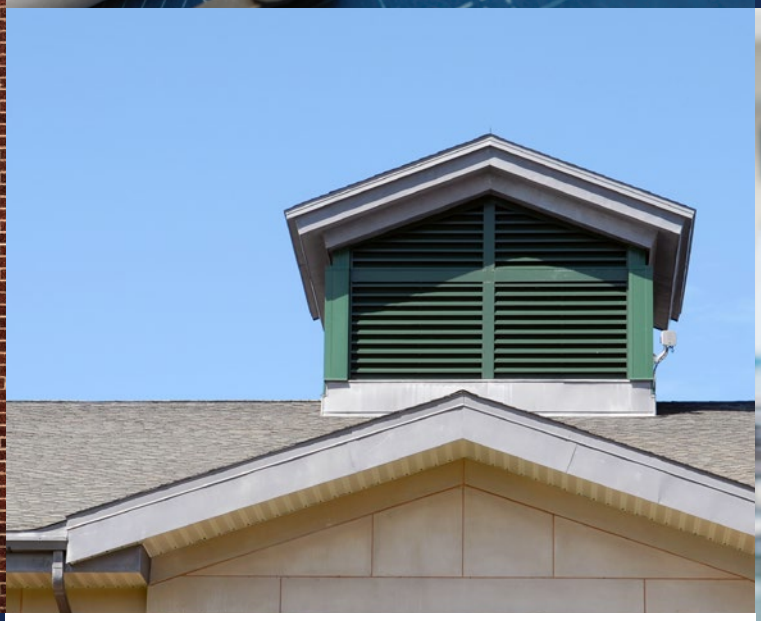
TVA EnergyRight®



School Uplift SEM Manual

STRATEGIC ENERGY MANAGEMENT

Your textbook for energy savings

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SEM foundation

Finding opportunities

Engagement & empowerment

Implementing opportunities

Appendix

Introduction

INTRODUCTION

Cohort information


TVA EnergyRight

INTRODUCTION

Cohort information

School Uplift contact information

TVA EnergyRight® Senior Program Manager

Clay Hoover
gchoover@tva.gov

Energy Coaches

Thomas Irwin
tlirwin@tva.gov

Other: _____

Other: _____

TRC Program Manager

Brittany Alvarado
balvarado@trccompanies.com

Local Power Company (LPC) representative

List your school's LPC representative in the space below.

_____
NAME

_____
CONTACT

Your school's Energy Team

List your school's Energy Team names and contact information in the spaces below.

Energy Champion(s)

1 _____
NAME

_____
CONTACT

2 _____
NAME

_____
CONTACT

Energy Team members

1 _____
NAME

_____
CONTACT

2 _____
NAME

_____
CONTACT

3 _____
NAME

_____
CONTACT

4 _____
NAME

_____
CONTACT

5 _____
NAME

_____
CONTACT

6 _____
NAME

_____
CONTACT

Materials and activities

As part of your participation in School Uplift, your school will be involved in different activities and receive materials to maximize your energy savings.

Training and implementation

Through training and implementation activities, TVA and your local power company will provide expert-level support throughout the duration of the program. Training includes cohort-based activities, where you can learn and share best practices and network with schools throughout the Tennessee Valley. You will also receive one-on-one support with a dedicated Energy Coach.

Workshops

These will be cohort-based interactive sessions that will focus on targeting skill development, networking with other schools, sharing best practices and collaboration.

Consulting support

An Energy Coach will work with you throughout the entire School Uplift process to offer support and advice through the various activities.

Assessments

TVA, with your school's support, will conduct site and energy management assessments so you will have an accurate understanding of your building's current energy performance and potential areas for improvement and cost savings.

Virtual webinars

Prerecorded webinars will be available to target skill development through topic-specific educational training and to review key components of the School Uplift program and grants process.

Energy scope and goal

Setting an energy goal allows you to track the progress of your school's energy-saving efforts.

ANNUAL GOAL

Reduce our energy by

_____ %

that is

_____ kBTU

Engagement resources

Use the provided engagement resources, also available at EnergyRight.com/school-uplift-resources, to create and sustain program momentum and increase overall energy education in your school. The materials can be used to engage school members in energy saving, provide energy education and spread awareness of your school programs and activities within your community.

More information and tips to engage your school community can be found in Chapter 5.

Investment grants

As part of School Uplift, your school can apply for competitive, performance- and needs-based grants.

Building Energy Upgrade grants

All schools can apply for a Building Energy Upgrade grant, which is awarded based on a number of factors, including greatest need.

Learning Environment grants

Based on program participation, cohort schools compete to win a Learning Environment grant to fund long-term improvements addressing student well-being in various impact areas. All schools who complete all program milestones are eligible for funds, with additional grants available for the highest performing schools.

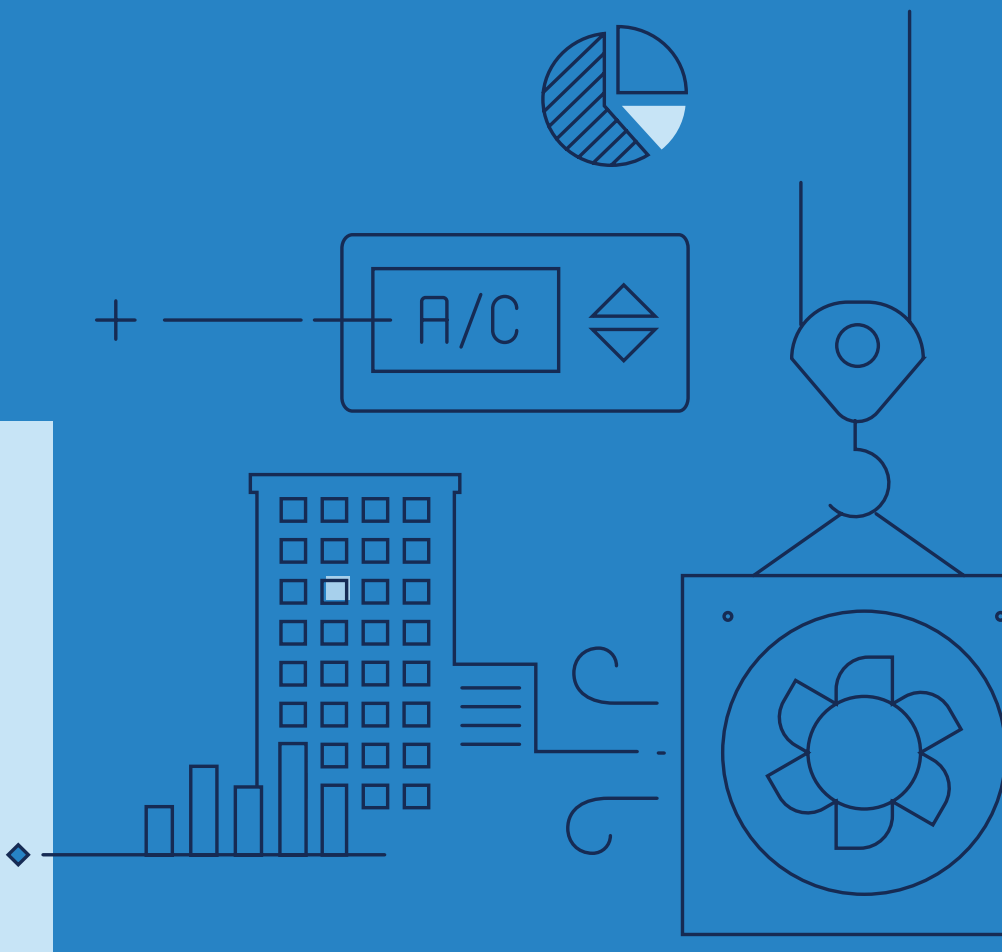
SEM foundation

CHAPTER

1. What is SEM?

CHAPTER 1

What is SEM?



UP TO

10%

energy savings with no capital investment

WHAT IS SEM?

SEM integrates energy management into everyday business and operations practices.

Strategic Energy Management (SEM) is a method to operate buildings efficiently and effectively.

Energy is a cost that can be managed with a plan. SEM integrates energy management into everyday business and operations practices. This results in persistent energy savings. Staff at all levels participate in daily operational habits to ensure your buildings – and the equipment in them – are operating as efficiently and cost-effectively as possible.

In K-12 school districts, energy costs are typically the second largest budget consideration after personnel costs – totaling approximately $8 billion annually nationwide. Implementing an SEM Program within schools can significantly reduce these energy costs with very little investment by the district.

SEM process

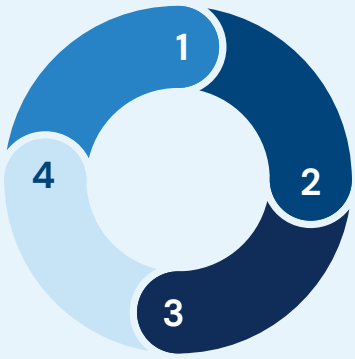
SEM is best applied as a continuous and evolving process. This cycle of continuous improvement can be illustrated by the SEM Sequence, which includes four key questions that prompt building operators to better understand, operate and maintain their buildings. It is important that this cycle continues indefinitely. As staff changes, equipment is replaced or appliances are added, your building and SEM processes will need to continue to evolve.

WHAT DO I HAVE?

Create an initial baseline of all energy-using systems and equipment within your buildings. This may include an analysis of billing data, equipment inventories and identification of system types.

HOW DO I FIX AND MAINTAIN IT?

Adjust equipment to the recommended settings identified, so each building functions in a manner that boosts efficiency, comfort and health.



HOW SHOULD IT WORK?

Identify the ideal conditions, optimal settings or target energy use levels for your systems and equipment.

HOW IS IT WORKING?

Assess your building as a whole, as well as individual pieces of equipment, to identify how they are functioning currently compared to the optimum conditions identified above. Identify the ways you can engage and empower students, faculty, staff and other school members in the SEM process.

Benefits

SEM supports the development of long-term goals, strategies to reach them and activities to continuously improve. Participating schools may see additional benefits such as:

1. Cost savings through reduced energy and water use.
2. Increased building and equipment durability and longevity.
3. Reduced maintenance costs and time needed to address recurring facility issues.
4. Maintenance staff provided with training and tools to help them better manage buildings.
5. Increased staff and student comfort, productivity and concentration.
6. Achieved savings can be directed toward other school needs.
7. Reduced carbon emissions and other environmental impacts.
8. Optimized safety with well-placed exterior lighting.
9. Improved indoor air quality.

Key terms

See the Appendix for more key terms.

ENERGY MANAGEMENT ASSESSMENT (EMA)

An analysis of your team's energy-related business practices. An EMA scores your team's strengths and weaknesses in multiple energy management categories and outlines next steps to prioritize, develop and improve your SEM practices.

ENERGY TEAM

Your core team of people helping to run an effective, efficient SEM Program. By engaging multiple people at different levels within your organization, team members bring a variety of skill sets and perspectives to the work creating greater impact for your school. Energy Teams consist of Champions, Committees, Sponsors and Steering Committees.

ELEVATOR PITCH

A quick and effective way of explaining the work you do. Meant to be stated in under a minute, an elevator pitch should answer the basic questions of what, why and how, and may end in a call to action or a request from your listener.

Action planning

Before you can identify opportunities, you need to start by understanding your school's current performance.

Assess current energy performance

In this stage, you will track performance in ENERGY STAR® Portfolio Manager to establish baselines and benchmarks of your school's current energy use. These steps are covered in detail in Chapter 2. As part of your participation in the School Uplift cohort, you will complete an Energy Management Assessment (EMA) to help analyze your current energy-related practices.

Identify opportunities and set goals

With current performance established, you will identify opportunities to improve the energy efficiency of your school and set goals towards implementing those opportunities.

Developing an Energy Team and setting goals together helps everyone understand the purpose of the SEM Program. Energy goals will address potential energy savings as well as behaviors, ongoing activities and engagement within the school. More information on Effective Energy Teams is covered later in this chapter.

Develop an action plan

Based on your opportunities and goals, you will create an action plan with specific tasks assigned to Energy Team members. Assigning deadlines to each task holds everyone accountable. Your action plan will help your school identify O&M opportunities that can be implemented in three-months, six-months and yearly intervals. Include the resources, activities and performance targets for each opportunity. While implementing your action plan, raise awareness of the effort. This will motivate the Energy Team, staff and students to participate. Track and monitor progress using ENERGY STAR Portfolio Manager and regularly meet with the Energy Team.

Evaluate progress

Evaluate progress quarterly and annually by reviewing your action plan. Identify items that have been completed, or not yet started. Track your progress on current tasks. Work through any challenges with the Energy Team. Re-evaluate and update your action plan to reflect any changing needs and priorities in your school.

Effective Energy Teams

Energy Management is a team effort that requires buy-in from all levels. An integrated Energy Team adopts energy efficiency best practices into their daily responsibilities. To create an Energy Team, identify personnel within the district and school with different perspectives and skills. For more information refer to the Energy Team Worksheet and the Efficient Energy Teams Webinar materials.

Developing your Energy Team

- [ ] Review Energy Team roles and responsibilities.
- [ ] Determine those needed in your school.
- [ ] Determine who will hold each position.
- [ ] Note potential responsibilities.
- [ ] List resources needed for each position.

Member roles and responsibilities

SEM success begins with a strong team with clear goals. The work is best accomplished through a diverse group of school members focused on different pieces of these goals. Teams can draw on strengths in different knowledge areas such as facility operations and management, administration, student education, community engagement, financing and more.

ENERGY SPONSOR(S)

Energy Sponsors are senior leaders who help set strategic direction and provide support to SEM implementation. Ideally, there will be at least one Energy Sponsor at the district level (Superintendent or District Director) and one Energy Sponsor at the facility level (Principal). The facility level Energy Sponsor will appoint faculty and staff to the Energy Team, set the Team's high-level goals and approve projects, resources and funding. The facility Energy Sponsor communicates regularly with the Energy Champion to be aware of the progress being made.

ENERGY STEERING COMMITTEE

For schools with competing initiatives and resources, an Energy Steering Committee can be helpful. This committee works with the Energy Champion to provide continual direction to ensure the Energy Program supports the existing business plan. This also provides a format for the Energy Champion to keep the larger school district informed of progress. The Energy Steering Committee should consider providing their school board with monthly or quarterly updates regarding the progress of the Energy Team's efforts. An additional or alternative consideration would be to include a member of the school board on the Energy Steering Committee. In cases where multiple schools within a district are participating in SEM, Steering Committee members could be comprised of leaders and staff from each school (e.g., high school, middle school and elementary).

ENERGY CHAMPION

The Energy Champion is the key person responsible for orchestrating the SEM work within the school. The ideal Energy Champion has the ability and experience to influence others and has a deep understanding of the school's culture. The Energy Champion encourages, engages and holds others accountable for their roles within the Energy Team and in the school.

ENERGY TEAM RESPONSIBILITIES

Performance tracking

Facilities management

Stakeholder engagement

Student and staff training (curriculum development)

Meeting minutes and reminders

ENERGY TEAM

An Energy Team is comprised of the Energy Champion and at least three other supporting staff. Members with expertise can be enlisted to participate to complete a specific task and then roll off to other assignments. This allows the Energy Champion to replace a team member that is not a good fit without creating staff tension. Energy Team members report to the Energy Sponsors for strategic direction, resource allocation and roadblock removal.

Other roles for a high-performing Energy Team

The following roles are additional key functions needed to serve and implement the SEM program in your school. Depending on the size of your school, the interest, expertise and capacity of staff, these roles may be accomplished by the same people on the Energy Team or the Energy Champion.

DATA CHAMPION

The Data Champion has primary responsibility for managing the Performance Tracking tool: ENERGY STAR® Portfolio Manager. See Chapter 2 for more information on performance tracking. This includes collecting monthly energy data, collaborating with operations to capture the specific activities that are driving change in the tool; creating reporting scorecards to communicate energy performance to the organization, and tracking costs/expenses that go toward implementing SEM.

FACILITY/SYSTEMS CHAMPION

The Facility/Systems Champion is responsible for informing the Energy Team about facility systems, operations and issues in buildings. Knowledge of systems can include but is not limited to electrical, HVAC, controls, refrigeration, boilers, motors, pumps, cooking equipment and water use. This person reports on usage at the process and equipment level, suggests efficiency projects and assists in designing those projects. The Facility/Systems Champion works closely with the Engagement and Empowerment Champion on projects that solicit employee and student participation or input. The Facility/Systems Champion should be someone with knowledge and responsibility for facility operations and staff.

ENGAGEMENT AND EMPOWERMENT CHAMPION

The Engagement and Empowerment Champion can be any Energy Team member with a passion for educating and engaging the school on energy efficiency and SEM. The Engagement and Empowerment Champion is responsible for developing an Engagement Plan. This includes developing, coordinating and implementing general and job/system-specific initiatives at each school. The Engagement Plan may include presentations at meetings and items such as posters, progress tracking materials/graphs, idea solicitation, reward programs, scoreboard progress tracking, progress reporting and holiday/break set back programs. See Chapter 5 for more information on Engagement and Empowerment.

TEAM SCRIBE

The Team Scribe develops meeting agendas, takes notes, records action items and keeps meetings on time. The scribe is responsible for publishing meeting minutes for all team members. Other responsibilities include sending out task deadlines, meeting reminders and meeting room reservations, if applicable.

TRAINING CHAMPION

The Training Champion takes responsibility for planning and coordinating specific employee trainings. Planning may require a matrix of training needs for different job types. Coordination may include tasks such as: obtaining approval for training time, funding and notifying employees and supervisors of training sessions. The Training Champion works closely with the Engagement and Empowerment Champion. The Training Champion may be any Energy Team member with a passion for the task.

Energy Team meetings

Monthly Energy Team meetings should be held to discuss the action plan, review progress, address new opportunities and identify next steps. To ensure participation and attendance, the Energy Team should pick a reoccurring time and date that works with each member's schedule. Someone should be appointed to take and distribute notes to their fellow Energy Team members following each meeting.

SAMPLE AGENDA

1 WELCOME AND ENERGY CHAMPION REPORT

- ✓ Welcome remarks
- ✓ Energy Champion to share progress on how the school is doing on savings, on the team's current action items, etc.

2 REVIEW OF PROGRESS AND SHARE NEW INFORMATION

- ✓ The Energy Team will report out individually on their progress
- ✓ The team will share any new information they have learned from webinars, workshops, students, etc. that would help the Energy Team

3 REVIEW ENGAGEMENT PLAN

- ✓ The team will discuss and review their strategies to engage and empower faculty, staff, students and the community

4 ADDRESS NEW ACTION ITEMS

- ✓ If applicable, after review of the opportunities register, action plan, webinars, workshops, etc. – the team will discuss any new action items – assigning each item to a person and a deadline or proposed due date

5 ROUND TABLE

- ✓ Open call for any other topics

6 REVIEW AND ADJOURN

- ✓ Review new and continued action items assignments and deadlines
- ✓ Confirm the next meeting date and time
- ✓ Adjourn

Talking about School Uplift

To secure buy-in and effectively "sell" your program scope to your school's leadership, you will need to know how to talk about SEM in an engaging way.

Use the **"Introduction to School Uplift"** video, provided with the engagement resources, to communicate what School Uplift is and how your school is benefiting by participating.

Gaining buy-in is all about persuasive communications. To start, you need to know who your audience is, what their motivators are and how they prefer to receive information.

If you can gain insights into these three questions, you will be on your way.

Who is your audience?

Tailoring your message to the person or people you are addressing is key. Think through your different stakeholders and what pieces of SEM might resonate the most. This might mean you create several different scripts or outlines for how you talk about your work.

What excites or motivates your audience(s)?

For instance, does your School Principal or District Superintendent want to know about the financial savings of SEM? Or do they want to know how SEM will improve the lives of students? The story of SEM can accommodate both. It is up to you to determine which story your audience wants to hear.

How does my audience want information given to them?

Continuing with the previous example, does your audience want logic? Logical responses might include numbers and statistics around savings or improvements in test scores that support the work of SEM. Do they want to hear heartfelt stories? If so, spark emotion with the possible impact to students. Paint a story around your school's challenges that may impede learning (e.g., the difficulty in paying attention to lesson plans because the classroom temperature is uncomfortable). Lastly, does your audience want credibility? If so, work to build trust. This might mean setting the stage by explaining your knowledge, opinion and expertise. Back any claims around the benefits of SEM from other credible sources.

Persuasive communication should also take format into account. When possible, figure out the preferred way your audience wants to receive information, e.g., email, meetings, text messages, phone calls.

Elevator pitch

As you develop any conversation or pitch around SEM, be efficient. Many people start with something called an "elevator pitch." This is typically a quick 30-60 second explanation of your work – roughly the same length of time as a typical elevator ride.

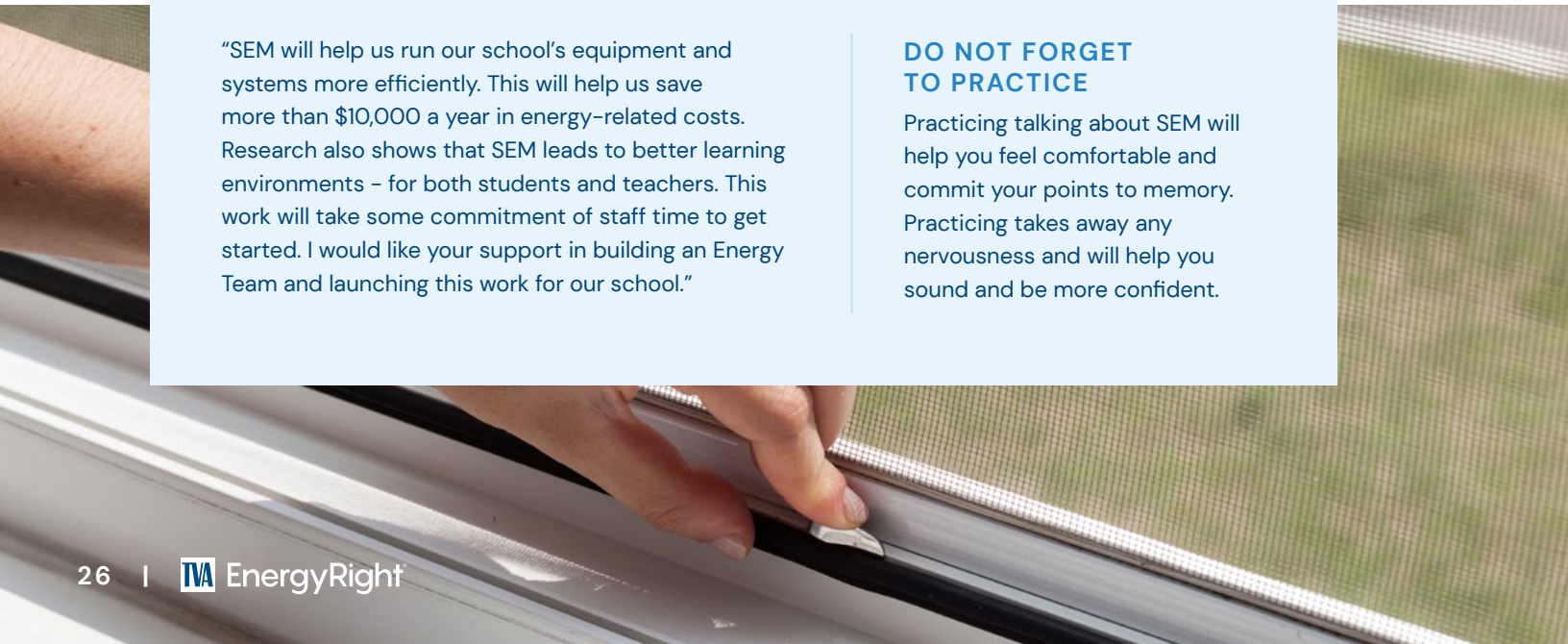
Consider structuring your message around the phrase: "What? So what? Now what?" You might begin with your challenges, explain the proposed solution and anticipated benefits, and end with your request, a call to action or way to get involved.

SAMPLE ELEVATOR PITCH

"SEM will help us run our school's equipment and systems more efficiently. This will help us save more than $10,000 a year in energy-related costs. Research also shows that SEM leads to better learning environments - for both students and teachers. This work will take some commitment of staff time to get started. I would like your support in building an Energy Team and launching this work for our school."

DO NOT FORGET TO PRACTICE

Practicing talking about SEM will help you feel comfortable and commit your points to memory. Practicing takes away any nervousness and will help you sound and be more confident.



Overcoming obstacles

Even with an excellent elevator pitch and sound business case, you may run into obstacles. Knowing what opposition you may encounter will help you be prepared with a response. Below are some commonly heard concerns around SEM efforts and example responses you could use.

"We don't have the time"

It may feel like investing in energy efficiency is not a good use of time. However, the energy costs we pay every month can offset and surpass the cost of the time spent. Low- and no-cost measures can be added gradually to begin our energy journey at our own pace. Additionally, a successful SEM program can spread responsibilities over several staff positions and require relatively little time.

"We don't have the expertise"

The thought of implementing an energy management plan can feel overwhelming. TVA is partnering with our school and their network of building professionals. If we don't have the in-house expertise, TVA and our local power company are available to answer our questions and give us the technical support we need to make the right decision every step of the way.

"We don't have the money"

The benefit of SEM is that it saves money with low- and no-cost improvements, like behavior change, that help us manage our money and energy strategically. We can structure our SEM program in a way that all it will cost is time. For example, we could create a "shut it off" campaign that could save significant energy just by shutting down equipment during times when the building is unoccupied. From there, we can continue making improvements gradually in line with the financial strategies that make sense for our school.

Working with your LPC

School Uplift wouldn't be possible without your local power company (LPC). TVA partners with 153 individual LPCs throughout the Tennessee Valley. LPCs purchase power from TVA and distribute it to consumers, like your school and your home, throughout the seven-state Tennessee Valley region.

Partnering with TVA, LPCs offer programs, incentives and local resources to their customers. Working with your LPC can further develop your school's SEM program.

Your LPC is a great resource your school can utilize to further energy savings and increase energy education and awareness for students. Partnering with your LPC provides the opportunity to connect with and educate future customers. If you need help connecting with your LPC, reach out to your Energy Coach.

Partnership ideas

- Show a video or give a presentation on the basics of how electricity is generated, transmitted and distributed within your service area.
- Ask your LPC to help support your school in understanding your energy bill and connect your energy use with ENERGY STAR Portfolio Manager.
- Host a bucket or line truck at your school – students can take turns riding!
- LPC employees visit the school and share more about their jobs.
- Ask your LPC if it has an electric vehicle students could explore and learn how it works.
- Conduct an electrical safety demonstration.
- Invite your LPC to host a booth at an open house or parent-teacher conference.
- Take a field trip to your LPC!

Finding opportunities

CHAPTERS

2. Performance tracking
3. Alternative financing
4. Shutdown checklist

CHAPTER 2

Performance tracking

11K+

schools already use performance tracking

PERFORMANCE TRACKING

Tracking your energy gives you the data to make well-informed decisions.

Performance tracking is the practice of measuring building energy usage over time. It ensures that you have an accurate picture of how energy is being used by your building on a month-to-month basis. Tracking your energy gives you the data to make well-informed decisions regarding your energy performance and targets.

Performance tracking tools typically use monthly utility and energy usage data to compare a building's performance against itself historically and against similar peer buildings. This practice is called benchmarking. These tools consider a building's size, operational functions and local weather patterns to ensure properties are equitably compared.

Why benchmark?

Having an accurate understanding of a property's energy performance in the context of usage history or compared to similar buildings is critical to making well-informed investment decisions about energy efficiency measures. Once a baseline energy use has been established and put into perspective, a building manager is significantly more equipped to make and work towards feasible energy targets.

Key terms

See the Appendix for more key terms.

BENCHMARKING

A comparison of current performance to a baseline or peers. Benchmarking allows you to evaluate and verify changes and improvements in your performance.

BASELINE

Refers to an initial set of data that serves as the benchmark for your improvements. Baseline data should include typical usage patterns to compare your energy management efforts accurately and realistically. For example, a baseline that includes atypical and prolonged school closures will not give you a true representation of your improvements.

ENERGY USE INTENSITY (EUI)

An indicator of energy efficiency that compares annual energy consumption to the total (gross) square footage or area. In Portfolio Manager, EUI is given as energy per square foot per year. EUI may vary greatly depending on the type of building measured. Several types of EUIs can be calculated including Site EUI, Source EUI and Weather Normalized EUIs. See Glossary of Terms for more information on the different types of EUIs.

For more information, please see: energystar.gov/buildings/benchmark/understand_metrics/what_eui

ENERGY STAR® Portfolio Manager

One of the most popular and effective performance tracking tools is ENERGY STAR Portfolio Manager. As both a measurement tool and metrics calculator, Portfolio Manager provides a whole-building snapshot of energy consumption with quantifiable utility data.

Developed by the U.S. Environmental Protection Agency (EPA), Portfolio Manager is a free, secure online benchmarking platform that allows users to quickly compare their building's performance against themselves over time, as well as against other properties in their same portfolio (e.g., within a school district) and against more than 11,000 other schools across the United States. Tracking your performance through benchmarking helps you see trends and identify underperforming buildings and systems. While Portfolio Manager also has the capability to track water, waste and materials categories as well, our work in School Uplift will focus on energy.

To help users better understand their buildings, performance tracking tools calculate Energy Use Intensity (EUI), which represents the property's energy use over a year-long period. EUI can also be calculated using average weather and occupancy patterns.

By understanding the EUI of your buildings, you can see the trends of your energy usage and building performance as a baseline. Knowing your starting point allows you to set realistic and actionable targets to reduce energy over time and see your progress towards these targets. Tracking performance to a benchmark also helps you clearly communicate the anticipated or actual results of energy efficiency measures and investments.

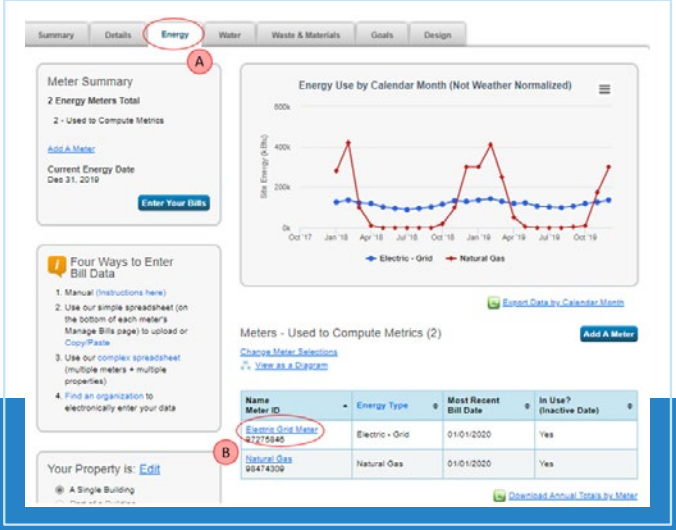
Once properties are in Portfolio Manager with at least 12 months of utility data, they are assigned an ENERGY STAR score ranging from 1 to 100. This score incorporates verified statistical data from the Commercial Building Energy Consumption Survey (CBECS) to compare your property against national peers. When a property reaches a score of 75 or greater, it demonstrates a nationally recognized level of high-performance and becomes eligible for ENERGY STAR certification.

Navigating Portfolio Manager

To track and maintain your metrics, you must regularly enter utility data. To do this, first log in to your account by going to portfoliomanager.energystar.gov and entering your provided login credentials. If you do not already have an account, your school district's account and login credentials will be provided to your Energy Champion. This will take you to your homepage where you can see all properties that have been created from the information provided by your school and your main dashboard. Your dashboard shows an overview snapshot of your properties, the most recent full month of utility data entered, your Energy Star Score and your EUI data.

To update your energy use, select the property you wish to update first. Navigate to the "Energy" tab and select the meter for which you would like to add usage data (Figure 1).

Figure 1: Energy tab (A) and meters to add utility data to (B)

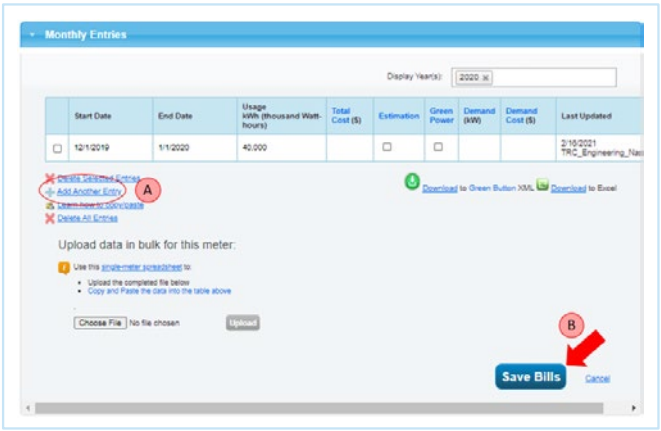


DETAILS TAB

The first time you log in, review the information in the property homepage's "Details" tab. The information on this tab was input from the Information Request Form provided by your school—it is imperative that the values are correct to receive an accurate score. Expand the dropdown menu by "Building Use" and double check to ensure values are accurate (such as Gross Floor Area). If changes are required, you can modify these values by selecting "Correct Mistakes" in the dropdown menu under the "Action" heading.

From the "Energy" tab, select "Add another entry." Populate the fields with start and end dates (ensuring no gaps) and energy usage, then click "Save Bills" (Figure 2).

Figure 2: Adding usage data entries (A) and saving (B)



Sharing property access

You can also share access to your property's Portfolio Manager account with anyone who has their own account.

Connect with them by selecting "Contacts" (Figure 3-A) in the upper right corner and searching for their name/affiliation. After the recipient confirms the connection request ("Notifications" tab, Figure 3-B), you can share one or more properties with customizable levels of permissions on the "Sharing" tab (Figure 3, C-D).

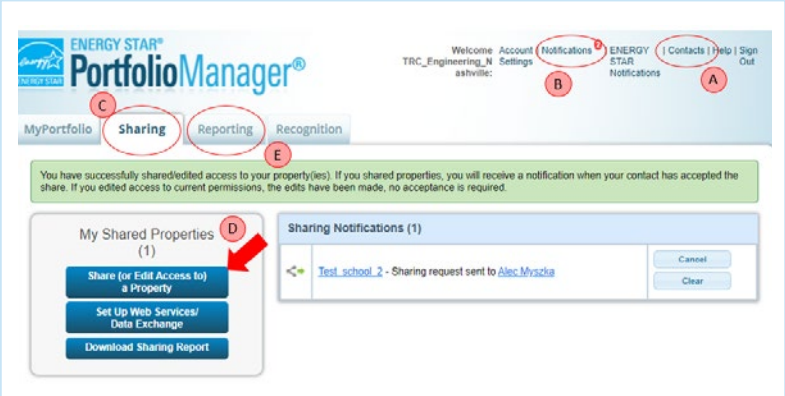


Figure 3:
Sharing properties with other users

Reporting

Portfolio Manager also allows for highly customized reporting so you can communicate effectively with your team. These options are found in the "Reporting" tab (Figure 3-E). Pre-formatted reports such as the Statement of Energy Performance or the ENERGY STAR Scorecard can be found here. Additionally, you can create and customize report templates by selecting from many different metrics for one or all your properties to effectively communicate with your team.

Analytics

Tracking building energy performance in Portfolio Manager can help identify increases or spikes in energy use due to deficiencies in mechanical equipment, ducts, building envelope, appliances, lighting and other systems that consume energy.

Case study

The Davenport Community School District, the third largest district in Iowa, has been an ENERGY STAR partner since 1998. By using Portfolio Manager's tracking system and other ENERGY STAR informational resources to identify and prioritize energy measures, they have saved millions of dollars and reduced the costs per student to $88.46 (compared to the national average of $181.53). Through simple measures like changing thermostat setpoints and removing convenience appliances from classrooms, they successfully reduced their total energy consumption by 22% and have achieved an average district-wide ENERGY STAR score of 85.

Target Finder

Suppose you are considering an addition to your facility or switching from a gas to an electric water heater. ENERGY STAR offers the Target Finder tool as a way to quickly calculate these “what if” scenarios without having to modify your properties in Portfolio Manager. By entering building details, estimated annual energy consumption and EUI goals, Target Finder provides metrics to quickly assess a proposed design and show you a predicted ENERGY STAR score (Figure 4).

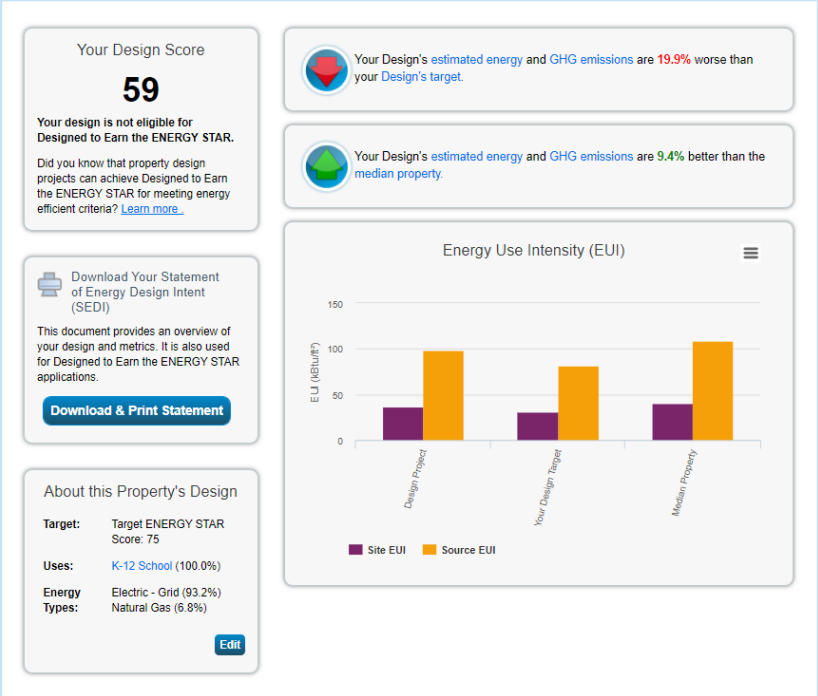


Figure 4:
ENERGY STAR Target Finder tool

Building Efficiency Targeting Tool for Energy Retrofits (BETTER)

Developed by the Department of Energy and the Lawrence Berkeley National Laboratory, BETTER is a free web-based tool for benchmarking your properties. It's particularly helpful if you handle multiple buildings.

BETTER helps identify which buildings in your portfolio require the most attention and which cost-effective energy measures to consider implementing. The tool integrates energy, costs and carbon emissions performance from individual buildings into a portfolio level so you can visualize the impact of all your facilities. Once a report is generated, you can view several metrics about individual buildings or as a whole portfolio and learn more about potential measures. BETTER integrates well with ENERGY STAR Portfolio Manager, allowing data uploads directly to BETTER's system with no manual input. Instructions can be found on the BETTER website:

better.lbl.gov

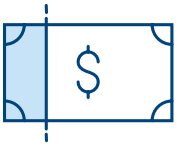
CHAPTER 3

Alternative financing

MORE THAN

$8B

spent on energy every year by U.S. K-12 schools



ALTERNATIVE FINANCING

Updated facilities and equipment will reduce energy consumption and maintenance needs significantly.

Energy-related building improvements are an investment in your school. While the upfront costs of energy conservation measures (ECMs) can present a challenge to budget-constrained school districts, the monthly cost of wasted energy can add up quickly if replacements are put on hold. It is important to take energy savings into account when evaluating the financial costs of replacing equipment.

Outdated technologies develop hidden costs as they age, including:

- Increased maintenance and repair costs
- Reduced occupant comfort
- Noises that affect productivity
- Unanticipated disruptions when the system fails

Often, it will ultimately cost more to do nothing versus acting proactively. Installing ECMs in your school allows you to budget appropriately, choose the right time to install new equipment and address issues before they become unavoidable. Updated facilities and equipment will reduce energy consumption and maintenance needs significantly. Many ECMs have a reasonable payback, meaning the energy savings they generate pay for, or offset, the upfront installation costs over a relatively short amount of time.

Key terms

RETURN ON INVESTMENT (ROI)

A financial performance metric to determine efficiency or profitability of an investment. For SEM's purposes, ROI is the amount, expressed as a percentage, that is saved by an energy conservation measure or project. It is measured by dividing the savings by the total cost of the measure or total capital investment.

PAYBACK TIME

The amount of time needed for the energy savings to fully pay and offset the expense of the upgrade.

ENERGY SERVICE COMPANIES (ESCOs)

Develop, design, build and arrange financing for projects that save energy, reduce energy costs and decrease operations and maintenance costs at their customers' facilities. In general, ESCOs act as project developers for a comprehensive range of ECMs and assume the technical and performance risks associated with a project.

ENERGY CONSERVATION MEASURES

Projects or technologies designed to reduce energy consumption in a facility.

Performance contracting

A performance contract (PC) is an agreement between a building owner and an energy services company (ESCO). In a typical PC, the ESCO identifies, designs and installs energy-related improvements and guarantees their performance. In exchange, the customer makes regular debt service payments to the ESCO.

How the cost savings are distributed is an integral part of negotiating a performance contract. The savings always go first to the ESCO servicing the debt incurred in financing the project. Additional savings then get distributed according to contract stipulations. Three of the most common stipulations in performance contracting include:

Guaranteed savings

The building owner receives a guaranteed amount, and the ESCO gets the rest. If the actual savings are lower than was estimated, the ESCO pays the difference between the actual and the guaranteed savings.

Shared savings

The building owner and the ESCO split the savings according to a percentage, such as 60/40. In shared-savings contracts, it is critical to determine the energy saved through measurement and verification (M&V).

Paid-from savings

The ESCO receives a guaranteed amount, and the building owner gets the rest. If the anticipated savings are not met, the ESCO does not receive payment.

See the Appendix for more key terms.

PERFORMANCE CONTRACTING

A financing method used by ESCOs that pays for the initial capital investment with the energy savings produced from the work.

MEASUREMENT & VERIFICATION (M&V)

The process of planning, collecting and analyzing data related to energy conservation efforts. Through the measurement of the work, the data will confirm or verify the actual results achieved.

RETROFITS

Additions, upgrades or modifications to a facility or a specific piece of equipment that was not a part of the original installation.

REVOLVING LOAN FUNDS

Self-replenishing pools of money that use interest, loan repayments and sometimes energy savings to fund new loans or projects.

During the term of the contract, the ESCO provides ongoing services that vary by project. These often include operations and maintenance, repair, service upgrades and M&V of savings. After the PC term expires, the building owner stops making service payments to the ESCO, takes responsibility for maintaining the equipment and keeps all future energy savings. Some PCs allow ESCOs to implement deeper retrofits by blending longer-payback energy conservation measures with shorter-payback measures in a single contract.

Other financial resources

Other federal, state and local development opportunities and financing options may exist for your school. These may include low-interest loans and grants for energy-saving improvements to your facilities. Because financial resources change and are updated regularly, always include research as the first step of your funding development for energy upgrades.

Alabama

The Alabama Department of Economic and Community Affairs' (ADECA) Energy Division administers energy efficiency programs designed to decrease energy consumption in the state's public facilities, including K-12 schools performance contracting program. ADECA advocates energy performance contracting agreements to reduce energy consumption and cost for all governmental units in the state.

adeca.alabama.gov/performancecontracting

Georgia

The Georgia Environmental Finance Authority (GEFA) provides state agencies with a list of energy services companies to complete cost-saving energy and water efficiency initiatives.

gefa.georgia.gov/energy-resources/energy-performance-contracting

Kentucky

The Mountain Association provides affordable financing to eligible businesses and organizations, with loans up to $50,000 at 5% interest with 60-month terms for general energy efficiency projects.

mtassociation.org

Mississippi

The Mississippi Development Authority's (MDA) energy efficiency revolving loan program provides loans to businesses and public facilities, including public schools, to increase energy efficiency in their buildings. Eligible projects include lighting retrofits and heating and cooling systems upgrades.

MDA's Energy Division: (601) 359-3449

North Carolina

Guaranteed Energy Savings Contract (GESC) is a performance contract for governmental units wanting to finance energy efficiency projects through realized energy savings.

(828) 556-9250
deq.nc.gov/conservation/energy-efficiency-resources/utility-savings-initiative/performance-contracting

Tennessee

For schools located in Tennessee, the State of Tennessee's Energy Efficiency Schools Initiative (EESI) is a resource and potential funder for your work. For more information on EESI, please refer to the Partner introduction at the beginning of this manual.

tn.gov/eesi

Pathway Lending is another community development financial institution that offers an Energy Efficiency Loan Program providing low-interest loans to Tennessee schools that make energy or utility-saving improvements.

pathwaylending.org

Virginia

The Virginia Department of Mines, Minerals and Energy (DMME) allows any state facility to enter an energy performance contract (EPC) to reduce energy costs. DMME serves as a third-party advisor to state agencies considering an EPC with an energy services company. DMME provides a list of pre-approved ESCOs to service Virginia.

dmme.virginia.gov

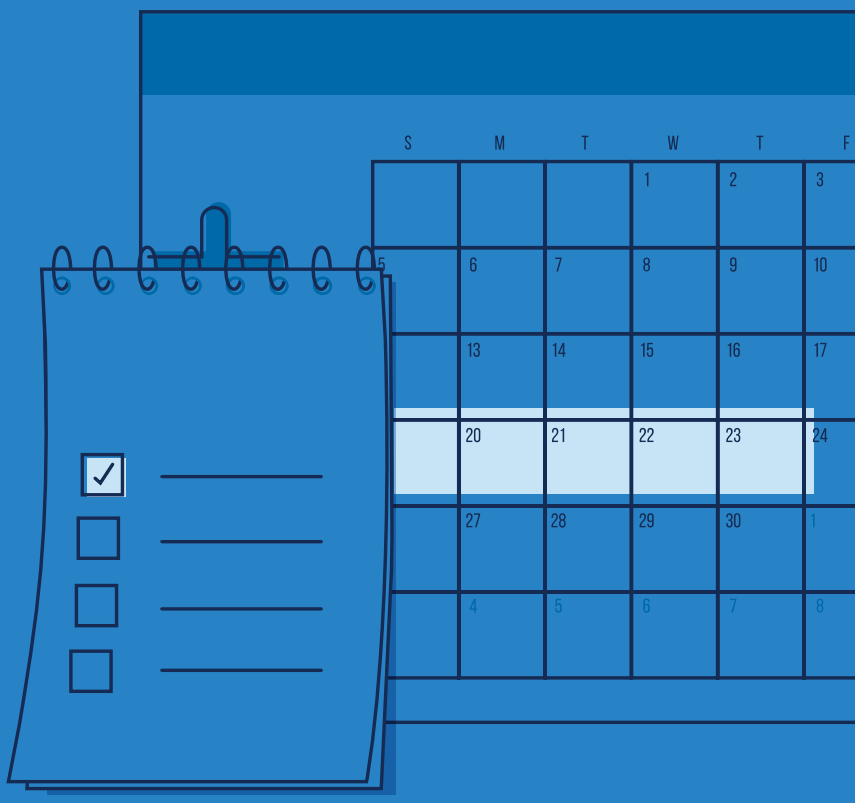
CHAPTER 4

Shutdown checklists

An important component of SEM is limiting, or even eliminating, energy usage when the building is unoccupied. The following checklists summarize recommended shutdown tasks by location area, length of shutdown (daily, short and extended) and suggested responsible parties. Checklists should be easy to find and use.

20%

reduction in energy use with proper shutdowns



INSTRUCTIONS

Complete daily tasks at the end of each school day. Before short breaks (e.g., fall, winter, spring) or extended breaks (e.g., summer), continue down the list and complete the other tasks as applicable.

OWNER	SUPPORT
Teachers	Administration & maintenance staff

Classrooms

		✓
DAILY	Close doors, windows and blinds/shades.	☐
	Turn off lights and ceiling fans.	☐
	Turn off TVs, radios, VCR and DVD players.	☐
	Turn off computers, monitors, speakers and printers.	☐
	Turn off document cameras (Elmo), overheads and projectors.	☐
	Turn off interactive whiteboards (SMART Board, Promethean ActivBoard, etc.).	☐
	Turn off lamps and personal appliances (coffee makers, space heaters, etc.).	☐
	Turn off bathroom exhaust fan, if applicable.	☐
SHORT BREAKS	Unplug audio/visual equipment (TVs, radios, VCRs, DVD players, etc.).	☐
	Unplug computers, monitors, speakers and printers.	☐
	Unplug document cameras, projectors and interactive white boards.	☐
	Unplug personal appliances (coffee makers, fans, space heaters, etc.).	☐
	Unplug lamps (floor, desk, etc.), air fresheners and decorations (such as string lights).	☐
	Unplug chargers (cell phone, laptop, etc.).	☐
	Unplug pencil sharpeners and staplers, if applicable.	☐
EXTENDED BREAKS	Unplug clocks.	☐
	Empty, defrost and unplug personal refrigerators.	☐
	Remove perishable items from classroom.	☐

INSTRUCTIONS

Daily tasks should be completed by the last person to use/leave the space at the end of each school day. Responsibility for short and extended breaks tasks should be assigned ahead of time, and completion should be confirmed by administrative and/or maintenance staff.

OWNER	SUPPORT
Shared	Administration & maintenance staff

Common areas

DAILY	Close doors, windows and blinds/shades.	☐
	Turn off lights, ceiling fans, air fresheners and decorations.	☐
	Turn off computers, printers, copiers and laminators.	☐
	Turn off media equipment and audio systems (excluding public address needed for emergencies).	☐
	Turn off small appliances (microwaves, coffee makers, toasters, etc.).	☐
	Turn off exhaust fans (excluding high humidity spaces and electrical rooms).	☐
SHORT BREAKS	Unplug computers, printers, copiers and laminators.	☐
	Unplug small appliances (microwaves, coffee makers, toasters, etc.).	☐
	Unplug lamps, air fresheners and decorations.	☐
EXTENDED BREAKS	Unplug clocks.	☐
	Unplug vending machines that do not require refrigeration.	☐
	Empty, defrost and unplug non-essential refrigerators.	☐

EXTERIOR WINDOW BLINDS

Some exterior window blinds and shades need to be left open for safety. Coordinate with your school's security measures.

INSTRUCTIONS

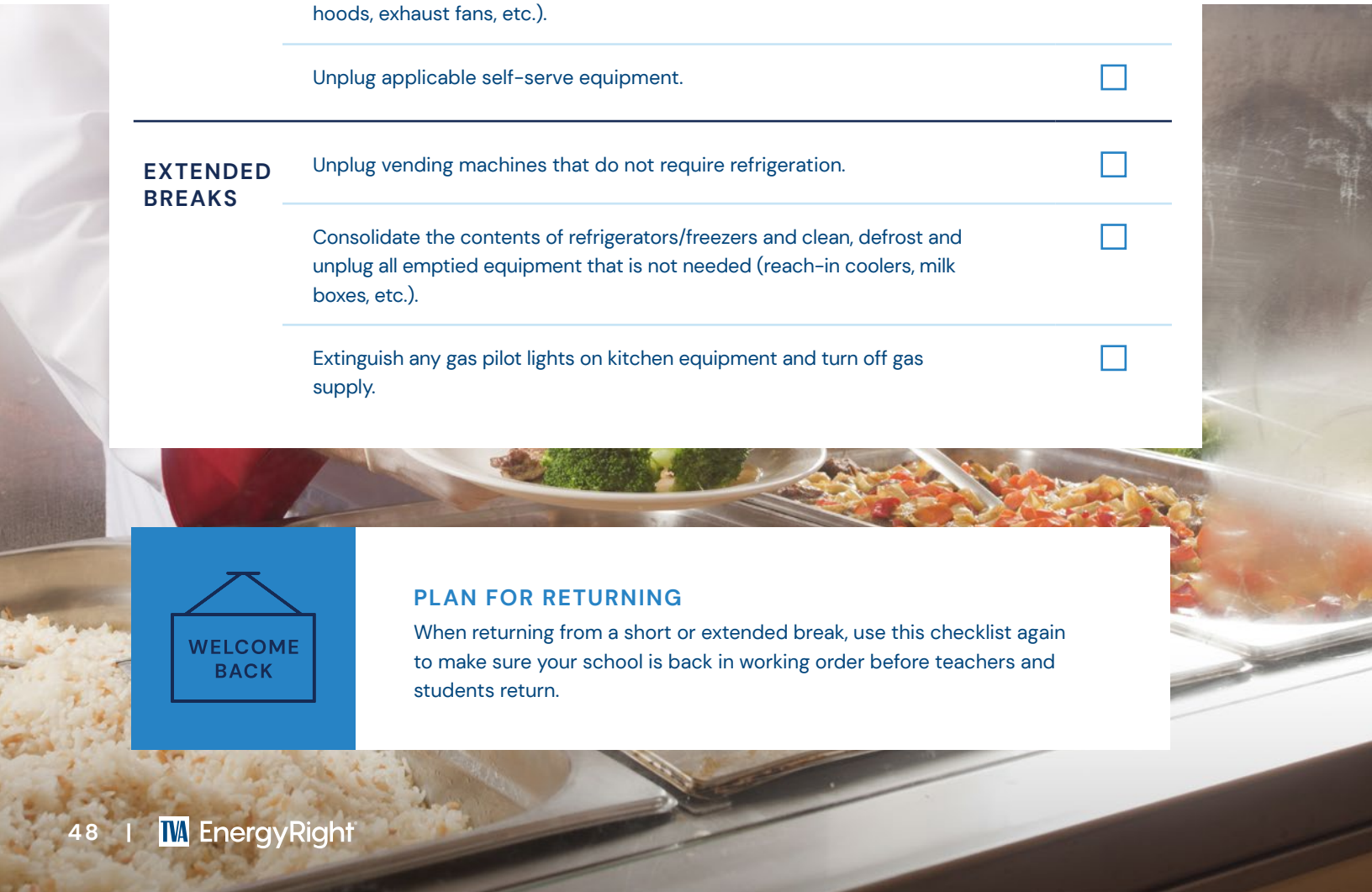
Complete daily tasks at the end of each school day. Before short (e.g., fall, winter, spring) or extended (e.g., summer) breaks, continue down the list and complete the remaining tasks as applicable.

OWNER
Kitchen staff

SUPPORT
Administration & maintenance staff

Kitchens and cafeterias

DAILY	Close doors, windows and blinds/shades.	☐
	Turn off lights and ceiling fans.	☐
	Turn off small appliances (microwaves, coffee makers, toasters, etc.).	☐
	Turn off accessory equipment (convection cookers, range hoods, exhaust fans, etc.).	☐
SHORT BREAKS	Unplug small appliances (microwaves, coffee makers, toasters, etc.).	☐
	Unplug accessory equipment if possible (convection cookers, range hoods, exhaust fans, etc.).	☐
	Unplug applicable self-serve equipment.	☐
EXTENDED BREAKS	Unplug vending machines that do not require refrigeration.	☐
	Consolidate the contents of refrigerators/freezers and clean, defrost and unplug all emptied equipment that is not needed (reach-in coolers, milk boxes, etc.).	☐
	Extinguish any gas pilot lights on kitchen equipment and turn off gas supply.	☐



PLAN FOR RETURNING

When returning from a short or extended break, use this checklist again to make sure your school is back in working order before teachers and students return.

INSTRUCTIONS

Complete daily tasks at the end of each school day. Many daily tasks can be automated by using programmable controls and other building automation systems – confirm these are functioning properly.

Before short breaks (e.g., fall, winter, spring) or extended breaks (e.g., summer), continue down the list and complete the remaining tasks as applicable. Some tasks may require the use of specialty tools and buy-in from administrative staff.

OWNER	SUPPORT
Maintenance staff	Administration staff

Facility operations

DAILY	Set building automation system to unoccupied, if applicable.	☐
	Set thermostats to proper unoccupied setpoints (55˚F heat/80˚F cool).	☐
	Set HVAC fans to "Auto" mode to ensure fans are not short cycling.	☐
	Set HVAC to maintain a relative humidity below 60%.	☐
	Do not set back HVAC units serving server rooms.	☐
	Ensure security and emergency systems are operating normally.	☐
SHORT BREAKS	Shut off leaky faucets, urinals or toilets and plan or schedule a repair.	☐
	Close outside air dampers.	☐
	Turn off, unplug or deenergize water fountains.	☐
	Turn off network equipment (routers, wi-fi access points) excluding those that require internet during unoccupied times.	☐
EXTENDED BREAKS	Lower temperature settings or set water heaters to vacation settings.	☐
	Turn off hot water recirculating pumps.	☐
	Consider reducing outdoor lighting (excluding lighting needed for security).	☐

Notes

Engagement & empowerment

CHAPTER

5. Engagement & empowerment

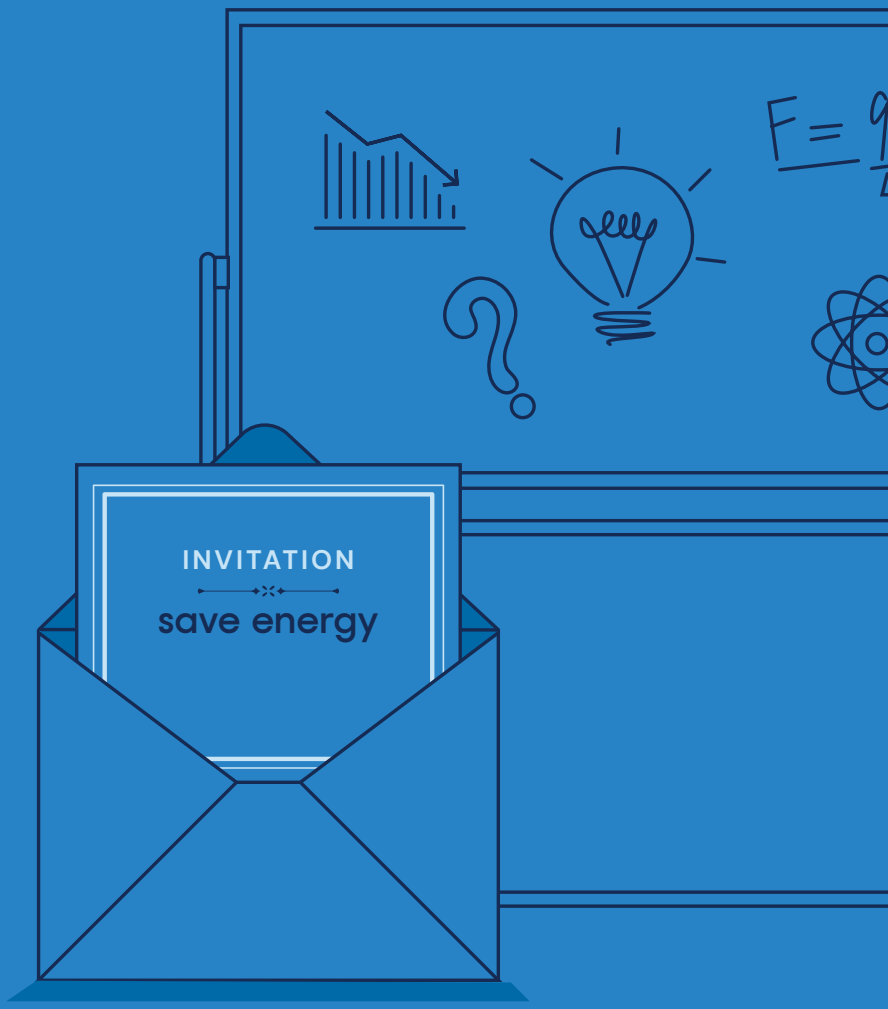
CHAPTER 5

Engagement & empowerment

IT TAKES

7X

for someone to remember a message



ENGAGEMENT & EMPOWERMENT

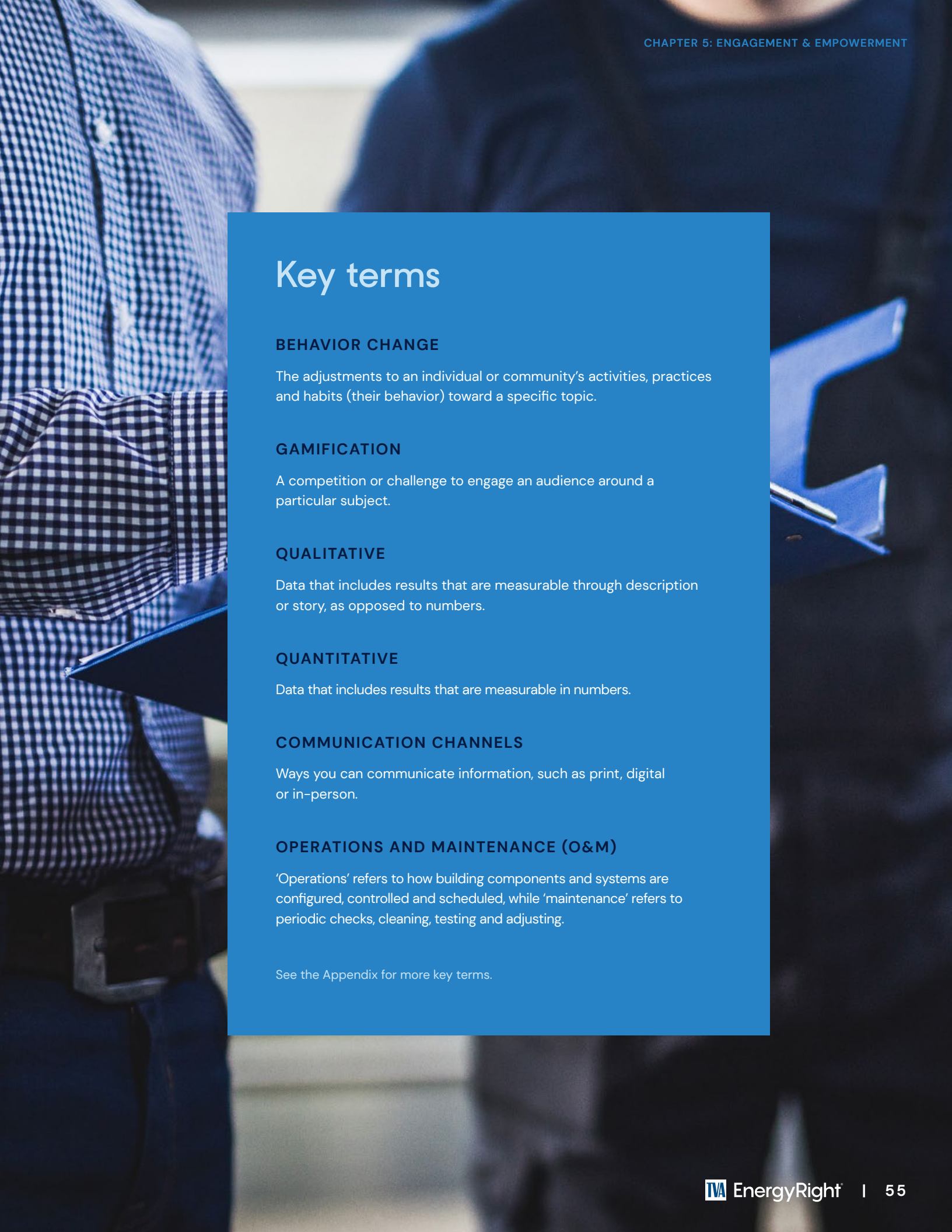
Empowering school occupants and other external stakeholders will help your community save energy.

Every building occupant – faculty, staff and student – uses energy. As much as 30% of a school district's total energy is used inefficiently or unnecessarily.

Even though you cannot control behavior, you can educate, build awareness and engage occupants by demonstrating proper use and maintenance of energy.

Benefits

1. Reduce operating costs by 5-10% without capital investments.
2. Help create a healthier learning environment that increases productivity and learning.
3. Create team building and leadership development for faculty and staff.
4. Use SEM as a curriculum-based learning tool.
5. Help students develop good energy habits from a young age.
6. Help reduce carbon emissions.
7. Create community-level buy-in by involving the public (e.g., community leaders, local businesses, organizations and volunteer groups) in the SEM process.



Key terms

BEHAVIOR CHANGE

The adjustments to an individual or community's activities, practices and habits (their behavior) toward a specific topic.

GAMIFICATION

A competition or challenge to engage an audience around a particular subject.

QUALITATIVE

Data that includes results that are measurable through description or story, as opposed to numbers.

QUANTITATIVE

Data that includes results that are measurable in numbers.

COMMUNICATION CHANNELS

Ways you can communicate information, such as print, digital or in-person.

OPERATIONS AND MAINTENANCE (O&M)

'Operations' refers to how building components and systems are configured, controlled and scheduled, while 'maintenance' refers to periodic checks, cleaning, testing and adjusting.

See the Appendix for more key terms.

Getting started

Start with a strategy that works for your school. Here are the key steps you can take to create your School Uplift engagement and empowerment plan.

WHAT TO LOOK FOR

BUILD ENGAGEMENT & EMPOWERMENT TEAM

DEVELOP GOALS

CREATE ENGAGEMENT PLAN

LAUNCH ENGAGEMENT PLAN

1 Build Engagement and Empowerment (EE) Team

- ✓ This group may consist of members of the Energy Team or it can be a new audience-specific team.

2 Create engagement plan

- ✓ Strategies and activities grouped by your three main audiences: students, faculty/staff and others (e.g., parents, general community).
- ✓ Channels to create awareness of and interest in your school's SEM work. Examples include:
  - Website
  - Newsletters
  - Email
  - Surveys
  - Social media
  - Dashboards
  - School/classroom announcements (including signage)
- ✓ A timeline outlining the order of steps and timeframes or deadlines needed for the work to happen.
- ✓ Metrics to track and measure your success. Examples include:
  - Number of faculty and staff participating.
  - Number of students/classrooms attending educational workshops, events, activities, etc.
  - Number of parents/families attending educational workshops, events, activities, etc.
  - Behavior-based energy savings (if quantifiable).
  - Survey results.

3 Develop goals

- ✓ Use a Team Charter to develop goals, objectives and visions for success. You can do this by considering the following questions:
  - What is our vision for this work? How do we align with the broader school vision and guiding principles?
  - What do we want to do?
  - How will we know we are successful?

4 Launch engagement plan

- ✓ Continually identify opportunities for improvement.

Engagement resources

Interested in using an established engagement plan? As part of your participation in School Uplift, a suite of engagement resources is available to your school to engage students, staff and the broader community.

These resources were provided to your school at the beginning of School Uplift, but are also available online at:

EnergyRight.com/school-uplift-resources

Find more information about these resources and ideas for using them in the Engagement Binder!

PROVIDED RESOURCES

ENERGY DASHBOARD

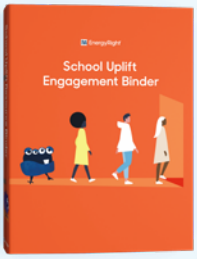
The dashboard is an easy-to-read snapshot of your school's progress toward your energy-reduction goal. It illustrates your school's energy-saving measures and how those measures affect the environment.

CLINGS

Similar to stickers, but can be easily removed from walls and surfaces, the clings prompt students to practice energy-saving behaviors. Use the clings on hard, flat surfaces like walls, cubbies, desks and near light switches and doors.

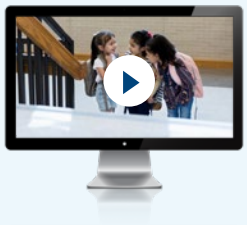
POSTERS

The series of posters communicate and encourage SEM practices and energy-saving behaviors. Hang throughout your school to remind students of simple and easy energy-saving behaviors they can practice each day.



ENGAGEMENT BINDER

Sectioned by monthly themes, the binder provides turn-key activities for each grade level (elementary, middle and high) to promote energy awareness and education. The engagement binder also includes a Community Outreach Guide, which provides tips, best practices and plug-and-play content for communicating your participation in School Uplift to the broader community.



INTRODUCTION VIDEO

This two-minute video introduces the basic concept of SEM and the importance of energy management in school environments. The video is a great resource for your school's Energy Team, administrators and communications team.

Student engagement and education

This section outlines the various tools, events and activities your school community could use to engage and educate students.

Tip

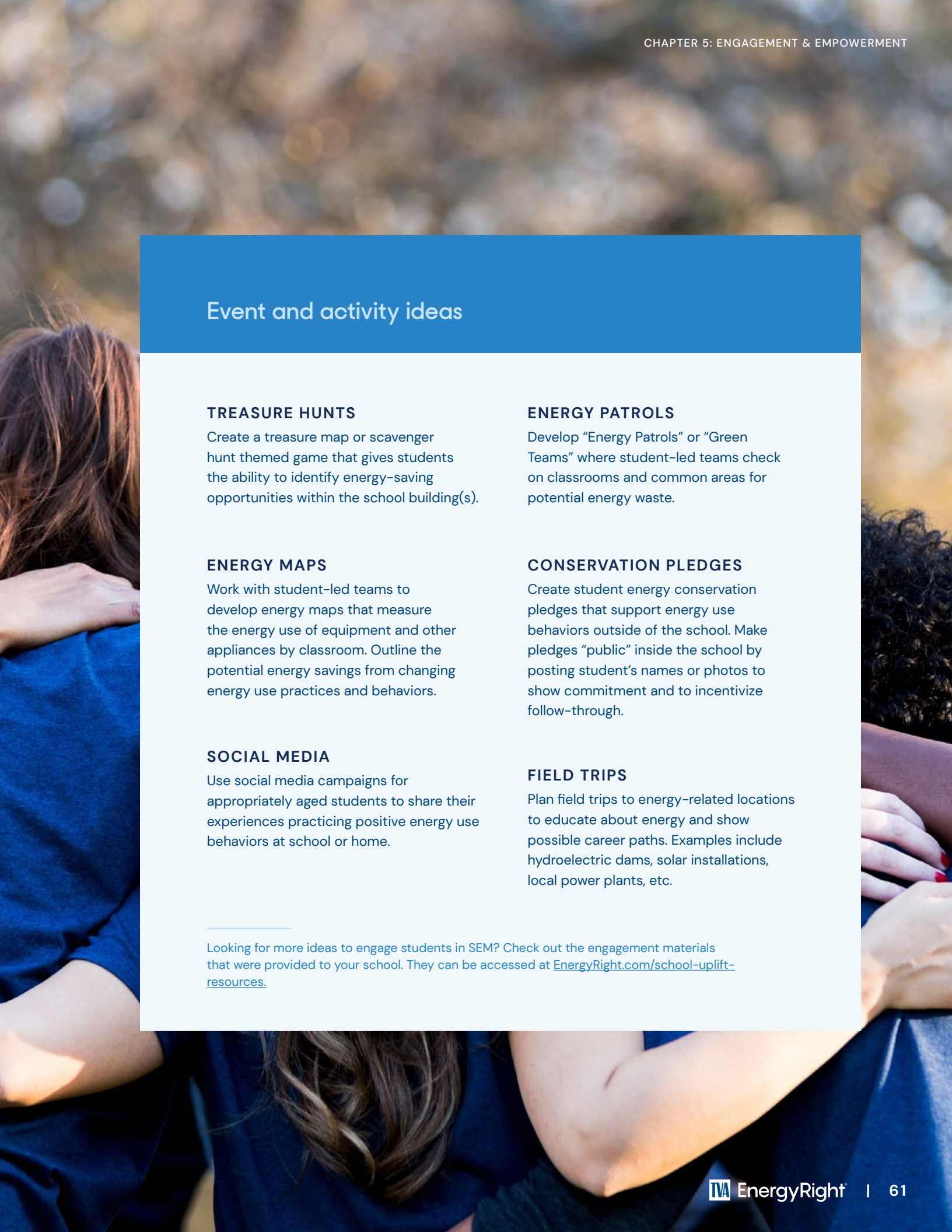
Use the provided posters and clings along with the monthly activities in the Engagement Binder to engage and educate students on energy-saving behaviors!

Events and activities

Hands-on engagement through events and activities is a proven way to engage and educate students. Research shows students are more likely to change their perspectives and behaviors when they are active participants in learning-based activities.

ACTION PLAN

- ✓ Identify events and activities that are appropriate for your school, tailored by age, grade level and season.
- ✓ Confirm the necessary approvals, logistics and timeline for your activity or event.
- ✓ Promote your activity or event to generate awareness, interest and drive participation.
- ✓ Launch the activity or event and gather feedback afterward to measure your impact.



Event and activity ideas

TREASURE HUNTS

Create a treasure map or scavenger hunt themed game that gives students the ability to identify energy-saving opportunities within the school building(s).

ENERGY MAPS

Work with student-led teams to develop energy maps that measure the energy use of equipment and other appliances by classroom. Outline the potential energy savings from changing energy use practices and behaviors.

SOCIAL MEDIA

Use social media campaigns for appropriately aged students to share their experiences practicing positive energy use behaviors at school or home.

ENERGY PATROLS

Develop "Energy Patrols" or "Green Teams" where student-led teams check on classrooms and common areas for potential energy waste.

CONSERVATION PLEDGES

Create student energy conservation pledges that support energy use behaviors outside of the school. Make pledges "public" inside the school by posting student's names or photos to show commitment and to incentivize follow-through.

FIELD TRIPS

Plan field trips to energy-related locations to educate about energy and show possible career paths. Examples include hydroelectric dams, solar installations, local power plants, etc.

Looking for more ideas to engage students in SEM? Check out the engagement materials that were provided to your school. They can be accessed at EnergyRight.com/school-uplift-resources.

Gamification

People are often naturally competitive. Used as a tool for engaging the school community in your SEM work, gamification can encourage all audiences to model positive energy-use behaviors through a friendly challenge.

Game on

There are several competition-based activities in the Engagement Binder that can be used to strengthen energy savings in your school.

- ✓ **Energy Pledge competition (November section)**

  Middle and high school students compete against other classrooms or grades by committing to an energy-saving behavior to see who can save the most energy.

- ✓ **Power Down poster (December section)**

  Elementary students compete to design the most creative poster that shows how to power down their classroom for school breaks.

- ✓ **STEM Competition (February section)**

  High school students compete to ideate, build and implement projects that can save energy in their community.

- ✓ **The Next Big Solar Invention (March section)**

  Groups brainstorm solar inventions they think can revolutionize society. Groups present their invention and peers vote for the best idea.

- ✓ **Ecochallenge (April section)**

  Empower high school students to complete and track energy-saving actions through this online platform. Each tracked action is worth points, so groups, clubs and classes can compete against one another.

Gamification ideas

ENERGY CHALLENGES

Consider "Energy Challenges" to help schools reach a specific energy-saving goal.

CONTESTS

Launch age-appropriate contests for students to show their knowledge and understanding of energy efficiency, its benefits and how their behavior changes the school's energy use. These contests could range from early elementary art depictions to upper-grade poster presentations using data analytics and scientific principles.

For more ideas on engagement and empowerment activities, see the Additional Resources provided at the end of this chapter.

ACTION PLAN

- ✓ Identify an activity (or set of activities) you would like to improve. An example may be creating a schoolwide challenge to save 10% on total energy usage over six months compared to the same period last year.

- ✓ Develop an implementation plan that includes:
  - **Audience** – think through where the competition could happen and how you would be able to measure it fairly (e.g., is it between classrooms or grade levels, a goal for the whole school to achieve together, or a challenge between other schools in your same district).
  - **Rules** – create a set of guidelines to help your school understand how to take part.
  - **Tracking** – identify ways to track and record energy usage and school participation throughout the event.
  - **Timeline** – consider when to announce the challenge and how often you will share updates.
  - **Messaging** – consider how you will announce the challenge and communicate regular updates.
  - **Communications outreach** – decide which channels you will use to share the message (e.g., schoolwide email, newsletter, notes to parents).
  - **Materials** – decide if you need handouts, flyers or signage to generate awareness.
  - **Awards** – consider the way(s) you will recognize individuals or groups for their positive contributions (e.g., bragging rights, names on a banner, an ice cream social).

- ✓ Launch the activity.

- ✓ Communicate progress to participants to drive competition.

- ✓ Conclude the challenge by recognizing success, winners or high performers, measuring impact and gathering feedback from participants.

Staff support and empowerment

Staff support is vital to a successful School Uplift engagement campaign. Teachers are key players in connecting students with education and awareness. They are also important connections with parents and community members. Finding naturally interested or academically motivated teachers will be the starting place for developing your Engagement and Empowerment Team.

ACTIVITIES

- Empower teachers to take an active role in planning or providing feedback on student engagement activities. Support from teachers will help your engagement efforts be age/grade appropriate and assist in achieving your school's educational goals.
- Educate non-O&M staff on general SEM principles, practices and benefits.
- Create SEM engagement activities, tools and resources that work with existing curriculum and state learning standards to make the process as easy as possible.
- Make sure teachers can take part in activities and events to further their personal and professional learning and engagement.
- Provide staff with communications and outreach tools to engage individuals outside the school, namely parents and other interested community members.

An easy introduction

Wondering how to introduce the faculty and staff to School Uplift and help them understand SEM? The "Introduction to School Uplift" video and sample language in the Engagement Binder are meant to introduce School Uplift and the importance of SEM to faculty and staff. Use the script and video in an email or staff meeting.

Community engagement and outreach

You can share your engagement and empowerment work beyond your school through interested parents and community members who can become advocates or direct supporters if they are aware of your work. Consider using the following channels to help share the success stories that result from your SEM efforts:

- Take-home letters
- Email
- Newsletters
- Social media
- Traditional media outlets (TV, newspapers and radio)

To help tell the story of your success, share the qualitative and quantitative benefits gained from engaging faculty, staff and students in SEM. These benefits may include non-energy impacts like better learning environments due to improvements in thermal comfort and lighting, cost savings from building improvements or changes in behavior. Telling the story of direct impacts on teachers, staff and students can be a compelling human-interest news story that puts a face to the benefits of your school's SEM work.

RESOURCES

The provided engagement resources feature a number of strategies that can be used to effectively engage your community and communicate your participation and success in School Uplift. Use the "Introduction to School Uplift" video at a school board meeting, send out social media and newsletter content about the activities you are doing or display your Energy Dashboard in the lobby.

Additional resources

BETTER BUILDINGS, BACK TO SCHOOL: ENGAGING STUDENTS IN ENERGY EFFICIENCY AT HOME AND IN THE CLASSROOM

PowerPoint slides featuring three school engagement program examples.

energy.gov/sites/prod/files/2017/09/f36/bbrn_Call%20Summary_081717_Education_Students.pdf

CENTER FOR GREEN SCHOOLS

Resources include a Green Schools Getting Started Checklist, Learning Lab with teacher resources for sustainable curriculum, energy audit ideas, ways to engage students, signage and more.

centerforgreenschools.org/green-schools

EMPOWERED SCHOOLS

A membership-based program includes project-based curriculum and STEM-based lesson plans to educate in energy efficiency. This free public resource includes green jobs lesson plans and information, best practices and tips from EmPowered schools, lesson plans on energy efficiency and sustainability and engaging materials from the Energy Hog energy efficiency campaign.

empoweredschools.org

ENERGY STAR® ENERGY EFFICIENCY STUDENT TOOLKIT

A free resource to help you create engagement and empowerment activities.

energystar.gov/sites/default/files/tools/K12EnergyEfficiencyStudentToolkit.pdf

ENERGY STAR ENERGY-SAVING COMPETITIONS

A free resource to help schools create a competition process, from planning and data management, to outreach and communications. Includes activity kits and communications resources – posters, social media graphics, print-ready reminds, banners and more.

energystar.gov/buildings/save_energy_commercial_buildings/ways_save/energy_saving_competitions

ENERGY STAR ENERGY TREASURE MAP: K-12 SCHOOLS

A free resource that helps students walk around their school looking for quick ways to save energy.

energystar.gov/buildings/tools-and-resources/energy_treasure_map_k_12_schools

EPA ENERGY EFFICIENCY PROGRAMS IN K-12 SCHOOLS

This free PDF provides examples from elementary and secondary schools, along with entire districts across the United States.

epa.gov/sites/default/files/2015-08/documents/k-12_guide.pdf

EPA LORAX ACTIVITY BOOK

A free activity book focused on energy-saving practices based on Dr. Seuss' classic book.

energystar.gov/about/newsroom/the-energy-source/new_and_improved_lorax_activity_book

NEED CURRICULUM, CLASSROOM GRANTS & SPECIAL PROGRAMS

A free resource from the National Energy Education Development (NEED) Project that provides curriculum on a variety of energy topics. This site includes resources for NEED grants and special programs for schools and local communities.

need.org/partners/curriculum-classroom-grants-special-programs

OPTIONS FOR EDUCATING OREGON ON ENERGY EFFICIENCY

This free PDF report from the Energy Trust of Oregon summarizes research conducted by Grounded Research of three potential energy education areas, including K-12 school engagement.

energytrust.org/wp-content/uploads/2018/08/Energy-Education-Final-Report_2017_07_11.pdf

POWERING DOWN: A TOOLKIT FOR BEHAVIOR-BASED ENERGY CONSERVATION IN K-12 SCHOOLS

This report examines five public schools that have reduced their energy use through successful behavior-based strategies.

centerforgreenschools.org/sites/default/files/resource-files/Behavior-based-Efficiency.pdf

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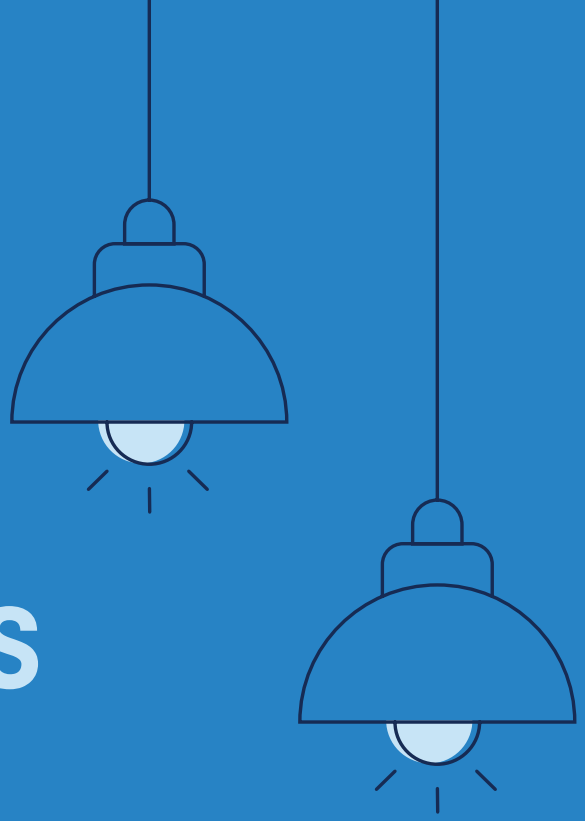
Notes

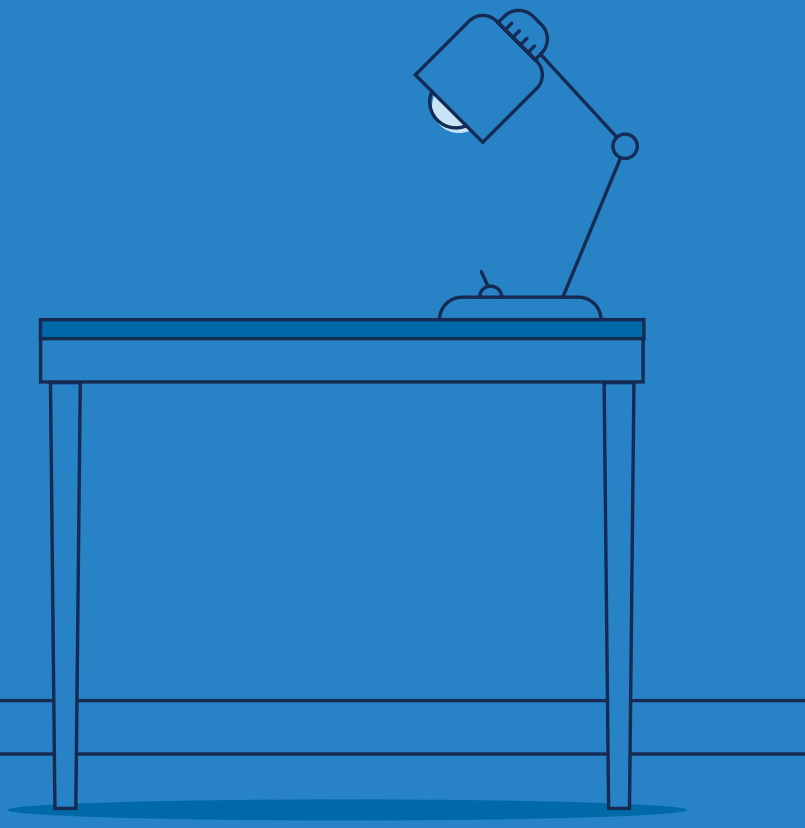
Implementing opportunities

CHAPTERS

CHAPTER 6

Lighting & controls





UP TO

30%

of a school's energy use

LIGHTING & CONTROLS

One of the simplest ways to lower energy costs and increase comfort and safety of staff and students.

Lighting typically accounts for 15-30% of a school's energy use. Upgrading to energy-efficient lighting is one of the simplest and most cost-effective ways to lower energy costs and increase comfort and safety for staff and students. Replacing fluorescent, incandescent and compact fluorescent lighting (CFL) with light-emitting diodes (LEDs) can improve lighting quality, reduce energy costs, decrease maintenance demands and improve the learning environment.

LED lighting allows faculty to optimize lighting levels and color temperature to best suit specific academic tasks. LEDs can also simulate daylight, improving circadian rhythms which affect the sleep/wake cycle, sleep quality and sharpness of the mind. Using LEDs to illuminate poorly lit areas such as parking lots, storage areas and garages also increases safety, security and reduces theft.

Adding controls, such as occupancy sensors and timers, can extend equipment life while creating additional energy and cost savings. Controls automate your lighting system to ensure an area is lit only when and where it is needed. This automation prevents the lighting of unoccupied spaces and use of excess energy and money.

UP TO A

25%

increase in learning with LEDs

Lighting quality – including light levels, color temperature and glare reduction – impacts student performance, attention and even test scores. LEDs are shown to have a calming effect that can increase attention spans and improve students' mood and performance in the classroom, increasing student productivity by 20% and learning by 25%. For students with Attention Deficit Hyperactivity Disorder (ADD/ADHD) or Autism Spectrum Disorder (ASD), LEDs can increase focus and attention while decreasing anxiety and distractions caused by flickering lights.

Benefits

1. Reduce energy costs with long-lasting and efficient LED lighting.
2. Decrease the amount of time staff spends replacing equipment.
3. Improve students' mood, attention, productivity and learning with enhanced lighting quality.
4. Optimize lighting levels and color temperature to best suit specific tasks.
5. Increase safety and reduce theft by using LEDs to illuminate poorly lit areas such as parking lots, storage areas and garages.
6. Improve overall aesthetic of the school.

Key terms

See the Appendix for more key terms.

LED

A versatile and highly efficient lighting technology that lasts longer and provides comparable or improved light quality over other types of lighting.

LAMPING / LAMPS

Refers to the light source or light bulbs used. Source types may include incandescent, linear or tubular fluorescent, compact fluorescent (cf) and high-intensity discharge (HID) types which may include high-pressure sodium, mercury vapor or metal halide.

DAYLIGHTING / DAYLIGHT HARVESTING

The intentional placement of windows, skylights, reflective surfaces and more to allow natural sunlight into an area and reduce electrical lighting needs.

LUMEN

The scientific unit of luminous flux, or light output, from a uniform source. The higher the lumens the brighter the light.

COLOR TEMPERATURE

A measurement of the quality and color of light output stated in Kelvin (K).

GLARE

An important consideration in light quality. It is produced by an intensity in light that negatively affects performance or creates discomfort.

TASK LIGHT

Specific, directional or adjustable light that can be added to a space.

FOOTCANDLE

A unit of measurement for the brightness of light or illuminance originally equal to one candle.

AMBIENT LIGHT

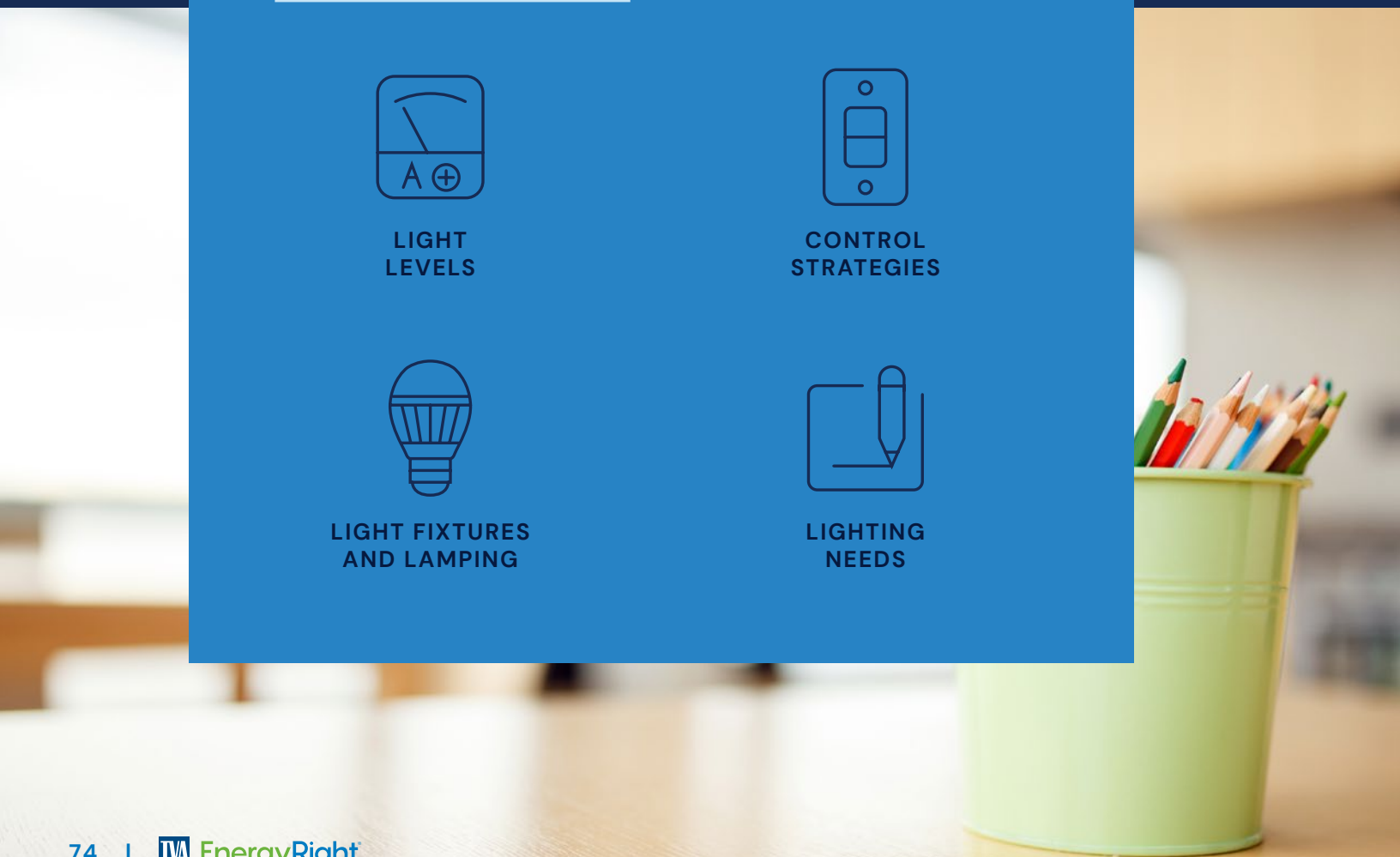
The general, non-directional light level in a space.

Getting started

To begin assessing your lighting system, it is important to first document lighting needs, existing fixtures, control strategies and lighting levels throughout your facility.

WHAT TO LOOK FOR

- LIGHT LEVELS
- CONTROL STRATEGIES
- LIGHT FIXTURES AND LAMPING
- LIGHTING NEEDS



1 Light levels

- Measure existing light levels with a light meter. Use the recommended lighting levels provided later in this section to determine if any adjustments should be made.

2 Light fixtures and lamping

- Identify the types and variety of fixtures found throughout each different space.
- Determine the lamp type and wattage of each fixture. If the fixture is fluorescent, determine what ballast type is installed (magnetic or electronic). If you cannot open fixtures, check maintenance or storage rooms for spare replacement lamps.
- Note areas with inefficient or inadequate lighting, and any areas that may be over lit.
- Note the lamp type of the exit signage in your school and if any incandescent types are still present.

3 Control strategies

- Identify areas already using control systems (occupancy sensors, daylight sensors, schedules, etc.) and assess effectiveness.
- Note any frequently unoccupied spaces (bathrooms, storage areas, etc.) that would benefit from the addition of controls to turn the lights off when unoccupied.

4 Lighting needs

- Identify the different spaces or space types of each building, room or area (e.g., classroom, gymnasium, hallway).
- For each space or space type, identify its lighting needs, the activities that take place within it and any relevant attributes (occupant types, existing and potential daylighting, etc.).

You will need:

LIGHTING METER
to measure footcandle illumination levels.

MECHANICAL COUNTER
to help count lighting fixtures in each area.

LASER MEASURING DEVICE
to measure fixture spacing and ceiling heights.

Interior lighting and controls

LIGHTING

With lighting, small investments can provide a quick financial return and substantial improvement for occupants.

SEM MEASURES

- Turn lights off when not in use. Consider an engagement campaign to encourage the whole school to improve their behavior. See Chapter 5 for more information.
- Consider locations and times where daylight could be used to illuminate a space instead of overhead lighting. This might involve addressing your window treatments (e.g., blinds or shades) to make them easier to operate and adjust throughout the day. See Chapter 11 for more information.
- Be mindful of where additional light is needed (such as a work surface or countertop) and direct light to that location, rather than lighting up the entire room.
- If a space has too much light, see if you can remove lamps from a fixture to lessen the light and the energy used in that space.
- Regularly clean your fixture lenses and reflectors to maintain original lighting output.

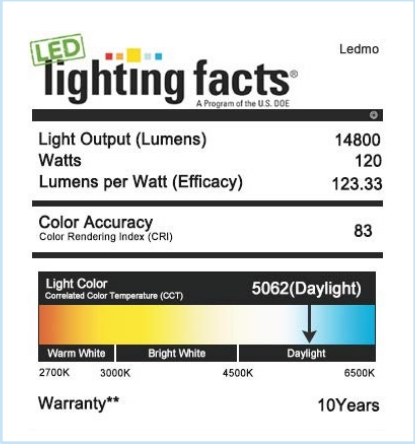
After documenting your building lighting as outlined in the previous "Getting Started" section, evaluate opportunities to achieve quick, no-cost savings, as well as potential upgrades. Keep in mind that schools have a variety of spaces that require unique lighting and control strategies to meet comfort and performance requirements. Each space may require an assortment of light sources and control strategies to provide appropriate light and reduce energy usage.

Fixtures and lamps

Replacing incandescent lamps

Incandescent fixtures and lamps can be retrofit with LEDs. A comparable LED lamp can replace most screw-based incandescent lamps with a similar lumen rating. Lumens measure a lamp's light output and can be found on the back of the LED lamp's packaging, under the "Lighting Facts" label.

The Lighting Facts label lists the lumens, watts, efficacy, other important color characteristics and applicable warranty information about the bulb.



Replacing compact fluorescent lamps (CFL)

To replace screw based CFL lamps with LEDs, use the Lighting Facts label to match the lumen output of your existing CFL.

Pin-based CFL lamps/bulbs come in typical wattages ranging from 7 to 55 watts. When considering an LED replacement lamp, make sure to match the number of pins on your existing CFL. Most 4-pin CFLs are dimmable, but make sure the LED replacement lamp is compatible with your dimmer.

Tip

BULB REPLACEMENT

Before you replace an existing incandescent or compact fluorescent lamp with an LED retrofit lamp, make sure the light fixture is in good condition. If an existing lens or reflector assembly is damaged, it is better to replace the entire fixture.

Replacing linear fluorescent lighting

There are two main options when upgrading fluorescent lighting systems: replacement (of the fixture) and retrofit (changing the lamp/bulb).

Typical upgrades for fluorescent tubes include installing new LED fixtures, such as flat panels, which provide more controllability and better light distribution. Another upgrade option is to replace fluorescent tubes with tubular LED lamps (TLEDs). The table below summarizes TLED retrofit options, installation considerations and estimated energy savings.

TLED RETROFIT GUIDE

TLED TYPE	DIRECT FLUORESCENT REPLACEMENT	REQUIRES BALLAST REMOVAL	NOTES	ESTIMATED ENERGY SAVINGS*
Type A	Yes	No	These lamps are designed to directly replace linear fluorescent lamps in existing fixtures and are compatible with existing fluorescent ballasts.	20%
Type B	Yes	Yes	Type B TLED lamps have integrated drivers. In addition to removing the existing ballasts, the wiring between the LED drivers and lamp holders should also be replaced.	30% - 50%
Type C	Yes	Yes	Existing lamp holders can be reused if they are in good shape. Type C retrofits have the best overall performance and control functionality compared to other retrofit options.	30% - 50%
Type AB	Yes	Sometimes	Type AB TLED lamps are designed to operate with either an existing ballast or integral LED driver. If the existing fluorescent ballast fails, the lamp will revert to driver operation.	20% - 50%
Type AC	Yes	Sometimes	Type AC TLED lamps are designed to operate on an existing fluorescent ballast. When the ballast fails, an external driver can be installed for continued operation.	20% - 50%

NOTE: Some hybrid Type AB and AC will replace existing lamps, ballasts and reflector assemblies with a new LED insert kit.

SEM MEASURES

- ✓ Replace linear fluorescent tubes (T5, T8 or T12) with tubular LED lamps (TLEDs) or LED light fixtures such as flat panels.
- ✓ Replace or retrofit existing incandescent and CFLs with LEDs.
- ✓ Replace older LEDs with newer, more efficient LEDs.
- ✓ Replace exit signs that use incandescent or CFLs with LED signs.
- ✓ Use LED task lighting on desks or under cabinets in place of overhead ambient light, when appropriate.
- ✓ Ensure fixtures and lamps are compatible with controls (e.g., dimmer switches should only be used with dimmable LED lamps or dimming-compatible fixtures).

SMART LEDS

Some new LED fixtures also incorporate intelligent devices that allow customization and control of each lighting system through a smart phone or tablet, providing potential for additional savings through the application of lighting controls.

Control strategies

Lighting controls enable the flexibility to adjust light levels manually or automatically, based on usage and occupancy.

Typical lighting controls include the addition of zoned switching and sensors such as occupancy, vacancy and daylight to automatically control lights in each space. These strategies can be leveraged throughout the school to reduce lighting energy use by up to 60%.

Zoned switching

Zoned switching groups different light fixtures together so some can be turned off while others remain on. For example, within a classroom, the lights at the teaching headwall (near the location of a projector screen) could be grouped separately from the lights over student desks. With a zoned switch, the teacher could darken the room at the projector but leave the lights on over the students who are taking notes.

Occupancy sensors

Occupancy sensors automatically turn lights on when motion is detected, and off after a set amount of time has passed without motion being detected. Occupancy sensors in classrooms can save anywhere from 20-60% of lighting energy.

If a space is only used at certain times during the day or is only occupied sporadically, occupancy sensors can ensure energy savings while the space is unoccupied. For example, occupancy sensors placed in hallways can be programmed so the lights dim significantly when unoccupied. Energy savings can be realized while still maintaining the required minimum footcandle level for safety purposes.

Vacancy sensors

Vacancy sensors require lights to be turned on manually but will automatically turn off when no motion is detected for a set period. This strategy allows faculty to leave lights off when natural light is enough. Like occupancy sensing, vacancy sensors have the potential to save between 20-60% of lighting energy.

SEM MEASURES

- ✓ Promote occupant behavior changes for manual switches with prompts and reminders to turn lights off when you are the last to leave.
- ✓ Zone lights and associated switching to manually lower the lighting in a room based on the space function or daylight harvesting.
- ✓ Add dimmable lighting where needed (e.g., in front of classrooms with projectors or smart boards).
- ✓ Install occupancy sensors to automatically turn lights off when spaces are unoccupied.
- ✓ Install daylight sensors to automatically reduce light levels when daylight is appropriate.
- ✓ Set lighting schedules to automatically adjust light levels based on time of day.

Daylight sensors

Daylight sensors signal the lighting system to turn off or dim when the natural light from windows is sufficient for the space. The Illuminating Engineer Society (IES) recommends using a dimming system in schools to achieve a more comfortable transition from the electric lighting system to natural light. Daylight harvesting can save between 25-60% of lighting energy cost.

Dimmers

Dimmers can also be used manually to control light levels in classrooms and auditoriums during presentations, or automatically for daylight harvesting strategies. Lighting dimmers require lamps and fixtures that are rated for dimming. For the lights to dim, they also require a control device to signal when to reduce the light and how much light to reduce.

Light levels

When upgrading lighting systems, it is important to be mindful of both the baseline and recommended light levels in each space and consider how any upgrades will impact existing light levels. Recommended light levels for common space types found in academic buildings are measured at 30 inches above the floor (desk height).

SEM MEASURES

- ✓ More is not always better when referring to light. Identify over-lit areas where it may be appropriate to remove lamps from fixtures or to remove fixtures entirely. These opportunities can be extremely common.
- ✓ Only implement lighting system changes that either maintain or improve the quality of existing light levels in the space.

Interior lighting summary

RECOMMENDED LIGHTING STRATEGIES BY SPACE TYPE

SPACE TYPE	LIGHT LEVEL (FC)*	FIXTURES & BULBS	CONTROL STRATEGIES
Classrooms	**40** Classrooms **50** Arts and drafting rooms **30** Study halls	**LED replacements for:** • Fluorescent fixtures • CFLs • Incandescent bulbs • Exit signs Use LED task lighting on (teacher) desks in place of the overhead ambient light when classroom is unoccupied to save energy.	• Install occupancy sensors to automatically turn lights off when rooms are unoccupied. • In classrooms with windows, install daylight sensors with zoned continuous or multi-step dimming. • Use dimmable lighting for multimedia presentations, and to compensate for daylight contribution when using lighted whiteboards.
Offices	**40**	**LED replacements for:** • Fluorescent fixtures • CFLs • Incandescent bulbs • Exit signs Use LED task lighting on desk or under cabinet lighting in place of the overhead ambient light to save energy.	• Install occupancy sensors for personal offices separated by walls to turn lighting off automatically when rooms are unoccupied. • In offices with windows, install daylight sensors with zoned continuous or multi-step dimming.
Hallways & stairwells	**25**	**LED replacements for:** • Fluorescent fixtures • CFLs • Incandescent bulbs • Exit signs	Use occupancy sensors for bi-level or continuous dimmed lights to reduce lighting and energy use after class changes and at the end of the school day.
Entrances	**25**	**LED replacements for:** • Fluorescent fixtures • CFLs • Incandescent bulbs	Dim or turn lights off close to exterior windows when enough daylight is available (daylight harvesting).

* Published by the Illuminating Engineering Society (IES).

RECOMMENDED LIGHTING STRATEGIES BY SPACE TYPE (CONT.)

SPACE TYPE	LIGHT LEVEL (FC)*	FIXTURES & BULBS	CONTROL STRATEGIES
Auditoriums, dedicated A/V viewing spaces, or computer labs	**5** Auditoriums & A/V viewing rooms **15** Computer labs	**LED replacements for:** • Fluorescent fixtures • CFLs • Incandescent bulbs • Exit signs	Use dimming systems that provide lighting flexibility for multiple functions in the space.
Gyms & cafeterias	**50** Gyms **25** Cafeterias	**LED replacements for:** • HID fixtures • Fluorescent fixtures • Exit signs	• Use dimmable lighting for multifunction capabilities, and specifically for "cafetoriums." • Use daylight harvesting for gyms with windows and/or highlights. • Use zone controls when light level requirements vary. For example, light levels for spectators can be decreased while higher light levels are provided for players.
Libraries	**40**	**LED replacements for:** • Fluorescent fixtures • CFLs • Incandescent bulbs • Exit signs	Use a combination of dimmable LED lighting and occupancy sensors to lower light levels during times where circulation areas are unoccupied.
Restrooms & locker rooms	**20**	**LED replacements for:** • Fluorescent fixtures • CFLs • Incandescent bulbs • Exit signs	Use occupancy sensors – dual technology ultrasonic and infrared can "see" around stalls.

Exterior lighting and controls

Outdoor lighting is an important aspect of a school's energy savings strategy, and it is also important for the security of the school buildings after hours. Wall pack lights, flood lights, parking area lights and under-canopy lights typically provide security lighting for windows, entrances, walkways and exits of the building's perimeter.

SEM MEASURES

- Save energy by dimming LED lighting systems after hours.
- Make sure all exterior lighting is controlled with a dusk to dawn sensor, either centrally or on each fixture.
- Replace existing high-pressure sodium, mercury vapor or metal halide parking lot, site, security, façade, sports lighting or pathway lighting with dimmable LED sources.
- When replacement is needed, replace exterior parking and walkway light fixtures with high-performing directional lights to efficiently use lower light and energy levels.

Depending on the fixture type, energy savings may be achieved by installing LED fixtures. This can provide more uniform light and eliminate dark spots. When installing new fixtures, it is important to consider the fixture directionality. Fixtures should direct light downward on the parking lot surface within the school property line to limit "spill light", which wastes energy by lighting up neighboring areas or the night sky.

In some outdoor spaces, such as parking lots, stadium areas and athletic fields, adding a time-clock control to the lighting system can be a great strategy to reduce energy use. Time-clock controls can be integrated into a lighting control panel or stand alone on the system to ensure the lights are turned on or off at predetermined times to specified levels. A common use of time-clock control is

site lighting for parking and exterior areas around the school, utilizing an astronomical time clock that can be programmed to change the light levels based on sunrise and sunset times.

Additionally, many of these lights are on continuously from dusk to dawn – but some do not have to be lit at 100% light output after hours. Reducing the brightness by 50% after midnight can yield significant energy savings.

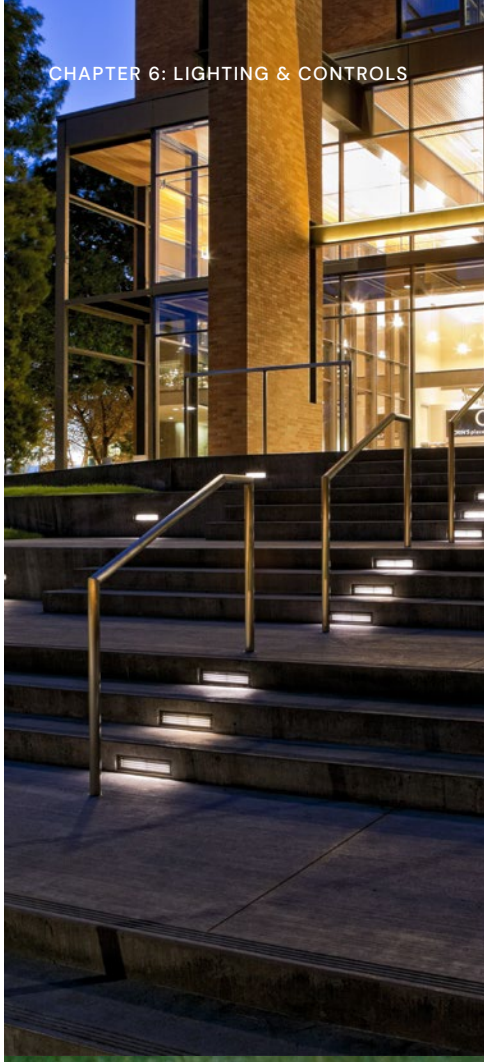
Exterior lighting maintenance

Exterior lighting fixtures are prone to debris accumulation – bugs, water residue and foreign particles will inevitably adhere to exterior and interior surfaces of the fixture. Debris can negatively affect light output and fixture operating temperatures.

LED fixtures are more sensitive to buildup in the areas of the fixture that are designed to dissipate heat, which could have a negative effect on fixture operation and can potentially cause premature lamp failure.

SEM MEASURES

- ✓ Note any fixture failures to ensure safety and security.
- ✓ Regularly clean exterior fixtures, paying special attention to the fixture's optical assemblies and heat sinks of the LED lamps.



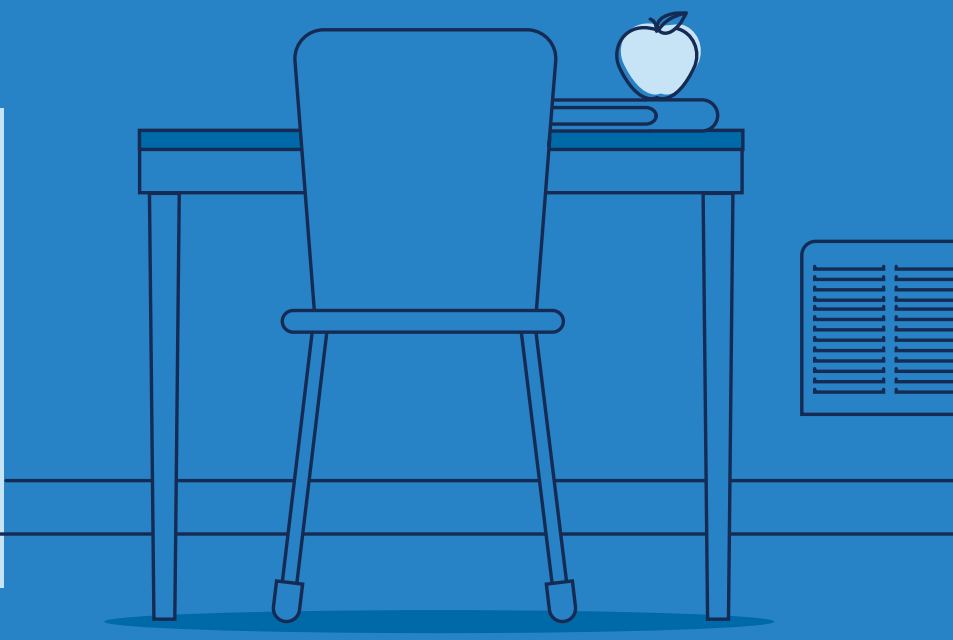
CHAPTER 7

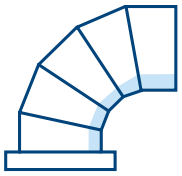
Heating, ventilation & air conditioning

ACCOUNTS FOR

47%

of a school's energy use





HVAC

Largest energy user and the biggest opportunity for efficiency measures.

Heating, ventilation and air conditioning (HVAC) accounts for up to 47% of a school's energy use – by far the largest energy user and the biggest opportunity for efficiency measures. Luckily, there are some easy and simple methods to save energy, reduce costs and improve or maintain occupant comfort.

The performance of your existing HVAC system depends on two things: usage and maintenance. In SEM, confirming how your system is meant to be operated and how it is currently performing will let you know what steps are needed to adjust or maintain it. Just like with your car, mechanical systems need tune-ups too. Maintaining your HVAC systems on a regular schedule – before they break – is the same concept as changing your oil every 3,000 miles before you damage the motor. With schedules and routines, a preventative maintenance strategy is an easy efficiency and durability measure to incorporate.

Beyond the energy benefits of a high performing system, HVAC directly affects humidity levels, thermal comfort and indoor air quality. An energy efficient HVAC system provides a cleaner, quieter and healthier environment for both faculty and students, with fewer environmental distractions.

UP TO

15%

decrease in health-related absences

When air is filtered, sanitized or purified, it can prevent the circulation of bacteria, viruses and mold spores, and remove volatile organic compounds (VOCs) that can cause health problems. An upgraded HVAC system reduces these risks, improving student and faculty health and decreasing health-related absences by up to 15%.

Benefits

1. Reduce energy costs immediately by addressing issues within the school's HVAC system.
2. Lower annual energy costs with even slight improvements in system efficiency.
3. Reduce the potential for mold, health problems and maintenance burdens.
4. Increase comfort and control for students and staff.
5. Improve productivity, focus and concentration for students and staff.
6. Decrease the likelihood of outages and related downtime with improved operations and maintenance.
7. Eliminate premature equipment replacement and large, unexpected capital projects by keeping existing systems working properly.
8. Extend equipment life through preventative maintenance.

Key terms

See the Appendix for more key terms.

INDOOR AIR QUALITY (IAQ)

Refers to the air quality within a building, especially as it relates to the health and comfort of the building's occupants.

VENTILATION

The process of intentionally exchanging or replacing air within a space to improve indoor air quality, control temperature and humidity, and remove odors, pollutants, and other airborne particulates.

AIR INTAKE

Refers to an opening through which fresh air enters the HVAC system from outside.

LOUVERS AND DAMPERS

Louvers and dampers control and manage airflow and redirect it to/from specific areas.

SETBACKS

A strategy for reducing how often the heating or cooling system operates by allowing the temperature in a room to drift to a higher or lower setting, based on occupancy.

MINIMUM EFFICIENCY RATING VALUE (MERV)

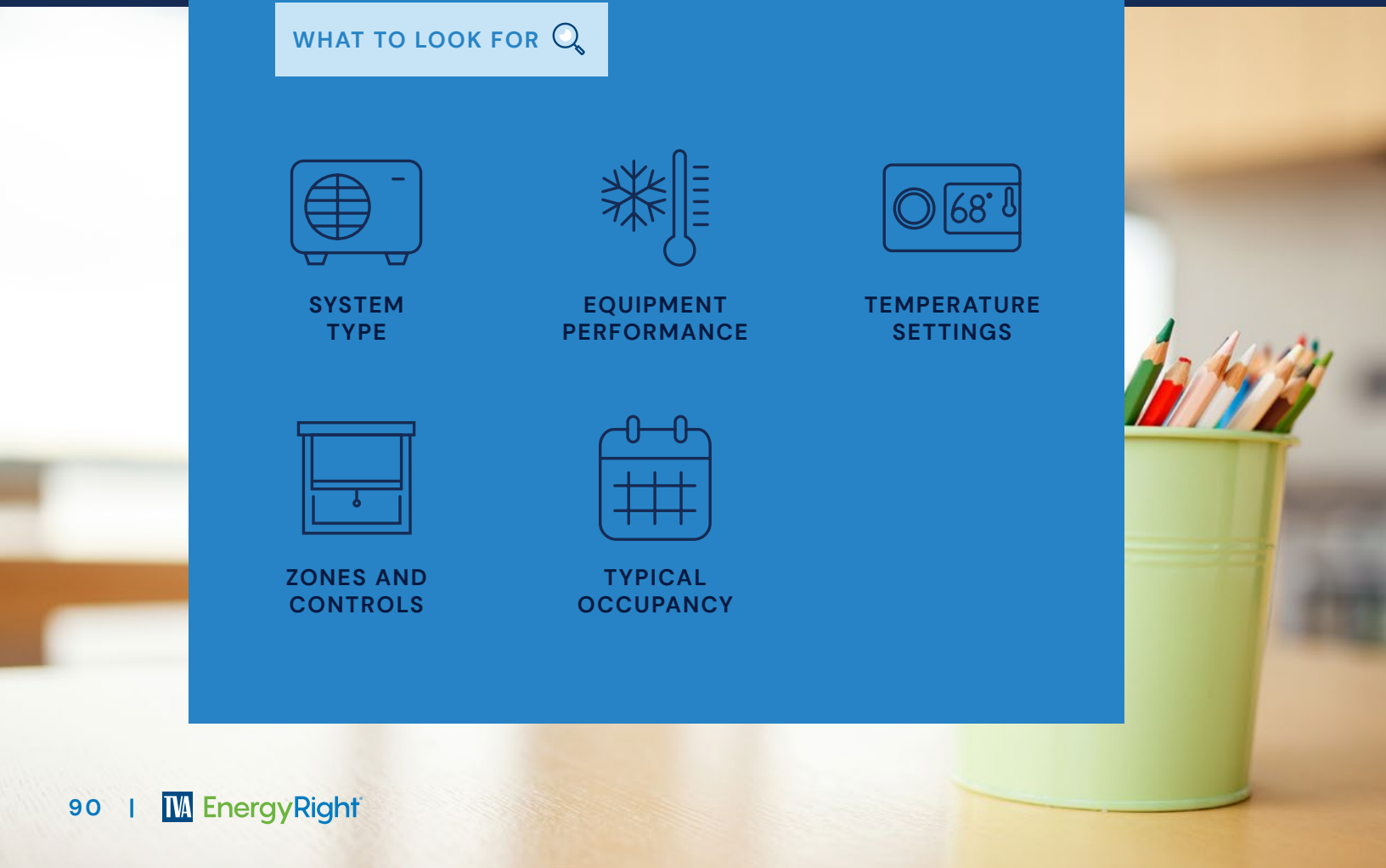
An air filter's MERV rating tells you the size of particulates the filter is capable of capturing. The higher the rating, the smaller the particulate which can be filtered.

Getting started

To begin assessing your HVAC system, it is important to first document system type, equipment age, typical occupancy and comfort requirements. Equipped with the knowledge of how your system is currently working, you can then use the information in this section to identify improvement opportunities and implement changes to increase your HVAC system's efficiency.

WHAT TO LOOK FOR

- SYSTEM TYPE
- EQUIPMENT PERFORMANCE
- TEMPERATURE SETTINGS
- ZONES AND CONTROLS
- TYPICAL OCCUPANCY



1 System type

- ✓ Identify how the building is being heated and cooled. System types can vary across the facility, and may include chillers, rooftop package units (RTUs), boilers, furnaces, water source heat pumps, individual classroom Packaged Terminal Air Conditioner (PTAC), dual fuel BARD units, etc.
- ✓ Make a note of where and how each system is zoned and controlled.

2 Equipment performance

- ✓ Verify or estimate the age of equipment; note any units more than 10 years old.
- ✓ Review your HVAC system's performance to determine what changes have happened over time. This may include reviewing utility bills, reports from your service company, maintenance logs and paying attention to indoor temperatures.
- ✓ Determine the people who have knowledge or could provide insight into your system's performance, such as a manufacturer sales representative, mechanical engineer of record or previous service provider or technician.

3 Temperature settings

- ✓ Note temperature and run-time settings for various locations or building zones such as classrooms, hallways and common areas.
- ✓ Collect feedback on temperature and humidity comfort levels in different areas. Note any areas where staff or students indicate adjustments may be necessary.

4 Zones and controls

- ✓ Close windows/doors as appropriate to isolate individual HVAC zones (this can help determine which zones are not operating as they should).
- ✓ Locate and review original HVAC plans, specifications and O&M manual sections.

5 Typical occupancy

- ✓ Assess the school's typical weekly occupancy and group by school day, after school and weekend schedules.
- ✓ Note any special events such as sporting events or open houses.
- ✓ Note any unique functional areas such as gymnasiums, cafeterias and theaters.

Preventative HVAC maintenance

Properly maintained HVAC equipment improves reliability, saves energy by running systems at designed performance levels and ultimately reduces the need for emergency replacements.

Establishing regular maintenance checks and schedules will improve the effectiveness of your HVAC systems. Building automation systems and HVAC controls, such as thermostats, should also be monitored.

Preventative HVAC maintenance checklist

- [ ] Confirm system schedules match facility hours and occupancy patterns.
- [ ] Confirm thermostats are functional and not working against operable windows, open doors or other building zone settings.
- [ ] Replace air handling equipment filters at least quarterly. Refer to unit specifications for the correct level of filtration (MERV). Using a higher level than is specified can decrease system's performance, and too low a level may not be effective in trapping particulate matter.
- [ ] Verify outside air louvers and dampers open and close properly.
- [ ] Confirm outside air intakes are clean and away from any pollution sources.
- [ ] Brush and clean coils to remove excess dirt and debris.
- [ ] Check the integrity of existing duct and refrigerant line insulation. Seal any gaps with foil tape and mastic resin and add/or replace insulation as needed.
- [ ] Check valve conditions for corrosion and control responsiveness.
- [ ] Clean and check compressors, motors, fans, belts and blades for deterioration, damage and debris.
- [ ] Ensure all return air vents are clear of blockages or obstructions.

HVAC improvements

Understanding how to properly use and maintain your HVAC system will help you prevent and address any issues before they occur, and ensure your systems are efficient, effective and produce a comfortable learning environment.

Temperature setpoints

Adjusting equipment temperature setpoints can improve HVAC system performance and reduce operating costs. Even a slight change can make a significant impact – for every degree you adjust the thermostat, the system will reduce energy use by an estimated 1-3%. In general, the closer your temperature is set to the outside air temperature, the less your system will need to work.

Scheduling and controls

For most school buildings, the use of schedules and setbacks offers significant cost savings with little to no investment. Using the zones within your HVAC system allows you to set specific setback schedules for the different needs of each space. Savings can be substantial, as unoccupied or rarely used areas are often heated or cooled unnecessarily. This method is mainly applicable when incorporating existing building automation systems. See Chapter 12 for additional information.

SEM MEASURES

- ✓ Adjust temperature setpoints to 65-68°F in the winter and 72-75°F during warm months. During breaks, set thermostats to unoccupied setpoints (55˚F heat/80˚F cool).
- ✓ Make minor temperature adjustments as needed to account for feedback on comfort levels.
- ✓ Make sure run-times reflect building occupancy.
- ✓ For thermostats located in shared spaces, install security covers to prevent tampering.

Schedules

For many schools, equipment capable of implementing schedules is already in place but is bypassed or unused. If this is the case, inspect the equipment to determine its condition and any maintenance needs. An HVAC technician may be required to program controllers and update schedules, but this can be a simple and low-cost means of achieving significant savings.

Controls

Schools can benefit from adding controls to monitor system performance and energy consumption. Programmable thermostats with automatic controls are a simple, inexpensive option. More sophisticated options – such as central controls that can override all site thermostats – provide increased precision, accuracy and management. See Chapter 12 for additional information.

Programmable controls can also be used to implement air economization by bringing outside air into a space to supplement the air in the building (both improving indoor air quality as well as reducing HVAC load). At times, this may allow HVAC units to shut off completely.

SEM MEASURES

- ✓ Install programmable thermostats as needed.
- ✓ Add schedules and utilize the controls system to reduce the load and run-time of equipment.

Chilled water temperature setpoints

Monitoring chilled water temperature setpoints can also reduce energy waste. The industry standard for chilled water is a 10°F difference between supply and return temperatures. When the temperature differences are >10°F, it increases the energy used at the chiller to make up for the amount of heat transfer occurring at one time. Temperature differences above or below 10°F increase energy use at the chiller or the pumps to make up for the differences. Maintaining the industry standard of 10°F difference results in the most efficient chiller operation and pump speed.

CONTROL TYPE	ADVANTAGES	DISADVANTAGES
Thermostats	• Low cost • Easy operation	• Inability to schedule setpoints • Often left at occupied setpoints
Programmable thermostats	• Low cost • Ability to schedule daily setpoints	• Scheduling limitations • No central control or override • Inability to include more sophisticated control strategies
Central controllers	• Can maintain several schedules for individual spaces • Can control and monitor different zones centrally • Can be used to incorporate economization and other strategies	• Higher cost • Can require training or specialist to update

Piping insulation

When hot or chilled water pipes are exposed and uninsulated, energy from the circulating water is lost. As a result, the equipment operates for extended periods of time or at higher capacities to meet the school's load. Adding or replacing insulation can improve performance and occupant comfort and reduce energy consumption by reducing heat losses (or gains) as the fluid moves throughout the building.

Insulation requirements will vary based on the temperature of the water flowing through the pipe and the thickness of the pipe. Generally, the hotter or colder the fluid is compared to ambient conditions, the thicker the insulation should be.

For more information

energycodes.gov/sites/default/files/2019-09/2018_IECC_commercial_requirements_mechanical.pdf

SEM MEASURES

- ✓ For chiller systems, consider increasing the chilled water temperature and/or lowering the condenser water temperature.
- ✓ Ensure all pipes are insulated and maintain pipe insulation.
- ✓ For older burners, consider replacing the burner for improved turndown rate when high temperatures aren't required.

HVAC unit replacement

As a unit ages it will become less efficient and require more frequent repairs. Monitoring the age and condition of individual units can help forecast maintenance costs and upcoming repairs.

Installing a newer unit before the older one gives out will increase the system's efficiency and allow the school to proactively plan for costs and scheduling to ensure minimal impact on the learning environment. If you need to replace your HVAC unit, upgrade to an ENERGY STAR® certified model.

SEM MEASURES

- ✓ Replace inefficient or aging units (older than or approaching 10 years old) with high-efficiency or ENERGY STAR® certified models.
- ✓ Confirm refrigerant type. Some refrigerants, such as R-22, have been identified as ozone-depleting chemicals and are being phased out. If your system uses one of these coolants, it may impact your efficiency and replacement options.
- ✓ For hydronic systems with a non-condensing boiler approaching the end of its useful life, consider upgrading to a high-efficiency condensing boiler.

Additional considerations

Variable frequency drives

Many HVAC systems can benefit from a variable speed fan so that the fan motor is not running at 100% when less is required to keep the building supplied with conditioned air. Variable Frequency Drives (VFDs) control and reduce motor energy when full motor load is not required. Implementing VFD technology typically requires an upgrade or modification to HVAC system controls to ensure fan speeds adjust appropriately and respond to the appropriate triggers.

Reducing ventilation air is a common energy saving method. Optimizing the amount of outside air a space requires can be automated using Demand Control ventilation. This technology measures the carbon dioxide in the space and increases or decreases the amount of outside air required during less occupied or unoccupied periods. Not only does this save energy, it also reduces the amount of humidity introduced into the space. Decreasing supply fan speed to reduce the amount of excess ventilation air needed can be directed by schedule or Demand Control. Likewise, savings can be achieved by adjusting the fan speed for supply and return fans. See Chapter 12 for more information.

Economizing

Economizer controls regulate the amount of outside air incorporated into the HVAC system to supplement ventilation and cooling needs. Introducing outside air is an easy way to improve air quality during times of high occupancy.

When occupancy is high, occupants contribute to the heat load, CO_2 levels and indoor pollutant levels resulting from the frequent opening of doors and natural body functions. Adding increased levels of fresh outside air helps maintain indoor air quality and comfort levels by mixing and diffusing fresh air with the conditioned air already inside the building.

During the temperature extremes of the heating and cooling season, higher levels of outside air will make your HVAC system work harder to reach the desired temperature setpoint. The harder your unit must work to keep building occupants comfortable, the more likely you are to see increased energy consumption and higher energy bills.
See Chapter 11 for more information.

Belts

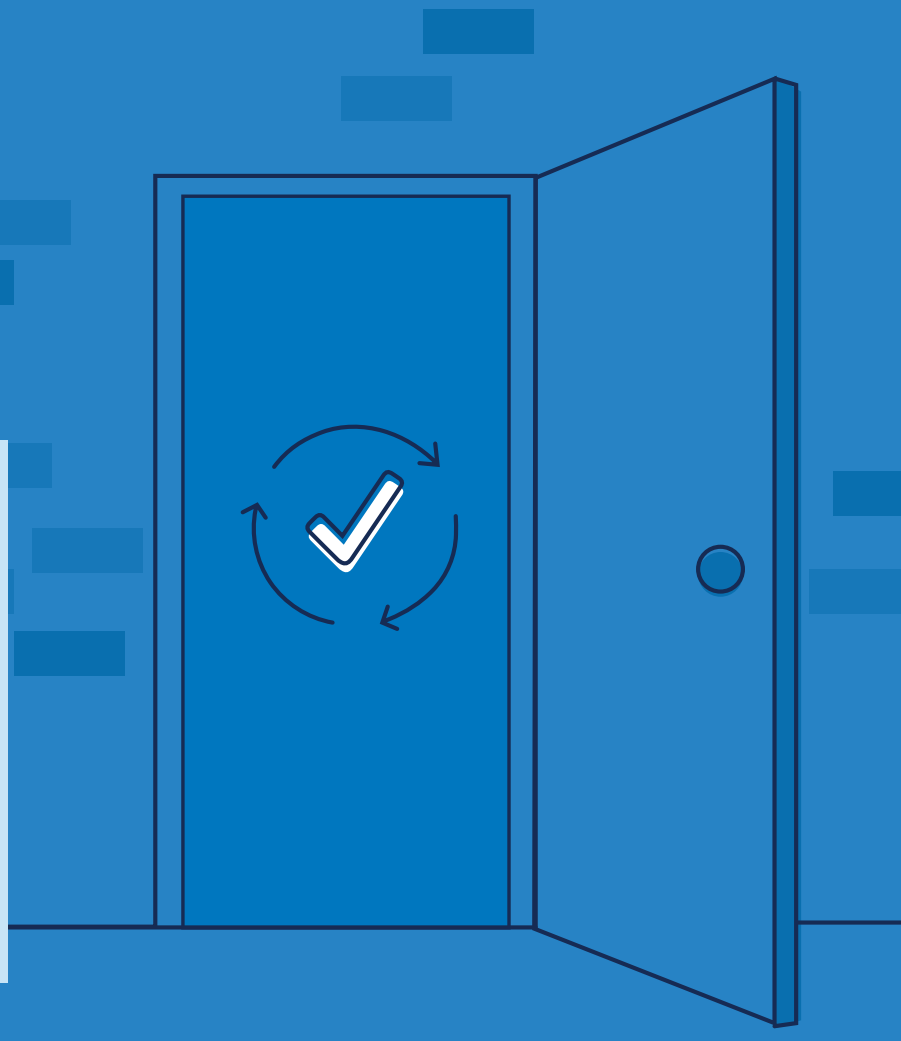
While direct-drive motors are typically the most efficient, steps can be taken to improve the efficiency of existing belt-driven motors. Standard V-belts lose efficiency due to slippage. Replacing these belts and pulleys with notched or synchronous belts in large air handlers and cooling towers can reduce slippage, resulting in up to 5% savings.

Notes


CLEAN AIR ON

CHAPTER 8

Indoor environmental quality



NEARLY

1 in 13

school-aged children has asthma

INDOOR ENVIRONMENTAL QUALITY

Poor indoor air quality (IAQ) can lead to increased allergens, dust and sustained odors, as well as reduced energy and focus for building occupants.

Indoor Environmental Quality (IEQ) describes the general conditions within a building that affect the health and well-being of the occupants. While IEQ encompasses many factors, this section focuses on how air quality of the building affects IEQ.

Air quality is made up of both airborne particulate matter and the percentage of oxygen and carbon dioxide in the air. Indoor air quality (IAQ) affects both the health and comfort of building occupants. In severe cases, poor IAQ can cause or contribute to short- and long-term health problems, including asthma, respiratory tract infection and disease, allergic reactions, headaches, nasal congestion, eye and skin irritations, coughing, sneezing, fatigue, dizziness and nausea. A building has two primary methods for cycling air: infiltration and mechanical ventilation.

Key terms

INDOOR AIR QUALITY (IAQ)

Refers to the air quality within a building, especially as it relates to the health and comfort of the building's occupants.

INDOOR ENVIRONMENTAL QUALITY (IEQ)

Refers to the quality of a building's environment related to the health of occupants' breathing, sight, hearing, feeling (temperature and humidity) and psychological aspects of life indoors.

MINIMUM EFFICIENCY RATING VALUE (MERV)

An air filter's MERV rating tells you the size of particulates the filter is capable of capturing. The higher the rating, the smaller the particulate which can be filtered.

HIGH EFFICIENCY PARTICULATE AIR (HEPA)

Filters meeting HEPA standards must remove at least 99.97% of any airborne particles with a size of 0.3 microns (µm).

Benefits

1

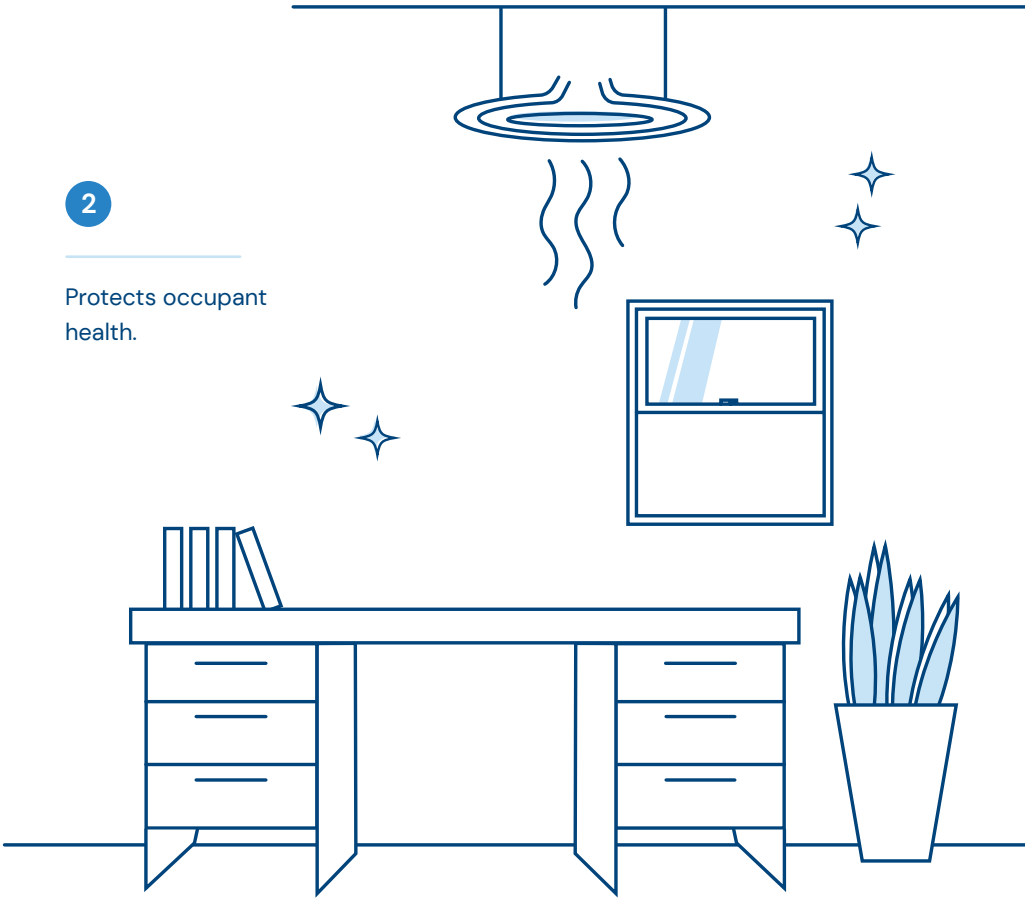
Increases focus and energy for building occupants.

2

Protects occupant health.

3

Reduces stress and potential injuries.



See the Appendix for more key terms.

DEDICATED OUTSIDE AIR SYSTEM

Used to bring fresh outside air into interior spaces independently from heating or cooling efforts.

OUTSIDE AIR

The air outside a building or structure. Outside air is unconditioned fresh air.

RETURN AIR

Air that returns to the HVAC system from the space that is being heated or cooled.

MIXED AIR

The mixture of return air and outside air in an HVAC system.

ULTRA-VIOLET GERMICIDAL IRRADIATION (UVGI)

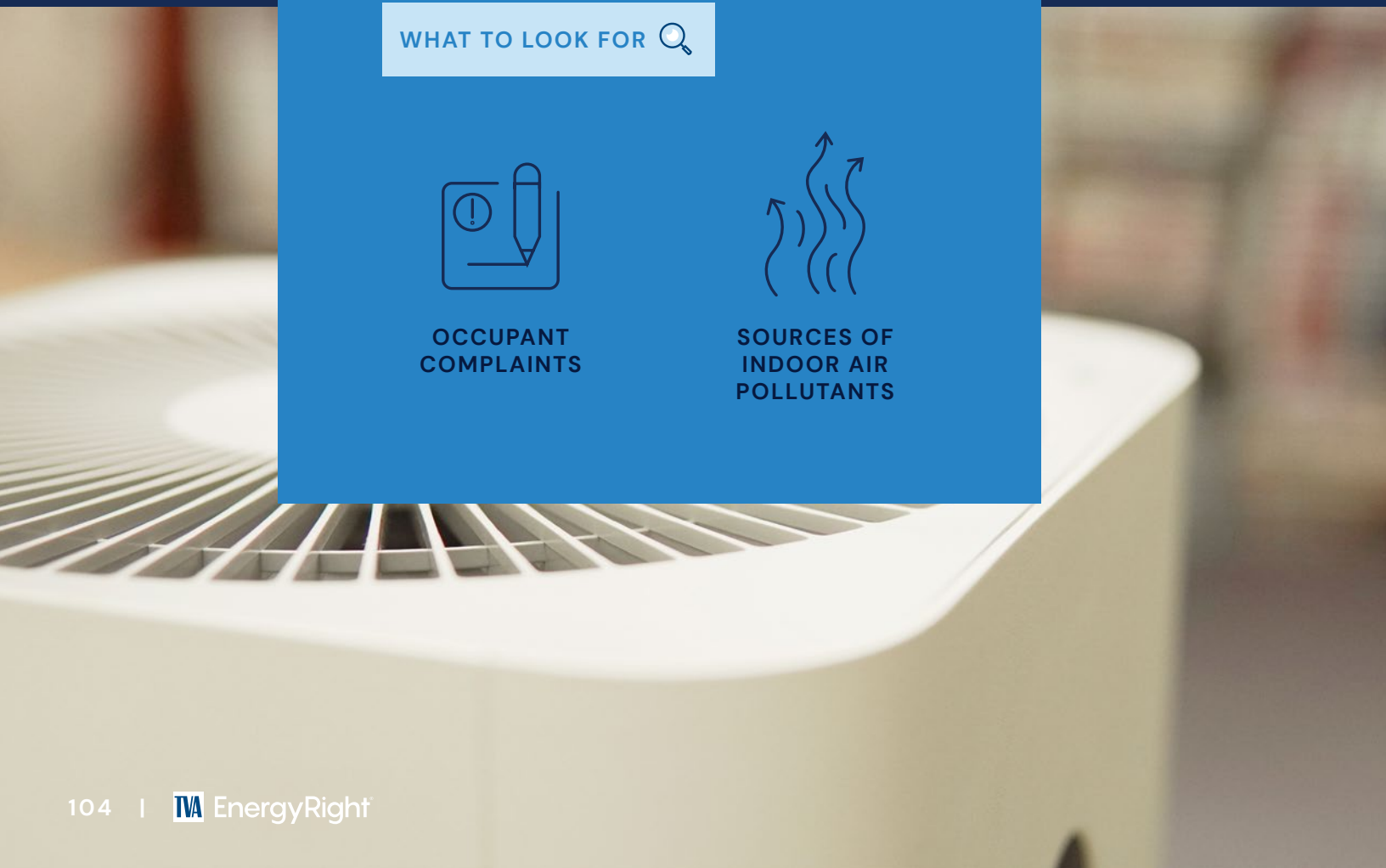
A disinfection method that uses a specific wavelength of light (UV-C) to eradicate/deactivate microorganisms and pathogens, purifying the air.

VENTILATION

The mechanical or natural process of supplying outdoor air to occupied areas within the school.

Getting started

Indoor environments are highly complex. Understanding the factors of indoor environmental quality and sources of contaminants can help prevent or resolve health and well-being issues. It is important to choose strategies that ensure the comfort of occupants is met while also promoting energy efficiency.



WHAT TO LOOK FOR

OCCUPANT COMPLAINTS

SOURCES OF INDOOR AIR POLLUTANTS

1 Take note of any occupant complaints

- ✓ Take note of any occupant complaints related to health, thermal comfort, acoustics and odor such as:
  - Irritating smells (e.g., cleaning products, plumbing odors, car exhaust fumes).
  - Thermal issues (e.g., drafty spaces, stuffy rooms, stale air, humid spaces, mold growth, extreme temperature zones).
  - Acoustic issues (e.g., outside noises, competitive noise environments, mechanical noises).
  - Health concerns (e.g., headache, shortness of breath, sinus congestion, coughing, sneezing, dizziness, nausea, irritation of the eye, nose, throat and/or skin).

2 Sources of indoor air pollutants

- ✓ Identify any potential indoor air pollutants and their sources. Typical sources include:
  - Outdoor sources.
  - HVAC systems and other building equipment.
  - Material components and new furnishings.
  - Occupants, including pets and animals.

Preventing infiltration

Infiltration refers to the unintentional entry of outside air into the building generally through gaps or cracks in the building envelope, worn out weatherstripping along doors and open doors and windows. Due to the uncontrolled nature of this airflow, infiltration is typically designed to be minimized or prevented. While infiltration delivers fresh air to a space, it is unconditioned air which makes the HVAC system work harder to maintain temperature setpoints and to filter out any additional particulate introduced to the space.

Air balancing is a method HVAC contractors can use to perform space measurements to determine if a location has a specific or correct air pressure. The modern solution to air leakage is introducing positive pressure to buildings, so conditioned air is pushed out through any crack or open space rather than outside air being pulled in. Different locations are regulated at different pressures (e.g., science classrooms with hoods are designed with negative pressure to vent out possible chemicals in the space, while typical buildings have an overall positive pressure to prevent infiltration).

SEM MEASURES

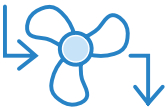
- ✓ Enlist an HVAC and/or Air Testing & Balancing Contractor to determine your school's correct air pressure.
- ✓ Regularly check and clean your HVAC units, air filters and air intake areas.
- ✓ Regularly replace your HVAC filters. Consider upgrading to a higher filtration level filter that still meets the air flow requirements of your HVAC units.
- ✓ Seal and insulate ductwork or exterior air leaks.
- ✓ Watch for signs of pests and plan for preventative pest control.

Ventilation

Ventilation can be either natural or mechanical. For this section, we will be discussing mechanical ventilation. There are many different commercial ventilation strategies; however, there are two main strategies schools use most often: the conditioning and supply of either 100% fresh air, or a combination of fresh and recirculated air. The strategies depend on the equipment in each building, so it is helpful to understand how the ventilation of your space is designed.

SEM MEASURES

- Lower ventilation rates after school hours during periods of low occupancy.
- Ensure you are using the proper ventilation rates based on occupancy for each space, equipment and overall size of the space.
- Utilize a schedule through a control system for ventilation rates.
- Install CO_2 sensors to enable Demand Control ventilation which provides more fresh air when high occupancy is detected. Periodically check to ensure all sensors are functioning properly.
- Connect restroom exhaust fans to occupancy sensors to ensure motors do not run during periods of low occupancy.



VENTILATION

Top strategies for schools:

1. **Condition and supply of 100% fresh air, or**
2. **Combined fresh and recirculated air.**

Strategy one:

FRESH AIR

A dedicated outside air system is often used in commercial buildings to condition and supply fresh outside air to interior spaces. These units work side-by-side with recirculating units to condition the remaining spaces to appropriate levels. This strategy draws the heaviest load to more centralized locations, which increases efficiency and decreases the initial infrastructure needed across the building area. A downside of this strategy is the outside air must be mixed mechanically or allowed to be mixed naturally between spaces.

Strategy two:

COMBINATION OF FRESH AND RECIRCULATED AIR

The second common strategy is to utilize equipment that supplies a mix of outside air and returned air from the space. This strategy increases the supply of the outside air directly into each specific space and ensures that if a specific piece of equipment malfunctions, the remaining spaces are unaffected. A downside to this strategy is the higher initial investment in equipment and infrastructure.

To save energy when conditioning outside air, ventilation rates can be lowered after school hours or during periods of low occupancy. This can be done easily through a control system (as described in Chapter 7) or manually at the end of each day. Proper ventilation rates are based on the quantity of people, any equipment located in the space and overall size of the space. Ventilation rates should ideally be controlled on a schedule along with temperature setpoints. More advanced control systems, such as Demand Control, can alter ventilation rates based on measured CO_2 concentration associated with the number of occupants in the space. This method is most often seen in gymnasiums and cafeterias. Chapter 7 can provide additional information on efficient strategies.

Airborne particulate

Outside air is conditioned in a few ways before it is introduced to an indoor space. The physical matter, or airborne particulate, consists of material that can be filtered out of the air, eradicated using UV lights or eliminated by other methods. Particulate material includes but is not limited to: dust, leaves, dirt, pollen, insects, mold and microorganisms such as the Flu and COVID-19 viruses.

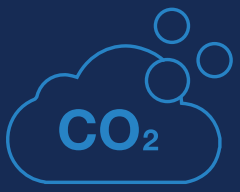
ASHRAE's (American Society for Heating, Refrigeration, and Air-conditioning Engineers) MERV scale regulates filtration methods from 1 to 20. As the MERV rating increases, so does the ability for the filter to remove particulate. Higher-rated filters capture larger amounts of microorganisms, but not 100% of them. Ultraviolet Germicidal Irradiation (UVGI) technology has been the only Food and Drug Administration (FDA) and ASHRAE acknowledged technology to eradicate up to 99.97% of Flu and COVID-19 microorganisms.

UVGI lamps have grown in popularity in recent years. Using a specific wavelength of light called UV-C, UVGI systems reduce facility-wide airborne pathogens by inactivating microorganisms and disinfecting and purifying the air. An effective in-duct UVGI system can improve overall air quality within the space. Depending on the placement and intensity of the lamps, UVGI can also help maintain HVAC coils by keeping them free of possible biological growth.

There are other recognized filtration technologies on the market (e.g., ionizers). However, their results have not been proven or recognized by the FDA and ASHRAE. Simply using the highest-rated filters isn't always the best strategy for mitigating airborne particulates, as it takes more energy for the fan system to push air through higher-rated filters. Be cautious of using higher MERV filters than your system is designed for as motors will be more likely to prematurely burn out.

SEM MEASURES

- ✓ Use the correct Minimum Efficiency Rating Values (MERV) rated filter for each piece of equipment.
- ✓ Add UVGI to increase IAQ and reduce coil blockages.



Carbon Dioxide (CO_2) and outside air

SEM MEASURES

- Periodically check that mechanical ventilation equipment is functioning properly (equipment could be undersized, broken, not maintained, etc.).
- Ensure outdoor air manual dampers are not permanently closed and/or are properly utilized. Open or close as necessary.
- Confirm Demand Control ventilation sensors are operating correctly. Perform regular recalibration.
- Check to see if air vents/grilles are unobstructed.
- Periodically open exterior windows/doors and use fans for improved airflow, if possible.

In addition to mechanically conditioning the air, HVAC systems also introduce fresh outside air to the space, reducing indoor CO_2 concentration by diluting build-up from occupants. The amount of outside air introduced to a space can be estimated by collecting CO_2 concentration measurements using industry standard methods. The primary method, mass balance analysis, uses indoor CO_2 concentrations to evaluate building ventilation. This determines the percent outdoor air intake at an air handler. Another common method is taking individual measurements within occupied spaces.

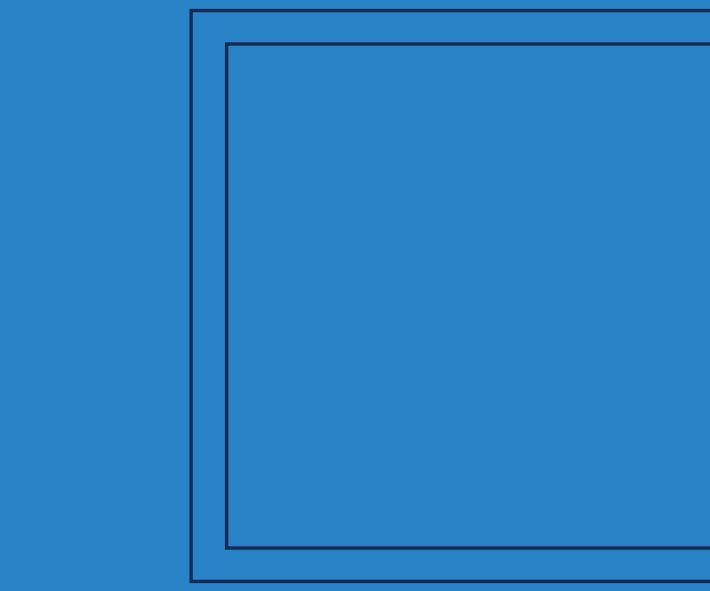
CO_2 concentration in air is measured in parts per million (ppm). Earth's atmosphere composition, which makes up the air we breathe, consists of different gases, including 78% nitrogen (N_2), 21% oxygen (O_2), 1% argon (Ar), 0.04% carbon dioxide (CO_2) and a small mix of other gases. The typical outside air CO_2 concentration is 400 ppm, which is found by multiplying the 0.04% atmosphere CO_2 concentration by 1 million. This value is typically accurate, although values can vary considerably depending on proximity to CO_2 sources. ASHRAE Standards 62.1 and 62.2 are detailed reference materials for ventilation system design and acceptable indoor air quality.

CO_2 CONCENTRATION	EFFECTS ON HUMAN HEALTH
1,000–2,000 ppm	Drowsiness
2,000–5,000 ppm	Headaches, sleepiness and loss of concentration
5,000 ppm	Permissible daily exposure limit averaged over an 8-hour workday
>40,000 ppm	Immediately harmful due to oxygen deprivation

Schools can have varying indoor CO_2 levels based on their age, HVAC equipment and ventilation levels. It is important to understand your ventilation strategy so that if you are replacing HVAC equipment, you can ensure indoor air quality is maintained or improved by the new equipment.

CHAPTER 9

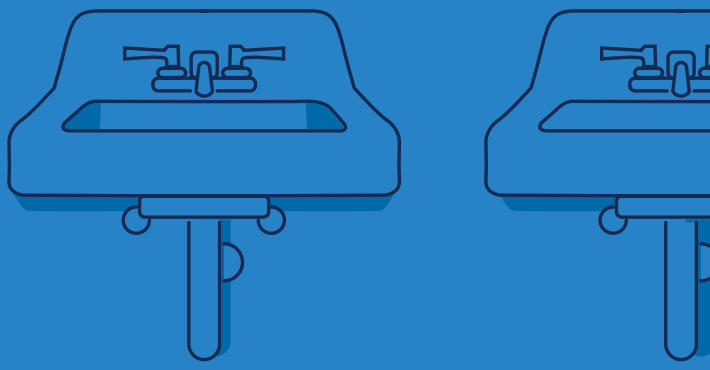
Plumbing & water heating



UP TO

1,667

gallons per year wasted from a faucet leaking one drip per second



PLUMBING & WATER HEATING

Water waste directly impacts energy, water and sewer costs.

An often-overlooked part of reducing energy usage is limiting and strategically maintaining your building's plumbing system and water heating equipment. Domestic hot water (DHW) systems deliver hot water to fixtures used by people at sinks, showers and appliances (e.g., dishwashers).

Wasting water wastes energy. Reduce water consumption by right-sizing fixtures and fixing leaks. Do not forget to use schedules and conduct routine maintenance to keep your plumbing and water heating systems running effectively and efficiently. The gallons of water saved and the reduction in hot water usage can add up directly on energy, water and sewer bills.

Fixture degradation can cause significant water and energy waste over time. Familiarizing yourself with the most common plumbing fixture problems and maintenance measures can prevent damage and save significantly on water and energy bills.

Benefits

1

Reduce electric bills and emissions through properly maintained systems and efficient appliances.

2

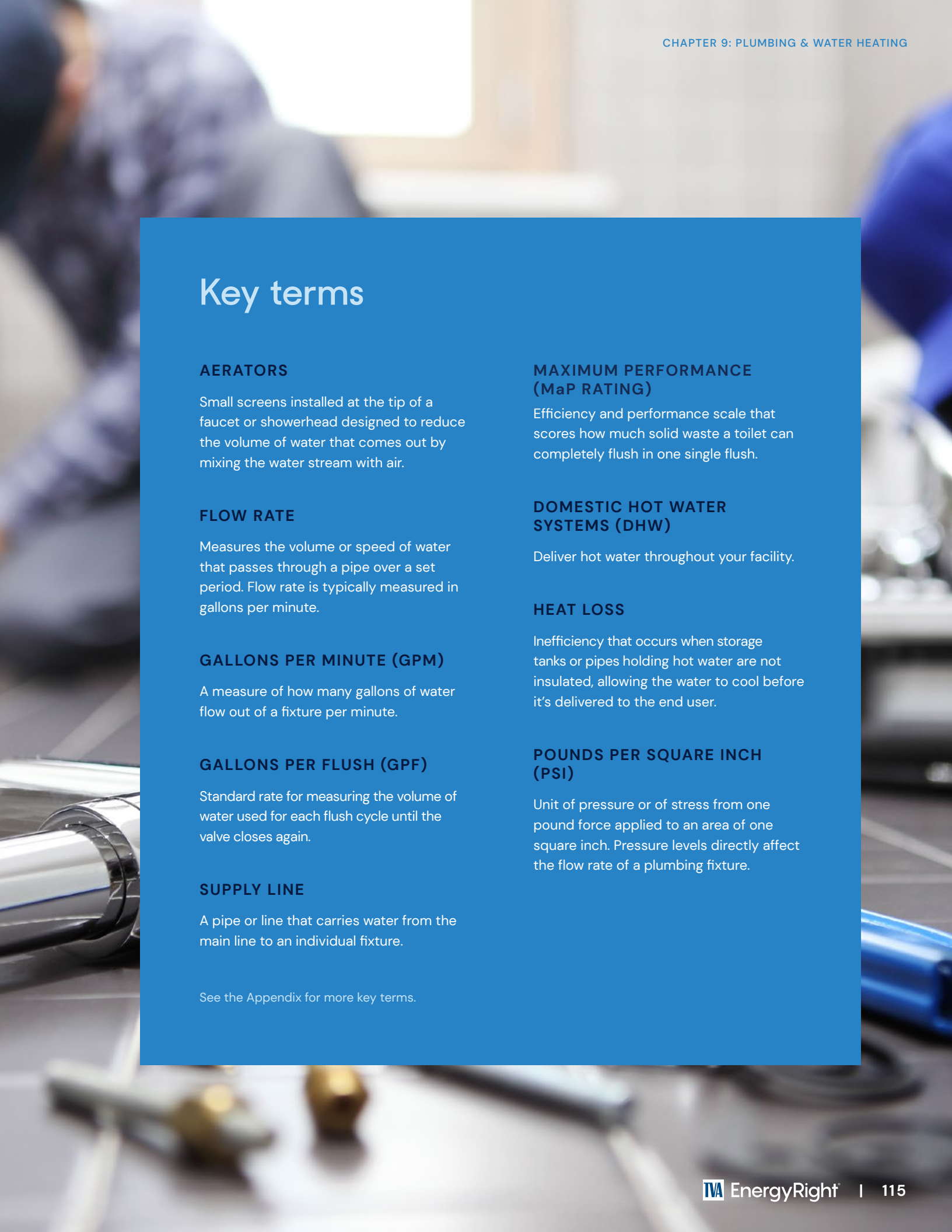
Lower water and sewage bills through water conservation, aerators and low-flow systems.

3

Improve occupant satisfaction and extend the life of equipment through regular maintenance.

4

Improve hygiene by upgrading to hands-free fixtures when possible.



Key terms

AERATORS

Small screens installed at the tip of a faucet or showerhead designed to reduce the volume of water that comes out by mixing the water stream with air.

FLOW RATE

Measures the volume or speed of water that passes through a pipe over a set period. Flow rate is typically measured in gallons per minute.

GALLONS PER MINUTE (GPM)

A measure of how many gallons of water flow out of a fixture per minute.

GALLONS PER FLUSH (GPF)

Standard rate for measuring the volume of water used for each flush cycle until the valve closes again.

SUPPLY LINE

A pipe or line that carries water from the main line to an individual fixture.

See the Appendix for more key terms.

MAXIMUM PERFORMANCE (MaP RATING)

Efficiency and performance scale that scores how much solid waste a toilet can completely flush in one single flush.

DOMESTIC HOT WATER SYSTEMS (DHW)

Deliver hot water throughout your facility.

HEAT LOSS

Inefficiency that occurs when storage tanks or pipes holding hot water are not insulated, allowing the water to cool before it's delivered to the end user.

POUNDS PER SQUARE INCH (PSI)

Unit of pressure or of stress from one pound force applied to an area of one square inch. Pressure levels directly affect the flow rate of a plumbing fixture.

Getting started

Reducing hot water usage will save energy, and any water saved adds up directly on water and sewer bills. As you walk through the school's buildings, take stock of your existing system, current water use and any opportunities to install low-flow systems and aerators.

WHAT TO LOOK FOR

OCCUPANT COMPLAINTS

WATER HEATING

PLUMBING FIXTURES

1 Take note of any occupant complaints

- ✓ Note any complaints from staff and students.

2 Water heating

- ✓ Determine system type, control types, pump type and condition, settings and maintenance requirements.
- ✓ Check whether hot water supply pipes are insulated, including at elbows. Note any insulation that has degraded, come unstuck or is missing.
- ✓ Note any areas where hot water delivery is significantly delayed.
- ✓ Check your efficiency standards to find your hot water use target.
- ✓ Ensure hot water is delivered to all fixtures quickly (i.e., within xx seconds).
- ✓ Note end use fixtures to ensure the correct water flow and reduce water waste.
- ✓ Track water system energy usage regularly.

3 Plumbing fixtures

- ✓ Identify the hot water source and supply lines for each fixture.
- ✓ Check whether hot water supply pipes are insulated, including at elbows. Note any insulation that has degraded, come unstuck or is missing.
- ✓ Note any areas where hot water delivery is significantly delayed (i.e., it takes more than xx seconds).
- ✓ Measure or record actual flow rates on kitchen and bathroom faucets, showers and toilets.
- ✓ Toilets:
  - Toilet tank should fill to the “fill line” after flushing.
  - Stop valves should close fully; no water should exit via the overflow tube.
  - Water should not leak through flappers into the bowl.
  - Toilets should flush promptly, efficiently and effectively on the first flush.
- ✓ Check whether bathroom and kitchen faucets provide smooth, even flow at the specified rate.
- ✓ Check whether showerheads provide smooth, even flow at the specified rate.
- ✓ Monitor whole building water use via digital water pressure sensors (as sudden, significant changes may indicate a system leak).

Water heating

A school's hot water load is comprised of two key factors: the hot water used by building occupants and the amount of energy needed to heat the water. Water heaters have no way to predict the hot water needs of a building. Without added schedules or controls, your water heater will continually heat water throughout the day.

There are two main types of water heaters and storage tank systems: on-demand (tankless) and storage tank.

- **On-demand water heaters** work by quickly heating water for specific areas and are limited to a set amount of water flow. These are often referred to as tankless heaters.
- **Storage tank water heaters** utilize electric resistance heaters or gas to heat water in a tank and supply water to fixtures. Storage tanks should be flushed out annually to remove sediment buildup and keep tank efficiency at its maximum.

The temperature setpoints of all water heaters should be adjusted to the minimum acceptable levels. For most water heating needs, setting the temperature to between 115–120°F should be acceptable for all

SEM MEASURES

- Visually inspect each water heater for rust, corrosion, pooled water under the tank, aged gaskets and any loose screws, nuts and bolts.
- Check your efficiency standards to identify your hot water use target.
- Confirm your water heater temperature setpoint as well as the temperature at each fixture. Adjust your temperature setpoints and pipe insulation accordingly.
- Use pipe insulation to reduce energy waste.
- Flush out storage tanks annually to remove sediment buildup.

occupants. This assumes there is not excess heat loss as water is transferred from the water heater to the fixture. If higher temperatures are required for specific purposes, such as kitchen dishwashers, consider installing an inline water heater booster dedicated to that piece of equipment.

Because aging water heating infrastructure is often overlooked, there are usually many energy and cost savings opportunities available. Take advantage of these opportunities by following energy efficiency guidelines for temperature settings and maintenance. Following these guidelines can reduce wasted energy, improve equipment lifespan and keep occupant satisfaction high.

Insulation

Insulating storage tanks and piping is the most effective way to reduce energy waste in hot water systems. Adding tank insulation can reduce heat loss by up to 45% and prevent the unit from frequently activating to maintain the appropriate temperature. Insulating your hot water pipes can reduce heat loss and raise the water temperature by 2-4°F at delivery points within the system. Pipe insulation also helps mitigate unwanted heat transfer into the surrounding space and decreases the run-time of the hot water heater.

Bare pipes – including fittings such as elbows, valves and tees – should be insulated, and damaged insulation should be repaired or replaced. Similarly, bare storage tanks and external heaters should be sufficiently insulated to reduce heat loss and prevent the water heater from working harder to maintain the hot water temperature setpoint.

Image:
An exposed tank surface area without insulation (red colored side) results in significant heat loss.

SEM MEASURES

- ✓ Add pipe and tank insulation to reduce wasted heat.
- ✓ Repair or replace any damaged pipe or tank insulation.

Pump maintenance

Pumps supply water to the different areas throughout the facility and can also supply water to heating equipment (e.g., boilers). A regular pump maintenance schedule should be implemented and followed to keep the system functioning efficiently.

SEM MEASURES

- ✓ Visually inspect all pumps monthly for unnecessary vibration, leaks, loose mounting brackets and electrical connections.
- ✓ If the pump is leaking, safely turn off and lock out all equipment when the facility is unoccupied, then replace O-rings or packing within the motor.

Scheduling

In older systems, hot water tanks may not be added to building automation systems (BAS) or included in any form of operational scheduling. Traditional systems may use time clocks to schedule the water pump's supply of hot water to the rest of the facility. If the system is only checked when a problem arises, it is likely that the time clocks have broken, been abandoned in place or were removed entirely. Adding the DHW system to the BAS (or another form of scheduling) will reduce excess energy consumption when the building is unoccupied.

SEM MEASURES

- ✓ Schedule heating cycles based on occupied times of use.
- ✓ Reduce water temperatures during unoccupied periods.

Aging equipment

Typical water heater tanks last an average of 8-12 years, while tankless water heaters can last up to 20 years. Typical signs that an existing water heater needs to be replaced include:

- ✓ **Discolored water** due to rust in the hot water tank.
- ✓ **Leaks around the tank** that cause the water heater to frequently cycle into heating mode. Leaks can also cause water damage and unexpectedly high energy bills.

As your water heaters need to be replaced, look for high-efficiency models with the ENERGY STAR® label. These models use less energy than standard models while performing efficiently and reliably.

If viable, consider installing heat pump water heaters (HPWHs) and/or a high-efficiency central boiler. Heat pump water heaters pull heat from the surrounding air to heat water and are especially efficient in temperate or warmer climates.

Plumbing fixtures

A plumbing fixture is any device that connects to a plumbing system to deliver or drain water. Energy and water are intricately connected, as the delivery, heating and removal of water or sewer waste all require energy.

Energy is primarily wasted through leaks and inefficient technologies. Good quality, low-flow plumbing fixtures are simple to install and maintain. They also provide a positive user experience. Properly maintained water heating systems combined with water conservation measures add up to tangible savings on energy, water and sewage bills.

Plumbing fixture maintenance

As buildings age, plumbing fixtures will begin to fail or leak if left unattended. Fixture degradation can cause significant water and energy waste over time. Familiarizing yourself with the most common plumbing fixture problems and maintenance measures can prevent damage and save significantly on water and energy bills.

Finding leaks

A water leak is an energy leak, since energy is required to heat and pump water throughout the building. Leaks also result in wasted water, and leaks can cause water temperature fluctuations and low water pressure. Identifying and fixing leaks in a facility can save on costly repairs from water damage and prevent expensive water bills. Periodically check faucets, toilets, showers, water fountains, dishwashers, clothes washers and any other water-using equipment to ensure no leaks are present.

Toilets will typically leak water into the bowl due to a brittle flapper or aging flush valve. If a toilet is suspected to be leaking, food coloring can be put into the tank side – if the flapper is allowing water to escape, the dye will appear in the bowl within five minutes.

Visually inspect faucets, drains, showers, tubs, flush valves and sinks to see if water can escape the main fixture when the knobs are turned off. Leaks are commonly due to failed O-rings in the fixture that become brittle over time and allow water to escape when the water is turned off.

If you suspect there is a leak, use your water meter to confirm. Ensure all water valves are turned off and check the reading number on the water meter. If the number goes up after a few hours, there is a leak present within the system.

SEM MEASURES

- ✓ Periodically check faucets, toilets, showers, water fountains, dishwashers, clothes washers and any other water-using equipment to ensure no leaks are present.
- ✓ Visually inspect faucets, drains, showers, tubs, flush valves and sinks to see if water can escape the main fixture when the knobs are turned off.
- ✓ Consider installing a deduct meter on the makeup water line if your building utilizes a cooling tower. While this won't save energy, this meter can save you money on sewage fees by reducing the volume of calculated water on your bills.

Toilets

Toilets are the main source of water use in a school. Routine maintenance should include checking leaks as discussed previously. As toilets need replacing, consider moving to low-flow options. Although they may be more expensive initially, low-flow toilets use 20% less water than standard models, which can add up to significant savings over the course of the toilet's lifespan.

Low-flow toilet technologies have come a long way in recent years, and do not sacrifice performance for efficiency – they simply make better use of the water that goes into each flush. Maximum Performance (MaP) ratings can provide insight into the performance of individual models. For maximum performance, choose models with at least a 350-500+ grams MaP rating.

Dual-flush toilets are another water-saving option that provide different buttons or levers that allow the user to control how much water is used for each flush. Inexpensive dual-flush kits are also available and can be installed in existing toilets.

SEM MEASURES

- ✓ Identify leaks in existing fixtures.
- ✓ Take note of any occupant complaints.

Aerators

Aerators reduce the volume of water from the faucet or showerhead by adding air. These fixtures increase the perceived water pressure, which can be especially beneficial in buildings with low water pressure. Aerators also decrease the demand on water heaters, saving energy costs related to heating water.

Installing aerators on kitchen and bathroom faucets or showerheads can reduce the amount of water used without sacrificing performance. Generally, if your faucet flow rate is more than 1.5 gpm, an aerator should be added or replaced. For low-flow showerheads, the flow rate should be 2.5 gpm.

SEM MEASURES

- ✓ Ensure faucets utilize high-efficiency aerators.
- ✓ Replace existing fixtures with low flow options, where possible.

Irrigation

Some schools use irrigation systems to support exterior landscaping and watering needs. While utilizing native plants that require little or no additional watering beyond what the natural habitat provides is best, drip irrigation systems are the next best solution.

Monitor your irrigation system to ensure it is functioning properly with no excessive leaks. Confirm the amount of water needed for your plants to make sure you are not overwatering.

SEM MEASURES

- ✓ Know what type of plants and soil you have, how much water they need and time your watering appropriately.
- ✓ Irrigate at night or in the early morning – never in the middle of the day when water evaporates most quickly.
- ✓ Coordinate your irrigation with local weather conditions.
- ✓ Monitor your grounds for leaks.
- ✓ Water the lawn or garden only – not the street or sidewalk.
- ✓ Consider if a rainwater harvesting system could work for your school's irrigation needs.
- ✓ Consider installing a deduct meter on the landscape water line. While this won't save energy, this meter can save you money on sewage fees by reducing the volume of calculated water on your bills.

Automatic fixtures

Smart sense technology allows for bathroom sinks, kitchen sinks and toilets (and other accessories) to only operate when they sense movement, and ensures they turn off correctly after the operator moves away from the device. In addition to saving water, automatic fixtures also prevent the spread of germs by limiting touch and minimize odors through ensured flushes.

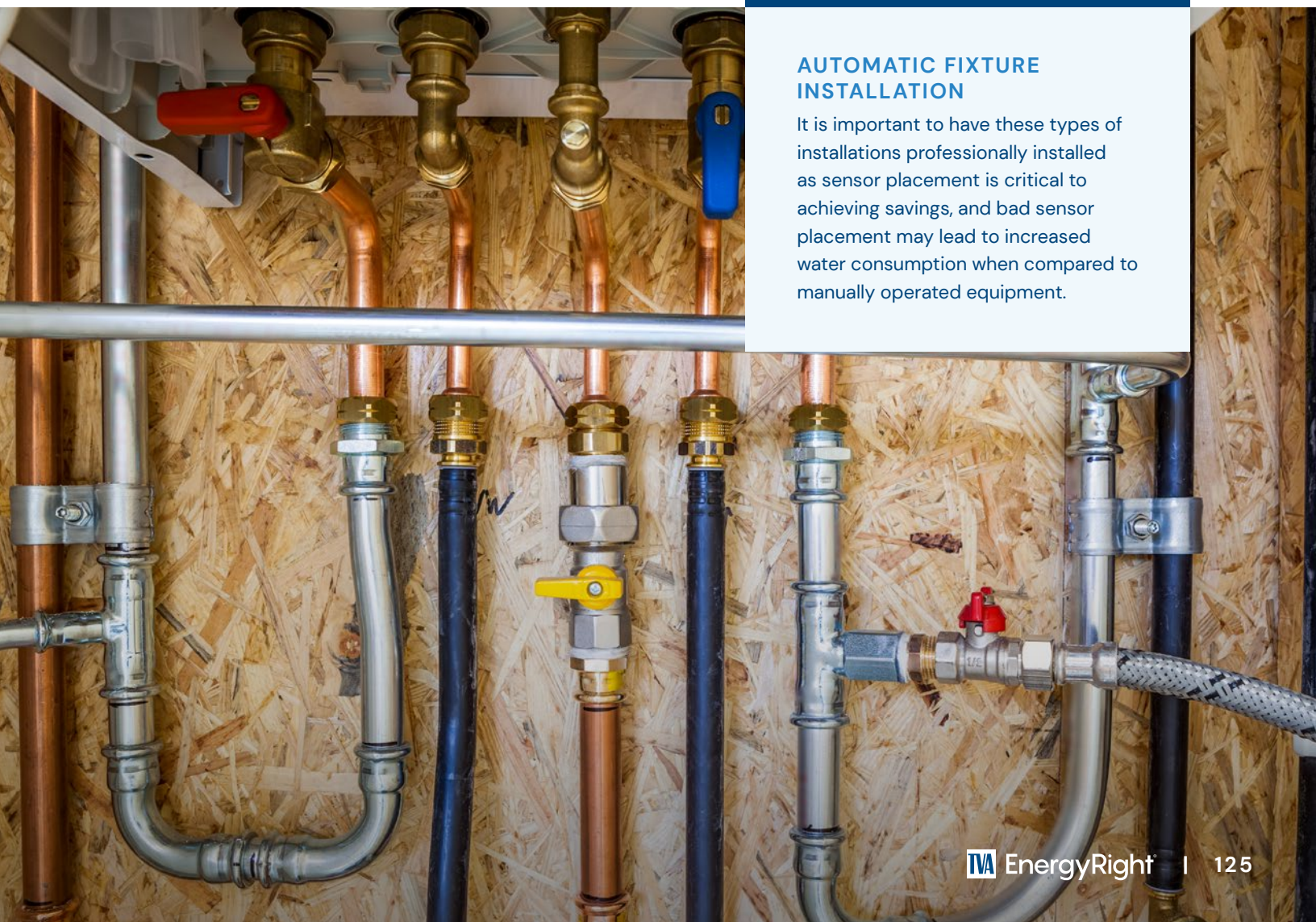
SEM MEASURES

- ✓ Note any occupant issues.
- ✓ Install automatic fixtures where applicable.
- ✓ Confirm sensor placement and functionality.

Tip

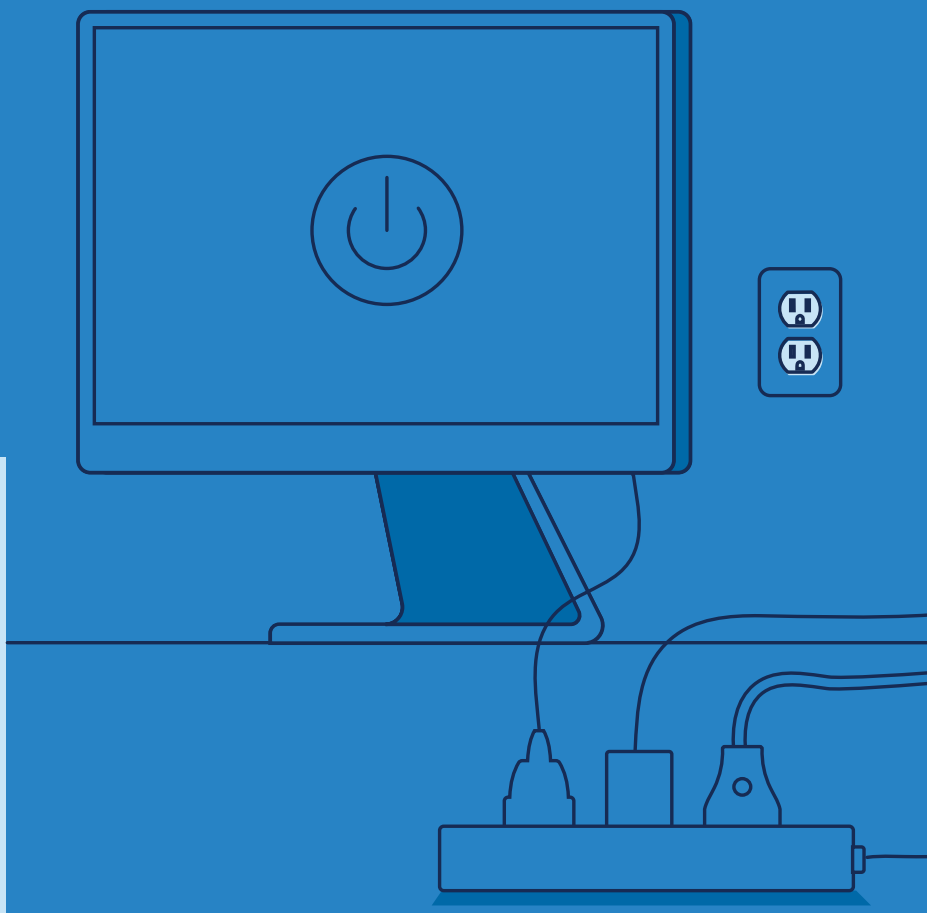
AUTOMATIC FIXTURE INSTALLATION

It is important to have these types of installations professionally installed as sensor placement is critical to achieving savings, and bad sensor placement may lead to increased water consumption when compared to manually operated equipment.



CHAPTER 10

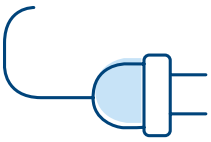
Plug loads & appliances



UP TO

20%

of total energy consumption



PLUG LOADS & APPLIANCES

Unplugging devices and using smart power strips can improve energy efficiency.

Anything that plugs in consumes energy – from small items such as phone chargers, coffee pots and fans, to large equipment like refrigerators, copiers and vending machines. Although some devices only draw a small amount of power, the combined energy use of these devices can account for up to 20% of a school's total energy consumption.

Phantom loads – also known as vampire loads – come from plug-in devices that continue to use electricity while not in use. Phantom loads usually occur with devices or appliances that have default signal lights that are always on – even when the device is switched off, it is still drawing energy to power the light. Some examples include computers, electronic clocks or timers, remote controls and cell phone chargers. These phantom loads can consume up to 5% of a school's electrical plug load and can contribute to increased demand charges. The only way to prevent these loads from wasting energy is to physically unplug the device, manually turn off multiple devices with a power strip off/on switch or use a smart power strip to designate times to automatically cut power to specific outlets.

Knowing what you have plugged in, the energy it consumes, and proper maintenance of your equipment is easy to do and can improve your school's energy efficiency. While operations and maintenance steps can be taken to minimize phantom loads, occupant engagement and education will also play a key role in the ongoing management of plug loads.

UNPLUG FOR AT LEAST

5%

reduction in energy bills

By completely disconnecting power from unused devices, a school can reduce its electrical plug load. A combination of well-maintained appliances, ENERGY STAR®-rated appliances, and smart technology surge protectors can further reduce a school's energy consumption.

Benefits

1

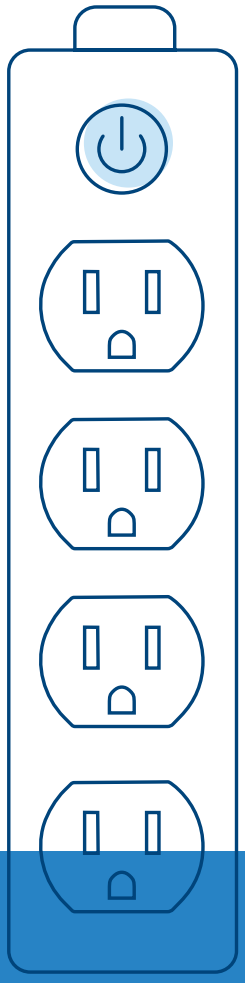
Keep energy costs more manageable with functional and efficient appliances.

2

Improve safety with properly maintained appliances.

3

Increase equipment motor life by decreasing on/off cycles.



Key terms

SMART POWER STRIPS

Energy-saving surge protectors with smart device technologies, such as power auto-switching or occupancy sensors.

RECEPTACLE

A power outlet or socket.

ENERGY STAR LABEL

A trusted, government-backed symbol for energy-efficient products and practices created to reduce greenhouse gas emissions and other pollutants caused by the inefficient use of energy; and make it easy for consumers to identify and purchase energy-efficient products that offer savings on energy bills without sacrificing performance, features and comfort (www.energystar.gov).

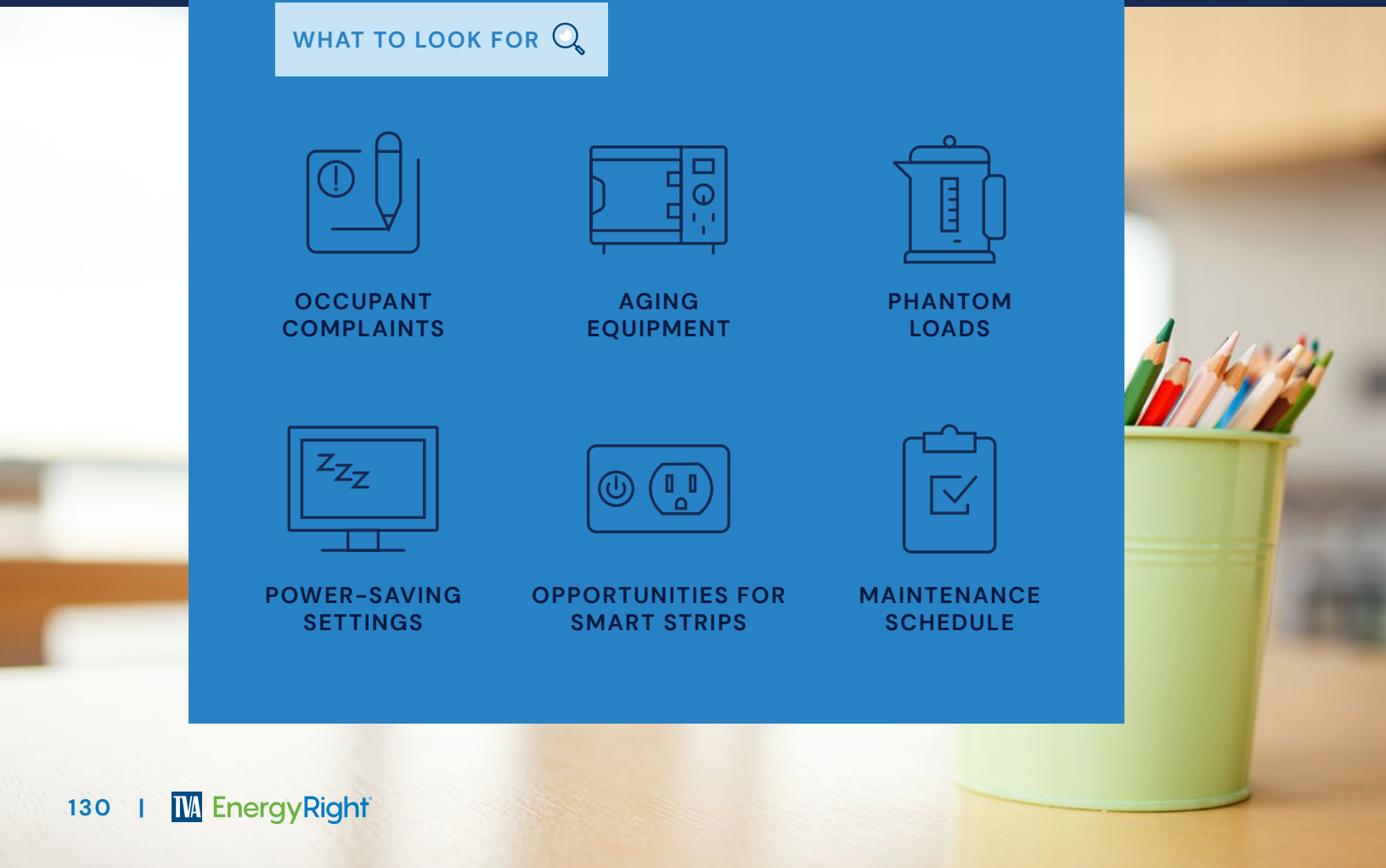
See the Appendix for more key terms.

Getting started

Start assessing your school's existing plug load by walking through your facility and taking note of what you currently have, including the age, condition, type and model of existing appliances and devices. You will also want to look at how devices are plugged in (e.g., receptacle or power strip), and which devices have "always on" features such as LED clocks, computers and charging lights. You can engage your school community in identifying and mitigating plug loads as part of your engagement and empowerment plan. See Chapter 5 for more information.

WHAT TO LOOK FOR

- OCCUPANT COMPLAINTS
- AGING EQUIPMENT
- PHANTOM LOADS
- POWER-SAVING SETTINGS
- OPPORTUNITIES FOR SMART STRIPS
- MAINTENANCE SCHEDULE



School plug load assessment checklist

- ☐ Inventory the age and efficiency of individual appliances.
- ☐ Locate O&M instructions and identify the optimal settings, controls and efficiency for each appliance.
- ☐ Identify the staff member or contractor responsible for maintaining each appliance and the schedule of tasks.
- ☐ Note any staff or student comments related to the condition or functionality of appliances.
- ☐ Note any models you are repairing or replacing more often than expected.
- ☐ Identify appliances and equipment that may be turned off after school hours.
- ☐ Refrigerators, coolers and freezers should maintain temperature without excessive energy use or noise.
- ☐ Dishwashers should clean dishes without pre-washing.
- ☐ Identify phantom loads and implement an unplug plan or checklist.
- ☐ Identify equipment with power-saving settings, such as computers, vending machines, copiers and printers.
- ☐ Determine if computer hibernation settings are turned on for the entire network.
- ☐ Note equipment or appliances that do not have power-saving settings or are not plugged into smart strips and consider providing or purchasing.

Plug load management

Begin your plug load energy reduction plan by first targeting low- or no-cost measures, then expand your plan to include more complex plug load management measures such as procurement policies, IT computer management systems and smart devices.

Classroom and office equipment

Plug loads in school classrooms and offices can vary significantly. Beyond the items needed for teaching and administrative activities, there are often appliances that staff and students bring from home that, while not directly related to education, are routinely found in classrooms (e.g., space heaters, fans, chargers).

Educating faculty, staff and students about the impacts of their behavior on energy consumption and encouraging energy efficiency best practices will play a significant role in managing the plug load of these areas. Share responsibility for managing plug load through best practices like educational workshops, end-of-day checklists and weekend and extended period shutdown plans. See Chapter 4 for more information.

Power management

Enable multifunction devices (e.g., a printer with scanning, copying and faxing capabilities) with power management settings to switch to a low-power standby mode after 15 minutes of idle time. If your office has multiple single-function devices, consider consolidating them into a single multifunction device.

Smart power strips

Using smart strips can be an easy, efficient way of saving energy in classrooms and offices. These can be set so that when the computer is turned off – or the strip does not detect a user's presence – everything else plugged into the strip turns off too. A less expensive option is to simply plug all devices from a single workstation (e.g., computer, monitor, phone) into a single power strip and encourage users to simply switch it off when they are done for the day.

Replacing office equipment

If you need to purchase or replace equipment, look for the ENERGY STAR label. ENERGY STAR certified equipment saves energy and money by entering sleep mode or turning off when not in use and is generally more efficient than standard products. Virtually all office and classroom equipment manufacturers offer a wide range of ENERGY STAR models, including copiers, printers, fax machines, monitors, computers and more.

EQUIPMENT	OPERATIONAL COST SAVINGS
Fax machines	50%
Multifunction devices	40–55%
Copiers	6.5–50%
Printers	33–40%
Computers	32%
Computer monitors	20%
Scanners	3.5%

Operational cost savings when choosing ENERGY STAR over standard equipment.

SEM MEASURES

- ✓ Power down equipment not being used, unplug equipment infrequently used.
- ✓ Use smart strips, power strips or surge protectors to turn all office equipment off at once.
- ✓ Plug small devices, such as projectors, into electrical outlet timers or smart strips so they are powered down during after-school hours.
- ✓ Set equipment with power management settings to go into standby mode after no more than 15 minutes.
- ✓ Remember to include unplugging classroom equipment in your daily, short break and extended break procedures.

Appliance management

Kitchen appliances

School kitchens range from those with just a few appliances to a complete kitchen with significant refrigeration equipment, such as a walk-in freezer, walk-in cooler, ice machine, pass-through refrigerators and milk coolers. Kitchens are a unique challenge, as many appliances may be outfitted and serviced by outside vendors. In this case, it is best to work with the vendor to understand equipment maintenance that can be performed between service times that will help you best manage energy in the kitchen.

For schools with walk-in coolers, ensure door seals are in good quality and that there are no unnecessary holes or gaps in the walls of the cooler causing air leakage. Repair or replace any missing/damaged insulation on refrigerant lines supplying coolers. If possible, increase setpoint for freezers to maximum allowable temperature (typically between -10°F and 0°F).

If schools are unoccupied for extended periods (e.g., during the summer), turning off ice makers can reduce annual ice making energy consumption by as much as 22%. In general, as the size and production increases, the potential energy savings also increases. However, smaller ice machines use more energy per pound of ice harvested.

Replacing kitchen appliances

Choosing efficient, ENERGY STAR certified appliances will provide the largest opportunity to save energy in the kitchen.

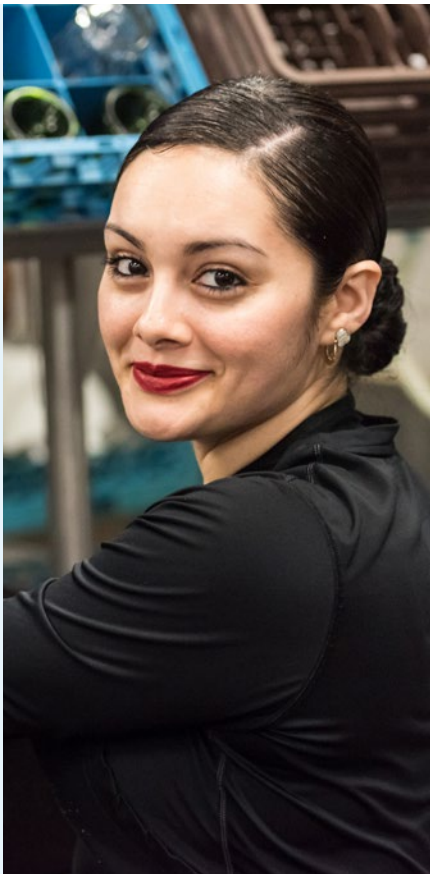
When selecting replacements, choose cooking appliances that reduce radiant heat loss. Heat-producing appliances may be replaced with appliances that produce less radiant heat. This means the HVAC system will not have to work as hard to keep temperatures comfortable. For example, broilers, griddles and ranges may be replaced with combination oven-steamers (combi ovens), tilting skillets, convection ovens, microwaves or other lighter-duty appliances.

Other considerations when replacing kitchen equipment includes:

- Select ENERGY STAR certified food service equipment.
- Select appliances that minimize idle energy use.
- Select exhaust hood styles that reduce exhaust air and make-up airflow.
- Select walk-in freezers and coolers with high-performance thermal envelopes and refrigeration systems.

SEM MEASURES

- Shut down coolers and freezers during long periods when the school kitchen is not in use, such as summer break.
  If possible, move any remaining food to one school in the district and shut down the rest.
- Turn off ice machines over extended periods of inactivity.
- Plug small kitchen devices, such as coffee pots and toasters, into electrical outlet timers or smart strips so they are powered down during after-school hours.
- Dishwashers: clean filters regularly and instruct staff to do the same. Consider electrically connecting dishwasher unit to exhaust fan to prevent accidentally leaving fan running when not in use.
- Refrigerators: check door seals for proper door closure.
- Stoves: clean exhaust hood filters regularly in the dishwasher or by hand with hot soapy water.



Vending machines

Vending machines are widely used throughout school buildings and are on 24/7. Existing machines can be retrofit with remote occupancy sensor kits that mount on top of the machine and turn lights off when no one is around.

ENERGY STAR certified vending machines use 40% less energy than standard machines. Look for machines that come with onboard software that puts the machine into low energy lighting and refrigeration modes during inactivity, cutting energy use by 20%. When vending machines are supplied by a vendor, request energy data information as part of the selections process.

SEM MEASURES

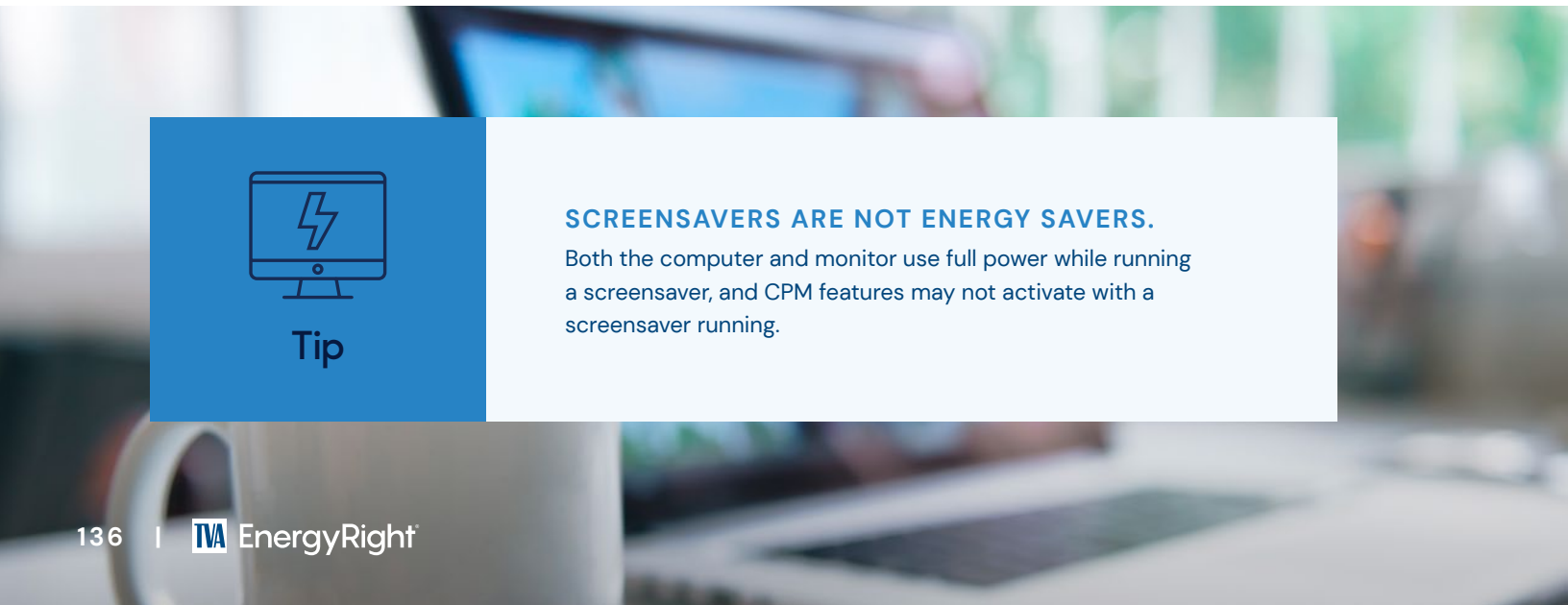
- ✓ Remove underused machines.
- ✓ Use occupancy sensors to turn off lighted vending machines when no one is around.
- ✓ Empty and unplug machines during extended periods of inactivity.

Computers

Most computers today come with power management features. Activating computer power management (CPM) settings on all computers throughout the school can save a significant amount of energy with little to no upfront cost.

Found in the computer's settings, CPM features can automatically move computers into low-power settings (sleep mode or hibernate) after a specified amount of time without activity. Computers will wake automatically when the mouse or keyboard is touched. Using CPM settings not only saves money but can help equipment run cooler and last longer as well.

Make sure all monitors, printers and other accessories are plugged into a smart strip, electrical outlet timer or surge protector. During extended periods of inactivity, each surge protector can be switched off to prevent equipment from drawing power while shut off. Surge protectors will also defend against possible voltage spikes that can damage your equipment.



Tip

SCREENSAVERS ARE NOT ENERGY SAVERS.

Both the computer and monitor use full power while running a screensaver, and CPM features may not activate with a screensaver running.

Computer management software allows IT administrators to centrally control power management settings on individual computers and monitors. Depending on the program, staff can manually wake up computers for maintenance, monitor energy consumption and savings and apply different settings to different computer groups. Computer management software generally costs $10–20 per computer, and many suppliers offer discounted rates for bulk purchases.

When choosing computer management software, consider programs that:

- ✓ Permit different settings for different users.
- ✓ Allow administrators to estimate energy savings and payback.
- ✓ Identify the hardware and operating system used at each workstation.
- ✓ Can shut computers down remotely if allowed.
- ✓ Has "wake-on-LAN" capability to provide administrators access to any computer at any time.

SEM MEASURES

- ✓ Enable the existing power management features on all computers and turn off computers at night (if allowed).
- ✓ Use power management settings of networked workstations.
- ✓ Ensure existing power management capabilities of computers are enabled.
- ✓ Work with IT to control power management settings.
- ✓ Use third-party software to establish and implement a computer power-management policy across the company local area network (LAN) or wide area network (WAN).
- ✓ Work with staff and teachers to be aware of their plug load usage and share responsibility for powering down, turning off and unplugging. Incorporate this education as part of your engagement and empowerment plan. See Chapter 5 for more information.
- ✓ Implement shutdown procedures for computers that will not be in use during extended break periods.
- ✓ Consider purchasing advanced laptop/tablet charge carts capable of alternating or scheduling when devices are being charged.
- ✓ Reduce active computer monitor brightness when environment light levels allow.

CHAPTER 11

Building envelope

UP TO

26%

improvement in test scores with natural daylight

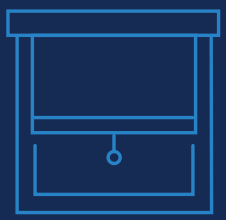
BUILDING ENVELOPE

Together, insulation and sealed penetrations play a role in your energy use.

A major factor in building energy performance, the building envelope is the exterior shell of the structure that separates indoors from outdoors. Two overarching factors that determine building envelope performance are insulation and sealed penetrations. Air flow is affected by the number and size of penetrations in your building envelope. Heat transfer is controlled with insulation. Together, insulation and sealed penetrations play a role in your energy use, in moisture and pollutant infiltration and in heat transfer such as solar heat gains.

Identifying places within a building's envelope that should be sealed, such as doors, window frames, ceilings and insulated areas, alert you to sources of energy waste, cost savings and occupant discomfort. When your building envelope is sealed tight, conditioned air will not escape, and drafty winter air will not get in. Additionally, unwanted moisture or humidity, outdoor air pollutants and even pests will not be able to get inside.

A building's insulation controls energy and heat transfer. Insulation should be in all exterior surfaces of a building – roof, walls, windows and floors, as well as in the ducts and pipes that transport conditioned air or chilled water.



In warmer months, solar heat gain through the building envelope needs to be managed to minimize the energy needed to keep your building cool, energy costs down and occupant discomfort to a minimum. Certain problem areas to maintain are doors, windows frames, ceilings and insulated areas. When used properly, solar heat gain is not always a bad thing. In the winter months, expose windows where appropriate and allow the heat from the sun to assist in warming up spaces.

Benefits

1. Improve occupant comfort by eliminating drafts and decreasing solar heat gain.
2. Avoid energy waste through the leakage of conditioned air.
3. Reduce the infiltration of outside pollutants and pests.
4. Prevent mold and mildew by controlling humidity and moisture.
5. Reduce energy usage and associated bills.
6. Increase the durability of your building and its HVAC systems.

Key terms

See the Appendix for more key terms.

SOLAR HEAT GAIN

Occurs when the sun's radiation is absorbed or passes through a window and increases the heat within a room or building. Rooms with South- and West-facing windows tend to heat up faster because they get more direct sunlight. While this effect is desirable in the winter, when the weather is hot it can be an unwelcome side effect. Also known as solar loading.

POSITIVE PRESSURE

Is when HVAC systems add more air to a space than it would normally have. This is like a tank of compressed air, but on a much smaller pressure scale. Building codes call for positive pressure for a couple of reasons. First, positive pressure prevents contaminants and unwanted air infiltrations from entering conditioned space. Second, positive pressure assures that most spaces will be conditioned to the same level. Otherwise, areas with more infiltration would also have greater temperature variation or need more conditioning.

INFRARED (IR) CAMERAS

Allow you to see and measure temperature differences from a distance. These can be an extremely helpful tool for identifying drafts and hot spots in an area or building.

INFILTRATION

Refers to the unintentional introduction of outside air, pollutants or pests into a building.

LOW-EMISSIVITY (LOW-E)

Surfaces emit low levels of radiant heat. A low-e coating on windows will reduce the amount of heat that transfers from one side of the glass to the other.

U-FACTOR (OR U-VALUE)

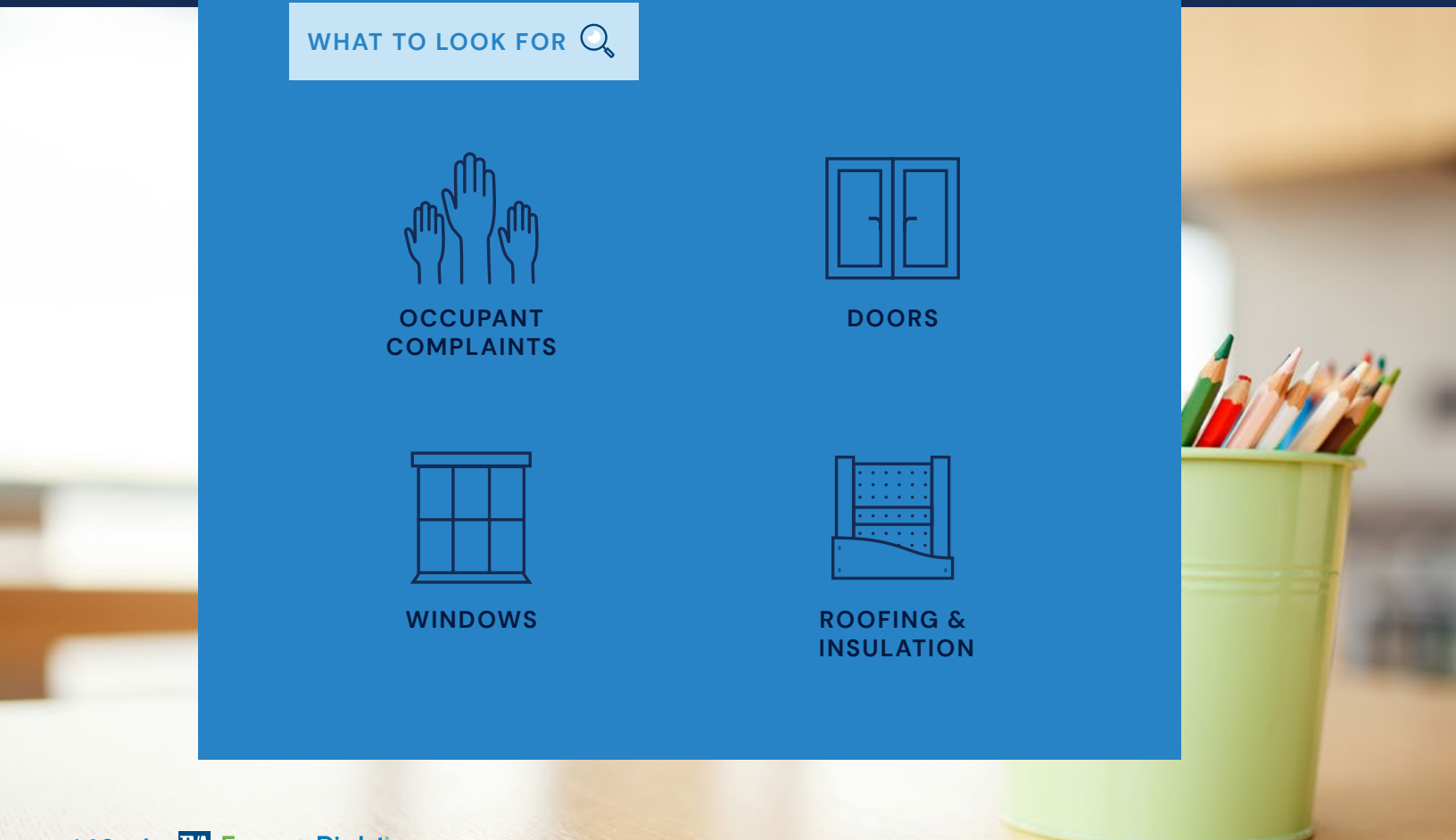
Is a measurement of how well glass or glazing elements such as windows, doors or skylights insulate a space. The lower the U-factor, the less heat transfer which means better performance.

Getting started

To evaluate ways to improve the efficiency of your building envelope, you need to confirm how it is meant to work and how it is currently performing. Once equipped with an understanding of your building's existing envelope, use this information to identify what steps are needed to adjust or maintain it, and any opportunities to improve efficiency.

WHAT TO LOOK FOR

- OCCUPANT COMPLAINTS
- DOORS
- WINDOWS
- ROOFING & INSULATION



1 Take note of any occupant complaints

- ✓ Note any complaints from staff and students.

2 Windows

- ✓ Identify any East-, South- and West- (E/S/W) facing windows.
- ✓ Identify old or damaged windowpanes (cracks in the glass or moisture between panes indicate damage that should be noted and addressed).
- ✓ Inspect window sealing (caulking) for cracks or gaps.
- ✓ Note type and condition of window coverings.

3 Doors

- ✓ Check that all doors close and seal properly.
- ✓ Check condition of door sweeps and weatherstripping. Can you see daylight through air gaps when the door is closed?
- ✓ Identify doors that are frequently opened or left open. Are door stops/wedges nearby?

4 Roofing and insulation

- ✓ Identify water marks on ceiling tiles.
- ✓ Check for cracks in walls and note any visible insulation.
- ✓ Check for cracked, damaged or missing roof deck material, or cracked/broken roof deck seals.
- ✓ Consider using an infrared camera to identify poor insulation and air leaks. Alternatively, on frosty or snowy days, check for excessive or irregular melting patterns on the roof that provide visual cues of where heat is escaping the building.

Building envelope maintenance

To begin assessing your building envelope, first document any occupant complaints and any East-, South- or West-facing windows before assessing for drafty areas and roof or window damage.

SEM MEASURES

- ✓ Ensure windows close and lock properly.
- ✓ In cooling season, limit excess heat from the sun through E/S/W facing windows by adding tinted, reflective or low-e film or blinds to windows.
- ✓ Seal any gaps around windowpanes. Use silicone or caulking for ¼" or smaller cracks. Larger cracks require a foam backer rod to fill the gap prior to caulking.

Windows

Read on for strategies that will help you avoid temperature extremes, pollutant infiltration and humidity and moisture problems while improving occupant comfort and concentration throughout the day.

Window caulking

The caulking around windows can deteriorate over time, creating drafts that let conditioned air out and unconditioned air in. If a window has dried or cracked caulking, it can be stripped (removed) and replaced. Use caulking or a silicone substitute to eliminate outside air infiltration.

Window closure

Opening windows when it's not "nice" outside is often a symptom of a poorly functioning HVAC system or a leak

in the building envelope. Instead of using windows as a method to control the temperature in a room, find and fix the root cause to avoid wasted energy. If occupants open windows for any reason, they should be closed and locked when the occupants leave the space.

Window blinds and shades

During warm months, heat from the sun is a major factor in determining how hard the HVAC system needs to work to keep the building at the desired temperature. Use window blinds and shades to reflect the sun's rays, reduce unwanted heat infiltration and help the room stay cooler. Blinds should be closed when the space is unoccupied.

Additionally, adding exterior shades outside of the windowpane reduces the heat from the sun that your HVAC system must counteract, and can even serve as insulation.

Double pane windows

If your building has single pane glass windows, consider upgrading to multi-pane windows. Although window replacement is a more expensive option, multi-pane windows can be up to 50% more efficient because of the added insulation they provide.

Most multi-pane windows have a gas (such as argon) trapped inside. If you see moisture in multi-pane glass, there is a leak. Moisture inside the pane reduces its insulation value, or U-factor, rendering it less efficient.

Window film

Window film is another option used to prevent or lessen solar heat gain. A low emissivity (low-e) film can be applied to any E/S/W facing window to reflect the sun away from the building, reducing the heat intensity and ultraviolet exposure. This will reduce glare all year long and reduce solar heat gain in the cooling season.

FOR MORE INFORMATION

energy.gov/energysaver/energy-efficient-window-attachments.

EXTERIOR BLINDS

Hard mounted exterior blinds and retractable exterior blinds can help prevent solar loading by blocking heat from entering through windows.

Doors

Weatherstripping

Over time, the seals around a door wear down, creating gaps between the door and the door frame. These gaps allow air through, making your HVAC system work harder to replace the lost conditioned air. Replace the weatherstripping or upgrade to new and more efficient seals to reduce or eliminate drafts.

Interior doors

All doors should be kept shut during the day, or at least after hours. Keeping interior doors closed separates HVAC zones from each other so units only operate to condition their designated spaces.

If an HVAC system in one location is not working properly and interior spaces are not kept separate, other HVAC units will over-condition to compensate. Make sure each unit is operating at its design specifications – if one unit is continually working harder, this tells you where to look for a potential problem.

The best way to control air infiltration into a conditioned space is to make sure that enough outside air is brought into the space and conditioned appropriately as it is brought in. This results in a positive pressure within the space and allows for maximum operating efficiency of HVAC equipment and optimal indoor air quality within the space.

SEM MEASURES

- ✓ Adjust any doors that do not close properly.
- ✓ Verify that conditioned areas have positive pressure through doors to the exterior.
- ✓ Seal any gaps around doorframes with weatherstripping.
- ✓ Replace weatherstripping and door sweeps that have degraded or broken.

Roofing and insulation

Roofing

Check roofing periodically for damage. Cracks allow leaks and air infiltration, which can cause water damage and energy waste. Any issues should be fixed immediately, and any damaged insulation should be replaced.

Many schools have flat roofs, which are typically constructed using dark-colored materials. In general, dark-colored roofing materials absorb heat from the sun and transfer it to the building's interior.

For an aging roof due to be replaced, consider specifying a cool roof to save energy costs. Cool roofs utilize a white color and different material to reflect as much sunlight and solar radiation as possible and are proven to be just as effective and durable.

SEM MEASURES

- ✓ Replace wet, ruined or missing insulation in walls and the ceiling.
- ✓ Examine insulation for significant air leakage – damaged insulation will be brown or black.

Insulation

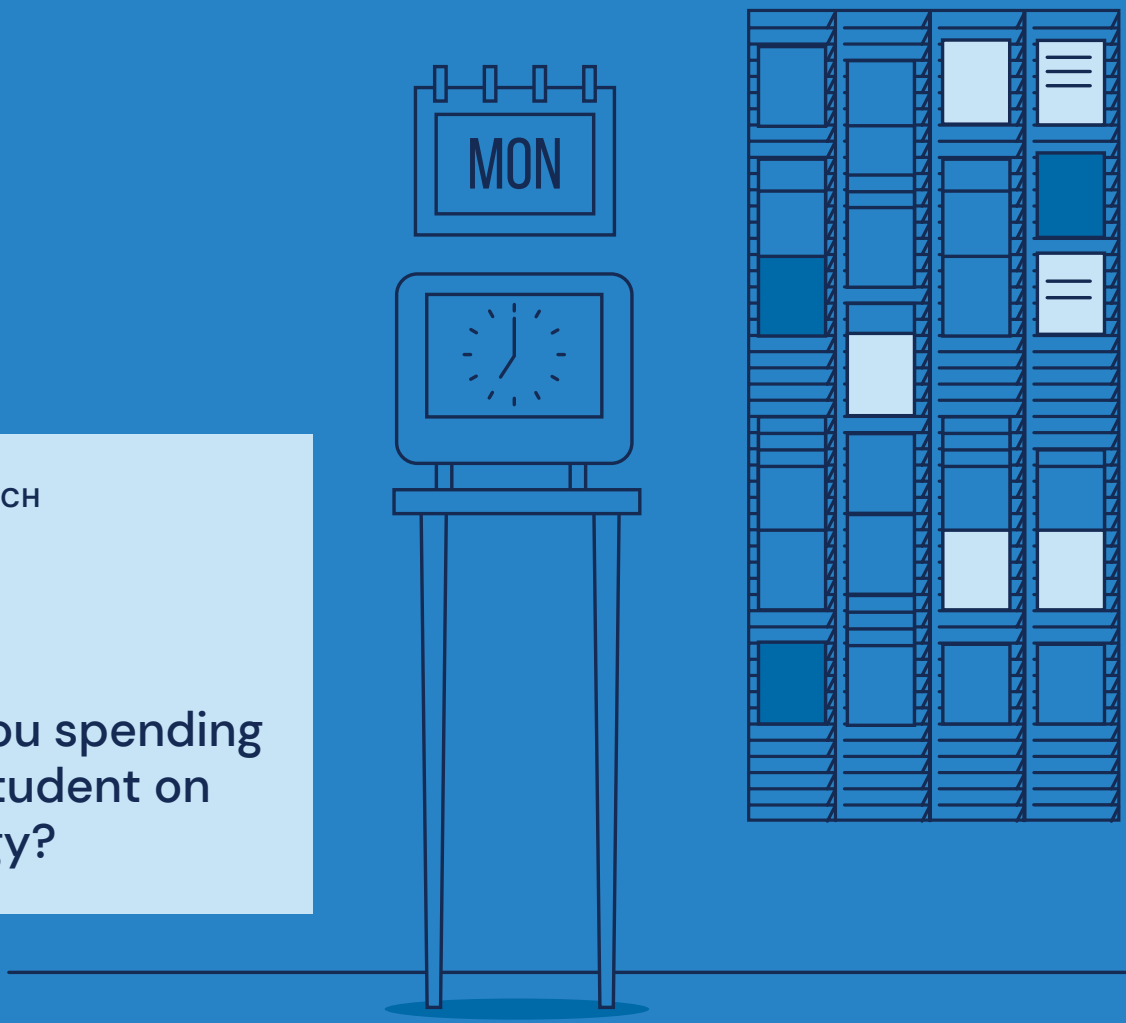
Any visible insulation is likely a symptom of a greater issue. Sometimes it simply came loose and needs to be replaced. However, discolored or degraded insulation is likely caused by some form of leak, whether by air infiltration blowing down/through it, or by a water leak ruining the adhesive (e.g., piping insulation). Investigate the insulation itself for moisture or the surrounding area for other damage. Fix the necessary issue and replace the insulation properly.

As a building ages, there are opportunities for the insulation to become damaged or settle without any indication to the naked eye. Infrared cameras are a great option to help locate this damage, since wet or missing insulation will show up on the screen as an energy transfer between the outside and conditioned spaces.

When using an infrared camera for detection, the temperature difference shows up better when the target areas are viewed from the colder side. During the winter months, view from the outside where you will see the energy transfer to the exterior wall; in the summer, view from the cooled interior to see the outside air infiltrating in.

CHAPTER 12

Operations & maintenance



HOW MUCH

$

are you spending per student on energy?

OPERATIONS & MAINTENANCE

Just like cars, buildings need tune-ups and preventative maintenance.

Operations and maintenance (O&M) strategies serve as the backbone of your school's SEM efforts. By comparing existing scheduling and maintenance activities with manufacturer recommendations, you can improve the energy performance of existing systems.

Just like cars, buildings need tune-ups and preventative maintenance. Over time, parts wear out. Maintenance is executed by different people. New equipment is installed. Control settings are changed or adjusted. These variables can unintentionally decrease the building's efficiency when changes are not addressed, documented or communicated. Proactive and thorough O&M practices can decrease maintenance needs and utility costs, improve reliability and extend the useful life of your equipment.

Following the building's current operating schedule is the fastest way to generate energy savings while spending the least amount of money. If applicable, logging into your school's Building Automation System (BAS) can give you a quick look at any changes that might have been made over time.

Even without a BAS, you can verify performance outputs versus actual setpoints, damper positions or valve settings. With this information, you can save energy by ensuring your existing equipment is operating efficiently, maintained properly and functioning according to manufacturer specifications.

Benefits

1. Reduce operating costs by 5-10% without capital investments.
2. Improve reliability to decrease the likelihood of outages and related downtime.
3. Minimize premature equipment replacement and large, unexpected capital projects by properly maintaining existing systems.
4. Improve occupant comfort, health and productivity.

Key terms

See the Appendix for more key terms.

BUILDING AUTOMATION SYSTEM (BAS)

Intelligent, integrated system of hardware and software that connects HVAC equipment, lighting, security systems and more on a single platform.

ENERGY MANAGEMENT SYSTEMS (EMS)

Computer-based systems that measure your energy consumption and evaluate opportunities to improve your energy efficiency.

POTABLE WATER

Water that is fit for drinking or washing – anything that might be ingested or come in contact with the skin.

NON-POTABLE WATER

Sometimes referred to as gray, recycled or reclaimed water, is water that is not usable for human consumption but may be used in other ways depending on its quality.

ECONOMIZERS

Part of an HVAC air handler system that mixes outdoor air or fresh air with the return air from the HVAC system to ventilate and cool the space. Sensors determine if the outside air is below a certain temperature and humidity level and appropriate for use in your HVAC system.

VARIABLE FREQUENCY DRIVES (VFD)

Motor controls that adjust motor torque and speed through energy phasing which results in greater power efficiency.

ACTUATORS

Devices that connect the control system to the mechanical system. They translate the electrical system input into the mechanical motion.

BLEEDING A WATER LINE

The act of using a valve to remove any air that might be in the line. Using the valve at the highest point in a piped water system, you gently open it so that the air sputters out until only water comes out, then shut the valve.

WATER HAMMER

When air gets trapped in a water line. This can cause serious damage to pipes – such as cracking or holes – as the pressure increases and decreases rapidly. Water hammer most typically occurs as a pressurized air pocket makes a turn in a bend of pipe.

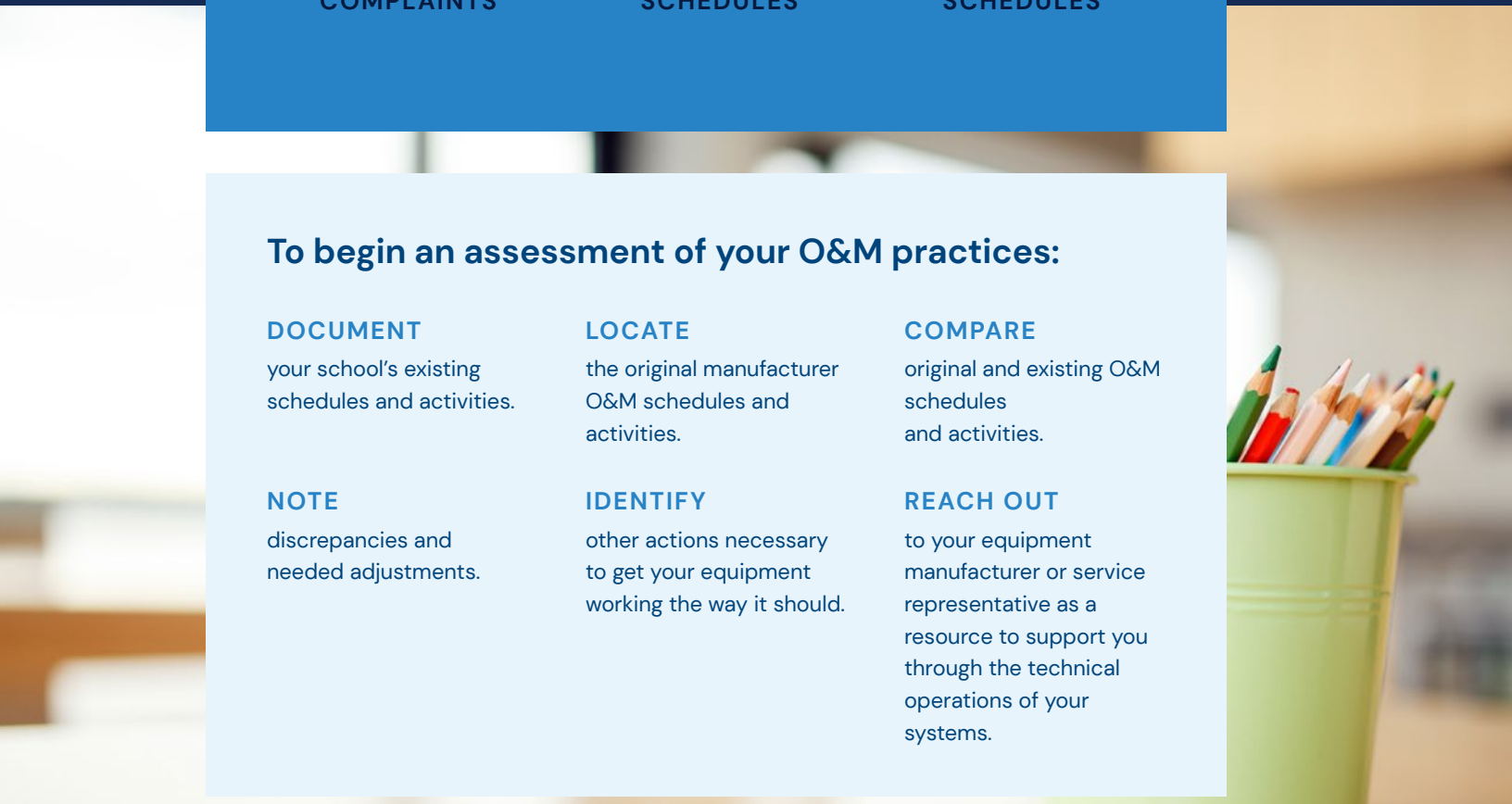
MARBLING

The sound pressurized air pockets make when moving around the bends in the piping prior to damage being sustained in a water system. It is named such because it is reported to sound like marbles clicking and clacking either together or through the pipe.

Getting started

WHAT TO LOOK FOR

- **OCCUPANT COMPLAINTS**
- **OPERATIONAL SCHEDULES**
- **MAINTENANCE SCHEDULES**



To begin an assessment of your O&M practices:

DOCUMENT
your school's existing schedules and activities.

LOCATE
the original manufacturer O&M schedules and activities.

COMPARE
original and existing O&M schedules and activities.

NOTE
discrepancies and needed adjustments.

IDENTIFY
other actions necessary to get your equipment working the way it should.

REACH OUT
to your equipment manufacturer or service representative as a resource to support you through the technical operations of your systems.

1 Take note of any occupant complaints

- ✓ Review common staff and student complaints and investigate whether they can be resolved.

2 Operational schedules

- ✓ Check whether equipment is shut down during unoccupied hours. Equipment switches may be manual or scheduled.
- ✓ Identify whether thermostats are scheduled. If applicable, ensure they are being rescheduled after adjustments or power outages.
- ✓ Determine whether overrides for events and extracurricular activities are temporary or permanent.
- ✓ Check to see if Variable Frequency Drives (VFD), sensors and equipment BAS outputs match actual outputs.
  - VFDs should match BAS output voltage, the voltage at VFD and equipment operating percentage.
  - Sensors should match actual values (temperature, Carbon Dioxide [CO_2], etc.).
  - Valve and damper positions should match control values.

3 Maintenance schedules

- ✓ Verify whether a preventative maintenance schedule exists for your facility.
- ✓ Confirm all mechanical equipment filters are being replaced regularly.
- ✓ Note whether refrigeration seals/levels have been checked recently and are in line with manufacturer specifications.
- ✓ Note any locations where incandescent, fluorescent or High Intensity Discharge (HID) lighting could be replaced with LEDs.
- ✓ Verify routine service schedules for equipment.
- ✓ Check if water lines are bled regularly to remove air.
- ✓ Verify if any gas or water leaks have recently occurred. If so, check to see if any insulation was damaged. If so, replace damaged insulation.
- ✓ Visually inspect equipment for damage or deterioration. Look for excessive dirt or debris, rust, holes, flickering or abnormal noises. Note any equipment that is due to be replaced.
- ✓ Regularly test your potable water quality. Rusty or dirty water often means a less efficient heat transfer.
- ✓ Always check the surrounding area for any damages or age breakdown whenever work is completed.

Operations schedules

Operations schedules help ensure equipment is turned on when needed and turned off when it is not. Reducing the number of run-time hours for equipment is a no-cost way to save energy and money. Reducing run-time hours simultaneously helps prolong the life of your equipment. The following control methods highlight the various options a school may have to reduce energy waste simply by turning equipment off when it is not needed.

Scheduling

Schools often have events and activities that take place after hours or on weekends. Due to varying schedule changes, it is important to adjust equipment schedules as each event schedule is known. This applies to unoccupied hours and extended breaks.

SEM MEASURES

- Create and/or implement equipment schedules.
- Track and implement temporary schedule changes, if possible. Consider consolidating after-school programs to certain areas and utilize zone changes for temporary schedule adjustments.
- Verify equipment is scheduled to shut down during unoccupied hours.
- Verify thermostats are rescheduled after adjustments or power outages.
- Shut down off-season equipment fully and properly.
- Contact your local power company to discuss enrolling in a Demand Response Program to save money on your utility bills by reducing energy usage during peak demand windows.

Thermostats

Thermostats regulate the indoor temperature by monitoring and adjusting the HVAC system to meet the desired temperature. Standard thermostats work by setting the temperature, then relaying the signal to the HVAC unit to maintain that temperature. Start by confirming thermostats work as expected. If your thermostat setpoint is not achieved, this could signify an issue with the HVAC unit.

Many older thermostats and systems are designed so that one thermostat controls the temperature of multiple spaces. This causes temperature fluctuations as occupants change the settings to fit their comfort level and inadvertently affect the other spaces. Note the zone each thermostat controls and create a plan to balance the comfort needs of all occupants.

Programmable thermostats

Programmable thermostats, also known as setback thermostats, are one way to promote energy efficiency in schools. The setback feature allows the thermostat to adjust the temperature based on periods of occupancy and vacancy. Consider replacing older, non-programmable thermostats to optimize the energy performance of your HVAC system(s).

SEM MEASURES

- ✓ Verify setback temperatures are being used (where applicable).
- ✓ Verify the original setback temperatures are still in place. Check if any modifications were made.
- ✓ Track and implement temporary schedule changes, if possible. Utilize zone changes for temporary schedule changes if only part of the building will be used.
- ✓ Check your schedules and setback temperatures after power outages – some thermostats will reset.
- ✓ Note the zone controlled by each thermostat and create a plan to balance the comfort needs of all occupants in that HVAC zone.

Building automation systems

A Building Automation System (BAS) is an intelligent, integrated system of hardware and software that connects HVAC equipment, lighting, security systems, etc. on a single platform. Automation systems reduce energy and maintenance costs compared to a non-controlled building. The BAS provides enhanced control over specific zones and schedules, monitors performance and provides notice when a system is malfunctioning.

BAS control is centralized to allow for adjustments to the entire system from a single location or source. This includes changing temperature settings in different locations, adjusting outside air requirements, turning off lighting, ensuring equipment is functioning properly and more.

SEM MEASURES

- Verify BAS settings match the system outputs.
- Verify damper positions match the BAS-controlled position setting.
- Ensure valve positions match the BAS-controlled position. If a valve is left open, simultaneous heating and cooling may occur.
- Make sure economizers are working. Check dampers to make sure they are functioning properly.
- Verify that VFDs are working correctly.
- Verify sensor readings for accuracy. This may include checking CO_2 levels for Demand Control ventilation or temperatures throughout a system.

Energy management systems

Energy Management Systems (EMS) are computer-based systems that measure your energy consumption and evaluate for opportunities to improve your energy efficiency. EMS also provides the ability to meter, submeter and monitor functions that enable you to gather more data and insights. These can help you make more informed decisions about energy activities across the school. EMS usually include sensors and actuators of different types to facilitate data collection, and provide data analysis, find trends and assess opportunities for improvement.

If your school has a basic BAS, it may be worthwhile to add an EMS overlay. However, this requires careful consideration since overlays have added requirements, such as VFDs, economizing and scheduling.

Maintenance schedules

To keep your equipment as efficient as possible, proper maintenance of your building's systems is one of the most important activities you can do. Systems are designed to operate in a specific way. Keeping equipment well maintained will help sustain peak operation. Regular activities such as replacing filters, checking refrigerant levels or maintaining motor and pump oil levels are key maintenance items that will ensure equipment durability and energy efficiency.

Preventative maintenance

Preventative maintenance means attending to your equipment before problems occur. Properly maintained equipment improves reliability, saves energy by running systems at designed performance levels and ultimately reduces the need for emergency replacements.

Create a plan or schedule to ensure a consistent effort by maintenance staff to keep equipment running as close to the manufacturer's specifications as possible. Establishing regular maintenance checks will improve the effectiveness of your systems, maintain high efficiency and extend the life of equipment. Compile a comprehensive list of items and plan to keep the existing building systems performing optimally.

Combining other methods, such as scheduling, with preventative maintenance will help the equipment run as efficiently as possible, extending the life of the equipment. Beyond cost savings, extending the life of equipment allows time to budget for capital improvement projects by creating replacement plans. When you do have to replace equipment, select the most efficient options that work for your facility. Using life-cycle costing can help justify the purchase of higher-priced, higher efficiency equipment.

SEM MEASURES

- ✓ Create a preventative maintenance schedule if one does not exist.
- ✓ Implement identified service plans for equipment.
- ✓ Regularly replace filters on all equipment as prescribed by the equipment manufacturer.
- ✓ Check refrigeration seals and levels at least yearly.
- ✓ Visually inspect all equipment for damage or deterioration.
- ✓ Test water quality and treat as needed.
- ✓ Bleed water lines regularly to remove air from the system and perform sound checks to catch and fix water hammer and marbling.

Equipment replacement

Performing regular and preventative maintenance can prolong the life of your equipment. Additionally, it will help you recognize when equipment is nearing the end of its useful life-cycle so a replacement plan can be put into place ahead of time.

Each system should be checked regularly for signs that it may be nearing the end of its useful life-cycle. It is important to make a cost analysis of aging equipment since there will come a point where it transitions from “old but well maintained” to “old and inefficient.” Knowing that tipping point will allow you to make the best decision for your facility. When that time finally comes, it is also good to check if there is a more efficient piece of equipment that can still meet the system’s needs. That way, you can have an operating system for years to come that will provide a better return on your investment.

SEM MEASURES

- ✓ Check facility for damaged, defective or malfunctioning equipment. Replace it as needed.
- ✓ Replace damaged or degraded insulation as needed. Verify insulation has been replaced around fixed leaks in piping.
- ✓ When replacing old equipment, check to see if it can be replaced with a more energy efficient model. A cost analysis can be done based on the additional cost versus energy savings over time.

Appendix

Glossary of terms

TERM	ABBV.	DESCRIPTION	CHAPTER
Actuator		A device that connects the control system to the mechanical system. They translate the electrical system input into the mechanical motion.	12
Aerator		A small screen installed at the tip of a faucet or showerhead designed to reduce the volume of water that comes out by mixing the water stream with air.	9
Air intake		An opening through which fresh air enters the HVAC system from outside.	8
Ambient light		The general, non-directional light level in a space.	6
Ballast		An electrical device that regulates voltage and current supplied to the fixture.	6
Baseline		A baseline refers to an initial set of data that serves as the benchmark for your improvements. Baseline data should include typical usage patterns to compare your energy management efforts accurately and realistically. For example, a baseline that includes atypical and prolonged school closures will not give you a true representation of your improvements.	2
Behavior change		This refers to the adjustments to an individual or community's activities, practices and habits (their behavior) toward a specific topic.	5
Benchmarking		A benchmark is a comparison of current performance to a baseline or peers. Benchmarking allows you to evaluate and verify changes and improvements in your performance.	2
Bleeding a water line		The act of using a valve to remove any air that might be in the water line. Using the valve at the highest point in a piped water system, you gently open it so that the air sputters out until only water comes out, then shut the valve.	12
British thermal unit	BTU or Btu	A unit of heat, or the heat it takes to raise water temperature by one degree Fahrenheit.	9

TERM	ABBV.	DESCRIPTION	CHAPTER
Building automation system	BAS	An intelligent, integrated system of hardware and software that connects HVAC equipment, lighting, security systems and more on a single platform.	12
Color temperature	K	A measurement of the quality and color of light output is stated in Kelvin (K). Color temperature is measured on a 1,000 – 10,000 scale, where 1,000K is the red orange color of candlelight, 3,000K is the typical warm incandescent light bulb, and 5,000K and up is a cool white to blue light (similar to natural daylight). In an art classroom, the color temperature of lighting greatly affects the color rendering or appearance of colors.	6
Communication channels		The ways you can communicate information, such as print, digital or in-person.	5
Daylighting		The intentional placement of windows, skylights, reflective surfaces, etc. to bring natural sunlight into an area so that electrical lighting needs are reduced.	6
Domestic hot water systems	DHW	These deliver hot water throughout your facility.	9
Economizer		A part of an HVAC air handler system that mixes outdoor air or fresh air with the return air from the HVAC system to ventilate and cool the space. Sensors determine if the outside air is below a certain temperature and humidity level and appropriate for use in your HVAC system.	7
Efficacy		In lighting, this refers to a ratio of light output to the energy input that explains how well a fixture produces light.	6
Elevator pitch		An elevator pitch is a quick and effective way of explaining the work you do. Meant to be stated in under a minute, an elevator pitch should answer the basic questions of what, why and how, and may end in a call to action or a request from your listener.	1
Energy conservation measures	ECMs	ECMs are the specific potential facility upgrades that can be made to increase energy efficiency. Examples include operating a system in a more efficient manner, fixing equipment that may not be working correctly, replacing an outdated system with a more modern/efficient system or updating practices or policies.	3

TERM	ABBV.	DESCRIPTION	CHAPTER
Energy management assessment	EMA	An EMA is an analysis of your team's energy-related business practices. An EMA scores your team's strengths and weaknesses in multiple energy management categories and outlines next steps to prioritize, develop and improve your SEM practices.	1
Energy management systems	EMS	Computer-based systems that measure your energy consumption and evaluate opportunities to improve your energy efficiency.	12
Energy services company	ESCO	A company that provides a broad range of energy solutions including power generation and supply, design and implementation of energy savings projects, retrofitting, energy infrastructure outsourcing and risk management.	3
ENERGY STAR® label		A trusted, government-backed symbol for energy-efficient products and practices, created to reduce greenhouse gas emissions and other pollutants caused by the inefficient use of energy and make it easy for consumers to identify and purchase energy efficient products that offer savings on energy bills without sacrificing performance, features and comfort (www.energystar.gov).	10
Energy Team		Your core committee of people helping to run an effective, efficient SEM Program. By engaging multiple people at different levels within your organization, team members bring a variety of skill sets and perspectives to the work creating greater impact for your school. Energy Teams consist of Champions, Committees, Sponsors and Steering Committees.	1
Energy use intensity	EUI	An indicator of energy efficiency that compares annual energy consumption to the total (gross) square footage or area. In Portfolio Manager, EUIs are given as energy per square foot per year. EUIs may vary greatly depending on the type of building measured. Several types of EUIs can be calculated including Site EUI, Source EUI and Weather Normalized EUIs. For more information, please see: energystar.gov/buildings/benchmark/understand_metrics/what_eui	2
Energy waste		Energy that is wasted as a result of inefficient or unneeded processes or equipment.	1
Flow rate		The volume of water per unit time. Typically, gallons per minute (gpm).	9
Footcandle		A unit of measurement for the brightness of light or illuminance originally equal to one candle (fc).	6

TERM	ABBV.	DESCRIPTION	CHAPTER
Gallons per flush	gpf	Rate of water use. Typically used in water valves, specifically in restrooms, it is the industry standard for the volume of water used for each flush cycle until the valve is closed again. The U.S. has federal requirements that each device (toilet, urinal) must adhere to, but recent technology allows for lower GPF with the same results.	9
Gallons per minute	gpm	Also known as "flow rate," GPM is a measure of how many gallons of water flow out of a fixture per minute.	9
Gamification		Competition or challenges to engage an audience around a particular subject.	5
Glare		An important consideration in light quality. It is produced by an intensity in light that negatively affects performance or creates discomfort.	6
Greenhouse effect		The greenhouse effect takes place when the sun shines through a transparent surface (such as a window) and the heat gets trapped. Radiation flows through the glass and heats opaque surfaces which then heat the interior space. This is also called "solar loading" when talking about cooling loads.	11
Heat loss		This occurs when storage tanks or pipes holding hot water are not insulated, allowing the water to cool before it's delivered to the end user.	9
Indoor air quality	IAQ	Refers to the air quality within a building, especially as it relates to the health and comfort of the building's occupants.	7
Infiltration		Refers to the unintentional introduction of outside air, pollutants or pests into a building.	11
Infrared	IR	A type of radiation that can be seen using special equipment to measure thermal emission (heat) in an area. IR cameras allow you to see and measure temperature differences from a distance. These can be extremely helpful tools for identifying drafts and hot spots in an area or building.	11
Kilowatt hour	kWh	A measurement of electricity. In other words, the amount of energy it would take to keep a 1,000-watt appliance running for one hour.	1
Lamping		Refers to the light source or light bulbs used. Source types may include incandescent, linear or tubular fluorescent, compact fluorescent (cf), and high-intensity discharge (HID) types which may include high-pressure sodium, mercury vapor or metal halide.	6

TERM	ABBV.	DESCRIPTION	CHAPTER
Lens		Also referred to as reflector, optical devices that disperse, focus or redirect light from a lamp.	6
Light-emitting diodes	LEDs	LEDs are a versatile and highly efficient lighting technology that lasts longer and provides comparable or improved light quality over other types of lighting.	6
Louvers and dampers		Louvers protect the air intake from weather and debris while dampers control and manage airflow and redirect it to/from specific areas.	7
Low emissivity	low-e	Low-e surfaces emit low levels of radiant heat. A low-e coating on windows will reduce the amount of heat that transfers from one side of the glass to the other.	11
Lumen		The scientific unit of luminous flux, or light output from a uniform source. The higher the lumens, the brighter the light.	6
Marbling		The sound pressurized air pockets make when moving around the bends in the piping prior to damage being sustained in a water system. It is named such because it is reported to sound like marbles clicking and clacking either together or through the pipe.	12
Maximum performance ratings	MaP	Efficiency and performance scale that scores how much solid waste a toilet can completely flush in one single flush.	9
Measurement and verification	M&V	M&V is the process of determining the real load of a building or piece of equipment. M&V can be done through estimation, physical measurement using handheld, semi-permanent or permanent devices, using the building power meter to study the overall energy consumption or using energy modeling software.	3
Minimum efficiency reporting value	MERV	An air filter's MERV rating tells you the size of particulates the filter is capable of capturing. The higher the MERV rating, the smaller size of particulates the filter is rated to capture.	7
Non-potable water		Sometimes referred to as gray, recycled or reclaimed water, this is water that is not usable for human consumption but may be used in other ways depending on its quality.	12

TERM	ABBV.	DESCRIPTION	CHAPTER
Operations and Maintenance (O&M)		"Operations" refers to how building components and systems are configured, controlled and scheduled, while "maintenance" refers to periodic checks, cleaning, testing and adjusting.	12
Payback time		The amount of time needed for the energy savings to fully pay and offset the expense of the upgrade.	3
Performance Contract	PC	An agreement between a building owner and an ESCO that identifies, designs and installs energy-related improvements and guarantees their performance. Performance contracting is a financing method used by ESCOs that pays for the initial capital investment with the energy savings produced from the work.	2
Performance Tracking		The act of keeping track of energy consumption. Normally this is done before a project to create a baseline, and after to distinguish the amount of energy and money saved. To determine annual savings, the baseline will also be "normalized" so the weather from the baseline period matches the target year, or vice versa.	2
Positive pressure		When HVAC systems add more air to a space than it would normally have. This is like a tank of compressed air, but on a much smaller pressure scale. Building codes call for positive pressure for a couple of reasons. First, positive pressure prevents contaminants and unwanted air infiltrations from entering conditioned space. Second, positive pressure assures that most spaces will be conditioned to the same level. Otherwise, areas with more infiltration would also have greater temperature variation or need more conditioning.	11
Potable water		Water that is fit for drinking or washing – anything that might be ingested or come in contact with the skin.	12
Pound per square inch	psi	A unit of pressure or of stress from one pound force applied to an area of one square inch. Pressure levels directly affect the flow rate of a plumbing fixture.	9
Qualitative		Data includes results that are measurable through description or story, as opposed to numbers.	5
Quantitative		Data includes results that are measurable in numbers.	5
Receptacle		A power outlet or socket.	10
Reflector		Also referred to as lens, optical devices that disperse, focus or redirect light from a lamp.	6

TERM	ABBV.	DESCRIPTION	CHAPTER
Retrofit		An addition, upgrade or modification to a facility or a specific piece of equipment that was not a part of the original installation.	3
Return on investment	ROI	ROI is a financial performance metric to determine efficiency or profitability of an investment. For SEM's purposes, ROI is the amount, expressed as a percentage, that is saved by an energy conservation measure or project. It is measured by dividing the savings by the total cost of the measure or total capital investment.	3
Revolving loan funds		Self-replenishing pools of money that use interest, loan repayments, and sometimes energy savings to fund new loans or projects.	3
Setbacks		A strategy for reducing how often the heating or cooling system operates by allowing the temperature in a room to drift to a higher or lower setting, based on occupancy. Normally, during cooling season the setback will be a few degrees higher, and during heating season the setback will be a few degrees lower.	7
Site EUI		Refers to the properties' on-site energy use per square foot of floor space.	2
Smart power strips		Energy-saving surge protectors with smart device technologies, such as: power auto-switching or occupancy sensors.	10
Source EUI		Refers to all the energy or raw fuel used to power the property, including energy losses from generation, transmission and distribution.	2
Solar heat gain		This occurs when the sun's radiation is absorbed or passes through a window and increases the heat within a room or building. Rooms with South- and West-facing windows tend to heat up faster because they get more direct sunlight. While this effect is desirable in the winter, when the weather is hot it can be an unwelcome side effect. Also known as "solar loading."	10
Supply line		The line going "in" to a piece of equipment before the equipment process changes it somehow. Example: the supply line chilled water temperature to an air handler unit (AHU) is colder than the return line going back to the chiller.	9
Task light		Specific, directional or adjustable light that can be added to a space.	6

TERM	ABBV.	DESCRIPTION	CHAPTER
U-factor		Also known as U-value, this is a measurement of how well glass or glazing elements such as windows, doors or skylights insulate a space. The lower the U-factor, the less heat transfer – which means better performance.	11
U.S. Environmental Protection Agency	EPA	An independent executive agency of the United States federal government tasked with environmental protection matters.	5
Ventilation		The process of intentionally exchanging or replacing air within a space to improve indoor air quality, control temperature and humidity and remove odors, pollutants and other airborne particulates.	7
Variable frequency drive	VFD	Motor controls that adjust motor torque and speed through energy phasing, which results in great power efficiency.	12
Water hammer		This is when air gets trapped in a water line. This can cause serious damage to pipes – such as cracking or holes – as the pressure increases and decreases rapidly. Water hammer most typically occurs as a pressurized air pocket makes a turn in a bend of pipe.	12
Wattage		The operating power of a lamp or other electrical appliance expressed in watts. With incandescent sources, wattage once provided an indication of brightness. Today, with the efficiency of LEDs, wattage is no longer a measure of brightness. Instead, lumens are an indicator for brightness. For example, a 40-watt incandescent is now replaced with a 4-watt LED.	6
Weather Normalized EUI		When Site or Source EUI is shown as "Weather Normalized," it means the calculations have been adjusted to account for atypical or abnormal weather occurrences or other external efficiency losses that can skew the performance data for your building's energy consumption.	2

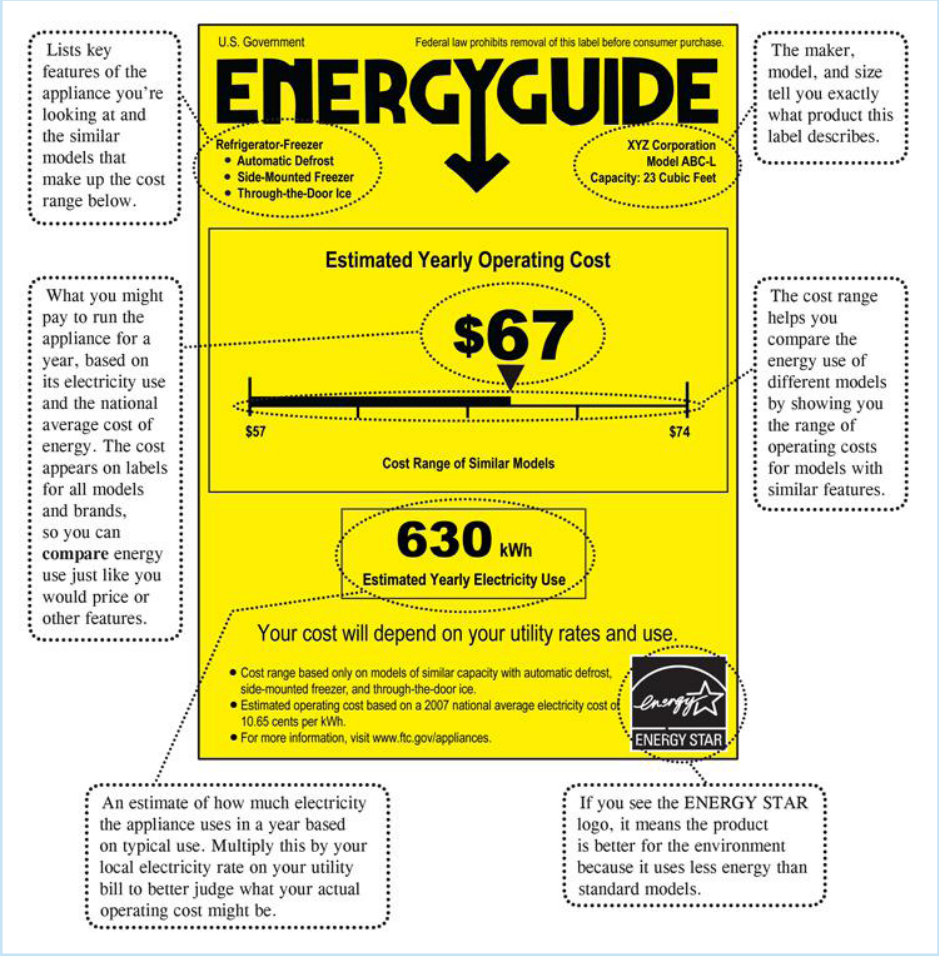
Products and procurement

When choosing new equipment, lighting and plumbing fixtures, begin by understanding how the equipment you have should function, and whether it can be fixed or needs to be replaced. If it needs replacement, use these tips to help you select the most efficient, cost-effective products from reputable sources.

Determine current conditions

To ensure your new equipment will save energy, water and money, the first step is to determine the efficiency of the existing equipment and compare it to replacement models you are considering. The EnergyGuide from ENERGY STAR® is an easy way to determine current energy usage for many pieces of equipment:

consumer.ftc.gov/articles/0072-shopping-home-appliances-use-energyguide-label



Select replacement product

Purchasing an ENERGY STAR-certified piece of equipment is the easiest way to ensure you are getting an energy efficient and durable product. Compare EnergyGuides to confirm you are selecting a model that is more efficient than what you are replacing. The following table provides a summary of the benefits of selecting ENERGY STAR models as well as any other considerations.

EQUIPMENT	ENERGY STAR BENEFITS	OTHER CONSIDERATIONS
Refrigerators	9% more efficient than standard models.	Choose frost-free models without ice makers.
Dishwashers	Uses 12% less energy and water than standard models.	Consider models with eco-mode.
Clothes washers (commercial)	Uses 25% less energy and 45% less water than standard.	
Clothes dryers	Uses 20% less energy than standard models.	Choose models with moisture sensor and proper ducting sealed with foil-backed tape.
Water heaters	Uses 15% less energy than conventional commercial units.	
Exhaust fans	Provides increased efficiency and comfort with less noise; high-performance motors and improved blade design provide better performance and longer life.	Consider integrating a humidistat instead of (or in addition to) the controls.
Range hoods	Provides better efficiency and comfort with less noise; features high-performance motors and improved blade design, providing better performance and longer life.	Ensure range hoods duct to the exterior; only use mastic or rated foil-faced tape (no duct tape).
HVAC	6% more efficient than standard equipment.	According to the Consortium of Energy Efficiency, at least 25% of all rooftop HVAC units are oversized, resulting in increased energy costs and equipment wear. Properly sized equipment dramatically cuts energy costs, increases the life of the equipment, and reduces pollution.

Lighting

To reduce energy and maintenance costs, consider upgrading to LED fixtures and/or lamps when replacing incandescent and fluorescent lamps and fixtures. The table below offers some proposed solutions and benefits to replacing common lamps and fixtures.

CURRENT LIGHTING	SOLUTION & BENEFITS
Incandescent lamps	Incandescent lamps are the least efficient lighting type currently available and need to be replaced about every two years. Replacing lamps and fixtures with LED technology can reduce lighting energy consumption by up to 90% while reducing replacement and maintenance costs. LEDs have an average performance life of more than 12 years.
Compact fluorescent lamps (CFL)	LEDs last nearly twice as long as CFL lamps and use up to 40% less energy.
Linear fluorescent tubes	Consider replacing T5, T8 and T12 with LED tubes and fixtures.
Ballast replacements	Consider upgrading to a new, ballast-free LED fixture and never change a ballast again.

Plumbing fixtures

A large portion of water use is attributed to plumbing fixtures such as sink faucets, showers and toilets. Installing low-flow aerators, showerheads and toilets can reduce total water use – and its associated energy costs – significantly.

FIXTURE	CONSIDERATIONS
Toilets	Select only WaterSense models and consider 0.8 gpf or ≤1.28 gpf. Use MaP Test results to help select the best toilet.
Lavatory faucets & aerators	Select only WaterSense models (≤1.5 gpm). Consider that 0.5-1.0 gpm is usually sufficient for bathroom faucets.
Kitchen faucets	Select models with flow rates 1.5-2.2 gpm, depending on occupant practices. Consider a swivel-head aerator that has an on-sprayer shut-off, especially in units without dishwashers.
Showerheads	Select only WaterSense models (≤1.75 gpm). Verify showerhead and automatic compensating mixing valve are marked with the same flow rate at a pressure of 45 psi.
Flow restrictor	Install flow restrictors on showerheads to prevent unwanted hot water waste.
Plumbing insulation	Install pipe wrap on any exposed hot water supply pipes.

Vendor and contract management

To receive the value and effectiveness you are looking for when hiring a contractor or vendor, make sure you provide them with the right expectations and all relevant information. This will help ensure they can jump into work fast and focused. Below are some tips on managing contractors through different project phases.

Project planning

- Provide your building's operating schedules and any conditions that impact the systems they will be working on.
- Explain specifically where electric, mechanical, water and waste system components are located, and how they operate within your building.
- Provide all relevant maintenance records.
- Offer the names and contact information for all staff members related to the project.
- Share your organization's ethical standards and help the contractor translate those into the project at hand.
- Schedule frequent check-in meetings to ensure objectives are being met on time and work is being completed to a high standard.
- Make sure a staff member is available to the contractor at all times.
- Be flexible and creative if scope changes are needed, but do not compromise on components that are important to your organization.

Product purchases

- New product selection — Select the product that is right for your property. If you have selected a product that is not currently offered by your contractor/vendor, ask them to secure pricing before considering an alternative product.

- Retail price comparison — Compare pricing with local retailers that may offer the same product. If you find another supplier with better pricing, share that information with your current vendor/contractor. Most vendors and contractors want to remain competitive and will be willing to price match.

- Bulk price comparison — Forecast how many appliances you plan to replace on an annual basis. Share your forecast with your vendor to see if they can provide you with bulk pricing.

Project follow-up

- Conduct a final meeting to make sure that all project goals have been accomplished.

- Task someone on your staff or a third-party to conduct independent quality assurance (QA) on the project.

- Give honest feedback about how the engagement could have been improved from your perspective.

- If you are satisfied with the work, offer to be a reference; this helps create a thriving building industry that benefits us all.

Additional resources

Technical resources

- **EnergyRight:** EnergyRight.com/business-industry

- **TVA Energy Advisor (filter by category):** TVA.bizenergyadvisor.com/categories/technologies

- **My Energy Advisor:** EnergyRight.com/business-industry/mea

- **Find a Contractor:** EnergyRight.com/business-industry/find-a-contractor

- **Request for Expert Solutions:** EnergyRight.com/business-industry/request-expert-solutions

- **SEMHub:** semhub.com

HVAC

- **Consortium of Energy Engineers:** cee1.org
- **American Society for Heating, Refrigerating and Air-conditioning Engineers (ASHRAE):** ashrae.org
- **Air Conditioning, Heating & Refrigeration Institute:** ahrinet.org/home

Building envelope

- **ACEEE – Building Envelope:** aceee.org/topic/building-envelope
- **Better Buildings Initiative – Building Envelope:** betterbuildingssolutioncenter.energy.gov/alliance/technology-solution/building-envelope

Lighting

- **ENERGY STAR Lamps:** energystar.gov/productfinder/product/certified-light-bulbs/results
- **ENERGY STAR Fixtures:** energystar.gov/productfinder/product/certified-light-fixtures/results
- **Design Lights Consortium:** designlights.org
- **Lighting Design Lab:** lightingdesignlab.com
- **Illuminating Engineering Society (IES):** ies.org

Plumbing, water heating & irrigation

- **WaterSense:** epa.gov/watersense
- **MaP Testing:** map-testing.com
- **Irrigation:** epa.gov/sites/default/files/2017-12/documents/ws-commercialbuildings-waterscore-irrigation-landscape-guide.pdf
- **Piping insulation requirements:** energycodes.gov/sites/default/files/2019-09/2018_IECC_commercial_requirements_mechanical.pdf

Energy efficiency

- **Building Efficiency Targeting Tool for Energy Retrofits (BETTER):** better.lbl.gov
- **Association of Energy Engineers:** aeecenter.org
- **DOE Energy Efficiency:** energy.gov
- **Windows – energy efficient window attachments:** energy.gov/energysaver/energy-efficient-window-coverings

K-12 schools

- **Center for Green Schools:** centerforgreenschools.org
- **TVA Energy Advisor for K-12 Schools:** TVA.bizenergyadvisor.com/article/k-12-schools
- **DOE Better Buildings Initiative for K-12 School Districts:** betterbuildingssolutioncenter.energy.gov/challenge/sector/k-12-school-districts
- **DOE Operating and Maintaining EnergySmart Schools:** eere.energy.gov/buildings/publications/pdfs/energysmartschools/ess_o-and-m-guide.pdf
- **EmPowered Schools:** empoweredschools.org
- **EPA Energy Efficiency Programs in K-12 Schools:** epa.gov/statelocalenergy/energy-efficiency-k-12-schools
- **NEED Curriculum, Classroom Grants & Special Programs:** need.org/partners/curriculum-classroom-grants-special-programs
- **NREL Energy Design Guidelines for High Performance Schools:** nrel.gov/docs/fy02osti/29105.pdf
- **NREL Energy-Smart Building Choices:** nrel.gov/docs/fy02osti/31604.pdf
- **Options for Educating Oregon on Energy Efficiency:** energytrust.org/wp-content/uploads/2018/08/Energy-Education-Final-Report_2017_07_11.pdf
- **Teachers Pay Teachers:** teacherspayteachers.com

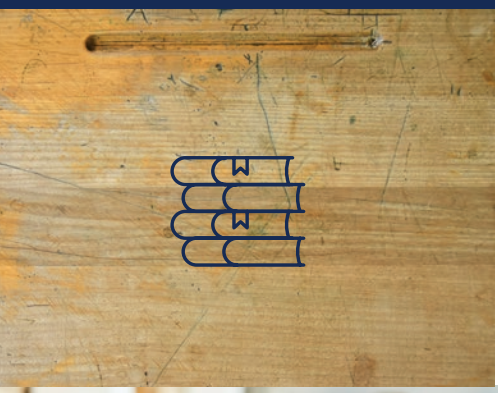
ENERGY STAR®

- **ENERGY STAR Portfolio Manager Login:** portfoliomanager.energystar.gov/pm/login.html
- **ENERGY STAR Energy Efficiency Student Toolkit Tutorial:** energystar.gov/sites/default/files/tools/K12EnergyEfficiencyStudentToolkit.pdf
- **ENERGY STAR Energy Use Intensity (EUI):** energystar.gov/buildings/benchmark/understand_metrics/what_eui
- **ENERGY STAR Energy-Saving Competitions:** energystar.gov/buildings/save_energy_commercial_buildings/ways_save/energy_saving_competitions
- **ENERGY STAR Energy Treasure Map:** energystar.gov/buildings/tools-and-resources/energy_treasure_map_k_12_schools
- **ENERGY STAR Lorax Activity Book:** energystar.gov/buildings/tools-and-resources/lorax_activity_book

Financing resources

- **ADECA Energy Division (Alabama):** adeca.alabama.gov/performancecontracting
- **GEFA (Georgia Environmental Finance Authority):** gefa.georgia.gov/energy-resources/energy-performance-contracting
- **Energy Efficient Schools Initiative (State of Tennessee EESI:):** tn.gov/eesi.html
- **Pathway Lending Energy Efficiency Loan Program (Tennessee):** pathwaylending.org/energy-efficiency-loans
- **State Grants - Kentucky Department of Education:** education.ky.gov/districts/fin/Pages/State-Grants.aspx
- **School Improvement Grants - Mississippi Department of Education:** mdek12.org/OSI/resources/sig
- **Guaranteed Energy Savings Contract or GESC (North Carolina):** deq.nc.gov/energy-climate/energy-group/utility-savings-initiative/guaranteed-energy-savings-performance-contracts
- **Virginia Energy:** energy.virginia.gov

Notes



Your textbook for energy savings