contractor practices, rather than the “stick” of requiring good installation practices to receive equipment rebates.

Marketing

Different parties play more central roles for marketing various aspects of the program, as shown in Table C-10.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Contractors</th>
<th>Designers</th>
<th>Large &amp; Multi-Site Customers</th>
<th>Other Customers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficient unitary equipment sales</td>
<td>Critical marketing channel</td>
<td>Important for new construction</td>
<td>Direct contact is important</td>
<td>Reach through contractors</td>
</tr>
<tr>
<td>Unitary duct design (new buildings)</td>
<td>Critical participant</td>
<td>Critical participant</td>
<td>Critical participant</td>
<td>Participant</td>
</tr>
<tr>
<td>Unitary installation</td>
<td>Direct contact is important</td>
<td>NA</td>
<td>Direct contact is important</td>
<td>Secondary target market</td>
</tr>
<tr>
<td>Chiller efficiency</td>
<td>Critical marketing channel</td>
<td>Important for new construction</td>
<td>Direct contact is important</td>
<td>Reach primarily thru contractors</td>
</tr>
<tr>
<td>Chiller right-sizing</td>
<td>Can sometimes influence design</td>
<td>Critical participant</td>
<td>Critical participant</td>
<td>Critical participant</td>
</tr>
<tr>
<td>Optimize chiller system, optimize against loads</td>
<td>Secondary participant</td>
<td>Critical participant</td>
<td>Critical participant</td>
<td>Critical participant</td>
</tr>
</tbody>
</table>

Unitary sales are heavily influenced by contractors and vendors. The best marketing approach for vendors would involve consistent rebates and promotion across all program sponsors in a region. For example, Northeast Energy Efficiency Partnerships has contracted for “circuit riders” to visit vendors and provide promotion for their unitary rebate program (NEEP 2000). Additionally, for new buildings, it is important to work with customers, designers, and developers to promote efficient units. Under the NEEP program, utilities mostly work directly with customers to compliment the circuit rider's efforts with contractors. However, it may be more practical in some cases for marketing contractors to work with both parties in tandem. Conectiv Power Delivery of New Jersey, a NEEP program member utility, uses this approach.

Unitary installation would be best influenced by working both with contractors and customers to promote a set of efficient practices. While experience in this area is limited, as of this writing NEEP is experimenting with a set of customer education materials on this topic. These materials will help explain why it is important to hire a contractor who follows quality installation practices and what those practices are. A group of New Jersey utilities is also working to develop contractor training installation practices (Lim 2000). Because there is little understanding of the relationship between installation quality, efficiency, and performance...
among customers and contractors, program sponsors could need to take a leadership role in working with contractors to demonstrate quality practices and show the benefits.

Unitary HVAC contractors across the country have become leery of utilities because some electric utilities are buying unitary contractors and competing directly for customers. For this reason, utilities would need to assure contractors that they would not use customer data or other intelligence gathered through efficiency programs for their own purposes. However, this situation also creates an opportunity. To survive, unitary HVAC contractors are increasingly receptive to the idea of premium services as a tool to differentiate themselves in the market. A “premium contractor program,” endorsed by utilities or other program sponsors as a group, could consist of promoting the use of high-efficiency equipment and high-quality controls and economizers (e.g., programmable thermostats, dual enthalpy economizers), and the adherence to a list of quality installation practices.

Chiller sales are heavily influenced by manufacturers’ representatives and distributors. Some highly successful programs market efficient chillers primarily by setting up relationships with these parties. However, larger and more sophisticated customers (some chains, property managers, multi-site office and retail owners, some hospitals, and large institutions) often play a more significant role in product selection and would need to be marketed to as well.

Financial Incentives

These were discussed under “Measures,” above.

Financing

Financing is particularly important for chiller optimization projects due to the significant capital cost. The type of financing referral system discussed under the lighting retrofit acceleration program (later in this appendix) is recommended.

Quality Control

For equipment rebates, the utility would need to review the proposed equipment (proposed specifications in advance where possible,12 installed equipment after the fact) to confirm that it meets program standards. For all equipment, inspections to verify that the specified equipment is installed would be also important. We recommend that efforts to assure proper unitary equipment installation be carefully crafted to not sabotage efforts to enlist vendors. Given the delicate relationships between vendors and utilities discussed above, programs should focus on

12 Because unitary equipment is often replaced under emergency circumstances, it is important that the program permit rebates without pre-inspection as long as equipment qualifies.

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education and marketing for some time before installation quality becomes a program requirement.

Expert engineering review is important to assure that any studies of metered data to help size systems are properly done.

Relationship of Program Strategies to Market Barriers.

These relationships are summarized in Table C-11.

<table>
<thead>
<tr>
<th>Market Barrier</th>
<th>Intervention Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer Access to Information</td>
<td>• Educational materials and promotion for customers explaining equipment efficiency, system performance, design, project planning, and installation.</td>
</tr>
<tr>
<td>Customer Organizational Barriers</td>
<td>• Program sponsors (staff or technical contractors) reduce the burden of recommending strategies and quality control.</td>
</tr>
<tr>
<td></td>
<td>• Development of model bid specifications for efficient equipment.</td>
</tr>
<tr>
<td></td>
<td>• Education for customer regarding how to identify quality contractors.</td>
</tr>
<tr>
<td>Trade Ally Barriers</td>
<td>• Training on efficiency economics, equipment choices, duct design, and installation practices.</td>
</tr>
<tr>
<td></td>
<td>• Help for contractors using efficiency to differentiate themselves in the market.</td>
</tr>
<tr>
<td></td>
<td>• Customer promotions to create the “market pull” to engage contractors. Start with the largest and most motivated customers.</td>
</tr>
<tr>
<td></td>
<td>• Use of unitary rebate program to encourage stocking.</td>
</tr>
<tr>
<td></td>
<td>• Use of technical studies and quality control to bring design contractors and energy specialists to the next level of capability.</td>
</tr>
<tr>
<td>Design Methods and Values</td>
<td>• Promotion of case studies that show quality design paying off.</td>
</tr>
<tr>
<td></td>
<td>• Working closely with manufacturers of chillers to influence toward efficient designs.</td>
</tr>
<tr>
<td></td>
<td>• Use of metered information to improve engineer confidence in appropriately sized systems.</td>
</tr>
<tr>
<td>Product Definition</td>
<td>• Promotion of the CEE Tier II unitary HVAC standard.</td>
</tr>
<tr>
<td></td>
<td>• Development and promotion of the minimum efficiency standards for chillers.</td>
</tr>
<tr>
<td></td>
<td>• Development of utility-endorsed unitary installation checklists.</td>
</tr>
<tr>
<td></td>
<td>• Development of specification and/or certification for quality commissioning.</td>
</tr>
<tr>
<td>Financial Barriers</td>
<td>• Rebates — prescriptive and custom.</td>
</tr>
<tr>
<td></td>
<td>• Financing referral service for large projects.</td>
</tr>
<tr>
<td></td>
<td>• Promotion of successful jobs with bottom-line oriented case studies.</td>
</tr>
<tr>
<td></td>
<td>• Financial planning as a key element of chiller planning workshops.</td>
</tr>
<tr>
<td></td>
<td>• Where practical, promotion of equipment downsizing as capital savings.</td>
</tr>
<tr>
<td></td>
<td>• Promotion of life cycle costing, but don’t expect customer tendencies to focus on first cost to change overnight.</td>
</tr>
</tbody>
</table>
Key Indicators of Success

- Sales of efficient chillers and unitary equipment as a proportion of total sales. For unitary equipment, stocking and sales of Tier II unitary systems would be particularly important.

- Contractor and customer awareness of efficiency issues, including efficient design and installation.

- Contractors who market themselves as “premium service” contractors while adhering to utility-approved equipment selection and procedures.

- Proportion of chiller systems being optimized during design.

- Proportion of chiller systems and large unitary systems commissioned.

Cost and Savings Assumptions

Savings

Efficient chillers are available that exceed the baseline peak efficiencies shown for Conectiv’s program (Table C-7) by 5–20%, depending on the size, type, and brand. Comprehensive chiller optimization generally results in greater savings, typically resulting in additional savings of around 10% or more (Wolpert et al. 1994). CEE Tier I unitary HVAC units reduce energy use by approximately 10% relative to typical non-qualifying units, varying with size. Tier II units save an additional 6–13%, varying with size and manufacturer. Given that efficiency is rated for peak operation, the savings should translate directly into peak savings.

Savings from economizers vary significantly from site to site. Additionally, these measures do not always reduce peak use. Economizers bring air into buildings during cool hours, which in some climates occur in the morning of peak days. This is especially true in moderate, dry summer climates where cool mornings can be followed by peak heat. Economizers that fail in the open mode significantly increase peak load. Experts differ regarding whether such failures are often noticed and corrected, but there is limited information to support any position on this topic. Economizers that fail in the closed mode can also add to peak. If installation of higher-quality economizers results in avoiding failure in a modest share of units, the energy savings would be significant and the peak savings would be significant in many climates.

When comparing savings to cost, it is important to consider the benefit of energy savings as well as peak savings. These depend on hours of use, time of use, and local electric rates.
Cost

For chiller rebates, incentives are paid per kW/ton, so cost/kW can be derived directly from the incentive chart. For example, if a 300 ton chiller were purchased at 0.54 kW/ton instead of 0.60, the cost would be $45/ton for 0.6 kW/ton, or $750/kW. Assuming that the average chiller operates at 85% of capacity during peak (and assuming conservatively that savings are proportional to loading), this would be $882/kW.

For unitary equipment, kW savings at full load can be estimated using the formula:

\[
\text{Peak kW} = \frac{\text{Btu}/\text{EER}}{1000} \\
\text{Where:} \\
\text{Btu/hour} = \text{tons} \times 12,000
\]

Depending on local conditions, some unitary equipment runs at less than full load during utility peak hours because the equipment is oversized or not in use. A 85% loading factor may be reasonable (as discussed above, 70% is typical in residential but commercial average loading is higher). For example, for a 7.5 ton unit, if local common practice were the federal standard of 8.9 EER, the more efficient equipment would cost $311/peak kW.\(^6\)

Local baseline sales patterns should be considered; many areas probably sell a mix of equipment including some at the CEE Tier I standard and some less efficient. Administrative costs should be added to this figure (perhaps 20%, depending on program design and volume).

Non-Energy Benefits

Well-designed HVAC systems tend to meet user requirements better, because the cooling system is better tailored to building requirements. Chiller optimization can often lead to reduced chiller size and consequent reduced capital costs.

Measure life

According to the ASHRAE Handbook (ASHRAE 1999), rooftop air conditioners have a median service life of 15 years and packaged chillers have a median service life of 23 years for centrifugal and absorption units and 20 years for reciprocating units.

\(^6\) Peak kW = \(7.5 \times 12,000(8.9 \times 1000)(11-8.9)/11\) \times 0.85 = 1.64 kW. The incentive suggested in Table C-8 is $68/ton, providing a cost of $311/utility peak kW.
Market Penetration

Penetration rates for efficient equipment, as a share of the units sold each year, are estimated in Table C-12. Bear in mind that this is a generalized projection based on market potential and early field results from existing programs. Anecdotal information indicates that baseline penetrations vary significantly by region. "Before-program" penetration rates should be assumed to be static over the forecast period, except for Tier II unitary equipment, where a "without program" projection is provided. The penetration rates shown are market shares, including nonparticipants.

For unitary equipment, the net increase in penetration would likely include a significant number of nonparticipants who have been influenced by the program (perhaps half, depending on how the program is marketed.). It is less clear whether nonparticipants would be influenced by chiller rebates. This depends on existing baselines and design practices.

Table C-12. Unitary HVAC, Chiller Efficiency, and Chiller Optimization Penetration Rates

<table>
<thead>
<tr>
<th>Year</th>
<th>Unitary Tier II*</th>
<th>Chiller</th>
<th>Chiller Optimization</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Without Program</td>
<td>With Program</td>
<td></td>
</tr>
<tr>
<td>Before</td>
<td>15%</td>
<td>15%</td>
<td>5%</td>
</tr>
<tr>
<td>1</td>
<td>18%</td>
<td>20%</td>
<td>10%</td>
</tr>
<tr>
<td>2</td>
<td>21%</td>
<td>30%</td>
<td>30%</td>
</tr>
<tr>
<td>3</td>
<td>24%</td>
<td>40%</td>
<td>50%</td>
</tr>
<tr>
<td>4</td>
<td>25%</td>
<td>50%</td>
<td>70%</td>
</tr>
<tr>
<td>5</td>
<td>25%</td>
<td>50%</td>
<td>70%</td>
</tr>
</tbody>
</table>

*Assumes significant base year natural market penetration. A 1998 study showed 7% penetration of Tier II equipment in the Massachusetts market in 1998, and availability of Tier II equipment has increased significantly since then (RLW Analytics 1999). Rebate programs help change the market, but many of the influenced customers do not collect the rebate.

These penetrations apply to chiller and unitary equipment sales, not to the existing stock. We estimate that, in 5 years, in regions with an even distribution of equipment ages over the measure life and a 4% annual growth rate, sales will equal 44% of the existing stock of chillers and 55% of the existing stock of unitary HVAC equipment.17

These proportions will vary locally depending on the predominant age of existing system. For example, if there was a boom in unitary installation 15-20 years ago, there will be a boom in replacement sales about now.

17 Chiller turnover = 5 years/23 year life = 22%; chiller growth = 1.04(35 power)-1 = 22%, while 22%+22% = 44%. Unitary turnover = 5 years/15 year life = 33%; Unitary growth = 1.04(35 power)-1 = 22%, while 33% +22% = 55%.
4. Commercial Building Retrocommissioning and Maintenance

Overview

The goal of this program is to promote widespread retrocommissioning and proper ongoing maintenance of large commercial buildings. This program also seeks to build a sizable ongoing local market for retrocommissioning services by addressing the major barriers that hinder retrocommissioning today, particularly the limited number of qualified commissioning engineers and the fact that most building owners and managers are unaware of the benefits of commissioning services. Furthermore, the program seeks to maintain the savings from commissioning over time by training and certifying building maintenance staff in good building operations and maintenance procedures. The program combines training and technical assistance for building owners, managers, maintenance staff, tenants, and commissioning providers with local demonstration projects and other promotions as well as financial incentives to reduce the cost of commissioning services. Key program strategies are discussed below and include:

- Education for building owners and facility managers;
- Local demonstration projects and case studies;
- Establishing a benchmarking system to help building owners assess the performance of their buildings relative to other buildings;
- Active marketing to building owners and managers;
- Defining key services so they would be easier to understand and market;
- Commissioning service provider training and technical assistance;
- Maintenance staff training and certification; and
- Financial incentives to reduce the cost of commissioning services.

In addition, the following recommended strategies complement the above-listed activities and would contribute to the success of the program:

- Local market research;
- Tenant education to encourage tenants to talk to their property managers about workspace quality; and
- Cooperation with other commissioning programs around the country on the development of additional commissioning-related procedures and tools.

Target Market

The prime market for this program, at least in its early years, would be large commercial buildings, over approximately 100,000 square feet in size, with an emphasis on owner-occupied buildings and Class A leased space. Owner-occupants should be targeted because they generally care the most about building energy use since they pay the energy bills and not a tenant. They
are also generally more interested in making investments in their buildings. Class A offices should be targeted because they have the highest rents and maintaining tenant satisfaction is important for keeping occupancy rates and rents high. Large buildings (as well as multiple smaller buildings on common campuses) should be targeted because these buildings generally have complicated HVAC and control systems that could usually benefit from commissioning. Also, large buildings use large amounts of energy, providing opportunities for large energy and cost savings in a single project. And large buildings often have in-house maintenance staff, providing greater opportunities to maintain the savings over time. Eventually, medium-size buildings (50,000-100,000 square feet and possibly even smaller) could be targeted, but initial efforts should target large buildings.

Efficiency Measures

The prime measure to promote would be retrocommissioning services. Retrocommissioning is an event in the life of an existing building that systematically looks for opportunities to improve and optimize a building’s operation and maintenance. Retrocommissioning seeks cost-effective ways to improve functionality of existing equipment and systems, and optimizes how they operate in order to reduce energy waste, extend equipment life, and improve building operation and comfort (Haasl and Sharp 1999).

Retrocommissioning is typically done by a skilled engineer with extensive trouble-shooting and commissioning experience. The commissioning process typically includes four stages — planning, investigation, implementation, and handoff (Haasl and Sharp 1999). The planning stage includes identifying project objectives and systems to be targeted, defining tasks and responsibilities, and preparing a plan that could be used to procure the desired services. The investigation stage includes on-site assessments and testing, including a review of energy use data and maintenance procedures, walk-throughs of the site (during both the day and night), and short-term monitoring of key systems. The investigation phase leads to identification of deficiencies in system operation and maintenance and the development of recommendations to correct these deficiencies. The implementation phase includes implementation of most no- and low-cost recommendations as well as development of a plan for implementing additional improvements over time. Finally, the completed improvements are “handed off” to the owner and their staff, along with information and knowledge gained during the process to help the owner and staff better maintain their building in the future.

In addition, the program promotes training of building maintenance staff on good operations and maintenance procedures. Such training could result in direct energy savings as staff identify and implement improved building management practices (details on many of these procedures can be found in Herzog 1997). Trained personnel are also in a much better position to keep building systems optimized, helping to maintain commissioning savings.
Program Strategies

Several market barriers presently hinder the commissioning of existing commercial buildings. These are summarized in Table C-13.

Table C-13. Barriers to Retrocommissioning

<table>
<thead>
<tr>
<th>Market Barrier</th>
<th>Key Issues</th>
</tr>
</thead>
</table>
| Customer Access to Information               | • Few owners and managers are familiar with commissioning services and their benefits.  
• The value of commissioning services has not been demonstrated enough to satisfy some owners and managers; some perceive that the claims are too good to be true. |
| Shortage of Skilled Contractors, Staff, and  | • Experienced staff and outside service providers are few in number.  
• Training for engineers and building staff in commissioning-related activities is often not readily available.  
• The limited size of the current market for commissioning services makes many potential service providers reluctant to get the training and experience necessary in order to enter the business.  
• Commissioning-procedures and software tools tend to be custom-developed by each commissioning specialist with the result that many tools are not user friendly and there is much overlap of effort. |
| Tools                                        | Customer Difficulty Identifying Quality Contractors and Staff  
• Managers often do not know how to locate experienced staff or outside providers nor can they identify which staff and service providers are well qualified to do commissioning work. |
| Split Incentives                             | • In rental spaces, tenants often pay energy bills, reducing the incentive for building managers to properly commission their buildings.  
• Tenants are unfamiliar with building optimization approaches that could improve the quality of building space as well as reduce operating costs.  
• Even in owner-occupied spaces, internal accounting practices, such the separation of energy, maintenance, and capital budgets, makes it difficult to obtain funds for new services or to provide direct financial benefits to those who agree to finance these services out of their budget. |
| Lack of Time and Institutional Inertia        | • Lack of time, short-planning horizons, and institutional inertia makes it difficult for owners and managers to consider new approaches. |

Program strategies seek to address these barriers in order to:

• Motivate the building owner and their staff to act;  
• Make expertise to optimize building operations readily available; and  
• Institutionalize the building optimization and maintenance process so that savings continue over time.

The relationship between the different barriers and strategies are summarized in Table C-14. Each of the program strategies are discussed further in the sections below.
Using Targeted Energy Efficiency Programs, ACEEE

Table C-14. Relationship Between Retrocommissioning Barriers and Program Strategies

<table>
<thead>
<tr>
<th>Market Barrier</th>
<th>Intervention Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer Access to Information</td>
<td>- Introductory workshops for owners and managers on commissioning and its benefits</td>
</tr>
<tr>
<td></td>
<td>- Marketing to owners and managers</td>
</tr>
<tr>
<td></td>
<td>- Local and owner-specific demonstration projects</td>
</tr>
<tr>
<td></td>
<td>- Establish benchmarking system to help owners compare their buildings to other buildings</td>
</tr>
<tr>
<td>Shortage of Skilled Contractors, Staff, and Tools</td>
<td>- Commissioning service provider training</td>
</tr>
<tr>
<td></td>
<td>- Technical assistance to local service providers by leading commissioning experts</td>
</tr>
<tr>
<td></td>
<td>- Training and certification for building maintenance staff</td>
</tr>
<tr>
<td></td>
<td>- Cooperation with other commissioning programs on the development of improved procedures and tools</td>
</tr>
<tr>
<td>Customer Difficulty Identifying Quality</td>
<td>- Educational workshops for and marketing to building owners and managers</td>
</tr>
<tr>
<td>Contractors and Staff</td>
<td>- Certification program for trained and qualified building maintenance staff</td>
</tr>
<tr>
<td>Split Incentives</td>
<td>- Financial incentives to reduce the cost of commissioning services</td>
</tr>
<tr>
<td>Lack of Time and Institutional Inertia</td>
<td>- Educational materials for tenants on the benefits of building optimization</td>
</tr>
<tr>
<td></td>
<td>- One-on-one marketing efforts</td>
</tr>
<tr>
<td></td>
<td>- Financial incentives to reduce the cost of commissioning services</td>
</tr>
</tbody>
</table>

Owner/Manager Education and Marketing

Education for building owners and facility managers is needed to familiarize these decision-makers regarding the opportunities for and the benefits of commissioning, and to provide information on how to obtain quality services. These efforts should generally target the person with budget authority for a building. A potential marketing strategy would be to emphasize how, for many buildings, building operation is a multimillion expense that is largely unmanaged. To support education efforts, standard materials would be useful such as written materials, case studies, and slide presentations (including short, medium, and long versions for different levels of decision-makers). Much of the marketing would need to be done face-to-face with individual decision-makers or through building owner associations and peer groups. One general approach that has been effective is to identify one site or system to optimize, monitor performance before and after optimization, and use the results to help convince decision-makers to optimize other systems or buildings. Utility/government endorsements could also be useful, as could be referrals to qualified contractors. Both the Building Commissioning Association (BCA) and the Association of State Energy Research and Technology Transfer Institutions (ASERTTI) have developed one-day training programs for building owners and managers that could be adapted for use in different regions of the country (Doyle 2000; York 2000).
Local and Owner-Specific Demonstration Projects

While some case studies have been compiled, these cover only a few regions of the country. Local programs should utilize local demonstrations and case studies to help promote optimization in their local areas. In compiling these case studies, in addition to standard information on costs and energy savings, it would be useful to document non-energy benefits of retrocommissioning such as O&M cost savings or changes in worker comfort and productivity. Furthermore, for many building owners, the most relevant demonstration would be one in their own facility, or short of this, a competing firm in the same industry and market. An effective promotion technique would be to work with owners of large or multiple buildings and undertake a pilot project in one of their facilities, so they could see the benefits directly.

Establish Benchmarking System

Building owners want to know how their buildings compare to other buildings. A benchmarking system that is easy to use and adjusts for major climatic and operations differences would be a useful tool for comparing buildings and by extension, motivating owners of subpar buildings to improve their operations. EPA is working on this issue through its ENERGY STAR Buildings™ program. As of this writing, ENERGY STAR has developed benchmark tools for offices and schools, is working on a tool for retail buildings, and is developing plans for tools on several other building types. Local program managers should run several local buildings through these tools in order to validate these benchmarks for use in local programs. Another database to tie into this effort would be the Building Owners and Managers Associations’s (BOMA) Experience Exchange reports.

Commissioning Service Provider Training

Many HVAC and controls engineers have experience in designing and troubleshooting building systems. However, design experience and systems operation experience are different things. Furthermore, many engineers have limited experience in using observed and metered data together to solve problems. Likewise, engineers may know how to troubleshoot problems, but are unfamiliar with how to set up procedures so that building managers can prevent problems from recurring. Still, with proper training and experience, many of these practitioners could progressively become commissioning service providers. In order to assist this process, the program should sponsor training programs for service providers — including HVAC consulting engineers, control specialists, and others — and then offer them technical assistance for their first retrocommissioning projects using experienced commissioning providers that the program would hire on a retainer basis. These experienced providers would also conduct quality control reviews on initial retrocommissioning projects.
Training programs should be a week long and include hands-on field experience. Training courses of this type have been developed by BCA and ASERTTI. Following completion of the training program, trainees would begin to market their services, but would receive free technical assistance and quality control reviews on their first few commissioning projects in order to help them gain knowledge and experience with practical commissioning procedures and troubleshooting. Technical assistance would include assistance with preparing the commissioning plan, developing a short-term metering plan, analyzing meter and other data, reviewing draft reports, reviewing draft customer O&M plans, and answering questions. (Note: trainers and technical assistance providers would need to be carefully selected—they must be willing to help new people get started in the field; sometimes this would mean hiring experts from other regions since experts from the local region may be reluctant to train future competitors.)

**Maintenance Staff Training and Certification**

Building maintenance staff can perform some commissioning work, and they are very important for maintaining commissioning savings. The Northwest Energy Efficiency Council operates a building operator training and certification program with two levels of proficiency. People trained at the highest level are qualified to maintain the high level of building operation that commissioning initiates. The program includes certification in order to help building owners identify skilled staff and to help skilled staff get recognition and possible promotions for gaining these skills (Putnam 2000). The same program is operated in the Northeast by Northeast Energy Efficiency Partnerships. Other operator certification programs are run by BOMA (BOMA 2000) and the Association of Facility Engineers (AFE 2000). Each program operates in a different way, appeals to a different niche among operators, and works with the networks for operators that exist in different regions. Such programs should be available in each region with a retrocommissioning program, and designed to reach operators with a wide range of skills and knowledge.

**Financial Incentives**

Financial incentives would make it much easier to market commissioning services and substantially increase the number of projects that could be undertaken in the initial years of the program. Based on experience in the Northwest and California, we recommend that incentives cover at least 50% of the cost of commissioning services. On the other hand, the building owner should also pay a portion of the commissioning costs so that they have “buy-in” on the project. In addition, incentives for the implementation of capital measures identified during the commissioning process could increase savings significantly (by capital measure we mean measures that have a significant cost to the building owner and that are not paid back with savings in the first year). These incentives, for example, could pay half the cost of capital measures or could be sufficient to buy-down the cost of these capital measures to a particular
simple payback period (e.g., 12 months). Dodds, Baxter & Nadel (2000) provided information on incentives offered by many commissioning programs operating in 2000.

In addition to these core program activities, there are several additional activities that could improve the effectiveness of the program, including additional market research, tenant education and marketing, and cooperation with other retrocommissioning programs on procedure and tool development. These additional activities are discussed in the sections below.

Additional Market Research

Some market research on building O&M and commissioning practices has been conducted. For example, reports with market research components include a manual sponsored by DOE on commissioning existing buildings (Haasl and Sharp 1999), a study for the Northwest Energy Efficiency Alliance on commissioning practices and needs in the Northwest (SBW 1998), and a research project on O&M practices commissioned by a group of utilities in the Northeast (RLW Analytics 1999). What is still needed is more focused research in other regions to determine current baseline commissioning knowledge and practices, and reactions to various strategies to increase local use of commissioning. Also, there is a need for further market research to explore specific markets for specific approaches, such as focus groups or interviews with engineering firms and specific types of customers to explore their interest in different business and training models for optimization services.

Tenant Education and Marketing

For leased space with "triple net" leases (where tax, insurance, and operating costs — including energy costs — are passed onto tenants), in order to help motivate owners to improve building operations, it would be useful to educate tenants about the range of triple net payments in their local area, and to encourage prospective tenants to consider the sum of rent plus triple net costs when they compare buildings. An example of such a marketing program is the Better Bricks program recently started by the Northwest Energy Efficiency Alliance (NEEA 2000). Simple ways to help tenants identify efficient buildings, such as the new ENERGY STAR Buildings™ program, would also be useful. Creative approaches in which tenants and owners share commissioning costs and benefits should also be explored.

Procedure and Tool Development

Procedures for commissioning existing buildings are still in their infancy. Peter Herzog, a consulting engineer, has developed some procedures and written a book outlining how to develop an in-house team to commission specific end-use processes (Herzog 1997). Many organizations and firms have drafted procedures including Portland Energy Conservation, Inc. for DOE and Texas A&M University.
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There are a wide variety of services offered by different service providers, ranging from simple low-cost O&M services to extensive metering, data analysis, and trouble shooting. There is also substantial variation in the systems covered, with some providers focusing on one or several pieces of equipment (e.g., chillers) and others focusing on the whole building. While different service packages may be appropriate for different customers, when all packages are labeled "retrocommissioning" it makes it difficult for potential customers to understand what services they are offered and it also makes it difficult for providers to market their services relative to other providers that are offering differing services. There is a need to better define specific retrocommissioning packages (e.g., "full commissioning," "commissioning-lite," "chiller commissioning," etc.) to match the needs of different customers and the skills of different providers. For each of these service packages, standard tools and procedures could assist new providers in getting started in the field and could also assist current providers in streamlining their operations. Procedures should be flexible enough to service different building types, scales, systems, and design intent.

Local commissioning programs around the country should work together on the development of common definitions and additional procedures and tools that would make training, marketing, and service delivery easier. Development of a library of public domain procedures, with some index to their appropriate application, would be a useful starting point for new providers and would also be very useful for use in government buildings where there is frequently a need for the establishment of formal procedures. Similarly, improved software and hardware should be developed for better diagnosing buildings. In particular, ways to better build diagnostic capabilities into key building equipment (such as energy management systems, chillers, and economizers) should be explored. With such capabilities, it would be easier to monitor and diagnose equipment operations.

Key Indicators of Success

Given the goals of this program, which are to both reduce peak demand and to overcome barriers so that recommissioning and good building O&M grow in the marketplace, indicators of program success should include:

- Steady increases in building owner and manager familiarity and interest in commissioning and good O&M procedures;
- Growth in the number of skilled local commissioning service providers;
- Steady growth in the number of commissioning projects undertaken;
- Good average energy and energy-cost savings (evaluated on a percentage basis so that the depth of commissioning savings can be assessed);
- Proportion of commissioning recipients who implement good operations and maintenance programs;
- Peak energy savings achieved; and

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DOE003-0090

Obtained and made public by the Natural Resources Defense Council, March/April 2002
Cost and Savings Assumptions

Savings

A 1997 review of field data on 44 commissioning projects for existing buildings found that commissioning existing buildings “often result[s] in whole-building energy savings of 5–15% and paybacks of two years or less.” Energy cost savings in these projects ranged from 2–49% with a median of 19% (Gregerson 1997). However, given that this program would be a mass production program that works with many different service providers, we would expect average energy savings to be more modest — on the order of 10%.

Little data are available on the peak demand savings of commissioning. However, two programs did collect data on average peak (kW) and energy (kWh) savings, allowing a ratio of energy to peak savings to be calculated. For the Commonwealth Edison program in Chicago, this ratio was 1,950 kWh/kW. For work by Texas A&M on their campus, this ratio was 860 kWh/kW (Dodds, Baxter, & Nadel 2000). In our opinion, the Texas A&M figure is unlikely to be sustained across many projects and the Commonwealth Edison experience is more likely. Based on this thinking, kW savings can be approximated by first estimating kWh savings (based on the 10% estimate discussed above) and then dividing by 1,950.

Cost

The 1997 study on 44 retrocommissioning projects included costs per square foot for all of the projects. Costs ranged from $0.03–0.43 per square foot of building floor area, with a median of $0.17 (Gregerson 1997). More recently, a review of experience with eight retrocommissioning programs found that costs varied from $0.16–0.63 per square foot, with an average of $0.34. However, these latter programs were a bimodal distribution, with four of the programs ranging from $0.16–0.19 per square foot and the other three ranging from 0.52–0.63. These latter programs either used out-of-state service providers or involved very extensive continuous commissioning services. Based on these data points and considerations, we would estimate that commissioning, on average, should cost approximately $0.20 per square foot. All of these figures include costs to implement low-cost commissioning recommendations.

Non-Energy Costs and Benefits

In addition to direct energy savings, there are numerous citations in the literature on how specific commissioning projects have improved occupant comfort (e.g., by eliminating hot and cold spots) and improved equipment reliability and extended equipment life (e.g., because
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equipment cycles on and off less often). No systematic study has been conducted on how extensive these benefits are on average.

Measure Life

To our knowledge, there are no studies on the lifetime of commissioning energy savings. In practice, the lifetime of savings would vary from project to project, and could range from just a few months (for projects that are not maintained and where building use changes) to in perpetuity (for projects that are very well maintained. A 1998 analysis for the Northwest Energy Efficiency Alliance estimated an average measure life of 7 years (Suozzo et al. 1998).

Possible Market Penetration Rates

As of this writing, commissioning programs are only in the pilot stage. A typical trajectory for commissioning programs might be 4-12 projects in the first year (Dodds, Baxter, & Nadel 2000). However, in New York State, a pilot chiller retrocommissioning program signed up more than 130 participants in just a few months (Henderson 2000). Based on these different experiences, we estimate that a good full-scale program could maybe complete a dozen projects in the first year, perhaps 40 in the second, and on the order of 100 per year thereafter until about 50% of the target market is served. Thereafter, participation rates would slow as the program seeks to serve harder-to-reach customers.
5. Commercial and Industrial Lighting Retrofit Acceleration Program

Overview

The purpose of this program is to increase the saturation of efficient lighting among existing commercial and industrial buildings. The program accelerates and broadens the efforts already underway by customers and a wide array of contractors to replace obsolete lighting systems with the more efficient systems that have become common practice for most new construction. For the proportion of the building stock that replaces lighting periodically to upgrade appearance (i.e., replaces fixtures sometimes during remodeling), a large proportion of the savings from this program would occur with or without the program over the next 15–20 years. Nevertheless, accelerating the large amount of available low-cost savings would produce significant benefits in areas where there is a need for near-term, large-volume savings. This program would be complemented by a separate but related effort to enhance the quality and efficiency of common practice for lighting design, as described below.

The retrofit acceleration program follows the model of highly successful programs that have evolved over more than a decade and are relatively easy to implement. Programs at National Grid and Conectiv Power Delivery were selected as models for various components because the programs are well-known to the authors, the programs have established track records, and further information is readily downloadable on the Web. Key features are described below.

- Customers would be provided with a range of technical assistance suitable to the scope of each project.

- Prescriptive and customized (site-specific) rebates would be provided.

- Higher rebate levels and an optional separate procurement process are proposed to address the particularly hard-to-reach small business customers (<100 KW). The small business component would provide the minority of the savings and could require higher expenditures per kWh, but would likely have the greatest impacts after 5 years. This is because smaller businesses are less prone to adopt new technology on their own.

- The program would be promoted directly by the utility or other program sponsor, but also would be designed to complement the efforts of energy service companies and other proactive marketers of efficiency.
**Target Market**

The target market is all existing buildings that do not yet have high-efficiency lighting throughout the structure. While this encompasses a wide range of customers, the following groups are prominent:

- Hundreds of thousands of small-scale businesses with modest individual electric bills but huge cumulative potential savings.

- Larger buildings, including many retail buildings, that are leased on a short-term basis and where the tenant pays electric bills. In these situations, the owner has no responsibility for the bills and tenants have no long term interest in capital investments in the buildings, so many owners have been slow to adopt efficient lighting.

- Large institutions and firms with limited capital or internal organizational knowledge, or internal barriers to energy efficiency decision-making and contracting. In particular, many federal and state buildings have not yet been retrofit. In areas where there have not been extensive prior programs, many local government buildings also use obsolete, inefficient lighting. While energy service companies in some of these areas have addressed large institutions, many smaller ones remain largely untouched.

- Many buildings retrofit in the early 1990s with efficient magnetic ballasts and 34 W lamps could experience much higher savings with more aggressive approaches.

- New technologies that are easily retrofit, such as pulse start metal halide lamps for high intensity discharge (HID) applications, create additional opportunities even for buildings that have previously installed efficient hardware.

- In recent years, utilities have informed the authors that even sophisticated high-tech companies are still installing T-12 lamps and electronic ballasts in large new buildings simply because they are paying attention to other issues. The lesson is that retrofit opportunities can be found virtually anywhere.

For purposes of incentives and delivery structure, the market is divided into businesses with loads over 100 kW (including chain stores of smaller buildings) and businesses with loads under 100 kW.

**Efficiency Measures**

The program includes any retrofit lighting efficiency measure that clearly reduces peak load. However, to simplify and accelerate contractor participation, it would useful to pre-calculate
typical cost and savings, and establish prescriptive incentives for more common measures. For example, National Grid (formerly New England Electric) offers incentives separately for each of the following types of equipment:

- T-8 lamps and electronic ballasts (incentives only available for retrofits);
- A variety of different fluorescent fixtures that are highly reflective and use efficient lamps and ballasts—fixtures are differentiated to reflect different costs and efficiencies;
- Compact fluorescent lamps with hard-wired ballasts (screw-in compacts are less permanent and often pay back so quickly that an incentive is not needed);
- Light-emitting diode (LED) exit signs;
- LED red traffic lights (Note: some other program sponsors also provide incentives for green LEDs.);
- Pulse start metal halide retrofit kits;
- New pulse start metal halide fixtures;
- New high pressure sodium fixtures;¹⁸
- Wall-mounted and remote-mounted occupancy sensors;
- Daylight dimming systems;
- Occupancy-controlled high-low control systems — for fluorescent and HID lighting; and
- Fluorescent de-lamping with reflectors.

Specific prescriptive measures, incentives, minimum performance requirements, and other features are detailed on National Grid’s Web site in an Adobe Acrobat downloadable file (National Grid 2000b). In addition, as discussed below, other lighting improvements are eligible for custom incentives.

National Grid’s basic approach to prescriptive lighting rebates is to specify minimum watt reductions per fixture and specify quality elements of the installation (such as power factor, total harmonic distortion, and component quality issues such as fixture efficiency). These specifications leave manufacturers and contractors with leeway to design and select a range of products, but avoid situations where shoddy equipment is installed. They also assure that National Grid is paying only for measures that are more efficient than baseline equipment.

National Grid offers an incentive for T-8 lamps and electronic ballasts as one-for-one replacements for T-12 lamps and standard magnetic ballasts. They will also retrofit low-power ballasts (where lighting levels allow) in place of efficient magnetic ballasts (Keena 2000). While these measures reduce load, it is often possible to save much more by reducing the number of lamps and ballasts through use of reflectors or new fixtures. One-for-one swaps can “lock in” an inefficient fixture layout and thus create lost opportunities for these additional savings. Therefore, it is important, in working with customers and contractors, to encourage the more

¹⁸ National Grid does not pay for HPS retrofit kits.
comprehensive approach wherever feasible. At the same time, it’s important to recognize that delamping will not produce adequate light levels in all situations and many customers are not willing to move fixtures.

National Grid complements its prescriptive rebates with a custom approach. This is for retrofit measures that do not easily fit into rebate categories. National Grid has a separate worksheet to handle these custom measures. This worksheet also can be viewed as a downloadable Adobe Acrobat file (National Grid 2000b). Among the many strategies eligible for this approach are use of T-5 lamps to replace HID lighting in high-bay industrial settings. Because this involves careful fixture selection to assure proper light distribution, and because there are other alternatives that may be preferable in some situations, National Grid addresses this as a custom measure instead of providing a prescriptive rebate.

Program Strategies

The market infrastructure to retrofit buildings with efficient hardware is in place,19 The equipment is available in volume and with predictable quality; numerous contractors market, finance, and manage this type of retrofit; customers have seen the equipment; and so on. In fact, this year a consensus was reached between efficiency advocates and lighting equipment manufacturers to recommend equipment standards that would essentially outlaw magnetic fluorescent ballasts for new fixtures by the middle of this decade, and outlaw magnetic ballasts for most replacement applications in 2010. In September 2000, DOE formally adopted these consensus recommendations (Federal Register 2000). However, ballasts and lamps can last for many years, so acceleration of this trend would produce significant savings. Furthermore, many technologies that could be retrofit are not covered by this standard.

Customers who have not yet converted their lighting systems often have a number of firm-specific issues that make it difficult for them to address efficiency. These issues were discussed to some degree in the section on the target market, but are summarized in Table C-15.

The barriers are many, and no single approach could address all these barriers. However, private contractors are achieving some retrofit savings with the most motivated customers. Program sponsors have been able to add significant savings (more savings per building and more customers) by offering programs with incentives; multi-pronged marketing; and streamlined, intensive technical assistance. These tools help by calling attention, reducing paybacks, increasing credibility, taking some of the management burden off the customer, and simply forcing a decision.

19 Except for cutting-edge technologies such as T-5 lamps and daylighting where only some designers are proficient.
Table C-15. Market Barriers to Commercial and Industrial Lighting Retrofit

<table>
<thead>
<tr>
<th>Market Barrier</th>
<th>Key Issues</th>
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| Customer Access to Information        | • Many customers do not have the technical familiarity to manage contracts to install efficient lighting or to do the retrofits on their own.  
• Customers often lack expertise and time to engage in performance contracts.  
• Early performance problems with reflectors, electronic ballasts, and motion sensors have left some customers gun-shy; they do not know that consistency has improved and don’t know how to specify highest-quality products.  
• Customers usually are less familiar with more recent products such as pulse start metal halide lamps.  
• Many customers do not know how much light they need, so they are conservative about reducing lighting levels. They also don’t know that quality reflectors and fixtures could improve light distribution. |
| Customer Organizational Barriers      | • Customers often lack the time and confidence to perform quality assurance.  
• Many customer organizations (small and large) have not assigned responsibility to any individual to carry out efficiency measures. This hampers decisions and limits expertise.  
• In many large organizations such as state and federal government and multi-site corporations, the unit that pays for construction often is not the unit that pays energy bills, and the two do not communicate effectively about management of costs.  
• Many businesses and government entities consider energy efficiency and lighting improvements to be a low priority for funding because energy costs are a small part of their overall operating costs. |
| Financial Barriers                    | • Many government entities have legal or political barriers to borrowing (although leasing is possible in many cases).  
• Split incentives — properties on short-term leases often leave the owner with no responsibility for electric costs and the tenant with no long-term interest in the property.  
• Small businesses are often run on a cash-flow basis and lack capital for even quick payback investments. |
| Scale Issues                          | • Many hundreds of thousands of customers are too small to attract the attention of contractors or engineering firms.  
• Performance contractors (that provide off-balance-sheet financing as part of its service) typically target transactions of at least a hundred thousand dollars, and most contractors target larger transactions than this. These criteria exclude all but the largest commercial and industrial customers from performance contracting. |

**Marketing**

The program should be marketed extensively to customers and trade allies. National Grid, for example, works directly with larger customers, but has also set up contracts with a group of trade allies to augment staff in marketing the program to medium-sized customers. Trade ally training sessions for other contractors are also held. Special arrangements have been made to encourage energy service companies to participate in both technical studies and measure installation. In an effort to keep prices down, National Grid has also set up the "Buyers"
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Alliance," a form of a buyers’ club. National Grid competitively selects specific firms (one per equipment type) to offer low prices on specific equipment types. National Grid then offers (at no profit to itself) the customer the option of using the Buyers’ Alliance contractor to supply equipment or working with a contractor of the customer’s choice to procure equipment. While the program would be workable without this arrangement, it helps assure a competitive price on smaller equipment installations.

Financial Incentives

National Grid’s incentives are detailed on its Web site (National Grid 2000a, 2000b). In general, National Grid pays about 40–50% of the cost of prescriptive efficiency measures. Prescriptive incentive levels for specific items are fine-tuned based on market response through an annual review process. The custom incentive is set at 50% of equipment cost.

These incentive levels would be sufficient to create large-scale program demand. Areas where less efficiency has already been implemented (ergo there is more pent-up demand) could use lower incentives for a time. However, with significantly lower incentives, there would be the danger that a large proportion of the transactions that would be subsidized through the program would occur without the program. Higher payments would accelerate demand for the program, resulting in a smaller share of “freeriders.”

National Grid’s custom incentives are paid as a percent of equipment cost. They have chosen to pay a share of cost because the cost/kW or kWh from different measures varies dramatically. Costs used to calculate incentives are based on bids or invoices that are reviewed for reasonableness. Savings for custom measures are determined through a technical study, usually performed by a utility contractor but sometimes provided by an equipment vendor.

Other utilities have chosen to pay a fixed $/kW for custom incentives, or a fixed amount per fixture, to reduce “gaming” of costs by the contractor and to simplify technical review.

Financing

National Grid also helps customers locate financing for their share of the cost of efficiency measures, working with a variety of banks and other lending and leasing firms. These offers complement financing available through many contractors and through the customers’ own contacts. National Grid facilitation for financing has proven to be valuable, but is used only in a small minority of transactions. Additionally, National Grid offers customers with loads less than 100 kW the option of financing their share of costs on the utility bill, through National Grid’s small C&I program. Other utilities have offered this option and it has proven to be an important complementary lever to increase participation.
Quality Control

The key quality control steps would be review of the proposal and site inspection. Proposal review for prescriptive measures would verify that the specified equipment would save the indicated number of watts compared to prior equipment, would meet program requirements, and would be appropriate for the customer use of space. Inspections would confirm that the specified equipment was installed properly. Payment would be made after installation. When a contractor would begin work in a program, it would be prudent to inspect all sites. Where contractors have installed equipment in many buildings and have established performance records, post-installations could be on a sample basis.

For custom installations, there would be one major difference—a more detailed proposal review to verify the reasonableness of the engineering assumptions behind the savings estimate and the adequacy of the lighting levels. The cost estimate, which drives the custom incentive, would also be reviewed for reasonableness.

Small Building Approach

Smaller businesses (e.g., under 100 kW at all sites) present a special problem. Smaller transactions tend to have higher analysis costs, and due to the lower volume, higher equipment costs. Small business owners have less time to deal with efficiency or with contractors, and the savings/building trend to be smaller. As a consequence, small businesses tend not to respond in large numbers to the type of program described above.

The simplest way to address this problem would be to simply increase incentive levels for smaller business. This would hypothetically encourage contractors to develop special services to bring in smaller customers. However, the use of turnkey contractors has met with limited success at utilities such as Sacramento Municipal Utility District and United Illuminating. Both these utilities decided to increase the degree of utility administration (while still using contractors for audits and installation) to reduce costs and increase program effectiveness.

National Grid addresses small businesses with a special program approach involving bulk purchase of both labor and equipment and direct installation by utility contractors. Its small C&I program is one of the most successful in the country, having treated two to four thousand customers per year for nearly a decade. They have reached about a third of their small customer base. Under National Grid's approach, a handful of firms are competitively selected to provide checklist audits (using an utility-determined standardized format) and install most equipment. Equipment suppliers are selected through a separate competition to provide large volumes of specific types of common measures. The installation contractors use a utility computer system to order the equipment and have it drop shipped to the site for installation. A separate specialist contractor installs case cooler efficiency measures.

National Grid’s share of the cost was originally 100%, but over several years has been lowered to 70–80% (varies by state). This has significantly increased the number of customers that refuse to participate, but the program is still able to address thousands of customers per year. To help induce participation, the utility offers to finance the customers’ share of costs on the utility bill.
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Relationship of Program Strategies to Market Barriers

Table C-16 shows how these program strategies would address each of the key market barriers to efficiency investments in the C&I lighting retrofit market.

Table C-16. Market Barriers and Intervention Strategies for Commercial and Industrial Lighting Retrofit

<table>
<thead>
<tr>
<th>Market Barrier</th>
<th>Intervention Strategy</th>
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<tbody>
<tr>
<td>Customer Access to Information</td>
<td>• Utility staff and contractor technical assistance</td>
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<td></td>
<td>• Marketing through contractors</td>
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<tr>
<td></td>
<td>• Marketing and technical materials</td>
</tr>
<tr>
<td></td>
<td>• Technical studies where needed</td>
</tr>
<tr>
<td>Customer Organizational Barriers</td>
<td>• Utility/sponsor endorsement sometimes focuses attention</td>
</tr>
<tr>
<td></td>
<td>• Financial rebate opportunity could focus attention</td>
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<tr>
<td></td>
<td>• Utility/sponsor assistance in project implementation</td>
</tr>
<tr>
<td></td>
<td>• Utility/sponsor quality control and administrative advice to customer</td>
</tr>
<tr>
<td>Financial Barriers</td>
<td>• Incentives</td>
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<tr>
<td></td>
<td>• Financing facilitation</td>
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<tr>
<td></td>
<td>• Alliances with performance contractors and leasing firms to overcome</td>
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<tr>
<td></td>
<td>government entity restrictions on financing</td>
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<tr>
<td></td>
<td>• Financing to produce positive cash flow, preferably on the electric bill</td>
</tr>
<tr>
<td>Scale Issues</td>
<td>• Higher incentives for small customers</td>
</tr>
<tr>
<td></td>
<td>• Bulk purchase/direct install approach to minimize hassle for small customers</td>
</tr>
</tbody>
</table>

Key Indicators of Success

The primary indicator of success for retrofit lighting programs would be the level of savings and participation. It is important to consider the savings beyond what the private sector would accomplish in the absence of utility programs. While this can never be precisely determined, post-installation interviews with customers often reveal their prior intentions.

A secondary indicator would the comprehensiveness with which buildings would be treated. As previously discussed, delamping with reflectors or fixture change-outs can often save much more than one-for-one lamp and ballast swap-outs. Many of the lighting design approaches discussed in the section on the lighting quality enhancement program could be applied to retrofit situations if the customer and contractor are sufficiently motivated and sophisticated.

Cost and Savings Assumptions

Savings

Precise data on the percent of building peak load that has been saved through this type of program are difficult to obtain, in part because many programs have been evaluated as part of