



Guide to Operating and Maintaining EnergySmart Schools



U.S. DEPARTMENT OF
ENERGY

Energy Efficiency &
Renewable Energy

Endorsed
by



NSBA

National School
Boards Association





ACKNOWLEDGMENTS

The U.S. Department of Energy would like to thank the Council of Educational Facility Planners International (CEFPI) for assisting in the development of this guide as a participating sponsor. DOE also acknowledges the invaluable contributions of the working group members and case study subjects listed on the inside back cover. This constructive and informative document would not have been possible without their active engagement.

Table of Contents

Executive Summary & Introduction	i
Chapter 1. Identifying Energy Savings and Getting Started.....	1
Chapter 2. Developing and Implementing an Energy Management Plan	6
Chapter 3. Technical Considerations.....	15
Building Systems	18
Lighting	19
Heating, Ventilating, and Air Conditioning (HVAC)	23
Water Heating.....	30
Building Envelope.....	31
Distribution Transformers	32
Plug Loads	33
Kitchen Equipment.....	35
Swimming Pools	35
Building Automation Systems	36
Other Special Equipment and Considerations	37
Action Plan Templates	39
Appendix A: Additional Questions for Staff During Initial Data-Gathering	40
Appendix B: ENERGY STAR® Portfolio Manager and K–12 School Data Input	43
Appendix C: Energy Report Card for Presenting Audits and/or Benchmarking Results.....	44
Appendix D: Detailed Energy Management Strategies to Support Making the Business Case and O&M Program Implementation.....	45
Appendix E: Energy Policy Examples	46
Appendix F: Elements to Consider During the Development of Energy Management Policies, Procedures, or Plans	46
Appendix G: High-Performance School O&M Barriers and Solutions.....	47
Appendix H: Detailed Critical Factors for Implementing Advanced O&M Management.....	48
Appendix I: U.S. Green Building Council Template for Building Operating Plan for Schools.....	51
Appendix J: Additional Resources.....	53
Acknowledgments.....	<i>Inside Back Cover</i>

Executive Summary & Introduction

Through a commitment to high performance, school districts are discovering that smart energy choices can create lasting benefits for students, communities, and the environment. For example, an energy-efficient school district with 4,000 students can save as much as \$160,000 a year in energy costs. Over 10 years, those savings can reach \$1.6 million, translating into the ability to hire more teachers, purchase more textbooks and computers, or invest in additional high-performance facilities. Beyond these bottom-line benefits, schools can better foster student health, decrease absenteeism, and serve as centers of community life.

High-Performance School:

A school facility that improves the student learning environment and achieves the maximum level of energy performance possible—saving energy, resources, and money.

The U.S. Department of Energy's EnergySmart Schools Program promotes a 30 percent improvement in existing school energy use. It also encourages the building of new schools that exceed code (ASHRAE 90.1-1999) by 50 percent or more. The program provides resources like this **Guide to Operating and Maintaining EnergySmart Schools** to assist school decision-makers in planning, financing, operating, and maintaining energy-efficient, high-performance schools. It also offers education and training for building industry professionals.

What Is Operations and Maintenance?

Operations and maintenance refer to all scheduled and unscheduled actions for preventing equipment failure or decline with the goal of increasing efficiency, reliability, and safety. A preventative maintenance program is the organized and planned performance of maintenance activities in order to prevent system or production problems or failures from occurring. In contrast, deferred maintenance or reactive maintenance (also called diagnostic or corrective maintenance) is conducted to address an existing problem.

This guide is a primary resource for developing and implementing a district- or school-wide operations and maintenance (O&M) program that focuses on energy efficiency. The **EnergySmart Schools Solutions** companion CD contains additional supporting information for design, renovation, and retrofit projects. The objective of this guide is to provide organizational and technical information for integrat-

ing energy and high-performance facility management into existing O&M practices.

EnergySmart Schools Solutions CD

For more information about this CD, visit www.energysmartschools.gov

The guide allows users to adapt and implement suggested O&M strategies to address specific energy efficiency goals. It recognizes and expands on existing tools and resources that are widely used throughout the high-performance school industry. External resources are referenced throughout the guide and are also listed within the EnergySmart Schools O&M Resource List (**Appendix J**).

While this guide emphasizes the impact of the energy efficiency component of O&M, it encourages taking a holistic approach to maintaining a high-performance school. This includes considering various environmental factors where energy plays an indirect or direct role. For example, indoor air quality, site selection, building orientation, and water efficiency should be considered. Resources to support these overlapping aspects will be cited throughout the guide.

The U.S. Department of Energy's Federal Energy Management Program (FEMP) *Operations and Maintenance Best Practices Guide* reports energy-efficient O&M programs can save 5 to 20 percent on energy bills without a significant capital investment.

Why Become an EnergySmart School?

Energy is a controllable cost that districts can decrease with the right kind of investment and management. Studies estimate nearly one-third of the energy consumed in the average U.S. school is wasted. The country's least energy-efficient schools use nearly four times as much energy per square foot as the most energy-efficient schools. Schools that

As schools age, they require repair and maintenance. In 2008, public schools in the United States were planning to spend approximately \$254.6 billion on at least one major repair, renovation, or replacement of a building feature within the next two years. States and local agencies are planning to invest more than \$50 billion in the next three years to build or renovate schools.

Building Minds, Minding Buildings: School Infrastructure Funding Need. A state-by-state assessment and an analysis of recent court cases, Faith E. Crampton and David C. Thompson, American Federation of Teachers, December 2008.

U.S. DOE EnergySmart Schools,
www.energysmartschools.gov

reduce their energy bills can redirect that money toward their primary mission: education.

The average U.S. school is more than 40 years old, but school districts often face budget constraints that prevent them from investing in new schools. An American Association of School Administrators (AASA) survey reported 59 percent of respondents were implementing energy conservation measures (see **Figure 1**) during a time when rising fuel and energy costs were taking a toll on school system budgets nationwide. Additionally, 37 percent of respondents were cutting back on heating and air conditioning use and 29 percent of respondents were delaying nonessential facility upgrades and repairs.

Additional Resources

In addition to cost, poorly maintained facilities can affect student and teacher performance, health, and morale. The National Center for Education Statistics reports that the cumulative value of deferred maintenance nationwide for all K–12 public schools is several hundred billion dollars.

For more information, visit *The Digest of Education Statistics 2007* available at the National Center for Education Statistics Web site (www.nces.ed.gov).

Figure 1: American Association of School Administrators (AASA) Fuel and Energy Snapshot Survey

Top 10 Cost-Cutting Strategies

Percentage of respondents selecting the response

1. Implementing energy conservation measures: 59%
2. Cutting back on student field trips: 44%
3. Cutting back on heating and air conditioning use: 37%
4. Consolidating bus routes: 35%
5. Limiting staff business travel: 34%
6. Eliminating/modifying support personnel positions: 33%
7. Cutting back on purchasing supplies: 31%
8. Delaying nonessential facility upgrades and repairs: 29%
9. Eliminating/modifying instructional personnel positions: 29%
10. Eliminating/modifying administrative personnel positions: 21%

An AASA survey asked school superintendents about the effect of rising fuel and energy costs on their school districts. Ninety-nine percent of respondents reported these rising costs are having an impact on their school systems. AASA Fuel and Energy Snapshot Survey, July 29, 2008

With new construction projects also being reduced, a focus on existing buildings is a critical factor for school energy costs. By implementing energy-efficient strategies, school districts can achieve substantial energy cost savings, extend the life of equipment, and improve facilities' overall physical environment.

The U.S. Department of Energy aims for a 50 percent improvement in energy use for new schools, but only a few hundred new buildings are built each year. This is a small fraction of district square footage and energy consumption. Most school districts will need to target the energy performance of existing facilities to achieve significant energy and cost savings. Even the most energy-efficient new schools must manage O&M properly to perform as they are designed and avoid wasting energy and accruing unnecessary costs.

How Do I Use This Guide?

The guide allows users to adapt and implement O&M strategies to address specific energy efficiency goals. School district management, business officials, and administrators should use this guide to become better acquainted with high-performance O&M strategies and to integrate these strategies into new and existing energy policy. Facility management

should use this tool to manage district energy costs by properly identifying and implementing O&M, repairs, and retrofits, and by calculating O&M measures' life-cycle costs and benefits. Tips on making the business case for a sustained high-performance O&M plan to school district management are also included.

The guide is organized into the following sections:

- **Chapter 1: Identifying Energy Savings and Getting Started** introduces enhanced O&M practices to increase energy efficiency. This chapter describes the essential steps to immediately improve O&M for novice facility managers and schools with limited resources.
- **Chapter 2: Developing and Implementing an Energy Management Plan** describes advanced steps necessary for integrating energy-focused O&M into renovations, curriculum, and business planning. This chapter is intended for advanced readers and schools with better access to financial and staffing capabilities.
- **Chapter 3: Technical Considerations** is a reference chapter that details O&M best practices compiled from numerous sources. This resource is appropriate for all levels of experience.
- **EnergySmart Schools O&M Action Plans** contain customizable take-away checklists for all users to begin planning and implementing energy-focused O&M.
- **Appendices A–K** are supplementary O&M information and additional resources.

EnergySmart Schools O&M Action Plans

The guide provides O&M Action Plans that are customizable lists intended as a starting point for scheduling preventative maintenance and training. The intended audience for the action plans is senior facilities managers and custodial staff. The action plans are organized into sections for benchmarking, lighting, HVAC, water heating, building envelope, transformers, plug loads, kitchens, swimming pools, building automation systems, and other special equipment.

Action Plan Template • BENCHMARKING

Action
Once
Install building automation system
Calculate energy use baselines for buildings (partner with utility)
Monthly
Collect energy and water data by fuel type
Convert site energy to source energy for standardized measurements
Input energy use into Energy Management System (EMS)
Compare monthly data by building and through time. Identify reasons for disparities
Adjust O&M to fix unexpected changes from baseline
Quarterly
Bi-Annually

In the context of this guide, an **Energy Policy** is the broadest statement of a school's or district's energy goals. This is most often written by senior administrators with input from all relevant stakeholders.

An **Energy Management Plan** is a more concrete and strategic tool. This document establishes methodology and accountability for achieving energy efficiency savings.

The **O&M Program** specifically targets energy savings from enhanced O&M practices. It is a component of the larger Energy Management Plan.

Lastly, the **Action Plans** supplement the O&M component and consist of concrete steps, scheduling, and responsibilities.

Target Audience

Effective, energy-efficient O&M requires communication, cooperation, and consensus-building among stakeholders. It is also necessary to have the support of senior district administrators, technically trained facility management, and custodial and maintenance staff who are aware of the impact of O&M on overall building performance. These employees are essential to the long-term success of energy strategies.

The guide's primary audience is a school district's senior facilities staff and supporting O&M staff. Certain sections of the guide, such as the Executive Summary, target school administrators and business officials because they are responsible for implementing programs and policy districtwide.

Evaluating Districts' O&M Experience

Schools at various stages of facility management and operation will benefit from the guide, as its strategies can be adapted to aid those starting new energy efficiency O&M programs or those improving existing programs. Throughout the guide, each section will target a specific experience level, interest (business, management, implementation, etc.), and resource availability. Although most readers have levels of experience that overlap these simple divisions (i.e., beginner, intermediate, and advanced), the following descriptions should help schools identify whether their district is a high-performance school district.

Table 1: Target Audience
Guide to Operating & Maintaining EnergySmart Schools

School Personnel	✓ Principals ✓ O&M Management & Staff ✓ Administrators
School Type	✓ Public ✓ Private ✓ Charter ✓ Parochial
Institutions	✓ Elementary ✓ Secondary
School Location	✓ Nationwide
School Setting	✓ Urban ✓ Suburban ✓ Rural
Status of Existing Energy Management Program	✓ Advanced ✓ Intermediate ✓ Just Started ✓ None

Signs of a High-Performance School District

- The district has an energy policy or a procedure manual of energy-efficient O&M practices.
- The district tracks monthly energy consumption or collects historic information about building energy performance.
- The district has recently performed energy surveys, re-commissioning, or benchmarking on its schools.
- The district has trained its facility staff on ways to reduce energy costs.
- The district recognizes or rewards staff or individual schools for reductions in energy and operating costs.
- Schools share best practices and performance data not only with one another but also with the community.
- The district has developed and implemented an energy management plan.
- The district provides energy awareness training to all school personnel and has incorporated energy topics into the classroom.

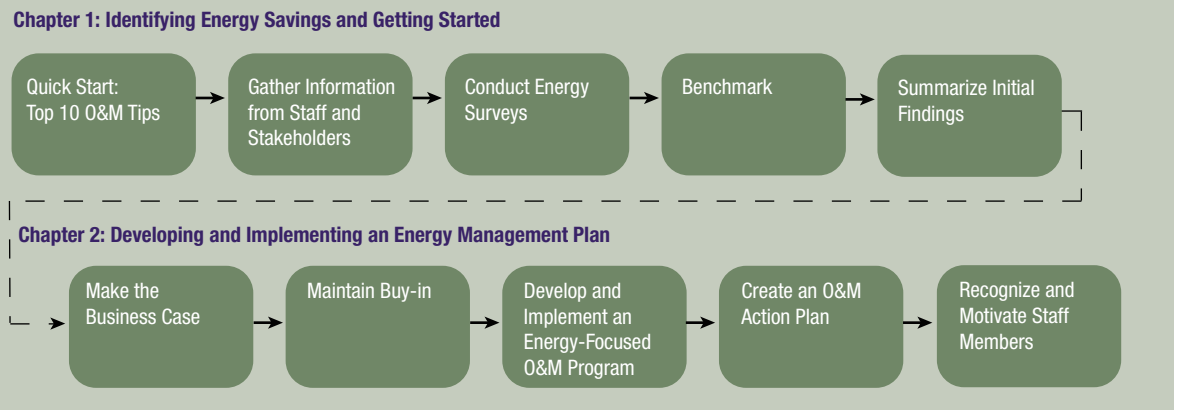
The **Executive Summary & Introduction** is intended for senior-level administrators. This section provides an enhanced understanding of how O&M fits into broad school missions and with other core school functions. **Chapters 1 and 2** are outlined in **Figure 2**.

Chapter 1 is designed to serve as a starting point for improving O&M practices. The section provides checklists, applies the O&M Action Plans, and identifies resources for guidance and partnership. It also offers tips for communicating successes to the community and to senior administrators.

Chapter 2 is intended for facilities managers with varying experience. It is appropriate for districts with more resources available to devote to O&M and energy planning and long-term policy and energy management. The advanced topics discussed in this chapter include how to coordinate advanced implementation, such as an integrated energy management plan, and furthering communication.

Chapter 3, the EnergySmart Schools O&M Action Plans and Appendices are appropriate for all levels of experience. These sections serve as takeaways and references for future or immediate use in implementation, scheduling, education, and training. Case studies featured throughout the guide emphasize key aspects of energy-focused O&M and highlight lessons learned applicable to the target audience.

Figure 2: Operations and Maintenance Investigation and Implementation Process



“Frequently, districts that are scrambling to find cuts rob facilities budgets to avoid cuts on the curriculum side, for example. If there is no way to document and maintain efficiency savings over time, there is no way to distinguish between a cut and an efficiency gain. Facilities will have little incentive to strive for efficiency if they cannot get recognition for their efficiency gains and/or if they believe their reductions are true cuts; not a ‘harvest’ of efficiency.”

—David Furr, Salem-Keizer School District, Oregon

“Preventive maintenance really contributes to our ability to control energy consumption. We required it in our performance contract and it has really been worth it.”

—Barry Pickelsimer, Harford County Schools, Maryland

Chapter 1. Identifying Energy Savings and Getting Started

This chapter is for facilities managers with limited experience and resources and for districts just beginning to think about O&M as a tool for managing energy use. It is intended as a starting point and opens with an overview of the top 10 O&M tips. The guide then steers the reader toward the beginning steps for integrating O&M into energy management: surveys, benchmarking, and communications.

Experience Meter



Target Audience or End User

- Facilities managers and staff
- Administrators
- Business officials

Takeaways

After reading this chapter, users will be able to:

- Identify O&M practices that can be implemented immediately, at negligible cost, to increase energy efficiency and create energy savings
- Gather information from key staff and stakeholders to begin assessing opportunities to further increase energy savings from improved O&M practices
- Collect information on the current state of facilities and O&M through surveys and audits
- Produce both a snapshot of current energy management and O&M practices and quick recommendations for further study or action

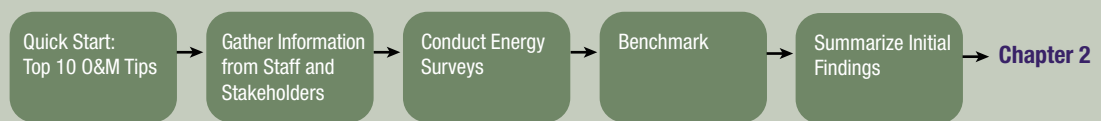
- Identify internal and external resources for improved surveying and auditing
- Conduct an energy-use benchmark comparing facilities across a district using an internally developed or externally sourced tool
- Communicate the results of surveys, auditing, and benchmarking to senior administrators and other relevant stakeholders to begin to plan for more advanced O&M programming for energy management.

O&M Toolbox

- *National Clearinghouse for Educational Facilities*, www.ncef.org
- ENERGY STAR® Portfolio Manager, www.energystar.gov/benchmark
- U.S. Green Building Council and its *Energy Efficiency Strategies for Schools Webinar Series*, www.usgbc.org/DisplayPage.aspx?CMSPageID=1898
- Alliance to Save Energy's Green Schools Program, <http://ase.org/section/program/greenschl/gsresources>

O&M Investigation Process

Chapter 1: Identifying Energy Savings and Getting Started



Getting Started: Top 10 O&M Tips

The following O&M tasks have either low or no cost and can produce low to moderate energy efficiency gains. They were adopted from the U.S. Green Building Council Webinar Series, Energy Efficiency Strategies for Schools, *Top Ten No-Cost Ways to Lower Your School's Utility Bills* and *Top Ten Low-Cost Ways to Lower Your School's Utility Bills*. For a more technical discussion about these strategies, please refer to **Chapter 3**.

The practice of preventative maintenance is an O&M best practice and will help maximize a building's energy efficiency. It is implicit in many of the O&M measures described in the guide. Please refer to **Chapter 3** for a detailed description of preventative maintenance.

Table 2: Top 10 O&M Tips¹

O&M Measure	Brief Description	Estimated Magnitude of Significance ²
Install programmable thermostats (HVAC)	Temperature controls can be programmed to shut down heating and cooling during periods when spaces are unoccupied	
Perform energy surveys and audits (Information)	Walk-throughs and more intensive audits can quickly identify O&M problems and solutions	
Keep doors and windows closed (Building Envelope)	Open windows waste heating and cooling energy	
Review cleaning and maintenance activities (Preventative Maintenance)	Consistent and scheduled cleaning and maintenance are key to extending equipment life and avoiding costly breakdowns	
Provide training for key staff (Preventative Maintenance)	Knowledgeable personnel are imperative to sustained energy efficiency from O&M	
Conduct a plug load survey and develop a plan (Plug Loads)	Computers and vending machines can waste energy if their settings are not properly set to shut down after inactivity	
Control exhaust fans (HVAC)	Shut down exhaust fans when building ventilation is off to avoid unwanted outside air	
Inspect outside air systems (HVAC)	Clean roof units and economizers for proper operation	
Install outdoor lighting controls (Lighting)	Timers and photosensors decrease wasted lighting for outdoor use	
Replace exit sign lights with LEDs (Lighting)	LEDs require much less maintenance and have longer lives than conventional lights so they are great fits for exit signs	

Best
 Above Average
 Average
 Moderate
 Small

¹ O&M measures, description, and value were adopted from the USGBC Webinar Series, Energy Efficiency Strategies for Schools, Top Ten No-Cost Ways to Lower Your School's Utility Bills and Top Ten Low-Cost Ways to Lower Your School's Utility Bills. <http://www.usgbc.org/DisplayPage.aspx?CMSPageID=1898>

² "Estimated Magnitude of Significance" is the O&M measure's potential effect on decreasing a school's overall energy bill. The guide avoids quantifying this effect as it will depend on factors such as climate, school age, and electricity and gas rates.

Gather Information from Staff and Stakeholders

Staff members striving to become effective advocates for district changes should collect accurate and relevant information about the district's facilities and energy use. First, they should gather basic information from facility department staff, students, and teachers.

Note: During this initial data-gathering phase, it is important to gauge the current level of stakeholder support to begin to make the business case for the O&M path forward. Advanced information for making a business case for O&M is detailed in **Chapter 2**.

To develop an energy-efficient O&M program that is workable in the existing facilities management system, it is essential to talk to facility department staff and ask the following questions:

- What tools and information do staff members currently use to effectively manage energy costs?
- What is the current status of O&M energy savings practices in the district, and how are practices communicated to O&M professionals?
- Would changes in facility O&M practices likely produce significant operating savings?
- Would senior administrators actively support an energy-focused O&M effort?
- What local resources may be available to assist in an enhanced O&M effort?
- What is the perspective of facilities and building staff on implementing an enhanced O&M effort? What suggestions do they have?
- Are there existing metrics, or comparisons, of energy costs and O&M practices with other districts or within buildings in the district?

It is also important to ask students, teachers, and staff (including O&M staff) about the O&M improvements they would like to see in their school. Sample questions include:

- What types of energy waste do you see in the school?
 - Are the classrooms too hot or cold?

- Are lights left on when no one is in the classroom or building?

- If you report an O&M energy-related issue, is it addressed in a timely manner?
- Is training on how to use energy-efficiency controls, like programmable thermostats and lighting controls, adequate in frequency (annual or biennial)?

For additional questions for staff and building occupants, see **Appendix A**.

Conduct Energy Surveys or Auditing to Identify O&M Opportunities

Energy surveys are the next, or even parallel, steps to gathering information from stakeholders. A survey is a way of determining the status of the facility at a given time—that is, it provides a snapshot of how the various systems and components are operating. Thus, a survey provides the starting point against which all facilities maintenance efforts and planning occur. Surveys are assessments of buildings, grounds, and equipment and recommendations of service options to increase efficiency, reduce waste, and save money. Surveys offer a simple and quick method for identifying information about energy components, energy use, policies, and procedures for new or existing facilities.

There are three main types of energy surveys, depending on the depth of desired information and available resources. They include student-conducted walk-throughs (facilitated by teachers), in-house facilities personnel-conducted walk-throughs, and third-party-conducted energy audits.

Additional Resources

For examples of and resources for conducting energy audits, visit:

- Alliance to Save Energy's Green Schools Resources, <http://ase.org/section/program/greenschl/gresources>
- Savings Through Energy Management (STEM) Program, www.wilsoned.com/STEM.html

The objective of a walk-through survey is not to take measurements or to conduct technical equipment testing. The objective is to produce a snapshot of how the building is being operated and maintained with respect to energy. Although a variety of useful building survey protocols are available from school districts, utilities, consultants, and government agencies, the primary information of importance is listed below. This list is categorized by actions that may be taken by facilities personnel or teachers and students and is based on safety considerations and capability:

Table 3: A List of Recommended Information to be Surveyed	
By Facilities Personnel or Teachers and Students	
Building use and occupancy schedules	
Classroom lighting levels and fixture control	
Control of computers, vending machines, and other plug loads	
Condition of building envelope, windows, and weather-stripping	
By Facilities Personnel	
Status of control strategies for major building systems, such as temperature control and setbacks	
Shutdown procedures during unoccupied periods	
Boiler and cooling system efficiency and maintenance practices	
Condition of steam, water, or air distribution systems	
Identification of prominent problems, such as indoor air quality	
O&M staff resources	

Of the three energy survey options discussed, third-party energy audits are likely the most costly, but they provide the most comprehensive analysis of the existing facilities equipment status and energy management efforts. Contracting a third party to conduct the energy audit will also require financial support from school officials. Consider contacting the district's local utilities; they may offer trainings and technical support for energy management. This level of analysis may need to be postponed until after business officials have bought into the energy management O&M plan. For more advanced information on auditing, refer to "Create an O&M Action Plan" in **Chapter 2**.

Benchmark the District's Energy Use

Benchmarking is the next step to enhancing O&M for energy management. This concept goes beyond surveys and audits by making data available for schools to compare their energy use with similar schools around the nation. To use a relevant analogy, benchmarking "grades" schools' and districts' energy efficiency over time and compares their performance with their peers. Schools and districts may monitor and make improvements based on these grades.

To paint a complete picture of the district's energy use and energy management O&M program, use current and historical building performance information gathered from utilities and bills. Many utilities will provide online access to the account information. Strong relationships between local utilities and districts are important because utilities can be helpful throughout the entire energy management process, from benchmarking to program implementation. Once data are captured and synthesized, they should be shared with maintenance staff, students, and teachers to keep them engaged and educated. For more on how to gain stakeholder buy-in, see **Chapter 2**.

A school district's total savings depends on a number of factors, including weather, building construction style, building age, building occupancy, existing system models, hours of use, and additions or replacement of equipment. Savings must be calculated against a school's baseline, or historical, energy use. How much a district can save also depends on the baseline condition and operating practices of the building. A district can't determine how much energy it can save until it knows how much energy it is using.

The ENERGY STAR Portfolio Manager, an online benchmarking tool, is an example of a way to assess a school's energy performance. The program requires users to input building information including total square footage, typical building age, how the space is used, and energy billing information. After all the data have been collected, a staff member needs just

an hour with the tool to benchmark building energy use. The ENERGY STAR Portfolio Manager program gives each building an energy consumption score, from 1 to 100, which indicates how well its energy performance compares with similar schools.

Additional Resources

For more information on ENERGY STAR Portfolio Manager, see **Appendix B**, consult the Benchmarking O&M Action Plan, and visit: www.energystar.gov/benchmark

Whether using an existing tool, such as ENERGY STAR Portfolio Manager, or developing an in-house benchmarking tool, energy data should be converted into one standard unit for comparison. To measure energy cost or consumption per square foot on a monthly basis helps to compare months between years. The information may also be presented as energy consumption per student, or any format that is logical for a district.

Additional tools help data monitoring during O&M program implementation. Several commercial organizations specifically target school O&M management. Also, officials should consider developing an in-house tool to meet a district's unique needs. Again, a district should leverage existing relationships and resources provided by local utilities.

For more advanced information on auditing, refer to **Chapter 2**. For supplemental information on benchmarking, refer to **Appendices B and C**.

Summarize the Survey and Benchmarking Results

The last step in the investigative process—and the first step to developing a business case for an energy-management-focused O&M program—is to summarize findings in a manner that is complete and accessible to other district staff. Whether the research has taken a few days, a few weeks, or a few months, the process of reviewing and summarizing the findings concisely will positively impact the district's overall building practices and prospects for better management of operational costs.

Poudre School District, Fort Collins, Colorado

Enrollment: 24,700

**Number of Schools: 50 schools,
40 portable classrooms**

Total Building Sq. Ft.: 4 million

Poudre School District (PSD) is a good example of how to combine internal O&M knowledge with external expertise to create an energy plan. The district has established an Energy Efficiency team in charge of evaluating and publicizing the effects of renovations, commissioning efforts, and benchmarking. This team is made up of stakeholder representatives, including the local utility. The team publishes an “Energy Conservation Program Annual Report” detailing and aggregating the results of energy projects throughout the district. This document is a fundamental pillar in PSD's energy management plan because it justifies funding and produces accountability.

To track energy consumption for all of its schools, the district uses ENERGY STAR Portfolio Manager and shares the information with O&M staff at the site-level to coordinate management and identify problems. Schools participate in a utility partnership called “Energy Rules” that redistributes 10 percent of energy savings back to schools as an incentive to conserve energy. PSD provides funding for staff training and incorporates energy into its curriculum through the National Energy Education Development (NEED) program.

Chapter 2. Developing and Implementing an Energy Management Plan

This chapter is for facilities managers with intermediate- to expert-level knowledge of school O&M practices and for districts looking to expand basic O&M into a more integrated energy management strategy. First, this chapter details how to organize information to gain buy-in from administrators. High-level support from all stakeholders is essential for a sustained energy management effort. Then, the guide details advanced strategies for developing and implementing O&M practices into a larger O&M management plan.

Experience Meter



Target Audience or End User

- Facilities managers and staff

Takeaways

After reading this chapter, users will be able to:

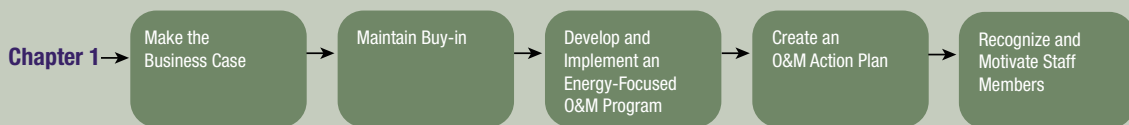
- Obtain buy-in from all stakeholders by effectively presenting the business case for improving O&M practices
- Conduct energy efficiency comparisons between their district and national and regional averages
- Develop an O&M management plan by synthesizing school and district energy needs with O&M management strategies
- Sustain an O&M management plan by communicating successes and integrating O&M into core school functions
- Identify internal and external resources for O&M planning and coordination

- Create customized O&M action plans
- Identify O&M successes and reward O&M staff to increase energy savings and staff motivation

O&M Toolbox

- National Center for Education Statistics, www.nces.ed.gov
- *ENERGY STAR for K–12 School Districts*, www.energystar.gov/schools
- U.S. DOE Energy Efficiency and Renewable Energy's *Get Smart About Energy: K–12 Energy Lessons and Activities*, www1.eere.energy.gov/education/
- U.S. DOE EERE's *Kids Saving Energy*, www.eere.energy.gov/kids/
- New York State Energy Research and Development Authority's High Performance Schools Design, Maintenance and Operations Online Course, www.nyserda.org/hps
- U.S. Green Building Council's *Build Green Schools*, www.buildgreenschools.org

O&M Implementation Process



See customizable ESS O&M Action Plans & Chapter 3

Make the Business Case

After completing energy surveys or audits and benchmarking, it is important to organize the information in a format that helps make the business case to decision-makers, such as school administrators, business officials, and superintendents. The business case should provide a clear narrative of:

1. **The Baseline:** the school or district's current energy efficiency, expressed in the most effective and appropriate metric such as energy use per square foot, per student, or per classroom. This information includes data collected from surveys and benchmarking activities and should be compared to that of other districts, a regional average, or a national average.
2. **The Benefits:** energy- and cost-saving possibilities of energy-efficient O&M measures, as outlined in this guide and in the resources it provides.
3. **The Plan:** steps that need to be taken to improve the energy efficiency of the school or district—as well as the level of investment that the decision-maker will need to commit.

When making the business case, keep in mind the audience and its area of interest. Rather than focusing on the technical conditions of the equipment, the audience may be more interested in current and historic energy consumption information, current and historic energy spending, or benefits to student learning. The primary points to summarize in the business case are listed in **Table 4**.

Table 4: Primary points to summarize for making the business case
District Energy Costs (as compared across schools and with other districts, if data are available)
General Strategies to Manage Operational Costs with Improved O&M
Success Stories in This and Other Districts
Prevalent O&M Practices in the District
Availability of Adequate Information and Management Tools
Prospects for Energy Cost Reductions
Possible Sources of External Assistance
Recommendations from O&M Staff

If students, teachers, and the greater community were involved in the information gathering or are interested in a more healthy and energy-efficient school, use their support to help make the business case stronger. Encourage students, teachers, and the community to let school officials know that they support the energy efficiency projects, or bring them to the business case meetings to give personal anecdotes. Simple details, such as photos of and reports from student-and-teacher energy efficiency projects, will give the business case additional leverage. Getting the school community involved gives community members a sense of empowerment and involvement with their school decision making and makes the case that much more compelling.

The Baseline

Meaningful statistics and comparisons can flesh out the baseline. Here are some interesting statistics to highlight energy costs nationally:

- K–12 schools spend more than \$12 billion annually on energy.³ Energy is schools' second-highest expense, trailing personnel costs.



EnergyPlus is a powerful way to generate quantitative before-and-after scenarios that can be used to make the business case for increased O&M and preventative maintenance. The program is an advanced computer modeling tool. Based on predecessor DOE programs (BLAST and DOE-2), EnergyPlus produces models of a building's heating, cooling, lighting, ventilating, and other energy and water flows.

The stand-alone simulation program requires the entry of the building's energy use data. The simulation capabilities include time steps of less than an hour, heat balance-based zone simulation, multizone air flow, thermal comfort, water use, natural ventilation, and photovoltaic systems.

EnergyPlus is available for free at <http://apps1.eere.energy.gov/buildings/energyplus/>. This site also provides guidance on using the software, training resources, and links to graphical interface options.

³ Agron, J., *36th and 37th Annual Maintenance and Operation Cost Study*. American School & University. April 2008. <http://asumag.com/Maintenance/2008M&OCostStudy.pdf>

- Per pupil, energy expenditure rose 19 percent from 2007 to 2008, as reported by the National Center for Education Statistics⁴, whereas the rate of inflation in the United States only rose 4 percent. Had energy expenditure risen at the rate of inflation, an additional \$2 billion would be available for school programming.⁵
- In 2008, typically, school districts pay approximately \$1.25 per square foot annually for energy costs.⁶ This means a mid-sized school district (approximately 800,000 sq. ft. or more in total) may pay more than \$1 million a year for electricity and heating fuel.

A simple and effective way to convey the results of energy benchmarking is to use an “energy report card” format. Please refer to **Appendix C** for a sample energy report card.

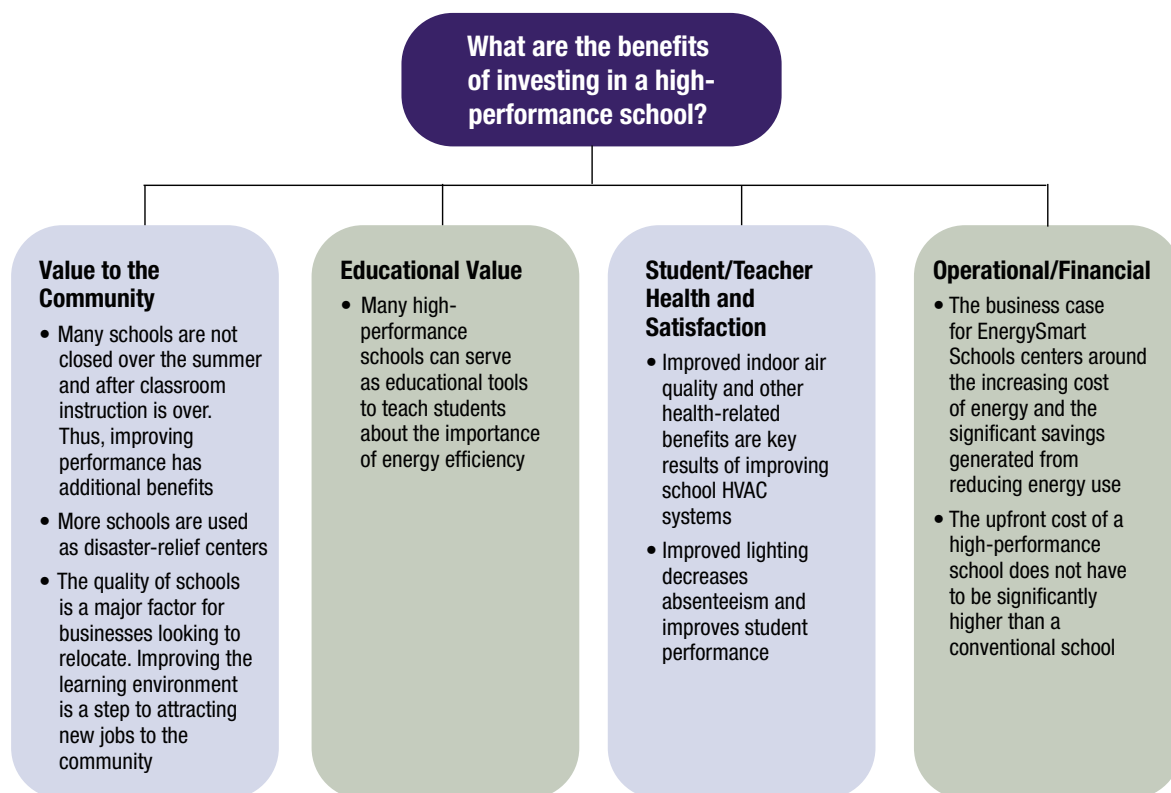
The Benefits

Although the benefits can be numerous, the key message to deliver is that energy is a controllable cost despite often being considered a fixed cost. Energy

costs are a major component of a school’s manageable budget and they pose an ongoing challenge for school districts. However, they can be managed to the benefit of the district through low-cost or no-cost solutions that do not require large capital investment in retrofits or renovations. As a result, energy cost management has the potential to be a major source of cost savings.

A facility’s physical environment plays an important role in achieving the overall educational objectives of the school. A growing body of research shows indoor air quality, ventilation, thermal comfort, lighting, acoustics, building age, quality, and aesthetics are linked to educational achievement and student performance. Physical conditions can also positively or negatively affect teacher morale and classroom effectiveness. In addition, poor school conditions can adversely affect the health of teachers and students, resulting in lower staff retention rates and increased absenteeism.

Figure 3: The Benefits of High Performance Schools



⁴ Ibid.

⁵ CPI Inflation Calculator. Bureau of Labor Statistics. U.S. Department of Labor. May 2009. http://www.bls.gov/data/inflation_calculator.htm

⁶ Agron, J., 37th Annual Maintenance and Operation Cost Study. American School & University. April 2008. <http://asumag.com/Maintenance/2008M&OCostStudy.pdf>

“Every dollar spent on maintenance and repair will save districts six to ten times that amount in the long run.”

–Claire Barnett, Director of the Healthy Schools Network (2004)

The Guide to Financing EnergySmart Schools provides several examples of simple technological and behavioral changes that can reduce energy use by as much as 33 percent.

- Leaving a computer on costs \$0.01 to \$0.03 per hour
- Leaving a copier on all day costs up to \$150 per year
- Operating each soft drink machine costs up to \$350 per year
- Operating a urinal costs \$450 per year in water, sewer, and maintenance

“Good school buildings contribute to good education just as bad school buildings interfere with it. Studies demonstrate the relationship between school infrastructure and student achievement, but this relationship is not straightforward, and a myriad of other variables go into making good schools. In other words, school infrastructure contributes to, but does not decide, the quality of a school. As such, infrastructure is not distinct from other issues of school reform or educational excellence; rather, school infrastructure decisions are a central component of whole-school reform.”

Source: Planning Guide for Maintaining School Facilities, National Forum on Education Statistics and Association of School Business Officials International, p. 14, February 2003.

<http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2003347>

Additional Resources

A National Center for Education Statistics (NCES) survey of teachers found that significant numbers—20 percent in Chicago and 40 percent in Washington, D.C.—felt their school facilities were unsuitable for effective teaching and learning. The most serious complaint, by two-thirds of the Washington teachers and half the Chicago teachers, was poor indoor air quality. In addition, one-third of the teachers complained of uncomfortable temperatures. Other complaints related to O&M included inadequate lighting and dirty or inoperable windows.

For more information about this survey, visit: www.edfacilities.org/pubs/teachersurvey.pdf

The Plan

In the United States, there are approximately 13,900 public K–12 school districts.⁷ They are highly diverse in terms of school size, facility age and condition, financial situation, growth rate, and other characteristics. After presenting the energy survey results and the various benefits of an energy O&M project, it is equally important to present a plan for an energy O&M project or program that is tailored to a particular school district’s culture and available resources.

Four general approaches to energy-focused O&M are summarized below. The categories are defined based on input from reviewers and on the range of programs in the field. For more information, a summary table in **Appendix D** describes the pros and cons of each option. For example, an Energy Tracking and Accounting program is the most advanced strategy and requires the most effort and resources, while a Quick Fix and Low Cost program requires the least.

1. **Quick Fix and Low Cost** projects are generally easily identified by existing building staff, equipment vendors, outside consultants, or through the existing O&M program manual. These projects are supplementary to existing preventative maintenance work, with little or no systematic building energy consumption tracking or educational focus.
2. **Energy Awareness** projects are mainly focused on the communications and educational aspect

⁷ U.S. Department of Education. National Center for Education Statistics, National Forum on Education Statistics, Planning Guide for Maintaining School Facilities, NCES2003-347, prepared by T. Szuba, R. Young and the School Facilities Maintenance Task Force. Washington, D.C.

Fairfax County Public Schools (FCPS) in Fairfax, Virginia, implemented an energy performance program that reduced FCPS's energy and operating costs by replacing inefficient and antiquated building system equipment. FCPS facilities (107 of the district's 196 schools) will benefit from the energy performance program in a series of bundles. For more information, visit: www.fcps.edu/fts/facmanagement/energy/esco.htm

of energy management to garner voluntary support from teachers, students, and staff. Some energy awareness programs may include staff training, district energy policies, posters, student curricula, or awards and recognitions.

3. **Performance Contracting** involves a fixed-term contractual agreement with a performance contractor known as an Energy Service Contractor (ESCO). The ESCO provides specific energy services, including suggestions for improving the energy efficiency of the building systems. The agreement includes a guarantee of annual savings with the payment based on the resulting savings. ESCOs typically provide project development and implementation, which includes staff training materials, energy measurement and verification, and energy tracking. The school staff is responsible for proper operations and maintenance of the newly installed systems.

4. **Energy Tracking and Accounting (ETA)** is usually the most comprehensive and frequently discussed method. ETA involves collecting, recording, and tracking monthly energy costs in all school district facilities. Once collected and analyzed, this information allows staff to effectively compare energy performance across all schools and identify problems at individual facilities for the O&M staff to address. Usually, this option involves a computer-based software application to collect and manage monthly energy data from all district buildings. There are many commercially available software tools, customized specifically for school energy management O&M. Some companies may also offer energy tracking services for a fee. Weigh the costs and benefits of implementing the ETA method in-house against contracting the task.

Although the guide lists four separate options, they only serve as guidelines. The energy O&M plan ultimately recommended by a facility manager should be customized with any component of the

Additional Resources

To strengthen and supplement business case planning, refer to the U.S. DOE *Guide to Financing an EnergySmart School*. This guide provides resources and case studies for funding new school construction and renovations. For example, it describes the financing used by the Portland Public School District in Portland, Maine, to renovate its East End Community School. This district used a combination of a State Aid Grant and a Standard Bond Issuance to finance its project.

- For more information, visit: www1.eere.energy.gov/buildings/energysmartschools/financing_guide.html
- And for the detailed case study, see the *Financing an EnergySmart School Fact Sheet*, also available in the EnergySmart Schools Solutions package: www1.eere.energy.gov/buildings/energysmartschools/publications.html

four options listed above. These options are detailed further in **Appendix D**.

Maintain Decision-Makers' Buy-in and Involvement

With the data collected through the energy surveys and audits, a list of benefits for conducting energy management O&M projects, and a basic outline for a plan, the essential steps are complete for making a convincing business case for an energy O&M program. However, gaining initial buy-in from decision-makers is only the first step. Making the business case is a continuous process. After the energy O&M plan is launched, keep a record of the results and update the administrators to maintain their engagement with the program. This will help the proposal process in the future and will give decision-makers confidence when they look at renewing the program.

One strategy for maintaining buy-in, involvement, and interest from critical audiences is to create an overarching energy policy. An energy policy should be a living tool that has high visibility within the district. This document, similar to a mission statement, establishes major goals and milestones. It is intended as a guide from upper-level decision-makers to management for developing more specific strategies in energy management, including O&M and others.

Increased awareness of the benefits of high-performance schools and the current conditions of school buildings have spurred various funding programs for improving school building conditions. As this information is constantly evolving, refer to the EnergySmart Schools Web site for the most up-to-date information (www.energysmartschools.gov).

The process of developing this policy should be collaborative and include input from all interested parties. This will help stakeholders feel that their views are respected and valued and provide diverse perspectives to school management. Creating an inclusive atmosphere of respect often fosters staff and community support of the decisions and, perhaps more importantly, the day-to-day steps that must be taken to achieve set goals.⁸

Stakeholders include anyone who has a sense of ownership in facilities decision-making, even though they might not have any formal say in decisions about school facilities and property. As the list of stakeholders grows larger, it often makes sense to include representatives of stakeholder groups—for example, a few parent association representatives, rather than all parents. This selection process should be conducted fairly.⁹

For additional examples of elements to include in energy policy development and examples of energy policies, see **Appendices E and F**.

Additional Resources

For more information on energy management, visit:

- U.S. Department of Energy, EnergySmart Schools, www.energysmartschools.gov
- ENERGY STAR for K–12 School Districts, www.energystar.gov/schools
- The Alliance to Save Energy, www.ase.org

Develop an Energy-Focused O&M Program

Once a district has assessed its energy use through interviews, energy surveys or audits, and benchmarking, and it has gained buy-in from stakeholders, the district is ready to implement advanced O&M strategies for energy management.

A school district will first need to develop or revise its O&M program to ensure that it is able to meet its energy management goals, as well as provide resources for successful implementation. A typical “critical path” for the first year of advanced program development is detailed in **Appendices G and H** and briefly described in this chapter, using the following critical factors:

1. **Program Visibility and Progress Reporting.** The primary objective is to ensure the program and its results are visible to the superintendent, the school board, staff, teachers, students, and the community.
2. **Communicating Energy Savings Expectations and Timeframe.** It is important to emphasize that energy savings from O&M may not be immediately visible on energy bills but accumulate over time.
3. **Distribution of Information.** Building staff and administrators can only effectively manage their buildings once they are familiar with their building’s energy information. Learning what works and what does not is important to identify and adapt the program accordingly.
4. **Education and Training.** In addition to addressing building systems, it is important to teach students, teachers, and staff that their personal actions can reduce energy use.
5. **Detailed Procedures Manual.** The facilities manager will need to develop a detailed technical reference that provides specific guidance to building staff. The objective of a procedures manual is to define standardized building management practices for O&M staff at all school facilities.
6. **External Support (Neighboring School Districts).** Obtaining assistance from other school districts with O&M program experience will help managers accurately estimate costs and define staffing responsibilities. Neighboring school districts may be willing to provide materials, such as training curricula, district energy standards, and maintenance checklists.

⁸ Association of School Business Officials International (ASBO). *Planning Guide for Maintaining School Facilities*. <http://nces.ed.gov/pubs2003/2003347.pdf>

⁹ *Ibid.*

7. External Support (Local Utilities).

As mentioned in previous chapters, local utilities can be important partners and often offer substantial technical assistance in the form of training, energy audits, energy monitoring, and other services.

8. **Energy Management.** The district must think pragmatically about the administrative and logistical details of the energy aspect of the O&M program, such as a budget. Unless the district uses a performance contractor, which can provide a dedicated staff, all programs will require the selection of an energy manager to provide leadership and handle day-to-day administrative duties.

9. **Budget Resources.** It is helpful to identify the energy-specific O&M effort as an independent line item in the O&M budget. Having a dedicated budget enables the program to carry out core activities such as staff training, obtaining consulting services, and funding the repair or modification of energy-related building systems.

Poudre School District, Fort Collins, Colorado

Enrollment: 4,700

**Number of Schools: 50 schools,
40 portable classrooms**

Total Building Sq. Ft.: 4 million

With more than 15 years of energy management experience under its belt, the Poudre School District (PSD) has learned it must keep adapting to new technologies and challenges. Stu Reeve, PSD's energy manager, says he is always learning from his mistakes and stresses it is important to "be collaborative, both internally and externally." This sustained effort is made possible by support at the upper levels of management. Since 1994, PSD has completed 140 energy efficiency projects and has saved \$1.9 million cumulatively through 2007. For more information, visit the district's operation services Web site: www.psdschools.org/services/operations/index.aspx.

Additional Resources

For more information about educating and training personnel and the community, consider the following resources:

- For educating and training facilities staff:
 - New York State Energy Research and Development Authority's High Performance Schools Design, Maintenance and Operations Online Course, www.nyserda.org/hps/default.asp
 - USGBC LEED in Existing Schools Pilot Project, www.greenexschools.com
 - Training offered through the U.S. Green Building Program, www.buildgreenschools.org
 - Consider working with others in the school district or other school districts to share best practices
- For educating and training the community:
 - U.S. Department of Energy EnergySmart Schools' *Get Smart About Energy: K-12 Energy Lessons and Activities*, www1.eere.energy.gov/education/
 - U.S. Department of Energy Energy Efficiency and Renewable Energy, *Kids Saving Energy*, www.eere.energy.gov/kids/

O&M Implementation: Create an O&M Action Plan

Once the district has developed its O&M program, it is the responsibility of individual schools to execute O&M action plans for specific energy issues. (Note: Small districts may only need one O&M action plan at the district level.) The purpose of an O&M action plan is to document how the building systems will be brought into good, energy-efficient working order and kept as such through preventative maintenance. Schools should track the results of their work and regularly report back to district officials.

Table 5: Sample High-Performance O&M Plan

High Performance O&M Plan	Preventative Maintenance Plan
Description of school condition	<i>Goal:</i> Efficient operation and extending the useful life of equipment
Health and safety issues	<i>Focus:</i> The largest energy loads—cooling/heating, lighting, ventilation, and refrigeration
Equipment inventory	Link to work order systems and transmit electronically to technicians
Schedule for repairs	Track data and recurring repairs
Preventative Maintenance Plan	Annual energy surveys
Benchmarking	
Training	
Budget	

As more accurate energy information becomes available, it will become easier to compare monthly and annual energy costs among schools, school districts, and even other types of commercial buildings. If resources permit, it is a good strategy to integrate annual surveys over time. This practice allows planners to ascertain realized, rather than expected, savings; the impact of various maintenance strategies on equipment life and energy use; and potential future needs or issues. This information can be used to increase the efficiency and cost effectiveness of facility use and maintenance efforts going forward.¹⁰

Thinking of the system as a whole helps to identify an order for prioritizing energy efficiency improvements, retrofits, and maintenance measures. Prioritizing

energy efficiency improvements also avoids waste and unnecessary expenses. This strategic implementation depends on a district’s unique financial and technical needs.

Reducing energy consumption should be the first action taken to maximize a school’s energy efficiency. This decreased energy demand strategy should start with easier and broader areas, such as lighting and weatherizing, before considering measures such as resizing and right-sizing the HVAC system. In general, improving energy efficiency should start with consumption reductions through conservation and efficiency. That step can be followed by changing energy sources through measures such as fuel switching and renewables.

To develop an O&M Action Plan, consult **Chapter 3** and the supporting **EnergySmart Schools O&M Action Plans**. These spreadsheets provide customizable starting point checklists for facilities managers.

Action Plan Template • BENCHMARKING

Action	Roles & Responsibilities	Implementation Dates			
Once		Fill in implementation Date			
Install building automation system					
Calculate energy use baselines for buildings (partner with utility)					
Monthly		Fill in Implementation Date			
Collect energy and water data by fuel type					
Convert site energy to source energy for standardized measurements					
Input energy use into Energy Management System (EMS)					
Compare monthly data by building and through time. Identify reasons for disparities					
Adjust O&M to fix unexpected changes from baseline					
Quarterly		Fill in Implementation Date			
Bi-Annually		Fill in implementation Date			
Annually		Fill in implementation Date			
Review O&M changes as a result of benchmarking analysis					

¹⁰ Ibid.

Recognize and Motivate Staff Members

A top-down approach to O&M is likely to have just a short-term impact if it does not create a broader buy-in among staff members and stakeholders. Centralized energy managers or senior staff have a limited ability to monitor or enforce new policies or requirements at multiple schools. School staff may perceive the new O&M program as just another district mandate they can ignore unless officials can answer the question: “What’s in it for me?”

In general, schools approach incentives or rewards in two distinct ways. One recognizes or rewards individual staff members for identifying energy waste and proposing solutions to energy management issues. The other approach is to reward the successful school as a whole, providing incentives that broadly reward administrators, faculty, building staff, and students, all of whom contributed to improved energy management. The critical factor is to develop a creative approach for recognizing success at little or no cost to the district. Successful programs typically include individual, team, and school-wide recognition.

Additional Resources

For information about the ENERGY STAR Award programs for K–12 schools, visit: www.energystar.gov/schools

Recognition strategies are most appropriate for O&M staff—districts with successful O&M programs make this a high priority. However, some districts have also implemented recognition systems for principals and other school administrators because of their roles in the motivation of school staff and the oversight of building operations. Districts typically use the following approaches:

- **Public Recognition.** Custodial and maintenance staff often feel invisible or undervalued by district organizations. Recognition in local media or the public presentation of achievement awards effectively acknowledges staff contributions. Sometimes these awards have been combined with other incentive plans.

- **Performance Evaluations.** Districts could include a specific energy management element in staff members’ annual evaluations.
- **Low-Cost Perks.** Districts may use low-cost items such as gift certificates, restaurant meals, and customized apparel to reward outstanding staff.
- **Training Opportunities.** Supporting attendance at technical training is both an effective reward and a means of increasing staff energy expertise and professionalism. Successful completion of staff training can also reduce dependence on services provided by outside vendors.¹¹

In addition to (or in lieu of) recognizing specific staff, many districts have opted to more broadly recognize the progress and achievements of individual schools. For energy tracking and accounting programs, this recognition is commonly awarded on the basis of schools’ annual energy savings. In other districts, school awards are not savings-based, but made on the basis of specific O&M program efforts successfully completed by school staff.

Districts that choose to offer financial incentives typically give 10 to 30 percent of estimated energy savings to a school’s discretionary spending budget. Other districts may choose to purchase specific resources or equipment, such as improved cleaning, audiovisual, or sports equipment, as an incentive to schools. Community-focused incentives may include friendly competitions between schools or divisions within a school, such as grade levels. The winners may receive parties, movies, banners, or other low-cost, high-visibility recognitions.

¹¹ A few of these offerings are provided by the BOC training program mentioned above, the Association of Energy Engineers (AEE) and Schooldude.com. For more information, visit: <http://www.theboc.info/locations.html>

Chapter 3. Technical Considerations

Facilities managers and staff should use this chapter as a technical reference. The chapter outlines low-cost and no-cost solutions to improve the energy efficiency of building systems during operations and maintenance. It also offers brief energy efficiency recommendations to consider during a design phase or renovation.

Experience Meter



Target Audience or End User

- Facilities managers and staff
- Architects
- Engineers

Takeaways

After reading this chapter, readers will be able to:

- Simplify preventative maintenance, such as cleaning and inspections, to keep equipment operating efficiently
- Use commissioning, re-commissioning, and retro-commissioning to help ensure building equipment is installed correctly and operating efficiently
- Evaluate lighting, cooling, space heating, and water heating, keeping in mind they are the four systems that draw the most energy and offer the greatest opportunity for energy savings
- Consider de-lamping, daylighting, and light-control strategies to save energy
- Maintain HVAC and water heating equipment per the manufacturer recommendations. Clean all ducts, air filters, fans, belts, and other parts and make sure to lubricate the parts accordingly. Inspect all equipment regularly. Consider monitoring and controlling equipment using an energy management system
- Inspect doors, windows, and walls for cracks and fill them when necessary
- Communicate with building occupants on the amount of energy that plug loads and phantom loads can draw, and work with them to reduce plug loads

- Install and use the building automation system (BAS) to monitor and control building equipment energy use
- Consider reducing energy use in portable classrooms and on school buses
- Use innovative operations and maintenance approaches to save energy
- Communicate regularly to all the school stakeholders, such as school administrators, students, teachers, and facilities staff, the operations and maintenance efforts, results, and strategic plan to manage energy use

EnergySmart Schools O&M Action Plans

- Please refer to the Action Plans for the following systems:
 - Lighting
 - HVAC
 - Water Heating
 - Building Envelope
 - Transformers
 - Plug Loads
 - Kitchen Equipment
 - Swimming Pools
 - Building Automation Systems
 - Other

O&M ToolBox

- U.S. Department of Energy's *Guide to Financing EnergySmart Schools*, www1.eere.energy.gov/buildings/energysmartschools/finance.html
- ASHRAE *Advanced Energy Design Guide for K-12 School Buildings*, www.ashrae.org/publications/page/1604

- U.S. Department of Energy’s Energy Efficiency Renewable Energy Building Technologies Program, www1.eere.energy.gov/buildings/commercial/commissioning.html
- Association of School Business Officials International (ASBO), *Planning Guide for Maintaining School Facilities*, <http://nces.ed.gov/pubs2003/2003347.pdf>
- The Collaborative for High Performance Schools, *Planning Guide for maintaining School Facilities*, <http://chps.net/manual/index.htm#BPM>
- U.S. Department of Energy, *Federal Energy Management Program Operations and Maintenance Best Practices Guide*, www1.eere.energy.gov/femp/operations_maintenance/om_bpguide.html
- *The Safe Route to School Guide*, www.saferoutesinfo.org/guide/
- *ENERGY STAR Energy Management Guidelines*, www.energystar.gov/guidelines
- *ENERGY STAR Building Upgrade Manual*, www.energystar.gov/bldgmanual

Preventative Maintenance

Scheduled equipment checks, replacements, and upgrades save money in the long run by extending equipment life and by helping schools avoid costly unexpected breakdowns. Thus, preventative maintenance is a foundation for maximizing energy efficiency O&M. Although it is not discussed in detail in **Chapters 1 and 2**, it is implicit to the O&M component of energy management. In this section and throughout **Chapter 3**, most individual strategies follow the concept of preventative maintenance.

Timely replacement of parts is a simple way to keep equipment running at top efficiency and should not be delayed until equipment fails. Worn filters, belts, gaskets, valves, and other parts often cause equipment to draw more energy and lead to equipment breakdowns. Preventative maintenance should be standardized into every O&M schedule.

There are several challenges to successfully implementing the preventative maintenance strategy. In addition to a lack of staffing, training, and management, some schools and districts also lack sufficient funding to implement a proper preventative maintenance program. Most building system components interact with one another, so if one

piece of equipment is operating below its optimal efficiency, other systems may become inefficient as a result. Adding to the challenge of multiple energy systems, one building may have several additions constructed over time. To appropriately address these problems, facilities managers should establish maintenance schedules that evolve to face new challenges for each building system and component.

Inspection schedules and task checklists can be as complicated as a computerized system or as simple as printed note cards. The purposes of these schedules are to establish maintenance routines and record pertinent data in a standardized fashion, which will help alert maintenance personnel to existing or developing problems. Manufacturer manuals should be starting points for guidance on preventative maintenance. The ESS O&M Action Plans provide customizable lists with technical tips from this guide.

In addition to creating energy savings through energy efficiency and avoided breakdowns, preventative maintenance improves the educational function of the school. Properly functioning building energy systems contribute to the safety and cleanliness of the learning environment for teachers and students.

Design/Renovation Recommendations

During new construction or major renovations, schools and districts should consider maintenance concerns in the design phase. For example, cleaning carpeting is energy- and time-intensive, compared to cleaning hard surfaces. Carpet maintenance includes weekly hot-water extraction and annual steam cleaning. Redesign teams can gain insight on maintenance challenges and potential solutions by consulting with custodial or maintenance staff.

Whether replacing a water heater or instituting a new HVAC maintenance schedule, a district should consider how the energy efficiency change will affect the building system’s other components. Organized planning with input from all stakeholders will help identify co-effects. This integrated planning and strategizing method is often referred to as a “charrette.” During facility planning, schools should also consider future expansions and renovations and integrate systems flexible to expansion to decrease future costs.

In the context of this document, the term “charrette” refers to an integrated planning and strategizing meeting with all the stakeholders to discuss the decisions for and effects to the design or renovation project.

Performance Measurement/Data Collection

If a district has conducted energy surveys for all of its buildings (**Chapter 1**), then the data collection, performance measurement, and benchmarking process (discussed in **Chapters 1 and 2** in more detail) are a continuation of the work referenced in this section.

Data collection will be a cornerstone of the school or district's energy management program. Standardized and accurate data collection will give managers and decision-makers confidence in the results. The accuracy of data collection and analysis is essential in presenting maintenance and purchasing plans to administrators and in communicating results.

Maintenance personnel can track energy consumption data with meter readings and energy bills. Gas and electric utilities often assist in this type of data collection and may go as far as providing an hourly load profile for a school or district. As mentioned in **Chapter 1**, it helps if a district identifies its utility account representative and develops a strong relationship with the utilities. Most utilities will provide online access to monthly bills that reach back one to two years. Data should reflect monthly changes at a minimum, and it should be collected and stored in a standardized way so that it can be easily compared. To effectively use this data and convert it into useful information, collection should be part of the school's or district's energy management program. Personnel with training in handling quantitative data should analyze this energy data.

Commissioning

Commissioning, Re-Commissioning, and Retro-Commissioning

Building commissioning is the systematic process of ensuring a building performs according to the design's intent, contract documents, and the owner's operational needs prior to building occupancy.

Re-commissioning refers to building commissioning conducted again, during building occupancy, to ensure that the building continues to perform accordingly.

Retro-commissioning refers to building commissioning conducted during building occupancy for the first time.

Schools often hire contractors for more technical and integrated reviews of buildings' energy efficiency. This process is called commissioning for new construction and retro-commissioning for existing buildings that have never been commissioned. Commissioning and retro-commissioning go beyond evaluating individual components (as in an energy audit) to ensure the entire system of components is operating as efficiently as possible. The cost of commissioning ranges from 0.5 to 1.5 percent of total construction for a new building and retro-commissioning ranges from 3 to 5 percent of the annual operating cost for an existing building.¹² On average, the operating costs of a building after commissioning are 8 to 20 percent below those of a non-commissioned building.¹³

Those schools pursuing the **U.S. Green Building Council's (USGBC's) LEED for Existing Buildings: Operations and Maintenance** certification are required to use a Building Operating Plan (template available in **Appendix I** and referenced in the *LEED for Existing Buildings: Operations & Maintenance Reference Guide*). The Building Operating Plan is a dynamic document that can be updated to include changes to further optimize the efficiency of building systems during building operation. This tool is used as documentation to meet the commission requirements under the Energy and Atmosphere prerequisite 1. Although it is unique to the USGBC, it is very similar to the Basis of Design document used in new construction and required for the commissioning of new schools. It is a useful resource, even for those schools not planning to pursue the USGBC LEED EB O&M certification.

A school must earn a minimum ENERGY STAR Portfolio Manager rating of 69 to apply for LEED-EB: O&M certification. A summary of energy use, such as the Statement of Energy Performance generated in Portfolio Manager, must be submitted, along with other required documentation, to demonstrate compliance through current energy performance. Buildings that receive 75 or better are eligible to receive the ENERGY STAR, proof of which is sufficient for meeting a streamlined application approach in LEED-EB: O&M.

¹² U.S. DOE EERE Building Technologies Program, <http://www1.eere.energy.gov/buildings/commercial/commissioning.html>. Accessed February 2009.

¹³ *Ibid.*

Ideally, commissioning is initiated with the design of a building and concludes with a commissioning report, O&M staff training, and operations procedures and manuals specific to the building. For the purposes of this guide, it is recommended that retro-commissions be conducted for buildings that have never been commissioned. Retro-commissioning should be conducted under each seasonal condition to ensure proper system functioning in both the heating and cooling seasons. It is good practice to re-commission buildings every five years.¹⁴

Building Systems

In a typical school, energy distribution can be attributed to five main categories:

1. Lighting
2. Cooling
3. Space heating
4. Water heating
5. All other systems

Of those energy uses, lighting and cooling systems draw the most energy, with space heating following closely. Although the numbers vary by climate zone, the results from this analysis provide a generalized summary of the systems with the largest opportunity for energy savings: lighting, HVAC, and water heating.

The following sections in this chapter provide low-cost or no-cost energy management operations and

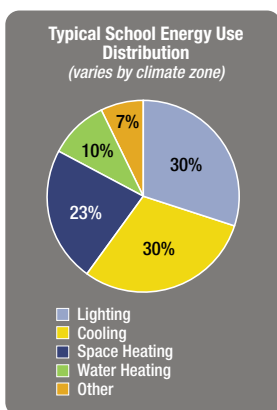
Consider the Building Systems as a Whole

This guide has stressed the importance of evaluating O&M strategies from the perspective of the entire system of building components. To maximize the system's energy efficiency, each component must be properly and consistently checked, cleaned, and serviced. Building maintenance includes all grounds and all equipment, from lawn mowers to school buses. Think of maintenance and data collection as part of the school or district's mission. In fact, efficiently functioning building systems increase comfort and safety for students, faculty, staff, and administrators.

maintenance practices for the major systems within school buildings. When available, these sections also provide overview information on energy efficiency considerations for retrofits or major renovations. Refer to the Action Plan for each section for a detailed list of this information, which is ready to be incorporated into an existing O&M or energy management plan.

Additional Resources

For more tips on measuring the cost effectiveness of energy efficiency measures, see the U.S. Department of Energy's *Guide to Financing EnergySmart Schools*, www1.eere.energy.gov/buildings/energysmartschools/finance.html



Wake County Public School System, Raleigh, North Carolina

Enrollment: 137,706

Number of Schools: 156

Commissioning, controls, and teacher support are the three keys to high-performance school O&M, stresses Jyoti Sharma, the director of facility planning for Wake County Public School System (WCPSS). Following energy conservation renovations or upgrades, WCPSS consults with a combination of outside consultants and an internal team to ensure the proper operation of new systems and components. This quality-assurance step is especially vital to the HVAC system, Sharma says. WCPSS also uses Direct Digital Control (DDC) systems to control setback temperatures for its schools when they are unoccupied. This energy control ensures that system down-times achieve the highest possible energy savings. The systems are managed centrally but can be altered at the level of the individual school to account for after-school programming. Finally, teacher support is vital to achieving energy savings, Sharma says. For example, daylighting is a great strategy for decreasing lighting energy consumption, but it can only be effective if teachers are educated to keep lights off. WCPSS complements its teacher education with student action, leading to students and teachers working together to take responsibility for their school's energy conservation.

¹⁴ Association of School Business Officials International (ASBO). *Planning Guide for Maintaining School Facilities*. <http://nces.ed.gov/pubs2003/2003547.pdf>

Implementation Order

An advanced strategy for retrofitting is to stage upgrades to maximize building energy efficiency. For example, it is most efficient to upgrade an HVAC system after upgrading building components that reduce heating and cooling loads, such as lighting. Right-sizing an HVAC system should be among the last of the energy efficiency retrofits.

For more information, see:

- **Chapter 2. O&M Implementation: Create an O&M Action Plan**
- The ENERGY STAR *Building Upgrade Manual*, Chapter 10, Facility Type: K–12 Schools, www.energystar.gov/index.cfm?c=business.EPA_BUM_CH10_Schools
- The ENERGY STAR Cash Flow Opportunity Calculator, www.energystar.gov/financiaevaluation

Lighting

Refer to the **Lighting Action Plan** for a customizable checklist of O&M measures, trainings, and communications.

Action Plan Template • LIGHTING—Page 1

Action
Once
Establish voluntary teacher/student program to turn off lights to save energy
Install building automation system to monitor lighting energy use
Commission or re-commission timer controls, photosensors, and motion sensors
Install timer controls, photosensors, and motion sensors where appropriate, especially in occasionally used areas
• Consult the manufacturer manual for setting calibrations
• All timer and sensor settings should be adjusted for school activities and for changing sunset/sunrise times
• All sensor settings should be adjusted to turn off lights after 15 minutes of inactivity
• Place contact information near the control in case occupants need assistance
Install dimming ballasts if appropriate and compatible with lighting system
Install LED lights on exit and emergency signs
Daily
Turn off lights in unoccupied rooms (work with teachers, students, and other building occupants to make this through "lighting patrols" or other programs), if lighting monitor and control systems are not installed or functional
Turn off all lights at night with the exception of security lights and exit signs, as safety considerations allow, if monitor and control systems are not installed or functional
Turn outdoor lights off selectively, as safety considerations allow, if lighting monitor and control systems are not installed or functional
Delay turning lights on in the morning until staff arrive, if lighting monitor and control systems are not installed or functional
Monthly
Check that all interior and select exterior lights are turned off during nights
Analyze lighting building automation system for opportunities to decrease lighting electricity use
Check for broken lamps and replace

Lighting efficiency is typically considered an energy efficiency “low-hanging fruit.” Strategies such as switching off lights, delamping, cleaning, and daylighting are simple and inexpensive. Relamping, or periodically replacing groups of lamps, requires slightly more investment. Similarly, schools can install dimmers, timers, and sensors to have more control over when lights are turned on. Not only is lighting O&M necessary for good visibility and security, it also saves money. Simply delamping (a lighting strategy detailed in this section) can save 25 to 50 percent of lighting energy, which equals about one-third of schools’ energy use.

Lighting O&M Best Practices

- Maintain interior illumination levels in accordance with current building design standards.
- Establish scheduled cleaning routes for lamps and luminaires.
- Replace discolored plastic diffusers in fluorescent fixtures. Prismatic lenses are generally the most efficient type for the degree of glare control provided; fresnel-type lenses are the most efficient for recessed incandescent and high-intensity discharge fixtures.
- Use light-colored paints, carpets, tile, and upholstery.
- In areas with similar hours of operation, replace all lamps simultaneously to reduce labor costs. Consider replacing the lamps on a single switch at 70 to 80 percent of their average lamp life. If delayed much longer, lamps will start to burn out in a relatively short time, creating a maintenance problem, using additional energy, and providing insufficient illumination.
- Consider the installation of occupancy sensors and photosensors in classrooms and common areas.
- Teach staff and students about energy conservation and how to use classroom lighting controls.
- Measure light levels in all areas. Use Illuminating Engineering Society of North America (IESNA) standards or your state recommendations to evaluate existing light levels and delamp or make other operational changes.

Low-Cost and No-Cost Lighting Strategies

- Turning off lights in unoccupied rooms can save from 8 to 10 percent of lighting energy annually.
- Automatic lighting controls can generate significant savings with short payback periods.
- Switching from T-12 to T-8 lighting with electronic ballasts can reduce lighting energy by 20 to 30 percent. When making this replacement, a four-tube T-12 fixture can be replaced with a three-tube T-8 lamp and achieve the same illumination. In some instances, four T-12 lamps can be replaced with two T-8 lamps. Lighting measurements are key in making this determination.

Monitor and Control

Turning off lights in unoccupied rooms can often save up to 10 percent of lighting energy and can decrease cooling costs, too. All students, faculty, and staff can participate in this strategy through “lighting patrols,” assuming that the school does not have an energy management system or other lighting controls. At night, only security lights and exit signs should be left on. Outdoor lights can be selectively turned off as safety considerations allow. In the morning, turning on lights can be delayed to save energy use until people arrive. Cumulative energy use for lighting and space conditioning should be modeled with energy auditing software to accurately determine energy cost savings. Automated lighting monitoring and controls are critical to maintaining control of the system and should be calibrated to minimize energy use while preserving comfort.

Cleaning

Cleaning dirt and dust off lamps and their covers (also called luminaires) is a simple way to make sure light output stays at the maximum level. Without cleaning, light output decreases by as much as 15 percent every year. Most maintenance procedures prescribe annual cleaning of light fixtures and luminaires. However, O&M staff can more frequently keep this equipment clean if the job is incorporated into every lighting maintenance procedure, such as relampings and replacements. Diffusers, or the plastic coverings over lamps, tend to get darker with

Andover Public School System, Andover, Massachusetts

Enrollment: 6,000

Number of Schools: 10

As the director of plant and facilities for the Town of Andover, Joe Piantedosi coordinates the town’s school facilities. These buildings are a mix of old and new construction with some as old as 1923. Thus, energy management of existing school buildings and preventative maintenance are priorities for the town.

Andover was the first town in Massachusetts to link its schools with a centralized energy management system. With its energy management system, Andover school lighting is interfaced with school security systems to decrease building lighting energy. When janitors leave the building at the end of the day and engage the security system, all of a school’s lights automatically shut down. Piantedosi reports decreases in vandalism and in energy consumption with this energy management effort.

The Town of Andover received the 2009 Energy Efficiency Municipal Leader of the Year Award during the Northeast Energy Efficiency Summit.

age and they should be replaced when they reduce light output. For outdoor lights, trees and shrubs should be cleared from lights in addition to regular cleaning of fixtures and luminaires.

Delamping

Delamping is the process of removing lamps from a light fixture—for example, using only two fluorescent tubes in a three-tube fixture—wherever there is extra light. The best places for this no-cost strategy are where bright light is not a necessity: windows, doors, corners, computers, televisions, skylights, and corridors. Confirm that removing lighting from these areas does not compromise the health, safety, or security of students, staff, or faculty. Lastly, installing spectral reflectors should be considered as a complement to delamping. The best time to delamp the lighting system is over weekends or holiday vacations, so the lighting change is less noticeable to building occupants.

To delamp T-12 lighting, which usually contain four larger-diameter bulbs, lights must be removed in pairs. Any of the lamps can be removed if delamping T-8 lamps, which can contain two to four smaller-diameter bulbs.

Additional Resources

To be more precise in delamping, staff members can measure lighting levels established by the Illuminating Engineering Society of North America (www.iesna.org). Its rule of thumb is that staff members should not delamp a fixture if in doing so there will be fewer than two 4-foot lamps for every 64 square feet. In addition, do not remove lamps from fixtures that are still under warranty. Delamping could void the warranty if something were to happen to the fixture.

Daylighting

Daylighting is the practice of using natural light, rather than electric lights, to illuminate a space. This strategy is effective in classrooms (with consideration for glare), cafeterias, offices, shops, gyms, pools, corridors, locker rooms, and study halls. By keeping lights off, users increase the lifetime of lamps and reduce maintenance costs.

Strategically opening or tilting window blinds can reduce heat loss in the winter or solar heat gain in the summer. Tilted window blinds can also help manage glare while still taking advantage of the natural light. This strategy can save on heating and cooling bills. However, there are tradeoffs between savings on cooling bills and increased costs on lighting bills during the warmer months when the blinds are closed.

Installing window film can help reduce solar heat gain in the summer. The film will also cut down on glare in classrooms but at the same time will reduce the amount of available daylight. Proper installation is critical for durability and aesthetics.¹⁵

Light-Emitting Diodes

Light-emitting diode (LED) exit signs use about 95 percent less energy than incandescent exit signs and 20 percent of the energy used by compact fluorescents. Combining these energy savings with the increased lifetime of the lamp, the payback period for LED exit signs is less than one year. LEDs can last 25 years,

significantly reducing maintenance time to change bulbs. Because emergencies may require exit signs to operate when the power goes out, batteries for emergency power should be checked in groups in accordance with the lifetime specified by the manufacturer.

Design/Renovation Recommendations

Relamping

Relamping is the replacement of lamps that are not performing at their peak performance. Lamps should be replaced at 75 to 80 percent of their rated life, and they should be disposed of according to local waste regulations because they may contain toxins such as PCBs (polychlorinated biphenyls) and mercury. Replacing all fluorescent lamps every five years or replacing one-third of all lamps biennially can maximize lamp life while reducing labor costs. This practice of group relamping is an excellent example of preventative maintenance and can be scheduled months or years in advance at cost-effective intervals. The practice can improve lighting performance by as much as 25 to 50 percent.

Installation and equipment costs of lamps can be up to 6 percent of annual operating costs. Scheduled group relamping can decrease these operating costs by minimizing storage requirements. Reusing individual lamp replacements can also decrease costs. After a group relamping, some lights will not be the original lights installed. These will have been used for less time and can be used as replacements for future burn-outs. This strategy requires careful record keeping of individual and group lamp replacements but can be used to save on the cost of new replacement lamps.

Large-scale lighting retrofits are significant investments that may be most appropriate during a major renovation. Although upgrading from T-12 to T-8 lamps can decrease the electric bill by as much as 6.6 percent, the payback period for this upgrade may be up to three years, depending on electricity rates. The T-8 lighting upgrade can save as much as 20 to 30 percent of lighting energy and T-5 fluorescents can save almost half of electricity consumption compared to metal halide lamps with magnetic ballasts.

For screw-in sockets, compact fluorescent lights (CFLs) have lower maintenance needs and reduce long-term costs. They use about 25 to 30 percent of the energy of incandescent lamps. Lastly, metal halide lamps are generally used to replace mercury lamps

¹⁵ David Barista, "Sun Block," *Building Design and Construction*, December 2003.

for lighting large spaces or for outdoor lighting. Over the lifetime of metal halide lamps, the light output from these lamps decreases and their color rendering changes markedly.

Lighting Control

There are a number of lighting control mechanisms, such as timers, occupancy sensors, and photosensors, which are designed to minimize lighting system energy use. Each of these is designed for different settings, as described below.

The electricity and natural gas rate structures pose additional challenges for calculating energy cost savings. For a flat-rate billing structure (for example, electricity rates that are the same at noon as they are at 9 p.m.), an average electricity price is satisfactory. For regions that have other rate structures, cost savings will depend on the time of day during which the energy savings occur. For example, an occupancy sensor that shuts off the lights in an unoccupied room is saving more expensive electricity at noon than at 9 p.m., so it must be evaluated accordingly. Districts that are not certain what kind of billing structure schools are operating under should call the local utility for information.

Time controls switch off lights at specified times and are a good solution for areas with predictable occupancy such as libraries, auditoriums, and exteriors. All timer settings should be adjusted for before- or after-school activities and for changing sunset and sunrise times. Key users for the controls should be trained and manufacturer's instructions should be accessible. If a control is accessible to room occupants, place a contact number near the control in case occupants need assistance. Users may damage or manually disarm timers, so regularly checking timer settings is critical to achieving energy savings.

Occupancy sensors automatically turn off lights in unoccupied spaces when motion sensors detect inactivity. They should not be used with lights that require warm-up or re-strike times, like high-intensity discharge lamps. A study by the Florida Solar Energy Center reported 11 percent savings and a payback of less than four years by installing occupancy sensors.¹⁶ Careful checking of sensors is necessary because they can be set off by irrelevant motion. For

example, motion outside windows might cause the sensor to turn on lights at times when they are not needed. Such problems can be fixed by changing the sensor's placement or partially shading it. Maintenance contact information should be readily available to building occupants in case a sensor is malfunctioning. Annual commissioning is recommended as a preventative maintenance measure for occupancy sensors to assure they are operating correctly. Current sensors use infrared and ultrasonic technologies, which are a significant improvement from earlier generation sensors.

Photosensors dim or switch off lights when daylight reaches bright levels. The sensors and the dimming ballast should work together to achieve a slow, smooth dimming response for indoor areas. Facility personnel should carefully calibrate these sensors; changes such as painting walls, new carpeting, and additional desks can change a sensor's setting. Photosensors should be located at an unobstructed location, such as the ceiling in the middle of a classroom. Care should be taken to make instructions and maintenance contact information accessible to building occupants. Initial commissioning is essential for these controls to achieve their potential energy savings.

Dimming ballasts are most commonly installed during new school design but may be appropriate as retrofits in some situations. Determining existing ballast quality is difficult, but they usually last seven to 10 years. This equipment allows for manual or automatic dimming and can dramatically decrease the energy used in lighting. To manually use the dimming ballasts, install dimming switches for occupants to adjust. If using fluorescent dimmable lights, make sure the lighting ballasts are dimmable. Otherwise, the bulb will burn out very quickly. For automatic control, the dimming system should be programmed into an existing or new energy management system. They are most effective in well-lit areas of a school.

Daylighting

During renovations, spaces should be painted with light, reflective colors to increase the effectiveness of daylighting. In the design phase, there are many strategies for increased daylighting. For example, slanted roofs significantly reduce ceiling reflectivity compared to flat roofs. Well-designed daylighting can save 40 to 60 percent of electric lighting lifecycle costs, incorporating control systems into the design.

¹⁶ Floyd, D., Parker, D., Sherwin, J., "Measured Field Performance and Energy Savings of Occupancy Sensors: Three Case Studies". FSEC-PR-209-96. www.fsec.ucf.edu/en/publications/html/fsec-pf-309-96/

Gym Lighting

If possible, daylighting and electric lighting should be used in combination for gyms and large open spaces. There are multiple strategies to reduce glare in gyms. Shades and glazing can eliminate direct sun, and very bright surfaces should be avoided on walls. Most gyms use basic high bay lights, but because some systems require long warmup and restrike periods, a separate system of halogen lights is recommended. Be sure to choose luminaires that can withstand sports equipment and make sure controls and switches are relatively inaccessible to occupants. T-5 lamps are recommended for gyms because they are well suited for enclosed luminaires in tall spaces.

Heating, Ventilating, and Air Conditioning

Refer to the **HVAC Action Plan** for a customizable checklist of O&M measures, trainings, and communications.

Action Plan Template • HVAC—Page 1

Action
Once
Establish expected HVAC system efficiency - Write down the expected efficiency of HVAC systems to use as a baseline - Add this information to maintenance plan documentation - Some efficiency measures to collect are: - EER or kW/ton of cooling equipment - Thermal efficiency or HSPF for heating equipment - Bhp for fans and pump motors - Expected air and water flows
Determine type of economizer and proper operation both during benchmarking and at the installation of new equipment economizer - Collect information on the type of economizer installed in each system and document the intended operation maintenance plan - Type of controls: fixed dry bulb temperature setpoint, fixed enthalpy setpoint or differential dry bulb or enthalpy control - Note whether the economizer is intended for integrated (together with compressor) or non-integrated operation
Commission, re-commission, or retro-commission HVAC system once for each season to identify baseline efficiency of HVAC system
Daily
Conduct overall visual inspection of all systems *
Turn off or sequence equipment when unnecessary *
Air Compressor
Look for and report any system leakages *
Check compressor lubricant level, color, and pressure. Compare with trended values *
Drain condensate from tank, legs, and traps *
Verify operating temperature is per manufacturer's specifications *
Air Conditioning
Chiller
Check all setpoints for proper setting and function *
Cooling Tower
Check for clogging by making sure water is flowing in tower *
Adjust all belts and pulleys *
Controls
Verify in control software that schedules and setpoints are accurate for season and occupancy *
Heating
Boilers
Follow manufacturer's recommended procedures in lubricating all components. Compare temperatures with performed after annual cleaning *

Regular maintenance of heating, ventilation, and air conditioning (HVAC) equipment has a number of benefits¹⁷:

- Energy savings
- Extension of equipment life to avoid premature replacement and reduce life-cycle cost
- Enhanced indoor air quality and ventilation
- Elimination of contaminant sources
- Increased occupant comfort
- Improved reliability and reduction in emergency equipment issues
- Avoidance of classroom disruptions with equipment operating at maximum efficiency
- Integration into pest management through cleaning procedures
- Empowerment of maintenance staff to take charge through demonstrated energy savings

This section of the guide focuses mainly on the energy savings from HVAC maintenance. Space conditioning uses more than half the energy consumed in school buildings. Accordingly, it is a primary target for energy savings, much of which can be achieved at little cost. Listed below is a summary of the low-cost or no-cost energy-saving maintenance actions that will be described in detail later in this section:

- Ensure systems run only during occupied periods
- Clean burners and air conditioner coils
- Replace and clean air filters and keep economizer dampers clean
- Check ducts for leaks at joints and flexible connections
- Check hot and cold duct and pipe insulation and seals for inadequate insulation
- Fix faulty equipment
- Verify and adjust refrigerant charge on packaged air conditioning systems
- Check, adjust, calibrate, and repair all controls, such as thermostat controllers and valve and damper operators

¹⁷ The Collaborative for High Performance Schools. *Best Practices Manual Volume IV. Maintenance & Operations.* <http://chps.net/manual/index.htm#BPM>

- Monitor, calibrate, and repair enthalpy controls and mixed-air controls to maintain efficient operation
- Repair or replace all defective dampers
- Check, adjust, or replace fan belts
- Lubricate all bearings and other friction points, such as damper joints
- Inspect fan wheels and blades for dirt accumulation and clean them as required
- Adjust or repair packing glands and seals on valve stems and pumps
- Ensure that no oil or water enters the main air supply for the control systems

Low-Cost and No-Cost Heating, Ventilation, and Air Conditioning (HVAC) Strategies

- Schedule regular maintenance on HVAC units, clean burners and air conditioner coils, clean or replace air filters, and check ducts and pipe insulation for damage.
- Have a qualified technician perform annual maintenance on the hot water boiler. This step alone can reduce energy consumption by 10 to 20 percent, reduce emissions, and increase occupant comfort.

The first step to improving the energy efficiency of HVAC systems is to reduce its loads. Then, similar to benchmarking, it is necessary to establish the expected HVAC system baseline efficiency for evaluation before taking maintenance measures to reduce energy use. Write down the expected efficiency of the HVAC systems from manufacturers' literature or design documents. Key information to record includes:

- EER of cooling equipment
- kW/ton of cooling equipment
- Thermal efficiency or heating season performance factor (HSPF) of heating equipment
- Break Horsepower (BHP) of fans and pump motors
- Expected air and water flows¹⁸

Another good source for information on energy consumption is the sub-meter. For facilities that may

have sub-meters on individual buildings or systems, such as chilled water plants, that are not read by the utility and are not on the utility bill, make the effort to collect that information monthly. Sub-meter information can help explain energy consumption and can contribute to the overall energy audit.

Heating

In most climates, the boiler is the largest single piece of energy-using equipment in a school building—a good fact to keep in mind. As a result, it is critical to keep detailed records of boiler energy use and maintenance. Although sophisticated software is available to analyze energy consumption, simple data analysis, such as comparing energy data with that of similar buildings, can also be useful. It is helpful if this comparison is done between buildings with similar equipment and if it is a season-to-season comparison, normalized for heating degree days. The boiler maintenance log may also be a good resource for this exercise.

Maintaining a detailed service notebook is a better data management strategy than keeping old service invoices. Simply saving invoices from service calls does not provide a detailed history of your boiler. Service invoices deteriorate over time, contain quick

Newark Public Schools, Newark, New Jersey

Enrollment: 41,000

Number of Schools: 73

Newark Public Schools uses energy monitoring software at all of its schools. Upon installation and commissioning of a building automation system (BAS), Weequahic High School noticed that its gas consumption was 7.9% above the baseline on weekends. Weequahic investigated this inefficiency and found that boilers were being kept on constantly during weekends and heating appliances were not shutting down. By identifying and fixing this increase in energy use, Weequahic was able to save \$2,300 per month on its energy bill. This example shows how adjusting boiler temperatures during non-use periods can save money on energy bills. In addition, Weequahic used a BAS to quickly catch an O&M problem and create energy savings without any significant capital outlay.

¹⁸ *Ibid.*

Heating and Boiler Lessons Learned

Presented by Joe Piantedosi during SchoolDude's "Boiler Preventive Maintenance" Webinar in January 2009 (www.schooldude.com/pm).

- During unoccupied periods:
 - Turn off boilers, as recommended by equipment manufacturer. Some buildings shut down boilers when the outside air temperature is greater than 32°F and building temperature is greater than 50°F
 - Avoid shutting down boilers when temperatures are freezing or are close to freezing to prevent frozen coils
 - Program night setback temperatures on thermostats, though the settings will vary according to weather and season
 - Keep in mind system restart times to avoid negative consequences for normal building operations and delayed heating for building occupants
- In general:
 - Set boilers to operate automatically, using controls from the manufacturer
 - Maintain tight control on make-up water to avoid using water treatment chemicals; maybe use alcohol or antifreeze to prevent equipment damage
 - Institute a steam trap maintenance program

notes or abbreviations, and are easy to lose. Notes that are prepared when the information is fresh are most useful for future service calls. For example, service records and fuel consumption records can show patterns that indicate problems—or verify that the boiler is functioning smoothly.

Scheduled maintenance should be performed one to four times per year. Boiler inspection is essential for safe and efficient operation and may already be required by your state. A qualified technician should perform boiler maintenance. However, O&M staff have an important role as well: They need to check for leaks, look for damaged or missing insulation, and monitor energy efficiency.

The U.S. Department of Energy, Federal Energy Management Program (FEMP) online manual recommends combustion efficiency be measured and recorded at least once a month during the heating season. Combustion efficiency can be measured by the flue gas analysis. Typical combustion efficiencies for standard boilers range from 70 to 85 percent, depending on the firing rate of the boiler. Efficiency usually drops at lower firing rates. The efficiency for condensing boilers should be around 95 percent.

Boilers also require other routine maintenance, such as checking feedwater, which will not be discussed here. For more details, see the boiler manufacturer's operating manual, a standard reference text, or the local air quality management district regulations for required boiler tests.

Similar inspection guidelines apply to schools that heat spaces using furnaces:

- Inspect the furnaces for smooth ignition and proper flame color
- Check the operation of limit devices or flame sensors
- Test gas connections for leaks
- Perform the American Gas Association furnace heat exchanger leakage test annually
- Inspect the flue for blockage
- Always see the manufacturer's guidelines for proper operation

If staff members identify any problems with the ignition or the flame, facilities personnel or a trained professional should clean the burners as needed and repair or replace the appropriate components.

Steam heating systems are not generally used in new schools but are still common in older schools in cold climates. These systems have specific O&M needs, which are overviewed in the list below. Of

Additional Resources

- U.S. Department of Energy, *Federal Energy Management Program Operations and Maintenance Best Practices Guide*, www1.eere.energy.gov/femp/operations_maintenance/om_bpguide.html
- American Gas Association, www.aga.org

these, steam trap maintenance is one of the most crucial, because just one malfunctioning steam trap can waste thousands of dollars a year. See the FEMP's *Operations and Maintenance Best Practices Guide*, Chapter 7.3, for more detailed information.

Steam Heating System O&M Best Practices

- Continually survey the steam system to identify and repair all steam leaks. Steam leaks pose a danger to personnel, as they are a burn hazard.
- Steam system leaks can be difficult to locate; use acoustic or temperature probes to find invisible steam leaks.
- Tune up the boiler frequently, as specified in the preventative maintenance program.
- Inspect and repair steam traps periodically to ensure that all traps are properly sized.
- Annually inspect insulation on pipes and pressure vessels and repair or replace deteriorated or missing insulation.

Air Conditioning

Regular maintenance of air conditioning systems maintains optimal cooling performance and saves energy. The most common causes of degraded performance are:

- Dirty filters and fans
- Improper belt alignment and adjustment
- Air leaks in equipment cabinets and ducts
- Improper air damper operation
- Dirty condenser and evaporator coils
- Improper refrigerant charge

Most of the maintenance recommendations apply to all types of air conditioning systems found in schools, including package systems and classroom unit ventilators.

The general cooling efficiency of the air conditioning system should be checked every three to five years or following a change of the HVAC system. Cooling efficiency can be found based on measurements of

Additional Resources

Central chillers and cooling towers require additional maintenance not discussed in this guide. For additional information, visit:

- ASBO International, *School District Energy Manual*, pp. 13–14
- U.S. Department of Energy, *Federal Energy Management Program Operations and Maintenance Best Practices Guide*, www1.eere.energy.gov/femp/operations_maintenance/om_bpguide.html

airflow, temperatures, and electrical demand. There are commercially available measurement systems to help automate the process and help diagnose problems. Air flow and refrigerant charge measurements should be the first priorities, but efficiency estimation may not cost much more if an automated measurement and diagnostic system is used.

Air Filters

Dirty air filters increase static pressure, reduce fan motor power, and reduce airflow through the system. Inspect and replace all filters on a regular schedule, as recommended by the equipment manufacturer, typically every one to three months. This maintenance should be increased under severe operating conditions or when the economizer cycle is being used.

The filter's resistance to air flow increases as it gets dirtier. Measuring the pressure drop across the filter will determine when it should be changed, commonly when the static pressure increases by 0.5 in. of water.¹⁹ For systems not manufactured with pressure taps, installation is a simple and inexpensive job. A complete air pressure testing kit with a dial gauge typically costs between \$30 and \$100.

Filters with increased area provide more friction to capture dust and other materials and, therefore, less energy is needed to move air across the filter. When replacing filters, minimize energy consumption by increasing the filters' cross-sectional area. Options include:

- Pleated filters
- Bag filters
- Angled filter banks

¹⁹ 1999 ASHRAE *Systems and Equipment Handbook*, Chapter 24.

Fans

Fans typically operate trouble-free for several years with minimal required maintenance, but maintenance neglect can lead to premature failure of the fan. Some steps that prolong fan life include: 1) clean the fan blades, 2) inspect the bearings, 3) adjust or change belts, and 4) check fan current. Generally, these systems should be inspected quarterly. Fan blades should be inspected for cracks and damages at least once a year.

Cleaning fan blades is time consuming but worthwhile. Small fans can take an hour or two to clean properly, while larger fans can take considerably longer. Fan blades should also be checked for chips or cracks that may cause noise or vibration.

Although most new fans have sealed, self-lubricating bearings, older units may require periodic lubrication every three to six months. Bearings should be inspected for excessive noise, vibration, or heat, which are common signs of impending failure.

Fan belts should be checked for wear and to correct tension. If belts are too loose, they can compromise performance, increase noise, and increase wear. Belts that are too tight can damage motors, bearings, and the belts themselves. The maintenance plan should include information on how to conduct the belt tightness test for each piece of equipment (based on the manufacturer's recommendations). Check belts and pulley alignment. Belts should be replaced annually or more frequently, as necessary.

Additional Resources

Periodic cleaning and servicing enables fans to operate at high efficiency and prevent energy waste. For more information, visit:

- *Top-Level HVAC Maintenance*, FacilitiesNet Maintenance Solutions, October 2003, www.facilitiesnet.com/ms/oct03/oct03HVAC.shtml
- *School District Energy Manual*, Association of School Business Officials International, 1997, p. 16

If fans need to be upgraded, consider replacing them with a more energy-efficient system. Right-size the fans and take advantage of load reduction strategies before selecting a fan. Reduce the motor size, adjust the pulley sizes, and reset the static pressure set

Additional Resources

- For equipment efficiency recommendations, refer to the ENERGY STAR Web site, www.energystar.gov/products
- For retrofit and major renovation considerations, refer to the *ASHRAE Advanced Energy Design Guide for K-12 School Buildings* at the U.S. DOE EnergySmart Schools Web site, www.energysmartschools.gov

points for variable air volume systems. A 20 percent reduction in speed can save up to 50 percent of the motor energy use, and larger pulleys can slow motors.

Ducts

Wasting conditioned air reduces system efficiency and occupant comfort. These leaks can come from the HVAC equipment cabinet or ductwork. Checkups should be conducted one to four times per year and should include inspections of all access panels and gaskets, particularly on the supply-air side, where pressure is higher. Survey the area on a regular basis to see that access panels are not blocked by equipment, furniture, or other obstructions.

Duct leakage tests should be conducted once every two years or following a change to the duct system or replacement of HVAC equipment. Duct leaks can be sealed using the traditional mastic on the outside of the duct joints or from the inside with the aerosol sealing system. When sealing from the inside, and while taking appropriate precautions, workers should test and seal the ducts at the same time. Leaks should be plugged through small droplet deposits around the edge of the leaks.

If the opportunity arises to replace the air distribution system, use ducts, rather than building cavities, for ventilation, and keep ducts out of unconditioned spaces. Consider the shape and size of the ducts for energy efficiency. Larger ducts require less pressure and energy, and round ducts are more efficient at delivery than rectangular ones. As with existing systems, insulate and seal the ducts to prevent energy loss during transport and minimize leakages.

Damper and Economizer

One of the most common problems with HVAC systems is improperly operating or leaking outside air dampers, which can affect not only energy efficiency but also indoor air quality.

An economizer is a set of automatically controlled dampers that can open to draw 100 percent outside air for free cooling, or close to a minimum position for ventilation when the outdoor air temperature is higher than indoors or when the outdoor air is very cold. Economizers have significant energy savings potential but require constant maintenance to work over the long term. The moving parts in economizers may cause reliability issues and require constant maintenance.

If stuck open, dampers and economizers overload the cooling coil with hot outside air; if stuck closed, they lose the opportunity for free cooling. Moveable surfaces should be cleaned and lubricated every three to six months. If this maintenance causes a 5-ton compressor to operate even one or two fewer days, the energy savings will pay back the additional labor cost.²⁰

Heat Exchange Coils

Dirty condenser and evaporator coils reduce cooling capacity and make the compressor work harder and longer. Cleaning the condenser coil is one of the most cost-effective maintenance steps for the HVAC system O&M. A dirty coil that raises condensing temperature from 95°F to 105°F cuts cooling capacity by 7 percent and increases power consumption by 10 percent, with a net compressor efficiency reduction of 16 percent. In a 10-ton unit operating 1,000 hours per year, this can waste more than \$120 per year in electricity costs.

A dirty evaporator coil reduces air flow and degrades heat-transfer efficiency. Although the evaporator coil should stay fairly clean with good air filtration, it should be inspected at least once a year and cleaned as required.

Refrigerant Charge and Compressor

An improper refrigerant charge reduces compressor efficiency. In an overcharged system, the compressor works harder to overcome increased head pressure. In an undercharged system, the evaporator does not have enough refrigerant and cooling capacity is lost. Either condition may be due to improper charging,

but insufficient refrigerant is usually due to a leak, for which repair costs may range widely. Thus, it is important to check the air conditioning system at least quarterly, not only for proper refrigerant charge, but also system fitting leaks.

Compressors are checked by measuring the current draw and by analyzing the oil to see if moisture or acid are present. Inexpensive temperature indicator tapes may be used to measure case temperature, a frequent precursor of compressor failure. Compressor maintenance should be handled based on the manufacturer's guidelines.

Ventilation

Adequate ventilation is an essential part of maintaining a healthy and comfortable building environment. ASHRAE 61-2001 requires 15 cubic feet per minute of outdoor air per occupant. Besides fan power, a considerable amount of energy can be required to bring this outside air to the proper temperature and to control humidity. Therefore, ventilation levels should be reduced as much as possible, consistent with code and health standards. During the heating season, unoccupied areas should not be ventilated (with the exception of special areas such as boiler and mechanical rooms, pools, or rooms with caustic chemicals).²¹

In the cooling season, a good ventilation strategy is essential for humidity and mold control.²² Use of the air conditioning system to control mold is complex; while it can lower humidity, its effectiveness depends on many factors. During low load periods, such as when the building is unoccupied, the latent heat performance of most air conditioning systems is poor, so they do not remove much moisture.

Every three to five years, the air flow rates should be tested to ensure they meet requirements. Low air flow causes lower cooling efficiency and reduced total cooling capacity. The maintenance plan should list the appropriate air flow supply for each system. The plan should also describe the air flow measurement method. Refer to the Action Plan for specific test plan details.

²⁰ Environmental Protection Agency, *Putting Energy Into Profits—ENERGY STAR Small Business Guide*, December 1997.

²¹ Association of School Business Officials International, *School District Energy Manual*, 1998.

²² The Environmental Protection Agency has developed a *School Advanced Ventilation Engineering Software (SAVES)* package that contains an Indoor Humidity Assessment Tool.

Additional Resources

For more information on ventilation levels, visit:

- *IAQ Tools for Schools Kit, IAQ Coordinator's Guide, Appendix H, Mold and Moisture*, www.epa.gov/iaq/schools/
- Florida Solar Energy Center, *Priorities for Commercial Buildings*, www.fsec.ucf.edu/en/consumer/buildings/commercial/priorities.htm

Controls

Of all the O&M processes, verification of the control settings can have the biggest impact on energy consumption. It is important to ensure that the following control settings match the values in the facility maintenance plan. They may have been altered by users or may have become faulty.

- Setback and setup temperatures
- Start and stop times
- Fan operations
- Adequate dead band between cooling and heating operation (or manual changeover between heating and cooling mode)
- Heat pumps controlled to use electrical strip heaters, only when necessary
- Pressure
- Humidity
- Carbon monoxide
- Carbon dioxide

Some successful school districts have established policies and procedures for maintaining temperature settings. ASBO International's *School District Energy Manual* states that many school districts use 68°F for heating and 78°F for cooling in classrooms.²³ Montgomery County, Maryland, Public Schools sets temperatures at 70°F heating and 76°F cooling.²⁴ In addition, check for proper operation of thermostats and calibrate temperature set points quarterly. Determine if any control changes need to be made

²³ New Jersey Association of School Board Officials, *International. School District Energy Manual*, 1998.

²⁴ Montgomery County Public Schools, *Bulletin*, March 30, 2009. <http://www.montgomeryschoolsmd.org/bulletin/article.aspx?id=43332>

²⁵ U.S. Department of Energy, *Rebuild America EnergySmart Schools Programs: National Best Practices Manual for Building High Performance Schools*, p. 298.

due to factors such as occupant discomfort, and update the maintenance plan accordingly.

Programmable thermostats, which range from \$50 to \$200, are cost effective. Where an energy management system is not used for temperature control, a programmable thermostat installed in a room can increase energy savings and enhance comfort. Programmable thermostats must be set properly to achieve energy savings and increase occupant comfort. This step requires training of the teachers or other staff who will be using them.

A central Energy Management System (EMS) can be either a great benefit or a major time drain for a district. The EMS needs constant monitoring by O&M personnel trained to use it. System scheduling needs to be updated according to building use. The system should be recalibrated once or twice a year²⁵ to adjust for daylight-saving time changes, meet current building-use demands, and reduce energy use, where appropriate.

Miscellaneous

Inspections and fixes of other systems, such as piping and electrical connections, may also lead to better energy efficiency. Piping insulation should be checked annually as it tends to degrade over time, especially if exposed to sunlight. Loose electrical connections not only pose a danger but also may lead to overheating or improper equipment operation. Inspect electrical connections twice a year and tighten, if necessary. For safety reasons, shut off all power to the unit before handling.

All of these O&M recommendations require attention to building systems and changes in behavior. The facilities staff needs to be aware of the value of preventative maintenance and inspections. Energy savings are achieved through continuous monitoring and improvement.

Students, teachers, and staff should monitor and maintain thermostats and windows. They should understand the importance of the following tasks:

- Keep thermostats set at the appropriate level
- Do not open windows and turn on the thermostat at the same time
- Turn off thermostats when rooms are unoccupied

Design/Renovation Recommendations

Replacing older equipment with newer, more efficient units can save a significant amount of energy. Replacement will be most cost effective when energy prices are very high or the existing equipment is near the end of its useful life.

Additional Resources

For more information about energy-efficient equipment and building features that can be used during a retrofit project, visit:

- *ASHRAE Advanced Energy Design Guide for K–12 School Buildings*, www.ashrae.org/publications/page/1604
- ENERGY STAR, www.energystar.gov/commercialbuildingdesign
- *The Collaborative for High Performance Schools Best Practices Guide*, www.chps.net

Water Heating

Refer to the **Water Heating Action Plan** for a customizable checklist of O&M measures, trainings and communications.

Action Plan Template • WATER HEATING—Page 1

Action
Monthly
Walk-through check for leaks and pipe corrosion <ul style="list-style-type: none"> - Pipes - Valves - Fixtures
Track water usage and compare seasonally
Identify water usage disparities and adjust O&M
Maintain notes on service records and electricity consumption. Prepare the notes when the information is fresh
Compare water consumption with similar school buildings seasonally, normalized for heating degree days
Quarterly
Walk-through check: <ul style="list-style-type: none"> - Burners - Gauges - Pumps
Bi-Annually
Calibrate water temperature setpoints to between 120°F and 140°F
Annually
Establish and re-evaluate policies and procedures for maintaining temperature settings
Flush water heating system with hot water including storage tanks and pipes. Sediments reduce heat transfer efficiency
Inspect piping insulation annually, as it tends to degrade over time, especially if exposed to sunlight
Training
Train O&M personnel: <ul style="list-style-type: none"> - Setting water temperature - Identifying aging insulation - Identifying leaks
Train facilities staff to conduct water heating energy consumption comparisons with similar school buildings (season-to-season comparison, normalized for heating degree days)
Train facilities staff to maintain detailed notes on the equipment service records and energy use (fuel consumption). Prepare the notes when the information is fresh

On average, water heating is responsible for 8 to 11 percent of a school's energy demand. Routine servicing addresses three possible sources of water heating inefficiency:

- Recovery efficiency, or how effectively heat is transferred from burner to water
- Standby loss, or the heat lost from the water stored in the tank
- Cycling loss, or the heat lost from water as it cycles through the heater, pipes, and valves

An effective water heater preventative maintenance plan addresses all of these areas and also increases the lifetime of the equipment. The typical hot water heater must be replaced every 10 to 15 years.

The first step for effective operations and maintenance of water heaters is routine inspection. Any leak from a valve, pipe, or fixture is a source of energy inefficiency because lost water translates into more water that must be heated. Pipe repairs typically have a payback of one to two years and leakage can be spotted by looking for corrosion on pipes and fixtures. Other routine maintenance includes checking burners, gauges, and pumps at least once a year. If a pump's motor is vibrating unnecessarily, the pump may not be functioning at the right pressure and needs to be replaced. Lastly, insulation should be properly maintained to minimize heat lost during storage and as water circulates through the entire system. This repair will typically pay for itself in less than six months.

Another important low-cost measure that improves energy efficiency is periodic flushing of the hot water system. This maintenance removes sediments from the system that reduce heat-transfer efficiency. Hot water storage and pipes should be flushed once or twice a year.

Shutting off water heating for extended periods when it is not needed, such as during the summer months, and lowering the temperature range of hot water decreases energy usage. It is helpful to set water heaters on timers, which are inexpensively priced at \$40 to \$50 per unit. A mixing valve can be used to limit the temperature range of hot water faucets to 140°F; the Plumbing Manufacturing Institute recommends a range higher than 130°F for health reasons. The financial payback for this temperature setback strategy is less than six months.

Design/Renovation Recommendations

Replacing storage water heaters with tankless water heaters eliminates the need to store hot water and avoids standby losses. Tankless water heaters can be used in most applications and should be located as close as possible to their point of use. However, storage water heaters are generally necessary in areas that require large volumes of hot water, such as cafeterias, kitchens, and gymnasiums.

Another redesign option is to install booster water heaters for areas of a school that need water at a higher temperature. For example, kitchens often require temperatures above 140°F for dishwashing. Booster heater installation costs should be monitored closely and compared to energy use from centralized water heating alternatives.

Building Envelope

Refer to the **Building Envelope Action Plan** for a customizable checklist of O&M measures, trainings, and communications.

Action Plan Template • BUILDING ENVELOPE—Page 1

Action
Monthly
Ensure all doors and windows are closed when the air-conditioning or heating system is operating
Ensure all freight or overhead doors are closed when they are not in use
Maintain notes on service records and electricity consumption. Prepare the notes when the information is fresh
Compare building envelope energy consumption with similar school buildings seasonally, normalized for heating degree days
Quarterly
Check for and repair building leaks in the following areas:
- Doors (caulking and weather-stripping)
- Windows (caulking and weather-stripping)
- Foundation (caulking and weather-stripping)
- Walls (caulking and weather-stripping)
- Roofs (caulking, weather-stripping, clean roof drain screens)
Bi-Annually
Annually
Inspect all attic spaces to monitor and maintain proper attic space ventilation (unless the space was specifically designed as non-vented space). Note, exhaust system should not exhaust into the attic space, especially if it contains moisture. Exhaust diminishes insulation effectiveness
Training
Train facilities staff to conduct building envelope energy consumption comparisons with similar school buildings season-to-season comparison, normalized for heating degree days
Train facilities staff to maintain detailed notes on the equipment service records and energy use (electricity consumption). Prepare the notes when the information is fresh
Train facilities staff, teachers, students, and staff not to open doors and windows when the air-conditioning or heating system is operating
Train facilities staff to close all freight or overhead doors when not in use
Train facilities staff how to check for and repair building leaks in the following areas:
- Doors (caulking and weather-stripping)
- Windows (caulking and weather-stripping)
- Foundation (caulking and weather-stripping)
- Walls (caulking and weather-stripping)
- Roofs (caulking and weather-stripping)

While it is easiest to incorporate building envelope energy efficiency into new buildings, existing building envelopes also can be optimized for energy efficiency. Retro-commissioning or energy audits will identify potential retrofit options that can require large capital expenditures and will result in greater cost savings. These retrofits can be complex and expensive, but they are always worth evaluating. This guide will only explore options that are low-cost or that are necessary for health and safety.

The simplest approach to a building envelope O&M task is to monitor doors and windows and maintain the integrity of the building envelope by finding and repairing leaks. All doors and windows should be closed when the air conditioning or heating system is operating, including unused freight or overhead doors. Make sure that doors and windows close tightly and check the caulking and weather-stripping for leaks. Caulking and weather-stripping help minimize air infiltration and can reduce energy waste. This O&M action affects energy use, as well as school security.

Caulking and applying weather-stripping to the building's foundation, walls, and roofs also can protect the building from water leaks that cause mold growth, a major health problem in schools. Moisture can come from leaks in the roof, walls, or windows, from plumbing, or from condensation on cool surfaces, such as pipes and air ducts.²⁶

The following indicators of a poor building envelope should be checked on a regular basis and improved by caulking or weather-stripping:

- Complaints regarding drafty areas
- Doors remaining ajar
- Cracked caulking at joints
- Light visible in cracks
- Water marks

²⁶ Charlene W. Bayer et al., *Causes of Indoor Air Quality Problems in Schools*, Oak Ridge National Laboratory, ORNL/M-6633/R1, May 2000, p. 5.

Monitoring the building envelope for energy efficiency will require cooperation from the students, teachers, and staff who occupy the buildings—and an understanding of the consequences of opening doors and windows while the HVAC system is operating. It is important to train and communicate to building occupants the importance of closing all doors and windows when the air conditioning or heating system is operating.

Design/Renovation Recommendations

When a building is being retrofitted, consider energy-efficient options for foundations, floors, exterior wall types (insulation, sealants, etc.), roofs, windows, and doors. Many of these options will have a higher upfront cost than their inefficient counterparts but will pay for themselves in reduced energy use and maintenance costs in two to 10 years. The contractor, engineer, or architect in charge of the project will be able to design a system that fits the school or district. Many of these options also significantly increase occupant health and comfort and may provide educational opportunities for students. Such measures may include:

- Doors and windows
 - Upgrade to more energy-efficient windows and doors. Replace windows with at least double-paned or low-emissivity coating windows to reduce cooling and heating costs
 - Install vestibules with two sets of doors
- Roof
 - Upgrade roofing reflectivity
 - Install vegetative roofs
 - Upgrade roof insulation
- Walls
 - Upgrade insulation in exterior walls
 - Install shading and flora on the exterior
 - Use reflective coloring
- Upgrade foundation insulation
- If reconstructing building, consider a southern building orientation

Additional Resources

- *Advanced Energy Design Guide for K–12 School Buildings, Achieving 30 percent Energy Savings Toward a Net Zero Energy Building*, ASHRAE, June 2008, www.ashrae.org/freeaedg
- National Fenestration Rating Council, www.nfrc.org
- National Clearinghouse for Educational Facilities, *Resource List: Roof Maintenance and Repair for Schools*, www.edfacilities.com/rl/roof_maintenance.cfm
- Roof Consultant Institute, www.RCI-Online.org
- Roof Coatings Manufacturers Association, www.roofcoatings.org

Distribution Transformers

Refer to the **Transformers Action Plan** for a customizable checklist of O&M measures, trainings, and communications.

Action Plan Template • TRANSFORMER

Action
Once
Prior to renovations, sample test building distribution transformers to determine the loading profile. Right-size distribution transformers based on the loading profile and use the most efficient distribution transformer allowed Code
Monthly
Clean transformer rooms: - Clean cooling fins - Inspect transformer rooms to ensure transformers are not blocked by storage material. Remove any storage material to avoid excess heat build-up
Quarterly
Bi-Annually
Annually
Training
Communications
Other Actions

Schools built or renovated since the late 1960s normally contain several dry transformers that transform the 480/277 volts entering the building to the 120/208 volts used in outlets throughout the building. These transformers range in size from 15 kVA to 500 kVA and are placed in either mechanical rooms or electrical closets throughout the building. An existing 75 kVA transformer, typical in most schools, consumes more than 850 watts per hour per day of electrical energy to energize its core without any load on the transformer. This consumption is all day, every day, whether in use or not.

Although transformers are no longer ENERGY STAR qualified, upgrading to a CSL-3 75 kVA transformer is an improvement on the federally mandated minimum TP-1 transformer. This retrofit will reduce the wattage needed to energize the transformer to 180 watts, saving between 200 and 700 watts per hour. The CSL-3 75 kVA transformer has an efficiency of 98.3 percent at 16.7 percent loading and has total energy losses 30 percent less than the legislated minimum TP-1. Though the CSL-3 has a lower life-cycle cost, its initial cost is between 30 and 35 percent higher.

To lower the loading on transformers, test the existing transformers prior to renovations to determine the current loading profile. Results likely will show that the replacement transformer sizes can be a third or half the original size.

Note: New designs are required to follow the National Electric Code, which will result in significantly larger transformers than are actually needed. Existing transformers can be replaced with smaller units when load testing shows the units' actual loads.

Plug Loads

Refer to the **Plug Loads Action Plan** for a customizable checklist of O&M measures, trainings, and communications.

Action Plan Template • PLUG LOADS—Page 1

Action
Once
Install computer hibernation settings on network
Install power strips to help students and teachers turn off appliances and equipment together when not in use Note: Do not overload the power strip and/or building circuit
Conduct a survey of all the plug-in appliances <ul style="list-style-type: none"> - Determine their loads - Identify the appliances that may be turned off during after-school hours - Identify the appliances with phantom loads and implement an unplug plan
Daily
Check and unplug any equipment or appliances that are not in use (turning off may not be enough; some appliances draw phantom loads, even when off). Students and teachers are the best group to conduct this check <ul style="list-style-type: none"> - Computers - Televisions - DVD players - VCRs - Projectors - Radios - CD players - Printers, scanners, fax machines, copiers - Desktop and floor lamps - Coffee makers - Personal electric heaters - Toaster ovens - Etc.
Monthly
Set computer hibernation settings to shortest tolerable time (recommended 30 minutes)
Recognize students and staff for good computer energy efficiency habits
Maintain notes on service records and electricity consumption. Prepare the notes when the information is fresh
Compare plug load energy consumption with similar school buildings seasonally, normalized for heating degree days
Quarterly

Office, instructional, vocational, and cleaning equipment, as well as personal appliances brought from home, are considered plug loads in schools and can account for up to 25 percent of the electricity consumed annually. Most of this equipment is left on all day. To conserve energy from these loads, O&M procedures should include management approaches. If the average computer is left running, it will consume \$285 of electricity over its lifetime (depending on the electricity rate).²⁷ Monitors consume approximately two-thirds of this energy.

Adjusting built-in activity features is a simple strategy to achieve energy savings without requiring significant staff resources. Most pieces of office equipment are used for only a few hours a day and can be set to low-power modes. At night, the equipment should be shut down. ENERGY STAR recommends setting systems to hibernate after a half-hour or an hour, but the shorter this time, the more savings. Even in cases where a computer must be left on for remote access, shutting down its monitor will produce energy savings.

²⁷ Cost savings calculated using ENERGY STAR savings calculator. Savings will vary with electricity rate.

Low-Cost and No-Cost Computers and Office Equipment Strategies

- Computers use about twice as much energy as monitors, and, unlike monitors, computers' sleep settings are rarely activated. The ENERGY STAR Low Carbon IT campaign provides free software that sets computers across a network to enter a low-power sleep mode automatically, saving organizations up to \$50 per computer. For more information, visit: www.energystar.gov/lowcarbonit
- ENERGY STAR qualified copiers can provide energy savings of 30 percent over a standard copier.
- Individual printers should be turned off when not in use. Printers that must be online all the time can save as much as \$15 a year by implementing an ENERGY STAR power-down feature.

Additional Resources

Free software from the ENERGY STAR Power Management Program (www.energystar.gov/powermanagement) can apply energy saving features across entire networks. ENERGY STAR calculates energy savings of up to \$50 per computer.

Student and faculty participation is integral to successful energy management of computer and office equipment. A computer energy savings program establishes computer responsibilities for students and faculty. One option to increase participation in energy management is to establish a program recognizing students or faculty members for energy saving actions. Options for awards programs are given in **Chapter 2**.

Other Appliances in Schools

Computers are not the only plug loads that contribute to electrical energy waste. Any device with a power switch can be a load and managing that load helps save electricity and money. Plug loads have been found to contribute to the electrical usage in a school by as much as 25 percent with an average range of 10 to 20 percent.

Other oft-overlooked plug loads include: televisions, DVD players, VCRs, overhead and LCD projectors, radios, CD players, fish tanks, microwave ovens, vocational equipment, and sound systems.

Teachers and staff members' personal appliances can significantly add to energy use and waste. These appliances include electric heaters, coffee makers, mini-refrigerators, hot plates, microwave ovens, popcorn poppers, cappuccino machines, table-top lamps, and toaster ovens. Regardless of the purpose, reducing the use of plug load items by turning them off, unplugging them, and controlling their use can reduce electricity consumption by as much as 50 percent. Using automated controls for these loads and educating the staff about them can help reduce energy waste during after-school hours.

Often, it is not enough to turn off the appliances. Some appliances, such as VCRs, draw standby power, even when turned off. This is known as a "phantom load," which can draw up to 5 percent of the electrical consumption. Usually, phantom loads are created by equipment with electronic clocks, timers, or remote controls; portable equipment; and office equipment with wall attachments, such as a cell phone docking station. The only way to eliminate phantom loads is to unplug the device. Power strips can help the unplugging process if multiple appliances are attached to the power strip and turned off there.

Design/Renovation Recommendations

Through their normal procurement processes, schools and districts can purchase ENERGY STAR qualified equipment that will decrease energy bills. These computers, copiers, printers, and other equipment have built-in low-power modes for periods of inactivity. ENERGY STAR qualified printers and fax machines print double-sided, increasing paper savings.

Kitchen Equipment

Refer to the **Kitchen Equipment Action Plan** for a customizable checklist of O&M measures, trainings, and communications.

Action Plan Template • KITCHEN EQUIPMENT	
Action	
Monthly	
Routinely clean coils and vents	
- Refrigerators	
- Ovens	
- Fryers	
- Ice makers	
- Dishwashers	
Reduce preheating and non-use times for appliances	
Maintain notes on service records and electricity consumption. Prepare the notes when the information is fresh	
Compare kitchen equipment energy consumption with similar school buildings seasonally, normalized for heating degree days	
Quarterly	
Bi-Annually	
Annually	
Ensure adequate amounts of make-up air for kitchen exhaust systems, to avoid exhausting conditioned air	
Training	
Train facilities staff to conduct kitchen energy consumption comparisons with similar school buildings and season comparison, normalized for heating degree days	
Train facilities staff to maintain detailed notes on the equipment service records and energy use (electricity consumption). Prepare the notes when the information is fresh	
Train staff on importance of reducing preheating and non-use times for appliances	
Communications	
Communicate importance of reducing preheating and non-use times for appliances	
Communicate the importance of conducting kitchen energy and water consumption comparisons with similar schools and season-to-season comparison	
Communicate the importance of maintaining notes on service records and electricity consumption for kitchen	
Communicate kitchen equipment energy consumption comparison results to school and district administrators to demonstrate the benefits of energy management	
Maintain adequate communications between central staff and building operators	

Schools can optimize their operations and maintenance of ovens, warmers, mixers, vent hoods, refrigerators, and dishwashers to minimize energy consumption. According to Pacific Gas and Electric's Food Service Technology Center, the commercial food sector wastes as much as 80 percent of the energy it buys.

While keeping appliance surfaces clean is a priority for sanitation and health, cleaning hidden coils and vents should not be overlooked. Reducing the operating time of kitchen appliances can reduce energy consumption by as much as 60 percent. For example, ovens should need no longer than 15 minutes to preheat and oven fans should only be operated when stoves are in use. Operate vent hoods only when necessary.

Design/Renovation Recommendations

Schools can purchase efficient appliances that use as much as 50 percent less energy than their conventional counterparts. ENERGY STAR qualifies fryers,

refrigerators, steam cookers, dishwashers, and ice makers. Also, consider installing variable steam drive vent hoods and using convection ovens, which are more energy efficient than standard-bake ovens.

Swimming Pools

Refer to the **Swimming Pools Action Plan** for a customizable checklist of O&M measures, trainings, and communications.

Action Plan Template • SWIMMING POOL	
Action	
Monthly	
Ensure that the swimming pool is covered when unused	
Maintain the pool for the following settings:	
- Correct water temperature control	
- Nighttime setback	
- Proper filter cleaning	
Maintain notes on service records and electricity consumption. Prepare the notes when the information is fresh	
Compare swimming pool energy and water consumption with similar school buildings seasonally, normalized heating degree days	
Quarterly	
Bi-Annually	
Annually	
Training	
Train facilities staff to conduct swimming pool energy consumption comparisons with similar school buildings season-to-season comparison, normalized for heating degree days	
Train facilities staff to maintain detailed notes on the equipment service records and energy use (electricity consumption). Prepare the notes when the information is fresh	
Train pool maintenance staff, students, teachers, and staff to maintain the pool for energy efficiency and to cover the pool cover	
Communications	
Communicate the importance of conducting pool energy and water consumption comparisons with similar schools and season-to-season comparison	
Communicate the importance of maintaining notes on service records and electricity consumption for pools	
Communicate swimming pool energy consumption comparison results to school and district administrators to demonstrate the benefits of energy management	
Maintain adequate communications between central staff and building operators	
Other Actions	

The annual energy cost of maintaining an indoor pool can exceed \$20,000.²⁸ Daily use of a pool cover is the single most effective energy management technique for pools. Pool covers reduce the need to heat make-up water, and the reduced humidity means less energy for ventilating and conditioning the intake air. Water evaporation accounts for approximately 70 percent of energy loss for indoor and outdoor pools. Energy savings of 50 to 70 percent are possible, along with 30 to 50 percent in make-up water, and 35 to 60 percent in chemicals. Most maintenance staffs agree that no significant effort is required as the covers glide easily across the pool surface. These personnel reel in the covers in the morning, and lifeguards (or the last user) reel out the pool cover at night. The following energy-saving

28 Florida Solar Energy Center, FSEC-CR-951-97. <http://www.fsec.ucf.edu/en/publications/html/FSEC-CR-951-97/>

practices also reduce the energy needed to heat make-up water:

- Correct water temperature control
- Check nighttime setback
- Properly clean filter

As with any of the technical systems, training and communication lead to behavioral changes. Everyone involved with using and maintaining the pool, such as the pool manager, students, teachers, and staff, should be aware of the importance of covering the pool when it is not in use. Facilities staff should establish protocols dictating who is responsible for covering the pool after use.

Chesaning Union Middle School in Chesaning, Michigan, reduced pool energy costs by half in just eight months with the implementation of a pool cover system.

Building Automation Systems

Refer to the **Building Automation System Action Plan** for a customizable checklist of O&M measures, trainings, and communications.

Action Plan Template • BUILDING AUTOMATION SYSTEMS

Action
Once
Upon the initial installation of the control system, request the system installer to check the program and build ensure proper system operation. Note: Setting the control system parameter to the mechanical engineering specifications without confirming the settings with actual building operation may not be energy-efficient
Monthly
Check and calibrate BAS settings for accuracy and adherence to the building operations manual If BAS has data trending and downloading function, analyze BAS data for areas of potential energy savings. reference BAS data with benchmarking and baselines Compare school energy consumption with similar school buildings seasonally, normalized for heating degree days
Quarterly
Bi-Annually
Annually
Training
Train facilities staff how to use all of the functionalities of the BAS Train facilities staff on the importance of the BAS for energy management Train facilities staff to conduct school building energy consumption comparisons with similar school buildings season-to-season comparison, normalized for heating degree days Train facilities staff to maintain detailed notes on the equipment service records and energy use (electricity consumption). Prepare the notes when the information is fresh
Communications
Communicate the importance of the BAS for energy management and all the BAS's capabilities to monitor the building Communicate energy consumption comparison results to school and district administrators to demonstrate the benefits of energy management Maintain adequate communications between central staff and building operators
Other Actions

A building automation system (BAS) can be used to customize buildings' operations and optimize energy use. It can be used to schedule buildings' setbacks, startup times, and settings based on outside conditions and to create day, night, weekend, seasonal, and vacation settings.

Building automation systems, or energy management systems (EMS), go hand-in-hand with performance measurement and data collection, as mentioned in the previous section and in **Chapter 1**. The data analysis will provide justifications and insight for making adjustments to the BAS settings.

Some systems can graph energy trend data. This information can provide insight into system abnormalities, such as spikes in energy use and simultaneous heating and cooling, and can help identify areas for energy savings, such as a delayed startup at the beginning of the school day or an expedited shut-down at the end of the school day.

To fully utilize the features of the BAS, facilities personnel need to be well trained in using the system and interpreting its energy savings suggestions. If used incorrectly, the result can be energy waste, rather than energy savings.

One drawback to extensive energy data collection is that the process can be demanding on staff and resources. To simplify it, schools can use a computer-based application to manage data. Data stored electronically are more easily accessed, transferred, and analyzed. Information software should be compatible with the district's or school's other systems. Districts larger than 500,000 square feet often dedicate a full-time staff position to energy data collection and analysis. For districts larger than 1.5 million square feet, additional staff may be required.

Other Special Equipment and Considerations

Refer to the **Other Action Plan** for a customizable checklist of O&M measures, trainings, and communications.

Action Plan Template • OTHER

Action
Monthly
Check portable classroom programmable thermostat settings
Reduce non-use times for heavy appliances
Maintain notes on service records and electricity consumption for portable classrooms. Prepare the notes when information is fresh
Compare portable classroom energy consumption with similar school buildings seasonally, normalized for heating degree days
Quarterly
Check portable classroom insulation for air leaks
Bi-Annually
Annually
Training
Train facilities staff to conduct portable classroom energy consumption comparisons with similar school buildings and season-to-season comparison, normalized for heating degree days
Train facilities staff to maintain detailed notes on the equipment service records and energy use (electricity consumption). Prepare the notes when the information is fresh
Communications
Limit use of heavy specialty appliances to non-peak hours
Communicate to staff and faculty the portable classroom programmable thermostat temperature policy
Communicate the importance of conducting portable classroom consumption comparisons with similar school buildings and season-to-season comparison
Communicate the importance of maintaining notes on service records and electricity consumption for portable classrooms
Communicate portable classroom energy consumption comparison results to school and district administrators to demonstrate the benefits of energy management
Maintain adequate communications between central staff and building operators
Other Actions

Vending Machines

It can cost as much as \$350 to operate one vending machine for a year. Using a timer, these units can be shut down during non-school hours to save as much as 47 percent of energy costs. Lights on the vending machine can either be deactivated or they can be upgraded from T-12 to T-8 to save approximately 1,000 kWh per year.

Low-Cost and No-Cost Vending Machines Strategies

- Vending machines that operate constantly can cost anywhere from \$200 to \$350 annually. Installing energy control devices to can save as much as 47 percent annually.
- Some beverage wholesalers install timers on school vending machines for free, so ask the vendor about these commercially ready devices.

Kent Intermediate School District, Grand Rapids, Michigan

Enrollment: 2,800

Number of Schools: 5

As an early adopter of building automation system (BAS) technology, Kent Intermediate School District has been reaping benefits for years. Its BAS screens for conditions approaching emergency levels, and, with software integration, it automatically opens a pre-emptive work order in the district's on-demand work order management system. This has helped avoid costly catastrophic equipment failure, which saves time, money, and energy. With thresholds set by maintenance technicians, the BAS never reaches poor performance levels and consequently avoids excessive energy consumption.

The most prominent energy savings, however, stems from the integration of the BAS with the district's facility use scheduling system. After-hours events that use the HVAC system are pre-scheduled by zone, allowing the district to conserve energy by not heating or cooling rooms not in use after school. The BAS automatically returns the HVAC system to its normal schedule after the event is complete. While quantifying savings is not easy, because the district has multiple energy savings methods in place, officials believe this effort alone has generated a 3 percent savings. The effort also has recovered hours of technician time previously lost to daily schedule overrides.

Source: www.schoolde.com, March 2009.

Portable Classrooms

Schools often use portable classrooms to house offices or overcrowded students. These spaces are often exclusively powered by purchased electricity, and the operating cost per unit may be as much as twice that of a conventional space. Portable classrooms should be properly insulated and checked for air leaks. Also, programmable thermostats can control heating and cooling systems so they operate only when the building is occupied. Reduced lighting will decrease cooling loads.

Additional Resources

- Refer to the *CHPS Best Practices Manual, Volume VI, Relocatable Classrooms*, for more detailed information on purchase and site considerations.
- Refer to the *Portable Classrooms and Modular Construction Resource List* at the NCEF Web site for more resources, www.edfacilities.org/rl/portable.cfm
- Refer to the *Preliminary Evaluation of Performance Enhanced Relocatable Classrooms in Three Climates* for more information, www.fsec.ucf.edu/en/research/buildings/schools/perc/

Transportation

Fuel use for transporting students to and from school might not seem like a direct school energy-efficient O&M issue, but it contributes to the overall energy cost for a school and its district. Schools around the country, like those in the Poudre School District in Colorado, are starting to implement an idle reduction policy to conserve fuel and improve the air quality at bus stops. Schools also have used GPS devices and online mapping tools to identify optimum routes for pick-up and drop-off to conserve fuel.

Extending the concept of school transportation even further, schools can consider reducing the energy used by teachers and parents. Developing ride-sharing programs throughout the community—among PTA members and teachers, for example—can save considerable amounts of fuel and cut down on traffic on school access roads and driveways. Although there is no direct financial impact for the school, the community may appreciate the program and become greater champions for the energy-efficient O&M cause.

Additional Resources

The *Safe Routes to School Guide* is a comprehensive online reference manual designed to support the development of Safe Routes to School programs. SRTS programs use a variety of education, engineering, and enforcement strategies that help make school routes safer for children to walk and bicycle. The programs also use encouragement strategies that entice more children to walk and bicycle. For more information, visit: www.saferoutesinfo.org/guide/

Action Plan Templates

The **EnergySmart Schools O&M Action Plan Templates** are customizable checklists used for planning and implementing energy-focused operations and maintenance for districts with all levels of experience, available funding and staffing resources. The Action Plans, which are organized by building system component (listed and color coded below), are valuable tools as senior facilities management and staff schedule preventative maintenance and training.

The action items listed within the templates are comprehensive and applicable to a wide range of school districts of varying sizes, locations, levels of experience, available resources, and phases in the energy management process. **Various action items listed within the Action Plan Templates may not apply to all districts due to a variety of factors (e.g., experience level, funding level, staffing requirements, etc.). Customize the Action Plans to yield the best results for your school district, and adapt and integrate them into existing work order and/or maintenance programs, if applicable.** Alternatively, the Action Plan Templates provide a robust starting point that can be used to develop an O&M plan that takes energy efficiency into account from the start.

NOTE: All recommended action items are based on research and industry outreach efforts that involved experts in the field. Modify the templates to fit your district’s needs (e.g., frequency of implementation, priority of actions). Additionally, use the Action Plans in conjunction with equipment-specific user manual recommendations for preventative maintenance and operation.

The EnergySmart Schools Program’s Web site (www.energysmartschools.gov) provides the Action Plans in a downloadable Microsoft Excel (MS Excel) format and portable document format (PDF). In conjunction with the Guide, the U.S. Department of Energy will also provide the Action Plans in hard-copy format upon request. Refer to the EnergySmart Schools Web site for contact information.

Action Plans

- Benchmarking
- Lighting
- HVAC
- Water Heating
- Building Envelope
- Transformer
- Plug Loads
- Kitchen Equipment
- Swimming Pool
- Building Automation Systems
- Other

Legend: Key Features	
Action	Specific operations and maintenance action items recommended for facilities staff to implement. The “Actions” are grouped by the frequency of implementation (e.g., Once, Daily, Monthly, Quarterly, Bi-Annually, Annually, Once Every Multiple Years), and by “Training” or “Communications” specific actions.
Roles & Responsibilities	Location for facilities staff or school officials to designate the individual or group of individuals responsible for each corresponding action.
Implementation Dates	Location for the individual or group of individuals responsible for the corresponding action to fill in the date an action was completed. For example, it is recommended that districts clean their air-conditioner filters and fans monthly. Thus, there are 12 implementation date boxes allotted.
Notes	Location for the individual or group of individuals responsible to notate any issues, challenges, follow-up actions, or other miscellaneous activity that may correspond with a given action.

NOTE: The “Roles & Responsibilities, Implementation Dates, and Notes” sections are most applicable to districts using the Action Plans as their primary O&M system, rather than integrating specific actions into existing operation and maintenance protocol.

Appendix A: Additional Questions for Staff During Initial Data-Gathering

Questions for Administrators/Senior Facility Staff

Energy Policy and Building Operations Procedures

- 1) Does the district have an overarching energy policy and a procedures manual of standard O&M practices that are actively applied in all schools?
- 2) If yes, when were these policies developed and last presented to O&M and administrative staff members?
- 3) Are O&M staff members aware of these policies and actively adhering to their objectives?

Building Energy Information

- 4) Who receives the utility bills? Are they reviewed and tracked for accuracy by the facilities staff?
- 5) Is annual district energy use increasing or decreasing? What is the explanation?
- 6) Are energy costs increasing or decreasing?
- 7) Is energy usage tracked monthly, and who does the tracking?
- 8) If yes, does the district periodically compare the energy consumption of specific buildings and use this information to identify problems in specific schools?
- 9) If yes, is this information made available to the principal and the operations staff at individual schools?
- 10) How does energy use per square foot at certain schools compare to use at schools at this and other districts?

School Condition and Operations

- 11) What is the age and general condition of each building?
- 12) What are the major problems with respect to school physical plants, such as advanced age, poor system or temperature control, indoor air quality, and staffing?

- 13) Has building profile/inventory information, such as size, occupancy, heating fuel type, and age, been collected, validated, and made available?
- 14) Does the central office or maintenance director currently have software, such as Computerized Maintenance Management System (CMMS), or other capabilities to plan, track, or schedule maintenance activities at individual schools, particularly for large systems such as heating and cooling systems?
- 15) Have recent energy audits been performed in schools? Were there any recommendations for changes in O&M practices? Were the recommendations implemented?
- 16) Which schools, if any, have computerized energy management systems (EMS)? Are these systems working effectively? Are outside vendors providing quality service? Do district and building staffs know how to operate them?
- 17) Briefly describe the district's vacation and weekend shutdown procedures. Are these applied in all schools?

O&M Staffing

- 18) What role, if any, do outside vendors or other public sector agencies play in building O&M? What is the quality of this service?
- 19) What level of training, if any, has been provided to custodial or maintenance staff that is relevant to energy management?
- 20) Identify any specific training needs that would enhance staff members' ability to manage energy costs at individual schools.
- 21) Does the district recognize or otherwise reward staff or individual schools for improvements in operating costs at specific facilities?

Questions for O&M Staff at Specific Schools

Energy Policy and Building Operations Procedures

- 1) Is the staff aware of a districtwide energy policy or list of standard building O&M procedures? Is the custodial and maintenance staff aware of this policy and do they actively adhere to its objectives?
- 2) Are maintenance records kept? Specifically, do these files record the testing and maintenance of boilers, air handlers, and other major building systems? Are these records provided to the central office? Are these records reviewed?
- 3) What was the date of the last energy audit, boiler combustion test and tune-up, or other important actions related to energy conservation?

Building Energy Information

- 4) Are annual energy costs at the school increasing or decreasing? What are the reasons for these changes?
- 5) Is the staff provided with the monthly energy consumption or billing information for the school?
- 6) If yes, how is the information used?
- 7) Does the staff know how energy costs at the school compare to costs in other district schools?

School Condition and Operations

- 8) What are the major problems with respect to the condition of the school's physical plant, such as indoor air quality, poor system or temperature control, and staffing?

- 9) How are maintenance decisions made? How does the central office plan, track, or schedule maintenance activities at individual schools, particularly for large systems such as heating and cooling systems?
- 10) Is the staff aware of any recommendations for changes in O&M practices that have been made in energy audits or other sources?
- 11) Does the staff have any recommendations for reducing energy costs at the school?
- 12) Does your school have a computerized energy management system (EMS)? Is it working effectively? Which building systems does it control? Does your staff know how to operate it effectively?
- 13) Briefly describe the school's nighttime, vacation, and weekend shutdown procedures. Is there a written procedure available?
- 14) What are the current thermostat settings and nighttime temperature setbacks?
- 15) Are teachers, students, and staff members careful about turning off computers and other equipment when not in use?

O&M Staff Training

- 16) What training has been provided to the school's custodial or maintenance staff that is relevant to reducing energy costs in the school?
- 17) Identify any specific training needs that would enhance the staff's ability to manage energy costs.

Questions for Building Occupants (Teachers, Students, Staff)

Energy Policy and Building Operations Procedures

- 1) Are occupants aware of the school's or district's overarching energy policy or views toward energy conservation?
- 2) If yes, do teachers, students, and staff members actively adhere to the policy? Why or why not?
- 3) If not, do teachers, students, and staff members want the school or district to develop an energy policy and conserve energy?

Building Energy Information

- 4) Are occupants provided with information about how much the school and district spends on energy?
- 5) Are occupants provided with information about how much energy the school or district uses?
- 6) Do occupants know how their behavior at school affects energy use?

School Conditions, Operation, and Occupant Interactions

- 7) What are the major problems with respect to school physical plants, such as advanced age, poor system or temperature control, indoor air quality, and staffing?
- 8) If there are major or minor problems, how do they affect teaching and learning?
- 9) What are some suggestions for improving the conditions and operations at the school or district to conserve energy?

10) Generally, are building occupants energy conscientious?

11) Generally, are building occupants actively attempting to save energy?

Building Occupant Training, Communication, and Engagement

12) Do occupants understand how saving energy may benefit the occupants and the school or district?

13) Do occupants feel energy efficiency or conservation is important to the school, district, and building occupants?

14) Does the school or district provide training or other academic resources to educate building occupants on energy conservation behaviors and programs?

15) Are teachers encouraged to save energy?

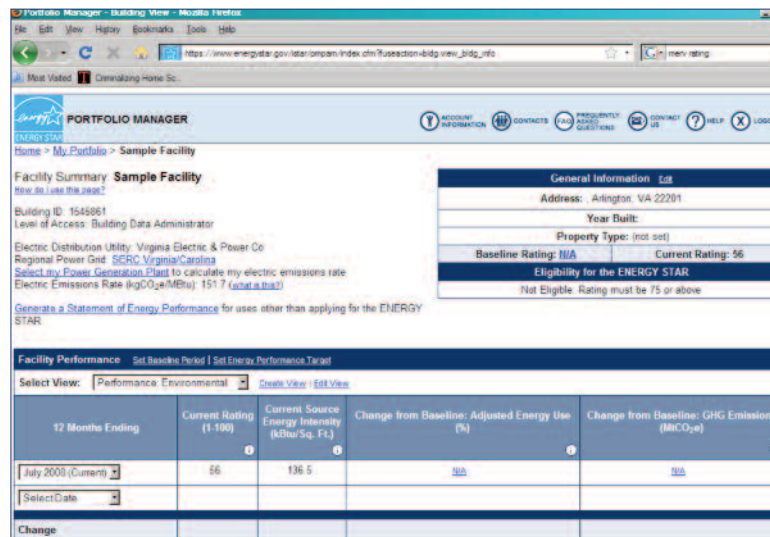
16) Have teachers included energy conservation into their curriculum?

17) Are teachers encouraged to involve students in energy saving activities?

18) Is the importance of energy conservation well communicated to the building occupants? If not, how can communications be improved?

19) How can school administrators or facilities staff engage teachers, students, and staff members in their energy savings efforts?

Appendix B: ENERGY STAR® Portfolio Manager and K–12 School Data Input



Data Input For All Facilities

- Facility Name
- Street Address, City, State, County, ZIP Code, Country
- Year Built
- Property Type
- Nearest City (for international facilities)

School Space

- Gross Floor Area
- Open Weekends (Yes/No)
- Number of Walk-in Refrigeration/Freezer Units
- Cooking Facilities (Yes/No)
- Percentage Air Conditioned
- Percentage Heated
- High School (Yes/No)
- Number of Personal Computers
- School District
- Months in Use

Energy Use (for all fuel types)

- Energy Meter Identification
- Energy Type (for associated meter)
- Energy Unit (for associated meter)
- Start Date of Energy Consumption Entered (for associated meter)
- End Date of Energy Consumption Entered (for associated meter)
- Energy Consumption (for associated meter)
- Energy Cost (for associated meter)

Water Use

- Water Meter Identification
- Water Type
- Water Unit
- Start Date of Water Consumption Entered
- End Date for Water Consumption Entered
- Water Consumption
- Water Cost

Parking Space

- Enclosed Parking Floor Area
- Non-Enclosed Parking Floor Area (with a roof)
- Open Parking Floor Area (no roof)
- Hours of Access/Week

Computer Data Center

- Floor Area
- Weekly Hours


Swimming Pool

- Pool Size
- Indoor or Outdoor
- Months in Use

For more information about ENERGY STAR Portfolio Manager, visit:
www.energystar.gov/benchmark

Appendix C: Energy Report Card for Presenting Audits and/or Benchmarking Results

An energy report card is one way of presenting schools' or districts' baseline energy use. It is a simple and concise way to display the information helpful to the business case. Below is an example of a high-performance school report card form (this example contains more categories for assessing a school building than just energy performance).

 REPORT CARD FOR A HIGH PERFORMANCE SCHOOL					
School: _____					
District: _____					
Administrator: _____		GREAT JOB	GOOD PROGRESS	NEEDS IMPROVEMENT	NOTES
Indoor Air Quality	Are classrooms well insulated from distracting sound? Are students and staff healthy?				
Heating, Ventilation and AC	Is equipment energy efficient, "right sized" for the school, and regularly maintained?				
Daylighting	Do classrooms receive adequate daylight?				
Materials and Surfaces	Are they durable? Do they protect air quality? Are they regularly maintained?				
Commissioning	Has the school been commissioned to verify that all systems are working properly?				
Energy saving	Are light fixtures using the most energy-efficient bulbs? Are computers and other equipment turned off when not in use?				
Water saving	Are water-saving fixtures used everywhere? Is the building free of leaks?				
Turned operating staff	Are all staff trained, as much as needed, on operating the building?				
Maintenance	Does the building receive regular and thorough maintenance?				

Source: Better Bricks. http://www.betterbricks.com/graphics/assets/documents/Report-Card_Final.pdf

Additional Examples of Energy Report Cards

Orange County Public Schools

This live Web tool allows anyone to view the Florida school district's daily or monthly energy use. http://apps1.eere.energy.gov/state_energy_program/project_brief_detail.cfm/pb_id=716

Utility Report Cards (URC)

This Web-based Energy Information System reports and graphs schools' monthly utility data. www.utilityreportcards.com/

Appendix D: Detailed Energy Management Strategies to Support Making the Business Case and O&M Program Implementation

Program Type	Pros	Cons	Example Projects
Quick Fix and Low Cost	<ul style="list-style-type: none"> Potential projects can be readily identifiable by existing staff or through existing O&M program manuals Expenses will be recouped in energy cost savings in two years or less Repairs can be completed by existing staff custodians and maintenance staff 	<ul style="list-style-type: none"> No educational focus No systematic tracking of building energy consumption Outside vendors may be required for some tasks if a rapid repair timeline is required 	<ul style="list-style-type: none"> Repair window and door glass and weather-stripping Clean and repair chilled water plants or package units Eliminate all-day operation of exhaust fan and vending machines Replace all incandescent light bulbs with equivalent compact fluorescent bulbs Establish districtwide vacation shut-down procedures
Voluntary Energy Awareness	<ul style="list-style-type: none"> Not dependent on analysis of “hard energy data” or repair of defective building systems, program costs are relatively low Can be easily implemented in conjunction with one of the other approaches Uses existing staff Provides educational content to students School districts may use readily accessible curriculum and awareness materials already developed by government agencies and nonprofit organizations 	<ul style="list-style-type: none"> Lack of energy cost tracking and accountability means that energy savings are more limited and may erode with the departure of key staff or the arrival of new classroom priorities Energy savings may be limited Behavior changes and savings may be short lived Cannot assess progress or estimate savings Not technical systems focused, and may be outside the scope of work of the facilities staff 	<ul style="list-style-type: none"> Post “Turn off the lights” stickers on all light switches Implement “Energy Patrols” to monitor energy use <ul style="list-style-type: none"> Lighting control in unoccupied areas Personal appliances (e.g., heaters) Temperature controls during unoccupied hours (e.g., weekends, breaks, mornings and evenings) Building envelope (e.g., close doors and windows while HVAC system is on; check for cracks to be caulked and repaired)
Performance Contracting	<ul style="list-style-type: none"> Zero or limited initial cost for schools Guaranteed savings Experience and expertise Payment is not due until all work is complete Savings begin immediately in conjunction with the first contractual action 	<ul style="list-style-type: none"> Contractual complexities with outside vendor High ultimate costs and reduced energy savings Chance for questionable marketing techniques and energy savings calculations that benefit the performance contractor May require a third party to review initial contract proposal and validate energy savings proposed against actual building performance 	Refer to the Financing Roundtable Outcomes and Best Practices/Recommendations posted at the EnergySmart Schools Web site (www.energysmartschools.gov) for specific recommendations
Energy Tracking and Accounting (ETA)	<ul style="list-style-type: none"> Most potential energy and cost savings Provides continual tracking and forecasting of building performance and operating costs for O&M, planning, and budgeting Provides ability to identify utility billing errors Quantified savings estimates can serve as basis for progress assessment or staff recognition and an educational tool for students and teachers If applicable, third-party tracking software with tracking services requires low-energy tracking personnel and resources 	<ul style="list-style-type: none"> If third-party tracking software with tracking services is purchased: <ul style="list-style-type: none"> Purchase and tracking service cost required If program is implemented by school system staff: <ul style="list-style-type: none"> Requires the most staff resources at initial setup Higher implementation costs due to increased staff and data responsibilities Common practice to dedicate a full-time staff position to ETA for districts larger than 500,000 square feet Part-time staff may be appropriate for smaller districts. Districts larger than 1.5 million square feet may require additional staff support <ul style="list-style-type: none"> Determination of accurate school baselines requires some technical expertise 	<p>If staff regularly inputs building data, the software has the capability to:</p> <ul style="list-style-type: none"> Track monthly energy bills for electric, fuel oil, propane, and natural gas Produce graphic summaries of facility energy use that effectively communicate energy performance to district staff Estimate achieved operational savings based on “baseline” costs Identify changes in monthly or seasonal energy consumption due to billing errors, control malfunctions and equipment deterioration Enables simple creation and evaluation of utility usage and cost budgets

Appendix E: Energy Policy Examples

The energy policy should be a living tool that has high visibility within the district. Districts new to developing energy policy should take cues from other districts that have developed and implemented one within their district. For more information, visit:

- Fairfax County (Virginia) Public Schools, www.fcps.edu/fts/facmanagement/energy/esco.htm
- Montgomery County (Maryland) Public Schools, www.montgomeryschoolsmd.org/departments/maintenance/shadygrove/ems/index.shtm
- Barrington (Illinois) 220 Community Unity School District, www.cusd220.lake.k12.il.us/documents/Energy/Policy%204.180-Energy%20Policy-8.14.07.pdf
- Poudre School District, Colorado, www.psdschools.org/psdinfo/leadership/superintendent/policies.aspx?policyid=139

Appendix F: Elements to Consider During the Development of Energy Management Policies, Procedures, or Plans

Element	Explanation
Program Mission	Broad environmental and management objectives. Establishes support by senior administrators
Energy Consumption Monitoring & Communications	Organization, ongoing monitoring, and distribution of facility-specific energy bills
Energy Savings or Consumption Targets	Reasonably achievable savings targets for annual energy consumption and costs
Staff Responsibilities & Training	Energy-related tasks for custodial, maintenance, and administrative staff, and Energy Manager, if appropriate
Staff or School Incentives/Recognition	Shared energy savings, formal or informal staff recognition, etc.
Energy Program Communications	Internal and external progress reports and visibility
Building Energy Assessments/Audits	Identification of poorly performing schools and likely opportunities
Building Operating Guidelines	Vacation shutdown, temperature control, etc.
Purchasing & Procurement Guidelines	Efficiency standards for replacement equipment or minimum payback requirements
Schedule for Program Planning/Revision	Anticipates need for ongoing program oversight

Appendix G: High-Performance School O&M Barriers and Solutions

The table below outlines challenges that districts commonly encounter and should be mindful of when developing a successful energy-focused O&M program. To help anticipate these potential obstacles prior to design and implementation, the challenges are matched with their related solutions. Details of the solutions are provided in the critical paths.

O&M Barriers	Critical Best Practices to Revitalize O&M
<ul style="list-style-type: none"> • Lack of awareness of energy opportunities • Resource constraints (budget and staff) • Lack of district expectations or policy • Limited access to energy expertise • Limited mission of facilities departments • Lack of comparative energy consumption information • Lack of a board constituency 	<ul style="list-style-type: none"> • Awareness of energy opportunities (e.g., conduct walk-through or energy audits) • Resilience against budget cuts (e.g., take low-cost or no-cost measures that require minimal resources, communicate with school officials the benefits of O&M energy actions) • District expectations and strong policy (e.g., develop an O&M or energy policy that has the support of all stakeholders) • Investment in training for building staff • Access to resources and expertise • Broad mission and empowerment for facilities departments • Comparative energy consumption information • Strong board and community constituency (e.g., engage the community and keep them aware of the energy O&M actions through newsletters and other methods)

Appendix H: Detailed Critical Factors for Implementing Advanced O&M Management

Critical Factor #1: Program Visibility and Progress Reporting

The first critical path element is to establish program visibility. If the administration has bought-in, as described previously, this step should be easy. The primary objective is to ensure the program and program manager are visible to the superintendent, school board, and other staff.

The periodic reporting of program objectives and progress is essential to sustain staff interest and to develop a broad constituency of support throughout the district. To achieve these objectives, O&M programs have successfully used periodic program newsletters, school board presentations, Web sites, and other outreach strategies.²⁹ Responses and feedback from staff have often identified school or district employees who are supportive and can contribute to the O&M mission. The anticipation of staff concerns is also an important element of program outreach. In particular, some staff will inevitably associate “energy conservation” with reduced occupant comfort, regardless of how large the monetary savings may be. Communicating program objectives and benefits is essential to alleviate such concerns, as is emphasizing the involvement of district staff in the planning and implementation of the O&M program.

In addition to internal outreach, school programs frequently have been successful in generating broader public interest by means of newspaper and other media coverage. Taxpayers generally will be interested in the district’s efforts to improve efficiency and reduce operating costs.

Without developing visibility and achieving broad support from staff, senior administrators, and elected officials, the new O&M program will be vulnerable to budget cuts, changing district priorities, and staff turnover. In addition, there is a high probability of “mission slippage,” as described above, unless administrators outside the facilities group are enthusiastic about the program’s progress in reducing operational costs.

Critical Factor #2: Communicating Energy Savings Expectations and Timeframe

In communicating the objective of reduced energy use and operating costs, it is important to emphasize that energy savings might not appear on energy bills right away. While the installation of new high-efficiency lighting or HVAC systems will yield immediate energy savings, O&M energy savings are not the product of a one-time capital investment and may take longer to accrue. As energy prices rise, energy bills might stay the same, rather than drop. Developing staff expertise and new management tools takes time, as does changing building maintenance and operation practices. For many programs, full O&M savings impacts may not be realized for six to 12 months, depending on the size of the district and available resources.

Critical Factor #3: Distribution of Information

Distribution of school-specific energy information to building staff is essential and should be a priority. Building staff and administrators can only effectively manage their buildings once they are familiar with their building’s energy information. Learning what is successful and unsuccessful is important to identify and adapt the program accordingly. This information may be as simple as looking at utility bills, but utilities may be willing to set up an automated Web format.

Perhaps the most important element common to all successful school O&M efforts has been the dispersal of energy use and billing information to staff at individual schools. Principals and custodial staff need energy use and cost information to assess the performance of the buildings they are charged with operating and to take steps to reduce energy costs. For an example of the distribution of energy information, see the Poudre School District case study in **Chapter 1**.

²⁹ If time is a limited factor, consider modifying existing outreach material developed for other settings.

Critical Factor #4: Education and Training

In addition to addressing building systems, it is important to teach students, teachers, and staff that their personal actions can reduce energy use. For example, the O&M program should provide education to encourage students and teachers to take responsibility for turning off lights and equipment, such as computers and printers, during unoccupied hours. Typical areas to address are:

- Classrooms
- Hallways
- Multipurpose rooms
- Cafeterias
- Restrooms
- Gymnasiums
- Locker rooms
- Conference/meeting rooms
- Stage
- Storage areas

Note: Equipment and safety issues should be taken into consideration when teachers and students are involved.

Critical Factor #5: Detailed Procedures Manual

The facilities manager will usually head the O&M program and will need to develop a detailed technical reference that provides specific guidance to building staff. The objective of a procedures manual is to define standardized building management practices, such as shutdown procedures and tune-up schedules, for O&M staff at all school facilities. These procedures should be updated regularly as use and equipment changes occur.

Of particular note is the importance of establishing procedures to minimize energy use during unoccupied periods or at times when school space is used by community groups during after-school hours. Schools are increasingly used by outside organizations, and this rise in after-hours use presents challenges to district facilities managers. School officials need to address new issues, such as energy cost reimbursement, minimizing energy use in unoccupied building zones, and establishing appropriate rental rates.

Critical Factor #6: External Support– Neighboring School Districts

Most successful school O&M programs sought and received outside help. A detailed program plan developed by a district, similar to a business plan, can provide credibility in efforts to obtain external assistance.

Obtaining assistance from other school districts with O&M program experience will help managers estimate costs and define staffing responsibilities. Neighboring school districts may be willing to provide materials, such as training curricula, district energy standards, and maintenance checklists. As the district moves forward with O&M, neighboring school districts may be open to collaboration, which allows for the opportunity to share resources, tools, lessons learned, best practices, and training opportunities.

Critical Factor #7: External Support– Local Utilities

As mentioned in previous chapters, local utilities can be an important partner. They offer substantial technical assistance to school districts seeking to reduce energy use and costs. Utilities across the country have helped schools establish and teach training programs for school facility personnel. This assistance has typically taken two forms: either utility staff members help design and present training material to school custodial and maintenance staff, or utilities subsidize the costs of providing outside technical training to staff. One example of utility training assistance is the Building Operators Certification program (BOC), a comprehensive building operations and maintenance training effort currently in place in 14 states. Utilities play a major role in the funding and implementation of this effort and often subsidize tuition costs for school personnel.³⁰

Large customers, such as school districts, usually have a utility account representative. Districts should build a strong relationship with the utility account representative, as he or she may be able to help with many of the energy management O&M efforts.

³⁰ See <http://www.boccentral.org/page.php?content=about> for BOC contact information.

In several states, utilities have technical staff responsible for assisting school district O&M programs.³¹ The role of this utility support staff is to provide the initial impetus and ongoing support for the many technical and organizational elements of school O&M efforts. In other states, utilities provide staff to support specific project elements, as requested by school districts. Utility staffs have played key roles in performing building audits, providing computer systems and energy data support, and helping with community outreach.

Most utilities will provide districts with their monthly metered data in electronic format upon request, which will enable the district to utilize computer software to track and analyze energy consumption.³² Utilities often will assist in the analysis of school load profiles. These profiles enable schools to identify large sources of off-hour energy consumption caused by poorly controlled lighting, HVAC, or underperforming energy management systems.³³ When utility and other sources of low-cost assistance are insufficient, some districts hire outside consultants or vendors to help in specific and strategic ways.

Critical Factor #8: Energy Management

The district must think pragmatically about the administrative and logistical details of the energy aspect of the O&M program, such as a budget. Unless the district uses a performance contractor, which can provide a dedicated staff, all programs will require the selection of an energy manager to provide leadership and handle day-to-day administrative duties. In addition, all programs will require the active participation of building staff.

The required qualifications of the energy manager will vary with the type of program. Because an energy tracking program depends on the use of software, a high level of computer skills is essential. An effective energy manager for an energy tracking program must be able to work with staff at all levels; training, writing, presentation, and general communication skills are probably more important than detailed knowledge of

boiler or HVAC systems. Because of limited availability of internal expertise, districts might have to select energy managers from outside the district to implement in-depth energy management programs. While usually hired as a new district employee, in some cases, the O&M energy manager has joined the payroll of the sponsoring utility or other organization.

For other programs that are less resource-intensive than the energy tracking options, designating an existing facilities employee as the energy manager or adding this responsibility to the tasks of the existing O&M manager may be sufficient. Their role includes managing regular energy-focused O&M tasks, monitoring energy use for irregularities and errors in the utility bill, and identifying additional energy-related O&M efforts.

Critical Factor #9: Budget Resources

It is helpful to identify the energy-specific O&M effort as an independent line item in the O&M budget. Having a dedicated budget enables the program to carry out core activities such as staff training, obtaining consulting services, and funding the repair or modification of energy-related building systems.

The O&M program budget will depend on district size, district energy policy, and other factors. Costs and resources needed for an energy awareness program in a small district may be small, while those of a full-scale and aggressive energy tracking and accounting program will be higher. The level of involvement and assistance of local utilities and other parties can also be a major factor in determining district costs.

The largest single component of most programs will be the salary costs for the program manager, if one is required. O&M program costs may include:

- Software, computer, and other office costs
- Training and limited travel
- Use of outside consultants and vendors
- Small-scale building repairs and modifications

³¹ The utility sponsors of “Resource Conservation Manager” (RCM) programs in West Coast and Northeast states have typically provided full-time staff to support these efforts.

³² It must be noted that obtaining similar fuel oil consumption data is unlikely.

³³ Don’t hesitate to request the permanent or short-term installation of interval meter equipment if none is currently installed at a specific school.

Appendix I: U.S. Green Building Council Template for Building Operating Plan for Schools

EA Prerequisite 1: Building Operating Plan • Template for Building Operating Plan for Schools

General Requirements for All Spaces

Description of Requirement	Classrooms	Offices	Media Center	Kitchen
1. Cooling Season Temperature				
2. Heating Season Temperature				
3. Humidity Levels				
4. Air Pressure Relationships				
5. Air Filters				
6. Outside Air Ventilation				
7. Air Changes				
8. Interior Lighting Levels				

Description of Requirement	Gymnasium	Auditorium	Cafetorium	Other
1. Cooling Season Temperature				
2. Heating Season Temperature				
3. Humidity Levels				
4. Air Pressure Relationships				
5. Air Filters				
6. Outside Air Ventilation				
7. Air Changes				
8. Interior Lighting Levels				

EA Prerequisite 1: Building Operating Plan • Template for Building Operating Plan for Schools

Equipment Inventory and Run Time Schedules

Building:	Last Update:
Responsible Building Operator:	

Item Description	Occupied Hours Weekdays	After Hours Weekdays	Weekends and Holidays	Vacation Periods
[Examples]				
PU-1 (Room 101)				
RTU-1 (Rooms 102, 103, 104, 105)				
AHU-01 (Building 06)				
AHU-02 (Wing A, 2nd Floor)				
DX-1				
Chiller (250 t)				
Cooling Tower				
Boiler #1 (Natural Gas)				
Parking Lot Lights				
Overhead Walkway Lights				
Tennis Court Lights				
Field Lights				

EA Prerequisite 1: Building Operating Plan • Template for Building Operating Plan for Schools

Design Set Points

Building:	Last Update:
Responsible Building Operator:	

Item Description	Supply Air Temperature	Supply Water Temperature	Static Pressure
[Examples]			
PU-1 (Room 101)			
RTU-1 (Rooms 102, 103, 104, 105)			
RTUs (All RTUs serving classrooms)			
AHU-01 (Building 06)			
AHU-02 (Wing A, 2nd Floor)			
Chiller (250 t)			
Cooling Tower			
Boiler #1 (Natural Gas)			

Appendix J: Additional Resources

General Resources

- National Clearinghouse for Educational Facilities (www.ncef.org)
- The Alliance to Save Energy (www.ase.org)

Studies and Research on Schools' Energy and/or Operations and Maintenance Issues

- National Center for Education Statistics, *Effects of Energy Needs and Expenditures on U.S. Public Schools*, July 2003 (www.nces.ed.gov)
- American School & University, *37th Annual Maintenance and Operations Cost Study*. J. Agron, April 2008 (<http://asumag.com/Maintenance/2008M&OCostStudy.pdf>)

Resources for Making the Business Case

- U.S. Department of Energy *EnergySmart School's Guide to Financing EnergySmart Schools* (www1.eere.energy.gov/buildings/energysmart/schools/financing_guide.html)
- ENERGY STAR *Cash Flow Opportunity Calculator* (www.energystar.gov/financiaevaluation)
- Economic Policy Institute, Paper #216, *Good Buildings, Better Schools: An economic stimulus opportunity with long-term benefits*, Mary Filardo, April 29, 2008 (www.sharedprosperity.org/bp216/bp216.pdf)
- *Greening America's Schools, Costs and Benefits Design*, Gregory Kats, October 2006 (<http://www.cap-e.com/ewebeditpro/items/O59F11233.pdf>)
- *Costing Green: A comprehensive Cost Database and Budgeting Methodology*. Davis Langdon, Lisa Fay Mattiessen, Peter Morris, July 2004 (http://www.usgbc.org/Docs/Resources/Cost_of_Green_Full.pdf)
- National Clearinghouse for Educational Facilities. *Do Green School Facilities Affect Academic Outcomes?* Mark Schneider, 2002 (www.edfacilities.org/pubs/outcomes.pdf)

Resources for High-Performance School Construction and/or Certification

Construction

- ASHRAE *Advanced Energy Design Guide for K-12 School Buildings* (www.ashrae.org/publications/page/1604)
- *Better Bricks. Integrated Design Steps for Designers* (www.betterbricks.com/graphics/assets/documents/BB_Web_integrated_design.pdf)

Certifications and Programs

- The Collaborative for High Performance Schools (CHPS) *Best Practices Manual*, 2006 (www.chps.net/manual/index.htm#BPM)
- U.S. Green Building Council (USGBC). *Leadership in Energy and Environmental Design (LEED), LEED for Existing Buildings* (www.usgbc.org/DisplayPage.aspx?CMSPageID=221)
- U.S. Green Building Council. *Leadership in Energy and Environmental Design (LEED), LEED for Schools* (www.usgbc.org/DisplayPage.aspx?CMSPageID=1586)
- *ENERGY STAR for K-12 School Districts* (www.energystar.gov/schools)

Resources for Energy Management and Operations and Maintenance

General O&M Issues and Recommendations

- Association of School Board Officials' *Planning for Maintaining School Facilities*, February 2003 (<http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2003347>)
- *The Collaborative for High Performance Schools (CHPS) Best Practices Manual, Volume IV and V*, 2006 (www.chps.net/manual/index.htm#BPM)
- U.S. Department of Energy, *Federal Energy Management Program Operations and Maintenance Best Practices Guide* (www1.eere.energy.gov/femp/operations_maintenance/om_bpguide.html)
- New Jersey Association of School Board Officials, International. *School District Energy Manual*, 1998

- ENERGY STAR *Building Upgrade Manual*, Chapter 10, Facility Type: K–12 Schools (www.energystar.gov/index.cfm?c=business.EPA_BUM_CH10_Schools)

Pre-Recorded Webinars

- USGBC Webinar Series: *Energy Efficiency Strategies for Schools*, sponsored by U.S. Department of Energy/U.S. Environmental Protection Agency (www1.eere.energy.gov/buildings/energysmartschools/training.html)

Interactive Training and Diagnostic Tools

- New York State Energy Research and Development Authority (NYSERDA) New York High Performance School Design—Online Training (www.nyserda.org/hps/default.asp)
- *Better Bricks, Building Operations, Systems Diagnosis Tool* (www.betterbricks.com/DetailPage.aspx?ID=493)

Building Systems Organizations

- National Fenestration Rating Council (www.nfrc.org)
- Roof Consultant Institute (www.RCI-Online.org)
- Roof Coatings Manufacturers Association (www.roofcoatings.org)
- American Gas Association (www.aga.org)
- National Clearinghouse for Educational Facilities, Resource List: *Roof Maintenance and Repair for Schools* (www.edfacilities.com/rl/roof_maintenance.cfm)

Interactive Benchmarking Tools

- ENERGY STAR Portfolio Manager (www.energystar.gov/benchmark)

Resources for Ventilation

- *IAQ Tools for Schools Kit—IAQ Coordinator's Guide*, Appendix H: Mold and Moisture (www.epa.gov/iaq/schools)
- Florida Solar Energy Center, *Priorities for Commercial Buildings* (www.fsec.ucf.edu/en/consumer/buildings/commercial/priorities.htm)
- *Top-Level HVAC Maintenance*, Mike Rogers, FacilitiesNet Maintenance Solutions, October 2003 (www.facilitiesnet.com/ms/oct03/oct03HVAC.shtml)

Resources for Portable Classrooms and Modular Construction

- National Clearinghouse for Educational Facilities, *Portable Classrooms and Modular Construction Resource List*, April 2009 (www.edfacilities.org/rl/portable.cfm)
- *Preliminary Evaluation of Performance Enhanced Relocatable Classrooms in Three Climates* (www.fsec.ucf.edu/en/research/buildings/perc/)

Resources for Getting Students, Teachers, and Staff Involved

- New Jersey Energy Diamond Foundation (www.njenergydiamond.com/)
- *Safe Routes to Schools Online Guide* (www.saferoutesinfo.org/guide)
- ENERGY STAR *Monitor Power Management Program*—Free software (www.energystar.gov/powermanagement)

Energy Report Cards

- *Orange County Public Schools Utility Report Card* (<http://utilityreportcards.com>)
- *Better Bricks Report Card for High Performance Schools* (www.betterbricks.com/graphics/assets/documents/Report-Card_Final.pdf)

Case Studies

- Fairfax County Public Schools
 - Capital Improvement Plan, Environmental Stewardship section (www.fcps.edu/fts/planning/cip.htm)
 - Virginia Air Pollution Control Board Regulation 9VAC 5-40 5670C (www.boarddocs.com/vsba/fairfax/Board.nsf/0/095151B923CEFD6A8525707E006375FF?OpenDocument)
 - Environmental Stewardship Policy (www.boarddocs.com/vsba/fairfax/Board.nsf/12e695cdb9981eb785256e56000c1bf3/d87677e10ab5226b872574ff0049a078?OpenDocument&Highlight=0,environmental)
- Montgomery County Public Schools (www.montgomeryschoolsmd.org/departments/maintenance/shadygrove/ems/index.shtml)

Acknowledgments

Participating Sponsor

Council of Educational Facility Planners International (CEFPI)

Guide to Operating and Maintaining EnergySmart Schools Working Group

Kristyn Ivey, Chair
Booz Allen Hamilton

Leslie Ballew
Springfield (Missouri) Public Schools

David Bishop
Springfield (Missouri) Public Schools

Matt Brown
New York State Energy Research and
Development Authority

Norm Etkind
Vermont Superintendents Association

Rachel Gutter
U.S. Green Building Council

Katy Hatcher
U.S. Environmental Protection Agency

Greg Lookabaugh
Association of School Business Officials
International, Texas Chapter

Martin Mets
Association of School Business Officials
International, West Palm Beach (Florida) Chapter

William Mutscheller
Fairfax County (Virginia) Public Schools

Carolyn Sarno
Northeast Energy Efficiency Partnerships

Larry Schoff
Energy Efficient Solutions

David Simmons
Association of School Business Officials
International, Texas Chapter

Carl Thompson
Charlotte Mecklenburg (North Carolina)
Schools

Rob Van Der Like
The Cadmus Group

Rodney Williams
New Jersey Energy Diamond Foundation

Roger Young
Roger Young and Associates

Case Study Contributors

Fred Hayward
Kent Intermediate School District,
Grand Rapids, Michigan

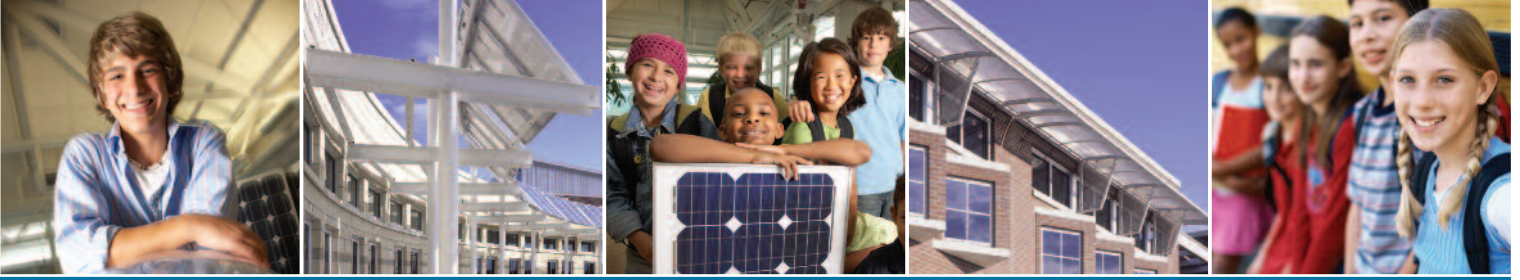
Doug Heurich
Northbrook (Illinois)
School District 27

Becky Horn
SchoolDude.com

Joe Piantedosi
Town of Andover, Massachusetts

Stu Reeve
Poudre School District, Fort Collins,
Colorado

Jyoti Sharma
Wake County (North Carolina) Public
School System



Council of Educational Facility Planners International (CEFPI)
is a participating sponsor of the U.S. Department of Energy's
Guide to Operating and Maintaining EnergySmart Schools.



For more information, contact:
EERE Information Center
1 877 EERE INF (1 877 337 3463)
www.eere.energy.gov

 Printed with soy ink on recycled paper