*
- ▶ *Implement cross-training and staff exchange of design and operations and maintenance management personnel to assure that life-cycle cost management principles and understanding of how life-cycle cost is controlled at all stages in the facility's service life are applied in practice.*
- ▶ *Establish a life-cycle cost management system to maintain O&M data and design decisions in a form that supports operations and maintenance management and feedback of O&M experience to future facility designs.*
- ▶ *Assign accountability for maintenance and repair at the highest levels in the agency. Responsibilities should include effective use of maintenance and repair funds and other actions required to validate prior decisions on facility life-cycle cost. Assure that adequate resources are available to implement life-cycle cost management decisions.*

³ National Research Council, *Pay Now or Pay Later: Controlling Cost of Ownership from Design Throughout the Service Life of Public Buildings*, National Academy Press, 1991.

Appendix B

The BEC List of Institutional Barriers

As part of its 1992 Urban Consortium Energy Task Force project, *Energy Management Action Plan*, the Bureau of Energy Conservation identified and described institutional barriers to energy efficiency in San Francisco municipal buildings. Appendix B is a summary of those barriers and some proposed solutions. The diagram on page A13 describes the interrelationships among barriers.

Motivation

Barrier	Description	General Solution
<i>No Budget Incentive</i>	Savings from conserved energy do not directly accrue to the department responsible for the conservation, thus there is no direct budgetary incentive for such conservation.	Structure a shared-savings program, allowing a conserving department to spend a portion of savings resulting from their efforts on departmental needs.
<i>No Policy</i>	There is no definitive policy mandating energy-efficiency and conservation, leaving energy decisions to individual discretion at facilities.	Convince individual decision-makers of the need for conservation, stressing benefits that overlap their agenda; help policy-makers create/enforce policies.
<i>Nearsighted Planning</i>	Political decision makers are most responsive to short-term visible issues, and are not motivated to plan for the long-term.	Make energy conservation an issue that political decision-makers cannot ignore by publicizing potential and risks of inaction.
<i>Low Awareness</i>	Staff (and public) do not fully understand or value the benefits of conservation.	Develop education programs for staff (and the public where appropriate).
<i>Low Priority</i>	Immediate, critical issues (ie. staff cutbacks) make energy conservation a low priority, especially in terms of funding.	Educate funding decision-makers about the benefits of conservation, emphasizing financial aspects and overlap with their agenda.
<i>Incomplete Buy-in</i>	Projects are not fully supported by those who are uninformed or outside of the decision-making process.	Cultivate lines of communications (in both directions) with all involved parties.
<i>Change Resisted</i>	Because changing the status quo is difficult and perceived as risky, staff resist change.	Use tangible project results to reduce perception of risk and illustrate the benefits of changing.
<i>Loan Anxiety</i>	Financial officers are unwilling to pursue loans for energy conservation projects because of the perceived risk and a low awareness of benefits.	Through success stories and thorough analysis, demonstrate to decision-makers that risk is low and return-on-investment high.
<i>No Constituency</i>	Public support for energy conservation is diffuse, so decision-makers are not pressured to support conservation.	Develop ties with local organizations that support conservation; publicize programs and enlist support.

Design

Barrier	Description	General Solution
<i>No Design Expertise</i>	Designers lack expertise in energy-efficient design practices and equipment.	Identify and develop resources for design review and training; provide technical guidance.
<i>Unknown Projects</i>	Energy review is not formally integrated into the design process so opportunities for review of planned projects are missed.	Study design process and identify key design staff; develop and institutionalize a mechanism for identifying upcoming opportunities.
<i>ECM First Cost</i>	Designers balk at cost-effective energy-efficient designs because they cost more than traditional designs.	Obtain funds for incremental costs; educate funders about decreased future operating costs.
<i>No Continuity</i>	Assisting designers on one specific project does not result in knowledge carried over to future projects.	Teach general energy-efficient design principles, using specific projects as case studies.
<i>No Ongoing Education</i>	Designers are not kept current on evolving energy-efficient equipment and practices.	Demonstrate benefits of keeping designers up-to-date, and supply materials, contacts, and training.

Purchasing

Barrier	Description	General Solution
<i>First-Cost Purchasing</i>	Purchasing is based on lowest first cost, resulting in selection of products which cost much more over their lifetimes.	Create a policy that mandates specific equipment; educate purchasers on fiscal logic behind Life-Cycle Cost purchasing methodology.
<i>New Technologies Hard to Get</i>	Purchasing contracts for equipment do not include new efficient products, giving traditional equipment undue price and administrative advantages.	Locate existing government contracts that include new efficient items, or create your own, making the products as easy to purchase as those on existing contracts.
<i>Unfamiliar Technologies</i>	Purchasers and specifiers hesitate to buy new efficient equipment that they are unfamiliar with.	Educate specifiers and purchasers about efficient products, and demonstrate a demand for them.

Information/Communications

Barrier	Description	General Solution
Poor Tracking	Facility energy use is not adequately tracked so billing errors are not found and valuable info regarding facility performance is unavailable.	Improve or create the tracking system to provide information to the appropriate departmental staffpersons in a useful format.
Savings Fall Short	Savings from ECMs fall short of projections due to faulty analysis, load increase, etc.	Directly measure savings when possible, document assumptions, follow up on projects., and emphasize <i>cost avoidance</i> .
Invisible Results	Project savings are difficult to demonstrate due to poor tracking or inadequate monitoring hardware.	Increase tracking and monitoring capability; use well-measured results from similar projects to back up projected results.
Out of Touch	Miscommunication or lack of communication (<i>one hand not knowing what the other is doing</i>) limits the effectiveness of programs.	Determine all relevant parties and keep them informed; establish permanent channels of communication between them.
Non-Budget Benefits	Benefits such as reduced maintenance or environmental externalities are not directly reflected in the budget and so are valued less.	Quantify these benefits, and educate budgetary staff about their importance both in terms of departmental missions and fiscally.
Lots of Facilities	Energy offices have insufficient resources to audit all municipal facilities in order to determine which need the most attention.	Identify existing resources that catalog facility data, develop a system-wide tracking system, and use indexing to characterize facilities.
New Technical Information	New efficient technologies raise many questions regarding performance and other issues that are difficult to keep pace with.	Cultivate a network of information resources from government and private designers, research labs, professional associations, and vendors.

Retrofits

Barrier	Description	General Solution
<i>Insufficient Funding</i>	Low funding levels do not allow energy offices to implement cost-effective retrofits.	Educate decision-makers about the need for conservation and the long-term costs of <i>not</i> investing in efficiency.
<i>No Multi-Year Contracts</i>	Because laws restrict contracts to one year, third-party financing is not possible.	Convince policy-makers of the value of third-party financing, and seek to make it legal.
<i>Funding Delays</i>	Obtaining funds for energy retrofits requires substantial effort and delays implementation.	Set up funding that can be used flexibly, with less administrative effort, for projects yet-to-be-identified.
<i>Isolated Projects</i>	Isolated retrofits at individual facilities are not fully integrated into departmental operating procedures.	Retrofit groups of facilities that offer similar opportunities and can be tied functionally under common policies.
<i>Narrow Focus</i>	Equipment retrofits lose additional savings (or fail to realize expected savings) due to non-equipment factors, such as occupant behavior.	Look for opportunities that complement equipment change-out; meet with occupants before and after retrofits to identify issues and opportunities.
<i>Environmental Issues</i>	Energy-saving retrofits can tie into other environmental issues, such as "generating" hazardous waste when replacing fluorescent ballasts.	Establish contacts and coordinate efforts with other city and regulatory agencies responsible for dealing with these issues.
<i>Action, Not Studies</i>	Facility staff are discouraged by lack of action (usually due to a lack of funding) and resent studies that do not seem to lead to any action.	Provide some action in the near term to gain confidence; demonstrate the value of audits and other studies to facility staff.
<i>Mixed Technologies</i>	Replacing old equipment (such as magnetic fluorescent ballasts) on an as-needed, partial replacement basis results in a confusing mixture of technologies.	Perform comprehensive retrofits to change all equipment at once; organize replacement on an orderly basis coordinated with operators.

Operations & Maintenance

<i>Barrier</i>	<i>Description</i>	<i>General Solution</i>
<i>Lack of Maintenance Knowledge</i>	HVAC maintenance staff are not extensively trained in the energy efficiency aspect of their work.	Help HVAC maintenance staff get training in efficiency; demonstrate the cost-effectiveness of this investment.
<i>Low Maintenance Funding</i>	Underfunded maintenance results in premature deterioration and inefficient operation of equipment.	Educate budgetary and O&M decision-makers on the fiscal implication of poor maintenance.
<i>Waiting for Failure</i>	Funds for replacing equipment are more available than for routine maintenance, so equipment is not maintained.	Restructure maintenance funding to support cost-effective ongoing maintenance strategies.
<i>Technology Anxiety</i>	New efficient products are not embraced by operators who are accustomed to familiar equipment and fear new complexities.	Provide training on new technologies, reference resources, and case studies of peers that use such technologies successfully.
<i>Job Preservation</i>	City facility maintainers believe they need to keep equipment in a condition where it fails regularly to keep their jobs.	Show the extensive work that is currently not being performed that could be if maintenance resources were freed up.

Institutional Barriers to Energy Efficiency:

A14

Appendix C

California Energy Commission's *General Energy Efficiency Guidelines for the Design of New Hospitals*

California Energy Commission (CEC) staff developed the following hospital energy efficiency design guidelines based on its experience of providing design assistance to several new and remodeled public hospital projects. The CEC offered this design assistance through its Energy Partnership Program. *CEC staff does not consider these recommendations to be exhaustive.*

General Energy Efficiency Guidelines for the Design of New Hospitals

The following is a summary of general areas for consideration of energy efficient design alternatives for hospitals based on typical recommendations to participants in the Energy Commission's Energy Partnership Program. These energy efficiency opportunities were identified and determined to be cost-effective for the specific projects analyzed after multiple technical reviews of drawings at several stages in the design process. Although these individual recommendations may not always be cost effective nor all inclusive for other projects , they suggest areas for consideration and analysis.

Building Envelope

Wall/Roof Insulation

Ceiling, floor and wall insulation should at minimum conform to the CAC Title 24 prescriptive standard in temperate climate zones. These standards list minimum thermal resistance ratings (R-values) for ceilings, floors and walls.

Glazing

For hospitals in warm summer climate zones, glazing area should be minimized on the south, west and east facing windows, and glazing with a high shading coefficient should be specified to minimize solar heat gain and to reduce reference luminance levels inside. Glazing with selective coatings (low-emittance or Heat-Mirror type glazing) should be specified where economical.

Shading

External shading should be used to limit the heat gain from direct solar incidence. Internal shading should also be provided for windows in work areas.

Daylighting

Skylights, light shelves, and north facing clerestory windows should be designed to utilize natural light for task illumination. Lay out lighting circuits to control daylight areas separately from nondaylit areas.

Surface Reflectivity

Very light colors (whites and off-whites) should be used for wall and ceiling paint, and light floor colors should be selected. This will increase the lighting system

efficiency and allow lower lighting densities, which will decrease operating costs and first costs, provided the electrical engineer uses this information in the design of the lighting system.

Lighting

Design Light Levels

Lighting levels are often unnecessarily over-designed in new hospitals. Recommended light levels for health facilities are shown in the attached table. These are derived from IES guidelines. Adhering to the recommended levels will result not only in operation cost savings, but may lower the construction cost as well through a reduction in the number of fixtures required.

Efficient Light Sources

Fluorescent fixtures should use either T-8 or T-10 lamps with electronic ballasts. This combination gives one-third more light output per power input than the conventional T-12 lamps with energy saver ballasts, and the color rendering index is higher.

Point sources such as down lights, task lights, and small fixtures should be designed for hard-wired compact fluorescents except where dimming is required.

Exterior lighting should be high intensity discharge lamps such as high or low pressure sodium, or compact fluorescent lamps for lower intensity applications.

Efficient Ballasts

Electronic ballasts should be specified for all fluorescent fixtures. Ballast life should be roughly double that of standard magnetic energy saver ballasts. It is also possible to use dimming electronic ballasts for additional flexibility.

Efficient Fixtures

Fluorescent fixtures should be chosen which have a high coefficient of utilization (a measure of useful light output). This could mean fluorescent fixtures with integral specular reflectors for applications where this lighting effect is appropriate. Parabolic louvers may also be desirable to reduce glare from fixtures in office areas with video display terminals.

Downlights should have reflectors and efficient cans. Lamp/reflector combinations should be matched with appropriate cans to avoid trapping light in the fixture.

Lighting Controls

Automatic daylighting controls should be incorporated with the use of skylights, light shelves, and other natural lighting designs. This would require a simple photocell located in the daylit area to turn off, stage off, or dim the lights as the availability of natural light increases. Utilities usually require appropriate controls to qualify for financial incentives for daylighting.

Occupancy Sensors

Occupancy sensors should be used where appropriate. These areas usually include offices, staff lounges, file rooms, and conference rooms. These controls save energy not only when an office is unoccupied during the day, but also when lights are left on at night.

HVAC Systems

Major heating and cooling systems must be designed according to the unique needs of a particular facility, the expected heating and cooling load profiles, the prevailing utility rates, the availability of energy efficiency financial incentives from local utilities, and the climate zone for the building site. A comprehensive life cycle cost analysis of the various heating and cooling strategies should be performed for your facility prior to selecting a system, its components, and controls. The following are general observations that are useful to keep in mind.

Cost Effective Heating

The most cost effective fuel source should be evaluated for heating equipment, which will depend primarily on expected local electric and fuel rates. In most areas of California, natural gas is the lowest cost heating source, if available in your area.

Hospitals typically use large, central boilers to provide heat for all heating requirements. Large boilers should use stack economizers and oxygen trim control to maximize their efficiency of operation. Blowdown heat recovery should be specified as an additional energy efficiency measure. Boilers and associated piping should be insulated to reduce standby losses. Boiler feedwater pump operation should cycle on and off to control water levels in the boiler.

Emissions levels are another concern in specifying a boiler. In most locations, boilers are required to have the best available control technology for limiting NOx emissions to prescribed levels. Typically, this will mean flue gas recirculation is incorporated in the boiler design. The appropriate air quality management agency should be contacted to determine the requirements for the site. All of the energy efficient technologies discussed above can be used with low NOx boilers.

For smaller systems, a form of high efficiency combustion, such as pulse combustion or condensing heat exchangers, is recommended. High standby losses should be eliminated through proper system design. Intermittent ignition devices (pilotless ignition) should be used for all equipment with this option available. Electric resistance space heating should be avoided.

Cost Effective Cooling

There are a variety of cost effective cooling technologies available. Electrically driven technologies include centrifugal, screw, reciprocating, and scroll chillers. Thermal energy storage may be cost effective depending on the cooling load profile and on what utility rate structures and financial incentives that are available locally. Gas fired or steam fired absorption chillers or natural gas fired engine driven chillers may be a cost effective alternative to the above chiller technologies depending on local utility rate structures and incentives. Heat recovery should also be considered for each of the above cooling technologies.

Use of the Natural Environment

Buildings in some coastal and alpine parts of the state can be adequately cooled with only ventilation. In all areas, air conditioning units should be specified with outside air economizers and adjusted to close down to provide only the minimum outside air required by CAC Title 24, Table 4-2110A ("Pressure Relationships and Ventilation of Certain Hospital Areas").

In areas with hot, dry summers, cooling can be adequately supplied or supplemented using indirect evaporative cooling. This can reduce or eliminate the need for mechanical cooling. In areas of the hospital with high outside air requirements, use of cool exhaust air to indirectly cool incoming outside air could provide energy savings and significantly reduce the peak cooling demand.

HVAC Controls

The selection of the most effective control system will usually result in the choice of direct digital control (DDC). Besides control advantages, this also permits easy scheduling of equipment operations. DDC should only be avoided where maintenance and programming requirements are beyond the capability of the site staff or nearby maintenance companies.

Sufficient status and control points should be included for energy efficient control strategies, which include hot and cold water loop temperature controls, chiller return water temperature controls, hot and cold deck temperature controls, damper controls, optimum start/stop/setback and chiller outside air lockout.

Air Handlers

The potential for energy efficient design strategies is much greater for built up air handlers than for package units. CAC Title 24 code requirements detail the minimum ventilation requirements and differential pressure relationships for hospital areas. It also limits the use of variable air volume (VAV) systems to areas that are not "critically sensitive" as defined in the code. As a result, two-speed and variable speed drive (VSD) fan systems have limited and well defined applicability.

Variable speed drives or two-speed motors should be investigated for areas with reduced night loads that are not "critically sensitive", provided required pressure differentials can be maintained. Reducing ventilation rates during unoccupied periods can provide significant energy savings for air handler fans with continuous operation.

For all fans that must be constant speed, the motors should be specified as "premium efficiency".

Occupancy Zoning

In a building that has areas with different levels of occupancy at different times of the day or week, the zones should be designed so that zones of similar occupancy are grouped together. This will allow HVAC systems to be zoned for maximum efficiency.

Mechanical Systems

Kitchen energy sources

Natural gas, as opposed to electricity, is the preferred energy source for cooking and water heating in kitchens. This is true both from an energy standpoint and from a food preparation standpoint. Electric equipment should be limited to microwave ovens and portable appliances.

Refrigeration heat recovery

Waste heat from refrigeration equipment or other equipment may be recovered and used to supplement heating of the domestic hot water supply or other process heat needs.

Efficient Dishwashers

Energy efficient dishwashing and sanitation equipment should be specified. The variety of system types and models available range widely in their consumption of hot water and electricity. For high temperature-sanitizing systems, select a model with a gas or steam booster heater to allow the primary hot water loop temperature

to be set lower which will minimize distribution heat losses. A chemical-sanitizing system can considerably reduce hot water consumption.

Domestic Hot Water

Natural gas fired water heaters or tanks heated by boiler steam or hot water are the typical choices for the most energy efficient system. Tanks and lines should be well insulated.

Energy Efficient Motors

All motors of at least one horsepower should be specified to be premium efficiency. Premium efficient motors can provide energy savings of up to 4%, which adds up to large cost savings, especially for continuously operating motors.

Efficient laundry equipment

Dryers should be gas or steam heated, and equipped with humidity sensors to run only as long as necessary for each load. In addition, a humidity sensor can be used to recirculate a gradually increasing portion of the exhaust air as the air becomes dryer in the latter stages of the drying cycle.

Appendix D

Draft Bond Report Language

Through the *Intervention Strategies* Bond Guidelines pilot project, the Bureau of Energy Conservation worked with the bond team on including energy elements in the scope of a proposed large (\$500 million) hospital project. Appendix D contains draft language for inclusion in the bond report.

Draft Energy Efficiency Language for the New Laguna Honda Hospital Bond Report

"This proposal explicitly budgets for a facility which minimizes life cycle costs, especially energy costs, over the 30-to-50 year life of the project. The proposal includes the following provisions to this end:

- A budget set-aside of \$5 million to fund design and construction of energy efficiency elements which are beyond State Building Energy Efficiency Standards (Title 24) or other applicable recommended design practices;
- Aggressive voluntary compliance with State Building Energy Efficiency Standards; specifically:
 - for patient-care ("Type I"-institutional) areas; compliance with post-1992 Title 24 lighting and building envelope requirements, and all HVAC requirements not prohibited by OSHPD;
 - for non-Type I areas, full compliance with the most recent Title 24 standards applicable to Type B occupancies (e.g. 1992 Office Standards). In no case shall building areas comply with pre-1985 standards; and
 - [IMPORTANT]**all reasonable efforts to hermetically separate patient care areas in order to maximize the total floor area fully complying with Title 24. **These separations may affect building layout;**
- An experienced independent energy efficiency consultant as part of the design team; and specifically:
 - Energy efficiency design studies deemed appropriate by the City during the schematic design phase, including at least glazing/daylighting, cogeneration, and electrical peak shifting studies;
- Input from building operations staff during design; also inclusion of a building operations and maintenance plan, and building operator training and documentation for energy efficient equipment;
- Maximum use, based on lowest life cycle costs, of natural daylight and ventilation, as well as efficient design features as described in CEC's "General Energy Efficiency Guidelines for the Design at New Hospitals"; and specifically:
 - appliances, laundry equipment, and office machines with the lowest life cycle costs."

To assure adequate operation and maintenance of the facility after construction, BEC also recommends a complete building "commissioning" process (defined below). Commissioning would require an additional line item in the budget.

Appendix E

Energy Efficient Design Practices Guidebook excerpt

Through the *Intervention Strategies* Energy Efficient Design Practices pilot project, the Bureau of Energy Conservation produced a guidebook of energy efficient lighting practices for City designers. Appendix E is an excerpt from this guidebook.

Lighting Design Practice 3

INSTALL FIXTURES WITH COMPACT FLUORESCENT LAMPS

Description

Light fixtures using compact fluorescent lamps should be used in place of fixtures with incandescent lamps in almost all applications. Compact fluorescent lights use one-third the energy of incandescent to produce the same amount of light. Furthermore, a compact fluorescent lamp lasts more than 10 times longer than an incandescent lamp, yielding significant maintenance savings. The longevity and low energy use of compact fluorescents make them a good investment compared to incandescents, even though compact fluorescents have a higher initial price tag. Also, compact fluorescent lamps have better color rendering than standard full-sized fluorescent lamps.

In new construction, the designer should specify a fixture designed specifically for a compact fluorescent lamp, rather than using a screw-in compact fluorescent lamp in a fixture designed for an incandescent. In response to the growing popularity of compact fluorescent lamps, fixture manufacturers now offer a wide variety of compact fluorescent fixtures that are comparable to incandescent fixtures, including downlights, wall sconces, wallwashers, task lights and chandeliers.

Most compact fluorescent fixtures use one or two twin-tube or quad type compact fluorescent lamps. These lamps range in length from 4 to 13 inches and in wattage from 5 to 26 watts. Larger fixtures make use of the long twin-tube ("biac") lamps, which range from 9 to 22½ inches, and from 18 to 39 watts (see Figure 3-1). Manufacturers of compact fluorescent fixtures include Hubbell, Shaper Lighting, Capri Lighting, Janmar, Halo, and Lumatech. Manufacturers of compact fluorescent lamps include Osram, Philips, and Sylvania. Be on the lookout in the future for fixtures that make use of some new sizes and shapes of compact fluorescents, such as General Electric's 2D lamp (shaped like the letter "B") and Panasonic's linear quad-tube lamp.

Title 24

Although Title 24 does not forbid the use of incandescent lamps, using incandescents in any significant quantity would make it impossible to stay within the allowed lighting power densities under Title 24. However, incandescent lights often appear in designs in areas that have special allowances or exemptions under Title 24, specifically decorative, display, and outdoor lighting.

When to Apply this Practice

Fixtures with compact fluorescent lamps should be specified virtually any place one would have specified an incandescent light fixture of less than 150 watts. Fixtures using compact fluorescent lamps can be used in desk task lights, wall-mounted sconce lights, undershelf lights, landscape floodlights, chandeliers, and downlights.

A	P	P	L	I	C	A	T	I	O	N	S

		Downlights	Surface Lights	Pendant Fixtures	2' x 2' Fixtures	Sconces	Exit/Step	Floodlights
+	+	-	-	+	+	+			
T-4 Twin-Tube
+	+	+	-	+	-	-			
T-4 Quad-Tube
-	+	-	++	+	-	+			
T-5 Twin-Tube
2	+	-	++	-	-	-	-			
Integral Ballast Lamp
-	+	+	-	+	-	-			
Circline
2	++	-	+	-	-	-	+			
Reflector Unit											
++ Uniquely superior lamp choice + Suitable lamp choice - Unsuitable lamp choice											

Source: EPRI High-Efficiency Electric Technology Fact Sheet, "Compact Fluorescent Lamps, Energy Efficient Alternatives to Incandescent Lighting"

¹ LED exit signs are recommended for new construction (see Lighting Design Practice 5).

² For retrofit only

Figure 3-1
Compact Fluorescent Lamp Applications

In almost all cases (except very low operating hours or a very high premium for a compact fluorescent version of a luminaire), the lifecycle cost of using compact fluorescent luminaires and lamps is lower than the lifecycle cost of using incandescent luminaires and lamps. Figure 3-2 shows that over three years, discounted to current dollars, San Francisco will spend \$120 (in energy and maintenance) to operate a 60-watt incandescent fixture and only \$75 to operate a compact fluorescent fixture.

What Designers Need to Know

Compact fluorescent lamps and ballasts are available as integral units (ballast and lamp as one part) and modular units (ballast and lamp as separate parts). Most integral units are designed to be screwed directly into incandescent sockets. These types are recommended only as retrofits to existing incandescent fixtures. In new construction, the designer should specify a fixture designed for a "modular" type fluorescent lamp, where the ballast is built into the fixture. Figure 3-3 shows a downlight designed for a compact fluorescent lamp. For more information on compact fluorescent lamps, see "Compact Fluorescent Lamps" in the CEC's *Advanced Lighting Guidelines*.

Rules of Thumb. When specifying compact fluorescent fixtures, some of the following rules of thumb apply:

- To find the compact fluorescent equivalent to an incandescent, divide the wattage of the incandescent lamp by 4, and find the compact fluorescent with the nearest wattage. (For example, 60-watt incandescent $\div 4 = 15$ watts, so use a 13-watt compact fluorescent (see Figure 3-4).
- Always specify fixtures that are "hardwired" for compact fluorescent lamps. "Screw-ins" are appropriate for retrofits, but generally are more susceptible to future replacement with inefficient incandescents, and are less cost-effective because screw-in compact fluorescents are twice as expensive to replace as the individual (modular) lamps.

Assumptions: 1) NPV @ 4% over 3 years
 2) Compact fluorescent original incremental cost = \$60
 3) Replacing incandescent = \$5 per 1000 hours
 4) \$0.045/kWh and \$89.11/kW/yr

Figure 3-2
Lifecycle Cost Comparison

Figure 3-3
Compact Fluorescent Downlight

Four Easy Steps

To ensure that the appropriate compact fluorescent fixtures are installed, a lighting designer can follow these steps:

- Step 1: If the original intent called for an incandescent fixture, find an equivalent fixture that uses a compact fluorescent lamp (the attached product literature provides a starting point). Use the 1:4 rule of thumb or Figure 3-4 to determine what fixture wattage is required to provide the same light output.
- Step 2: Verify that the fixture type and quantity provides the target light level (see Lighting Design Practice 1).
- Step 3: Indicate the selected fixture type on the fixture schedule (e.g., compact fluorescent downlight, Brand X Model AAA-BB-1234 or equivalent).
- Step 4: In the specifications, or as part of the fixture schedule, list the minimum requirements for compact fluorescent lamps and ballasts (see attached sample specification).

Other Considerations

Fixture Design. The light output of a compact fluorescent fixture depends not only on the lamp wattage, but also on the design of the fixture. For example, a downlight with a reflector behind the fluorescent lamp will deliver more light than a downlight with a dark housing (see the discussion of efficient fixtures in the "Advanced Lighting Practices" section of this guidebook). Fixtures that trap heat will also have lower light output; the light output of fluorescent lamps can drop up to 20 percent if the temperature within the fixture gets too high. To improve heat removal from fixtures, some manufacturers (e.g., Lithonia in its Gotham Ventimax) are beginning to add vents to recessed can fixtures. Another method entails embedding a thin metallic strip or fin (called thermal bridges) into plastic lenses on enclosed fixtures. If possible, specify a fixture such as the Ventimax. Also, light output is better with the base up (upside down) or in a horizontal position than with the base down, so try to avoid fixtures that are designed with the base down.

Figure 3-4
Comparison of Incandescent and
Compact Fluorescent Lamps

Power Factor. A "normal power factor" for a ballast for a compact fluorescent light is about 0.45, which is much lower than for full-size fluorescent lights. Electrical engineers will know that this increases the loading on circuits, even though it does not affect the power consumption as read at the meter. Most lighting designers, therefore, specify "high power factor" ballasts for compact fluorescents, which raise the power factor to about 0.90. If high power factor ballasts are not an option for a particular fixture, current loading should not exceed 50 percent of the conductor and circuit ratings.

Case Study: San Francisco Fire Station No. 2

Like most San Francisco fire stations, Fire Station No. 2 will have a dormitory area. In most fire station dormitories, fire fighters have reading lights attached to the headboards of their beds, and these typically use incandescent lamps. To save energy, the electrical engineer for Fire Station No. 2 decided to mount compact fluorescent reading lights behind each bed so that incandescent lamps would not be needed. These reading lights use 13-watt compact fluorescent lamps and provide light equivalent to a 60-watt incandescent lamp.

Given that there are 31 reading lamps and that each operates about 3 hours per day, the energy savings from this measure were determined through the following calculation:

Watts saved/lamp: 60 watts (incandescent lamp) - 15 watts (compact fluorescent lamp + ballast) = 45 watts

Total kW saved: 31 reading lamps x 45 watts/lamp ÷ 1,000 = 1.395 kW

Total kWh saved/year: 1.395 kW x 3 hrs/day x 365 days/year = 1,527 kWh

Total energy \$ saved/year: 1,527 kWh x \$0.045/kWh + 1.395 kW x \$89.11/kW = \$193

Because of the longer life of compact fluorescent lamps, it was calculated that the net savings in lamp replacements averaged \$110 per year (including labor). Therefore, the total annual savings of using compact fluorescent lamps were estimated at \$303. Assuming a 10-year life for the task light fixtures, the lifecycle savings were calculated to be:

$$\$303/\text{year} \times 8.11 \text{ (NPV multiplier for 10-year life)} = \$2,457$$

Compact fluorescent reading lamps were estimated to cost \$60 more than incandescent reading lamps, for a total added cost of \$1,860. Therefore, the total net benefit to the City was \$597 (\$2,457 - \$1,860).

Reference Material

To obtain a copy of the CEC's *Advanced Lighting Guidelines*, call (916) 654-5106 or (800) 772-3300.

SAMPLE COMPACT FLUORESCENT FIXTURE SPECIFICATION

Following are sample fixture schedule entries for compact fluorescent scone lights, downlights, and task lights.

Tag	Description	Lamp	Ballast	Volts	Watts	Product
B1	Sconce light, quarter sphere etched opal white glass with polished chrome trim.	(1) 13-watt twin tube	HPF	120	17	Shaper Lighting 634-CF-120-SC-TC or equivalent
B2	Downlight 6" diameter with clear specular Alzok reflector	(2) 13-watt twin tube, 3000K	HPF	120	34	Capri PL17/120, PL17/120 HPF-T442 or equivalent
B3	Compact fluorescent task light, fully adjustable 34" arm, swivel neck, metal clamp on bracket.	(1) 13-watt twin tube	HPF	120	17	Ledu XPL 610 Black or equivalent

Minimum Requirements for Lamps and Ballasts

1. Acceptable manufacturers are Osram, Panasonic, and Philips
2. Lamps shall have a color temperature of (2700 K, 3500 K, 4100 K). CRI shall be 80 or greater.
3. Lamps shall be rated at 10,000 hours or greater average lamp life.
4. Manufacturer's warranty shall cover replacement of all lamps showing defects within 90 days of use.

Minimum Requirements for Compact Fluorescent Ballasts

1. High power factor (over 90%) ballasts shall be used.
2. The wattage of the lamps and ballasts shall fall below the following maximums:

<u>Lamp Type</u>	<u>Maximum Wattage (lamp plus ballast)</u>
5-watt twin tube	9
7-watt twin tube	11
9-watt twin tube	13
13-watt twin or quad	17
18-watt quad (120 V)	25
18-watt quad (277 V)	22
26-watt quad (120 V)	37
26-watt quad (277 V)	31
27-watt quad	34

Appendix F

Roles of Commissioning Team Members

Through the *Intervention Strategies* Commissioning pilot project, the Bureau of Energy Conservation investigated various existing commissioning guidelines. Appendix F is an excerpt from the Bonneville Power Administration's *Building Commissioning Guidelines*¹.

¹ Bonneville Power Administration, *Building Commissioning Guidelines*, Second Ed., November 1992, publication DOE/BP-1574.

CHAPTER 3

ROLES OF THE COMMISSIONING TEAM MEMBERS

The process of commissioning a building is a team effort often involving the sponsoring utility, a Commissioning Agent (CA), the owner, the designer, the building contractors, the facility manager, and the building operating staff. The parties responsible for the various tasks involved in the process differ with each project and depend on the size of the building, the complexity of systems and controls, the number and complexity of the funded energy efficiency measures (EEMs), and the skills of the members involved. Smaller projects may not have all the parties involved as described here. In any project roles may overlap or be interchanged and combined among members. Flexibility is essential when defining the responsibilities of team members so that the needs of each individual project can be met.

The following description of the roles and responsibilities of team members would be typical for a large, complex project.

Utility

The utility's degree of responsibility depends on how involved the utility wants to become in the commissioning process and how much of the cost it chooses to bear. In some cases, utilities are taking a proactive role in the process. As part of their conservation program, the utilities are pre-qualifying and training the Commissioning Agents that will oversee the projects requiring commissioning. The utility-trained Commissioning Agent is then hired by the utility and reports directly to the utility.

In other cases, the utility and owner are partners in the process. The utility may pre-qualify and train a pool of Commissioning Agents and recommend that the owner hire an agent from that pool. The CA is then directly responsible to the owner. In any case, the utility may fund all or part of the commissioning endeavor.

The utility is responsible for negotiating with the owner the commissioning objectives, finding the most cost-effective and efficient ways to meet those objectives, and ensuring the objectives are in accordance with the owner's operating requirements. The utility often retains the responsibility for EEM acceptance and funding payment decisions based on the CA's reports and recommendations. The utility is also responsible for negotiating with the owner any evaluation requirements for the project (see Evaluation Phase in Chapter 4).

Owner

The owner sets the operating requirements, such as the occupancy schedule, special ventilation, and control and lighting for the facility. The owner often hires the Commissioning Agent. The owner works in partnership with the sponsoring utility to meet the commissioning objectives by facilitating communication with the contractors for scheduling of tests and gathering of documentation such as design intent documents and as-built drawings. The owner determines what role the facility manager and building operating staff will play in the process.

Commissioning Agent (CA)

The CA is a qualified person, company, or agency that plans and carries out the overall commissioning process. The only formal certification process for Commissioning Agents is through the National Environmental Balancing Bureau (NEBB); however, the certification is not widely recognized at this time. The qualifications are often generated by the owner or utility responsible for hiring the CA and are based on the needs and complexity of the projects (see Appendix B for a sample List of Commissioning Agent Qualifications). The CA's experience should be appropriate to the specific project. For example, if the main energy efficiency measure is thermal storage, the CA selected should be required to have experience that would adequately prepare him or her to commission a thermal storage plant.

Since many projects have a variety of measures, the CA chosen should be warned to subcontract work in which he or she lacks sufficient experience. Though an individual may have substantial experience in troubleshooting, designing, and balancing HVAC systems, he or she may have very little experience with the power quality issue that may arise due to the nonlinear loads produced by some of the new energy-efficient technologies.

The CA develops the commissioning plan, the detailed pre-functional and functional performance tests, and the final commissioning report, including all the necessary documentation. The CA schedules, coordinates, and facilitates the team to ensure members understand the objectives of commissioning and complete their assigned tasks. The CA submits regular progress reports to the utility and owner as required.

The CA oversees all of the functional performance tests, as well as the standard contractor start-up tests, the air and water testing and balancing procedures, and duct pressure tests. The CA may be required to perform all or some of the functional performance tests. The CA coordinates and documents the final evaluation of the systems' capabilities to meet the design intent and owner's criteria.

The CA provides review and comment on technical considerations during all phases of design and construction with a view towards the eventual operations and maintenance of the building. The CA also provides review and comment on the vendor-prepared and contractor-prepared training presentation before it is delivered to the building operating staff and facility manager. The CA may review the operation and maintenance manuals and design intent documentation for completeness (see Appendix C for Recommended Contents for Operation and Maintenance Manuals and Appendix D for Sample Design Intent Documentation). However, this review responsibility does not relieve other parties of their responsibilities concerning documentation. Chapter 4 describes the role of the Commissioning Agent throughout all of the project phases from predesign to evaluation.

Designers

The designer documents the design intent of all systems and controls; monitors construction activities; and reviews and approves shop drawings, mock-ups, operation and maintenance manuals, as-built drawings, and documentation. On very complex projects the designer may be asked to review the commissioning plan and functional performance tests. Also, the designer must generally ensure that the commissioning process is included in appropriate sections of the contract specifications. At the request of the CA, the designer may make site visits during construction to see that the work is being done according to plan.

General Contractor

The general contractor assists with the development and execution of the functional performance test procedures for all systems. The contractor also helps facilitate the commissioning schedule to keep the work proceeding smoothly.

Subcontractor

The various subcontractors are responsible for performing commissioning functions as described in the contract specifications. They generally assist in developing the commissioning plan and functional performance tests, perform the pre-functional performance tests and functional performance tests of the systems they install, make adjustments as appropriate, and document the performance of the systems. Subcontractors are responsible for providing equipment submittals, installation and O&M manuals, and design change information to the CA in a timely manner. They also provide O&M training to the building staff members for their respective equipment and systems as required.

Manufacturers' Representatives

Manufacturers' representatives provide manufacturer specifications and test data. If necessary, the manufacturers' representatives assist the contractors with the functional performance tests and the O&M training.

Building Operating Staff

The building operating staff may assist contractors with the functional performance tests when possible. This speeds up the tests and documentation and ensures that the staff understands the systems as installed. The facility manager and operators are responsible for attending the contractor or vendor training sessions.

Summary of Responsibilities of Commissioning Team Members

Utility.

- Develops Commissioning Agent qualifications.
- Trains or orients Commissioning Agents.
- Structures the commissioning process according to the objectives of the conservation program.
- Works closely with building owner or owner representative.
- Tracks energy use over time through metering.
- May hire the Commissioning Agent.
- Often responsible for acceptance and payment decisions.

Building Owner.

- Sets operating requirements and agrees to commissioning objectives.
- Works with utility to meet commissioning objectives.
- Determines the role of O&M staff in the commissioning process.
- May hire the Commissioning Agent.
- Facilitates communication between the CA and the contractors.

Commissioning Agent.

- Prepares commissioning plan, test plan, and final report, and submits regular progress reports.
- Coordinates the commissioning team and work schedule.
- Reviews commissioning specification.
- Oversees the pre-functional performance tests and standard contractor tests.
- Performs and/or oversees the functional performance tests .
- Reviews training material and procedures.
- Reviews submittals.

- Reviews operation and maintenance manuals.
- Reviews as-built drawings and documentation.
- Prepares the final report.
- Recommends acceptance or non-acceptance to owner and/or utility.

Designer.

- Documents design intent.
- Oversees construction activities.
- Participates in the commissioning process as required.
- Ensures commissioning is included in the design specifications.
- Reviews and approves shop drawings, mock-ups, and operation and maintenance manuals.
- Reviews as-built drawings, control strategies, and documentation.

Contractors.

- Develop commissioning plan.
- Perform the work and supply equipment and systems as stated in the contract documents.
- Provide documentation as required by the Commissioning Agent.
- Perform pre-functional tests and checks.
- Perform functional performance tests as required.
- Fine tune and adjust equipment and systems.
- Assemble operation and maintenance manuals.
- Provide O&M training to building staff.

Manufacturers' Representatives.

- Provide manufacturer's specifications and test data.
- Assist contractors with functional performance tests and O&M training.

Building Operating Staff.

- Assist with functional performance tests as required.
- Attend contractor and vendor training sessions.

Appendix G

Sample *Motormaster* Printout

Through the *Intervention Strategies* Motor Efficiency pilot project, BEC compiled tools for motor specifiers. One of these tools was Washington State Energy Office's *Motormaster* efficient motor selection software. Appendix G is a sample printout from this software.

07/14/93

Motor Comparison and Payback Analysis Report
Working Motor Replacement

	Existing Motor	New Motor
Manufacturer:	-n/a-	Reliance
Model:	Existing Motor	U-FRAME ENERGY EFF.
Enclosure:	Totally Enclosed	Totally Enclosed
Voltage:	230 V	230/460
Horsepower:	100	100
Speed:	1800	1800
Annual hours of use:	8760	8760
Percentage load:	75 %	75 %
Old motor loss (%):	2.0 %	
Efficiency (%):	85.0 %	96.1 %
Dealer discount (%):		35.0 %
Purchase price (\$):	\$	\$ 6274
Installation cost:		\$ 900
Motor rebate (\$):		\$ 425
Energy price (\$/kWh):	\$ 0.0460	
Demand charge (\$/kW-Mo):	\$ 7.42	

ENERGY SAVINGS	Existing Motor	New Motor	
Motor premium (\$):		\$ 6749	
Energy use (kWh/yr):	576614	510012	
Energy cost (\$/yr):	\$ 26524	\$ 23461	
Demand charge (\$/yr):	\$ 5861	\$ 5184	
Annual energy savings:		66602 kWh	\$ 3064
Demand savings:			\$ 677
Total savings (\$/yr):			-----
Simple payback (yrs):		1.80	\$ 3741

Appendix H

Directory of Motor Equipment Manufacturers and Associations

Through the *Intervention Strategies* Motor Efficiency pilot project, the Bureau of Energy Conservation compiled tools for motor specifiers. One of these tools was the American Council for an Energy Efficient Economy's (ACEEE) *Energy-Efficient Motor Systems* handbook¹. Appendix H is an excerpt from one of this handbook's appendices.

¹ *Energy Efficient Motor Systems: A Handbook on Technology, Program and Policy Opportunities*; American Council for an Energy Efficient Economy (ACEEE) for the Western Area Power Administration, 1991.

Equipment Manufacturers and Associations

This appendix is divided into seven sections:

1. Motor manufacturers
2. ASD manufacturers
3. Power-factor controller manufacturers
4. Vendors of power-factor correction systems
5. Test and repair equipment manufacturers
6. Software suppliers
7. Trade and professional associations related to motors and drives

1. Motor Manufacturers

Product characteristics are listed in parentheses as follows for those manufacturers who responded to our survey:

- (F) fractional horsepower
- (I) integral horsepower
- (L) large motors (over 350 hp)
- (1) single-phase
- (3) three-phase
- (p) permanent-magnet (brushless)
- (s) synchronous
- (i) induction

A.O. Smith Electric Motor Co. (FI13i)
531 N. Fourth St.
Box 688
Tipp City, OH 45371
(513) 667-6800
(513) 667-5030 (fax)

Baldor Electric Co. (FI13pi)
5711 S. 7th St.
Fort Smith, AR 72902
(501) 646-4711
(501) 648-5792 (fax)

ASEA-Brown Boveri (FI13psi; to
European specifications)
Industrial Systems
P.O. Box 372
Milwaukee, WI 53201
(414) 785-3200

Canadian General Electric Co.,
Ltd. (L3si)
107 Park St., North
Peterborough, Ontario K9J7B5
(705) 748-8486

Delco Products Division (FIL3i)
General Motors Corporation
P.O. Box 1042, Mail Stop 4-09
Dayton, OH 45401-1042
(513) 455-9097

Emerson Electric Co.
Emerson Motor Co. (F13i)
P.O. Box 3946
8000 W. Florissant Ave.
St. Louis, MO 63136
(314) 553-2000
U.S. Electrical Motors (FIL13i)
8100 W. Florissant Ave.
St. Louis, MO 63136
(314) 553-2000

Fasco Industries, Inc. (F1pi)
Motor Division
500 Chesterfield Center, #200
St. Louis, MO 63017
(314) 532-3505
(314) 532-9306 (fax)

Franklin Electric (FI13i)
400 E. Spring
Bluffton, IN 46714
(800) 437-6897

General Electric Co. (FIL13psi)
Commercial & Industrial
Sales Dept.
1635 Broadway
P.O. Box 2222
Fort Wayne, IN 46801
(219) 428-2000

Grainger Engineering (Dayton)
(FI13si)
5959 W. Howard
Chicago, IL 60648
(708) 647-8900

Leeson (FI13pi)
21000 Washington Ave.
Grafton, WI 53024
(414) 377-8810

Leroy-Somer (FIL13pi)
Division of Emerson Electric Co.
560 S. Hicks Rd.
Palatine, IL 60067-6996
(708) 359-2440
(708) 359-2156 (fax)

Lincoln Electric Co. (I3i)
22801 St. Clair Ave.
Cleveland, OH 44117-1199
(216) 481-8100

MagneTek Century Electric (FI;
DC only)
1881 Pine St.
St. Louis, MO 63103
(314) 436-7800
MagneTek Indiana General
(FI; DC only)
1168 Barranca Dr.
El Paso, TX 79935
(915) 593-1621

MagneTek Louis Allis (IL3si)
P.O. Box 2020
Milwaukee, WI 53201-2020
(414) 481-6000
(414) 481-8895 (fax)

MagneTek Universal Electric
(F13i)
300 E. Main Street
Owosso, MI 48867
(517) 723-7866

Marathon Electric Mfg. Corp.
(FI13i)
P.O. Box 8003
Wausau, WI 54402-8003
(715) 675-3311

Morrill Motors (F1i)
3685 Northrup
Ft. Wayne, IN 46805
(219) 484-1519

Powertec Corp. (Flp)
13504 S. Point Blvd.
P.O. Box 410129
Charlotte, NC 28241-0129
(704) 588-1956
(704) 588-7315 (fax)

Reliance Electric Co. (FIL13psi)
24701 Euclid Ave.
Cleveland, OH 44117
(800) 245-4501
(216) 266-7536 (fax)

Siemens Energy & Automation
(IL3psi)
Industrial Motor Div.
4260 Forest Ave.
Norwood, OH 45212-3396
(513) 841-3100

Sterling Electric (FIL13i)
16752 Armstrong Ave.
Irvine, CA 92714
(800) 654-6220
(714) 474-0543 (fax)

Teco American (FIL13si)
6877 Wynnwood
Houston, TX 77008
(713) 864-5980

Toshiba/Houston (IL3psi)
13131 W. Little York Rd.
Houston, TX 77041
(800) 231-1412

U.S. Motors
see Emerson Electric

Westinghouse Motor Co. (L3si)
P.O. Box 277
Round Rock, TX 78680-0277
(800) 451-8798

2. ASD Manufacturers

AC Technology Corp.
Douglas St.
Uxbridge, MA 01569
(508) 278-6781
(508) 278-7873 (fax)

Allen Bradley
Drives Division
1201 S. Second St.
Milwaukee, WI 53204
(414) 382-2000
(414) 382-4444 (fax)

ASEA-Brown Boveri
Industry Div.
1460 Livingston Ave.
North Brunswick, NJ 08902
(201) 932-6000

Autocon Industries, Inc.
995 University Ave.
St. Paul, MN 55104
(800) 328-3351

Baldor Electric Co.
P.O. Box 2400
Fort Smith, AR 72902
(501) 646-4711
(501) 648-5792 (fax)

BBC Brown Boveri
Industry Div.
1460 Livingston Ave.
North Brunswick, NJ 08902
(201) 932-6000

Eaton Corp.
Electric Sales Div.
3122 14th Ave.
Kenosha, WI 53141
(800) 322-4986

Emerson Electric Co.
Industrial Controls
3036 Alt Blvd.
Grand Island, NY 14072
(716) 773-2321

GEC Automation
Projects Incorporated
2871 Avondale Mill Rd.
Macon, GA 31206
(912) 784-5200

General Electric Co.
Drive Systems Dept.
1501 Roanoke Blvd.
Salem, VA 24153
(703) 387-8735

Graham Co.
8800 W. Bradley Rd.
Milwaukee, WI 53223
(414) 355-8800
(414) 355-6117 (fax)

Hampton Products Co.
Division of Danfoss
2995 Eastrock Dr.
Rockford, IL 61109
(815) 398-2770

Hitachi America Ltd.
50 Prospect Ave.
Tarrytown, NY 10591
(914) 332-5800

Lovejoy Electronics
2655 Wisconsin Ave.
Downers Grove, IL 60515
(800) 323-3534

MagneTek
Drives & Systems Div.
16555 W. Ryerson Rd.
New Berlin, WI 53151
(800) 541-0939
(414) 782-1283 (fax)

Mitsubishi Electric
Sales America
799 N. Bierman Circle
Mount Prospect, IL 60056
(800) 323-4216

Parametrics
Unit of ASEA
88 Marsh Hill Rd.
Orange, CT 06477
(203) 795-0811

Polyspede Electronics Co.
6770 Twin Hills Ave.
Dallas, TX 75231
(214) 363-7245

Relcon
80 Walker Dr.
Brampton, Ontario LGT 4H6
(416) 458-1100

Reliance Electric Co.
Electrical Drives Group
24703 Euclid Ave.
Cleveland, OH 44117
(216) 266-7000

Robicon Corp.
100 Sagamore Hill Rd.
Pittsburgh, PA 15239
(412) 327-7000

Rondo Motor Control
Motor Div. of ASEA-Brown Boveri
2150 W. 6th Ave.
Broomfield, CO 80020
(303) 469-1742

Ross Hill Controls Corp.
1530 West Belt Drive North
Houston, TX 77043
(713) 467-9888

Saftronics
5580 Enterprise Parkway
Ft. Myers, FL 33905
(800) 533-0031
(813) 693-2431 (fax)

Siemens Energy & Automation
150 Hembree Park Dr.
Roswell, GA 30077
(404) 442-2500

Southcon
3608 Rozzells Ferry Rd.,
Charlotte, NC 28216
(704) 393-1636

Square D Co.
P.O. Box 9247
Columbia, SC 29290-0247
(803) 776-7500

T.B. Wood's Sons Co.
440 N. 5th Ave.
Chambersburg, PA 17201
(717) 264-7161

Toshiba/Houston
13131 W. Little York Rd.
Houston, TX 77041
(800) 231-1412

Vee-Arc Corp.
50 Milk St.
Westborough, MA 01581
(617) 366-7451

Voith Transmissions
7 Pearl Ct.
Allendale, NJ 07401
(201) 825-8855

Westinghouse Electric Corp.
Control Div.
P.O. Box 819
Oldsmar, FL 33557
(813) 855-4621

Westinghouse Electric Corp.
I/C Projects Div.
2040 Ardmore Blvd.
Pittsburgh, PA 15221
(412) 636-3010

York Internat'l Corp.
P.O. Box 1592
York, PA 17405
(717) 771-7890

Zycron Systems
72 Acton St.
West Haven, CT 06516
(203) 932-8471
(203) 932-1459 (fax)

6. Software Suppliers

The number of suppliers of software related to motors and their applications is rapidly growing. The following listings are intended to be a sample rather than a comprehensive compilation. Several periodicals (including ASHRAE Journal, Consulting-Specifying Engineer, and Energy Engineering) publish directories of software on a regular basis.

Fan, Pump, Mechanical Transmission, Duct, and Pipe Software

In addition to general-purpose analysis tools, an increasing number of manufacturers have incorporated computerized versions of their catalogs into software written to assist users in finding the proper fan, pump, or transmission equipment for a given application. Software designations in this subsection are as follows:

- (d) ducts
- (f) fans
- (mt) mechanical transmission components
- (pi) pipes
- (pu) pumps

APEC, Inc. (d,pi)
Miami Valley Tower, Suite 2100
40 W. 4th St.
Dayton, OH 45402
(513) 228-2602

Aurora Pump (pu)
Unit of General Signal
800 Airport Rd.
North Aurora, IL 60542
(708) 859-7074

Bayley Fan Group (f)
843 Indianapolis Ave.
P.O. Box 646
Lebanon, IN 46052-0646
(317) 482-3650

Browning Manufacturing (mt)
P.O. Box 687
Maysville, KY 41056
(606) 564-2011

Buffalo Forge Co. (f)
Box 985
Buffalo, NY 14240
(716) 847-5282

Carrier Corporation (d,pi)
Carrier Parkway/TR-1
Syracuse, NY 13221
(315) 433-4018

E. Jessup & Associates (d,pi)
4977 Canoga Ave.
Woodland Hills, CA 91364
(808) 884-3997

Elite Software (d,pi)
P.O. Drawer 1194
Bryan, TX 77806
(800) 648-9523
(409) 846-2340

Engineered Software, Inc. (pi,pu)
1015 10th Ave. SE
Olympia, WA 98507
(206) 786-8545

Greenheck Fan Corporation (f)
Box 128
Schofield, WI 54476
(715) 359-6171

Hartzell Fan, Inc. (f)
P.O. Box 919
Piqua, OH 45356-0919
(800) 334-3267

ITT Bell & Gossett (pu)
ITT Fluid Technology Corp.
8200 N. Austin Ave.
Morton Grove, IL 60053
(708) 966-3700

MC-2 Engineering Software (d,pi)
8107 SW 72nd Ave. #425
Miami, FL 33143
(305) 665-0100

MTS Software (pu)
5 Oak Forest Ct.
St. Charles, MO 63303
(314) 441-1022

National Planning and Consulting
Corp. (mt)
P.O. Box 140489
Coral Gables, FL 33114-0489
(305) 442-1133

O-I/Schott Process Systems, Inc.
(pu)
Box T
Vineland, NJ 08360
(609) 692-4700

Penn Ventilator Co., Inc. (f)
Red Lion & Gantry Roads
Philadelphia, PA 19115
(215) 464-8900

Taco, Inc. (pu)
1160 Cranston St.
Cranston, RI 02920
(401) 942-8000

The Trane Company (d,pi)
3600 Pammel Creek Rd.
La Crosse, WI 54601
(608) 787-3926

United McGill Corporation (d)
Sheet Metal Products Engineers
200 E. Broadway
Westerville, OH 43801
(614) 882-7401

High-Efficiency Motor Savings Analysis

High-Efficiency Motor Financial Evaluation Program

Ontario Hydro
Technical Services and
Development Dept.
Attn: Gord Latos
700 University Ave.
Toronto, Ontario M5G 1X6
(416) 592-5332

High-Efficiency Motor Rebate Software Package

BC Hydro
Industrial Energy Management
HEMA Software Package
1045 Howe St., 6th floor
Vancouver, BC V6Z 2B1
(604) 663-3761

NEWMOTOR.WK1

Walter Johnston
Industrial Extension Service
North Carolina State University
Box 7901, Page Hall
Raleigh, NC 27695
(919) 737-2356

Industrial Motor Database

Washington State Energy Office
Electric Ideas Clearinghouse
809 Legion Way SE, #FA-11
Olympia, WA 98504-1211
(206) 956-2148 or
(800) 872-3568 in OR, WA, MT
and ID

Adjustable-Speed Drives Savings Analysis

Adjustable-Speed Drives Economic Analysis

BC Hydro
Industrial Energy Management
Drives Software Package
1045 Howe St., 6th floor
Vancouver, BC V6Z 2B1
(604) 663-3761

ASCON I and ASCON II

Power Electronics Applications
Center
10521 Research Dr., #400
Knoxville, TN 37932
(615) 675-9505

Appendix I

San Francisco Facilities Condition Monitoring Program

Through the *Intervention Strategies* Facilities Condition Monitoring Program (FCMP) pilot project, the Bureau of Energy Conservation coordinated with San Francisco's Capital Resource Management office to incorporate energy efficiency into facility audits and retrofit equipment specifications. Appendix I contains: a chart showing an overview of the FCMP program, a sample FCMP printout, a lighting retrofit guideline, and a sample efficient fixture cut sheet.

CITY OF SAN FRANCISCO, DEPARTMENT OF PUBLIC WORKS
FACILITY CONDITION MONITORING PROGRAM

PROGRAM ASSESSMENT FRAMEWORK

The chart below displays the assessment framework used to identify the nature of a deficiency for all elements within building systems. The class relates to the classification of a deficiency into six categories: 0 for operation maintenance, 1 for health and safety, 2 for cost avoidance, 3 for functional needs, 4 for facility improvement and 5 for facility expansion. The status relates to the time framework associated with correction of an identified deficiency. The combination of class and status values thus generates 14 assessment codes used to rate the type of deficiencies identified, as shown in the Program Assessment Framework chart.

STATUS				
CLASS	M MINOR REPAIR/ REPLACEMENT OF DETERIORATING COMPONENTS AND FINISH SURFACES WITH PROJECT COST LESS THAN \$10,000.	A -EXISTING IMMEDIATE CORRECTIVE ACTION NEEDED- HIGH LEVEL OF DETERIORATION	B -IMMINENT -CORRECTIVE ACTION NEEDED IN 2-3 YEARS -MODERATE LEVEL OF DETERIORATION.	C -POTENTIAL -CORRECTIVE ACTION MAY BE NEEDED IN 4-5 YEARS -LOW LEVEL OF DETERIORATION
0 OPERATION MAINTENANCE	OM			
1 HEALTH AND SAFETY CONCERN		1A		
2 COST AVOIDANCE		2A	2B	2C
3 FUNCTIONAL NEEDS		3A	3B	3C
4 FACILITY IMPROVEMENT		4A	4B	4C
5 FACILITY EXPANSION		5A	5B	5C

DEPT	FACILITY ID	FACILITY NAME	FACILITY STREET ADDRESS	BUILDING	CONTACT PERSON	TELEPHONE NO
42	000001308	ZOO - WELDING SHOP	GREAT HIGHWAY AND SLOAT	JOE	RUSK	(415) 753-7087
	000001309	ZOO RESIDENCE	GREAT HIGHWAY AND SLOAT	JOE	RUSK	(415) 753-7087
	000001311	ZOO - CAPYBARA SHELTER	GREAT HIGHWAY AND SLOAT	JOE	RUSK	(415) 753-7087
	000001312	ZOO - BEAR DENS	GREAT HIGHWAY AND SLOAT	JOE	RUSK	(415) 753-7087
	000001313	ZOO - SEALS	GREAT HIGHWAY AND SLOAT	JOE	RUSK	(415) 753-7087
	000001314	ZOO - AVIARY	GREAT HIGHWAY AND SLOAT	JOE	RUSK	(415) 753-7087
	000001315	ZOO - KOALA HABITAT	GREAT HIGHWAY AND SLOAT	JOE	RUSK	(415) 753-7087
	000001316	CHILDRENS ZOO - NURSERY	GREAT HIGHWAY AND SLOAT	JOE	RUSK	(415) 753-7087
	000001317	CHILDRENS ZOO - BARN	GREAT HIGHWAY AND SLOAT	JOE	RUSK	(415) 753-7087
	000001319	ZOO - HEATING PLANT/RESTROOM	GREAT HIGHWAY AND SLOAT	JOE	RUSK	(415) 753-7087
	000001320	ZOO - IRRIGATION PUMP HOUSE	GREAT HIGHWAY AND SLOAT	JOE	RUSK	(415) 753-7087
	000001321	ZOO - SEWAGE PUMP HOUSE	GREAT HIGHWAY AND SLOAT	JOE	RUSK	(415) 753-7087
	000001322	ZOO - MONKEY ISLAND	GREAT HIGHWAY AND SLOAT	JOE	RUSK	(415) 753-7087
	000001330	NURSERY-HOT HOUSE	GOLDEN GATE PARK	JIM	LUCEY	(415) 753-7013
	000001331	NURSERY-COLD HOUSE	GOLDEN GATE PARK	JIM	LUCEY	(415) 753-7013
	000001829	ADAM ROGER PARK	JENNINGS STREET/OAKDALE AVE	JIM	LUCEY	(415) 753-7013
	000001831	DESSIE CARTRIDGE	FOLSOM/SHERMAN STREETS	JIM	LUCEY	(415) 753-7013
	000001833	BROOKS PROPERTY	373 RAMSELL STREET	JIM	LUCEY	(415) 753-7013
	000001835	COUNTY FAIR BUILDING	9TH AVE/LINCOLN WAY	JIM	LUCEY	(415) 753-7013
	000001837	HALL OF FLOWERS	9TH AVE/LINCOLN WAY	JIM	LUCEY	(415) 753-7013
	000001839	MAINTENANCE YARD	3RD AVE/KING DRIVE			
	000001841	PORTSMOUTH SQ. PARKING GARAGE	733 KEARNY STREET			
	000001843	ST. HARRY'S PARKING GARAGE	PINE STREET/GRANT STREET			
44	000001053	DPW ENGINEERING OFFICES	460 MCALLISTER ST	ROBERT	NEWMAN	(415) 554-4930
45	000000930	150 OTIS OFFICE BUILDING	150 OTIS ST	JUDITH	SCHUTZMAN	(415) 557-6432
	000000932	170 OTIS / OFFICE BLDG	170 OTIS ST	JUDITH	SCHUTZMAN	(415) 557-6432
	000000111	POLK ST HOMELESS CENTER	1001 POLK STREET			(415) 554-4930
	000000112	FIFTH STREET HOMELESS CENTER	525 FIFTH STREET			(415) 554-4930
46	000000433	DAVIES SYMPH HALL/ZELLEBACH	201 VAN NESS AVE	JAY	CHRONISTER	(415) 621-6000
	000000435	WAR MEMORIAL OPERA HOUSE	301 VAN NESS AVE	JAY	CHRONISTER	(415) 621-6000
	000000437	WAR MEMORIAL VETERAN'S BLDG	401 VAN NESS AVE	JAY	CHRONISTER	(415) 621-6000
47	0000002031	WATER DEPT-ADMINISTRATION	425 MASON STREET	BOB	VASCOINCELLOS	(415) 923-0000
	0000002033	SUNOL-ADMIN/BUSINESS OFF/SHOPS	505 PALOMA AVENUE	BOB	VASCOINCELLOS	(415) 923-0000
	0000002035	SUNOL/MILES-VALVE HOUSE	8787 ENTERPRISE DRIVE	BOB	VASCOINCELLOS	(415) 923-0000
	0000002037	SUNOL-PUMP STATION (DRISCOLL)	DRISCOLL ROAD/GOMES STREET	BOB	VASCOINCELLOS	(415) 923-0000
	0000002039	SUNOL-PUMP STATION (IRVINGTON)	MISSION BLVD/PALM AVE	BOB	VASCOINCELLOS	(415) 923-0000
	0000002041	SUNOL/CALAVERAS-DAH STOREHOUSE	CALAVERAS DAM ROAD	BOB	VASCOINCELLOS	(415) 923-0000
	0000002043	SUNOL/SAN ANTONIO-TURNER DAM	TURNER DAM ROAD	BOB	VASCOINCELLOS	(415) 923-0000
	0000002045	ALUM TREATMENT PLANT (SAWYER)	CRYSTAL SPRINGS	BOB	VASCOINCELLOS	(415) 923-0000
	0000002047	CASEY QUARRY FLORIDATION	CRYSTAL SPRINGS	BOB	VASCOINCELLOS	(415) 923-0000
	0000002049	CITY DIST DIV-ADMIN/BUS OFFICE	1900 NEMCOB AVE	BOB	VASCOINCELLOS	(415) 923-0000
	0000002051	HYDRO-PNEUMATIC ST-AQUAVISTA	SKYVIEW & AQUAVISTA WAYS	BOB	VASCOINCELLOS	(415) 923-0000
	0000002053	HYDRO-PNEUMATIC ST-BERNAL HIGHT	BOCANA ST. SO. OF POMHATTAN	BOB	VASCOINCELLOS	(415) 923-0000

FCMP/BEC joint pilot project
GUIDELINES for lighting energy efficiency upgrades

Deficiency- <i>Remedy</i>	Description*	BEC rebate
1) Broken/non -functional incandescent EXIT sign.- <i>LED replacement</i>	Replace broken EXIT sign with LED sign.(TraceLite 1-W-W-BD-B or equal)	\$20/sign(single face) \$30/sign(double face)
2) Broken incandescent fixture(200-300watt)- <i>fluorescent replacement</i>	Replace broken fixture with T8/electronic ballasted fluorescent fixture	\$10/fixture
3) Broken fluorescent fixture - <i>T8/electronic ballasted replacement</i>	Replace standard fl.fixture with T8/electronic ballasted fixture(Daybrite CA-2224-4,T8/EB or equal)	\$30/fixture(1 ballast,2 lamps)
4) Burned out T12 magnetic ballast - <i>T8/electronic ballast modification</i>	Replace burned out T12 lamps/ magnetic ballast with T8 lamps/electronic ballast (Osram F032W/735K and Magnetek B232I120 or equal)	\$25/1 ballast, 2 lamp combination
5) Broken incandescent fixture - <i>Compact Fluorescent replacement (eg .recessed squares, downcans)</i>	Replace broken incandescent fixture with compact fluorescent fixture (Halo 6VCN9,Halo 6VCM9, Lithonia LQ/ROI/13QT or equal)	\$30/fixture
6)Burned out incandescent lamp- <i>Compact Fluorescent lamp</i>	Replace incandescent lamp(52W -135W) with compact fluorescent lamp(15W- 27W)	\$15/lamp
7) Broken exterior incandescent or quartz fixture - <i>HID replacement (plus controls)</i>	Replace broken incandescent or quartz fixture(200W-750W) with HID fixture(50W-250W) including photocell	\$50-\$200/fixture
8) Exterior fixture on 24 hours with no switch - <i>Controls</i>	Wire photocell or timer to existing fixture	\$30/photocell \$10/timer

* see attached supplemental materials

7" & 9" Lensed Squares & Trims

Ordering Information: Order housing module and trim separately.
Catalog Number Example: LSF7 2/9TT 120 FW7

Std Pkg = 1, Weight = 8-10 lbs. (3.6-4.5 kg).

Voltage 120, 277 or 347 must be specified

Glass Lens

Aperture: 6-5/8" (15.8 cm)

Aperture: 6-5/8" (15.8 cm)

FW7 Flat White

FR7 Fresnel

Wattage/Lamp S/MH Height in (cm)
2/9TT 1.3 5 (12.7)

Wattage/Lamp S/MH Height in (cm)
2/9TT 1.2 5 (12.7)

Std Pkg = 4, Weight = 8 lbs. (3.6 kg)

Std Pkg = 4, Weight = 8 lbs. (3.6 kg)

Aperture: 6-5/8" (15.8 cm)

Aperture: 6-5/8" (15.8 cm)

D07 Drop Opal Diffuser

CR7 Corning C73

Wattage/Lamp S/MH Height in (cm)
2/9TT 1.3 5 (12.7)

Wattage/Lamp S/MH Height in (cm)
2/9TT 1.2 5 (12.7)

Std Pkg = 4, Weight = 8 lbs. (3.6 kg)

Std Pkg = 4, Weight = 8 lbs. (3.6 kg)

Glass Lens

Aperture: 8-5/8" (20.9 cm)

Aperture: 8-5/8" (20.9 cm)

FW9 Flat White

FR9 Fresnel

Wattage/Lamp S/MH Height in (cm)
3/9TT 1.3 5 (12.7)
2/13TT 1.3 5 (12.7)

Wattage/Lamp S/MH Height in (cm)
3/9TT 1.4 5 (12.7)
2/13TT 1.3 5 (12.7)

Std Pkg = 4, Weight = 8 lbs. (3.6 kg)

Std Pkg = 4, Weight = 8 lbs. (3.6 kg)

Aperture: 8-5/8" (20.9 cm)

Aperture: 8-5/8" (20.9 cm)

D09 Drop Opal Diffuser

CR9 Corning C73

Wattage/Lamp S/MH Height in (cm)
3/9TT 1.3 5 (12.7)
2/13TT 1.3 5 (12.7)

Wattage/Lamp S/MH Height in (cm)
3/9TT 1.3 5 (12.7)
2/13TT 1.3 5 (12.7)

Std Pkg = 4, Weight = 8 lbs. (3.6 kg)

Std Pkg = 4, Weight = 8 lbs. (3.6 kg)

5" LSF9

Canadian Shipments: Consult factory for product specifications. Add CSA as suffix to catalog number.

Note: For options and accessories, see page 94.

Downlighting Advantage[®] Fluorescent Twin Tube

LSF7 7" Lensed Square

Advantage[®] Fluorescent Twin Tube

LSF9 9" Lensed Square

Appendix J

***Energy News* newsletter**

The Bureau of Energy Conservation publishes the *Energy News* newsletter for the purpose of informing other City staff of our programs and available resources. Appendix J is an example issue of the newsletter.

ENERGY NEWS

A Newsletter for Facility Maintainers, Designers, & Administrators

Hetch Hetchy Water & Power, Bureau of Energy Conservation

Winter 1993/4

Lighting Contract Saves Thousands in First Year

New products and rebate program in second year

Nine City departments (see table on back page) capitalized on the Energy-Efficient Lighting Materials (EELM) term contract in the last year, saving over \$143,000 in lifetime electricity costs and \$185,000 in avoided maintenance costs. Purchasing the efficient equipment instead of old standard equipment required paying a premium of only \$40,000.

The EELM contract was re-awarded in November to local distributors *Peerlight*

and *Graybar Electric*. It includes several new products—such as 4-watt LED exit signs—in addition to electronic ballasts and T8 lamps for fluorescent fixtures and an assortment of screw-in compact fluorescents (pictured on back page).

The Bureau is offering *rebates* to promote the use of the contract (see sidebar at right). For more information on the contract items or the rebate program, call Doug Johnson at 554-3178. ☼

Departmental Rebate Offer:

The Bureau of Energy Conservation will split costs on purchases from the EELM contract, up to \$2,000 per department. Here's what you do:

1. Purchase materials from the contract vendors (by TPA or PO)
2. Prepare a Journal Entry for 50% of the cost of your purchase up to a yearly maximum of \$2,000
3. Send us the JE and an invoice and we'll authorize the transfer.

Questions? Call Doug at 554-3178.

Energy Stars

Hall of Justice Building Superintendent Rene Bura and Electrician Manny Reyes changed 200 hallway fixtures to efficient electronic ballasts and T8 lamps, with a significant improvement in light quality.

DPW Project Manager Roger Wong and Architect Sue Fan specified extra ceiling insulation, electronic fluorescent ballasts, and lighting controls in the seismic renovation of Fire Station 8.

Finance Officer Gail Friedlander has promoted the use of compact fluorescents in desk lamps throughout the Tax Collector's Office.

Rec & Park Sets the Pace

Electricians, engineers retrofit department's lighting and boilers

Ever wondered what a department could do if they really set their minds to being energy-efficient and had resources to work with? Recreation & Parks is showing just that, employing Bureau funding and energy expertise as well as a lot of their own technical skill and initiative.

During the past year, the Bureau has teamed up with the Recreation & Parks department to undertake a focused program of lighting retrofits and boiler improvements.

For lighting retrofits, the Bureau and Rec & Park jointly funded a two-person installation crew (pictured at right). They replaced inefficient lighting—from exit signs to underwater pool lights to office lighting—in thirteen facilities. On average, these projects are saving 50% of the electricity used by the old lights.

For boiler improvements, the Bureau has provided training for Rec & Park engineers, a state-of-the-art combustion analyzer, and funding for conservation measures. Rec & Park engineers are pursuing several large projects, such as replacing the heating system in the Golden Gate Park Nursery, along with a program to implement smaller common measures such as installing timeclocks at many facilities. Retrofit work at Rossi Pool, including vent damper/overfire draft control and electronic ignition/gas train improvements will save 30% of the pool's natural gas use, worth \$10,000 annually.

Electrician Wirt Lewis (right) and Assistant Ron Perez under direction of Supervisor Mario Avendano (not pictured), have changed lighting in 13 major Rec & Park facilities during the past year.

BEC Project Manager Christine Vance with Engineers Mark Siegenthaler, Cornelius Murphy, Sr., Waymon Lynch, and Supervisor Frank Bezak are identifying and implementing boiler measures throughout Rec & Park.

The BEC continues to work with Rec & Park, and hopes to extend this focused approach to other departments.

EPA Green Lights Promotes Efficiency

The Environmental Protection Agency's *Green Lights* is a voluntary program that encourages the widespread use of energy-efficient lighting. Increased energy efficiency is the cornerstone of the EPA's new pollution prevention strategy, and is seen as beneficial to the nation's environmental health and economic vitality. Participants include corporations,

environmental groups, electric utilities, and government agencies. To become a partner, an organization must commit to addressing 90% of its cost-effective lighting retrofit opportunities within 5 years.

Based on the success of *Green Lights*, the EPA is initiating other programs, including *Energy Star* to promote energy-efficient computers, and *Water Alliance for Voluntary Efficiency (WAVES)* for water conservation.

The BEC Moves

Since mid-November, the Bureau of Energy Conservation has been working out of a new location: the 4th floor of 1155 Market Street, also home to Hetch Hetchy Water & Power and the Bureau of Light, Heat, & Power. Working in closer proximity with these groups will facilitate joint initiatives dealing with the City's demand-side energy planning and departmental billing. Our new phone numbers are:

General Office	554-3180
Fax	554-3181
John Deakin, Director	554-3175
Cal Broomhead	554-3186
Danielle Dowers	554-3183
Doug Johnson	554-3178
Terry O'Sullivan	554-3184
Roger Picklum	554-3179
Christine Vance	554-3185

From chandeliers...

Studio in the Sharon Arts Building

to boiler rooms...

Down under at Hamilton Pool

Compact fluorescents are doing the job!

Economics and Energy Efficiency

How energy efficiency can help the City budget

Energy costs are typically the second highest operating cost of a business or municipal enterprise, trailing only personnel costs. Lighting, heating, computing, transportation, processing—all these functions (and more) require energy. A key point, however, is that the amount of energy required to perform these functions is not fixed. Efficient equipment and habits can reduce energy and energy costs. *Improving energy efficiency represents an important opportunity for trimming operating costs.*

Energy efficiency in the U.S. can be improved on many levels, from raising mileage standards for vehicles to promoting efficient home appliances, from replacing motors in industrial processes to requiring efficiency in the booming computer market. One of the key factors in the economic success of countries such as Japan and Germany is their energy efficiency, which is several times higher than that of the U.S.

The U.S. Department of Energy estimates that government facilities can cut energy use by 25% by employing off-

the-shelf technologies, and that the energy savings from such projects pay back manyfold for the initial investment required. Federal programs like *Green Lights* (article page 2) target such goals.

Utilities also recognize the potential for efficiency. Today, PG&E offers rebates to offset the initial expense of efficiency measures; demand-side efficiency is more cost-effective for them than providing new energy supply.

Such incentives promote efficiency in the private sector, where lowered energy costs mean healthier businesses and community retention of money that used to be lost to energy bills.

In the public sector, City & County of San Francisco facilities get natural gas from PG&E (we are thus eligible for their gas rebate programs), but get electricity from Hetch Hetchy Water & Power, the City's own municipal utility. Overall, City facilities currently use about \$30 million of electricity and \$9 million of natural gas each year. Given that much of the City's equipment is old and many of our energy habits could be greatly improved, these costs represents a major money-saving opportunity.

In reality, many opportunities are not addressed, mostly because they encounter institutional barriers—insufficient funding, a lack of effective policies, and low awareness—that tend to resist change. The most cost-effective way to evaluate these opportunities is on a "life-cycle cost" basis: what is less expensive over the life of this proposed measure, to do it or not to do it? The option that looks cheaper during the current fiscal year often costs the City much more over the following years.

We encourage all departmental staff and City officials to put energy efficiency on their agenda. By working to realize the large savings potential of increased energy efficiency, we can each have a direct role in improving the City's fiscal health. ☉

Electronic Ballasts Now Cheaper than Standard Models

For several years, electronic ballasts (for fluorescent fixtures) have been cheaper than standard ballasts when lifetime energy costs are figured in; now, due to exploding demand for this efficient technology, the price of electronic ballasts has dropped below that of the old standard equipment!

	electronic	vs.	standard
4-foot	\$17.50		\$18.80
8-foot	\$26.50		\$31.61

[Prices through the City's Electrical Materials and EELM term purchasing contracts, not including prompt-payment discounts]

Updates...

☉ The Bureau presented a series of *Lighting Design Workshops* for DPW Architects and Engineers as part of an ongoing program to ensure energy-efficiency in new construction; another set of workshops is planned for this Spring. [T. O'Sullivan]

☉ The California Office of Energy Assessment is financing a *detailed technical energy audit* of S.F. Community College facilities. [C. Vance]

☉ Southeast Wastewater Treatment Plant is conducting a *trial office lighting project*, monitoring the effects of switching to electronic ballasts and T8 lamps, delamping fixtures from 4-lamps to 3 or 2, and installing specular reflectors. [Jim Smith, 648-6882]

☉ The City's new *Commission on the Environment* began meeting this summer, forming task forces to address a range of issues, including energy. [C. Broomhead]

☉ The Bureau has created an *energy training account* with DPW/Bureau of Engineering. [D. Dowers]

☉ In conjunction with the Bureau, Bayview's Young Community Developers initiated a *Minor Home Repair Program* that trains and employs a crew of young people to make improvements, including simple energy conservation measures such as weatherization, to neighborhood homes, especially those of elderly residents. [C. Broomhead]

☉ PG&E's *Pacific Energy Center* on Howard St. continues to offer excellent free workshops on design issues such as HVAC systems and daylighting. For course announcements, call 973-7268.

☉ Using a 1994 federal grant, the Bureau is researching strategies for assessing and achieving *municipal energy conservation potential*. This includes creating an inventory of conservation opportunities in City facilities and looking for innovative funding mechanisms to finance conservation projects. [D. Johnson]

New fluorescent fixtures with electronic ballasts and T8 lamps in the City College Children's Center (work performed by BBR Electric Shop). Upcoming project sites include Presidio and Ortega branch libraries; Youth Guidance Center's boiler room; the Tax Collector's Office; City College's Downtown campus, and BBR's own Plumbing Shop.

"The new lighting, with its higher output and superior color rendition, has improved the atmosphere of the Center, making it a more enjoyable place to spend the day for both the children and the daycare workers."

- Steve Rico, Director

The Bureau of Energy Conservation promotes energy efficiency in City & County of San Francisco facilities and in the community. The Bureau pursues efficiency through equipment retrofits, municipal policy planning, new construction design review, and community projects. **ENERGY NEWS** is published yearly to inform City facility staff about current issues and programs. For more information on the Bureau's programs, call us at 554-3180. Our inter-office mail address is: Dept. 32, 1155 Market Street, 4th floor.

All photos in **ENERGY NEWS** are the work of the PUC Photo Lab.

New on the contract:

LED exit signs use only 4 watts per face, require no lamp changing, and are available with an emergency battery backup... new compact fluorescents are smaller and perform diverse lighting functions. Call Doug for info, 554-3178.

Who's using the EELM contract?

	Purchase Quantities		Lifetime Savings	
	Compact Fluorescents & PL Lamps	Electronic Ballasts & Fixtures	Energy	Maintenance
Recreation & Parks	405	824	\$56,695	\$37,638
SF General Hospital	320	208	\$19,320	\$24,200
Muni Railway	698	0	\$16,054	\$47,115
Sheriff	303	250	\$21,344	\$23,578
DPW/Building Repair	0	164	\$9,430	\$2,050
Public Library	355	4	\$8,395	\$24,013
DPW/City Hall	180	0	\$4,140	\$12,150
DPW/Water Pollution Control	67	25	\$2,979	\$4,835
Social Services	110	0	\$2,530	\$7,425
War Memorial	0	37	\$2,128	\$463
Community College	28	0	\$644	\$1,890
TOTALS	2,466	1,512	\$143,658	\$185,355

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City & County of San Francisco

ENERGY NEWS

Bureau of Energy Conservation Winter, 1993/4

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REPORT AND INFORMATION SOURCES

Additional copies of "*Intervention of Strategies for Energy Efficient Municipal Buildings*" from the Bureau of Energy Conservation, are available from:

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For additional information on the process and the results of the work described in this report or for information on the overall energy management programs in the City of San Francisco, CA, please contact:

John F. Deakin
Director
Bureau of Energy Conservation
Hetch Hetchy Water and Power
1155 Market Street, 4th Floor
San Francisco, CA 94103

Order No: DG/93-301

SUSTAINABLE COMMUNITIES

AUSTIN, TX - *Sustainable Systems Rating Program*

The city of Austin, long a pioneer in sustainable research planning and practice, developed a sustainability rating system that can be used as a marketing tool to encourage high levels of resource conservation, appropriate usage, and economic development through residential building.

91-302. \$15.00

PTI - *How to Save Thousands - Even Millions of Dollars Through Energy Efficiency (Video)*

Looking for ways to save energy and money? This Urban Consortium Energy Task Force Video shows several cost-conscious and earth-minded methods to do so. Examples include how Phoenix saved \$32 million through retrofitting and how New York City built a natural-gas-powered fleet to comply with the Clean Air Act. 92-402 **FREE!**

SAN DIEGO, SAN FRANCISCO, CA, & PORTLAND, OR - *Sustainable Energy for Local Governments*

With scarce resources and environmental concerns mounting, how can local governments move toward a sustainable system? This practical workbook identifies key components of sustainable energy.

Call Conservation and Renewable Energy Inquiry and Referral Services(CAREIRS) at 1-800/523-2929 for a copy.

SEATTLE, WA - *Coordination of Energy and Air Quality*

Learn how Seattle City Light (SCL) worked with industry to reduce air pollution emissions with positive economic effect. The study conducted during 1991 and 1992 resulted in a working relationship between two agencies (Seattle City Light and the Puget Sound Air Pollution Control Agency) with the same objective - to improve air quality and reduce energy consumption. Read about some of the difficulties encountered and lessons learned by SCL in accomplishing energy conservation among residential and commercial customers.

92-318. \$20.00

TUCSON, AZ - *Tucson Solar Village—Project Management*

The City of Tucson's 820-acre Solar Village project seeks to provide a sustainable community for up to six thousand residents, using solar energy to reduce energy needs by 75%, water conservation methods to reduce usage by 65% per capita, and recycling programs to reduce landfill solid waste.

91-304. \$12.00

TUCSON, AZ - *Local Government Involvement in Long Term Resources Planning for Community Energy Services*

Tucson has also developed a program to coordinate government research, utility, and business energy saving efforts. Results show that by taking a state-wide perspective on resource planning, additional savings and environmental benefits can be achieved through conservation and demand management.

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ALSO AVAILABLE:

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SEATTLE, WA - *Integrating Energy Efficiency into Municipal Purchasing Decisions: Computerizing Procurement Choices*
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Building professionals obtain guidance through this technical support document for Austin's Green Builder Program, aimed at changing conventional building practices.

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MONTGOMERY COUNTY, MD - *Energy Efficient Building design: A Transfer Guide for Local Governments*

A proven "how to" guide for local governments and the private sector on the implementation of energy efficient construction programs.

91-317. \$7.50

SAN FRANCISCO, CA - *Energy Management Action Plan*

The City/County of San Francisco has developed a methodology for local government energy

ABOUT THESE PUBLICATIONS

These publications were produced through research conducted by the Urban Consortium Energy Task Force (UCETF) of Public

Technology, Inc. Many of the research projects were funded through a grant from the U.S. Department of Energy.

The task force was established to address critical energy needs of urban America. The UCETF acts as a laboratory to develop and test solutions and share the resulting products or management approaches with the wider audience of both large and small local governments, states, and local authorities around the world.

UCETF membership includes elected officials, management, and technical professionals from urban cities and counties. It links through the Urban Consortium and PTI to national organizations, such as the National Association of State Energy Officials (NASEO), the National League of Cities, the National Association of Counties, and the International City/County Management Association to ensure the widespread exchange of information and technology.

For more information about the Urban Consortium Energy Task Force (UCETF) or these guidebooks, contact Jack Werner, PTI Business Director, at 202/626-2421.

offices to use in designing Energy Management Action Plans (EMAP). The guide walks readers through the process of creating an EMAP: identifying barriers; researching a setting for the project; and generating ideas to remove specific barriers. Help create more effective facilities in your jurisdiction via a holistic methodology.

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This report explains how district energy systems can reduce the high cost associated with electricity prices for multi-use real estate.

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information on demand-side bidding information; learn advantages and disadvantages of participation; and, discover alternative and "ideal" scenarios for bidding. In addition, preview potential pitfalls and lessons learned from a municipal jurisdiction that has already been through the process and offers its transferable model for your benefit.

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92-301. \$7.50

ALSO AVAILABLE

DETROIT, MI - *Computer Assisted Control for Municipal Water Distribution*
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ALBUQUERQUE, NM - Alternative Vehicle Fuels in Municipal Duty: A Demonstration Project

A comparison of the comparative benefits of CNG, electricity, oxygenated fuels and gasoline as primary fuels for automobiles, with emphasis on environmental impact and fleet integration.
9-316 \$15.00

DENVER, CO - Technical Comparison between Hythane, CNG and Gasoline Fueled Vehicles

A study demonstrating performance of Compressed Natural Gas (CNG) as compared to Hythane, a mixture of CNG and Hydrogen. Hythane was shown to have the potential to meet California's Ultra-Low Emissions Vehicle (ULEV) standard, a criterion currently met only by electric vehicles.
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CONEG - Refueling Alternatives Fuel Vehicles: Lessons Learned from the Marketplace

A study supported by DOE, public officials and energy companies has been conducted by the Coalition of Northeast Governors (CONEG) Policy Research Center, Inc. The findings conclude that information and refueling are two critical needs if fleet managers are to operate alternative fuel vehicles. The study surveyed fleet operators in northeast states. This report provides useful quantitative information for decision makers to make preliminary assessments of potential market demand for the development of refueling infrastructure to serve alternative fuel vehicles.

Copies of the report are available from CONEG; (202)624-8450 for \$50 for the two volume set, \$20 for Volume I and \$40 for Volume II.

HOUSTON, TX - Compressed Natural Gas Fueled Vehicles: The Houston Experience
A feasibility study with additional focus on refueling infrastructure.
90-320 \$22.00

LONG BEACH, CA - NGV Fleet Fueling Station Business Plan

Promote compressed natural gas vehicle use in your municipality's fleet. In this report, based on the City of Long Beach's experience, market barriers as well as an econometric model for the implementation of a CNG infrastructure are addressed. This transferable model may help your municipality effectively address issues associated with the implementation of such an infrastructure.
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NEW YORK, NY- Alternative Transportation Fuels: Financing Issues

This study examines methods of financing alternative fuel vehicles which do not include government subsidies. Learn how high costs can be spread among a number of parties in the private sector.
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The full cost of acquiring and operating a fleet of low emission vehicles is cited in San Diego's compliance strategy report. Learn from this jurisdiction's experience how to create a well-planned approach to changing over to a low emission fleet with minimal municipal service interruption, and improve air quality in your region.
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PTI UCETF - Cleaner Fueled Vehicles (Video)
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The Urban Consortium Energy Task Force of Public Technology, Inc. is chaired by Mike Lindberg, Commissioner, City of Portland, Oregon.

Task Force Members: Albuquerque, NM; Austin, TX; Chicago, IL; Columbus, OH; Denver, CO; Hennepin County, MN; Houston, TX; Memphis, TN; Metro-Dade County, FL; Montgomery County, MD; Orange County, FL; Philadelphia, PA; Phoenix, AZ; Norfolk, VA; San Diego, CA; San Francisco, CA; San Jose, CA; Seattle, WA; Washington, DC.

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