

COMMERCIAL BUILDINGS OPERATIONS AND MAINTENANCE MARKET ASSESSMENT

Market Research Report

PREPARED BY

Quantum Consulting

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***COMMERCIAL BUILDINGS OPERATIONS AND
MAINTENANCE MARKET ASSESSMENT***

FINAL

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1. EXECUTIVE SUMMARY

This section provides a synopsis of the Commercial Buildings Operations and Maintenance (O&M) Market Assessment Study (Study) background, objectives, key findings and resulting program implications.

1.1 STUDY BACKGROUND

This report offers an examination of the O&M market operating in the Pacific Northwest (PNW) and a prospective assessment of the implications of those findings for a potential (enhanced O&M) energy efficiency program offering. The Northwest Energy Efficiency Alliance (the Alliance) is the sponsor of this study, and the Alliance is implementing a number of commercial sector projects that have relevant O&M components.

1.2 STUDY OBJECTIVES

This study characterizes the regional commercial O&M markets. This includes a description of the PNW large building market, the demand for O&M services in that market and the response of the supply chain to those demands. Also explored are services contracts for outsourcing O&M, the identification of current practices for O&M in the PNW large building market, enhanced O&M practices where substantial room for improvement exists and major barriers to achieving enhanced O&M. Two primary commercial building markets are focused on in the results presentation, the commercial real estate market (primarily offices and retail) and the institutional market (focused on government and universities).

1.3 STUDY APPROACH

Data used in this study came from a review of existing (secondary) studies and primary data collected in surveys and interviews with 99 building owners/decision makers, 10 property management companies and 20 O&M service providers.

1.4 STUDY FINDINGS

Existing Problems with Building Energy Using Equipment and Systems

Owners and decision makers were asked if there are any issues, needs or problems that they are currently facing with regard to their buildings' energy using equipment and systems. Problems were acknowledged among about half of the owner and decision maker respondents (45 out of 99 respondents). Furthermore, HVAC is at the root of most problems that owners and decision makers face. For the most part, respondents believe that these problems stem from age of the equipment, and believe that ultimately replacement is needed to resolve the bulk of the problems they face. However, a substantial number of respondents pointed to the fact that their equipment is not working properly, suggesting that O&M may mitigate many existing problems.

Follow-up questions regarding the issues raised above were asked to identify both possible solutions and barriers that exist for addressing them. Most owners and decision makers (89 percent based on a sample size of 45 respondents) believe they know of a solution to the problems they face in their buildings.

- Upgrading, replacing and adding equipment is largely perceived as the solution needed (64 percent of responses). This is followed by an acknowledgement that additional resources are needed, including money/time/staff/experts to address problems (27 percent of responses). Only a small minority of respondents indicated that equipment and systems woes were related to improper design and improperly functioning equipment (8 percent of respondents). The responses related to resources and improper design/functioning suggest that over one-third of respondents perceive O&M as a potential solution to their problems.
- Resource constraints are perceived to be the primary barriers that prevent owners and decision makers from implementing needed equipment upgrades (81 percent of respondents). Money is the predominant factor mentioned by those respondents. More than 15 percent of respondents perceive no barriers at all to solving building equipment and systems problems.

The fact that half of the respondents reported that they have problems with their major systems indicates that they would likely benefit from enhanced O&M offerings. It also suggests that education is needed, perhaps through the use of on-site experts, to identify and demonstrate that some fraction of these problems can be addressed using O&M or building tune up approaches. Further inhibiting enhanced O&M is the tendency to wait out any problems until equipment is replaced, even if the O&M measure and practice may have less than a year long payback.

O&M Market Characterization

The O&M market can be split into demand- and supply-side actors. Demand-side actors are generally building owners/decision makers (including property managers), while service providers supply services to the O&M market (often in conjunction with the building owners' internal facilities staff). Depending on the size and sophistication of the building O&M staff, owners may opt to have O&M measures implemented by in-house staff.

Building Owner/Decision Maker. "Building owner" is a broad category, made up of diverse actors such as owner-occupants and investor-owners, public and private sector entities, owners' representatives, property management companies, facility or property managers, and other financial decision-makers. Large facilities make ideal targets for O&M, and they often have complex, multi-level management structures. In these environments, it is important that O&M be supported by decision-makers at all levels of the organization—from the facility manager or building operating staff to the owner or key executives. Previous studies show that among large building owners, the ones most interested in O&M services are owner-occupants and owners of Class A leased space. Chief concerns for these owners are operating costs and/or keeping occupants comfortable.

Central to the O&M market is the question of who is ultimately responsible for decision-making in building operations. Owners and decision makers and property managers were each asked for the job title of the primary decision maker for building operations. Service providers, on the other hand, were asked for the job title of the building representative that typically hires their firm to provide O&M services, as this was thought to be an equivalent role where outsourcing is involved. Results of the property management and service provider surveys indicate that facility managers, property managers and owners are all important decision makers for building O&M. Property managers perceive less direct involvement of owners than do service providers; not surprising as these owners choose to outsource property management – and are therefore less involved in day-to-day operations of the buildings they own. Owners and decision maker responses were much more diverse, with 99 respondents mentioning over 50 unique O&M decision maker titles. However, there was some clustering of responses, the most common being building or facility manager (26%).

Outsourcing O&M. Frequently, building owners and managers outsource most if not all of their operation and maintenance services for their building systems. Even large national companies and institutions with in-house O&M staffs often use outside service contractors to supplement their work.

All three groups of market actors interviewed were asked how energy using equipment and controls are typically maintained. Exhibit 1-1 presents the resulting self-reported frequency with which facilities are maintained using in-house staff only, outsourcing to service providers only, or a combination of the two. These results suggest, in general, that O&M responsibilities are roughly split in the large facility PNW market among in-house personnel and service providers. The office (26%) and retail (28%) facilities are more likely to outsource all O&M services, while colleges and universities (35%) are more likely to use in-house staff only. These results also suggest that facilities overseen by property managers are less likely to rely exclusively upon an outsourcing solution than are facility owners.

*Exhibit 1-1
Use of In-House Personnel and Outsourcing for O&M
Based on Self-Reported Survey Results*

<i>Percentage of Facilities Using In-House Personnel, Outsourcing and a Combination</i>	<i>Owner and Decision Makers by Business Type</i>				<i>Average</i>	<i>Property Managers</i>	<i>Service Providers</i>
	<i>Office</i>	<i>College / University</i>	<i>Government</i>	<i>Retail</i>			
Use in-house staff only	13%	35%	17%	16%	18%	20%	-
Outsource all responsibilities to O&M service providers or vendors	26%	6%	17%	28%	22%	-	25%
Use BOTH in-house staff & outsource to O&M service providers or vendors	61%	59%	67%	56%	60%	80%	75%
N	38	17	12	32	99	10	20

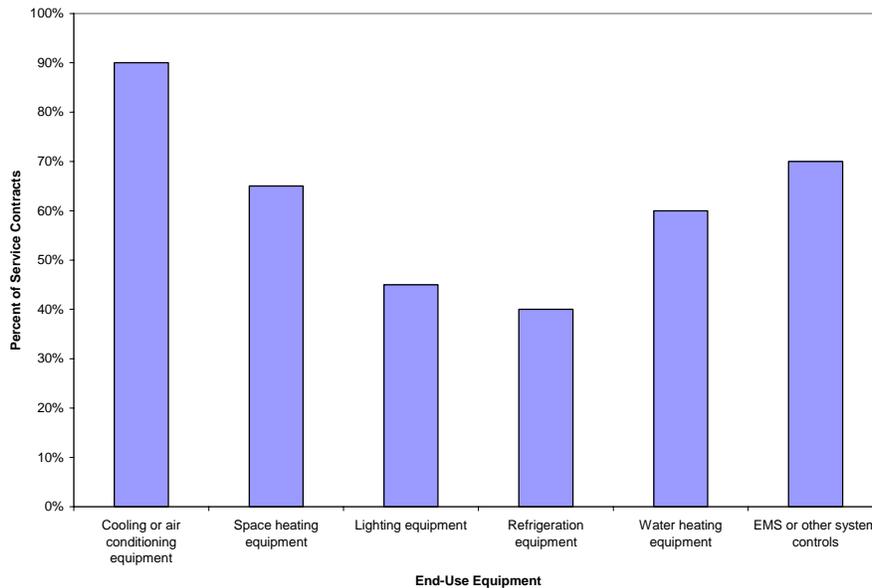
O&M Services Companies. A range of building services professionals offer O&M services, including engineering firms, general contractors, HVAC/controls contractors, commissioning specialists, testing, adjusting and balancing (TAB) contractors, energy services firms, and O&M service contractors.

Respondents to the owner and decision maker and property manager surveys were asked to provide the business name of the companies that provide O&M services for the facilities that they manage. The overwhelming majority of the resulting service providers are mechanical contractors. Furthermore, service providers were asked to provide the business names of their major competitors. The responses included over 100 separate providers.

- 60 percent of the companies were mentioned just once.
- Based on this it appears that no single contractor controls a substantial share of the O&M provider market in the PNW.

Service Contracts. According to the O&M service providers interviewed, services contracted are generally comprehensive, but concentrate on HVAC/controls, followed by water heating equipment and lighting and refrigeration. The contracts call for energy saving O&M improvements 65% of the time. The percentage of service contracts that address a given end-use equipment category is presented in Exhibit 1-2.

Exhibit 1-2
Service Provider
Self-Reported Energy Using Equipment Serviced for O&M
(N=20)



Owners and decision makers were asked how frequently they require their O&M service providers to engage in energy savings activities. Results indicate that this requirement is less frequent than reported by O&M service providers. Owner and decision makers say they require energy savings O&M improvements from their O&M providers 40% of the time, while property managers report requiring this just 25% of the time. It is not surprising that owners require energy saving efforts more frequently than property managers, as owners are more likely to reap the rewards of reduced energy bills.

Market Barriers. All three groups that were interviewed were asked about technical, organizational and financial barriers that might prevent them from implementing O&M operational enhancements. Across the technical, organizational and financial barrier categories just 4% of the owners and decision makers, none of the property managers and just 15% of the service providers mentioned no barriers at all to enhanced O&M operational procedures. Therefore, most respondents do perceive some level of barrier to overcome in the implementation of enhanced O&M.

While a considerable number of respondents indicated that there are no substantial technical barriers (40-50 percent of responses) or organizational barriers (45-60 percent of responses), financial barriers were mentioned by nearly all the respondents, as budgets for O&M are already tight. Just 11 percent of owners and decisions makers mentioned no financial barriers, just 10 percent of property managers, and 60 percent of service providers. Although many of the technical barriers mentioned are not substantial to overcome, organizational barriers appear more challenging and financial barriers are undoubtedly very difficult to overcome. Budgeting for operational enhancements and financing/demonstration of payback were most frequently mentioned by respondents as barriers.

1.5 PROGRAM IMPLICATIONS

Successful O&M program delivery will necessitate the careful identification of low-effort, best-odds entry points into that market and tactics to address key barriers to enhanced O&M.

Identify Market Entry Points

It is recommended that the Alliance identify particular market segments that represent the best opportunities for O&M market intervention, and likewise identify areas where substantial barriers exist that may be too difficult to cost-effectively reverse. This study has developed data and intermediate results that support this important objective, but further work in this area is recommended to improve upon progress made to date.

- **Focus on owner occupied buildings**, which are more likely to implement enhanced O&M strategies and become involved in implementing O&M best practices. About 60-75 percent of large commercial buildings are owner-occupied.
- **Focus on larger customers** and target owners and operators who are involved with more than one facility, especially chains.
- **Educate decision-makers** to change the way facility staff and service providers conduct their O&M operations.

Address Barriers to Enhanced O&M

Several strategies for overcoming barriers are discussed in the literature and reinforced by our primary research.

- Where O&M is not viewed as important to facility management, or is believed to be costly (and/or no budgets exist for O&M training), **case studies** and **site specific analyses** should be used to clearly demonstrate savings.

- In addition, providing **training, certification and tools** to analyze savings are important elements that should be leveraged to gain momentum in the market for enhanced O&M services and to develop interest. Education-oriented intervention (e.g. on-site training, group O&M seminars) is key to successful program implementation. Companies with untrained staff can take part in education, training, and certification programs. One example is the Building Operator Certification (BOC), a professional development program developed by the Northwest Energy Efficiency Council. Over 1000 building operators in the Northwest have completed the program since 1995.
- **Develop a list of best practices** based on the type of facility and/or technology for companies that lack written standards.

Program Delivery Through O&M Service Providers

The most successful entry into the O&M market will likely be achieved by harnessing the participation of **O&M service providers**.

- Providers are **contracted with for O&M services in roughly 80 percent of large buildings** in the PNW market, and complete work representing roughly 40-50 percent of the O&M needs in that market.
- A number of factors contribute to the **importance of O&M providers** in a successful program strategy: 1) they are deeply involved in the target market, 2) work directly with owners and decision makers, including the development of contractual O&M agreements, and 3) they emphasize HVAC/controls, an area of building operations with the greatest need for O&M assistance and the greatest opportunity for energy savings.
- In order for providers to effectively enhance their O&M services, it is necessary that they obtain the **independent backing of program implementers and administrators**. Offering enhanced services likely means expanding the scope of their O&M contracts, increasing the price of those contracts and potentially losing-out on a first cost-basis to other service providers with business as usual offerings. Therefore contractors with enhanced offerings must differentiate themselves from other providers in the market place to avoid pricing themselves out of the market. Program implementers should provide information (case studies and site-specific analyses) and referral services to support enhanced O&M offerings.
- Two clear barriers that must be addressed are that **there are few dominant players in the O&M services market** and that much of the market already perceives that it is implementing enhanced O&M. Therefore true enhanced O&M might be hard to sell, especially if enhanced services demand higher prices.

A successful program design will seek to **improve and enhance the contracts** being developed between end users and their service providers.

Deploy Commissioning and O&M Services at the Time of Building Renovation

Perhaps the greatest opportunity to incorporate energy efficiency within existing buildings is at the time of major renovation involving the replacement of permanent building equipment. Not only is the time of renovation an excellent opportunity to invest in high efficiency equipment and systems, but the start-up of new systems also represents a substantial opportunity for building commissioning services and the incorporation of best practices in equipment O&M methods, procedures, and contracts.

2. INTRODUCTION

The Commercial Buildings Operations and Maintenance (O&M) Market Assessment Study presented in this report offers an examination of the O&M market operating in the Pacific Northwest (PNW) and a prospective assessment of the implications of those findings for a potential energy efficiency program offering enhanced O&M. The Northwest Energy Efficiency Alliance (the Alliance) is the sponsor of this study, and the Alliance is implementing a number of commercial sector projects that have O&M components.

This chapter provides an introduction to the study objectives and scope of work, and a brief outline of the remainder of the report.

2.1 STUDY OBJECTIVES

The goal of the market research is to provide a thorough characterization of the market for O&M services in the PNW, including the following current practices:

- Energy-related O&M
- Energy efficient O&M (referred to in this report as enhanced O&M)
- Tuning-up commercial equipment
- Recommissioning of building energy using-systems

To the extent possible this includes an analysis of PNW market penetration for O&M measures/practices, and the approach used in implementing these practices.

The characterization also addresses the regional commercial O&M market describing the supply chain, major actors or groups of actors, and trends in the industry, including the following:

- An analysis of the motivations and drivers of the actors on the demand and supply side
- Opportunities for and barriers to the adoption of energy efficiency

Furthermore, program implications are presented that describe how the findings of this market research can be used in the Alliance's Commercial Sector Initiative.

2.2 REPORT CONTENTS

This section provides the structure of the Study report, as described below.

- The report includes a *Chapter 1 Executive Summary* providing a condensed version of the Study approach and key findings.
- The *Chapter 2 Introduction* lays the groundwork for the chapters that follow.
- The *Chapter 3 Study Methodology* focuses on the analytical approach employed to meet study objectives, including a section that describes the data collection plan, sample design and survey dispositions.
- The *Chapter 4 Study Results* then follows, with sections that describe the attributes of the PNW large building market, characterize the O&M market, and assess current and enhanced O&M practices.
- The fifth and final chapter combines key findings into a discussion of Study implications for the Alliance's Commercial Sector Initiative.

Supporting study material is found in the appendices.

- Appendix A presents relevant findings obtained from secondary literature.
- Appendices B through D provide the survey instruments that were used in the Study to collect primary data from selected players in the O&M market.
- Appendix E presents survey results for the Owner/Decision Maker, Property Management and Service Provider surveys.
- Appendix F presents previous studies and publications referenced in this Study.

3. STUDY METHODOLOGY

This section presents an overview of the Study approach and data collection activities.

3.1 STUDY OBJECTIVES, APPROACH AND DATA COLLECTION STRATEGY

The objectives and approach for fulfilling this study are presented below.

- Identifying the energy savings, costs and non-energy benefits associated with improved O&M practices and procedures in commercial buildings, including tune-ups of commercial equipment and recommissioning of energy using systems.
 - To meet this objective, existing reports and research documents and data on commercial O&M practices were collected, including costs and savings associated with these practices.
 - The Study identified current O&M measures/practices and a selected set of enhanced measures/practices to research in greater detail as part of the market characterization. O&M measure data collected included costs, savings, measure life and other benefits.
- Characterizing the market for these energy efficient O&M practices and procedures including estimates of awareness and market penetration, and identifying opportunities for and barriers to the adoption of these measures.
 - A characterization of the regional commercial O&M market was developed for this study, describing the supply chain, major actors or groups of actors, and trends in the industry. Market penetration of current and enhanced O&M practices was estimated.
 - Two primary commercial building markets were studied, the commercial real estate market (primarily offices and retail) and the institutional market (government and universities). Hospitals and groceries, two markets where the Alliance has on-going initiatives, were not studied. In the case of hospitals, existing research showed that they tend to have large, sophisticated in-house staff. This is not typical of the broader commercial market and would thus require a separate study to gain useful information. For groceries, the importance of refrigeration, which requires highly specialized service providers, also meant that broad market information would not be particularly applicable.
 - The market characterization also provides an analysis of the motivations and drivers of the actors on the demand and supply side. This includes the identification of opportunities for and barriers to the adoption of energy efficient O&M practices.

The study is primarily based on an assessment of interview responses, as well as a review of existing (secondary) studies. Interviews were completed with building owners/decision makers, property management companies and O&M service providers. The primary data collection sample designs and procedures are discussed in *Section 3.2* below.

Key secondary data source categories utilized in the Study are¹:

- Existing O&M research, studies and evaluations are used in developing the O&M market characterization
- The Alliance Building Performance Services (BPS) program and other program documentation and tools that were examined to inform a comprehensive O&M program strategy
- A compilation of existing site-specific O&M, building tune-up and commissioning reports and program tracking systems were used to develop a relevant measure database

3.2 SAMPLE DESIGN

As mentioned above, three market actor groups were interviewed to provide their perspectives from the most significant avenues for O&M decision-making and implementation.

- The principal survey solicited data and opinions from commercial building owners (or their internal facilities engineers or other decision makers) regarding operations and maintenance (O&M) performed within selected building segments.
- Supplementing this information were phone interviews with property managers affiliated with commercial property management companies.
- A third telephone survey tapped information from O&M service providers.

The interviews were limited to market actors with responsibility for large commercial buildings, those greater than 50,000 square feet in area, as it is believed that these buildings yield enhanced opportunities for energy efficiency improvement through O&M. As discussed in Chapter 4, Study Results, this is the recommended target market for the Alliance's Commercial Building O&M Initiative, due to the following: (1) availability of advanced control systems in that market, (2) reasonably large maintenance staffing levels, (3) a decision making structure that can be influenced, and, when influenced, one with potential savings that justify program marketing costs.

¹ A comprehensive listing of data sources is included in Appendix F.

The sample frame used and the planned and completed number of surveys is shown in Exhibit 3-1.

Exhibit 3-1
Data Collection Plan

Survey	Building Size	Primary Sample Frame	Secondary Sample Frames Used	Targeted Survey Completes	Actual Survey Completes
Building Owners/Decision Makers/Internal Facilities Engineer	>50,000 sf	Dun & Bradstreet Marketing and Solutions Database	None	155	99
Property Management Companies	>50,000 sf	On-Line Business Journal Reviews	Property manager data supplied by respondents to the building owner and decision maker survey	10	10
O& M Service Providers	>50,000 sf	Service provider data supplied by respondents to the building owner and decision maker survey	Service provider data supplied by project advisor	20	20

3.2.1 Owner/Decision Maker Survey

Exhibit 3-2 summarizes the population of building stock in the PNW greater than 100,000 sqft², the recommended target population for the Alliance commercial building O&M initiatives. Also shown is the distribution of the amount of floor space by building type and, for comparison, the relative total floorspace of all commercial buildings in the PNW. This data is based on market research performed in 2001 for the Northwest Energy Efficiency Alliance (*“Assessment of the Commercial Building Stock in the Pacific Northwest,” March, 2004.*) Floorspace square footage was a key factor for allocating sampling points by business type, government/non-government buildings and across the states that comprise the Pacific Northwest region.

² Due to limitations in the available sample frame, surveys were completed using a lower threshold to define large building of 50,000 square feet.

Exhibit 3-2
Summary of Commercial Building Floorspace in the Pacific Northwest*

Exhibit 3-2.A: Percent of total floorspace by size category, and building stock in millions of square feet

Size Category (sqft per building)	Retail	Grocery	Office	Restaurant	Warehouse	Hospital	Hotel / Motel	Other Health	Other	School	University	Vacant	TOTAL
Percent of Total Floorspace by Size Category													
100,000 to 499,999	31%	1%	36%	<1%	23%	61%	29%	11%	16%	29%	29%	16%	25%
500,000 and above	1%	<1%	11%	<1%	<1%	25%	14%	<1%	<1%	<1%	<1%	<1%	3%
Building Stock in Millions of Square Feet													
Total	401.3	84.0	458.3	37.8	237.0	41.1	116.0	114.5	473.2	235.9	84.3	82.4	2,365.8
100,000 and above	128.4	0.8	215.4	0.0	54.5	35.3	49.9	12.6	75.7	68.4	24.4	13.2	678.7

Exhibit 3-2.B: Percent of total floorspace made up by government buildings

Building Ownership	Retail	Grocery	Office	Restaurant	Warehouse	Hospital	Hotel / Motel	Other Health	Other	School	University	Vacant	TOTAL
Government			13%		2%				23%	78%			20%

* Estimated based on the Assessment of the Commercial Building Stock in the Pacific Northwest, KEMA-XENERGY, Inc., Report # 04-125, March, 2004.

This building stock assessment provides a sense of where the likely market exists for O&M services based on the amount of floor space dedicated to each building type. The study data collection plan emphasizes buildings 50,000 square feet and larger which account for 28% of the total floorspace within the Pacific Northwest. The largest percentages of total floor space over 100,000 square feet in the Pacific Northwest are found in hospitals (86%), offices (47%), hotels/motels (43%), retail (32%), and schools and universities (each 29%).

The project team put forward a general sampling strategy, to concentrate the study among offices and institutional buildings, including universities. Schools were excluded as it was felt that in many cases they would mimic the energy use characteristics of universities. Retail was also included because of its market size. Offices, retail and universities account for over 368 million square feet (54%) of floorspace out of the total of 679 million square feet of floorspace for buildings over 100,000 square feet.

Exhibit 3-2 also indicates the breakout of the amount of floor space within the Pacific Northwest for government-owned buildings. A substantial portion of office floorspace is government buildings, so a proportional sub-sample of office surveys completed were associated with government buildings. The objective of the sub-sample was to establish any general O&M differences between the two decision-making processes (as it is anticipated that decision making and criteria for investment might be different between these two groups).

The sample frame drawn from the Dunn and Bradstreet (D&B) database was based on the following selection criteria:

- SIC code groupings were used to represent each selected business type: non-government offices, government facilities, universities and retail facilities.
- Where sample frame constraints were not a concern, data collection was restricted to metro areas in an attempt to locate a relatively high concentration of large facilities³. This included the non-government office and retail segments, located in the following metro areas:
 - Seattle/Spokane metro areas (representing Washington)
 - Portland metro area (representing Oregon)
 - Boise metro area (representing Idaho)
 - Billings and Cheyenne metro areas (representing Wyoming and Montana)
- In all cases the building sample was screened for greater than 50 employees.

Exhibit 3-3 presents the resulting sample disposition for the owner and decision maker surveys, showing the resulting business type distribution, the distribution of completes by facility size and the distribution by state-defined Alliance region. Based on 2,318 available D&B data points, it was only possible to obtain 99 of the targeted 155 telephone survey completes for the owner and decision maker survey.

Exhibit 3-3 also identifies the distribution of building stock in millions of square feet, as well as the percent share of building stock for buildings greater than 100,000 sqft in size. A comparison of the distribution of survey completes and the distribution of the population provides evidence that all four business types are roughly represented in proportion to their contribution to the building population, with college and government buildings somewhat over-represented. The resulting stratified sample cannot be said to represent the building population at large; instead it represents just the four business type segments selected for sampling. Furthermore, the government strata only provides information for buildings that function primarily as offices.

³ Owner/decision maker surveys were only completed for facilities whose size was greater than 50,000 square feet.

Exhibit 3-3
Owner/Decision Maker Survey Sample Disposition
By Business Type, Building Size and State

Exhibit 3-3.A: Sample Disposition

Building Size and State	Survey Completes by Business Type				Total
	Office	College / University	Government Offices	Retail	
Total	38	17	12	32	99
Percent of Total	38%	17%	12%	32%	100%
< 50,000 sqft	0	0	0	0	0
50,000 to < 100,000 sqft	16	2	2	8	28
100,000 to < 250,000 sqft	10	3	2	14	29
250,000 to < 500,000 sqft	5	2	1	4	12
500,000 to < 750,000 sqft	2	1	1	1	5
750,000 to < 1,000,000 sqft	1	1	2	2	6
>= 1,000,000 sqft	4	8	4	3	19
Idaho	6	1	1	3	11
Montana / Wyoming	2	3	0	2	7
Oregon	15	4	2	11	32
Washington	27	7	2	13	49

Exhibit 3-3.B: Building Population*

Building Size	Building Stock by Business Type				Total
	Office	College / University	Government Offices	Retail	
Total Stock (Msqft)	398.7	84.3	59.6	401.3	943.9
Stock>100,000 sqft (Msqft)	187.4	24.4	28.0	128.4	368.2
Percent of Stock>100,000 sqft	51%	7%	8%	35%	100%

* Estimated based on the Assessment of the Commercial Building Stock in the Pacific Northwest, KEMA-XENERGY, Inc., Report # 04-125, March, 2004.

3.2.2 Property Manager Survey

Using primarily on-line business journals, more than 30 high volume property management firms were identified in the Portland and Seattle/Spokane metro areas. Nine out of ten interviews were completed with these top selling property management firms. The sample was supplemented using property management firms supplied by respondents that completed the owner/decision maker survey, yielding one final complete. The relatively small resulting sample of 10 completes should not be interpreted to be representative of the population of property management firms.

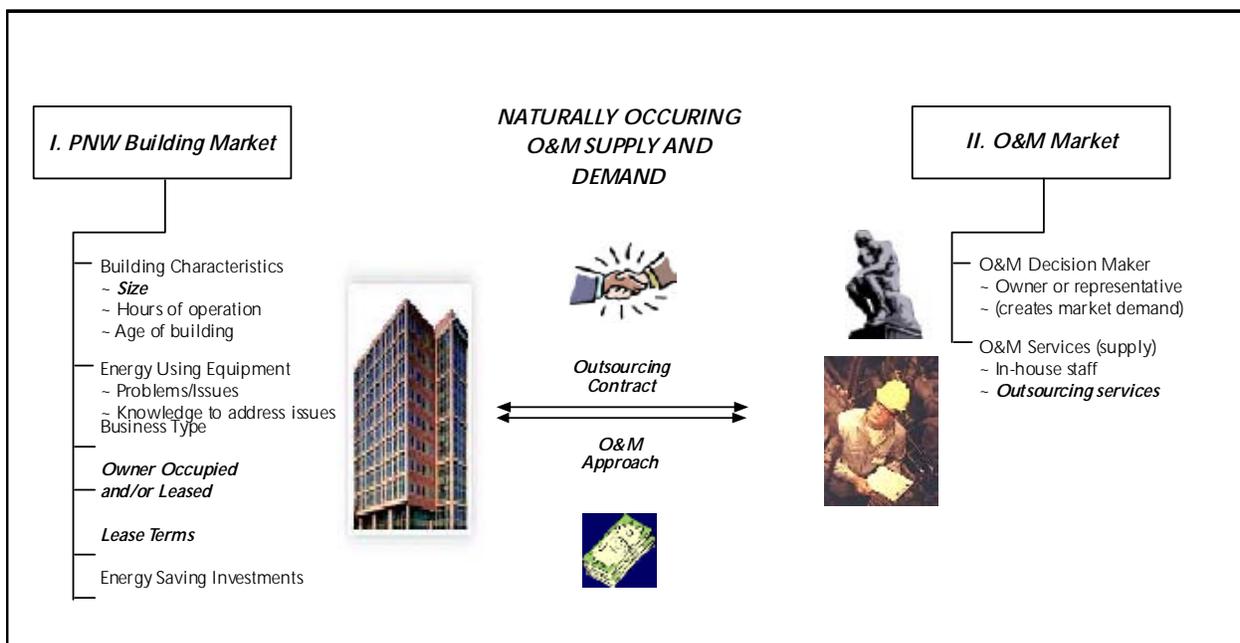
3.2.3 Service Provider Survey

Using primarily self-reports regarding companies retained for O&M services (from the owner/decision maker survey), more than 80 service providers were identified. The sample was supplemented using service provider data supplied by the Alliance project advisors. The resulting sample of 20 O&M provider firms should not be interpreted to be representative of providers operating in the Alliance's territory, due in part to the relatively large number of firms that appear to provide such services and also to the fact that survey results indicate that some segments of the building population are not served by the contractors that were interviewed. For example, a relatively low number of the service providers interviewed provide O&M services to retail facilities. It is hypothesized that this may be due in part to the fact that the data collection efforts for this project did not explicitly separate maintenance services from operations services. Perhaps this led to an under-reporting of service provider participation in a maintenance only role.

4. STUDY RESULTS

An overview of the O&M market is presented in Exhibit 4-1, showing the current market makeup, consisting of buildings in the PNW market and decision makers that drive demand for O&M services, as well as those who supply services in response to those demands. Also shown are key market drivers should an O&M program be introduced to the market, consisting of program influences and market barriers. Bolded items in the exhibit highlight important segments in the market that a successful program must properly and carefully address.

*Exhibit 4-1
O&M Market Characterization Overview*



The market characterization explores the motivations and drivers of the actors on the demand and supply side to inform the *Chapter 5 Program Implications*. Opportunities for energy efficiency in the market are explored as well as the barriers to program influences.

Throughout this chapter the results presented are principally based on primary, self-reported survey data. Where supporting findings are presented based on secondary literature, those findings are cited.

The remainder of this chapter includes the following sections:

- Overview of the PNW Large Building Market
- Characterization of the O&M Market
- Barriers to Enhanced O&M
- Current O&M Practice

Enhanced O&M program opportunities are addressed in the *Chapter 5 Program Implications*.

4.1 OVERVIEW OF THE PNW LARGE BUILDING MARKET

A solid understanding of the large building market in the PNW is first needed to characterize the O&M market. As described in *Chapter 3 Study Methods*, large office, college/university, government and retail facilities were emphasized in this study, and so the results presented in this chapter reflect characteristics that may be unique to these selected segments. This section presents the following:

- An overview of building characteristics and end-use systems applicable in these markets
- Building ownership and lease arrangements, and tenant responsibilities for paying electric and gas utility bills
- Energy saving actions being taken in the building population
- Issues, needs and problems with building equipment and systems, and solutions and barriers to addressing those problems

4.1.1 Building Characteristics and End Use Systems

The facilities represented by respondents to the Owner and Decision Maker survey are presented in Exhibit 4-2. These facilities were selected for data collection and analysis as they are thought to represent likely target markets for O&M and/or building tune-up/commissioning program offerings. As mentioned in Chapter 3, only respondents associated with facilities in excess of 50,000 sqft were selected for the survey.

Exhibit 4-2
Selected Facility Characteristics
Based on Owner/Decision Maker Survey

Building Size	Business Type				Average
	Office	College / University	Government	Retail	
Average Number of Buildings in Respondent Facilities	3	5	4	2	3
Average Size of Respondent Facilities (sqft)	372,409	1,667,706	1,519,208	315,383	715,407
Average Weekly Operating Hours	77	85	56	96	82
Average Age of Buildings in Respondent Facilities (years)	27	38	29	22	28
N	38	17	12	32	99

Among the business types sampled, clearly college/university and government buildings are the largest facilities, followed by office and retail. College/university and government facilities are also more prone to involve multiple buildings or a campus environment, and college facilities tend to be older, while retail buildings are more modern. In terms of operating schedules, government buildings, on average, operate the fewest number of hours in a week, followed by offices, colleges/universities and retail establishments.

Property managers and O&M service providers were each asked about the number of buildings in their area that they manage and provide O&M services to, respectively. Exhibit 4-3 presents these results, showing, as expected, that property management companies manage larger buildings (64% of the buildings they manage are greater than 50,000 sqft) while O&M providers serve buildings more diverse in size (just 13% of the buildings they serve are in excess of 50,000 sqft).

Exhibit 4-3
Self-Reported Number of Buildings Managed/Served by Size
Based on Property Manager and Service Provider Surveys

<i>Average Number of Buildings Managed or Served</i>	<i>Property Manager Survey</i>	<i>Service Provider Survey</i>
Total Buildings	20	251
Buildings > 50,000 sqft	13	32
N	10	17

During property manager and service provider interviews, respondents were asked about the primary use of the facilities they manage/serve; Exhibit 4-4 presents the resulting percentage breakdown. The property managers and service providers we spoke with agree that the majority of buildings they provide services to in the PNW are offices. Also shown for comparison purposes is the percentage of commercial building stock by business type.

It should be noted that the service provider sample for this Study appears to under-represent those who provide services to retail facilities. Underscoring this is self-reported data shown in Exhibit 4-17 below, which demonstrates that over 80 percent of the retail owners and decision makers outsource some or all of their O&M to service providers. A recent study also supports this conclusion, indicating that roughly 50 percent of retail facilities outsource their cooling system maintenance (*E SOURCE, Inc., February 2001*).

Exhibit 4-4
Self-Reported Building Types Managed/Served
Based on Property Manager and Service Provider Surveys

<i>Building Type</i>	<i>Property Manager Survey</i>	<i>Service Provider Survey</i>	<i>Commercial Building Population*</i>
Office Building(s)	90%	65%	32%
College or University		10%	4%
Retail		5%	19%
Hospital		5%	5%
Manufacturing		15%	NA
Industrial	10%		NA
N	10	20	--

* Percent of building floor space for buildings greater than 100,000 sqft, based on estimates from the Assessment of the Commercial Building Stock in the Pacific Northwest, KEMA-XENERGY, Inc., Report # 04-125, March, 2004.

Exhibit 4-5 presents survey results for the saturation of energy using equipment. HVAC and lighting systems are present in nearly all of the buildings sampled for this study, followed by water heating equipment (which is present 60+ percent of the time), refrigeration equipment (as much as 50% of the time) and cooking equipment (less than 50% of the time). In general these findings are consistent with other industry sources (i.e., *Energy Information Administration's Nonresidential Building Energy Consumption Survey, Characteristics of Commercial Buildings; E SOURCE, February 2001*). Some open-ended responses to the question, "which of the following types of permanent building equipment are operated at this location," were also recorded. Respondents also mentioned energy management systems (EMS's) and other control systems that are used in day-to-day operations and represent an important target for O&M. Other open-ended system types mentioned include building envelope systems, elevators/escalators and exhaust fans.

Exhibit 4-5
Energy Using Equipment Saturation in Existing Buildings
Based on Self-Reported Survey Results

<i>Equipment Saturation in Commercial Buildings</i>	<i>Owner and Decision Makers by Business Type</i>				<i>Average</i>	<i>Property Managers</i>
	<i>Office</i>	<i>College / University</i>	<i>Government</i>	<i>Retail</i>		
<i>Self-Reported Results</i>						
Cooling or air conditioning equipment	100%	100%	100%	100%	100%	100%
Area heating equipment	95%	100%	100%	94%	96%	83%
Lighting equipment	100%	100%	100%	97%	99%	100%
Refrigeration equipment	37%	71%	67%	47%	49%	17%
Water heating equipment	68%	94%	92%	63%	74%	
Cooking equipment	34%	71%	58%	34%	43%	
N	38	17	12	32	99	6

Exhibit 4-6 presents the frequency with which owner and decision makers reported their primary cooling and heating systems being either central plant-based, smaller packaged equipment or both. These results demonstrate that individual packaged systems are the most common large building equipment configuration for both heating and cooling systems. Answers to additional questions regarding primary system types are presented in *Section 4.4 Current O&M Practice* below.

Exhibit 4-6
Building End-Use Systems and Equipment
Based on Self-Reported Survey Results

System and Equipment Description	Owner and Decision Makers by Business Type				Average
	Office	College / University	Govern-ment	Retail	
Heating System Type					
Boiler-based plant	24%	65%	33%	6%	26%
Furnaces	71%	35%	67%	84%	69%
Both	3%	-	-	-	1%
Neither	-	-	-	6%	2%
Other	-	-	-	3%	1%
Don't know	3%	-	-	-	1%
Cooling System Type					
Chilled water plant	26%	41%	50%	9%	26%
Packaged air conditioners	71%	53%	50%	88%	71%
Both	-	6%	-	3%	2%
Other	3%	-	-	-	1%
N	38	17	12	32	99

Exhibit 4-7 presents the frequency of primary end-use system controls. Energy management systems are relied upon in about 30 percent of the large building markets. Penetration of electronic and DDC controls is also substantial. Manual controls persist at meaningful levels in the lighting market but have been largely replaced in the HVAC market. These manual control holdouts in the HVAC market represent considerable energy saving potential. The retail segment is clearly the furthest behind in retrofitting manual HVAC controls, as they are more likely to rely on packaged heating and cooling systems, as shown above in Exhibit 4-6.

Exhibit 4-7
Primary Building End-Use System Controls
Based on Self-Reported Survey Results

System Controls Description	Owner and Decision Makers by Business Type				Average
	Office	College / University	Government	Retail	
Heating System Controls					
EMS or EMCS	18%	24%	25%	50%	30%
Electronic or DDC controls	61%	41%	42%	22%	42%
Pneumatic controls	3%	24%	8%	3%	7%
Manual controls	11%	6%	8%	19%	12%
Computerized system	5%	6%	17%	-	5%
Other	-	-	-	3%	1%
None of these	-	-	-	3%	1%
Don't know	3%	-	-	-	1%
Cooling and Ventilation System Controls					
EMS or EMCS	21%	24%	33%	56%	34%
Electronic or DDC controls	61%	53%	42%	16%	42%
Pneumatic controls	3%	6%	-	3%	3%
Manual controls	11%	6%	-	22%	12%
Computerized system	3%	-	25%	-	4%
EMS/DDC	-	12%	-	-	2%
Don't know	3%	-	-	3%	2%
Lighting System Controls					
EMS or EMCS	18%	6%	25%	53%	28%
Daylighting controls	3%	-	-	6%	3%
Occupancy sensors	11%	41%	17%	13%	17%
Sweep controls	8%	-	-	3%	4%
None of these	11%	-	25%	6%	9%
DDC	5%	-	-	-	2%
Timers	-	-	17%	-	2%
Manual controls	37%	53%	17%	19%	31%
Other	3%	-	-	-	1%
Don't know	5%	-	-	-	2%
N	38	17	12	32	99

4.1.2 Building Ownership and Lease Arrangements

Also relevant is market share of owner-occupied versus leased property versus a combination of the two. As shown in Exhibit 4-8, 60% of large buildings represented in the survey are entirely owner-occupied, with another 15% being owner-occupied and leased. Findings from other industry sources tend to agree with these results, for example, results reported for the PNW building stock suggest that buildings are owned 62 percent of the time (*Commercial Building Stock in the Pacific Northwest*). In buildings that are leased, 73% of respondents report that tenants pay energy bills. Property manager responses also echo this finding, with all ten

respondents indicating that tenants pay their utility bills. Owner/decision makers indicated that tenants normally pay based on actual usage (65% of responses) and property managers agree (58% of responses). While fixed-fee arrangements are less common, owner/decision makers cited set maintenance fees and other fixed-fee structures 28 percent of the time and property managers mentioned fixed-fee strategies 42% of the time.

Exhibit 4-8
Reported Frequency of Owner-Occupied Versus Leased Property and the Parties Responsible for Paying Electric and Gas Bills Based on Owner and Decision Maker Survey

<i>Response Categories</i>	<i>Business Type</i>				<i>Average</i>
	<i>Office</i>	<i>College / University</i>	<i>Government</i>	<i>Retail</i>	
<i>Building Occupancy</i>					
Owner occupied only	53%	88%	58%	53%	60%
Leased only	32%	-	17%	34%	25%
Both owner occupied and leased	16%	12%	17%	13%	14%
Other (share with other departments)	-	-	8%	-	1%
N	38	17	12	32	99
<i>Who Pays Electric and Gas Bills in Tenant Occupied Buildings</i>					
Tenants	72%	50%	60%	80%	73%
Owner	28%	50%	20%	13%	23%
Management Company	0%	0%	20%	0%	3%
Other	0%	0%	0%	7%	3%
N	18	2	5	15	40

In the remaining 60 percent of the market that is strictly owner occupied, those owners pay their own utility bills.

Exhibit 4-9 presents the level of concern of the respondents regarding energy costs, and the frequency with which those respondents reported taking action to reduce their energy costs. Owner/decision makers and property managers nearly all expressed considerable concern regarding energy costs, with 96% of owner/decision makers indicating that they are very or somewhat concerned, and 90% of property managers. When asked if they actively seek to reduce energy costs, nearly all respondents said yes, including 97% of owner/decision makers, 100% of property managers and 90% of service providers.

Exhibit 4-9
Market Concern Level Regarding Energy Costs
and Frequency of Taking Action to Reduce Energy Costs
Based on Self-Reported Survey Results

Response Category	Owner and Decision Makers by Business Type				Average	Property Managers	Service Providers
	Office	College / University	Government	Retail			
Concern Level Regarding Energy Costs							
Very concerned	61%	65%	58%	69%	64%	50%	-
Somewhat concerned	32%	29%	42%	31%	32%	40%	-
Not very concerned	5%	6%	-	-	3%	-	-
Not at all concerned	3%	-	-	-	1%	10%	-
N	38	17	12	32	99	10	-
Frequency of Those Taking Action to Reduce Energy Costs							
Yes	94%	94%	100%	100%	97%	100%	90%
No	6%	6%	-	-	3%	-	10%
N	38	17	12	32	99	10	18

When those respondents that reported taking action to reduce energy costs were probed on an open-ended basis for specific actions they had taken to reduce energy costs, a wide array of actions were reported, with an emphasis on high efficiency equipment replacement/upgrades. The full set of self-reported energy saving actions are presented in Exhibit 4-10. A number of the open-ended actions mentioned fall under the broad O&M umbrella supported by this study, such as preventive maintenance, controls optimization, monitoring utility bills, monitoring equipment schedules, and several others. This demonstrates that O&M activities designed to save energy are “on the radar” for a substantial portion of the respondents.

Exhibit 4-10
Energy Saving Actions Taken by Respondents
Based on Self-Reported (Open-Ended) Survey Results

Energy Saving Actions Taken	Owner and Decision Makers by Business Type				Average	Property Managers	Service Providers
	Office	College / University	Government	Retail			
Adjust energy use schedules	6%	20%	-	6%	8%	-	-
Always looking for ways to reduce costs/ rebates	3%	-	-	6%	3%	22%	6%
EMS controlled	3%	7%	8%	13%	8%	11%	-
DDC controlled	3%	-	8%	0%	2%	-	-
Controlled by computer system	12%	-	8%	3%	6%	-	-
High efficiency equipment	29%	13%	17%	19%	22%	44%	44%
EE design	6%	-	-	3%	3%	-	11%
Energy audit	6%	-	-	3%	3%	-	-
Energy conservation	24%	7%	8%	16%	16%	-	-
Preventative maintenance	3%	13%	-	9%	6%	11%	28%
New technologies	3%	13%	8%	6%	6%	-	-
Monitoring utility bills	-	-	8%	3%	2%	33%	6%
Lighting sensors	-	7%	8%	3%	3%	-	-
Timer controlled equipment	3%	-	8%	9%	5%	-	-
Retrofit/Upgrade equipment	24%	33%	17%	19%	23%	11%	-
Proper Preventive Maintenance	-	7%	-	3%	2%	-	-
Monitor energy use schedules	3%	0%	-	-	1%	-	-
Turn equipment off	9%	0%	-	6%	5%	-	-
We have a resource conservation manager	-	7%	-	-	1%	-	-
Internal committee dedicated to EE	-	-	8%	3%	2%	-	11%
Accelerated maintenance program with vendors	3%	-	-	-	1%	-	-
Mostly manual	-	7%	-	-	1%	-	-
Benchmarking	-	-	8%	-	1%	-	-
VSD	-	-	-	-	-	11%	-
Equipment studies	-	-	-	-	-	22%	-
Various activities	-	-	-	-	-	-	6%
Change filters frequently	3%	-	8%	3%	3%	-	-
Other	-	-	8%	-	1%	-	-
N	34	15	12	32	93	9	18

Using strategies like those listed above, respondents were asked by what percentage they believe they could reduce energy usage in existing buildings. The resulting percent reduction distributions are presented in Exhibit 4-11. With the exception of service provider self-reports¹, 60 percent of respondents (66% in office buildings) believe that the potential for energy savings is 10% or less.

¹ Service providers claim to recognize substantially greater potential to save energy in existing buildings than do the other survey respondents.

Exhibit 4-11
Potential Energy Reduction in Existing Buildings
Based on Self-Reported Survey Results

Potential Energy Usage Reduction	Owner and Decision Makers by Business Type				Average	Property Managers	Service Providers
	Office	College / University	Government	Retail			
5 percent or less	41%	21%	25%	21%	29%	44%	6%
Between 6 to 10 percent	25%	36%	50%	31%	31%	22%	17%
between 11 to 15 percent	3%	14%	-	7%	6%	-	28%
between 16 to 20 percent	9%	14%	13%	7%	10%	-	11%
between 21 to 30 percent	3%	-	-	10%	5%	11%	22%
more than 30 percent	13%	7%	-	-	6%	22%	11%
Don't know	6%	7%	13%	24%	13%	-	6%
N	32	14	8	29	83	9	18

Service providers are more convinced than the other respondent groups that there is a substantial untapped reserve of energy efficiency savings. Over 70 percent of the service providers that were interviewed believe there is the potential to save more than 10% of energy usage. This contrasts sharply with owners and decision makers, with under 30 percent of respondents believing that a reduction in energy use of 10% is feasible. In fact, one-third of both service providers and property managers agree that there is the potential to save more than 20% of energy usage, though the remaining two-thirds of property managers are substantially more pessimistic, with 44 percent of respondents reporting 5% or less in savings potential and another 22 percent reporting 6 to 10% is savings potential.

These results suggest that owners and decision makers need additional information and training regarding energy efficiency potential in general and the benefits of building operator training and certification specifically. This assertion is based on the fact that most of those respondents understate the potential for energy savings in existing buildings. Given their knowledge and understanding of potential energy savings in general, enhanced O&M is likely to represent a “hard sell.”

4.1.3 Building Equipment Problems and Solutions/Barriers

Owners and decision makers were asked if there are any issues, needs or problems that they are currently facing with regard to their buildings’ energy using equipment and systems. These issues and problems were first described by the respondents, including the equipment affected and what the problem appears to be. Exhibit 4-12 summarizes these results, which demonstrates that some level of problems were acknowledged among about half of the owner and decision maker respondents². Furthermore, HVAC is at the root of most problems that owners and decision makers face. For the most part, respondents believe that these problems stem from age of the equipment, and believe that ultimately replacement is needed to resolve the bulk of the problems they face. But, a substantial number of respondents pointed to the fact that their equipment is not working properly, suggesting that O&M may solve many existing problems.

² A much lower problem rate was noted in the office and retail segments, at about 35% of respondents, versus the college/university and government business types, at roughly 70%.

Exhibit 4-12
Issues, Needs, Problems with Building Equipment and Systems
Based on Self-Reported Survey Results

<i>First Mentioned Issues, Needs and Problems</i>	<i>Owner and Decision Makers by Business Type</i>				<i>Average</i>
	<i>Office</i>	<i>College / University</i>	<i>Government</i>	<i>Retail</i>	
<i>Issues/Needs/Problems</i>					
Yes	37%	71%	67%	34%	45%
No	63%	24%	33%	66%	54%
Refused	-	6%	-	-	1%
N	38	17	12	32	99
<i>Equipment or Systems Affected</i>					
HVAC - heating and cooling	50%	33%	13%	55%	40%
Cooling - general	7%	17%	-	9%	9%
Cooling - chiller	-	8%	13%	-	4%
Heating - heat pump	7%	17%	-	-	7%
Heating - natural gas	-	-	-	9%	2%
Heating - steam	-	17%	-	-	4%
Heating - boiler	-	-	13%	-	2%
HVAC - ground source	-	8%	-	-	2%
Energy Management System	14%	-	25%	-	9%
Lighting	-	8%	13%	-	4%
Water heater	-	8%	-	-	2%
Electrical infrastructure	-	-	13%	9%	4%
CO2 Sensor	7%	-	-	-	2%
Dampers in HVAC	-	-	13%	-	2%
Escalator	-	-	-	9%	2%
Fixtures/Switches	7%	-	-	-	2%
All	-	8%	-	-	2%
Old equipment in general	-	-	13%	-	2%
Pneumatic motors	-	-	-	9%	2%
Envir controls for batteries UPS	7%	-	-	-	2%
N	14	12	8	11	45
<i>What are the maintenance or Other Needs Associated with the Problem</i>					
Age of equipment	29%	42%	50%	45%	40%
Age of building	7%	-	13%	-	4%
Equipment is not working properly	29%	33%	25%	18%	27%
Inadequate design	14%	17%	-	-	9%
Need to be upgraded	-	-	13%	9%	4%
Need additional units/more capacity	7%	8%	-	9%	7%
Need to replace	-	-	13%	9%	4%
Equipment is not working	-	-	-	9%	2%
Other	14%	-	-	-	4%
N	14	12	8	11	45

Follow-up questions regarding the issues raised above in Exhibit 4-12 were asked to identify possible solutions to those problems and barriers that exist for addressing those problems. Exhibit 4-13 indicates that in most cases owners and decision makers believe they know of a solution to the problems they face in their buildings. Upgrading and replacing equipment is largely what is perceived as the solution needed. Money is the factor that prevents owners and decision makers from implementing needed equipment upgrades.

Exhibit 4-13

**Solutions to Address Problems with Building Equipment and System
and Barriers to Addressing Those Issues Based on Self-Reported Survey Results**

<i>First Mentioned Solutions and Barriers</i>	<i>Owner and Decision Makers by Business Type</i>				<i>Average</i>
	<i>Office</i>	<i>College / University</i>	<i>Government</i>	<i>Retail</i>	
<i>Aware of Solutions to Building Equipment and System Problems</i>					
Yes	86%	83%	100%	91%	89%
No	14%	17%	-	9%	11%
N	14	12	8	11	45
<i>What Should Be Done to Address Those Problems</i>					
Age of equipment	8%	0%	-	-	3%
Equipment is not working properly	-	10%	-	-	3%
Inadequate design	8%	-	-	10%	5%
Need to be upgraded	17%	20%	25%	20%	20%
Need additional units/more capacity	-	-	-	10%	3%
Need to replace	17%	40%	50%	50%	38%
Money	25%	20%	-	-	13%
Hired an expert to work on it	17%	10%	-	-	8%
Time	-	10%	-	-	3%
Staff	-	-	13%	-	3%
Other	8%	-	13%	10%	8%
N	12	10	8	10	40
<i>Barriers Preventing the Implementation of Those Improvements</i>					
Money	58%	90%	63%	60%	68%
Time	-	10%	13%	-	5%
Staff	-	30%	-	-	8%
None	25%	-	13%	30%	18%
Other	8%	-	13%	-	5%
Don't know	8%	-	-	10%	5%
N	12	10	8	10	40

The fact that half of the respondents reported that they have ongoing problems with their major systems indicates that it would likely be difficult to get them to pay attention to what may be perceived to be routine O&M. Respondents also view replacement as the solution to their problems which may cause them to be less drawn to enhanced O&M as a solution. This suggests again that education is needed, perhaps through the use of on-site experts, to identify and demonstrate that some fraction of these problems can be addressed using O&M or building tuneup approaches. In the absence of this type of intervention many would likely relegate O&M to the backburner. Further inhibiting enhanced O&M is the tendency to wait out any problems until equipment is replaced, even if the O&M measure and practice may have less than a year long payback.

Second and third mentions were also collected of problems with building equipment and systems and the potential solutions to address those issues. Only about ¼ of those that made a first mention went on to offer secondary and tertiary issues with their equipment and systems, and those responses were much more likely to revolve around lighting systems and somewhat more likely to involve controls and the electrical infrastructure. Responses are available for inspection in Appendix D.

4.2 CHARACTERIZATION OF THE O&M MARKET

The O&M market can be split into demand- and supply-side actors. Demand-side actors are generally building owners/decision makers (including property managers), while service providers supply services to the O&M market (often in conjunction with the building owners internal facilities staff). Depending on the size and sophistication of the building O&M staff, owners may opt to have O&M measures implemented by in-house staff (*Thorne and Nadel, 2003, p. 2*).

The O&M services market is represented in this study by three main market players – commercial property owners or decision makers (acting on behalf of those owners), property management firms and O&M service providers. Primary data were collected from each of these market players regarding the O&M markets in which they participate. This section of the report addresses the interactions and perceptions of these three key market players, setting the stage for the discussions of market barriers and drivers, the market’s maturity with respect to energy efficiency potential, and the *Chapter 5 Program Implications* discussion.

4.2.1 O&M Approach

O&M tactics and approach were discussed – respondents were asked if they typically wait for equipment to break (or wait for complaints), regularly maintain equipment or test and analyze equipment on a regularly scheduled basis. Exhibit 4-14 presents those findings, demonstrating that completing regularly scheduled maintenance is the most common approach – used about 80% of the time.

Exhibit 4-14
O&M Approach
Based on Self-Reported Survey Results

O&M Approach Used	Owner and Decision Makers by Business Type				Average	Property Managers	Service Providers
	Office	College / University	Government	Retail			
Fix equipment when it breaks or there are complaints	8%	24%	0%	13%	11%		10%
Complete preventive maintenance on a regularly scheduled basis	82%	71%	83%	84%	81%	100%	75%
Test and analyze equipment (ie lubrication analysis-vibration analysis)	5%	0%	0%	0%	2%		5%
Mixture of above	5%	6%	17%	3%	6%		10%
N	38	17	12	32	99	10	20

Those owners and decision makers that complete regularly scheduled preventive maintenance, were asked for the frequency of those activities. Quarterly maintenance is the most common practice (38% of the time), followed by monthly (20%), weekly (10%) and daily (8%). There is substantial room for improvement among just over 30% of the population where maintenance is completed just once bi-annually (18%), annually (3%) or 11% of the time where no routine O&M is completed at all.

Crucial to an understanding of this market is identification of the entity that is ultimately responsible for paying for O&M services. As shown in Exhibit 4-15, all three market actor respondent groups were asked this question; in general, owners/corporate offices pay most O&M bills. In some cases, property management firms are responsible for paying those bills. The fact that owners and their property management representatives pay for O&M services may have negative implications for an energy efficiency program that targets the O&M market, as these two important players do not normally stand to benefit directly from the downstream energy savings in many tenant occupied buildings, where tenants are often responsible for paying energy bills (both directly and indirectly). This implies that split incentive barriers in tenant occupied buildings, like those that also affect the energy efficiency retrofit markets, are likely to hamper participation in any O&M initiative. However, tenants are sometimes directly responsible for paying O&M bills through, for example, net lease arrangements or presumably through a cost pass-down mechanism (or are perceived to ultimately pay for those services through their lease arrangement/terms). So, addressing this barrier is not insurmountable.

Exhibit 4-15
Parties Responsible for Paying O&M Bills
Based on Self-Reported Survey Results

<i>Party Responsible for Paying for O&M</i>	<i>Owner and Decision Makers by Business Type</i>				<i>Average</i>	<i>Property Managers</i>	<i>Service Providers</i>
	<i>Office</i>	<i>College / University</i>	<i>Government</i>	<i>Retail</i>			
Building Owner	63%	94%	58%	56%	66%	50%	85%
Property Manager	8%	-	25%	-	6%	20%	15%
Tenants that Lease Space	13%	-	-	13%	9%	30%	-
Corporate Office	5%	-	-	22%	9%	-	-
Other	11%	6%	17%	9%	10%	-	-
N	38	17	12	32	99	10	20

4.2.2 Role of Market Actors

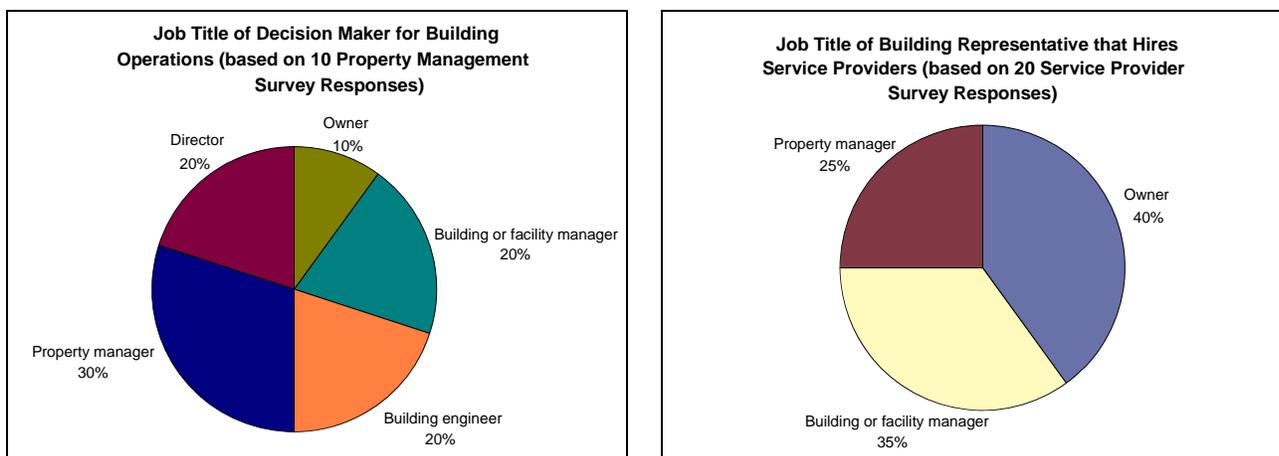
Building Owner/Decision Maker

“Building owner” is a broad category, made up of diverse actors such as owner-occupants and investor-owners, public and private sector entities, owners’ representatives, property management companies, facility or property managers, and other financial decision-makers (*Thorne and Nadel, 2003, p. 2*). Large facilities make ideal targets for O&M, and they often have complex, multi-level management structures. In these environments, it is important that O&M be supported by decision-makers at all levels of the organization—from the facility manager or building operating staff to the owner or key executives (*Thorne and Nadel, 2003, p. 2*). Previous studies show that among large building owners, the ones most interested in O&M services are owner-occupants and owners of Class A leased space. Chief concerns for these owners are

operating costs and/or keeping occupants comfortable (RLW 1999 cited in Thorne and Nadel, 2003, p. 2)

Central to the O&M market is the person (and their job title) within a particular organization that is ultimately responsible for decision making in building operations. Owners and decision makers and property managers were each asked for the job title of the primary decision maker for building operations. Service providers, on the other hand, were asked for the job title of the building representative that typically hires their firm to provide O&M services, as this was thought to be an equivalent role where outsourcing is involved. Exhibit 4-16 presents the property management and service provider survey results, indicating that facility managers, property managers and owners are all important decision makers for building O&M. Property managers perceive less direct involvement of owners than do service providers; not surprising as these owners choose to outsource property management – and are therefore less involved in day-to-day operations of the buildings they own. Owners and decision maker responses were much more diverse, with 99 respondents mentioning over 50 unique O&M decision maker titles³. However, there was some clustering of responses – building or facility manager (26%), operations manager (7%), owner (4%) and property manager (2%).

Exhibit 4-16
Job Title of Primary Decision Maker for Building Operations



Often a property management company represents the building owner in leasing a facility and maintaining facilities.

Outsourcing O&M

Frequently, building owners and managers outsource most if not all of their operation and maintenance services for their building systems. Even large national companies and institutions with in-house O&M staffs often use outside service contractors to supplement their work (PECI, 1997b, p. 1).

³ These titles and other survey responses are presented in Appendix E.

All three market actors interviewed were asked how energy using equipment and controls are typically maintained. Exhibit 4-17 presents the resulting self-reported frequency with which facilities are maintained using in-house staff only, outsourcing to service providers only, or a combination of the two. These results suggest, in general, that O&M responsibilities are roughly split in the large facility PNW market among in-house personnel and service providers. The office (26%) and retail (28%) facilities are more likely to outsource all O&M services, while colleges and universities (35%) are more likely to use in-house staff only. These results also suggest that facilities overseen by property managers are less likely to rely exclusively upon an outsourcing solution than are facility owners. Findings from a recent O&M study of a sample of U.S. and Canadian commercial buildings suggest that cooling outsourcing is used to some extent in 59% of buildings (*E SOURCE, Inc., February 2001*), which is somewhat lower than the self-report-based data shown here.

Exhibit 4-17
Use of In-House Personnel and Outsourcing for O&M
Based on Self-Reported Survey Results

Percentage of Facilities Using In-House Personnel, Outsourcing and a Combination	Owner and Decision Makers by Business Type				Average	Property Managers	Service Providers
	Office	College / University	Government	Retail			
Use in-house staff only	13%	35%	17%	16%	18%	20%	-
Outsource all responsibilities to O&M service providers or vendors	26%	6%	17%	28%	22%	-	25%
Use BOTH in-house staff & outsource to O&M service providers or vendors	61%	59%	67%	56%	60%	80%	75%
N	38	17	12	32	99	10	20

Survey results were used to calculate population estimates of average in-house full time equivalent (FTE) for O&M functions. Exhibit 4-18 presents the resulting estimates, which indicate that 5 to 10 in-house FTE is typical for larger facilities, with somewhat higher numbers of in-house staff needed in colleges and somewhat fewer in retail facilities, due in part to differences in average facility square footage. Estimates were also derived for the percent of O&M outsourced to service providers. About half of the O&M activities in the PNW market are outsourced through contracts with service providers (or vendors). Retail and office facilities are more reliant on outsourcing than are colleges and government facilities.

Exhibit 4-18
In-House FTE for O&M Facility Function and Percent of O&M Outsourced
Population Estimates Based on Self-Reported Survey Results

In-House FTE and Percent of O&M by Service Providers	Owner and Decision Makers by Business Type				Average	Property Managers	Service Providers
	Office	College / University	Government	Retail			
<i>Population Estimate of In-House O&M FTE</i>							
Average In-House FTE	5	20	7	2	7	9	-
N	38	17	12	32	99	10	-
<i>Population Estimate of Percent of O&M Outsourced to Service Providers</i>							
Average Percent Outsourced	63%	21%	36%	43%	46%	32%	66%
N	38	17	12	32	99	10	20

According to PECEI, 40% of all non-residential buildings contract maintenance service for heating, ventilation and air conditioning (HVAC) equipment (PECEI, 1997b, p. 1). By comparison, in this study we find that outsourcing to providers accounts for about 50% of all O&M activity in large buildings and that some level of outsourcing is present in 80% of all large buildings.

All three market players were asked if there are equipment or controls for which building managers rely almost exclusively upon the expertise of O&M service providers. Exhibit 4-19 presents the self-reported results, indicating that HVAC and EMS systems are the most likely to be maintained by O&M vendors. As noted above, most service providers are mechanical contractors, so there is consistency across these two findings. On an unprompted basis, respondents also mentioned elevators and compressed air systems.

Exhibit 4-19
O&M for which Managers Rely Almost Exclusively Upon the Expertise of Providers
Based on Self-Reported Survey Results*

<i>Equipment or Controls Almost Exclusively Maintained by Service Providers</i>	<i>Owner and Decision Makers by Business Type</i>				<i>Average</i>	<i>Property Managers</i>	<i>Service Providers</i>
	<i>Office</i>	<i>College / University</i>	<i>Government</i>	<i>Retail</i>			
Cooling or air conditioning equipment	67%	18%	30%	56%	52%	50%	45%
Area heating equipment	48%	27%	10%	41%	38%	50%	5%
Lighting equipment	30%	-	-	19%	19%	-	10%
Refrigeration equipment	3%	-	-	15%	6%	-	10%
Water heating equipment	3%	9%	-	11%	6%	-	5%
Cooking equipment	3%	-	-	4%	2%	-	-
EMS or other system controls	24%	18%	30%	30%	26%	-	35%
None	12%	27%	10%	33%	21%	50%	10%
N	33	11	10	27	81	8	20

* Percentages in each column sum to more than 100% as respondents often mentioned reliance upon service providers for more than one category.

O&M Suppliers

A range of building services professionals offer O&M services, including engineering firms, design professionals, general contractors, HVAC/controls contractors, commissioning specialists, testing, adjusting and balancing (TAB) contractors, energy services firms, and O&M service contractors (Thorne and Nadel, 2003, p. 2; NEEA/SBW, 1998).

A variety of contractors offer maintenance service agreements to owners of commercial buildings and retail facilities (PECEI, 1997b; PECEI 2001).

- *Mechanical contractors and full-service mechanical contractors:* install, repair and perform O&M on all types of mechanical equipment, including controls.
- *Maintenance service contractors:* janitorial, lighting maintenance, preventive HVAC maintenance. Hired by owners who outsource their building services.

- *National maintenance service firms (consolidators)*: serve either large retail chains or owners of multiple buildings, using qualified subs across the country, or a consolidator that buys up mechanical contracting firms nation wide.
- *Specialized service contractors*: narrowest scope of O&M services—sell, install and repair a particular type of equipment (i.e. controls, refrigeration or electrical equipment).
- *Manufacturers*: HVAC manufacturers often provide maintenance service contracts for equipment they make (chillers, boilers, package units, EMS).
- *Maintenance management firms*: provide full-time, on-site staff. A large portion of their business is based on O&M management and service. Amount of savings generated from improved O&M practices motivates this arrangement.

Respondents to the owner and decision maker and property manager surveys were asked to provide the business name of the companies that provide O&M services for the facilities that they manage. The overwhelming majority of the resulting service providers are mechanical contractors. Furthermore, service providers were asked to provide the business names of their major competitors. The survey responses suggest that there are many service providers in the area (as the resulting company list was long, consisting of over 100 separate providers).

- Respondents mentioned over 60 percent of the companies just once.
- Assuming no sampling irregularities, no single contractor appears to control a substantial share of the O&M provider market in the PNW.
- Only a handful of these companies appear to have captured much market share – Trane, McDonald Miller, McKinstry, Honeywell and Johnson Controls all have a slightly higher share of the market – but none of these commands a substantial share of the market.

4.2.3 O&M Services

According to the service providers that were interviewed for this project, on average they obtain 48 percent of their revenue through O&M services, with the remainder comprising equipment sales and related labor.

Service Contracts

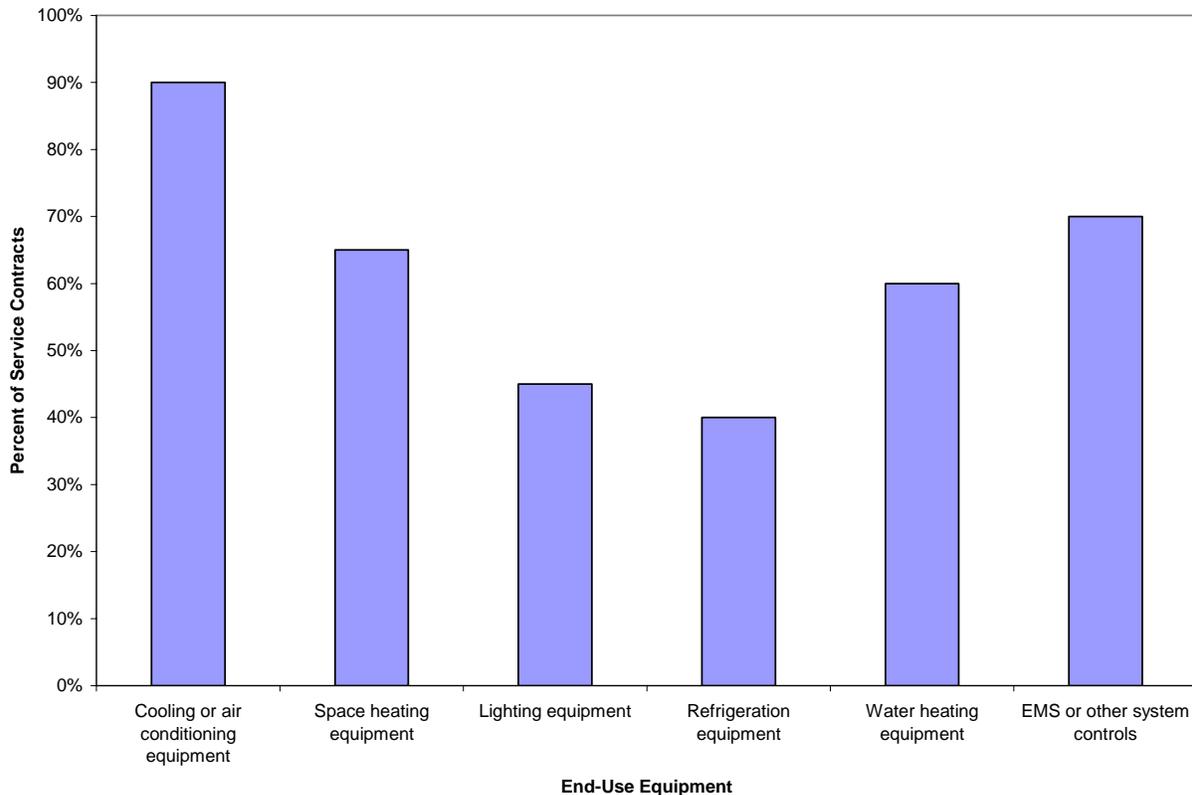
There are five basic types of contracts (*PECI, 1997b, pp. 3-4; DOE, 2002, p. 3.5*):

- *Full-coverage service contract* provides 100% coverage of labor, parts, materials, plus emergency service. One may purchase services for all building equipment or most critical equipment.
- *Full-labor service contract* covers 100% of labor to repair, replace and maintain most mechanical equipment.

- *Preventive-maintenance* service contract purchased for a fixed fee, includes scheduled and rigorous activities such as changing belts and filters, cleaning coils and cooling towers, testing control functions and calibration.
- *Inspection* service contract (or “fly-by” contract), is purchased for a fixed annual fee and includes a fixed number of periodic inspections. Much less rigorous than preventive maintenance. Inspection means looking to see if anything is broken or is about to break and reporting it to the owner.
- *End-Use or End-Result* contracting is a relatively new type of O&M contract (PECI, 1997b, pp. 3-4; DOE, 2002, p. 3.5). The O&M contractor takes over all operation *and* all operational risk. The contractor agrees to provide a certain level of comfort (i.e. space temperature), then is compensated based on how well this is achieved.

According to the O&M service providers interviewed, services contracted are generally comprehensive, but concentrate on HVAC/controls, followed by water heating equipment and lighting and refrigeration. The percentage of service contracts that address a given end-use equipment category is presented in Exhibit 4-20.

Exhibit 4-20
Service Provider
Self-Reported Energy Using Equipment Serviced
(N=20)



According to the O&M service providers that were interviewed, O&M contracts call for energy savings O&M improvements 65% of the time. Through the dissemination of energy efficiency information (possibly using an energy efficiency program vehicle) service providers might achieve greater energy savings and, in turn, differentiate their service offerings from those of their competitors.

Similarly, owners and decision makers were asked how frequently they require their O&M service providers to engage in energy savings activities. Results indicate that this requirement is less frequent than reported by O&M service providers. Owner and decision makers say they require energy savings O&M improvements from their O&M providers 40% of the time, while property managers report requiring this just 25% of the time. It is not surprising that owners require energy saving efforts more frequently than property managers, as owners are more likely to reap the rewards of reduced energy bills.

According to service providers that were interviewed, most O&M service agreements are priced using estimates of time and/or material requirements (65% of responses). Other methods for determining pricing were much less frequently mentioned, such as by equipment type and size (15%), per square foot (5%), fixed price (5%) and per unit (5%).

Service providers were asked what the two main things are that their customers focus on obtaining from their service contracts. According to service providers, quality/capability (40% of responses) is the most important factors in selecting service providers for O&M contracts, followed by speed of service (15%) and energy savings (15%). Also important is a competitive price for services (13%) and company reputation (12%), followed by comprehensive turnkey services (5%), equipment reliability (3%) and the availability of client references (2%).

O&M service providers were asked what are the main selling points that they stress – the most common responses were quality services (39% of responses), responsiveness (16%), company reputation (9%) and equipment reliability (9%). This is followed by energy cost savings (7%), bundling of services (7%), turnkey services (5%), costs for services (5%) and extended equipment life (4%).

4.3 BARRIERS TO ENHANCED O&M

This section identifies and describes market barriers to enhanced O&M, as well as recommendations for overcoming those market barriers. The market barrier results presented are based upon both the study interviews completed with key market actors and secondary literature.

The literature calls out technical, organizational and financial factors that discourage businesses from implementing enhanced O&M.

Technical. It is well known that the major technical factors that inhibit enhanced commercial O&M are related to customer energy use and intensity.

- **Facility energy use is limited.** Facilities that do not use much energy are usually uninterested in saving energy because energy costs make up a relatively small portion of their operating costs. Small customers and those that use energy at relatively low energy intensity level (i.e., the amount of energy consumed per square foot) both contribute to this low energy use profile.
 - Small/low usage customers typically have small O&M budgets, unsophisticated maintenance staff, and a poor understanding of the economics regarding improved O&M.
 - These customers offer little “bang for the buck.” It is therefore recommended that O&M program efforts focus on larger, energy intensive commercial customers that are motivated, capable and stand to benefit substantially from enhanced O&M.

Organizational. Four major organizational factors that inhibit enhanced O&M are described below.

- **Lack of customer interest.** Lack of interest may be the biggest culprit in a stagnant O&M market, as customer demand is fundamental to any market. A variety of behaviors and attitudes seem to result from customer indifference. When a business is uninterested in O&M, the following customer attributes are likely to also be present:
 - Unwilling to invest in enhanced O&M
 - Tend to run equipment until it breaks
 - Decision-makers are difficult to access
 - Reduced likelihood that system controls involve an EMS
 - Maintenance staff are not adequately trained in O&M and preventive maintenance
 - Hire “fly by” contractors for occasional, lax inspections, looking for equipment that’s broken or beyond repair
 - Perpetuate misperceptions about O&M as expensive and unproven

A successful O&M program will provide the market with information to increase building owner interest in improved building operating performance.

- **Unskilled maintenance staff.** A well-educated and trained staff may be the most essential component of enhanced O&M.
 - For a building to function at its optimal level, building operators and managers must have the skills to perform quality operation and maintenance (*US DOE, n.d. “Building Commissioning: The Key to Quality Assurance,” p. 58*). Maintenance staff are front-line actors in enhanced O&M. O&M is not uppermost in the minds of maintenance staff that are unskilled, stretched too thin, or turning over.

- Companies with untrained staff can take part in education, training, and certification programs such as Building Operator Certification. A variety of training opportunities can be offered, including the following: hold seminars, conduct training sessions, develop an O&M newsletter, provide literature that specifies maintenance schedules and equipment maintenance issues, create a checklist of no-cost measures that save money and energy (*1999 O&M Baseline Study*).
- **Facility does not track energy costs.** For companies that don't track energy costs and therefore don't see the value of O&M, education and training can provide tools for tracking those expenses on a continual basis (*1999 O&M Baseline Study*).
- **Uncertainty about energy savings potential.** A recent evaluation of an O&M program in the Northeast found that 95% of non-participants were uncertain about energy savings potential from O&M measures, compared with only 28% of participants (*NU, 2001, p. 67*).
 - It is not surprising that building owners are reluctant to invest in enhanced O&M practices without credible evidence of the downstream benefits (energy savings and other non-energy benefits).
 - A few strategies to overcome this barrier may prove useful. First, when management is uncertain regarding savings potential, an O&M program can demonstrate that efforts are cost effective with case studies and site-specific analysis to clearly demonstrate savings using proven, real-life examples of significant reductions in energy costs. Second, tools to help assess the costs and paybacks can be helpful in selling O&M to decision makers (*Thorne and Nadel, 2003*). Third, a business could sign an *end-result* contract with a service provider whereby the O&M contractor assumes all operational risk as well as responsibility for all O&M operation.
- **A variety of common lease arrangements and terms may cloud who pays for O&M and who receives the benefits.** The use of common economic tools to inform O&M investments, such as payback calculations, may not successfully motivate O&M decision makers due to uncertainty surrounding who will ultimately pay for improvements and who will benefit from the downstream energy savings.
 - For example, regardless of the fact that owners and property managers often pay O&M bills, one might suggest that those expenses are eventually passed along to the tenants that occupy buildings through some mechanism in their lease. Likewise, one could argue that the leasee ultimately pays the utility bills and so would be expected to benefit from any O&M enhancements. However, one could also argue that in a fixed fee lease arrangement (where the owner pays the electric and gas bills) it is the owner who stands to ultimately benefit from electric and gas bill savings.
 - Ultimately the wide array of lease arrangements and terms may confuse the decision making process and result in the decision to abandon perfectly good opportunities to implement enhanced O&M. It is important that any program information or program recruitment efforts (of owners, property management companies or service providers) address the influences of lease arrangements and terms.

Financial. The literature raised several financial issues that prevent enhanced O&M.

- **Lack of money.** Companies often claim they have limited or no money for enhanced O&M, and point to competing priorities for their capital and other, more profitable investments (*1999 O&M Baseline Study*).
 - In addition, the perception that O&M has long paybacks and is too costly may predispose businesses against allocating funds to O&M. Moreover, companies without O&M budgets are likely to spend the least they possibly can—a “run it until it breaks” mentality—by adopting a least-cost outlook to operating and maintaining their building equipment.
 - Several strategies may overcome the cost issue. First, innovative financing may help overcome lack of funds. For example, SCE’s ENVEST program paid for implementation and had customers repay them over time on their monthly bill to eliminate the upfront cost and allow customers to use the money they save to pay for their participation (*Martinez, 1997, “Measuring and Verifying Savings from Lighting Retrofits at DOD Facilities,” IEPEC paper, p. 49; summarized in NU, 1999, p. 55*). Second, in situations where companies have “fly by” contractors do work and consider least cost over O&M in the bids, the best thing may be to target contractors with standards, maintenance contracts and certification programs (*1999 O&M Baseline Study*). Third, low cost efforts, such as checklists of options, web-based tools for self-analysis, and benchmarking reports comparing the customer to others like them may be helpful to cost-sensitive customers. Lastly, a program emphasis on larger customers will eliminate the more cash-strapped population, as larger customers tend to be less constrained in capital investments.

All three groups of market actors that were interviewed were asked about technical, organizational and financial barriers that might prevent them from implementing O&M operational enhancements. Exhibit 4-21 presents the barriers mentioned by respondents using an open-ended data collection approach with post-collection coding to a set of common response categories.

Exhibit 4-21
Technical, Organizational and Financial Barriers to O&M Operational Procedures
Based on Self-Reported Survey Results

Barriers to O&M Operational Procedures	Owner and Decision Makers by Business Type				Average	Property Managers	Service Providers
	Office	College / University	Government	Retail			
Technical Barriers							
None	50%	47%	33%	47%	46%	50%	40%
Limited staff	-	6%	-	-	-	-	-
Money/ Initial cost	-	6%	-	-	1%	-	5%
Payback	-	-	-	3%	1%	-	-
Lack of knowledge on staff/Technical barriers	5%	18%	17%	13%	11%	-	10%
Age of building/equipment	13%	18%	25%	16%	16%	20%	-
Time constraints	3%	0%	0%	0%	1%	-	-
Having the tools	-	-	-	-	-	10%	-
Compatability	-	-	-	-	-	10%	-
Man power	-	-	-	-	-	-	10%
Small company	-	-	-	-	-	-	5%
Building engineers	-	-	-	-	-	-	5%
Lack of incentives	-	-	-	-	-	-	5%
Unsure about product	-	-	-	-	-	-	5%
N	38	17	12	32	99	10	20
Organizational Barriers							
None	53%	47%	25%	42%	45%	60%	48%
Budget	5%	18%	17%	6%	9%	10%	-
Limited staff	3%	18%	8%	3%	6%	-	5%
Management approval/Chain of command	11%	12%	17%	10%	11%	30%	5%
Money/ Initial cost	3%	12%	8%	6%	6%	-	5%
Payback	3%	0%	0%	3%	2%	-	-
We don't do preventive maintenance	3%	0%	0%	10%	4%	-	-
Time	-	-	-	-	-	-	14%
In-house people	-	-	-	-	-	-	5%
Communication	-	-	-	-	-	-	5%
No set up or focus	-	-	-	-	-	-	5%
Contractual dock	-	-	-	-	-	-	5%
N	38	17	12	32	99	10	20
Financial Barriers							
None	16%	6%	0%	13%	11%	10%	60%
Budget	21%	41%	75%	31%	34%	20%	-
Management approval/Chain of command	5%	12%	0%	9%	7%	-	5%
Money/ Initial cost	24%	35%	8%	16%	21%	40%	5%
Payback	21%	0%	0%	16%	13%	30%	-
We don't do preventive maintenance	3%	0%	0%	0%	1%	-	-
Our cost	-	-	-	-	-	-	15%
Not enough man power	-	-	-	-	-	-	5%
Change of my business	-	-	-	-	-	-	5%
N	38	17	12	32	99	10	20

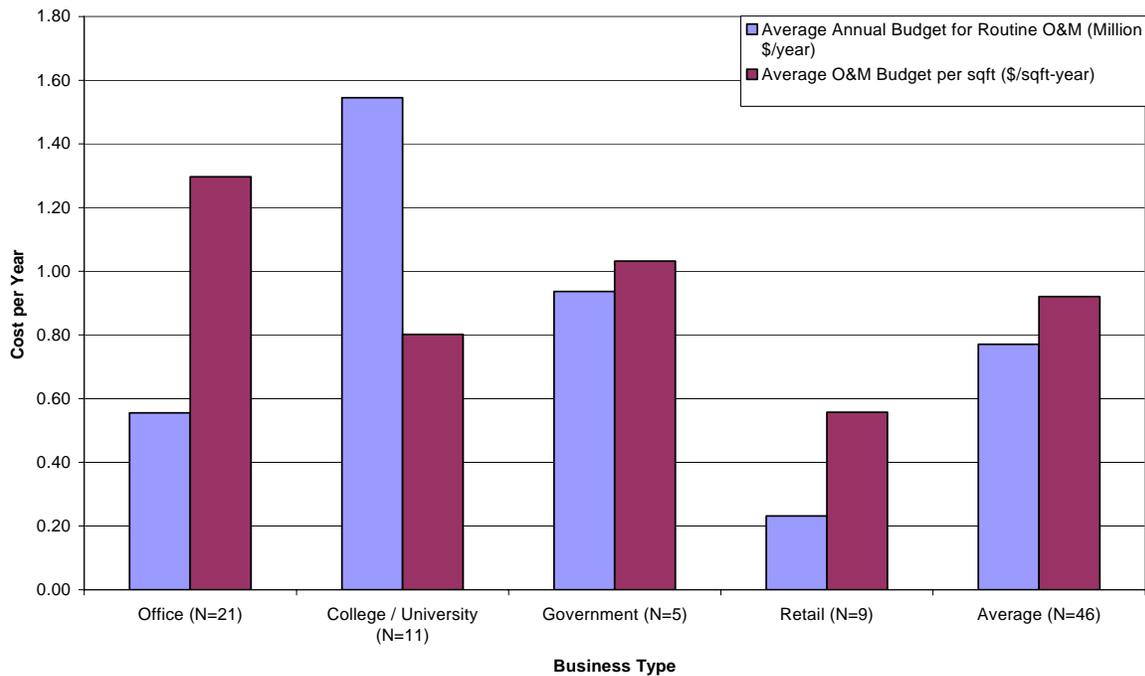
Although not shown in Exhibit 4-21, just 4% of the Owners and Decision Makers, none of the Property Managers and just 15% of the Service Providers we spoke with mentioned no barriers at all, across the technical, organizational and financial categories. Therefore, most respondents do perceive some level of barrier to the implementation of enhanced O&M.

While a considerable number of respondents indicated that there are no substantial technical or organizational barriers, financial barriers were mentioned by nearly all the respondents, as budgets for O&M are already tight. Although many of the technical barriers mentioned are not

substantial to overcome, organizational barriers appear more challenging and financial barriers are undoubtedly very difficult to overcome. For example, budgeting for operational enhancements and financing/demonstration of payback are all important barriers that must be overcome.

Funding levels for routine O&M using business as usual budgets would likely be unable to adequately support ongoing advanced O&M and commissioning activities. Exhibit 4-22 presents the average annual O&M budget by business type, based on responses from the owner and decision maker survey. Also shown is a square foot normalized annual O&M budget. Clearly retail facilities have less intensive O&M budgets than do the other business segments sampled, which would be expected, as relatively easy-to-maintain lighting systems are dominant in retail facilities and HVAC systems tend to be more straight-forward in design.

Exhibit 4-22
Annual Budget for Routine O&M



Staffing level limitations, however, are not viewed as being difficult to overcome. When property managers were asked directly if they viewed staffing limitations as a substantial barrier to enhanced operations, only 20% of respondents reported that this was important. Service providers, on the other hand feel more restrained by staffing limitations.

4.4 CURRENT O&M PRACTICE

Throughout the section that follows, survey respondents were asked to report on implementation rates for various lists of O&M activities and procedures. As anticipated in the study design, and based on engineering judgment, respondents appear to over-report O&M activity levels. This is a common market research issue that is encountered where activities are listed rather than asking about activities on an open-ended basis and then recording responses (and eventually post-coding to a set of consistent activities). Put simply, respondents are predisposed to answer yes when an activity is mentioned by an interviewer. For this reason, throughout this section an attempt is made to categorize all respondent reports as being either common practice or enhanced (less common) practices, with the latter representing activities where there is likely to be substantial room for improvement in the marketplace. Survey responses in conjunction with engineering judgment are used to categorize each O&M measure or practice. Thus the survey results presented in this section provide valuable directional information regarding the rate of O&M implementation at this time, rather than definitive evidence characterizing the market baseline.

It is important to note that characterizing this market using open ended responses would also have come with a set of unique problems, and that the study data collection plan using detailed lists of activities was geared to address many of those shortcomings. A major consideration was that the procedures/practices collected using an open-ended format would lead to downstream aggregation of measure results that were not defined in a consistent manner. More importantly, it was anticipated that actual O&M activity levels would be substantially under-reported.

As mentioned above, another area for improvement is that the quality of O&M being performed is largely unknown and there may be substantial variability across the respondents that perform a given practice or implement a given O&M measure. For example, tracking energy use monthly is quite different from completing such assessments on an annual basis. Furthermore energy use and the cost to purchase energy is gaining national attention, with the rise in oil, gas and gasoline prices as well as the increase in electric prices. Therefore related markets, like O&M and other energy-related activities, are more likely to be considered important at this time.

Respondents were asked to report on the implementation rates for various selected operational procedures. The resulting rates are presented in Exhibit 4-23. The first three activities shown in this exhibit are clearly commonplace and represent standard practice in the market. The remaining items are less frequently implemented and represent enhanced practices where we believe there is substantial opportunity for improved performance in the market (and where we also believe there is substantial over-reporting of implementation rates by the respondents we spoke with).

Exhibit 4-23
Implementation Rates for O&M Operational Procedures
Based on Self-Reported Survey Results

<i>O&M Operational Procedures</i>	<i>Owner and Decision Makers by Business Type</i>				<i>Average</i>	<i>Property Managers</i>	<i>Service Providers</i>
	<i>Office</i>	<i>College / University</i>	<i>Government</i>	<i>Retail</i>			
<i>Common Practice</i>							
Maintain O&M instructions and records of procedures performed	84%	94%	83%	88%	87%	100%	90%
Train & educate building operators and maintenance staff on O&M activities	66%	94%	83%	72%	75%	80%	90%
Track energy use	63%	82%	58%	84%	73%	80%	50%
<i>Enhanced Practices</i>							
Analyze energy use to optimize O&M	53%	65%	33%	72%	59%	80%	70%
Develop goals for reducing energy costs	50%	71%	58%	63%	59%	60%	75%
Incorporate goals for enhanced O&M practices into Strategic Business Plan	63%	47%	33%	63%	57%	60%	50%
Develop a facility energy management plan that emphasizes an energy-efficient O&M strategy	37%	47%	58%	53%	46%	50%	45%
Conduct retrocommissioning	26%	53%	17%	44%	35%	60%	55%
N	38	17	12	32	99	10	20

From a marketing perspective these results indicate that the service providers have an attentive audience when it comes to energy efficiency and cost reductions. However, due to uncertainty in the market regarding energy saving potential, service providers need to convincingly sell their energy efficiency products and services. Unfortunately one of their weakest points in the operational procedures noted in the exhibit above is the tracking of energy use. This creates difficulty for the service providers, as energy trends are unavailable for the demonstration of savings associated with their products and services.

The activity with the lowest implementation response rates is the retrocommissioning measure, especially in government facilities. Retrocommissioning therefore represents a substantial area for improvement and energy saving potential.

In the section that follows, self-reported O&M implementation rates are presented by end-use. Throughout this section, respondents are only asked to report additional results for the primary HVAC system type in their building or for the typical building configuration they are most familiar with. So, for example, an owner and decision maker in a building served by a chilled water plant would only be asked questions regarding their chiller system and not about packaged air conditioning systems. As a result, sample sizes contributing to results vary substantially throughout this section. Sample sizes are often too small to draw solid conclusions, to caution is warranted when using these results.

Space Heating

Respondents were first asked if their buildings are (or typically are, in the case of service providers) served by a central boiler-based system or individual heaters or furnaces. Results suggest that about 60% of large buildings are served by individual heaters or furnaces (see Exhibit 4-6 above), with colleges/universities being more likely to be served by a central boiler-based system. Furthermore, electronic and DDC controls are the most common heating system controls, followed by EMS systems (see Exhibit 4-7 above). Pneumatic and manual controls are very uncommon, accounting for just 10-15% of selected controls, each.

Next, respondents were asked about O&M activities being used for the heating system type in a particular building (or for the most common heating type being served by O&M providers).

O&M activity implementation rates for central boiler-based heating systems are presented in Exhibit 4-24, indicating activities that are baseline (common practice) and those that are enhanced practices. As noted above, there is little differentiation in implementation rates among the boiler O&M activities, but based on somewhat lower response rates and engineering judgment, some have been classified as enhanced practices. Again, it is likely that there is some level of over-reporting from survey respondents. Take note of small sample sizes.

Exhibit 4-24
Implementation Rates for Boiler Preventive Maintenance
Based on Self-Reported Survey Results

<i>Boiler O&M Activities</i>	<i>Owner & Decision Makers</i>	<i>Property Managers</i>	<i>Service Providers</i>
Common Practice			
Review and adjust boiler and hot water pump staging & scheduling	79%	100%	67%
Perform standard boiler maintenance (see above)	83%	100%	100%
Check oil fuel system (pumps, oil filters, system pressure)	79%	100%	83%
Repair or replace faulty hot water sensors and control points	92%	100%	83%
Implement a full boiler tuneup	79%		100%
Enhanced Practices			
Implement optimum start/stop schedule and sequencing	75%	100%	83%
Investigate and repair faulty steam valves and steam pipe leaks	71%	100%	83%
Repair faulty steam traps	67%	100%	83%
Modify hot water setpoints	63%	100%	100%
Analyze boiler trends and performance, and institute performance based maintenance	54%	100%	83%
Replace and resize steam traps	54%	100%	50%
Modify boiler control logic, including sequencing and steam pressure modulation	42%	100%	50%
N	24	1	6

The frequency distribution of respondents checking and inspecting central boiler-based heating systems is presented in Exhibit 4-25, and few clear patterns emerge regarding the frequency of these O&M activities. However, it appears that service providers may check and inspect less frequently than owners and decision makers and property managers. Also, steam traps are less likely to be checked on a regular basis than are other routine boiler maintenance procedures.

In the exhibit below (and those that are similar and follow in this section), respondents report the frequency with which they implement checking and inspecting of end-use systems. The bolded frequency category on the left-hand side of each exhibit indicates the recommended frequency for the O&M activities listed (based on engineering judgment). The reported distribution versus this recommended frequency is one indicator of the opportunities that exist to improve current practices, especially where reports exceed the recommended frequency of inspection. For example, it is recommended that boiler settings be checked on a weekly basis, and yet many respondents report a frequency well in excess of that amount. Take note of small sample sizes.

Exhibit 4-25
Frequency of Checking and Inspecting Rates for Boiler Preventive Maintenance
Based on Self-Reported Survey Results

<i>Boiler O&M Activities</i>	<i>Owner & Decision Makers</i>	<i>Property Managers</i>	<i>Service Providers</i>
<i>Frequency of Checking or Inspecting Boiler Settings</i>			
Monthly	21%	-	-
Quarterly	17%	100%	-
Bi-annually	4%	-	50%
Annually	8%	-	33%
Not at all	4%	-	-
Daily/continuous basis	33%	-	-
When needed	4%	-	-
Hourly	-	-	-
Weekly	-	-	17%
Don't know	8%	-	-
<i>Frequency of Checking or Inspecting Hot Water Setpoints</i>			
Monthly	33%	-	17%
Quarterly	17%	100%	17%
Bi-annually	8%	-	17%
Annually	8%	-	33%
Not at all	13%	-	-
Daily/continuous basis	8%	-	-
When needed	-	-	-
Hourly	-	-	-
Weekly	-	-	17%
Don't know	13%	-	-
<i>Frequency of Comparison of Boiler and Building Schedules</i>			
Monthly	8%	-	17%
Quarterly	4%	100%	33%
Bi-annually	8%	-	33%
Annually	17%	-	-
Not at all	17%	-	-
Daily/continuous basis	17%	-	-
When needed	4%	-	-
Hourly	21%	-	-
Weekly	-	-	17%
Don't know	4%	-	-
N	24	1	6

Exhibit 4-25 (Continued)
Frequency of Checking and Inspecting Rates for Boiler Preventive Maintenance
Based on Self-Reported Survey Results

<i>Boiler O&M Activities</i>	<i>Owner & Decision Makers</i>	<i>Property Managers</i>	<i>Service Providers</i>
Frequency of Checking Boiler Control Settings			
Monthly	25%	-	-
Quarterly	4%	100%	33%
Bi-annually	8%	-	17%
Annually	8%	-	33%
Not at all	8%	-	-
Daily/continuous basis	33%	-	-
When needed	4%	-	-
Hourly	4%	-	-
Weekly	-	-	17%
Don't know	4%	-	-
Frequency of Checking Hot Water Pump Settings			
Monthly	21%	-	-
Quarterly	13%	100%	33%
Bi-annually	13%	-	17%
Annually	4%	-	33%
Not at all	8%	-	17%
Daily/continuous basis	13%	-	-
When needed	4%	-	-
Hourly	8%	-	-
Weekly	-	-	-
Don't know	17%	-	-
Frequency of Checking Steam Traps			
Monthly	17%	-	-
Quarterly	4%	100%	-
Bi-annually	13%	-	-
Annually	13%	-	67%
Not at all	33%	-	33%
Daily/continuous basis	4%	-	-
When needed	4%	-	-
Hourly	-	-	-
Weekly	-	-	-
Don't know	13%	-	-
N	24	1	6

While this study was able to address rates of O&M measure implementation and the frequency of routine O&M inspections, data collection surrounding the quality of the O&M being applied was outside of the scope of this study. This is an important gap in our knowledge of the potential to improve the energy efficiency of O&M practices. To address this knowledge gap future studies should incorporate an understanding of the quality of O&M applied based on on-site inspections, preferably completed at the time of O&M implementation.

O&M activity implementation rates for packaged heating systems are presented in Exhibit 4-26, indicating activities that are baseline (common practice) and those that are enhanced practices. Take note of small sample sizes.

Exhibit 4-26
Implementation Rates for Packaged Heating Preventive Maintenance
Based on Self-Reported Survey Results

Packaged Heating O&M Activities	Owner and Decision Makers by Business Type				Average	Property Managers	Service Providers
	Office	College / University	Government	Retail			
<i>Common Practice</i>							
Implement night setback thermostat settings	95%	83%	80%	88%	89%	83%	100%
Clean burners and replace as needed	64%	50%	100%	92%	77%	50%	100%
<i>Enhanced Practices</i>							
Clean and maintain the combustion air and flue gas system	73%	67%	100%	83%	79%	33%	100%
Adjust fuel-air mixture	41%	50%	100%	58%	54%	17%	100%
N	22	6	5	24	57	6	5

Space Cooling

Respondents were first asked if their buildings are (or typically are, in the case of service providers) served by a central chilled water system or individual packaged air conditioners. Individual packaged AC is the predominant cooling system type (about 60% of the time), even in larger buildings, with colleges/universities and government buildings being more likely to be served by a central chilled water system. Furthermore, electronic and DDC controls are the most common cooling system controls, followed by EMS systems. Pneumatic and manual controls are very uncommon, accounting for just 5-15% of building controls, each.

Next, respondents were asked about O&M activities being used for the cooling system type in a particular building (or for the most common heating type being served by O&M providers).

O&M activity implementation rates for central chilled water cooling systems are presented in Exhibit 4-27 indicating activities that are common practice, those that are enhanced practices and also enhanced predictive maintenance methods. As noted above, there is little differentiation in implementation rates among O&M activities for these systems. To classify a subset of these activities as enhanced practices required engineering judgment to a greater degree than differences in self-reported implementation rates.

Exhibit 4-27
Implementation Rates for Chiller Preventive Maintenance
Based on Self-Reported Survey Results

<i>Chiller System O&M Activities</i>	<i>Owner & Decision Makers</i>	<i>Property Managers</i>	<i>Service Providers</i>
<i>Common Practice</i>			
Repair or replace faulty valves, sensors and control points in the chilled water system	92%	100%	100%
Pump and motor maintenance in chilled water and condenser water loops	85%	100%	100%
Check and correct chiller sequencing	85%	100%	83%
Clean chiller evaporator and condenser tubes	92%	100%	83%
Repair or replace faulty valves, sensors and control points in the condenser water system	88%	100%	100%
Check and adjust refrigerant levels	85%	100%	100%
Inspect and calibrate chiller controls	85%	100%	100%
Check and correct chiller on/off scheduling	88%	100%	83%
Cooling tower water treatment/replacement	81%	100%	50%
Clean and inspect cooling tower	77%	100%	83%
<i>Enhanced Practices</i>			
Analyze and optimize the condenser water loop by calibrating sensors, adjusting flow controls, and modifying pressure and temperature setpoints	92%	75%	100%
Analyze and optimize chiller stop/start, scheduling and staging (using existing controls)	81%	75%	100%
Analyze and optimize the chilled water loop by calibrating sensors, adjusting flow controls and modifying pressure and temperature setpoints	73%	75%	100%
Analyze chiller trends and performance, and institute performance based maintenance	65%	50%	100%
Add sensors to trend and analyze data for optimizing chiller performance	38%	75%	67%
<i>Enhanced Predictive Maintenance</i>			
Vibration analysis	42%	75%	17%
Passive ultrasonic testing	12%	50%	17%
Lubricant/wear particle analysis	54%	-	67%
Thermography	15%	50%	17%
Electrical condition monitoring	38%	25%	50%
N	26	4	6

Predictive maintenance methods are used with a frequency range of about 10 to 50%, although this varies by method. These advanced diagnostics seek to identify degenerative equipment prior to failure, allowing operators to act before entire systems are compromised.

The frequency distribution of respondents checking and inspecting central chilled water cooling systems is presented in Exhibit 4-28. Frequency of checking varies substantially, though most do regularly check chiller and condenser system control and equipment settings and calibration.

Exhibit 4-28
Frequency of Checking and Inspecting Rates for Chilled Water Preventive Maintenance
Based on Self-Reported Survey Results

<i>Chiller System O&M Activities</i>	<i>Owner & Decision Makers</i>	<i>Property Managers</i>	<i>Service Providers</i>
Check condenser water loop sensors, flow control settings, pressure and temperature setpoints and fan operation			
Monthly	35%		17%
Quarterly	23%	25%	17%
Bi-annually	8%	25%	17%
Annually	12%	25%	33%
Not at all	4%		
Daily/continuous basis	12%		
Weekly		25%	
Depends			17%
Don't know	8%		
Check chilled water loop sensors, flow control settings, and pressure and temperature setpoints			
Monthly	31%		
Quarterly	15%	25%	33%
Bi-annually	12%	25%	33%
Annually	15%	50%	17%
Not at all	4%		
Daily/continuous basis	19%		
Depends			17%
Don't know	4%		
Check chiller control settings			
Monthly	19%		
Quarterly	23%	25%	50%
Bi-annually	8%		17%
Annually	15%	50%	17%
Not at all	4%		
Daily/continuous basis	23%		
Weekly		25%	
Depends			17%
Don't know	8%		
Check chilled water pump settings			
Monthly	15%		
Quarterly	23%	50%	33%
Bi-annually	8%		17%
Annually	15%	25%	33%
Not at all	4%		
Daily/continuous basis	23%	25%	
Weekly	4%		
Depends			17%
Don't know	8%		
N	26	4	6

O&M activity implementation rates for packaged air conditioning systems are presented in Exhibit 4-29, indicating activities that are common practice and those that are enhanced practices. The market appears to apply many of the common and enhanced O&M methods, but appears to be largely unaware or unfamiliar with advanced diagnostic tools and procedures for packaged units, such as HVAC Service Assistant and CheckMe.

Exhibit 4-29
Implementation Rates for Packaged Air Conditioning Preventive Maintenance
Based on Self-Reported Survey Results

Packaged AC O&M Activities	Owner and Decision Makers by Business Type				Average	Property Managers	Service Providers
	Office	College / University	Government	Retail			
Common Practice							
Clean and check evaporator and condenser	92%	88%	100%	96%	94%	100%	88%
Check motor belts and lubrication	92%	88%	100%	93%	92%	100%	100%
Implement night setup thermostat settings	92%	88%	83%	93%	91%	100%	100%
Check, adjust or repair pneumatic or other control devices	83%	88%	83%	89%	86%	100%	100%
Review and adjust package unit start/stop times and scheduling	88%	88%	83%	85%	86%	100%	88%
Check and adjust refrigerant levels	92%	88%	67%	85%	86%	80%	100%
Clean or replace air filters	92%	88%	100%	96%	94%	100%	75%
Enhanced Practices							
Periodic recalibration of package unit sensors and controls	58%	75%	83%	59%	63%	80%	100%
Turn packaged units off in unoccupied zones	63%	88%	67%	37%	55%	80%	88%
Use CheckMe or HVAC Service Assistant maintenance equipment and procedures	-	13%	33%	11%	9%	-	13%
N	24	8	6	27	65	5	8

The frequency distribution of respondents checking and inspecting packaged AC systems is presented in Exhibit 4-30. Respondents conduct an array of regularly scheduled preventive maintenance activities, including checking economizer controls, checking equipment schedules versus use, verifying that equipment is turned off in accordance with schedules, checking thermostat settings and verifying system sensors and controls. The majority of respondents conduct preventive maintenance on a quarterly basis, although individual responses vary widely from daily to annually. Verification that packaged AC systems are turned off in accordance with schedules is typically completed on a monthly basis. Checking thermostat settings is done on a much more frequent basis, typically on a on a monthly, weekly or daily basis.

Exhibit 4-30
Frequency of Checking and Inspecting Rates for Packaged AC Preventive Maintenance
Based on Self-Reported Survey Results

Packaged AC O&M Activities	Owner and Decision Makers by Business Type				Average	Property Managers	Service Providers
	Office	College / University	Government	Retail			
Check or inspect economizer controls on packaged AC systems							
Monthly	4%	-	17%	22%	12%	20%	-
Quarterly	42%	13%	50%	41%	38%	40%	63%
Bi-annually	4%	38%	17%	11%	12%	20%	-
Annually	8%	25%	-	11%	11%	20%	25%
Not at all	-	13%	-	-	2%	-	-
Daily/continuous basis	8%	-	-	4%	5%	-	-
When needed	4%	-	-	4%	3%	-	-
Don't know	29%	13%	17%	7%	17%	-	13%
Compare equipment schedule for compatibility with current building/area schedule for packaged AC systems							
Monthly	4%	13%	-	22%	12%	20%	13%
Quarterly	25%	50%	-	15%	22%	40%	25%
Bi-annually	-	13%	-	11%	6%	-	13%
Annually	17%	-	17%	11%	12%	-	-
Not at all	17%	-	17%	11%	12%	-	38%
Daily/continuous basis	13%	13%	17%	15%	14%	20%	-
When needed	8%	13%	-	4%	6%	-	-
Weekly	4%	-	-	4%	3%	-	-
Don't know	13%	-	50%	7%	12%	20%	13%
Check that units are being turned off as scheduled for packaged AC systems							
Monthly	13%	13%	17%	41%	25%	40%	13%
Quarterly	17%	-	17%	-	8%	20%	38%
Bi-annually	4%	13%	-	4%	5%	-	13%
Not at all	21%	25%	-	19%	18%	-	13%
Daily/continuous basis	17%	50%	33%	22%	25%	-	13%
When needed	8%	-	-	-	3%	-	-
Weekly	13%	-	17%	-	6%	20%	-
Other	4%	-	17%	4%	5%	-	-
Don't know	4%	-	-	11%	6%	20%	13%
Check or inspect thermostat settings for packaged AC systems							
Monthly	13%	13%	17%	41%	25%	60%	13%
Quarterly	17%	-	17%	-	8%	-	63%
Bi-annually	4%	13%	-	4%	5%	-	-
Annually	-	-	-	-	-	-	13%
Not at all	21%	25%	-	19%	18%	-	-
Daily/continuous basis	17%	50%	33%	22%	25%	20%	-
When needed	8%	-	-	-	3%	-	-
Weekly	13%	-	17%	-	6%	20%	-
Other	4%	-	17%	4%	5%	-	-
Don't know	4%	-	-	11%	6%	-	13%
Check or inspect sensors and controls for packaged AC systems							
Monthly	-	-	33%	30%	15%	40%	13%
Quarterly	29%	25%	17%	22%	25%	20%	38%
Bi-annually	17%	50%	-	7%	15%	-	13%
Annually	4%	13%	17%	7%	8%	-	25%
Not at all	13%	-	17%	11%	11%	-	-
Daily/continuous basis	13%	13%	-	-	6%	20%	-
When needed	13%	-	17%	19%	14%	20%	13%
Weekly	8%	-	-	-	3%	-	-
Don't know	4%	-	-	4%	3%	-	-
N	24	8	6	27	65	5	8

Ventilation

Respondents whose buildings have a central HVAC system (or all respondents in the case of service providers) were asked about their preventive maintenance practices for building ventilation systems.

O&M activity implementation rates for ventilation systems are presented in Exhibit 4-31, indicating activities that are baseline (common practice) and those that are enhanced practices.

Exhibit 4-31
Implementation Rates for Ventilation System Preventive Maintenance
Based on Self-Reported Survey Results

Ventilation System O&M Activities	Owner and Decision Makers by Business Type				Average	Property Managers	Service Providers
	Office	College / University	Government	Retail			
Common Practice							
Motor, fan & belt checks, maintenance, repair & replacement (as needed)	100%	92%	83%	100%	94%	100%	100%
Repair, recalibrate or replace faulty thermostats & room temperature sensors	100%	92%	83%	100%	94%	100%	100%
Repair & maintain economizers, air handling units & outdoor air dampers	100%	92%	100%	100%	97%	100%	89%
Clean or replace air filters	100%	92%	100%	100%	97%	100%	89%
Repair, rebalance or replace faulty terminal units	100%	92%	67%	100%	91%	100%	100%
Review and adjust air handling unit staging, scheduling and control	80%	92%	67%	100%	84%	100%	94%
Clean heating & cooling coils in air handling units & terminal units	80%	83%	100%	75%	84%	100%	89%
Repair duct leaks	80%	92%	67%	75%	81%	100%	78%
Recalibrate or repair outdoor air & relative humidity sensors	80%	75%	67%	50%	72%	100%	89%
Enhanced Practices							
Analyze function of air handling units & economizers, & optimize outdoor air settings and damper controls	70%	100%	67%	100%	84%	100%	94%
Analyze & test the air pressure of the air handling & distribution system, & adjust air pressure and balance flows	80%	92%	67%	100%	84%	75%	78%
Implement hot and cold deck temperature resets in air handling units	70%	83%	50%	50%	69%	75%	94%
Recalibrate (or, if necessary, relocate) all air handling temperature, pressure and CO2 sensors	30%	100%	50%	50%	63%	75%	94%
Analyze air handler trends and performance, and institute performance based maintenance	50%	58%	50%	75%	56%	50%	78%
Recalibration or upgrading of all thermostats and room temperature sensors	40%	75%	50%	50%	56%	75%	-
N	10	12	6	4	32	4	18

Lighting

Respondents were asked about their preventive maintenance practices for building lighting systems, as reported in this section. Respondents were also asked about the type of lighting controls being used. Manual (30%) and EMS (30%) control of lighting systems are the most common methods applied in large buildings, followed by occupancy sensors (20%).

O&M activity implementation rates for lighting systems are presented in Exhibit 4-32, indicating activities that are baseline (common practice) and those that are enhanced practices. Compared with HVAC system results presented above, lighting system preventive maintenance appears to be somewhat less common, and therefore a larger percentage of measures have been classified as enhanced. There is significant room for improvement in de-lamping, stocking of high efficiency products and re-lamping with those technologies. In general we conclude that the market applies more proactive O&M for HVAC systems and is relatively passive with regard to lighting. As noted in the *Chapter 5 Program Implications* (in Exhibit 5-4), the market is even more passive with regard to refrigeration, water heating and cooking equipment, as system commissioning and tuneup work is relatively uncommon for those particular end uses.

Exhibit 4-32
Implementation Rates for Lighting System Preventive Maintenance
Based on Self-Reported Survey Results

Lighting System O&M Activities	Owner and Decision Makers by Business Type				Average	Property Managers	Service Providers
	Office	College / University	Government	Retail			
Common Practice							
Lighting fixture standard maintenance, including re-lamping, cleaning and ballast replacement	87%	94%	92%	91%	90%	90%	56%
Review and adjust outdoor lighting on/off scheduling or photo sensors	71%	94%	92%	81%	81%	100%	67%
Inspect, repair, or replace lighting timeclocks, controls & sensors	55%	88%	83%	84%	74%	100%	67%
Review and adjust indoor lighting on/off scheduling	39%	59%	67%	72%	57%	80%	67%
Enhanced Practices							
Test, clean, recalibrate or replace existing lighting timeclocks, controls and sensors	37%	82%	67%	69%	59%	90%	67%
Replace incandescent bulbs with CFLs	71%	88%	67%	63%	71%	70%	33%
Replace broken T12 fixtures with T8s or super T8s	58%	94%	58%	69%	68%	60%	44%
Stock CFLs	61%	88%	67%	53%	64%	70%	11%
Implement delamping	45%	71%	58%	47%	52%	50%	33%
Replace T8s with super T8s	34%	29%	33%	25%	30%	20%	33%
Stock Super T8s	26%	29%	25%	25%	26%	20%	11%
N	38	17	12	32	99	10	9

5. PROGRAM IMPLICATIONS

This chapter presents program implications stemming from the study results presented in *Chapter 4*. Recommendations are presented in conjunction with supporting study findings, and in some cases, supporting findings from relevant literature. The chapter is organized into the following two sections:

- Program design considerations
- Ongoing research suggestions

Program implications stemming from a review of relevant secondary literature is presented in Appendix A, providing a reiteration of existing knowledge surrounding O&M programs.

5.1 PROGRAM DESIGN CONSIDERATIONS

Program design considerations in this section address the key individual elements that we believe a program offering should include and delivery considerations stemming from our existing knowledge of the O&M market.

Program Delivery Through O&M Service Providers

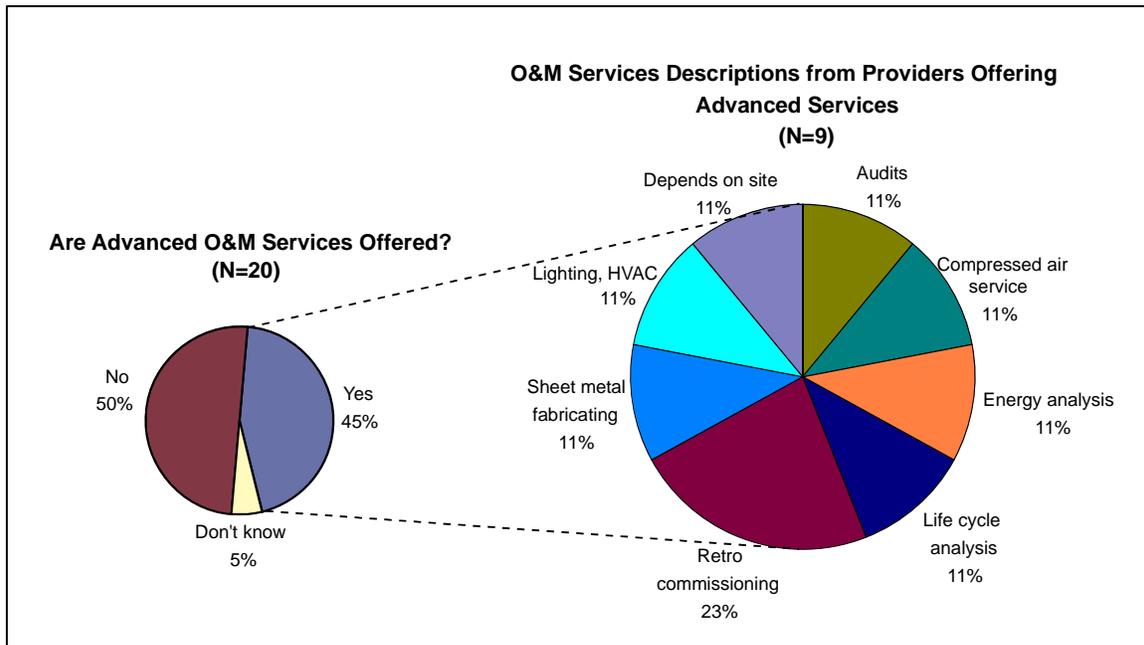
- The most successful entry into the O&M market will likely be achieved by harnessing the participation of **O&M service providers**.
 - Providers are **contracted with for O&M services in roughly 80 percent of the large buildings** in the PNW market, and complete work representing roughly 40-50 percent of the O&M needs in that market. Service provider efforts concentrate on facility maintenance surrounding HVAC and equipment controls; there is also greater reliance upon service providers surrounding HVAC and equipment controls.
 - A number of factors contribute to the **importance of O&M providers** in a successful program strategy: 1) they are deeply involved in the target market, 2) work directly with owners and decision makers, including the development of contractual O&M agreements, and 3) they emphasize HVAC/controls.
 - In order for providers to effectively enhance their O&M services, it is necessary that they obtain the independent backing of program implementers and administrators. Offering enhanced services likely means expanding the scope of their O&M contracts, increasing the price of those contracts and potentially losing-out on a first cost-basis to other service providers with business as usual offerings. Therefore contractors with enhanced offerings must differentiate themselves from other providers in the market place to avoid pricing themselves out of the market. Program implementers should provide information (case studies and site-specific analyses) and referral services to support enhanced O&M offerings.

- A clear barrier that must be addressed is the fact that there are few dominant players in the O&M services market and that much of the market already perceives that it is implementing enhanced O&M. Therefore true enhanced O&M might be hard to sell especially if enhanced services demand higher prices.
- A successful program design will seek to **improve and enhance the contracts** being developed between end users and their service providers.
- It is important to keep in mind that O&M offerings should provide a **combination of services under a menu of options** because, for example, an advanced level of service is not always appropriate for all applications in the market. You do not want to necessarily attempt to motivate all participants to an optimum O&M level, but should, instead seek to improve all participants to a higher level of O&M service that they are comfortable with. The services menu might be based in part on how advanced a given decision maker is with regard to O&M, possibly using the interest level ratings developed for the O&M baseline study completed in 1999 (*1999 O&M Baseline study*).
 - **O&M Experts** could make use of higher level training on testing and re-commissioning
 - **O&M Proficient** is a good program target for enhanced services
 - **Interested Amateur** is a good program target for the development of improved contracts between end users and their O&M providers
 - **Passive Underachievers** are better served with training on tracking and controlling energy costs

Piggyback on Existing Services Offered

Service providers were asked whether or not they offer any advanced O&M services, such as retro-commissioning, and what those services are. As shown in Exhibit, 5-1, roughly half of the O&M service providers we spoke with offer a range of energy services to aid in reducing energy costs. Alliance programs should seek to build upon existing provider services that meet the required energy efficiency and cost-effectiveness guidelines of any other Alliance program.

Exhibit 5-1
Service Provider
Self-Reported Advanced O&M Services



Furthermore, it is in the best interest of the Alliance to piggyback O&M services with other program interventions, such as retrofit programs. This would serve to increase program impacts by providing expanded services to participants. Not only is it advantageous to offer O&M services to participants that have already demonstrated an interest and/or willingness to invest in energy efficiency, but this provides a vehicle to obtain low cost/no cost savings in addition to resource acquisition-based impacts. Also, as discussed next, intervention at the time of building renovation is particularly advantageous.

Deploy Commissioning and O&M Services at the Time of Building Renovation

Perhaps the greatest opportunity to incorporate energy efficiency within existing buildings is at the time of major renovation involving the replacement of permanent building equipment. The self-reported occurrence of major renovations and the average number of years elapsed since each renovation is presented in Exhibit 5-2. Not only is the time of renovation an excellent opportunity to invest in high efficiency equipment and systems, but the start-up of new systems also represents a substantial opportunity for building commissioning services and the incorporation of best practices in equipment O&M methods and procedures.

Exhibit 5-2
Occurrences of Major Renovation of Energy Using Equipment in Existing Buildings
Based on Self-Reported Survey Results

Major Renovation Occurrences and Average Time Elapsed Since Last Renovation	Owner and Decision Makers by Business Type				Average
	Office	College / University	Government	Retail	
Major Renovation Occurrences					
Yes	42%	71%	50%	38%	46%
No	58%	29%	50%	59%	53%
Don't know	-	-	-	3%	1%
N	38	17	12	32	99
Average Time Elapsed Since Last Renovation					
Average Number of Years Since Renovation	12	13	8	5	10
N	16	12	6	11	45

According to the owners and decision makers and property managers interviewed, opportunities for O&M services exist for a number of building end uses, but appear greatest among HVAC systems, both in terms of equipment saturation and the underlying technical potential that lies with those systems.

The percentage of building systems that have undergone commissioning is presented in Exhibit 5-3, based upon self-report data collected during the telephone surveys. Commissioning of HVAC systems is most commonplace, followed by lighting systems and then EMS or other system controls. Commissioning among other systems is not common and therefore represents an area of opportunity, especially for refrigeration systems which stand to benefit substantially from commissioning services¹. Interviews conducted with property managers also indicate the substantial presence of commissioning services in the market, with 60 percent of respondents noting that in the buildings they serve, major energy using systems have been commissioned or undergone a building tune-up.

Exhibit 5-3
Energy Using Systems that have been Commissioned in Existing Buildings
Based on Self-Reported Survey Results

Systems Commissioned in Commercial Buildings	Owner and Decision Makers by Business Type				Average
	Office	College / University	Government	Retail	
Cooling or air conditioning equipment	80%	100%	63%	73%	79%
Area heating equipment	68%	63%	13%	60%	57%
Lighting equipment	24%	13%	38%	80%	39%
Refrigeration equipment	4%	13%	0%	7%	5%
Water heating equipment	4%	50%	13%	0%	11%
Cooking equipment	0%	13%	0%	0%	2%
EMS or other system controls	12%	50%	13%	33%	23%
Other	12%	0%	0%	7%	7%
N	25	8	8	15	56

¹ As noted in Chapter 4, it is hypothesized that the O&M market is generally very passive with regard to refrigeration, water heating and cooking equipment, somewhat passive with regard to lighting systems, and relatively proactive with regard to O&M applied to HVAC systems.

5.2 ONGOING RESEARCH SUGGESTIONS

The research methods applied in this study could be improved in certain instances and successful program implementation will likely involve the implementation of pilot program initiatives supported by simultaneous real-time evaluation. These needs are briefly discussed below.

- Data collection methods applied in this study surrounding current O&M practices sought to obtain implementation rates for various O&M actions by reading a series of measure categories to respondents over the phone and inquiring whether or not this is something they have applied in their O&M approach. As noted in Chapter 4, we believe that the resulting implementation rates were substantially over-reported.
 - We believe that respondents simply have a greater probability of saying yes because they do not wish to appear lax in their job duties or do not wish to appear uninformed regarding O&M procedures.
- To address this concern regarding over-reporting, it is recommended that additional research be conducted using open-ended inquiry into O&M practices rather than prompting respondents with specific measures. For example, one might ask respondents to describe boiler maintenance procedures they have implemented during the past year.
 - Furthermore, complete data collection using an alternative approach might require data collection with building maintenance staff and engineers rather than speaking with the owners and decision makers that were targeted for this study. To accurately determine the O&M activities used and the quality of the measures and practices applied, on-site data collection may work best, by yielding methods observed versus interview-based descriptions.
 - Another alternative might be to collect prompted data in a “peer-controlled” setting such as a focus group.
- The development of a successful program strategy will likely involve the implementation of various pilot strategies, to test and refine those methods. It is recommended that simultaneous real-time evaluation be implemented to inform program refinements.

APPENDIX A
PROGRAM SUGGESTIONS FROM SECONDARY LITERATURE

A. PROGRAM SUGGESTIONS FROM SECONDARY LITERATURE

Program implications stemming from a review of relevant secondary literature is presented in this appendix, providing a reiteration of existing knowledge surrounding O&M programs. Literature sources are clearly cited. The appendix is organized into the following three sections:

- Market-based program approach
- Program design considerations
- Program marketing suggestions

A.1 MARKET-BASED PROGRAM APPROACH

Successful O&M program delivery will necessitate the careful identification of low-effort, best-odds entry points into that market and tactics to address key barriers to enhanced O&M.

Identify Market Entry Points

It is recommended that the Alliance identify particular market segments that represent the best opportunities for O&M market intervention, and likewise identify areas where substantial barriers exist that may be too difficult to cost effectively reverse. This study has developed data and intermediate results that support this important objective, as demonstrated below, but further work in this area is recommended to improve upon progress made to date.

- **Owner occupied buildings** are more likely to implement enhanced O&M strategies and become involved in implementing O&M best practices. About 60-75 percent of large commercial buildings are owner occupied.
 - A key financial barrier that stands in the way of improvements in other O&M markets has little or no effect on building owners – **split incentives** with respect to paying for O&M enhancements and realizing the downstream benefits. In an owner occupied setting it is clear that the owner pays for those services and stands to benefit from the downstream energy savings and other non-energy benefits.
 - Enhancing O&M in **tenant occupied buildings**, especially where O&M decisions are made by property management companies, is less likely to be implemented. Clouding this issue are **lease terms** that affect who ultimately pays for O&M enhancements and who ultimately pays for utility bills. Cost effective entry into this market may simply be insurmountable. At a minimum, implementation of enhanced O&M in this market will require a solid understanding of lease terms and multiple strategies for working within the confines of those lease terms.
- **Focus on larger customers** (NU, 1999, p. 63) and target owners and operators who are involved with more than one facility, especially chains.

- **Educate decision-makers** to change the way customers conduct their O&M operations (NU, 1999, p. 63).
 - NSTAR’s commissioning program, emphasizes buy-in and support from key senior managers on the customer’s staff (Thorne and Nadel, 2003, p. 9).
 - Educate building owners and operators on the energy and non-energy benefits of retrocommissioning (RCx) for their businesses. Case studies and tools to help assess the costs and paybacks can be very helpful in selling RCx to decision maker (Thorne and Nadel, 2003, p 11). Recent research with building owners suggests that the key factors in their decisions regarding energy efficiency are financial performance, perceived effects on occupant comfort, and technology track record (IMT 2001; cited by Thorne and Nadel, 2003). Therefore, owners may be reluctant to invest in new practices without credible evidence of its potential payoffs (see NU, 2001).
- With regard to specific market segments, the literature also addresses best opportunities for enhanced O&M:
 - Health care (1999 O&M Baseline Study)
 - .. will respond well to benchmarking, as hospitals tend to compete for high quality patient comfort and safety
 - .. a good place to test services for other customers with similar equipment, as this is a relatively low barrier environment
 - .. a marketing path to explore are health care industry groups
 - Schools (NY Energy Smart Schools Program; see NU 1999 report, p. 47)
 - .. O&M programs should focus on HVAC and lighting maintenance
 - .. important is both training for maintenance staff and education for decision-makers
 - .. target schools with building ownership, prior utility program experience and high rates of contractor use
 - .. network through contractors and utility account executives

Address Barriers to Enhanced O&M

Several strategies for overcoming barriers are discussed in the 1999 O&M Baseline Study (1999 O&M Baseline Study).

- Where O&M is not viewed as important to facility management, or is believed to be costly (and/or no budgets exist for O&M training), case studies and site specific analyses should be used to clearly demonstrate savings. Providing training, certification and tools to analyze savings is also recommended.
- For companies that don’t track energy costs and therefore don’t see the value of O&M, education and training can provide tools to track energy costs. For manufacturing companies, use of submetering allows the allocation of energy costs by department to increase accountability.

- Those companies with insufficient staff to address problems can take part in energy management programs that offer facility audits and expert services from O&M providers.
- Companies with untrained staff can take part in education, training, and certification programs
 - Building Operator Certification (BOC) is a professional development program developed by the Northwest Energy Efficiency Council. Over 1000 building operators in the Northwest have completed the program since 1995.
 - The program has also spread to many other regions of the country through, for example, the Northeast Energy Efficiency Partnership and Midwest Energy Efficiency Alliance (*Thorne and Nadel, 2003, p. 10*).
- For those that lack an incentive mechanism for enhancing O&M, a building rating system can help to build internal support for O&M enhancements.
- Develop a list of best practices based on the type of facility and/or technology used for companies that lack written standards.
- In situations where companies hire contractors for O&M but do not consider energy efficiency improvements in those bids, targeting contractors with standards, maintenance contracts, and certification programs is recommended.
- Consider on-the-bill financing to overcome lack of funds.

A.2 PROGRAM DESIGN CONSIDERATIONS

Improvements to current market conditions for O&M can best be achieved through targeted enhancements to existing O&M approaches being supported in that market. This can be thought of as a gradual shifting of demand and supply for O&M services from business as usual to the incorporation of best practices.

Incorporate Fifteen O&M Best Practices

O&M best practices (*Haasl and Dodds, 1998, ACEEE; summarized in NU, 1999, p. 49-50*) are summarized in Exhibit A-1.

***Exhibit A-1
O&M Best Practices***

Management	
Goals	Incorporate goals for energy efficient building operation into strategic business plan
Planning	Require an energy management plan with operation as a component
Energy Accounting	Use an energy accounting system to locate savings opportunities
Teamwork	
Staffing	Hire or appoint an energy manager
Training	Train building operators in energy efficient O&M
Outsourcing	Require service contracts that support energy efficient operations
Partnerships	Acknowledge energy efficiency as a cross-functional activity (get everyone involved)
Resources	
Documentation	Continuity in documentation and manuals, document energy efficient control strategies, document all changes
Tools	Data loggers, trend reporting EMCS
Assessments	Perform O&M audits (different from energy audit)
Operation	
Implementation	Take building to its full potential before investing in capital improvements
Automatic controls	Fully utilize available systems
Scheduling	Operate equipment only when needed
Tracking	Track major equipment performance (actual) against expected performance
Preventive maintenance	Redefine preventive maintenance to include activities critical to energy efficiency

An important step to transforming the O&M market involves the adoption of the fifteen O&M best practices, first by program staff, and then transferring that belief system to key targeted market actors. Training and case studies are important elements that should be leveraged to gain penetration of that belief system.

Correcting Business as Usual

A good way to think about the incorporation of best practices is through correcting and breaking business as usual habits.

For example, improved building operation is often neglected in favor of maintenance (*PECI, 1999c*). Good building operation pays attention to how and when equipment operates, not just maintenance and repair. A preventive operation plan helps improve reliability and increase equipment life. Unlike typical preventive maintenance plans, preventive O&M plans periodically check operational and control issues (i.e. find settings and setpoints, develop reference list of operational parameters).

- First, performance tracking and scheduling are critical to preventive O&M plans. Performance tracking involves ongoing measurement and recording of actual performance against a baseline for the whole building as well as individual equipment. When equipment fails to meet the benchmark, steps are taken to improve maintenance procedures and to optimize operating parameters.
- Second, making improvements to equipment schedules is fairly straight-forward and provides a relatively large opportunity for energy savings. For example, schedule changes by users may not get returned to their original settings, so schedules don't match actual needs. Common scheduling issues can be solved with an after-hours walk-through every 6 months to observe behavior of heating, cooling, lighting and office equipment.

In summary, preventive O&M consists of the following:

- Don't assume equipment turns on and off as expected
- Schedule by zones and individual equipment within zones
- Pay attention to how and when equipment operates, not just maintenance and repair
- Settings and setpoints
 - assess how settings/setpoints have changed over time
 - .. have occupancy patterns or space layouts changed?
 - .. are timeclocks checked monthly?
 - find proper setpoints for control strategies
 - develop reference list of operational parameters

Another example involves implementing best practices in performance monitoring, including the following:

- Track actual performance against baseline (from, for example, manufacturer specifications)
 - whole building performance
 - equipment performance
- When equipment fails to meet benchmark:
 - improve maintenance procedures (i.e. cleaning, lubricating)
 - optimize operating parameters (setpoints, lockout strategies)
- Implement tracking schedule for ongoing monitoring, not one-time measurements
- Develop reproducible methods for assessing the operation of chillers, boilers, unitary equipment and coils

Another business as usual correction involves modifying current practice maintenance procedures and optimization of the frequency with which maintenance inspections are performed.

- **Improve interest in O&M** (*1999 O&M Baseline Study*) using many of the same strategies that have been successfully used in federal energy efficiency programs, such as the Compressed Air Challenge, Steam Challenge, Energy Star, Motors Matter and so forth.
 - With regard to customers the following are recommended: hold seminars, conduct training sessions, develop an O&M newsletter, provide literature that specifies maintenance schedules and equipment maintenance issues, create a checklist of no-cost measures that save money and energy, and use proven, real-life example of significant reductions in energy costs.
 - With regard to contractors the following are recommended: provide tools, incentives and marketing support to help stabilize and increase staffing levels for O&M services, recruit and utilize existing service providers, and create a marker of quality that customers could use when selecting contractors.
- **Training and case studies** are important elements that should be leveraged to gain momentum in the market for enhanced O&M services and develop interest. Education oriented intervention is key to successful program implementation (e.g. on-site training, group O&M seminars) (*NU, 2001, p. 79*).
 - “Perhaps the most essential component of operation and maintenance is training, unless building operators and managers are given the skills to perform quality operation and maintenance practices, there is no hope that a building will continue to perform optimally.” (*Commissioning for Better Buildings, p. 31*)
 - Focus on providing technical information and training, such as EMCS operation and programming, requirements and schedules for maintenance on equipment,

- thermostat programming (US DOE, n.d. "Building Commissioning: The Key to Quality Assurance," p. 59)
- O&M activities are largely behavioral, so commit utility resources towards instruction.
 - Program emphasis should be on educating customers about efficiency improvements that results from regular maintenance and proving the cost-effectiveness of such improvements
 - NSTAR's proposed commissioning program includes a facility staff training component (Thorne and Nadel, 2003, p. 9)
 - Encourage preventive maintenance -- "Preventive maintenance is the cornerstone of all operations and maintenance practices." It saves time and money by preventing losses of equipment and productivity (and resulting revenue); extends equipment life; identifies equipment degradation and likely failure prior to actual failures; makes buildings safer and decreases the owner's potential for liability. (US DOE, n.d. "Building Commissioning: The Key to Quality Assurance," p. 61)

The literature also addresses best opportunities for consideration in driving customers toward enhanced O&M.

- With regard to program approach, address individual buildings using the following (1999 O&M Baseline Study):
 - Target low cost measures
 - Provide O&M tools that support O&M enhancements, such as
 - .. a checklists of options
 - .. web-based tools for self-analysis
 - .. benchmarking reports comparing a given customer to a representative control group
 - Because manual control is widespread, programs may need to train facility managers to optimize operation and either provide rebates for those actions or cost share for contractor services to ensure proper operation
 - Training and certification of customer staff could bring about market change because training makes facility managers better at their jobs, rather than "showing them up" with lists of changes to be made
 - Focus on EMS training due to low turnover of EMS operators and importance of controls in implementing enhanced operations

A.3 PROGRAM MARKETING SUGGESTIONS

The literature review identified several program recommendations related to program marketing.

- Reach out to previous program participants, they are more likely to participate than non-participants (*NU, 2001, p. 81*).
- Recruit using existing relationships with utility staff and vendors (*NU, 2001, p. 80*), and partner with those vendor/contractors.
- Market to professional, trade and business associations (*NU, 2001, p. 80*), as this represents an opportunity to reach customer executives and financial managers.

APPENDIX B
OWNER AND DECISION MAKER SURVEY

Owner and Decision Maker Survey

<S4> What is the primary use of the facility located at [ADDRESS, CITY]? Is it...

- Office Building(s) NON GOVERNMENT
- College or University
- Government Buildings or
- Retail
- NONE OF THE ABOVE - record

<I1> How many buildings make up the facility you oversee?

- 1
- 2
- 3
- 4
- 5
- More than 5
- REFUSED
- DON'T KNOW

<S55> What is the size of the buildings in total enclosed square feet that you oversee?

<S5A> Would you say that the TOTAL enclosed square footage of your buildings is...

- Less than 50,000 square feet
- 50,000 to 100,000 square feet
- 100,000 to 250,000 square feet
- 250,000 to 500,000 square feet
- 500,000 to 750,000 square feet
- 750,000 to 1,000,000 square feet
- More than 1,000,000 square feet
- Refused
- Don't Know

<I2A1> What name do you use to refer to your largest building, for example, do you call it 1455 Market, or Administration, etc.

<I2A2> What is the square footage of this building?

<I2A2A> Would you estimate it to be...

- Less than 10,000 square feet
- Between 10,000 and 20,000 square feet
- 20,000 and 30,000 square feet
- 30,000 and 40,000 square feet
- 40,000 and 50,000 square feet
- 50,000 and 75,000 square feet
- Over 75,000 square feet
- REFUSED
- DON'T KNOW

<I2A3> How old is this building?

<I2A3A> Would you say it is....

Less than 5 years old

Between 6 and 10 years old

11 and 20 years old

21 and 30 years old

31 and 40 years old

41 and 50 years old

Over 50 years old

REFUSED

DON'T KNOW

<I2B1> What name do you use to refer to your next largest building, for example, do you call it 1455 Market, or Administration, etc.

<I2B2> What is the square footage of this building?

<I2B2A> Would you estimate it to be...

Less than 10,000 square feet

Between 10,000 and 20,000 square feet

20,000 and 30,000 square feet

30,000 and 40,000 square feet

40,000 and 50,000 square feet

50,000 and 75,000 square feet

Over 75,000 square feet

REFUSED

DON'T KNOW

<I2B3> How old is this building?

<I2B3A> Would you say it is....

Less than 5 years old

Between 6 and 10 years old

11 and 20 years old

21 and 30 years old

31 and 40 years old

41 and 50 years old

Over 50 years old

REFUSED

DON'T KNOW

<I2C1> What name do you use to refer to your next largest building, for example, do you call it 1455 Market, or Administration, etc.

<I2C2> What is the square footage of this building?

<I2C2A> Would you estimate it to be...

- Less than 10,000 square feet
- Between 10,000 and 20,000 square feet
- 20,000 and 30,000 square feet
- 30,000 and 40,000 square feet
- 40,000 and 50,000 square feet
- 50,000 and 75,000 square feet
- Over 75,000 square feet
- REFUSED
- DON'T KNOW

<I2C3> How old is this building?

<I2C3A> Would you say it is....

- Less than 5 years old
- Between 6 and 10 years old
- 11 and 20 years old
- 21 and 30 years old
- 31 and 40 years old
- 41 and 50 years old
- Over 50 years old
- REFUSED
- DON'T KNOW

<I2D1> What name do you use to refer to your next largest building, for example, do you call it 1455 Market, or Administration, etc.

<I2D2> What is the square footage of this building?

<I2D2A> Would you estimate it to be...

- Less than 10,000 square feet
- Between 10,000 and 20,000 square feet
- 20,000 and 30,000 square feet
- 30,000 and 40,000 square feet
- 40,000 and 50,000 square feet
- 50,000 and 75,000 square feet
- Over 75,000 square feet
- REFUSED
- DON'T KNOW

<I2D3> How old is this building?

<I2D3A> Would you say it is....

Less than 5 years old

Between 6 and 10 years old

11 and 20 years old

21 and 30 years old

31 and 40 years old

41 and 50 years old

Over 50 years old

REFUSED

DON'T KNOW

<I2E1> What name do you use to refer to your next largest building, for example, do you call it 1455 Market, or Administration, etc.

<I2E2> What is the square footage of this building?

<I2E2A> Would you estimate it to be...

Less than 10,000 square feet

Between 10,000 and 20,000 square feet

20,000 and 30,000 square feet

30,000 and 40,000 square feet

40,000 and 50,000 square feet

50,000 and 75,000 square feet

Over 75,000 square feet

REFUSED

DON'T KNOW

<I2E3> How old is this building?

<I2E3A> Would you say it is....

Less than 5 years old

Between 6 and 10 years old

11 and 20 years old

21 and 30 years old

31 and 40 years old

41 and 50 years old

Over 50 years old

REFUSED

DON'T KNOW

What is the start time for operations on MONDAY through FRIDAY?

1:00 AM

2:00 AM

3:00 AM

4:00 AM

5:00 AM

6:00 AM

7:00 AM

8:00 AM

9:00 AM

10:00 AM

11:00 AM

NOON

1:00 PM

2:00 PM

3:00 PM

4:00 PM

5:00 PM

6:00 PM

7:00 PM

8:00 PM

9:00 PM

10:00 PM

11:00 PM

MIDNIGHT

OPEN 24 HRS

REFUSED

DON'T KNOW

<I3A2> What is the ending time for operations on Monday through Friday?

- 1:00 AM
- 2:00 AM
- 3:00 AM
- 4:00 AM
- 5:00 AM
- 6:00 AM
- 7:00 AM
- 8:00 AM
- 9:00 AM
- 10:00 AM
- 11:00 AM
- NOON
- 1:00 PM
- 2:00 PM
- 3:00 PM
- 4:00 PM
- 5:00 PM
- 6:00 PM
- 7:00 PM
- 8:00 PM
- 9:00 PM
- 10:00 PM
- 11:00 PM
- MIDNIGHT
- OPEN 24 HRS
- REFUSED
- DON'T KNOW

<I3B1> What is the starting time of operations on Saturday?

1:00 AM

2:00 AM

3:00 AM

4:00 AM

5:00 AM

6:00 AM

7:00 AM

8:00 AM

9:00 AM

10:00 AM

11:00 AM

NOON

1:00 PM

2:00 PM

3:00 PM

4:00 PM

5:00 PM

6:00 PM

7:00 PM

8:00 PM

9:00 PM

10:00 PM

11:00 PM

MIDNIGHT

OPEN 24 HRS

Closed Saturday

REFUSED

DON'T KNOW

<I3B2> What is the ending time of operations on Saturday?

1:00 AM

2:00 AM

3:00 AM

4:00 AM

5:00 AM

6:00 AM

7:00 AM

8:00 AM

9:00 AM

10:00 AM

11:00 AM

NOON

1:00 PM

2:00 PM

3:00 PM

4:00 PM

5:00 PM

6:00 PM

7:00 PM

8:00 PM

9:00 PM

10:00 PM

11:00 PM

MIDNIGHT

OPEN 24 HRS

Closed Saturday

REFUSED

DON'T KNOW

<I3C1> What is the starting time of operations on SUNDAY?

1:00 AM

2:00 AM

3:00 AM

4:00 AM

5:00 AM

6:00 AM

7:00 AM

8:00 AM

9:00 AM

10:00 AM

11:00 AM

NOON

1:00 PM

2:00 PM

3:00 PM

4:00 PM

5:00 PM

6:00 PM

7:00 PM

8:00 PM

9:00 PM

10:00 PM

11:00 PM

MIDNIGHT

OPEN 24 HRS

Closed SUNDAY

REFUSED

DON'T KNOW

<I3C2> What is the ending time of operations hours on Sunday?

- 1:00 AM
- 2:00 AM
- 3:00 AM
- 4:00 AM
- 5:00 AM
- 6:00 AM
- 7:00 AM
- 8:00 AM
- 9:00 AM
- 10:00 AM
- 11:00 AM
- NOON
- 1:00 PM
- 2:00 PM
- 3:00 PM
- 4:00 PM
- 5:00 PM
- 6:00 PM
- 7:00 PM
- 8:00 PM
- 9:00 PM
- 10:00 PM
- 11:00 PM
- MIDNIGHT
- OPEN 24 HRS
- Closed SUNDAY
- REFUSED
- DON'T KNOW

<I4> What entity is ultimately responsible for, and pays the bills for, the operations and maintenance of the primary energy using equipment, such as heating and cooling equipment?

- Building owner
- Property Manager
- Tenants that lease the space
- OTHER-SPECIFY
- REFUSED
- DON'T KNOW

<I5> Is/are this/these building(s) exclusively owner occupied or is some or all of the space leased?

- Owner occupied only
- Leased only
- Both owner occupied and leased
- OTHER-SPECIFY
- REFUSED
- DON'T KNOW

<I6> Do the individual tenants pay for electric and/or gas energy bills, or does the building owner or management company pay for those bills?

- Tenants
- Owner
- Management Company
- OTHER-SPECIFY
- REFUSED
- DON'T KNOW

<I7> How, if at all, are the energy costs allocated to the tenants? Are they allocated ...

- Through set maintenance fees
- Or are Tenants invoiced based on actual total bill
- Based on submeters read by building owner or maintenance company
- OR OTHER METHOD - SPECIFY
- REFUSED
- DON'T KNOW

<I8> Which of the following best describes how concerned you are regarding energy costs? Would you say you are....

- Very concerned
- Somewhat concerned
- Not very concerned or
- Not at all concerned
- REFUSED
- DON'T KNOW

<II19NU> Would you say that you actively seek to reduce energy costs through O&M activities and improvements?

- Yes
- No
- REFUSED
- DON'T KNOW

<II19ANU> How do you seek to actively reduce energy costs?

- RECORD VERBATIM
- REFUSED
- DON'T KNOW

<II25NU> By roughly how much do you think that you can reduce your overall energy usage?

- 5 percent or less
- Between 6 to 10 percent
- between 11 to 15 percent
- between 16 to 20 percent
- between 21 to 30 percent
- more than 30 percent
- REFUSED
- DON'T KNOW

<I9> Which of the following types of permanent building equipment are operated (INSTALLED) at this location?

Cooling or air conditioning equipment

Area heating equipment

Lighting equipment

Refrigeration equipment

Water heating equipment

Cooking equipment

OTHER-SPECIFY

DON'T DO ANY OF THESE

REFUSED

DON'T KNOW

<I10> Have the building(s) undergone major renovation at any time that led to the replacement of all or most of the major permanent building equipment at this location?

Yes

No

REFUSED

DON'T KNOW

<I10A> How many years ago?

<I11> Have you commissioned or completed a comprehensive tune-up of any of the major energy using systems in your building?

Yes

No

REFUSED

DON'T KNOW

<I11A> Which energy using systems have you commissioned?

Cooling or air conditioning equipment

Area heating equipment

Lighting equipment

Refrigeration equipment

Water heating equipment

Cooking equipment

EMS or other system controls

OTHER SYSTEMS - SPECIFY

REFUSED

DON'T KNOW

The remainder of the questions in this study address the operations and maintenance, or O&M, at this location (this includes all building(s) space that you oversee). O&M includes routine activities to maintain or optimize equipment performance, including actions that prolong equipment life, maintain occupant comfort and save energy. O&M does NOT include large capital expenditures to purchase new equipment or controls. Where you can... please answer generically for all the buildings you oversee. Otherwise, answer for the largest building that you oversee.

<I11> What is your annual budget for routine O&M?

<II4> What is the job title of the primary decision maker for building operations?

Owner
Building or facility manager
Building engineer
Property manager
Tenant(s)
OTHER-SPECIFY
REFUSED
DON'T KNOW

<II6> How do you typically maintain the energy using equipment and controls at this location? Do you ...

Use in-house staff only
Outsource all responsibilities to O&M service providers or vendors
Use BOTH in-house staff & outsource to O&M service providers or vendors
OTHER - PROBE AND RECORD VERBATIM
REFUSED
DON'T KNOW

<II11> How many members of your staff are permanently assigned to building operations and maintenance activities, or, put another way, approximately how many full time equivalent (FTE) employees address equipment operation and maintenance at this location?

Adding up to 100 percent, about what percentage of equipment operation and maintenance work is completed by contractors and vendors that you outsource to, and what percentage is completed by in-house staff? This TOTAL SHOULD ADD TO 100 percent.

<II12A> PERCENTAGE OUTSOURCED

<II12B> PERCENTAGE IN-HOUSE STAFF

<II14A> Can you please provide the company name(s) that you contract with for equipment O&M?

FIRST COMPANY NAME
REFUSED
DON'T KNOW

<II14B> Can you give me another company name that you contract with for equipment O&M?

There are no other names
SECOND COMPANY NAME
REFUSED
DON'T KNOW

<II14C> Can you give me another company name that you contract with for equipment O&M?

There are no other names
THIRD COMPANY NAME
REFUSED
DON'T KNOW

<II14D> Can you give me another company name that you contract with for equipment O&M?

There are no other names
FOURTH COMPANY NAME
REFUSED
DON'T KNOW

<II16> Are there any equipment or controls for which you rely almost entirely upon the expertise of your contractors/vendors for O&M?

Cooling or air conditioning equipment
Area heating equipment
Lighting equipment
Refrigeration equipment
Water heating equipment
Cooking equipment
EMS or other system controls
NONE
PROBE and RECORD VERBATIM
REFUSED
DON'T KNOW

<II17> Which of the following best describes the maintenance practices that you use? Do you....

Fix equipment when it breaks or there are complaints
Complete preventive maintenance on a regularly scheduled basis
Test and analyze equipment (i.e. lubrication analysis-vibration analysis)
OTHER - SPECIFY
REFUSED
DON'T KNOW

<II18> How often do you complete regularly scheduled preventive maintenance

Weekly
Monthly
Quarterly
Bi Annually
Annually
OTHER- SPECIFY
DO NOT DO PREVENTIVE MAINTENANCE
REFUSED
DON'T KNOW

<II19> Would you say that you actively seek to reduce energy costs through O&M activities and improvements?

Yes
No
REFUSED
DON'T KNOW

<II19A> If so, how?
RECORD VERBATIM
REFUSED
DON'T KNOW

<II23> Do you contractually require that your O&M service provider(s) implement energy saving O&M improvements?
Yes
No
REFUSED
DON'T KNOW

<II24> Which of the following describe operational procedures that you currently implement? Do you...
Maintain O&M instructions and records of procedures performed
Periodically research & utilize new information on enhanced O&M procedures
Offer incentives to staff to improve O&M practices
Expand staffing/staff responsibilities to implement enhanced O&M practices
Address internal organizational barriers to improved O&M practices
Train & educate building operators and maintenance staff on O&M activities
Conduct equipment diagnostics as a predictive O&M strategy
Perform a comprehensive O&M site assessment
Incorporate goals for enhanced O&M practices into Strategic Business Plan
Utilize energy use data for tracking whole building &/or equip performance
Develop a facility energy management plan that emphasizes an energy-efficient O&M strategy
Conduct retrocommissioning
Utilize reliable information & 3rd party support for O&M contractor selection
Track energy use
Develop goals for reducing energy costs
Analyze energy use to optimize O&M
NONE OF THESE
REFUSED
DON'T KNOW

Next we would like to discuss what major TECHNICAL, ORGANIZATIONAL and or FINANCIAL ASPECTS of your business that might prevent you from implementing operational enhancements like those we have just discussed.

<II26A> What are some of the Technical barriers that might prevent you from implementing these operational enhancements?
RECORD VERBATIM
REFUSED
DON'T KNOW

<II26B> What are some of the ORGANIZATIONAL barriers that might prevent you from implementing these operational enhancements?

RECORD VERBATIM

REFUSED

DON'T KNOW

<II26C> What are some of the FINANCIAL barriers that might prevent you from implementing these operational enhancements?

RECORD VERBATIM

REFUSED

DON'T KNOW

<II26E> Do STAFFING limitations prevent you from implementing these operational enhancements?

Yes

No

REFUSED

DON'T KNOW

<II26D> Can you think of any other BARRIERS that prevent you from implementing these enhancements?

NO OTHER BARRIERS

YES- SPECIFY

REFUSED

DON'T KNOW

Next we would like to discuss some operational or maintenance issues, needs or problems that currently exist for the equipment that you oversee. First we will be asking for the END-USE affected, such as Cooling, Heating, Lighting, etc., then we will record the equipment affected, such as chilled water pumps, fluorescent ballasts, etc.

<II29A> Can you think of any issues, needs or problems facing you right now with respect to your COOLING, HEATING, LIGHTING or OTHER BUILDING SYSTEMS?

Yes

No

REFUSED

DON'T KNOW

<II29A1> What is the EQUIPMENT AFFECTED with these maintenance issues or needs?

EQUIPMENT NAME 1

REFUSED

DON'T KNOW

<II29A2> What are the maintenance issues/needs associated with [EQUIPMENT]?

RECORD ISSUES/NEEDS

REFUSED

DON'T KNOW

<II29A3> Are you aware of viable solutions for addressing the maintenance issues, needs and problems you've just mentioned for [EQUIPMENT] ?

Yes
No
REFUSED
DON'T KNOW

<II29A4> Briefly describe what should be done to address those issues/needs.

RECORD ACTIONS
REFUSED
DON'T KNOW

<II29A5> What are the factors that are preventing you from implementing those particular improvements?

RECORD PREVENTING FACTORS
REFUSED
DON'T KNOW

<II29B> Can you think of any other issues, needs or problems facing you right now with respect to your COOLING, HEATING, LIGHTING or OTHER BUILDING SYSTEMS?

Yes
No
REFUSED
DON'T KNOW

<II29B1> What is the EQUIPMENT AFFECTED with these maintenance issues or needs?

EQUIPMENT NAME 2
REFUSED
DON'T KNOW

<II29B2> What are the maintenance issues/needs associated with [EQUIPMENT]?

RECORD ISSUES/NEEDS
REFUSED
DON'T KNOW

<II29B3> Are you aware of viable solutions for addressing the maintenance issues, needs and problems you've just mentioned for [EQUIPMENT]?

Yes
No
REFUSED
DON'T KNOW

<II29B4> Briefly describe what should be done to address those issues/needs.

RECORD ACTIONS
REFUSED
DON'T KNOW

<II29B5> What are the factors that are preventing you from implementing those particular improvements?

RECORD PREVENTING FACTORS

REFUSED

DON'T KNOW

<II29C> Can you think of any other issues, needs or problems facing you right now with respect to your COOLING, HEATING, LIGHTING or OTHER BUILDING SYSTEMS?

Yes

No

REFUSED

DON'T KNOW

<II29C1> What is the EQUIPMENT AFFECTED with these maintenance issues or needs?

EQUIPMENT NAME

REFUSED

DON'T KNOW

<II29C2> What are the maintenance issues/needs associated with [EQUIPMENT]?

RECORD ISSUES/NEEDS

REFUSED

DON'T KNOW

<II29C3> Are you aware of viable solutions for addressing the maintenance issues, needs and problems you've just mentioned for [EQUIPMENT]?

Yes

No

REFUSED

DON'T KNOW

<II29C4> Briefly describe what should be done to address those issues/needs.

RECORD ISSUES/NEEDS

REFUSED

DON'T KNOW

<II29C5> What are the factors that are preventing you from implementing those particular improvements?

RECORD FACTORS
REFUSED
DON'T KNOW

<II29D> Are there any OTHER issues, needs or problems that you are faced with right now?

Yes
No
REFUSED
DON'T KNOW

<II29D1> What is the EQUIPMENT AFFECTED with these maintenance issues or needs?

EQUIPMENT NAME 4
REFUSED
DON'T KNOW

<II29D2> What are the maintenance issues/needs associated with [EQUIPMENT]?

RECORD ISSUES/NEEDS
REFUSED
DON'T KNOW

<II29D3> Are you aware of viable solutions for addressing the maintenance issues, needs and problems you've just mentioned for [EQUIPMENT]?

Yes
No
REFUSED
DON'T KNOW

<II29D4> Briefly describe what should be done to address those issues/needs.

RECORD ACTIONS
REFUSED
DON'T KNOW

<II29D5> What are the factors that are preventing you from implementing those particular improvements?

RECORD PREVENTING FACTORS
REFUSED
DON'T KNOW

<II29E> Are there any OTHER issues, needs or problems that you are faced with right now?

Yes
No
REFUSED
DON'T KNOW

<II29E1> What is the EQUIPMENT AFFECTED with these maintenance issues or needs?

EQUIPMENT NAME 5
REFUSED
DON'T KNOW

<II29E2> What are the maintenance issues/needs associated with [EQUIPMENT]?

RECORD ISSUES/NEEDS

REFUSED

DON'T KNOW

<II29E3> Are you aware of viable solutions for addressing the maintenance issues, needs and problems you've just mentioned for [EQUIP] ?

Yes

No

REFUSED

DON'T KNOW

<II29E4> What are you doing to fix them?

RECORD ACTIONS

REFUSED

DON'T KNOW

The questions that follow address specific energy using equipment. Consider all the buildings you oversee when answering all of the remaining questions.

<III2> Is the building(s) heating load primarily served by a central boiler-based plant or by individual heaters or furnaces?

Boiler-based plant

Furnaces

OTHER-SPECIFY

REFUSED

DON'T KNOW

<III3> Which of the following is the primary control system strategy employed for the space heating system?

EMS or EMCS

Electronic or DDC controls

Pneumatic controls

Manual controls

OTHER-SPECIFY

NONE OF THESE

REFUSED

DON'T KNOW

<III4> Which of the following preventive maintenance methods do you use for your boiler-based heating systems?

- Review and adjust boiler and hot water pump staging & scheduling
- Inspect and repair boiler controls
- Perform standard boiler maintenance (see above)
- Check oil fuel system: pumps, oil filters, system pressure
- Repair or replace faulty hot water sensors and control points
- Investigate and repair faulty steam valves and steam pipe leaks
- Hot water pump standard maintenance
- Repair faulty steam traps
- OTHER -RECORD VERBATIM
- NONE OF THESE
- REFUSED
- DON'T KNOW

How often, if at all, do you check or inspect the following components of your boiler based heating system. Please indicate if it is monthly, quarterly, bi-annually or annually

<III5A> How often do you check/inspect BOILER SETTINGS?

- Monthly
- Quarterly
- Bi-annually
- Annually
- Not at all
- OTHER - RECORD
- REFUSED
- DON'T KNOW

<III5B> How often do you check/inspect Hot Water SET POINTS?

- Monthly
- Quarterly
- Bi-annually
- Annually
- Not at all
- OTHER - RECORD
- REFUSED
- DON'T KNOW

<III5C> How often do you check/inspect Equipment schedule for compatibility with current building/area schedule?

- Monthly
- Quarterly
- Bi-annually
- Annually
- Not at all
- OTHER - RECORD
- REFUSED
- DON'T KNOW

<III5D> How often do you check/inspect BOILER CONTROL SETTINGS?

Monthly
Quarterly
Bi-annually
Annually
Not at all
OTHER - RECORD
REFUSED
DON'T KNOW

<III5E> How often do you check/inspect HOT WATER PUMP SETTINGS?

Monthly
Quarterly
Bi-annually
Annually
Not at all
OTHER - RECORD
REFUSED
DON'T KNOW

<III5F> How often do you check/inspect HOT WATER LOOP CALIBRATION SETTINGS?

Monthly
Quarterly
Bi-annually
Annually
Not at all
OTHER - RECORD
REFUSED
DON'T KNOW

<III5G> How often do you check/inspect STEAM TRAPS?

Monthly
Quarterly
Bi-annually
Annually
Not at all
OTHER - RECORD
REFUSED
DON'T KNOW

Which of the following operational improvements and repairs have you implemented for your boiler-based heating systems?

<III6A> Have you implemented ...Full boiler tune up

- Yes
- No
- REFUSED
- DON'T KNOW

<III6B> Do you Conduct full boiler system diagnostics and analysis?

- Yes
- No
- REFUSED
- DON'T KNOW

<III6C> Do you Modify Hot Water set points?

- Yes
- No
- REFUSED
- DON'T KNOW

<III6D> Do you Implement optimum start/stop scheduling and sequencing strategies for boiler and hot water pumps?

- Yes
- No
- REFUSED
- DON'T KNOW

<III6E> Do you Modify boiler control logic, including sequencing and steam pressure modulation?

- Yes
- No
- REFUSED
- DON'T KNOW

<III6F> Do you Modify or add controls for boiler and hot water pumps?

- Yes
- No
- REFUSED
- DON'T KNOW

<III6G> Do you Add sensors to trend and analyze data to optimize boiler performance?

- Yes
- No
- REFUSED
- DON'T KNOW

<III6H> Do you Analyze boiler trends and performance, and institute performance based maintenance?

- Yes
- No
- REFUSED
- DON'T KNOW

<III6I> Have you implemented Enhanced maintenance procedures for hot waterloop equipment, including recalibration, realignment and reconfiguration of motors, VFD's, valves and pumps?

- Yes
- No
- REFUSED
- DON'T KNOW

<III6J> Do you Replace and resize steam traps?

- Yes
- No
- REFUSED
- DON'T KNOW

Which of the following preventive maintenance methods do you use for your furnace or packaged heating systems?

<III7> Do you CLEAN BURNERS and REPLACE AS NEEDED?

- Yes
- No
- REFUSED
- DON'T KNOW

<III7B> Do you ADJUST FUEL-AIR MIXTURE?

- Yes
- No
- REFUSED
- DON'T KNOW

<III7C> Do you Clean and maintain the combustion air and flue gas system to ensure it is free of restrictions and flow is optimized?

- Yes
- No
- REFUSED
- DON'T KNOW

<III7D> Do you Implement night setback thermostat settings

- Yes
- No
- REFUSED
- DON'T KNOW

<IV2> Is the building(s) cooling load primarily served by a central chilled water plant or by individual packaged air conditioners?

- Chilled water plant
- Packaged air conditioners
- OTHER-RECORD VERBATIM
- REFUSED
- DON'T KNOW

<IV3> Which of the following is the primary control system strategy employed for the cooling (or air conditioning) and ventilation system? Is it...

- EMS or EMCS
- Electronic or DDC controls
- Pneumatic controls
- Manual controls
- OTHER-RECORD VERBATIM
- NONE OF THESE
- REFUSED
- DON'T KNOW

Which of the following preventive maintenance methods do you use for your chilled water-based cooling systems?

<IV4A> Clean and inspect cooling tower?

- Yes
- No
- REFUSED
- DON'T KNOW

<IV4B> Cooling tower water treatment/replacement?

- Yes
- No
- REFUSED
- DON'T KNOW

<IV4C> Repair or replace faulty valves, sensors and control points in the CHILLED water system?

- Yes
- No
- REFUSED
- DON'T KNOW

<IV4D> Repair or replace faulty valves, sensors and control points in the CONDENSOR water system?

- Yes
- No
- REFUSED
- DON'T KNOW

<IV4E> Check and adjust refrigerant levels?

- Yes
- No
- REFUSED
- DON'T KNOW

<IV4F> Clean chiller evaporator and condenser tubes?

- Yes
- No
- REFUSED
- DON'T KNOW

<IV4H> Pump and motor maintenance in chilled water and condenser waterloops?

- Yes
- No
- REFUSED
- DON'T KNOW

<IV4I> Check and correct chiller sequencing?

- Yes
- No
- REFUSED
- DON'T KNOW

<IV4K> Check and correct chiller on/off scheduling?

- Yes
- No
- REFUSED
- DON'T KNOW

<IV4L> Inspect and calibrate chiller controls?

- Yes
- No
- REFUSED
- DON'T KNOW

How often, if at all, do you check or inspect the following components of your chilled-water cooling systems? Please indicate if it is monthly, quarterly, bi-annually or annually

<IV5A> How often do you Check Condenser water loop sensors, flow control settings, pressure and temperature set points and fan operation??

- Monthly
- Quarterly
- Bi-annually
- Annually
- Not at all
- OTHER - RECORD
- REFUSED
- DON'T KNOW

<IV5B> How often do you Check Chilled water loop sensors, flow control settings, and pressure and temperature set points??

- Monthly
- Quarterly
- Bi-annually
- Annually
- Not at all
- OTHER - RECORD
- REFUSED
- DON'T KNOW

<IV5C> How often do you Compare equipment schedule for compatibility with current building/area schedule??

- Monthly
- Quarterly
- Bi-annually
- Annually
- Not at all
- OTHER - RECORD
- REFUSED
- DON'T KNOW

<IV5D> How often do you Check Chiller control settings?

- Monthly
- Quarterly
- Bi-annually
- Annually
- Not at all
- OTHER - RECORD
- REFUSED
- DON'T KNOW

<IV5E> How often do you Check Chilled water pump settings??

- Monthly
- Quarterly
- Bi-annually
- Annually
- Not at all
- OTHER - RECORD
- REFUSED
- DON'T KNOW

<IV6> Which of the following predictive maintenance methods have you used for your chilled water-based cooling systems? Have you used....

- Vibration analysis
- Passive ultrasonic testing
- Lubricant/wear particle analysis
- Thermography OR
- Electrical condition monitoring
- OTHER - RECORD VERBATIM
- NONE OF THESE
- REFUSED
- DON'T KNOW

Which of the following operational improvements and repairs have you implemented for your chilled water-based cooling systems?

<IV7A> Do you Analyze and optimize the CONDENSER water loop by calibrating sensors, adjusting flow controls, and modifying pressure and temperature setpoints?

- Yes
- No
- REFUSED
- DON'T KNOW

<IV7B> DO YOU Analyze and optimize the CHILLED water loop by calibrating sensors, adjusting flow controls and modifying pressure and temperature setpoints?

- Yes
- No
- REFUSED
- DON'T KNOW

<IV7D> Analyze and optimize chiller stop/start, scheduling and staging (using existing controls)?

- Yes
- No
- REFUSED
- DON'T KNOW

<IV7F> Do you Add or modify chiller controls to optimize performance?

- Yes
- No
- REFUSED
- DON'T KNOW

<IV7G> Do you Add sensors to trend and analyze data for optimizing chiller performance?

- Yes
- No
- REFUSED
- DON'T KNOW

<IV7H> Do you Analyze chiller trends and performance, and institute performance based maintenance?

Yes

No

REFUSED

DON'T KNOW

<IV8> Which of the following preventive maintenance methods do you use for your packaged air conditioning equipment? Do you...

Check and adjust refrigerant levels

Clean and check evaporator and condenser coils

Clean or replace air filters

Check motor belts and lubrication

Check, adjust or repair pneumatic or other control devices

PTAC/Window/Wall unit maintenance

Other - RECORD VERBATIM

DON'T DO ANYTHING

REFUSED

DON'T KNOW

How often, if at all, do you check or inspect the following components of your packaged air conditioning systems. Please indicate if it is monthly, quarterly, bi-annually or annually

<IV9A> How often do you check/inspect Economizer controls?

Monthly

Quarterly

Bi-annually

Annually

Not at all

OTHER - RECORD

REFUSED

DON'T KNOW

<IV9B> How often do you Compare your equipment schedule to make sure it is compatible with your current building/area schedule?

Monthly

Quarterly

Bi-annually

Annually

Not at all

OTHER - RECORD

REFUSED

DON'T KNOW

<IV9C> How often do you check/inspect that units are being turned off as scheduled?

- Monthly
- Quarterly
- Bi-annually
- Annually
- Not at all
- OTHER - RECORD
- REFUSED
- DON'T KNOW

<IV9D> How often do you check/inspect thermostat settings?

- Monthly
- Quarterly
- Bi-annually
- Annually
- Not at all
- OTHER - RECORD
- REFUSED
- DON'T KNOW

<IV9E> How often do you check/inspect sensors and controls?

- Monthly
- Quarterly
- Bi-annually
- Annually
- Not at all
- OTHER - RECORD
- REFUSED
- DON'T KNOW

Which of the following operational improvements and repairs have you implemented for your packaged air conditioning equipment?

<IV10A> Have you Used CheckMe or HVAC Service Assistant maintenance equipment and procedures?

- Yes
- No
- REFUSED
- DON'T KNOW

<IV10C> Have you Analyzed and reset temperature set points and fan schedules to optimize package unit performance?

- Yes
- No
- REFUSED
- DON'T KNOW

<IV10D> Have you Turned packaged units off in unoccupied zones?

- Yes
- No
- REFUSED
- DON'T KNOW

<IV10E> Have you Implemented night setup thermostat settings?

- Yes
- No
- REFUSED
- DON'T KNOW

<IV10F> Have you Reviewed and adjusted package unit start/stop times and scheduling?

- Yes
- No
- REFUSED
- DON'T KNOW

<IV10G> Have you Periodically performed recalibration of package unit sensors and controls?

- Yes
- No
- REFUSED
- DON'T KNOW

<V1> Which of the following preventive maintenance methods do you use for your building ventilation systems?

READ LIST

- Repair & maintain economizers, air handling units & outdoor air dampers
- Recalibrate or repair outdoor air & relative humidity sensors
- Repair duct leaks
- Clean or replace air filters
- Clean heating & cooling coils in air handling units & terminal units
- Motor, fan & belt checks, maintenance, repair & replacement (as needed)
- Repair, recalibrate or replace faulty thermostats & room temperature sensors
- Repair, rebalance or replace faulty terminal units
- Review and adjust air handling unit staging, scheduling and control

OTHER PM METHODS THEY GIVE YOU

NONE OF THESE THINGS

- REFUSED
- DON'T KNOW

<V3> Which of the following operational improvements and repairs have you implemented for your building ventilation systems? READ

Analyze function of air handling units & economizers, & optimize outdoor air settings and damper controls
Recalibrate (or, if necessary, relocate) all air handling temperature, pressure and CO2 sensors

Analyze & test the air pressure of the air handling & distribution system, & adjust air pressure and balance flows
Implement air flow management to reduce duct friction or enhance room-to-room flows

Inspect, clean and repair chilled and hot water coils and valves in air handling units, and repair faulty valve controls

Implement hot and cold deck temperature resets in air handling units

Analyze and optimize air handling unit staging, stop/start times and scheduling using existing controls

Enhancements to filtration systems, including filtration modification or replacement with advanced filters

Comprehensive recalibration or upgrading of all thermostats and room temperature sensors

Recalibration or upgrading of all thermostats and room temperature sensors

Add sensors for trending and analyze data to optimize air handling system performance

Analyze air handler trends and performance, and institute performance based maintenance.

OTHER MEASURE - RECORD VERBATIM

DON'T DO ANY OF THESE

REFUSED

DON'T KNOW

<VI1> Which of the following preventive maintenance methods do you use for your building EMS? READ

Inspect, calibrate & repair faulty control points for EMS

Review and adjust HVAC start/stop and scheduling

Routine EMS set point maintenance

OTHER MEASURE - RECORD VERBATIM

DON'T DO ANY OF THESE

REFUSED

DON'T KNOW

<VII2> Which of the following is the primary control system strategy employed for the lighting system? Is it...

EMS or EMCS

Daylighting controls

Occupancy sensors

Sweep controls

None of these

OTHER primary control - RECORD VERBATIM

REFUSED

DON'T KNOW

<VII3> Which of the following preventive maintenance methods do you use for your lighting systems? READ
Inspect, repair, or replace lighting timeclocks, controls & sensors
Lighting fixture standard maintenance, including re-lamping, cleaning and ballast replacement
Review and adjust indoor lighting on/off scheduling
Review and adjust outdoor lighting on/off scheduling or photo sensors
OTHER METHODS - RECORD VERBATIM
DON'T DO ANY OF THESE
REFUSED
DON'T KNOW

<VII4> Which of the following operational improvements and repairs have you implemented for your lighting systems?
READ
Test, clean, recalibrate or replace existing lighting timeclocks, controls and sensors
Lighten interior wall surfaces, clean windows and skylights
Implement delamping
Replace T8s with super T8s
Stock Super T8s
Replace incandescent bulbs with CFLs
Stock CFLs
Replace broken T12 fixtures with T8s or super T8s
Replace incandescent equipment indicator lights with LEDs
OTHER IMPROVEMENTS - RECORD VERBATIM
DON'T DO ANY OF THESE
REFUSED
DON'T KNOW

APPENDIX C
PROPERTY MANAGER SURVEY

Property Manager Survey

<S4> What is the primary use of this/these building(s)? Are they...

- Office Building(s) NON GOVERNMENT
- College or University
- Government Buildings or
- Retail
- NONE OF THE ABOVE - record

<S3A> How many buildings does your company manage in the [INSERT] area?

<S4A> How many of these buildings are greater than 50,000 square feet?

<I4> Who is financially responsible for the O&M of the primary energy using equipment, such as heating and cooling equipment in these buildings your firm manages. Is it USUALLY the

- Building owner
- Property Manager
- Tenants that lease the space
- OTHER-SPECIFY
- REFUSED
- DON'T KNOW

<I6> What percent of your tenants pay for their utilities?

I am going to read you four methods of how energy costs are allocated to tenants. Adding up to 100 percent, What percentage of the time do you use each of the following methods?

<I7A> First, what percent of the time are energy costs allocated to tenants through set operating expenses that are part of the base amount of monthly rent?

<I7B> Second, What percent of the time are tenants invoiced based on actual total bill?

<I7C> Third, What percent of the time are energy costs allocated based on submeters read by the building owner or maintenance company?

<I7D> Last, Are energy costs allocated using any other method?

- YES - SPECIFY
- NO

<I7DA> What percent of the time are these methods of allocation used?

<I8> Which of the following best describes how concerned you are regarding energy costs? Would you say you are....

- Very concerned
- Somewhat concerned
- Not very concerned or
- Not at all concerned
- REFUSED
- DON'T KNOW

<I19> Would you say that you actively seek to reduce energy costs through O&M activities and improvements?

Yes

No

REFUSED

DON'T KNOW

<I19A> How do you seek to actively reduce energy costs?

RECORD VERBATIM

REFUSED

DON'T KNOW

<I25> By roughly how much do you think that you can reduce your overall energy usage?

5 percent or less

Between 6 to 10 percent

between 11 to 15 percent

between 16 to 20 percent

between 21 to 30 percent

more than 30 percent

REFUSED

DON'T KNOW

<I11> Have you commissioned or completed a comprehensive tune-up of any of the major energy using systems in your building?

Yes

No

REFUSED

DON'T KNOW

<I11A> Which energy using systems have you commissioned?

Cooling or air conditioning equipment

Area heating equipment

Lighting equipment

Refrigeration equipment

Water heating equipment

Cooking equipment

EMS or other system controls

OTHER SYSTEMS - SPECIFY

REFUSED

DON'T KNOW

<I11> Do you typically have on-site engineering staff in the buildings you manage that are responsible for managing, maintaining and servicing energy-using systems?

Yes

No

REFUSED

DON'T KNOW

<I11NAME> Could you refer me to one or two of these on-site engineering staff members?

YES - Record NAME and NUMBER

NO

<I13> Is your firm responsible for O&M budgets in your buildings?

Yes

No

REFUSED

DON'T KNOW

<I14> What is the job title of the primary decision maker for building operations?

Owner

Building or facility manager

Building engineer

Property manager

Tenant(s)

OTHER-SPECIFY

REFUSED

DON'T KNOW

<I16> How do you typically maintain the energy using equipment and controls at this location? Do you ...

Use in-house staff only

Outsource all responsibilities to O&M service providers or vendors

Use BOTH in-house staff & outsource to O&M service providers or vendors

OTHER - PROBE AND RECORD VERBATIM

REFUSED

DON'T KNOW

<I11> How many full time equivalent (FTE) employees usually handle equipment operation and maintenance in buildings you manage that are more than 50,000 square feet? 88 IS REFUSED.....99 IS DON'T KNOW

Adding up to 100 percent, about what percentage of equipment operation and maintenance work is completed by contractors and vendors that you outsource to, and what percentage is completed by in-house staff? This TOTAL SHOULD ADD TO 100 percent.

<I112A> PERCENTAGE OUTSOURCED

<I112B> PERCENTAGE IN-HOUSE STAFF

<I114A> Can you please provide the company name(s) that you contract with for equipment O&M?

FIRST COMPANY NAME

REFUSED

DON'T KNOW

<I114B> Can you give me another company name that you contract with for equipment O&M?

There are no other names

SECOND COMPANY NAME

REFUSED

DON'T KNOW

<I14C> Can you give me another company name that you contract with for equipment O&M?

There are no other names
THIRD COMPANY NAME
REFUSED
DON'T KNOW

<I14D> Can you give me another company name that you contract with for equipment O&M?

There are no other names
FOURTH COMPANY NAME
REFUSED
DON'T KNOW

<I16> Are there any equipment or controls for which you rely almost entirely upon the expertise of your contractors/vendors for O&M?

Cooling or air conditioning equipment
Area heating equipment
Lighting equipment
Refrigeration equipment
Water heating equipment
Cooking equipment
EMS or other system controls
NONE
PROBE and RECORD VERBATIM
REFUSED
DON'T KNOW

<I17> Which of the following best describes the maintenance practices that you use? Do you....

Fix equipment when it breaks or there are complaints
Complete preventive maintenance on a regularly scheduled basis
Test and analyze equipment (i.e. lubrication analysis-vibration analysis)
OTHER - SPECIFY
REFUSED
DON'T KNOW

<I23> Do you contractually require that your O&M service provider(s) implement energy saving O&M improvements?

Yes
No
REFUSED
DON'T KNOW

<I124> Which of the following describe operational procedures that you currently implement? Do you...

- Maintain O&M instructions and records of procedures performed
- Train and educate building operators and maintenance staff on O&M activities
- Incorporate goals for enhanced O&M practices into STRATEGIC BUSINESS PLAN.
- Develop a facility energy management plan that emphasizes an energy-efficient O&M strategy
- Conduct retrocommissioning
- Track energy use
- Develop goals for reducing energy costs
- Analyze energy use to optimize O&M
- OTHER - RECORD VERBATIM
- REFUSED
- DON'T KNOW

Next we would like to discuss what major TECHNICAL, ORGANIZATIONAL and or FINANCIAL ASPECTS of your business that might prevent you from implementing operational enhancements like those we have just discussed.

<I126A> What are some of the Technical barriers that might prevent you from implementing these operational enhancements?

- RECORD VERBATIM
- REFUSED
- DON'T KNOW

<I126B> What are some of the ORGANIZATIONAL barriers that might prevent you from implementing these operational enhancements?

- RECORD VERBATIM
- REFUSED
- DON'T KNOW

<I126C> What are some of the FINANCIAL barriers that might prevent you from implementing these operational enhancements?

- RECORD VERBATIM
- REFUSED
- DON'T KNOW

<I126E> Do STAFFING limitations prevent you from implementing these operational enhancements?

- Yes
- No
- REFUSED

<I126D> Can you think of any other BARRIERS that prevent you from implementing these enhancements?

- NO OTHER BARRIERS
- YES- SPECIFY
- REFUSED

Next I have a few questions about the heating systems in these buildings. Remember, we are only interested in those buildings that are greater than 50,000 square feet.

<III2> Is the building heating load primarily served by a central boiler-based plant or by individual heaters or furnaces?

- Boiler-based plant
- Furnaces
- OTHER-SPECIFY
- REFUSED
- DON'T KNOW

Thinking about the CONTROL SYSTEM STRATEGIES that you use for space heating in your buildings, what percent of your buildings use....

- <III3A> EMS or EMCS
- <III3B> ELECTRONIC or DDC controls
- <III3C> Pneumatic controls
- <III3D> MANUAL CONTROLS
- <III3E> Are other CONTROL SYSTEM STRATEGIES used?
- YES - SPECIFY
- NO OTHER USED

<III3EQTY> What percentage of your buildings use this Strategy?

In what percent of your buildings do you use the following preventive maintenance methods for your boiler-based heating systems? The first one is...

- <III4A>Review and adjust boiler and hot water pump staging & scheduling
- <III4B>Perform standard boiler maintenance
- <III4C>Check oil fuel system pumps, oil filters and system pressure
- <III4E>Repair or replace faulty hot water sensors and control points
- <III4F>Investigate and repair faulty steam valves and steam pipe leaks
- <III4H>Repair faulty steam traps

How often, if at all, do you check or inspect the following components of your boiler based heating system. Please indicate if it is monthly, quarterly, bi-annually or annually

<III5A> How often do you check/inspect BOILER SETTINGS?

- Monthly
- Quarterly
- Bi-annually
- Annually
- Not at all
- OTHER - RECORD
- REFUSED
- DON'T KNOW

<III5B> How often do you check/inspect Hot Water SET POINTS?

Monthly
Quarterly
Bi-annually
Annually
Not at all
OTHER - RECORD
REFUSED
DON'T KNOW

<III5C> How often do you check/inspect Equipment schedule for compatibility with current building/area schedule?

Monthly
Quarterly
Bi-annually
Annually
Not at all
OTHER - RECORD
REFUSED

<III5D> How often do you check/inspect BOILER CONTROL SETTINGS?

Monthly
Quarterly
Bi-annually
Annually
Not at all
OTHER - RECORD
REFUSED
DON'T KNOW

<III5E> How often do you check/inspect HOT WATER PUMP SETTINGS?

Monthly
Quarterly
Bi-annually
Annually
Not at all
OTHER - RECORD
REFUSED
DON'T KNOW

<III5G> How often do you check/inspect STEAM TRAPS?

Monthly
Quarterly
Bi-annually
Annually
Not at all
OTHER - RECORD
REFUSED
DON'T KNOW

I am going to list some operational improvements and repairs that you may have implemented for your boiler-based heating systems. In the buildings you manage, ...

<III6A> Have you implemented ...Full boiler tune up

Yes
No
REFUSED

<III6C> Do you Modify Hot Water set points?

Yes
No
REFUSED
DON'T KNOW

<III6D> Do you Implement optimum start/stop scheduling and sequencing strategies for boiler and hot water pumps?

Yes
No
REFUSED
DON'T KNOW

<III6E> Do you Modify boiler control logic, including sequencing and steam pressure modulation?

Yes
No
REFUSED
DON'T KNOW

<III6H> Do you Analyze boiler trends and performance, and institute performance based maintenance?

Yes
No
REFUSED
DON'T KNOW

<III6J> Do you Replace and resize steam traps?

- Yes
- No
- REFUSED
- DON'T KNOW

Which of the following preventive maintenance methods do you use for your furnace or packaged heating systems?

<III7> Do you CLEAN BURNERS and REPLACE AS NEEDED?

- Yes
- No
- REFUSED
- DON'T KNOW

<III7B> Do you ADJUST FUEL-AIR MIXTURE?

- Yes
- No
- REFUSED
- DON'T KNOW

<III7C> Do you Clean and maintain the combustion air and flue gas system to ensure it is free of restrictions and flow is optimized?

- Yes
- No
- REFUSED
- DON'T KNOW

<III7D> Do you Implement night setback thermostat settings

- Yes
- No
- REFUSED
- DON'T KNOW

<IV2> Are these buildings primarily cooled by a central chilled water plant or by individual packaged air conditioners?

- Chilled water plant
- Packaged air conditioners
- OTHER-RECORD VERBATIM
- REFUSED
- DON'T KNOW

<IV3> Which of the following is the primary control system strategy employed for the cooling (or air conditioning) and ventilation system? Is it...

- EMS or EMCS
- Electronic or DDC controls
- Pneumatic controls
- Manual controls
- OTHER-RECORD VERBATIM
- NONE OF THESE
- REFUSED
- DON'T KNOW

Which of the following preventive maintenance methods do you use for your chilled water-based cooling systems?

<IV4A> Clean and inspect cooling tower?

- Yes
- No
- REFUSED
- DON'T KNOW

<IV4B> Cooling tower water treatment/replacement?

- Yes
- No
- REFUSED
- DON'T KNOW

<IV4C> Repair or replace faulty valves, sensors and control points in the CHILLED water system?

- Yes
- No
- REFUSED
- DON'T KNOW

<IV4D> Repair or replace faulty valves, sensors and control points in the CONDENSOR water system?

- Yes
- No
- REFUSED
- DON'T KNOW

<IV4E> Check and adjust refrigerant levels?

- Yes
- No
- REFUSED
- DON'T KNOW

<IV4F> Clean chiller evaporator and condenser tubes?

- Yes
- No
- REFUSED
- DON'T KNOW

<IV4G> Inspect and repair pipe insulation?

Yes

No

REFUSED

DON'T KNOW

<IV4H> Pump and motor maintenance in chilled water and condenser water loops?

Yes

No

REFUSED

DON'T KNOW

<IV4I> Check and correct chiller sequencing?

Yes

No

REFUSED

DON'T KNOW

<IV4K> Check and correct chiller on/off scheduling?

Yes

No

REFUSED

DON'T KNOW

<IV4L> Inspect and calibrate chiller controls?

Yes

No

REFUSED

DON'T KNOW

How often, if at all, do you check or inspect the following components of your chilled-water cooling systems? Please indicate if it is monthly, quarterly, bi-annually or annually

<IV5A> How often do you Check Condenser water loop sensors, flow control settings, pressure and temperature set points and fan operation??

- Monthly
- Quarterly
- Bi-annually
- Annually
- Not at all
- OTHER - RECORD
- REFUSED
- DON'T KNOW

<IV5B> How often do you Check Chilled water loop sensors, flow control settings, and pressure and temperature set points??

- Monthly
- Quarterly
- Bi-annually
- Annually
- Not at all
- OTHER - RECORD
- REFUSED
- DON'T KNOW

<IV5D> How often do you Check Chiller control settings?

- Monthly
- Quarterly
- Bi-annually
- Annually
- Not at all
- OTHER - RECORD
- REFUSED
- DON'T KNOW

<IV5E> How often do you Check Chilled water pump settings??

- Monthly
- Quarterly
- Bi-annually
- Annually
- Not at all
- OTHER - RECORD
- REFUSED
- DON'T KNOW

<IV6> Which of the following predictive maintenance methods have you used for your chilled water-based cooling systems? Have you used....

- Vibration analysis
- Passive ultrasonic testing
- Lubricant/wear particle analysis
- Thermography OR
- Electrical condition monitoring
- OTHER - RECORD VERBATIM
- NONE OF THESE
- REFUSED
- DON'T KNOW

Which of the following operational improvements and repairs have you implemented for your chilled water-based cooling systems?

<IV7A> Do you Analyze and optimize the CONDENSER water loop by calibrating sensors, adjusting flow controls, and modifying pressure and temperature set points?

- Yes
- No
- REFUSED
- DON'T KNOW

<IV7B> DO YOU Analyze and optimize the CHILLED water loop by calibrating sensors, adjusting flow controls and modifying pressure and temperature set points?

- Yes
- No
- REFUSED
- DON'T KNOW

<IV7D> Analyze and optimize chiller stop/start, scheduling and staging (using existing controls)?

- Yes
- No
- REFUSED
- DON'T KNOW

<IV7G> Do you Add sensors to trend and analyze data for optimizing chiller performance?

- Yes
- No
- REFUSED
- DON'T KNOW

<IV7H> Do you Analyze chiller trends and performance, and institute performance based maintenance?

Yes

No

REFUSED

DON'T KNOW

<IV8> Which of the following preventive maintenance methods do you use for your packaged air conditioning equipment? Do you...

Check and adjust refrigerant levels

Other - RECORD VERBATIM

DON'T DO ANYTHING

REFUSED

DON'T KNOW

How often, if at all, do you check or inspect the following components of your packaged air conditioning systems. Please indicate if it is monthly, quarterly, bi-annually or annually

<IV9A> How often do you check/inspect Economizer controls?

Monthly

Quarterly

Bi-annually

Annually

Not at all

OTHER - RECORD

REFUSED

DON'T KNOW

<IV9B> How often do you Compare your equipment schedule to make sure it is compatible with your current building/area schedule?

Monthly

Quarterly

Bi-annually

Annually

Not at all

OTHER - RECORD

REFUSED

DON'T KNOW

<IV9C> How often do you check/inspect that units are being turned off as scheduled?

Monthly

Quarterly

Bi-annually

Annually

Not at all

OTHER - RECORD

REFUSED

DON'T KNOW

<IV9D> How often do you check/inspect thermostat settings?

Monthly
Quarterly
Bi-annually
Annually
Not at all
OTHER - RECORD
REFUSED
DON'T KNOW

<IV9E> How often do you check/inspect sensors and controls?

Monthly
Quarterly
Bi-annually
Annually
Not at all
OTHER - RECORD
REFUSED
DON'T KNOW

<IV10A> Have you Used CheckMe or HVAC Service Assistant maintenance equipment and procedures?

Yes
No
REFUSED
DON'T KNOW

<IV10D> Have you Turned packaged units off in unoccupied zones?

Yes
No
REFUSED
DON'T KNOW

<IV10E> Have you Implemented night setup thermostat settings?

Yes
No
REFUSED
DON'T KNOW

<IV10F> Have you Reviewed and adjusted package unit start/stop times and scheduling?

Yes
No
REFUSED
DON'T KNOW

<IV10G> Have you Periodically performed recalibration of package unit sensors and controls?

Yes
No
REFUSED
DON'T KNOW

<V1> Which of the following preventive maintenance methods (if any) do you use for your building ventilation systems? READ LIST

- OTHER PM METHODS THEY GIVE YOU
- NONE OF THESE THINGS
- REFUSED
- DON'T KNOW

<V3> Which of the following operational improvements and repairs have you implemented for your building ventilation systems? READ

- Recalibrate (or, if necessary, relocate) all air handling temperature, pressure and CO2 sensors
- Analyze & test the air pressure of the air handling & distribution system, & adjust air pressure and balance flows
- Implement hot and cold deck temperature resets in air handling units
- Recalibration or upgrading of all thermostats and room temperature sensors
- Test and recalibrate all terminal units, including temperature resets and flow optimization
- Analyze air handler trends and performance, and institute performance based maintenance.
- OTHER MEASURE - RECORD VERBATIM
- DON'T DO ANY OF THESE
- REFUSED
- DON'T KNOW

<VI1> Which of the following preventive maintenance methods do you use for your building EMS? READ

- Inspect, calibrate & repair faulty control points for EMS
- Review and adjust HVAC start/stop and scheduling
- OTHER MEASURE - RECORD VERBATIM
- DON'T DO ANY OF THESE
- REFUSED
- DON'T KNOW

<VII2> Which of the following is the primary control system strategy employed for the lighting system? Is it....

- EMS or EMCS
- Daylighting controls
- Occupancy sensors
- Sweep controls
- Manual controls
- None of these
- OTHER primary control - RECORD VERBATIM
- REFUSED
- DON'T KNOW

<VII3> Which of the following preventive maintenance methods do you use for your lighting systems? READ

- Inspect, repair, or replace lighting timeclocks, controls & sensors
- Lighting fixture standard maintenance, including re-lamping, cleaning and ballast replacement
- Review and adjust indoor lighting on/off scheduling
- Review and adjust outdoor lighting on/off scheduling or photo sensors
- OTHER METHODS - RECORD VERBATIM
- DON'T DO ANY OF THESE
- REFUSED
- DON'T KNOW

<VII4> Which of the following operational improvements and repairs have you implemented for your lighting systems?

READ

Test, clean, recalibrate or replace existing lighting timeclocks, controls and sensors

Implement delamping

Replace T8s with super T8s

Stock Super T8s

Replace incandescent bulbs with CFLs

Stock CFLs

Replace broken T12 fixtures with T8s or super T8s

OTHER IMPROVEMENTS - RECORD VERBATIM

DON'T DO ANY OF THESE

REFUSED

DON'T KNOW

APPENDIX D
SERVICE PROVIDER SURVEY

Service Provider Survey

<S44> What is the primary use of these buildings? Are they...

- Office Building(s) NON GOVERNMENT
- College or University
- Government Buildings
- Retail
- NONE OF THE ABOVE - record

<S3A> To how many buildings in your local area does your firm provide operations and maintenance services?

<S55> Are any of these buildings greater than 50,000 square feet?

<S66> How many of these buildings are greater than 50,000 square feet?

<I11> What percent of your company's revenue is accounted for by O&M services contracts that you offer (versus sales of equipment, installation of equipment and other services)?

<I22> What are the main selling points that your company stresses in the O&M services that you offer?

- Quality of service
- Quality and/or capabilities of technicians providing services
- Energy cost savings
- Equipment reliability
- Extended equipment life
- Quick response time or technician responsiveness
- Cost for services
- Indoor air quality
- Ability to provide comprehensive turnkey services
- Size of company
- Geographic coverage
- Bundling of services
- Company reputation
- Availability of client references
- RECORD VERBATIM
- REFUSED
- DON'T KNOW

<I3> What energy using equipment and systems are typically included in the O&M service contracts your company offers?

- Cooling or air conditioning equipment
- Space heating equipment
- Lighting equipment
- Refrigeration equipment
- Water heating equipment
- Cooking equipment
- EMS or other system controls
- RECORD VERBATIM
- REFUSED
- DON'T KNOW

<14> Who normally pays your business for the O&M of the primary energy using equipment, such as heating and cooling equipment, in these buildings? Is it usually the....

- Building owner
- Property Manager
- Tenants that lease the space
- OTHER-SPECIFY
- REFUSED
- DON'T KNOW

<15> What are the TWO main things your customers focus on getting in their O&M contracts?

- Quality service
- Capable technicians
- Energy cost savings
- Equipment reliability
- Extended equipment life
- Quick response time or technician responsiveness
- Competitive costs for services
- Indoor air quality improvement
- Comprehensive turnkey services
- A large company
- Wide geographic coverage
- Bundling of services
- Strong company reputation
- Availability of client references
- OTHER-SPECIFY
- REFUSED
- DON'T KNOW

<16> Are there any advanced O&M services that you offer, such as commissioning services?

- Yes
- No
- REFUSED
- DON'T KNOW

<16A> Could you please provide some examples of the advanced O&M services that you offer?

- RECORD VERBATIM
- REFUSED
- DON'T KNOW

<17> Please describe the typical cost structure of your O&M service agreements. That is, how do you price your services?

- RECORD VERBATIM
- REFUSED
- DON'T KNOW

<I8> Does your business actively seek to reduce energy costs through O&M activities and improvements for your clients?

- Yes
- No
- REFUSED
- DON'T KNOW

<I8A> How does your business seek to reduce energy costs through O&M activities and improvements?

- RECORD VERBATIM
- REFUSED
- DON'T KNOW

<I9> By roughly how much do you think that you can reduce overall building energy usage through O&M improvements?

- 5 percent or less
- Between 6 to 10 percent
- between 11 to 15 percent
- between 16 to 20 percent
- between 21 to 30 percent
- more than 30 percent
- REFUSED
- DON'T KNOW

<I14> What typically is the job title of the building representative that hires your company to perform O&M services?

- Owner
- Building or facility manager
- Building engineer
- Property manager
- Tenant(s)
- OTHER-SPECIFY
- REFUSED
- DON'T KNOW

<I15> How are energy using equipment and controls typically maintained. Do your clients....

- Outsource all responsibilities to O&M service providers or vendors
- Use BOTH in-house staff & outsource to O&M service providers or vendors
- OTHER - PROBE AND RECORD VERBATIM
- REFUSED
- DON'T KNOW

<I16> About what percentage of equipment O&M work is usually completed by your client's INHOUSE Staff?

<II7A> Can you provide the company name of a primary competitor in the O&M services market?

RECORD NAME

REFUSED

Don't know any

<II7B> Can you name another competitor?

RECORD NAME

REFUSED

Don't Know Any

<II7C> Can you name another competitor?

RECORD NAME

REFUSED

Don't Know Any

<II7D> Can you name another competitor?

RECORD NAME

REFUSED

Don't Know Any

<II10> Do the O&M service contracts between your firm and your clients typically require the implementation of energy saving O&M improvements?

Yes

No

REFUSED

DON'T KNOW

<II8> Are there any equipment or controls for which your clients rely almost entirely upon the expertise of contractors or vendors for O&M. If Yes, what particular equipment and controls...

Cooling or air conditioning equipment

Space heating equipment

Lighting equipment

Refrigeration equipment

Water heating equipment

Cooking equipment

EMS or other system controls

No equip or controls need expertise

RECORD VERBATIM

REFUSED

DON'T KNOW

<II9> Which of the following best describes the maintenance practices activities for the equipment in the buildings your firm services? Do you....

Fix equipment when it breaks or there are complaints

Complete preventive maintenance on a regularly scheduled basis

Test and analyze equipment (i.e. lubrication analysis-vibration analysis)

OTHER - SPECIFY

REFUSED

DON'T KNOW

<II11A> Do you typically...Maintain O&M instructions and records of procedures performed ?

Yes
No
REFUSED
DON'T KNOW

<II11B> Do you typically...Track energy use ?

Yes
No
REFUSED
DON'T KNOW

<II11C> Do you typically...Develop goals for reducing energy costs ?

Yes
No
REFUSED
DON'T KNOW

<II11D> Do you typically...Train and educate building operators and maintenance staff on O&M activities ?

Yes
No
REFUSED
DON'T KNOW

<II11E> Do you typically...Incorporate goals for enhanced O&M practices into Strategic Business Plan ?

Yes
No
REFUSED
DON'T KNOW

<II11F> Do you typically...Analyze energy use to optimize O&M ?

Yes
No
REFUSED
DON'T KNOW

<II11G> Do you typically...Develop a facility energy management plan that emphasizes an Energy efficient O&M strategy ?

Yes
No
REFUSED
DON'T KNOW

<II11H> Do you typically...Conduct retrocomissioning ?

Yes
No
REFUSED
DON'T KNOW

<II12A> What are the major Technical barriers that might prevent your firm from implementing the operational procedures we have just discussed?

RECORD VERBATIM
REFUSED
DON'T KNOW

<II12B> What are the major ORGANIZATIONAL barriers that might prevent you from implementing these operational procedures?

RECORD VERBATIM
REFUSED
DON'T KNOW

<II12C> What are the major FINANCIAL barriers that might prevent you from implementing these operational procedures?

RECORD VERBATIM
REFUSED
DON'T KNOW

<II12D> Do STAFFING limitations prevent you from implementing these operational procedures?

Yes
No
REFUSED
DON'T KNOW

<II12E> Can you think of any other BARRIERS that prevent you from implementing these procedures?

NO OTHER BARRIERS
YES- SPECIFY
REFUSED
DON'T KNOW

<III1> Is the space heating in these buildings usually...

Boiler-based plant or
Furnaces
REFUSED
DON'T KNOW

<III2A> EMS or EMCS ?

<III2B> Electronic or DDC controls ?

<III2C> Pneumatic controls ?

<III2D> Manual controls ?

<III2E> Computerized Controls ?

<III2F> Other types of controls ?

<III2OTH> What are these other controls?

RECORD VERBATIM ~ ~
REFUSED ~ ~
DON'T KNOW ~ ~

<III3A> Review and adjust boiler and hot water pump staging and scheduling

Yes

No

REFUSED

DON'T KNOW

<III3C> Perform standard boiler maintenance

Yes

No

REFUSED

DON'T KNOW

<III3D> Check oil fuel system...pumps, oil filters, system pressure ?

Yes

No

REFUSED

DON'T KNOW

<III3E> Repair or replace faulty hot water sensors and control points ?

Yes

No

REFUSED

DON'T KNOW

<III3F> Investigate and repair faulty steam valves and steam pipe leaks ?

Yes

No

REFUSED

DON'T KNOW

<III3H> Repair faulty steam traps ?

Yes

No

REFUSED

DON'T KNOW

<III4A> How often do you check/inspect BOILER SETTINGS?

- Monthly
- Quarterly
- Bi-annually
- Annually
- Not at all
- OTHER - RECORD
- REFUSED
- DON'T KNOW

<III4C> How often do you check/inspect Hot Water SET POINTS?

- Monthly
- Quarterly
- Bi-annually
- Annually
- Not at all
- OTHER - RECORD
- REFUSED
- DON'T KNOW

<III4D> How often do you check/inspect Equipment schedule for compatibility with current building/area schedule?

- Monthly
- Quarterly
- Bi-annually
- Annually
- Not at all
- OTHER - RECORD
- REFUSED
- DON'T KNOW

<III4E> How often do you check/inspect BOILER CONTROL SETTINGS?

- Monthly
- Quarterly
- Bi-annually
- Annually
- Not at all
- OTHER - RECORD
- REFUSED
- DON'T KNOW

<III4F> How often do you check/inspect HOT WATER PUMP SETTINGS?

- Monthly
- Quarterly
- Bi-annually
- Annually
- Not at all
- OTHER - RECORD
- REFUSED
- DON'T KNOW

<III4J> How often do you check/inspect STEAM TRAPS?

Monthly
Quarterly
Bi-annually
Annually
Not at all
OTHER - RECORD
REFUSED
DON'T KNOW

<III5A> Full boiler tune up

Yes
No
REFUSED
DON'T KNOW

<III5C> Modify HW set points ?

Yes
No
REFUSED
DON'T KNOW

<III5D> Implement optimum start/stop scheduling and sequencing strategies for boiler and hot water pumps. ?

Yes
No
REFUSED
DON'T KNOW

<III5E> Modify boiler control logic, including sequencing and steam pressure modulation ?

Yes
No
REFUSED
DON'T KNOW

<III5H> Analyze boiler trends and performance, and institute performance based maintenance ?

Yes
No
REFUSED
DON'T KNOW

<III5J> Replace and resize steam traps ?

Yes
No
REFUSED
DON'T KNOW

<III6A> Do you...Clean burners and replace as needed ?

Yes
No
REFUSED
DON'T KNOW

<III6B> Do you...Adjust fuel air mixture ?

Yes
No
REFUSED
DON'T KNOW

<III6C> Do you...Clean and maintain the combustion air and flue gas system to ensure it is free of restrictions and flow is optimized ?

Yes
No
REFUSED
DON'T KNOW

<III6D> Do you...Implement night setback thermostat settings ?

Yes
No
REFUSED
DON'T KNOW

<IV1> Are the buildings your firm services primarily cooled by a central chilled water plant or by individual packaged air conditioners?

Chilled water plant
Packaged air conditioners
OTHER-RECORD VERBATIM
REFUSED
DON'T KNOW

Thinking about control system strategies that are typically used in the buildings your firm services, what percent use...

<IV2A> EMS or EMCS ?

<IV2B> Electronic or DDC controls ?

<IV2C> Pneumatic controls ?

<IV2D> Manual controls ?

<IV2E> Computerized Controls ?

<IV2F> Other controls ?

<IV2OTH> What are these other controls?

RECORD Control name
REFUSED
DON'T KNOW

Which of the following preventive maintenance methods do you use for your chilled water-based cooling systems in these buildings?

<IV3A> Clean and inspect cooling tower?

- Yes
- No
- REFUSED
- DON'T KNOW

<IV3B> Cooling tower water treatment/replacement?

- Yes
- No
- REFUSED
- DON'T KNOW

<IV3C> Repair or replace faulty valves, sensors and control points in the CHILLED water system?

- Yes
- No
- REFUSED
- DON'T KNOW

<IV3D> Repair or replace faulty valves, sensors and control points in the CONDENSOR water system?

- Yes
- No
- REFUSED
- DON'T KNOW

<IV3E> Check and adjust refrigerant levels?

- Yes
- No
- REFUSED
- DON'T KNOW

<IV3F> Clean chiller evaporator and condenser tubes?

- Yes
- No
- REFUSED
- DON'T KNOW

<IV3G> Inspect and repair pipe insulation?

- Yes
- No
- REFUSED
- DON'T KNOW

<IV3H> Pump and motor maintenance in chilled water and condenser water loops?

- Yes
- No
- REFUSED
- DON'T KNOW

<IV3I> Check and correct chiller sequencing?

- Yes
- No
- REFUSED
- DON'T KNOW

<IV3K> Check and correct chiller on/off scheduling?

- Yes
- No
- REFUSED
- DON'T KNOW

<IV3L> Inspect and calibrate chiller controls?

- Yes
- No
- REFUSED
- DON'T KNOW

<IV4A> How often do you Check Condenser water loop sensors, flow control settings, pressure and temperature set points and fan operation??

- Monthly
- Quarterly
- Bi-annually
- Annually
- Not at all
- OTHER - RECORD
- REFUSED
- DON'T KNOW

<IV4B> How often do you Check Chilled water loop sensors, flow control settings, and pressure and temperature set points??\

- Monthly
- Quarterly
- Bi-annually
- Annually
- Not at all
- OTHER - RECORD
- REFUSED
- DON'T KNOW

<IV4E> How often do you Check Chiller control settings?

- Monthly
- Quarterly
- Bi-annually
- Annually
- Not at all
- OTHER - RECORD
- REFUSED
- DON'T KNOW

<IV4F> How often do you Check Chilled water pump settings??

- Monthly
- Quarterly
- Bi-annually
- Annually
- Not at all
- OTHER - RECORD
- REFUSED
- DON'T KNOW

Which of the following predictive maintenance methods does your firm usually employ for the chilled water-based cooling systems in the buildings you service?

<IV5A> Vibration analysis ?

- Yes
- No
- REFUSED
- DON'T KNOW

<IV5B> Passive ultrasonic testing ?

- Yes
- No
- REFUSED
- DON'T KNOW

<IV5C> Lubricant/wear particle analysis ?

- Yes
- No
- REFUSED
- DON'T KNOW

<IV5D> Thermography ?

- Yes
- No
- REFUSED
- DON'T KNOW

<IV5E> Electrical condition monitoring ?

- Yes
- No
- REFUSED
- DON'T KNOW

Which of the following operational improvements and repairs does your firm typically implement?

<IV6A> Do you Analyze and optimize the CONDENSER water loop by calibrating sensors, adjusting flow controls, and modifying pressure and temperature set points?

Yes
No
REFUSED
DON'T KNOW

<IV6B> Do you...Analyze and optimize the CHILLED water loop by calibrating sensors, adjusting flow controls and modifying pressure and temperature set points

Yes
No
REFUSED
DON'T KNOW

<IV6D> Do you...Analyze and optimize chiller stop/start, scheduling and staging (using existing controls)?

Yes
No
REFUSED
DON'T KNOW

<IV6G> Do you... Add sensors to trend and analyze data for optimizing chiller performance?

Yes
No
REFUSED
DON'T KNOW

<IV6H> Do you... Analyze chiller trends and performance, and institute performance based maintenance?

Yes
No
REFUSED
DON'T KNOW

Which of the following preventive maintenance methods does your firm use for the packaged air conditioning equipment in the buildings your serve? Do you...

<IV7A> Do you...Check and adjust refrigerant levels ?

Yes
No
REFUSED
DON'T KNOW

<IV7B> Do you...Clean and check evaporator and condenser coils ?

Yes
No
REFUSED
DON'T KNOW

<IV7C> Do you...Clean or replace air filters ?

Yes
No
REFUSED
DON'T KNOW

<IV7D> Do you...Check motor belts and lubrication ?

Yes
No
REFUSED
DON'T KNOW

<IV7E> Do you...Check, adjust or repair pneumatic or other control devices

Yes
No
REFUSED
DON'T KNOW

<IV8B> How often do you check Economizer controls?

Monthly
Quarterly
Bi-annually
Annually
Not at all
OTHER - RECORD
REFUSED
DON'T KNOW

<IV8C> How often do you Compare equipment schedule for compatibility with current building/area schedule?

Monthly
Quarterly
Bi-annually
Annually
Not at all
OTHER - RECORD
REFUSED
DON'T KNOW

<IV8D> How often do you check that units are being turned off as scheduled?

Monthly
Quarterly
Bi-annually
Annually
Not at all
OTHER - RECORD
REFUSED
DON'T KNOW

<IV8F> How often do you check thermostat settings?

- Monthly
- Quarterly
- Bi-annually
- Annually
- Not at all
- OTHER - RECORD
- REFUSED
- DON'T KNOW

<IV8G> How often do you check sensors and controls?

- Monthly
- Quarterly
- Bi-annually
- Annually
- Not at all
- OTHER - RECORD
- REFUSED
- DON'T KNOW

Which of the following operational improvements and repairs does your firm typically implemented for the packaged air conditioning equipment in the buildings you service?

<IV9A> Have you used... CheckMe or HVAC Service Assistant maintenance equipment and procedures?

- Yes
- No
- REFUSED
- DON'T KNOW

<IV9D> Do you... Turn packaged units off in unoccupied zones?

- Yes
- No
- REFUSED
- DON'T KNOW

<IV9E> Have you... Implemented night setup thermostat settings?

- No
- REFUSED
- DON'T KNOW

<IV9F> Do you... Review and adjust package unit start/stop times and scheduling?

- Yes
- No
- REFUSED
- DON'T KNOW

<IV9G> Do you... Periodical recalibration of package unit sensors and controls?

- Yes
- No
- REFUSED
- DON'T KNOW

Which of the following preventive maintenance methods does your firm use for the ventilation systems in the buildings you service?

<V1A> Do you.. Repair & maintain economizers, air handling units & outdoor air dampers?

- Yes
- No
- REFUSED
- DON'T KNOW

<V1B> Do you...Recalibrate or repair outdoor air and relative humidity sensors?

- Yes
- No
- REFUSED
- DON'T KNOW

<V1C> Do you... Repair duct leaks

- Yes
- No
- REFUSED
- DON'T KNOW

<V1D> Do you ...Clean or replace air filters

- Yes
- No
- REFUSED
- DON'T KNOW

<V1E> Do you...Clean heating and cooling coils in air handling units and terminal units

- Yes
- No
- REFUSED
- DON'T KNOW

<V1F> Do you... Perform Motor, fan & belt checks, maintenance, repair and replacement (as needed)?

- Yes
- No
- REFUSED
- DON'T KNOW

<V1G> Do you repair... recalibrate or replace faulty thermostats and room temperature sensors?

- Yes
- No
- REFUSED
- DON'T KNOW

<V1H> Do you... Repair, rebalance or replace faulty terminal units?

- Yes
- No
- REFUSED
- DON'T KNOW

<V1I> Do you...Review and adjust air handling unit staging, scheduling and control?

- Yes
- No
- REFUSED
- DON'T KNOW

Which of the following operational improvements and repairs for building ventilation systems does your firm typically implement for the buildings you service?

<V2A> Do you...Analyze function of air handling units and economizers, and optimize outdoor air settings and damper controls?

- Yes
- No
- REFUSED
- DON'T KNOW

<V2B> Do you...Recalibrate (or, if necessary, relocate) all air handling temperature, pressure and CO2 sensors?

- Yes
- No
- REFUSED
- DON'T KNOW

<V2C> Do you....Analyze and test the air pressure of the air handling and distribution system, and adjust air pressure and balance flows?

- Yes
- No
- REFUSED
- DON'T KNOW

<V2F> Do you...Implement hot and cold deck temperature resets in air handling units?

- Yes
- No
- REFUSED
- DON'T KNOW

<V2I> Do you... perform...Comprehensive recalibration or upgrading of all thermostats and room temperature sensors?

- Yes
- No
- REFUSED
- DON'T KNOW

<V2J> Do you... Test and recalibrate all terminal units, including temperature resets and flow optimization?

- Yes
- No
- REFUSED
- DON'T KNOW

<V2L> Do you...Analyze air handler trends and performance, and institute performance based maintenance?

- Yes
- No
- REFUSED
- DON'T KNOW

Which of the following preventive maintenance methods for building energy management systems does your firm typically use for the buildings you service?

<VI1A> Do you ... Inspect, calibrate and repair faulty control points for energy control and management systems?

- Yes
- No
- REFUSED
- DON'T KNOW

<VI1B> Do you...Review and adjust HVAC start/stop and scheduling?

- Yes
- No
- REFUSED
- DON'T KNOW

<VI1C> Do you perform...Routine EMS set point maintenance?

- Yes
- No
- REFUSED
- DON'T KNOW

<VII1> In these buildings, Which of the following is the primary control strategy employed for the lighting system? Is it...

- EMS or EMCS
- Daylighting controls
- Occupancy sensors
- Sweep controls
- Manual controls
- None of these
- OTHER primary control - RECORD VERBATIM
- REFUSED
- DON'T KNOW

Which of the following preventive maintenance methods does your firm use for the lighting systems in the buildings you service?

<VII2A> Do you...Inspect, repair, or replace lighting timeclocks, controls and sensors?

Yes

No

REFUSED

DON'T KNOW

<VII2B> Do you perform...Lighting fixture standard maintenance, including re-lamping, cleaning and ballast replacement?

Yes

No

REFUSED

DON'T KNOW

<VII2C> Do you....Review and adjust indoor lighting on/off scheduling?

Yes

No

REFUSED

DON'T KNOW

<VII2D> Do you...Review and adjust outdoor lighting on/off scheduling or photo sensors?

Yes

No

REFUSED

DON'T KNOW

Which of the following operational improvements and repairs has your firm implemented for the lighting systems in the buildings you service?

<VII4A> Do you...Test, clean, recalibrate or replace existing lighting timeclocks, controls and sensors?

Yes

No

REFUSED

DON'T KNOW

<VII4C> Do you...Implement delamping?

Yes

No

REFUSED

DON'T KNOW

<VII4D> Have you...Replaced T8s with super T8s?

Yes

No

REFUSED

DON'T KNOW

<VII4E> Do you...Stock Super T8s?

Yes

No

REFUSED

DON'T KNOW

<VII4F> Do you...Replace incandescent bulbs with CFLs?

Yes

No

REFUSED

DON'T KNOW

<VII4G> Do you...Stock CFLs?

Yes

No

REFUSED

DON'T KNOW

<VII4H> Do you...Replace broken T12 fixtures with T8s or Super T8s?

Yes

No

REFUSED

DON'T KNOW

APPENDIX E
TELEPHONE SURVEY RESULTS

Telephone Survey Results

Building Size	Owner and Decision Maker Survey					Property Manager Survey	Service Provider Survey
	Business Type				Total		
	Office	College / University	Government	Retail			
< 50,000 sqft	0	0	0	0	0		
50,000 to < 100,000 sqft	16	2	2	8	28		
100,000 to < 250,000 sqft	10	3	2	14	29		
250,000 to < 500,000 sqft	5	2	1	4	12		
500,000 to < 750,000 sqft	2	1	1	1	5		
750,000 to < 1,000,000 sqft	1	1	2	2	6		
>= 1,000,000 sqft	4	8	4	3	19		
Total	38	17	12	32	99		
Buildings							
Average Number of Buildings in Facilities	2.9	5.5	3.7	2.4	3.3	19.8	251.0
N	38	17	12	32	99	10	17
Average Size of Buildings in Facilities	372,409	1,667,706	1,519,208	315,383	715,407		
N	38	17	12	32	99		
Average Age of Buildings in Facilities	27.4	37.7	29.5	22.0	27.7		
N	37	17	12	32	98		
Average number of buildings greater than 50,000 square feet						12.6	32.4
N						10	16
Percent of revenue accounted for by O&M services contracts							48%
N							18
Primary use of the building(s)							
Office Building(s) NON GOVERNMENT						90%	65%
College or University							10%
Retail							5%
Hospital							5%
Manufacturing							15%
Industrial						10%	
N						10	20
Hours of Operation							
Average Hours of Operation per Day Monday through Friday	13.1	14.5	11.1	14.6	13.6		
Average Hours of Operation on Saturday	6.4	7.8	0.0	12.3	8.0		
Average Hours of Operation on Sunday	5.2	4.9	0.0	10.5	6.4		
N	35	16	8	28	87		
<I22> Main selling points that your company stresses in the O&M services that you offer							
Quality of service							80%
Quality and/or capabilities of technicians providing services							30%
Energy cost savings							20%
Equipment reliability							25%
Extended equipment life							10%
Quick response time or technician responsiveness							45%
Cost for services							15%
Ability to provide comprehensive turnkey services							15%
Bundling of services							20%
Company reputation							25%
N							20

Telephone Survey Results

Building Size	Owner and Decision Maker Survey					Property Manager Survey	Service Provider Survey
	Business Type				Total		
	Office	College / University	Government	Retail			
<13> What energy using equipment and systems are typically included in the O&M service contracts your company offers?							
Cooling or air conditioning equipment							90%
Space heating equipment							65%
Lighting equipment							45%
Refrigeration equipment							40%
Water heating equipment							60%
EMS or other system controls							70%
Leak detecting system							5%
N							20
Who pays O&M bills?							
Building Owner	63%	94%	58%	56%	66%	50%	85%
Property Manager	8%	0%	25%	0%	6%	20%	15%
Tenants that Lease Space	13%	0%	0%	13%	9%	30%	
Corporate Office	5%	0%	0%	22%	9%		
Other	11%	6%	17%	9%	10%		
N	38	17	12	32	99	10	20
<15> What are the TWO main things your customers focus on getting in their O&M contracts?							
Quality service							65%
Capable technicians							15%
Energy cost savings							30%
Equipment reliability							5%
Quick response time or technician responsiveness							30%
Competitive costs for services							25%
Comprehensive turnkey services							10%
Strong company reputation							15%
Availability of client references							5%
N							20
<16> Are there any advanced O&M services that you offer, such as commissioning services?							
Yes							45%
No							50%
Don't know							5%
N							20
<16A> Could you please provide some examples of the advanced O&M services that you offer?							
Audits							11%
Compressed air service							11%
Energy analysis							11%
Life cycle analysis							11%
Retro commissioning							22%
Sheet metal fabricating							11%
Lighting, HVAC							11%
Depends on site							11%
N							9

Telephone Survey Results

Building Size	Owner and Decision Maker Survey					Property Manager Survey	Service Provider Survey
	Business Type				Total		
	Office	College / University	Government	Retail			
<17> Please describe the typical cost structure of your O&M service agreements. That is, how do you price your services?							
Time and materials							40%
Per square foot							5%
Per hour							25%
By equipment type/size							15%
Fixed price							5%
Per unit							5%
Don't know							5%
N							20
Owner occupied building or leased?							
Owner occupied only	53%	88%	58%	53%	60%		
Leased only	32%	0%	17%	34%	25%		
Both owner occupied and leased	16%	12%	17%	13%	14%		
Other (share with other depts)	0%	0%	8%	0%	1%		
N	38	17	12	32	99		
Who pays electric and gas bills?							
Tenants	72%	50%	60%	80%	73%		
Owner	28%	50%	20%	13%	23%		
Management Company	0%	0%	20%	0%	3%		
Other	0%	0%	0%	7%	3%		
N	18	2	5	15	40		
<16> What percent of your tenants pay for their utilities?							
Average percent						100%	
How are energy cost allocated to the tenants							
Through set maintenance fees	11%	50%	20%	13%	15%	41%	
Or are Tenants invoiced based on actual	44%	0%	40%	47%	43%	47%	
Based on submeters read by building owner	11%	50%	0%	20%	15%	11%	
Direct billing from utility	11%	0%	0%	7%	8%		
Based on occupied sqft	6%	0%	20%	0%	5%		
Included in lease/rent	11%	0%	20%	0%	8%		
Net lease						10%	
Don't know	6%	0%	0%	13%	8%		
N	18	2	5	15	40	10	
How concerned are you regarding energy costs							
Very concerned	61%	65%	58%	69%	64%	50%	
Somewhat concerned	32%	29%	42%	31%	32%	40%	
Not very concerned	5%	6%	0%	0%	3%		
Not at all concerned	3%	0%	0%	0%	1%	10%	
N	38	17	12	32	99	10	
Actively seek to reduce energy costs							
Yes	94%	94%	100%	100%	97%	100%	90%
No	6%	6%	0%	0%	3%		10%
N	36	16	12	32	96	9	20

Telephone Survey Results

Building Size	Owner and Decision Maker Survey					Property Manager Survey	Service Provider Survey
	Business Type				Total		
	Office	College / University	Government	Retail			
I119A. What actions do you take to reduce energy costs							
Adjust energy use schedules	6%	20%	0%	6%	8%		
Always looking for ways to reduce costs/ rebates	3%	0%	0%	6%	3%	22%	6%
EMS controlled	3%	7%	8%	13%	8%	11%	
DDC controlled	3%	0%	8%	0%	2%		
Controlled by computer system	12%	0%	8%	3%	6%		
High efficiency equipment	29%	13%	17%	19%	22%	44%	44%
EE design	6%	0%	0%	3%	3%		11%
Energy audit	6%	0%	0%	3%	3%		
Energy conservation	24%	7%	8%	16%	16%		
Preventative maintenance	3%	13%	0%	9%	6%	11%	28%
New technologies	3%	13%	8%	6%	6%		
Monitoring utility bills	0%	0%	8%	3%	2%	33%	6%
Lighting sensors	0%	7%	8%	3%	3%		
Timer controlled equipment	3%	0%	8%	9%	5%		
Retrofit/Upgrade equipment	24%	33%	17%	19%	23%	11%	
Proper PM	0%	7%	0%	3%	2%		
Monitor energy use schedules	3%	0%	0%	0%	1%		
Turn equipment off	9%	0%	0%	6%	5%		
We have a resource conservation manager	0%	7%	0%	0%	1%		
Internal committee dedicated to EE	0%	0%	8%	3%	2%		11%
Accelerated maintenance program with vendors	3%	0%	0%	0%	1%		
Mostly manual	0%	7%	0%	0%	1%		
Benchmarking	0%	0%	8%	0%	1%		
VSD						11%	
Equipment studies						22%	
Various activities							6%
Change filters frequently	3%	0%	8%	3%	3%		
Other	0%	0%	8%	0%	1%		
N	34	15	12	32	93	9	18
By how much can you reduce energy costs							
5 percent or less	41%	21%	25%	21%	29%	44%	6%
Between 6 to 10 percent	25%	36%	50%	31%	31%	22%	17%
between 11 to 15 percent	3%	14%	0%	7%	6%		28%
between 16 to 20 percent	9%	14%	13%	7%	10%		11%
between 21 to 30 percent	3%	0%	0%	10%	5%	11%	22%
more than 30 percent	13%	7%	0%	0%	6%	22%	11%
Don't know	6%	7%	13%	24%	13%		6%
N	32	14	8	29	83	9	18
<I11> Have you commissioned or completed a comprehensive tune-up of any of the major energy using systems in your building?							
Yes						60%	
No						30%	
Don't know						10%	
N						10	

Telephone Survey Results

Building Size	Owner and Decision Maker Survey					Property Manager Survey	Service Provider Survey
	Business Type				Total		
	Office	College / University	Government	Retail			
Equipment installed at facility							
Cooling or air conditioning equipment	100%	100%	100%	100%	100%	100%	
Area heating equipment	95%	100%	100%	94%	96%	83%	
Lighting equipment	100%	100%	100%	97%	99%	100%	
Refrigeration equipment	37%	71%	67%	47%	49%	17%	
Water heating equipment	68%	94%	92%	63%	74%		
Cooking equipment	34%	71%	58%	34%	43%		
Elevator/Escalator	0%	0%	0%	6%	2%		
Exhaust fan motors	3%	0%	8%	0%	2%		
EMS or other system controls						17%	
Glazing and roofing						17%	
Don't know	3%	6%	25%	0%	5%		
N	38	17	12	32	99	6	
Major renovation at any time							
Yes	42%	71%	50%	38%	46%		
No	58%	29%	50%	59%	53%		
Don't know	0%	0%	0%	3%	1%		
N	38	17	12	32	99		
How many years ago was the renovation							
Average Number of Years	11.7	13.0	8.0	5.2	10.0		
N	16	12	6	11	45		
<I11A> Which energy using systems have you commissioned?							
Cooling or air conditioning equipment	80%	100%	63%	73%	79%		
Area heating equipment	68%	63%	13%	60%	57%		
Lighting equipment	24%	13%	38%	80%	39%		
Refrigeration equipment	4%	13%	0%	7%	5%		
Water heating equipment	4%	50%	13%	0%	11%		
Cooking equipment	0%	13%	0%	0%	2%		
EMS or other system controls	12%	50%	13%	33%	23%		
Other	12%	0%	0%	7%	7%		
N	25	8	8	15	56		
II1. Annual budget for routine O&M							
Average Annual Budget	555,429	1,545,182	936,344	232,111	770,255		
N	21	11	5	9	46		
<I11> Do you typically have on-site engineering staff in the buildings you manage that are responsible for managing, maintaining and servicing energy-using systems?							
Yes						80%	
No						20%	
N						10	
<I11NAME> Could you refer me to one or two of these on-site engineering staff members?							
No						75%	
R. B. Musson - 503 849-0601						13%	
Scott - 503 572-6840						13%	
N						8	

Telephone Survey Results

Building Size	Owner and Decision Maker Survey					Property Manager Survey	Service Provider Survey
	Business Type				Total		
	Office	College / University	Government	Retail			
<I13> Is your firm responsible for O&M budgets in your buildings?							
Yes						100%	
N						10	
<I14> What is the job title of the primary decision maker for building operations?							
Owner	5%	0%	8%	3%	4%	10%	
Building or facility manager	26%	12%	25%	9%	18%	20%	
Building engineer						20%	
Property manager	3%	6%	0%	3%	3%	30%	
Director						20%	
Area manager	0%	0%	0%	3%	1%		
Assistant city manager	0%	0%	8%	0%	1%		
Assistant Director for Central Services	0%	0%	8%	0%	1%		
Assistant maintenance manager	0%	0%	0%	3%	1%		
Assistant Vice President for Facilities	0%	6%	0%	0%	1%		
BST Supervisor	0%	0%	0%	3%	1%		
Building and grounds supervisor A	0%	6%	0%	0%	1%		
Building Services Area Manager	0%	0%	0%	3%	1%		
Building services supervisor	3%	0%	0%	3%	2%		
Business Unit Manager	3%	0%	0%	0%	1%		
CEO	3%	0%	0%	3%	2%		
CFO	0%	0%	0%	3%	1%		
Chief engineer	0%	0%	0%	3%	1%		
Chief of buildings management	0%	0%	8%	0%	1%		
Corporate manager	3%	0%	0%	0%	1%		
Deputy Chief	3%	0%	0%	0%	1%		
Director broadcast/operations/facilities/engineering	3%	0%	0%	0%	1%		
Director of Campus Care	0%	6%	0%	0%	1%		
Director of Facility	0%	6%	0%	0%	1%		
Director of Facility operations and planning	0%	6%	0%	0%	1%		
Director of Facility services	0%	6%	0%	0%	1%		
Director of maintenance	3%	0%	0%	0%	1%		
Director of operations	5%	0%	0%	0%	2%		
Director of plant services	0%	6%	0%	0%	1%		
Director of the physical plant	0%	6%	0%	0%	1%		
Engineer	0%	6%	0%	3%	2%		
Facilities Coordinator	0%	0%	0%	3%	1%		
Facilities administrator	3%	0%	0%	0%	1%		
Facilities coordinator/buyer	0%	0%	8%	0%	1%		
Facilities manager	8%	6%	25%	3%	8%		
General Services Manager	3%	0%	0%	0%	1%		
Logistics Manager	3%	0%	0%	0%	1%		
Maintenance Manager	3%	6%	0%	0%	2%		
Maintenance supervisor	3%	0%	0%	0%	1%		
Maintenance Director	0%	0%	0%	3%	1%		
Manager of administrator services	3%	0%	0%	0%	1%		
Operations Manager	5%	0%	0%	16%	7%		
Outpatient Manager	3%	0%	0%	0%	1%		
Plant Manager	0%	6%	0%	3%	2%		
President	3%	0%	0%	0%	1%		
Region maintenance manager	0%	0%	0%	3%	1%		
Regional technical director	0%	0%	0%	3%	1%		
Senior manager	3%	0%	0%	3%	2%		
Senior property manager	0%	0%	0%	3%	1%		
site operations manager	0%	6%	0%	0%	1%		
Systems supervisor	0%	6%	0%	0%	1%		
Trades manager	0%	0%	8%	0%	1%		
VP	0%	0%	0%	3%	1%		
VP of building services	0%	0%	0%	3%	1%		
VP of construction and maintenance	0%	0%	0%	3%	1%		
VP of corporate resources	3%	0%	0%	0%	1%		
VP of corporate services	0%	0%	0%	3%	1%		
VP of operations	3%	0%	0%	0%	1%		
Warehouse manager	0%	0%	0%	3%	1%		
N	38	17	12	32	99	10	

Telephone Survey Results

Building Size	Owner and Decision Maker Survey					Property Manager Survey	Service Provider Survey
	Business Type				Total		
	Office	College / University	Government	Retail			
<II4> What typically is the job title of the building representative that hires your company to perform O&M services?							
Owner							40%
Building or facility manager							35%
Property manager							25%
N							20
II6. How do you typically maintain the energy using equipment and controls							
Use in-house staff only	13%	35%	17%	16%	18%	20%	
Outsource all responsibilities to O&M service providers or vendors	26%	6%	17%	28%	22%		25%
Use BOTH in-house staff & outsource to O&M service providers or vendors	61%	59%	67%	56%	60%	80%	75%
N	38	17	12	32	99	10	20
II11. Number of full time equivalent employees address equipment operation and maintenance							
Average Number of Members	6.3	21.3	8.7	2.5	8.6	9.0	
N	27	16	9	23	75	10	
II12A. Percentage of equipment O&M work outsourced to contractors and vendors							
Average Percent Outsourced	60.2%	25.1%	28.8%	27.1%	40.1%	40.0%	
N	23	10	8	17	58	8	
II12B. Percentage of equipment O&M work done by in-house staff							
Average Percent In-House	39.8%	74.9%	71.3%	74.6%	60.4%	60.0%	45.4%
N	23	10	8	17	58	8	12
<II14A-D> Can you please provide the company name(s) that you contract with for equipment O&M?							
Carrier						13%	
Trane						38%	
McDonald Miller						25%	
Stoner Electric						13%	
Alliant						13%	
McKinstrey						38%	
Willamette Electric						13%	
Hunter Davison						13%	
Puget Sound Refrigeration						13%	
Portland Mechanical						13%	
Refused						25%	
N						8	

Telephone Survey Results

Building Size	Owner and Decision Maker Survey					Property Manager Survey	Service Provider Survey
	Business Type				Total		
	Office	College / University	Government	Retail			
<I17A> Can you provide the company name of a primary competitor in the O&M services market?							
None							5%
Advanced heating and air							5%
Alliant							5%
Air systems							5%
American heating							5%
Banner fuel							5%
Barron heating							5%
Brenner sales and service							5%
Cascade mach.							5%
Delux fuel							5%
Divco							5%
Dunbuch							5%
Emaril aire							5%
Elec. control							5%
Feller							5%
Hunter davidson							5%
HVAC inc							5%
Ingersoll-rand							5%
Johnson controls							10%
McDonald Miller							25%
McKinstry							10%
Merit Mach.							5%
MTI							5%
Oregon electric							5%
Protamp Mac.							5%
Regway industrial							5%
Roger machinery							5%
Sun glow inc							5%
Sunset fuel							5%
Trane co.							5%
Tran rocky mountain							5%
TML							5%
Westside electric							5%
York							5%
Holiday parks							5%
Honeywell							15%
R&R compressors							5%
Reds							5%
Reitmyer Mac							5%
Tri city mac elec							5%
Trane co.							5%
Don't know							10%
N							20
I16. What equipment or controls do you rely almost entirely upon the expertise of your contractors/vendors for O&M							
Cooling or air conditioning equipment	67%	18%	30%	56%	52%	50%	45%
Area heating equipment	48%	27%	10%	41%	38%	50%	5%
Lighting equipment	30%	0%	0%	19%	19%		10%
Refrigeration equipment	3%	0%	0%	15%	6%		10%
Water heating equipment	3%	9%	0%	11%	6%		5%
Cooking equipment	3%	0%	0%	4%	2%		
EMS or other system controls	24%	18%	30%	30%	26%		35%
None	12%	27%	10%	33%	21%	50%	10%
Elevators	9%	27%	10%	4%	10%		
DDC Systems							10%
Compressed Air							5%
Other	9%	0%	10%	0%	5%		
Don't know	3%	9%	0%	4%	4%		10%
N	33	11	10	27	81	8	20

Telephone Survey Results

Building Size	Owner and Decision Maker Survey					Property Manager Survey	Service Provider Survey
	Business Type				Total		
	Office	College / University	Government	Retail			
II17. Maintenance activities							
Fix equipment when it breaks or there are complaints	8%	24%	0%	13%	11%		10%
Complete preventive maintenance on a regularly scheduled basis	82%	71%	83%	84%	81%	100%	75%
Test and analyze equipment (i.e. lubrication analysis-vibration analysis)	5%	0%	0%	0%	2%		5%
Mixture of above	5%	6%	17%	3%	6%		10%
N	38	17	12	32	99	10	20
<II10> Do the O&M service contracts between your firm and your clients typically require the implementation of energy saving O&M improvements?							
Yes							65%
No							35%
N							20
II18. How often do you complete regular							
Weekly	0%	0%	10%	26%	10%		
Monthly	19%	8%	10%	30%	20%		
Quarterly	52%	33%	40%	22%	38%		
Bi Annually	16%	33%	20%	11%	18%		
Annually	3%	0%	0%	4%	3%		
Daily/continuous basis	0%	25%	10%	7%	8%		
Depends on the equipment	10%	0%	10%	0%	5%		
N	31	12	10	27	80		
II23. Do you require that your O&M service provider implement energy saving O&M improvements							
Yes	42%	27%	40%	41%	40%	25%	
No	55%	73%	50%	44%	53%	63%	
Don't know	3%	0%	10%	15%	7%	13%	
N	33	11	10	27	81	8	
II24. Which of the following describe operational procedures that you currently implement?							
Maintain O&M instructions and records of procedures performed	84%	94%	83%	88%	87%	100%	90%
Train & educate building operators and maintenance staff on O&M activities	66%	94%	83%	72%	75%	80%	90%
Incorporate goals for enhanced O&M practices into Strategic Business Plan	63%	47%	33%	63%	57%	60%	50%
Develop a facility energy management plan that emphasizes an energy-efficient O&M strategy	37%	47%	58%	53%	46%	50%	45%
Conduct retrocommissioning	26%	53%	17%	44%	35%	60%	55%
Track energy use	63%	82%	58%	84%	73%	80%	50%
Develop goals for reducing energy costs	50%	71%	58%	63%	59%	60%	75%
Analyze energy use to optimize O&M	53%	65%	33%	72%	59%	80%	70%
N	38	17	12	32	99	10	20

Telephone Survey Results

Building Size	Owner and Decision Maker Survey					Property Manager Survey	Service Provider Survey
	Business Type				Total		
	Office	College / University	Government	Retail			
II26A. What are some of the Technical barriers that might prevent you from implementing these operational enhancements?							
None	50%	47%	33%	47%	46%	50%	40%
Limited staff	0%	6%	0%	0%			
Money/ Initial cost	0%	6%	0%	0%	1%		5%
Payback	0%	0%	0%	3%	1%		
Lack of knowledge on staff/Technical barriers	5%	18%	17%	13%	11%		10%
Age of building/equipment	13%	18%	25%	16%	16%	20%	
Time constraints	3%	0%	0%	0%	1%		
Having the tools						10%	
Compatibility						10%	
Man power							10%
Small company							5%
Building engineers							5%
Lack of incentives							5%
Unsure about product							5%
Other	13%	12%	0%	3%	8%		
Refused	0%	0%	8%	3%	2%		5%
Don't know	16%	0%	17%	16%	13%	10%	10%
N	38	17	12	32	99	10	20
II26B. What are some of the ORGANIZATIONAL barriers that might prevent you from implementing these operational enhancements?							
No other barriers	53%	47%	25%	42%	45%	60%	48%
Budget	5%	18%	17%	6%	9%	10%	
Limited staff	3%	18%	8%	3%	6%		5%
Management approval/Chain of command	11%	12%	17%	10%	11%	30%	5%
Money/ Initial cost	3%	12%	8%	6%	6%		5%
Payback	3%	0%	0%	3%	2%		
We don't do preventive maintenance	3%	0%	0%	10%	4%		
Time							14%
In-house people							5%
Communication							5%
No set up or focus							5%
Contractual dock							5%
Other	5%	0%	8%	0%	3%		
Refused	3%	0%	8%	0%	2%		
Don't know	13%	0%	8%	19%	12%		5%
N	38	17	12	32	99	10	21
II26C. What are some of the FINANCIAL barriers that might prevent you from implementing these operational enhancements?							
No other barriers	16%	6%	0%	13%	11%	10%	60%
Budget	21%	41%	75%	31%	34%	20%	
Management approval/Chain of command	5%	12%	0%	9%	7%		5%
Money/ Initial cost	24%	35%	8%	16%	21%	40%	5%
Payback	21%	0%	0%	16%	13%	30%	
We don't do preventive maintenance	3%	0%	0%	0%	1%		
Our cost							15%
Not enough man power							5%
Change of my business							5%
Other	5%	6%	8%	0%	4%		
Refused	0%	0%	8%	0%	1%		
Don't know	5%	0%	0%	19%	8%		5%
N	38	17	12	32	99	10	20

Telephone Survey Results

Building Size	Owner and Decision Maker Survey					Property Manager Survey	Service Provider Survey
	Business Type				Total		
	Office	College / University	Government	Retail			
<I126E> Do STAFFING limitations prevent you from implementing these operational enhancements?							
Yes						20%	55%
No						80%	45%
N						10	20
I126D. Can you think of any other BARRIERS that prevent you from implementing these enhancements?							
No other barriers	82%	76%	83%	78%	80%	70%	75%
Management approval/Chain of command	3%	0%	8%	0%	2%		
Money/ Initial cost	3%	0%	0%	0%	1%	10%	
Payback	3%	6%	0%	3%	3%		
Lack of knowledge on staff/Technical barriers	0%	0%	0%	3%	1%		
Age of building/equipment	11%	12%	0%	6%	8%		
Time constraints	0%	6%	0%	0%	1%	30%	5%
Space	0%	0%	0%	3%	1%		
Weather	0%	0%	0%	3%	1%		
Cooperation from contractors	0%	0%	0%	3%	1%		
Government	0%	0%	8%	0%	1%		
Competition							10%
Lack of interest							5%
Personal conflict							5%
Refused	0%	0%	0%	0%	0%		
N	38	17	12	32	99	10	20
I129A. Issues, needs or problems with cooling, heating, lighting or other building systems							
Yes	37%	71%	67%	34%	45%		
No	63%	24%	33%	66%	54%		
Refused	0%	6%	0%	0%	1%		
N	38	17	12	32	99		

Telephone Survey Results

Building Size	Owner and Decision Maker Survey					Property Manager Survey	Service Provider Survey
	Business Type				Total		
	Office	College / University	Government	Retail			
II29A1. What equipment is affected by these issues or needs?							
HVAC - heating and cooling	50%	33%	13%	55%	40%		
Cooling - general	7%	17%	0%	9%	9%		
Cooling - chiller	0%	8%	13%	0%	4%		
Heating - heat pump	7%	17%	0%	0%	7%		
Heating - natural gas	0%	0%	0%	9%	2%		
Heating - steam	0%	17%	0%	0%	4%		
Heating - boiler	0%	0%	13%	0%	2%		
HVAC - ground source	0%	8%	0%	0%	2%		
Energy Management System	14%	0%	25%	0%	9%		
Lighting	0%	8%	13%	0%	4%		
Water heater	0%	8%	0%	0%	2%		
Electrical infrastructure	0%	0%	13%	9%	4%		
CO2 Sensor	7%	0%	0%	0%	2%		
Dampers in HVAC	0%	0%	13%	0%	2%		
Escalator	0%	0%	0%	9%	2%		
Fixtures/Switches	7%	0%	0%	0%	2%		
All	0%	8%	0%	0%	2%		
Old equipment in general	0%	0%	13%	0%	2%		
Pneumatic motors	0%	0%	0%	9%	2%		
Envir controls for batteries UPS	7%	0%	0%	0%	2%		
N	14	12	8	11	45		
II29A2. What are the maintenance issues or needs associated with the equipment							
Age of equipment	29%	42%	50%	45%	40%		
Age of building	7%	0%	13%	0%	4%		
Equipment is not working properly	29%	33%	25%	18%	27%		
Inadequate design	14%	17%	0%	0%	9%		
Need to be upgraded	0%	0%	13%	9%	4%		
Need additional units/more capacity	7%	8%	0%	9%	7%		
Need to replace	0%	0%	13%	9%	4%		
Equipment is not working	0%	0%	0%	9%	2%		
Other	14%	0%	0%	0%	4%		
N	14	12	8	11	45		
II29A3. Are you aware of viable solutions for addressing the maintenance issues, needs and problems for the equipment you've just mentioned							
Yes	86%	83%	100%	91%	89%		
No	14%	17%	0%	9%	11%		
N	14	12	8	11	45		
II29A4. Briefly describe what should be done to address those issues/needs							
Age of equipment	8%	0%	0%	0%	3%		
Equipment is not working properly	0%	10%	0%	0%	3%		
Inadequate design	8%	0%	0%	10%	5%		
Need to be upgraded	17%	20%	25%	20%	20%		
Need additional units/more capacity	0%	0%	0%	10%	3%		
Need to replace	17%	40%	50%	50%	38%		
Money	25%	20%	0%	0%	13%		
Hired an expert to work on it	17%	10%	0%	0%	8%		
Time	0%	10%	0%	0%	3%		
Staff	0%	0%	13%	0%	3%		
Other	8%	0%	13%	10%	8%		
N	12	10	8	10	40		

Telephone Survey Results

Building Size	Owner and Decision Maker Survey					Property Manager Survey	Service Provider Survey
	Business Type				Total		
	Office	College / University	Government	Retail			
<i>II29A5. What are the factors that are preventing you from implementing those particular improvements?</i>							
Money	58%	90%	63%	60%	68%		
Time	0%	10%	13%	0%	5%		
Staff	0%	30%	0%	0%	8%		
None	25%	0%	13%	30%	18%		
Other	8%	0%	13%	0%	5%		
Don't know	8%	0%	0%	10%	5%		
N	12	10	8	10	40		
<i>II29B. Issues, needs or problems with cooling, heating, lighting or other building systems</i>							
Yes	7%	25%	38%	36%	24%		
No	93%	75%	63%	55%	73%		
Don't know	0%	0%	0%	9%	2%		
N	14	12	8	11	45		
<i>II29B1. What equipment is affected by these issues or needs?</i>							
HVAC - heating and cooling	0%	33%	0%	0%	9%		
Energy Management System	100%	0%	0%	0%	9%		
Lighting	0%	67%	33%	100%	64%		
Thermostats	0%	0%	33%	0%	9%		
Other	0%	0%	33%	0%	9%		
N	1	3	3	4	11		
<i>II29B2. What are the maintenance issues or needs associated with the equipment</i>							
Age of equipment	100%	33%	0%	0%	18%		
Equipment is not working properly	0%	33%	0%	0%	9%		
Need to be upgraded	0%	0%	0%	50%	18%		
Need to replace	0%	0%	0%	25%	9%		
Money	0%	33%	0%	0%	9%		
Time	0%	0%	33%	0%	9%		
Landlords decision	0%	0%	33%	0%	9%		
Other	0%	0%	33%	25%	18%		
N	1	3	3	4	11		
<i>II29B3. Are you aware of viable solutions for addressing the maintenance issues, needs and problems for the piece of equipment that you've just mentioned?</i>							
Yes	100%	100%	100%	75%	91%		
No	0%	0%	0%	25%	9%		
N	1	3	3	4	11		
<i>II29B4. Briefly describe what should be done to address those issues/needs</i>							
Need to be upgraded	0%	0%	33%	0%	10%		
Need additional units/more capacity	0%	0%	0%	33%	10%		
Need to replace	100%	33%	33%	67%	50%		
Money	0%	67%	0%	0%	20%		
None	0%	0%	33%	0%	10%		
Other	0%	33%	0%	0%	10%		
N	1	3	3	3	10		
<i>II29B5. What are the factors that are preventing you from implementing those particular improvements?</i>							
Money	0%	100%	33%	33%	50%		
Time	0%	0%	0%	33%	10%		
None	100%	0%	33%	0%	20%		
Landlords decision	0%	0%	33%	0%	10%		
Other	0%	0%	0%	33%	10%		
N	1	3	3	3	10		
<i>II29C. Issues, needs or problems with cooling, heating, lighting or other building systems</i>							
Yes	0%	33%	67%	0%	27%		
No	100%	67%	33%	100%	73%		
N	1	3	3	4	11		

Telephone Survey Results

Building Size	Owner and Decision Maker Survey					Property Manager Survey	Service Provider Survey
	Business Type				Total		
	Office	College / University	Government	Retail			
II29C1. What equipment is affected by these issues or needs?							
HVAC - heating and cooling	0%	0%	50%	0%	33%		
Heating - boiler	0%	0%	50%	0%	33%		
Electrical infrastructure	0%	100%	0%	0%	33%		
N	0	1	2	0	3		
II29C2. What are the maintenance issues or needs associated with the equipment							
Need to be upgraded	0%	0%	100%	0%	67%		
Need additional units/more capacity	0%	100%	0%	0%	33%		
N	0	1	2	0	3		
II29C3. Are you aware of viable solutions for addressing the maintenance issues, needs and problems for the piece of equipment that you've just mentioned?							
Yes	0%	100%	50%	0%	67%		
No	0%	0%	50%	0%	33%		
N	0	1	2	0	3		
II29C4. Briefly describe what should be done to address those issues/needs							
Need to be upgraded	0%	100%	0%	0%	50%		
Need to replace	0%	0%	100%	0%	50%		
N	0	1	1	0	2		
II29C5							
Money	0%	100%	100%	0%	100%		
N	0	1	1	0	2		
II29D. Issues, needs or problems with cooling, heating, lighting or other building systems							
No	0%	100%	100%	0%	100%		
N	0	1	2	0	3		
III2. Is the building(s) heating load primarily served by a central boiler-based plant or by individual heaters or furnaces?							
Boiler-based plant	24%	65%	33%	6%	26%	10%	46%
Furnaces	71%	35%	67%	84%	69%	60%	38%
Both	3%	0%	0%	0%	1%	10%	
Neither	0%	0%	0%	6%	2%		
Other	0%	0%	0%	3%	1%	20%	
Don't know	3%	0%	0%	0%	1%		15%
N	38	17	12	32	99	10	13
III3. Which of the following is the primary control system strategy employed for the space heating system?							
EMS or EMCS	18%	24%	25%	50%	30%	63%	60%
Electronic or DDC controls	61%	41%	42%	22%	42%	86%	57%
Pneumatic controls	3%	24%	8%	3%	7%	15%	16%
Manual controls	11%	6%	8%	19%	12%	14%	11%
Computerized system	5%	6%	17%	0%	5%		57%
Other	0%	0%	0%	3%	1%	8%	0%
None of these	0%	0%	0%	3%	1%		
Don't know	3%	0%	0%	0%	1%		
N	38	17	12	32	99	10	13

Telephone Survey Results

Building Size	Owner and Decision Maker Survey					Property Manager Survey	Service Provider Survey
	Business Type				Total		
	Office	College / University	Government	Retail			
III4. Which of the following preventive maintenance methods do you use for your boiler-based heating systems?							
Review and adjust boiler and hot water pump staging & scheduling	75%	91%	50%	100%	79%	100%	67%
Perform standard boiler maintenance (see above)	75%	100%	50%	100%	83%	100%	100%
Check oil fuel system (pumps, oil filters, system pressure)	88%	82%	50%	100%	79%	100%	83%
Repair or replace faulty hot water sensors and control points	88%	100%	75%	100%	92%	100%	83%
Investigate and repair faulty steam valves and steam pipe leaks	38%	91%	75%	100%	71%	100%	83%
Repair faulty steam traps	38%	82%	75%	100%	67%	100%	83%
Other	0%	27%	25%	0%	17%		
Don't know	0%	0%	25%	0%	4%		
N	8	11	4	1	24	1	6
III5A. How often do you check or inspect the boiler settings of your boiler-based heating systems?							
Monthly	50%	9%	0%	0%	21%		
Quarterly	50%	0%	0%	0%	17%	100%	
Bi-annually	0%	0%	0%	100%	4%		50%
Annually	0%	18%	0%	0%	8%		33%
Not at all	0%	0%	25%	0%	4%		
Daily/continuous basis	0%	64%	25%	0%	33%		
When needed	0%	9%	0%	0%	4%		
Hourly							
Weekly							17%
Don't know	0%	0%	50%	0%	8%		
N	8	11	4	1	24	1	6
III5B. How often do you check or inspect the HW setpoints of your boiler-based heating systems?							
Monthly	50%	36%	0%	0%	33%		17%
Quarterly	38%	0%	25%	0%	17%	100%	17%
Bi-annually	13%	0%	0%	100%	8%		17%
Annually	0%	9%	25%	0%	8%		33%
Not at all	0%	27%	0%	0%	13%		
Daily/continuous basis	0%	18%	0%	0%	8%		
When needed							
Hourly							
Weekly							17%
Don't know	0%	9%	50%	0%	13%		
N	8	11	4	1	24	1	6
III5C. How often do you compare the equipment schedule of your boiler-based heating systems?							
Monthly	25%	0%	0%	0%	8%		17%
Quarterly	13%	0%	0%	0%	4%	100%	33%
Bi-annually	13%	0%	0%	100%	8%		33%
Annually	0%	27%	25%	0%	17%		
Not at all	38%	0%	25%	0%	17%		
Daily/continuous basis	0%	27%	25%	0%	17%		
When needed	0%	9%	0%	0%	4%		
Hourly	13%	36%	0%	0%	21%		
Weekly							17%
Don't know	0%	0%	25%	0%	4%		
N	8	11	4	1	24	1	6

Telephone Survey Results

Building Size	Owner and Decision Maker Survey					Property Manager Survey	Service Provider Survey
	Business Type				Total		
	Office	College / University	Government	Retail			
III5D. How often do you check or inspect the boiler control settings of your boiler-based heating systems?							
Monthly	50%	9%	25%	0%	25%		
Quarterly	13%	0%	0%	0%	4%	100%	33%
Bi-annually	13%	0%	0%	100%	8%		17%
Annually	0%	18%	0%	0%	8%		33%
Not at all	13%	0%	25%	0%	8%		
Daily/continuous basis	0%	64%	25%	0%	33%		
When needed	0%	9%	0%	0%	4%		
Hourly	13%	0%	0%	0%	4%		
Weekly							17%
Don't know	0%	0%	25%	0%	4%		
N	8	11	4	1	24	1	6
III5E. How often do you check or inspect the HW pump settings of your boiler-based heating systems?							
Monthly	38%	9%	25%	0%	21%		
Quarterly	25%	9%	0%	0%	13%	100%	33%
Bi-annually	25%	0%	0%	100%	13%		17%
Annually	0%	9%	0%	0%	4%		33%
Not at all	13%	0%	25%	0%	8%		17%
Daily/continuous basis	0%	18%	25%	0%	13%		
When needed	0%	9%	0%	0%	4%		
Hourly	0%	18%	0%	0%	8%		
Weekly							
Don't know	0%	27%	25%	0%	17%		
N	8	11	4	1	24	1	6
III5G. How often do you test and check steam traps of your boiler-based heating systems?							
Monthly	25%	0%	50%	0%	17%		
Quarterly	0%	9%	0%	0%	4%	100%	
Bi-annually	0%	18%	0%	100%	13%		
Annually	0%	27%	0%	0%	13%		67%
Not at all	75%	9%	25%	0%	33%		33%
Daily/continuous basis	0%	9%	0%	0%	4%		
When needed	0%	9%	0%	0%	4%		
Hourly							
Weekly							
Don't know	0%	18%	25%	0%	13%		
N	8	11	4	1	24	1	6

Telephone Survey Results

Building Size	Owner and Decision Maker Survey					Property Manager Survey	Service Provider Survey
	Business Type				Total		
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III6A. Implemented a full boiler tune up							
Yes	50%	100%	75%	100%	79%		100%
No	50%	0%	25%	0%	21%		
Don't know	0%	0%	0%	0%	0%	100%	
N	8	11	4	1	24	1	6
III6C. Modify HW setpoints							
Yes	50%	73%	50%	100%	63%	100%	100%
No	38%	27%	25%	0%	29%		
Don't know	13%	0%	25%	0%	8%		
N	8	11	4	1	24	1	6
III6D. Implement optimum start/stop scheduling and sequencing strategies for boiler and hot water pumps							
Yes	63%	82%	75%	100%	75%	100%	83%
No	38%	18%	25%	0%	25%		17%
Don't know	0%	0%	0%	0%	0%		
N	8	11	4	1	24	1	6
III6E. Modify boiler control logic, including sequencing and steam pressure modulation							
Yes	38%	45%	25%	100%	42%	100%	50%
No	63%	45%	25%	0%	46%		50%
Don't know	0%	9%	50%	0%	13%		
N	8	11	4	1	24	1	6
III6H. Analyze boiler trends and performance, and institute performance based maintenance							
Yes	25%	73%	50%	100%	54%	100%	83%
No	75%	18%	25%	0%	38%		17%
Don't know	0%	9%	25%	0%	8%		
N	8	11	4	1	24	1	6
III6I. Replace and resize steam traps							
Yes	13%	82%	75%	0%	54%	100%	50%
No	75%	9%	25%	0%	33%		50%
Refused	13%	0%	0%	0%	4%		
Don't know	0%	9%	0%	100%	8%		
N	8	11	4	1	24	1	6

Telephone Survey Results

Building Size	Owner and Decision Maker Survey					Property Manager Survey	Service Provider Survey
	Business Type				Total		
	Office	College / University	Government	Retail			
III7. Clean burners and replace as needed							
Yes	64%	50%	100%	92%	77%	50%	100%
No	23%	17%	0%	4%	12%	50%	
Don't know	14%	33%	0%	4%	11%		
N	22	6	5	24	57	6	5
III7B. Adjust fuel-air mixture							
Yes	41%	50%	100%	58%	54%	17%	100%
No	45%	33%	0%	38%	37%	67%	
Don't know	14%	17%	0%	4%	9%	17%	
N	22	6	5	24	57	6	5
III7C. Clean and maintain the combustion air and flue gas system to ensure it is free of restrictions and flow is optimized							
Yes	73%	67%	100%	83%	79%	33%	100%
No	18%	0%	0%	8%	11%	50%	
Don't know	9%	33%	0%	8%	11%	17%	
N	22	6	5	24	57	6	5
III7D. Implement night setback thermostat settings							
Yes	95%	83%	80%	88%	89%	83%	100%
No	0%	17%	20%	8%	7%	17%	
Don't know	5%	0%	0%	4%	4%		
N	22	6	5	24	57	6	5
IV2. Is the building(s) cooling load primarily served by a central chilled water plant or by individual packaged air conditioners?							
Chilled water plant	26%	41%	50%	9%	26%	40%	33%
Packaged air conditioners	71%	53%	50%	88%	71%	50%	44%
Both	0%	6%	0%	3%	2%	10%	17%
Other	3%	0%	0%	0%	1%		6%
N	38	17	12	32	99	10	18
IV3. Which of the following is the primary control system strategy employed for the cooling (or air conditioning) and ventilation system?							
EMS or EMCS	21%	24%	33%	56%	34%	40%	53%
Electronic or DDC controls	61%	53%	42%	16%	42%	40%	71%
Pneumatic controls	3%	6%	0%	3%	3%		18%
Manual controls	11%	6%	0%	22%	12%		11%
Computerized system	3%	0%	25%	0%	4%		52%
EMS/DDC	0%	12%	0%	0%	2%		
Other							0%
Don't know	3%	0%	0%	3%	2%	20%	
N	38	17	12	32	99	10	18

Telephone Survey Results

Building Size	Owner and Decision Maker Survey					Property Manager Survey	Service Provider Survey
	Business Type				Total		
	Office	College / University	Government	Retail			
IV4A. Clean and inspect cooling tower							
Yes	90%	57%	67%	100%	77%	100%	83%
No	10%	14%	17%	0%	12%		17%
Don't know	0%	29%	17%	0%	12%		
N	10	7	6	3	26	4	6
IV4b. Cooling tower water treatment/replacement							
Yes	80%	71%	83%	100%	81%	100%	50%
No	20%	14%	17%	0%	15%		50%
Don't know	0%	14%	0%	0%	4%		
N	10	7	6	3	26	4	6
IV4c. Repair or replace faulty valves, sensors and control points in the chilled water system							
Yes	90%	100%	83%	100%	92%	100%	100%
No	10%	0%	0%	0%	4%		
Don't know	0%	0%	17%	0%	4%		
N	10	7	6	3	26	4	6
IV4d. Repair or replace faulty valves, sensors and control points in the condenser water system							
Yes	80%	100%	83%	100%	88%	100%	100%
No	20%	0%	0%	0%	8%		
Don't know	0%	0%	17%	0%	4%		
N	10	7	6	3	26	4	6
IV4e. Check and adjust refrigerant levels							
Yes	80%	100%	67%	100%	85%	100%	100%
No	20%	0%	17%	0%	12%		
Don't know	0%	0%	17%	0%	4%		
N	10	7	6	3	26	4	6
IV4f. Clean chiller evaporator and condenser tubes							
Yes	90%	86%	100%	100%	92%	100%	83%
No	10%	14%	0%	0%	8%		17%
Don't know	0%	0%	0%	0%	0%		
N	10	7	6	3	26	4	6
IV4h. Pump and motor maintenance in chilled water and condenser water loops							
Yes	90%	86%	67%	100%	85%	100%	100%
No	10%	0%	17%	0%	8%		
Don't know	0%	14%	17%	0%	8%		
N	10	7	6	3	26	4	6
IV4i. Check and correct chiller sequencing							
Yes	90%	86%	67%	100%	85%	100%	83%
No	10%	14%	17%	0%	12%		17%
Don't know	0%	0%	17%	0%	4%		
N	10	7	6	3	26	4	6
IV4k. Check and correct chiller on/off scheduling							
Yes	90%	86%	83%	100%	88%	100%	83%
No	10%	14%	17%	0%	12%		17%
Don't know	0%	0%	0%	0%	0%		
N	10	7	6	3	26	4	6
IV4l. Inspect and calibrate chiller controls							
Yes	90%	86%	83%	67%	85%	100%	100%
No	10%	0%	17%	33%	12%		
Don't know	0%	14%	0%	0%	4%		
N	10	7	6	3	26	4	6

Telephone Survey Results

Building Size	Owner and Decision Maker Survey					Property Manager Survey	Service Provider Survey
	Business Type				Total		
	Office	College / University	Government	Retail			
IV5a. Check condenser water loop sensors, flow control settings, pressure and temperature setpoints and fan operation							
Monthly	40%	29%	17%	67%	35%		17%
Quarterly	40%	14%	17%	0%	23%	25%	17%
Bi-annually	10%	0%	17%	0%	8%	25%	17%
Annually	10%	14%	0%	33%	12%	25%	33%
Not at all	0%	0%	17%	0%	4%		
Daily/continuous basis	0%	29%	17%	0%	12%		
Weekly						25%	
Depends							17%
Don't know	0%	14%	17%	0%	8%		
N	10	7	6	3	26	4	6
IV5b. Check chilled water loop sensors, flow control settings, and pressure and temperature setpoints							
Monthly	40%	14%	17%	67%	31%		
Quarterly	30%	0%	17%	0%	15%	25%	33%
Bi-annually	20%	0%	17%	0%	12%	25%	33%
Annually	10%	29%	0%	33%	15%	50%	17%
Not at all	0%	0%	17%	0%	4%		
Daily/continuous basis	0%	57%	17%	0%	19%		
Depends							17%
Don't know	0%	0%	17%	0%	4%		
N	10	7	6	3	26	4	6
IV5D. Check chiller control settings							
Monthly	30%	14%	0%	33%	19%		
Quarterly	40%	14%	17%	0%	23%	25%	50%
Bi-annually	10%	0%	17%	0%	8%		17%
Annually	20%	14%	0%	33%	15%	50%	17%
Not at all	0%	0%	17%	0%	4%		
Daily/continuous basis	0%	43%	33%	33%	23%		
Weekly						25%	
Depends							17%
Don't know	0%	14%	17%	0%	8%		
N	10	7	6	3	26	4	6
IV5E. Check chilled water pump settings							
Monthly	30%	0%	0%	33%	15%		
Quarterly	50%	0%	17%	0%	23%	50%	33%
Bi-annually	0%	14%	17%	0%	8%		17%
Annually	20%	14%	0%	33%	15%	25%	33%
Not at all	0%	0%	17%	0%	4%		
Daily/continuous basis	0%	43%	33%	33%	23%	25%	
Weekly	0%	14%	0%	0%	4%		
Depends							17%
Don't know	0%	14%	17%	0%	8%		
N	10	7	6	3	26	4	6
IV6. Which of the following predictive maintenance methods have you used for your chilled water-based cooling systems?							
Vibration analysis	40%	71%	17%	33%	42%	75%	17%
Passive ultrasonic testing	10%	29%	0%	0%	12%	50%	17%
Lubricant/wear particle analysis	80%	57%	17%	33%	54%		67%
Thermography	10%	43%	0%	0%	15%	50%	17%
Electrical condition monitoring	50%	57%	17%	0%	38%	25%	50%
Eddy Current Test	0%	0%	0%	33%	4%		
Don't know	0%	0%	50%	33%	15%	25%	
N	10	7	6	3	26	4	6

Telephone Survey Results

Building Size	Owner and Decision Maker Survey					Property Manager Survey	Service Provider Survey
	Business Type				Total		
	Office	College / University	Government	Retail			
IV7a. Analyze and optimize the condenser water loop by calibrating sensors, adjusting flow controls, and modifying pressure and temperature setpoints							
Yes	100%	86%	83%	100%	92%	75%	100%
No	0%	14%	17%	0%	8%		
Don't know	0%	0%	0%	0%	0%	25%	
N	10	7	6	3	26	4	6
IV7b. Analyze and optimize the chilled water loop by calibrating sensors, adjusting flow controls and modifying pressure and temperature setpoints							
Yes	70%	71%	67%	100%	73%	75%	100%
No	30%	29%	17%	0%	23%		
Don't know	0%	0%	17%	0%	4%	25%	
N	10	7	6	3	26	4	6
IV7d. Analyze and optimize chiller stop/start, scheduling and staging (using existing controls)							
Yes	80%	71%	83%	100%	81%	75%	100%
No	20%	29%	17%	0%	19%		
Don't know	0%	0%	0%	0%	0%	25%	
N	10	7	6	3	26	4	6
IV7g. Add sensors to trend and analyze data for optimizing chiller performance							
Yes	30%	57%	50%	0%	38%	75%	67%
No	60%	43%	50%	100%	58%		33%
Don't know	10%	0%	0%	0%	4%	25%	
N	10	7	6	3	26	4	6
IV7h. Analyze chiller trends and performance, and institute performance based maintenance							
Yes	60%	71%	50%	100%	65%	50%	100%
No	40%	29%	33%	0%	31%	25%	
Don't know	0%	0%	17%	0%	4%	25%	
N	10	7	6	3	26	4	6
IV8. Which of the following preventive maintenance methods do you use for your packaged air conditioning equipment?							
Check and adjust refrigerant levels	92%	88%	67%	85%	86%	80%	100%
Clean and check evaporator and condenser	92%	88%	100%	96%	94%	100%	88%
Clean or replace air filters	92%	88%	100%	96%	94%	100%	75%
Check motor belts and lubrication	92%	88%	100%	93%	92%	100%	100%
Check, adjust or repair pneumatic or other control devices	83%	88%	83%	89%	86%	100%	100%
Other specify:							
Outsourced	8%	13%	0%	7%	8%		
Check dampers	0%	0%	17%	0%	2%		
Electronically balance economizer dampers	4%	0%	0%	0%	2%		
Keep log	0%	13%	0%	0%	2%		
Upgrades as needed	0%	0%	0%	4%	2%		
N	24	8	6	27	65	5	8

Telephone Survey Results

Building Size	Owner and Decision Maker Survey					Property Manager Survey	Service Provider Survey
	Business Type				Total		
	Office	College / University	Government	Retail			
IV9A. How often do you check or inspect economizer controls of your packaged AC systems?							
Monthly	4%	0%	17%	22%	12%	20%	
Quarterly	42%	13%	50%	41%	38%	40%	63%
Bi-annually	4%	38%	17%	11%	12%	20%	
Annually	8%	25%	0%	11%	11%	20%	25%
Not at all	0%	13%	0%	0%	2%		
Daily/continuous basis	8%	0%	0%	4%	5%		
When needed	4%	0%	0%	4%	3%		
Don't know	29%	13%	17%	7%	17%		13%
N	24	8	6	27	65	5	8
IV9B. How often do you compare equipment schedule for compatibility with current building/area schedule of your packaged AC systems?							
Monthly	4%	13%	0%	22%	12%	20%	13%
Quarterly	25%	50%	0%	15%	22%	40%	25%
Bi-annually	0%	13%	0%	11%	6%		13%
Annually	17%	0%	17%	11%	12%		
Not at all	17%	0%	17%	11%	12%		38%
Daily/continuous basis	13%	13%	17%	15%	14%	20%	
When needed	8%	13%	0%	4%	6%		
Weekly	4%	0%	0%	4%	3%		
Don't know	13%	0%	50%	7%	12%	20%	13%
N	24	8	6	27	65	5	8
IV9C. How often do you check that units are being turned off as scheduled of your packaged AC systems?							
Monthly	13%	13%	17%	41%	25%	40%	13%
Quarterly	17%	0%	17%	0%	8%	20%	38%
Bi-annually	4%	13%	0%	4%	5%		13%
Not at all	21%	25%	0%	19%	18%		13%
Daily/continuous basis	17%	50%	33%	22%	25%		13%
When needed	8%	0%	0%	0%	3%		
Weekly	13%	0%	17%	0%	6%	20%	
Other	4%	0%	17%	4%	5%		
Don't know	4%	0%	0%	11%	6%	20%	13%
N	24	8	6	27	65	5	8
IV9D. How often do you check or inspect thermostat settings of your packaged AC systems?							
Monthly	13%	13%	17%	41%	25%	60%	13%
Quarterly	17%	0%	17%	0%	8%		63%
Bi-annually	4%	13%	0%	4%	5%		
Annually							13%
Not at all	21%	25%	0%	19%	18%		
Daily/continuous basis	17%	50%	33%	22%	25%	20%	
When needed	8%	0%	0%	0%	3%		
Weekly	13%	0%	17%	0%	6%	20%	
Other	4%	0%	17%	4%	5%		
Don't know	4%	0%	0%	11%	6%		13%
N	24	8	6	27	65	5	8

Telephone Survey Results

Building Size	Owner and Decision Maker Survey					Property Manager Survey	Service Provider Survey
	Business Type				Total		
	Office	College / University	Government	Retail			
IV9E. How often do you check or inspect sensors and controls of your packaged AC systems?							
Monthly	0%	0%	33%	30%	15%	40%	13%
Quarterly	29%	25%	17%	22%	25%	20%	38%
Bi-annually	17%	50%	0%	7%	15%		13%
Annually	4%	13%	17%	7%	8%		25%
Not at all	13%	0%	17%	11%	11%		
Daily/continuous basis	13%	13%	0%	0%	6%	20%	
When needed	13%	0%	17%	19%	14%	20%	13%
Weekly	8%	0%	0%	0%	3%		
Don't know	4%	0%	0%	4%	3%		
N	24	8	6	27	65	5	8
IV10a. Use CheckMe or HVAC Service Assistant maintenance equipment and procedures							
Yes	0%	13%	33%	11%	9%		13%
No	63%	75%	50%	56%	60%	80%	63%
Don't know	38%	13%	17%	33%	31%	20%	25%
N	24	8	6	27	65	5	8
IV10d. Turn packaged units off in unoccupied zones							
Yes	63%	88%	67%	37%	55%	80%	88%
No	25%	13%	17%	56%	35%		13%
Don't know	13%	0%	17%	7%	9%	20%	
N	24	8	6	27	65	5	8
IV10e. Implement night setup thermostat settings							
Yes	92%	88%	83%	93%	91%	100%	100%
No	4%	13%	17%	7%	8%		
Don't know	4%	0%	0%	0%	2%		
N	24	8	6	27	65	5	8
IV10f. Review and adjust package unit start/stop times and scheduling							
Yes	88%	88%	83%	85%	86%	100%	88%
No	8%	13%	17%	15%	12%		13%
Don't know	4%	0%	0%	0%	2%		
N	24	8	6	27	65	5	8
IV10g. Periodic recalibration of package unit sensors and controls							
Yes	58%	75%	83%	59%	63%	80%	100%
No	29%	13%	17%	26%	25%		
Don't know	13%	13%	0%	15%	12%	20%	
N	24	8	6	27	65	5	8
V1. Which of the following preventive maintenance methods do you use for your building ventilation systems?							
Repair & maintain economizers, air handling units & outdoor air dampers	100%	92%	100%	100%	97%	100%	89%
Recalibrate or repair outdoor air & relative humidity sensors	80%	75%	67%	50%	72%	100%	89%
Repair duct leaks	80%	92%	67%	75%	81%	100%	78%
Clean or replace air filters	100%	92%	100%	100%	97%	100%	89%
Clean heating & cooling coils in air handling units & terminal units	80%	83%	100%	75%	84%	100%	89%
Motor, fan & belt checks, maintenance, repair & replacement (as needed)	100%	92%	83%	100%	94%	100%	100%
Repair, recalibrate or replace faulty thermostats & room temperature sensors	100%	92%	83%	100%	94%	100%	100%
Repair, rebalance or replace faulty terminal units	100%	92%	67%	100%	91%	100%	100%
Review and adjust air handling unit staging, scheduling and control	80%	92%	67%	100%	84%	100%	94%
Other	0%	0%	17%	0%	3%		
N	10	12	6	4	32	4	18

Telephone Survey Results

Building Size	Owner and Decision Maker Survey					Property Manager Survey	Service Provider Survey
	Business Type				Total		
	Office	College / University	Government	Retail			
V3. Which of the following operational improvements and repairs have you implemented for your building ventilation systems?							
Analyze function of air handling units & economizers, & optimize outdoor air settings and damper controls	70%	100%	67%	100%	84%	100%	94%
Recalibrate (or, if necessary, relocate) all air handling temperature, pressure and CO2 sensors	30%	100%	50%	50%	63%	75%	94%
Analyze & test the air pressure of the air handling & distribution system, & adjust air pressure and balance flows	80%	92%	67%	100%	84%	75%	78%
Implement hot and cold deck temperature resets in air handling units	70%	83%	50%	50%	69%	75%	94%
Recalibration or upgrading of all thermostats and room temperature sensors	40%	75%	50%	50%	56%	75%	
Analyze air handler trends and performance, and institute performance based maintenance	50%	58%	50%	75%	56%	50%	78%
Other specify:							
Inspect all fans quarterly	0%	8%	0%	0%	3%		
Vent cleaning	0%	0%	17%	0%	3%		
Most of our large ventilation motors are vsd	0%	8%	0%	0%	3%		
Don't know	0%	0%	17%	0%	3%		
N	10	12	6	4	32	4	18
VII1. Which of the following preventive maintenance methods do you use for your building energy management systems?							
Inspect, calibrate & repair faulty control points for EMS	88%	100%	100%	82%	88%	83%	100%
Review and adjust HVAC start/stop and scheduling	88%	100%	100%	76%	85%	83%	91%
Routine EMS setpoint maintenance	75%	75%	50%	82%	76%	100%	64%
Other	0%	0%	0%	18%	9%		
Don't know	0%	0%	25%	12%	9%		
N	8	4	4	17	33	6	11
VII2. Which of the following is the primary control system strategy employed for the lighting system?							
EMS or EMCS	18%	6%	25%	53%	28%	10%	67%
Daylighting controls	3%	0%	0%	6%	3%	10%	
Occupancy sensors	11%	41%	17%	13%	17%	40%	22%
Sweep controls	8%	0%	0%	3%	4%	10%	
None of these	11%	0%	25%	6%	9%		
Other specify:							
DDC	5%	0%	0%	0%	2%		
Timers	0%	0%	17%	0%	2%		
Manual controls	37%	53%	17%	19%	31%	20%	
Digital Controls						10%	
Other	3%	0%	0%	0%	1%		
Don't know	5%	0%	0%	0%	2%		11%
N	38	17	12	32	99	10	9

Telephone Survey Results

Building Size	Owner and Decision Maker Survey					Property Manager Survey	Service Provider Survey
	Business Type				Total		
	Office	College / University	Government	Retail			
VII3. Which of the following preventive maintenance methods do you use for your lighting systems?							
Inspect, repair, or replace lighting timeclocks, controls & sensors	55%	88%	83%	84%	74%	100%	67%
Lighting fixture standard maintenance, including re-lamping, cleaning and ballast replacement	87%	94%	92%	91%	90%	90%	56%
Review and adjust indoor lighting on/off scheduling	39%	59%	67%	72%	57%	80%	67%
Review and adjust outdoor lighting on/off scheduling or photo sensors	71%	94%	92%	81%	81%	100%	67%
None	0%	0%	8%	3%	2%		
Other specify:							
90 day walkthru	0%	0%	0%	3%	1%		
Annual electrician check of panels and breakers	0%	6%	0%	0%	1%		
Coordinated w/scheduled use	0%	6%	0%	0%	1%		
Energy misers on vending machines	0%	0%	8%	0%	1%		
N	38	17	12	32	99	10	9
VII4. Which of the following operational improvements and repairs have you implemented for your lighting systems?							
Test, clean, recalibrate or replace existing lighting timeclocks, controls and sensors	37%	82%	67%	69%	59%	90%	67%
Implement delamping	45%	71%	58%	47%	52%	50%	33%
Replace T8s with super T8s	34%	29%	33%	25%	30%	20%	33%
Stock Super T8s	26%	29%	25%	25%	26%	20%	11%
Replace incandescent bulbs with CFLs	71%	88%	67%	63%	71%	70%	33%
Stock CFLs	61%	88%	67%	53%	64%	70%	11%
Replace broken T12 fixtures with T8s or super T8s	58%	94%	58%	69%	68%	60%	44%
Replace incandescent equipment indicator lights with LEDs	0%	6%	17%	9%	6%		
Other specify:							
Installed T-5s	0%	0%	8%	3%	2%		
Installed T-8s	3%	0%	8%	3%	3%		
Off at night desk	0%	0%	8%	0%	1%		
Reduce wattage if possible	3%	0%	0%	0%	1%		
Replaced exterior light to hi press sodium	0%	6%	0%	0%	1%		
Use all low mercury content lamps	0%	6%	0%	0%	1%		
We are using ultra-white in all garage areas	3%	0%	0%	0%	1%		
N	38	17	12	32	99	10	9
<OTH_PM> Can you point us to other property managers in %11. that manage LARGE buildings?							
No						40%	
1201 Lloyd - 503 282-7888						10%	
Bentell, Equity Office						10%	
Equity Office, Unico, Wright Runstead, Hines						10%	
Equity Property, Bentall Capitol						10%	
Equity, Benthall						10%	
Trammell Crowe, Vulcan						10%	
N						10	

APPENDIX F
LITERATURE SOURCES

Appendix F
List of Literature Sources Reviewed

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