



Developing Energy Efficiency Projects

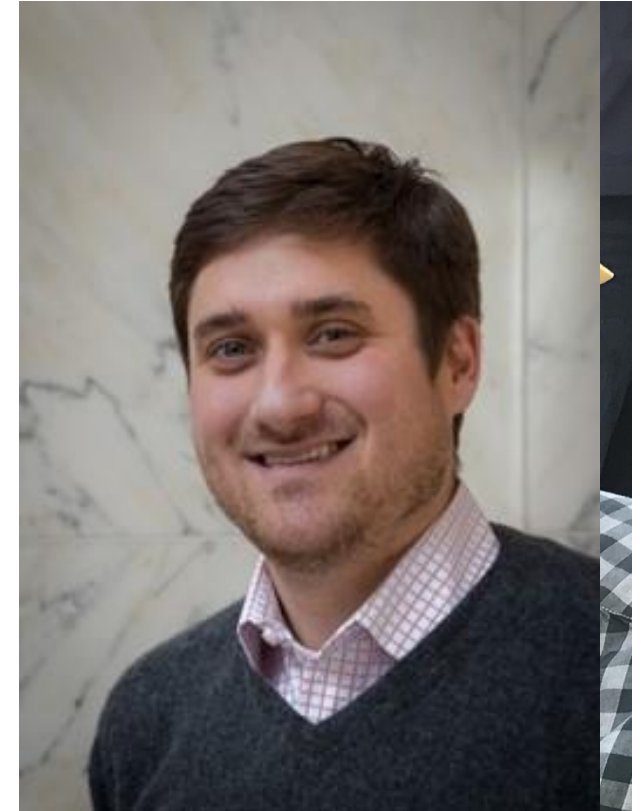
Module 3 in the “Benchmarking and Energy Management for K-12 Facility and Energy Managers” Course

October 31, 2023

Today's Presenter

Andrew Schulte

Mr. Schulte is a Director in ICF's Energy Efficiency and Sustainability group, with nearly 18 years of experience. In support of the U.S. Environmental Protection Agency's (EPA's) ENERGY STAR Buildings program, Mr. Schulte assists partners seeking to integrate ENERGY STAR tools and resources, including the Guidelines for Energy Management and Portfolio Manager, into organization-wide energy and sustainability strategies. He has also led the development, delivery, and evaluation of the ENERGY STAR Buildings training program, and has presented hundreds of benchmarking and energy management trainings over the course of his career. Mr. Schulte also supports engagement with service and product providers that are helping building owners and operators to develop and execute energy management projects.



Today's Agenda

- Welcome and Introductions
- Learning Objectives
- Understanding Different Types of Building Energy Assessments
- The Staged Approach to Building Upgrades
- Identifying Common Building Energy Performance Improvements
- Finding Expert Help
- Wrap-up and Q&A

Overview of the Benchmarking & Energy Management Course

- October 17, 2023: Introduction to Energy Management
- October 24, 2023: Energy Tracking and Benchmarking
- **October 31, 2023: Developing Energy Efficiency Projects**
- November 7, 2023: Institutionalizing Continuous Improvement
- November 14, 2023: Benchmarking & Energy Management Cohort

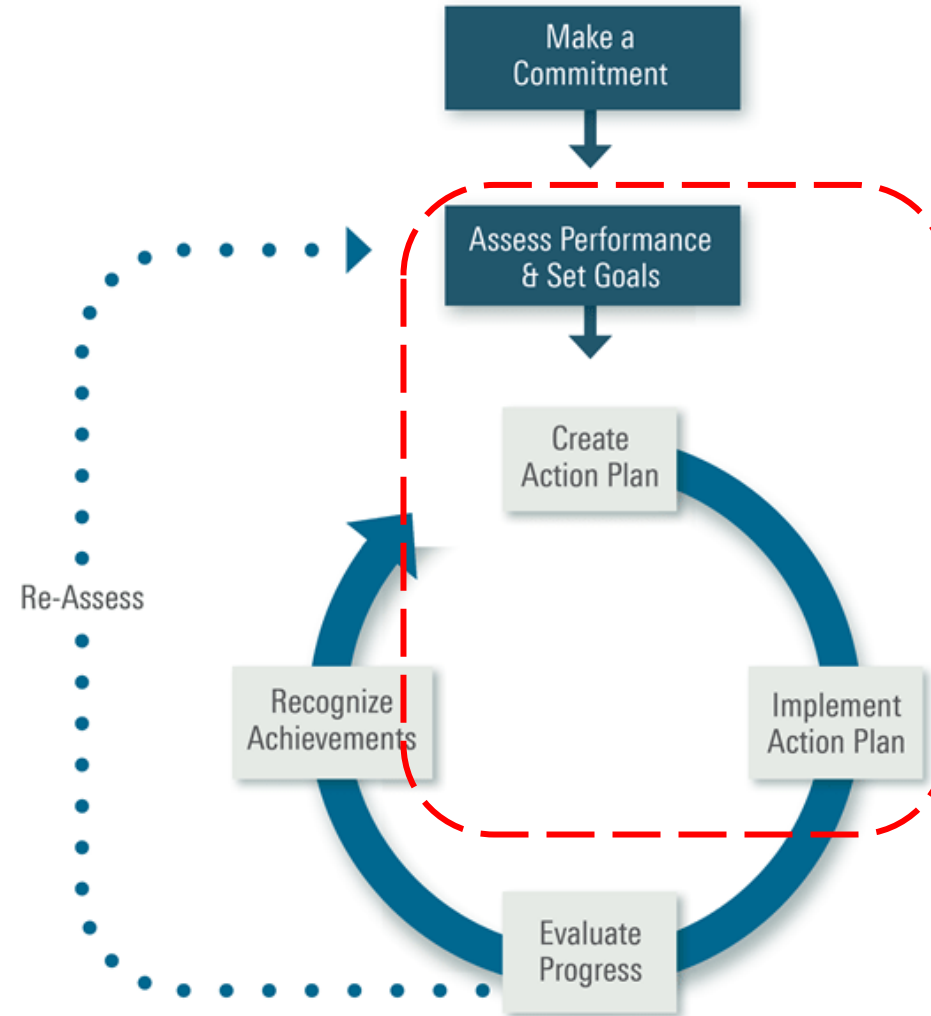
All sessions will take place from 3:00 – 5:00 PM (Eastern)

Learning Objectives

- In today's session, attendees will:
 - Understand how to take the next steps in identifying and pursuing energy improvements within school properties.
 - Recognize different types of energy assessments and when they are appropriate.
 - Understand the benefits of a staged approach to energy improvements.
 - Explore common improvements across different building systems.
 - Identify the types of solution providers that can support your projects.

Situating This Module Within the Energy Management Process

ENERGY STAR® Guidelines for Energy Management



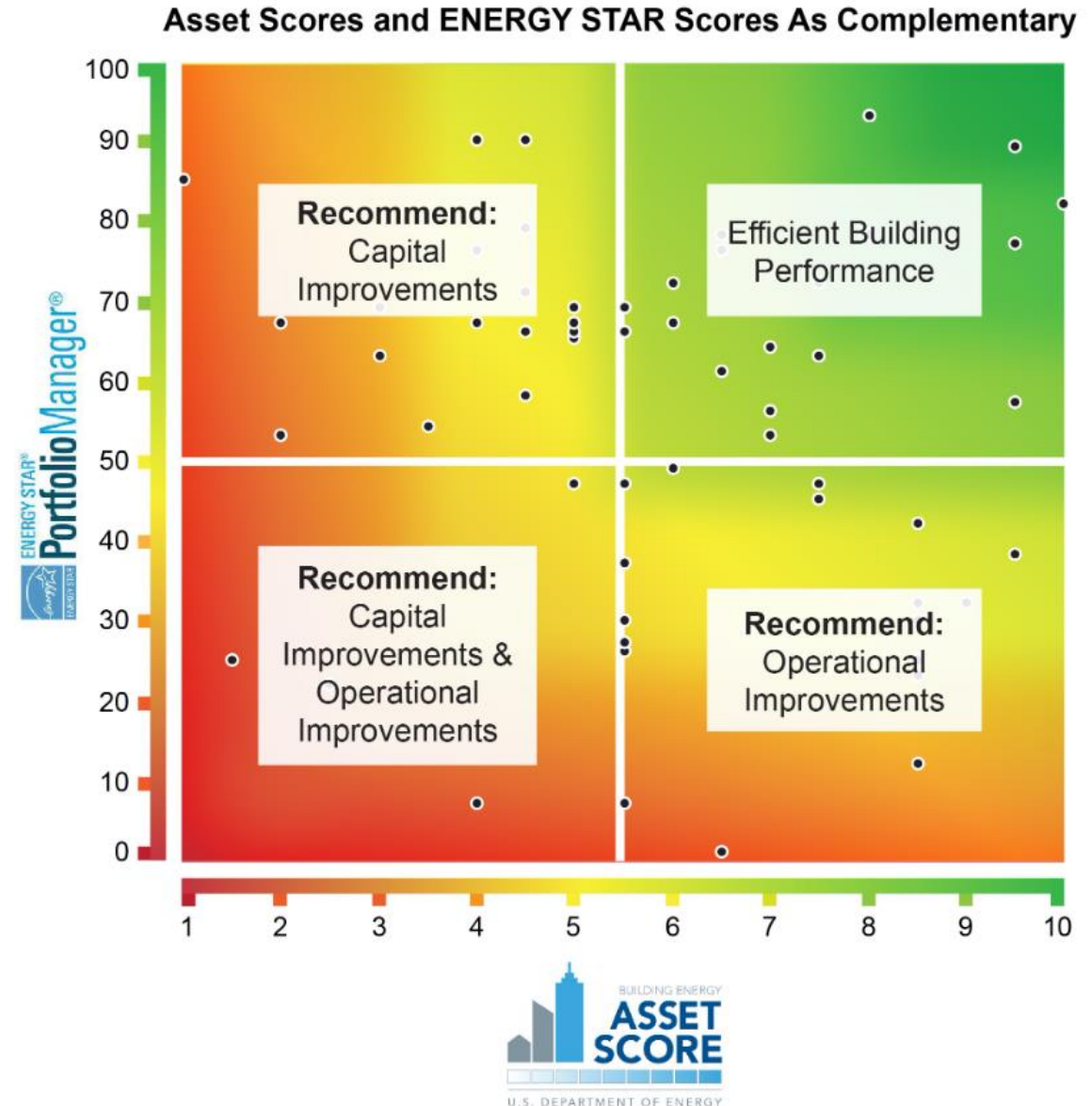
Understanding Different Types of Building Energy Assessments

Comparing Benchmarking to Other Forms of Assessment

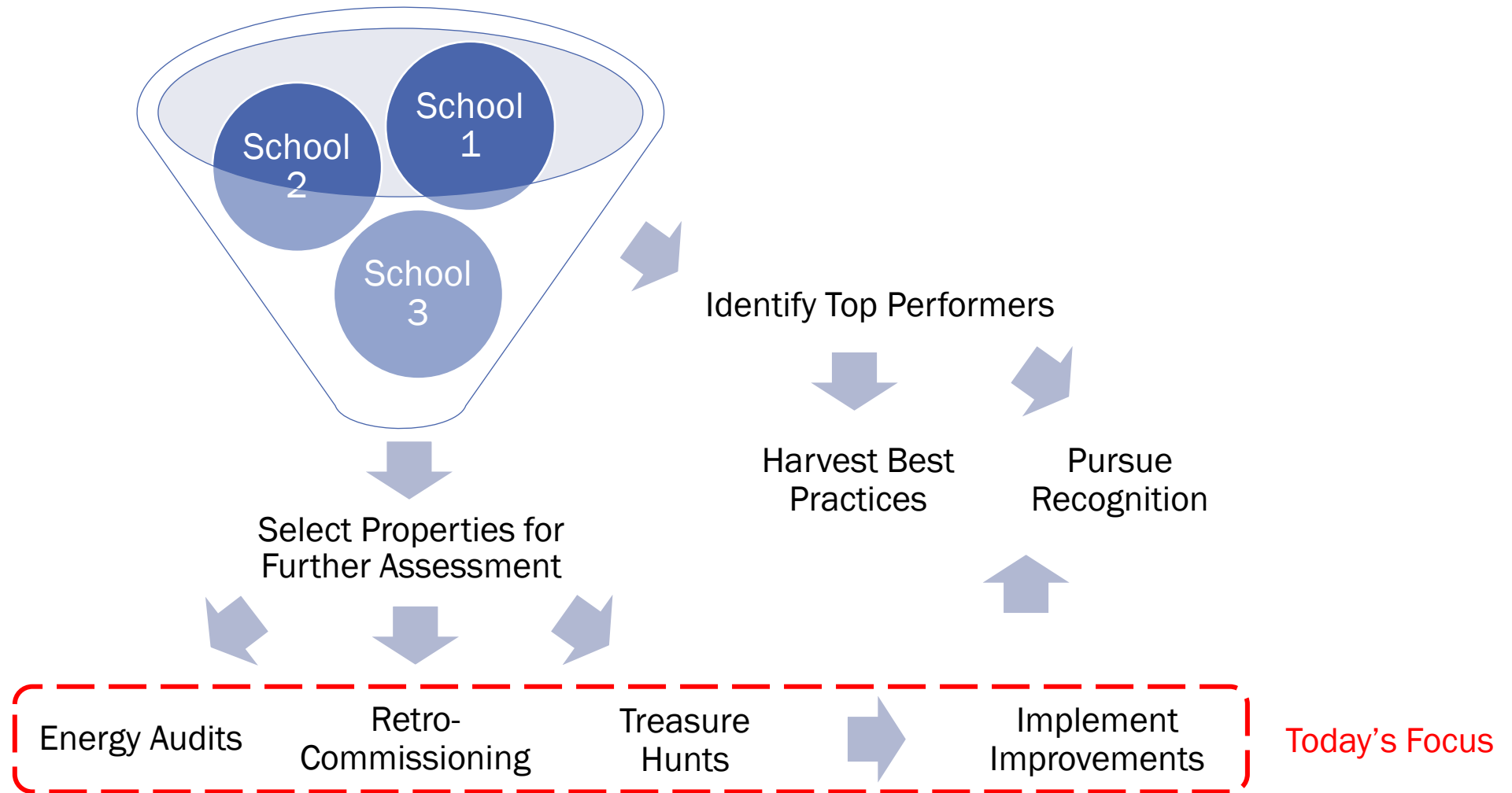
- Benchmarking is:
 - An important first step in the assessment of your building's energy requirements and opportunities for energy performance improvement.
 - Focused on how your building is performing compared to itself over time and/or compared to other similar buildings.
 - Doesn't tell you why your building is performing this way, nor what measures need to be implemented to achieve a specified level of energy performance.
 - Intended to be agnostic re: systems/equipment/technology.

Comparing Benchmarking to Other Forms of Assessment, cont'd.

- Portfolio Manager → how the building is actually performing based on energy consumption and basic operational attributes
- Building Energy Asset Score → how the building could/should perform based on design, construction, and energy systems



Benchmarking Informs Next Steps to Achieve Energy Performance Improvements



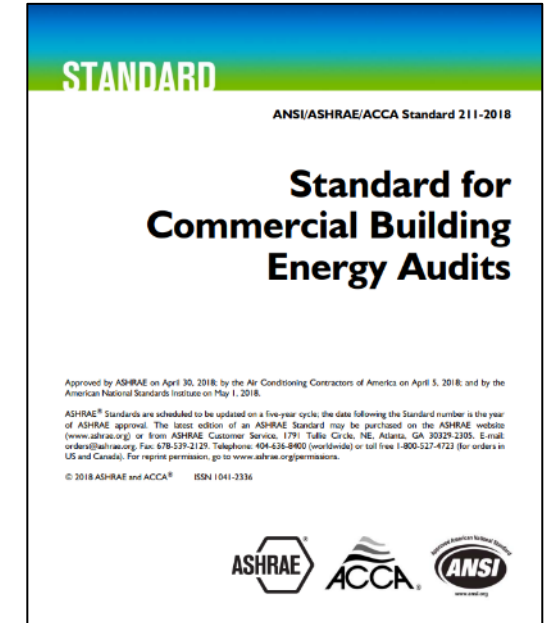
Different Assessment Types for Different Needs

- Audits
 - Document **where and how energy is being used within a property** (building systems as well as individual pieces of equipment).
 - Provide **recommendations for improvements/upgrades** (both O&M and capital projects), along with expected costs and benefits.
 - No guarantee that measures will be implemented.
- Commissioning / Re-commissioning / Retro-commissioning (RCx)
 - Documents the **extent to which the building is operating as intended**.
 - Generally **aligned with the identification of O&M measures** and other adjustments, which are implemented as part of the RCx process.
 - May also be referred to as “Tune-Ups”

Different Assessment Types for Different Needs, cont'd.

- Treasure Hunts
 - Collaborative effort to **identify and remedy sources of energy waste.**
 - Generally focused on no- and low-cost opportunities (but not exclusively).
 - **Promote the participation of a different groups**, including students and non-technical audiences, that may have valuable insight into building operations.

- Different “levels,” as defined by ASHRAE Standard 211-2018:
 - Level 1
 - Basic building walk-through
 - Interviews with building staff
 - Utility bill review
 - Level 2
 - Level 1 + detailed review of all building systems
 - Financial analysis of identified measures (including no-/low-cost and CapEx)
 - Level 3
 - “Investment-grade” analysis of expected costs and savings
 - Typically used as a “deeper dive” for larger measures uncovered by a Level 2 audit



- Level 1 Audit:
 - Review Historical Utility and Onsite Generation Data
 - Review Rate Structure
 - Facility Site Survey
 - Space Function Analysis
 - Identify Low-Cost and No-Cost Energy Efficiency Measures (EEM) Recommendations
 - Identify Potential EEM Capital Recommendations
 - Review EEMs with Owner's Representative

Source: https://ashrae.iwrapper.com/ASHRAE_PREVIEW_ONLY_STANDARDS/STD_211_2018_RA2023, sections 5.3 (procedure) and 6.1 (reporting)

- Level 2 Audit
 - Electric Cost Component Breakdown
 - Facility Site Survey (building upon the Level 1 survey)
 - Review of Current O&M Procedures
 - Determine Key Operating Parameters
 - Conduct End-Use Breakdown
 - Initial Measures List
 - Calculate Energy Savings
 - Estimate EEM Costs
 - Conduct Economic Analysis
 - Quality Assurance Review
 - Review EEMs with Owner's Representative

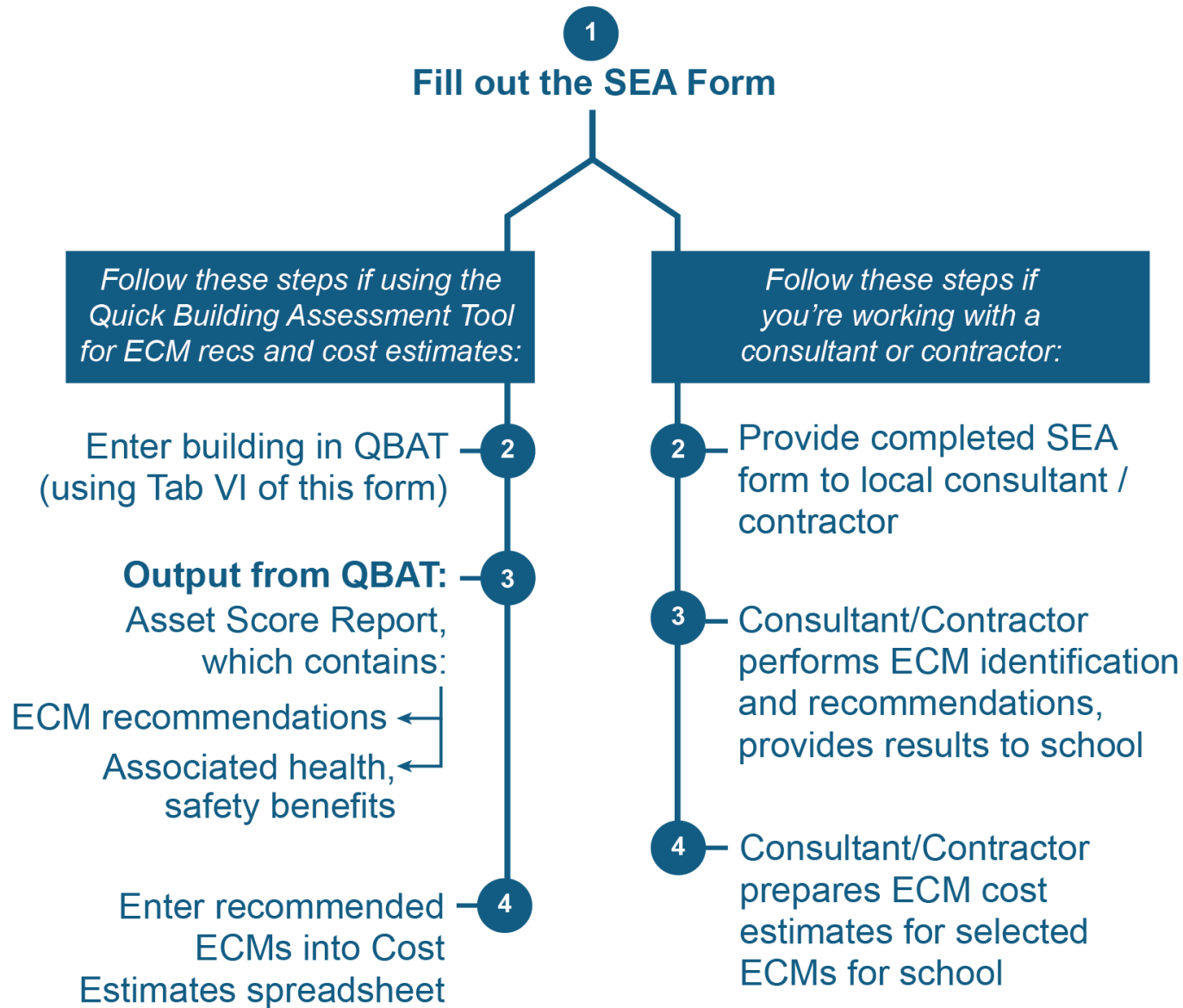
Source: https://ashrae.iwrapper.com/ASHRAE_PREVIEW_ONLY_STANDARDS/STD_211_2018_RA2023,
sections 5.4 (procedure) and 6.2 (reporting)

- Level 3 Audit
 - Determination of Recommended EEMs
 - Cost and Cost Savings of Recommended EEMs
 - Life-Cycle Cost Analysis
 - Risk Assessment
 - Review Recommendations with Owner's Representative

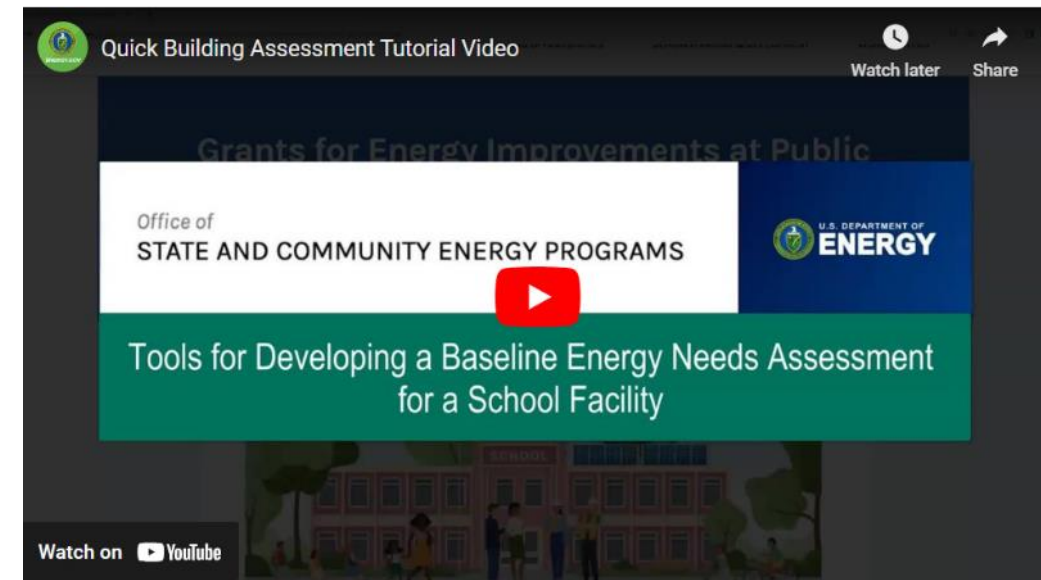
Source: https://ashrae.iwrapper.com/ASHRAE_PREVIEW_ONLY_STANDARDS/STD_211_2018_RA2023,
sections 5.5 (procedure) and 6.3 (reporting)

- DOE's School Energy Assessment (SEA) Form, in combination with the DOE [Quick Building Assessment Tool](#) (QBAT)
 - A “quick assessment capability for identification of energy improvement opportunities, recommendations for energy efficiency measures, and associated health and safety benefits.”
 - QBAT module located within the DOE [Building Energy Asset Score](#).
 - Can feed results into an Energy Conservation Measure (ECM) Cost Estimator tool.

SEA → QBAT → ECM Estimator Workflow



- [School Energy Assessment Form](#)
- [Asset Score Login](#)
- [Asset Score Documentation & Resources](#)
- [ECM Estimator Tool](#)



Commissioning / Re-commissioning / Retro-commissioning (RCx)

- Commissioning
 - “Process of ensuring that systems are designed, installed, functionally tested, and capable of being operated and maintained according to the owner’s operational needs.”
 - Typically associated with new building construction / major renovations.
- Retrocommissioning
 - Similar process, but for buildings that were never commissioned before entering into service.
- Recommissioning
 - Similar process, but for buildings that were commissioned.
 - Ideally scheduled every 3 – 5 years, but some organizations may opt for ongoing or “continuous” commissioning.

Source: https://www.energystar.gov/sites/default/files/buildings/tools/EPA_BUM_CH5_RetroComm.pdf

General Phases of RCx

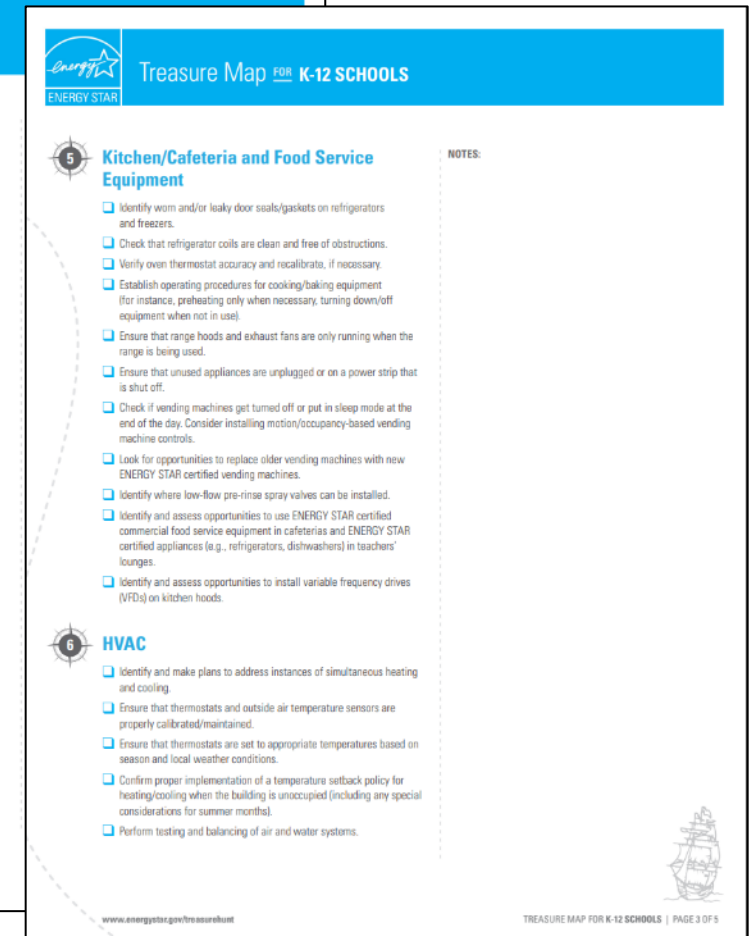
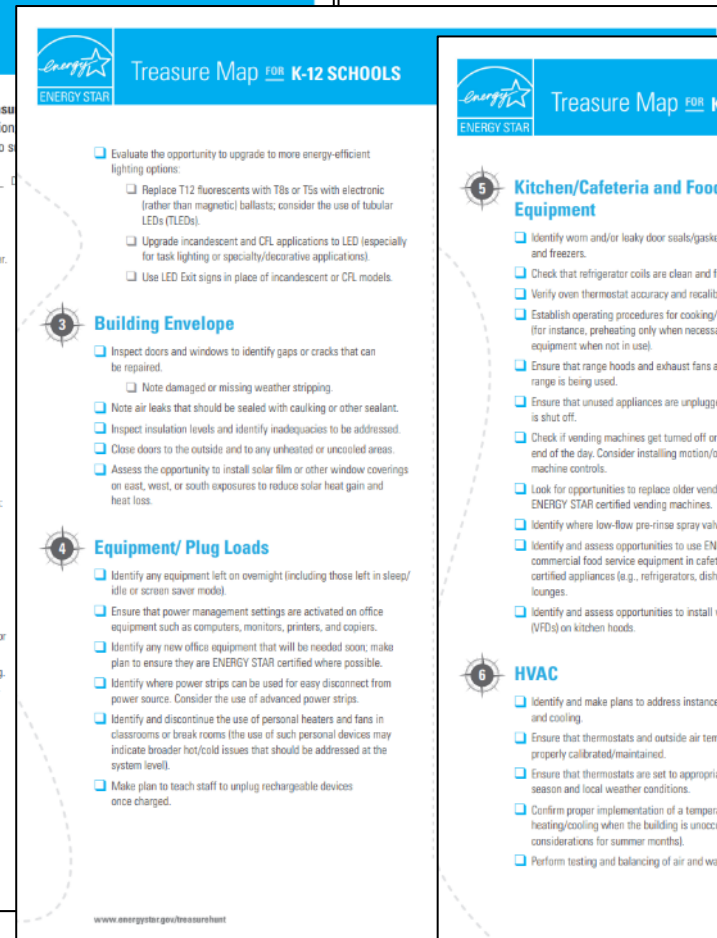
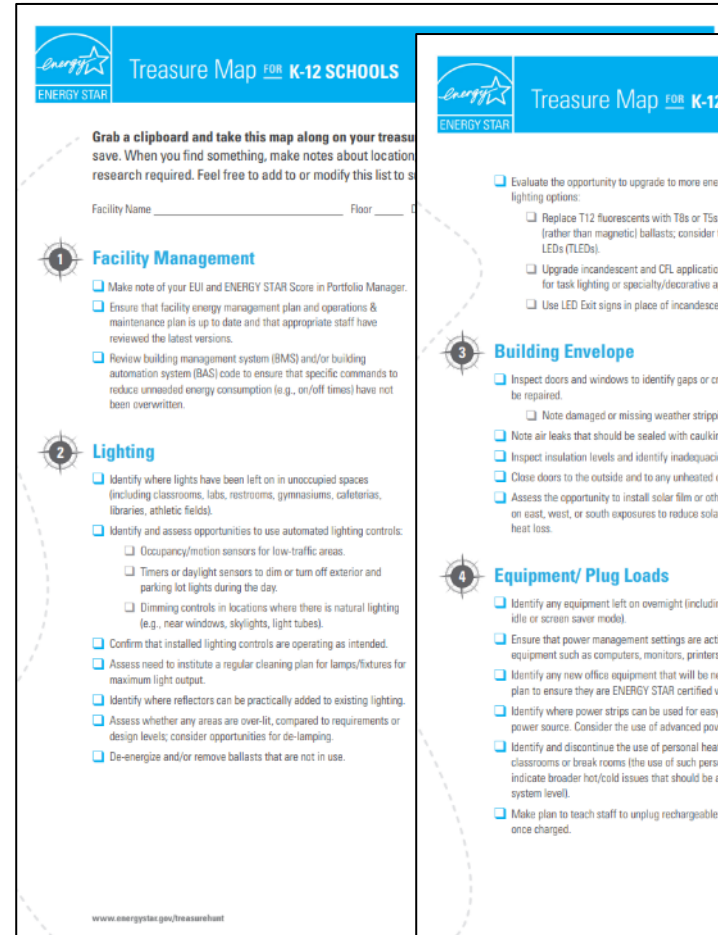
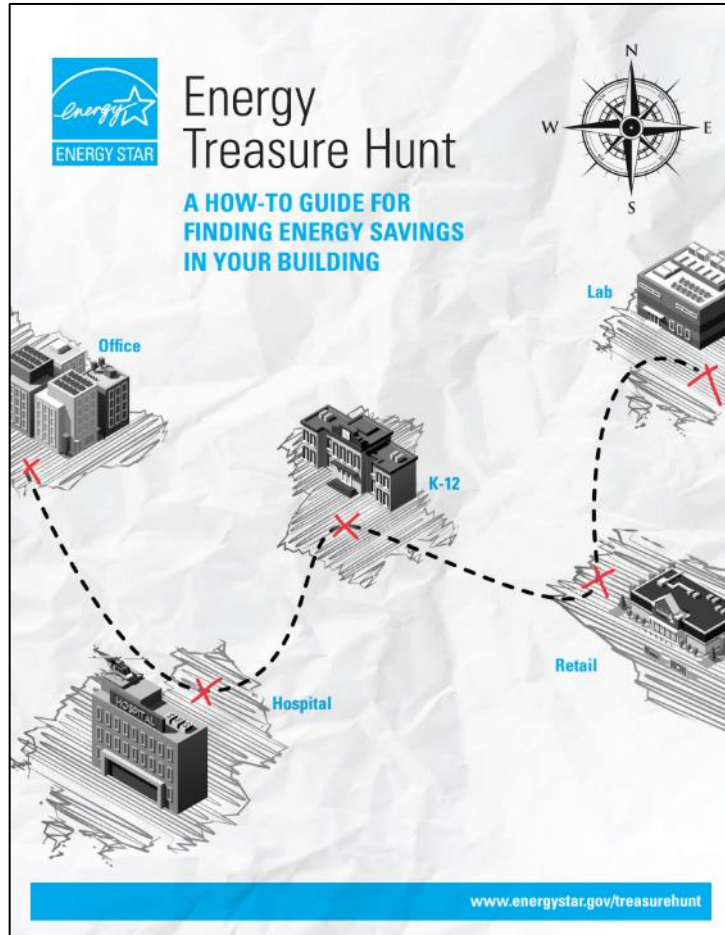
- Project Planning
 - Select property
 - Select a commissioning provider
 - Develop scope of work
- Project Execution
 - Conduct assessment
 - Implement recommendations (turnkey vs. hybrid vs. owner-led approach)
 - Verification of measures and savings
- Maintaining Performance
 - Training for relevant building staff
 - Review and update O&M / preventative maintenance plan

Source: https://www.energystar.gov/sites/default/files/buildings/tools/EPA_BUM_CH5_RetroComm.pdf

- A “collaborative quest” where a variety of organizational stakeholders – not just facilities staff! – play a role in finding opportunities for energy improvement.
- Goal is to “strike a positive, optimistic tone, focusing on outcomes and improving day-to-day operations.”
 - Identified measures are opportunities for improvement, as opposed to shortcomings or deficiencies.
- May involve outside expertise (e.g., consultants, contractors), but does not require these resources (as opposed to audits and RCx).

Treasure Hunts, cont'd.

- A wide variety of free resources are available via ENERGY STAR



Opportunities to “Share Your Treasure”



During an Energy Treasure Hunt, teams walk around

a facility looking for energy-saving opportunities. Those quick wins can add up. Hundreds of schools have participated in Energy Treasure Hunts, finding up to 15 energy-saving opportunities and saving the treasure.

Resources | Find the Treasure Campaign | What others have done | Share your treasure | Gúlas y mapas

Lewisville Independent School District

2021

Number of Treasure Hunts: 12

Average Size of Treasure Hunt Teams: 3

Top O+M Savings Opportunities Identified:

- Install vending machine misers
- VFD installation in kitchen hoods
- Unplugging microwaves
- Adding power strips
- Removing Christmas lights in classrooms
- Replaced dirty filters
- Boilers not following schedule

Potential Percentage Savings Identified from the Treasure Hunts: 0.1%, 0.2%, 0.2%, 0.3%, 0.4%, 0.4%, 0.5%, 0.6%, 0.9%

2020

Number of Treasure Hunts: 9

Average Size of Treasure Hunt Teams: 4

Top O+M Savings Opportunities Identified:

- Reversed chill water valve
- VFD installation in kitchen hoods
- Dirty air filters
- Supply fan motor manually on
- Christmas lights left on in two classrooms
- Install vending machine misers
- Replaced dirty AHU filters
- Indoor practice facilities controls installation
- Adding power strips to classrooms
- Retrofit lighting from fluorescent to LED
- Unplugging microwaves
- Replacing dirty filters
- Large area of school found running with no communication
- Exterior lighting controls update
- RTU not following schedule
- Projector lights found left on in classrooms
- AHU not responding to VFD
- IDF room setpoint adjustments

Potential Percentage Savings Identified from the Treasure Hunts: 0.2%, 0.4%, 0.6%, 1.1%, 2.1%, 2.3%, 2.4%, 3.2%, 6.3%



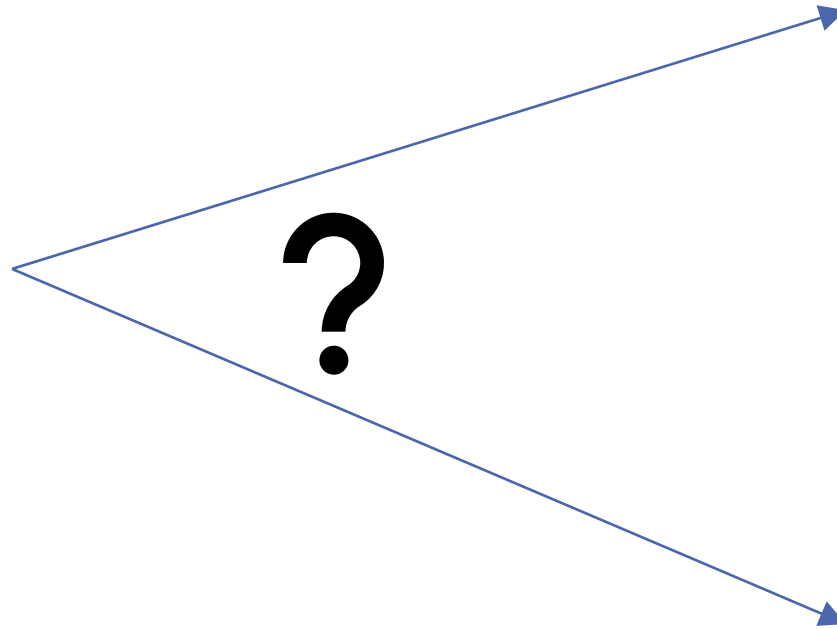
See: <https://www.energystar.gov/treasure-hunt-listing>

Polling Break

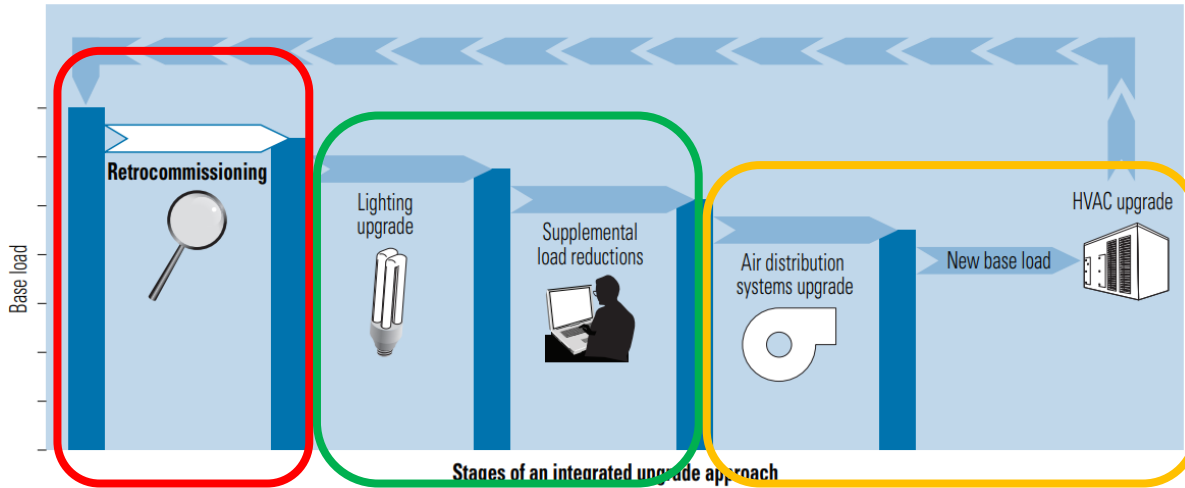
- Which of the preceding assessment activities have you carried out at schools in your District (select all that apply)?
 - 1) Energy audit (level 1, 2, or 3)
 - 2) Commissioning/re-commissioning/retro-commissioning
 - 3) DOE's Quick Building Assessment Tool
 - 4) Treasure hunt
 - 5) Other approach (please indicate)
 - 6) We have not implemented any school energy assessments

The Staged Approach to Building Upgrades

What Does This Symbol Mean To You?



The Staged Approach to Upgrades



Courtesy: E SOURCE



Source: DOE/NREL Advanced Energy Retrofit Guide: K-12 Schools,

<https://www.nrel.gov/docs/fy14osti/60913.pdf>

Source: ENERGY STAR Building Upgrade Manual,
https://www.energystar.gov/sites/default/files/buildings/tools/EPA BUM_CH1_Intro.pdf

The Importance of Staging/Sequencing Upgrades

- Systematic approach (consistent with a strategic, rather than piecemeal, approach to energy management).
- Each step builds on savings from prior steps.
- Accounts for interactive effects.
- Maximizes energy savings, minimizes unnecessary costs.
- Early wins make approval for subsequent measures more likely.

A Staged Approach May Not Always Be Possible

- Deferred maintenance items
- Emergency replacement
- COVID-driven focus on indoor air quality and HVAC systems
- You know your schools the best!

“Energy managers must tailor their plans to match the needs of the school, so the staged approach presented here may not always fit. Departing from the stages shown here may be necessary at times, to deal for example with financial constraints or school operations.”

[Advanced Energy Retrofit Guide – K-12 Schools](#) (pg. 52)

Polling Break

- Have you applied the staged approach to energy management at any of the schools in your District?
 - 1) Yes
 - 2) No
 - 3) We tried, but needed to deviate from the recommended sequence because *[please indicate]*
 - 4) I don't know

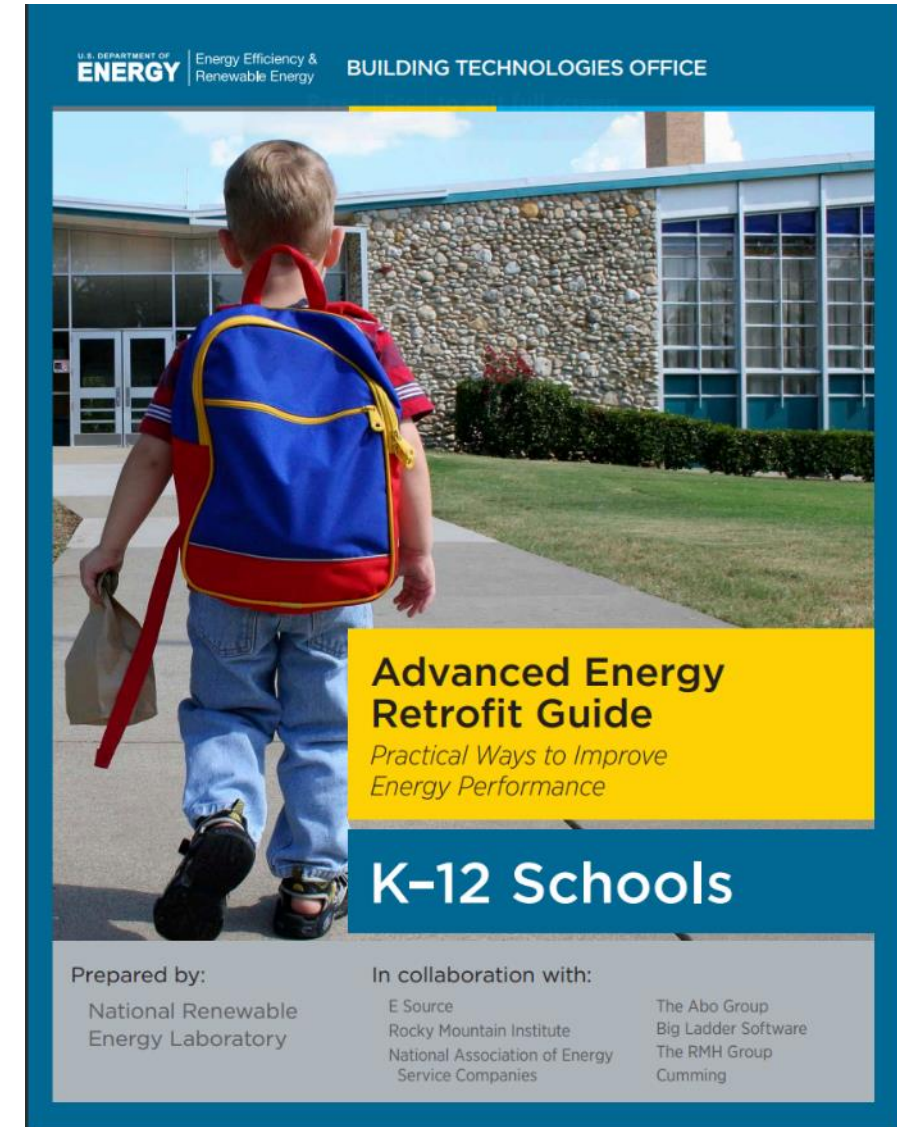
Identifying Common Building Energy Performance Improvements

Identifying Common EE Measures for Schools

- Review the Fundamental Building Science course for a system-by-system discussion, including common equipment types and common improvements.
- The most specific and relevant recommendations for your school are going to come from staff knowledge and onsite assessments.
- Today, we're focusing on resources that have already distilled best practices and likely measures.

Advanced Energy Retrofit Guide – K-12 Schools

- Extensive guide covering:
 - Planning
 - Existing Building Commissioning
 - Building Retrofits
 - Measurement & Verification
 - Operations & Maintenance
- Decision-aiding guidance re: types of assessments to perform
- Recommended EE measures and packages of measures



Better Buildings Low-Carbon Technology Strategies

- Resources for [Primary Schools](#) and [Secondary Schools](#)
- Recommendations broken out by Simple / Intermediate / Advanced
 - Lighting
 - Space Conditioning and Water Heating
 - Controls and Analytics
 - Building Envelopes
 - Plug and Process Loads
 - Renewables and Battery Storage



Low Carbon Technology Strategies

PRIMARY SCHOOL

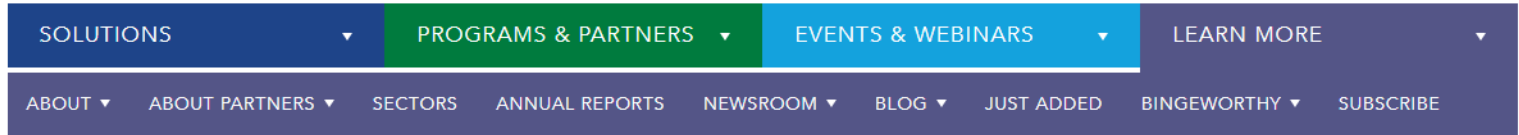
Driving our nation's buildings to low and zero carbon saves money, creates jobs, and leads to a healthier environment and more resilient economy. The table below includes steps that building owners and operators can implement to achieve smart, healthy, and low-carbon primary schools within their existing building portfolios. Primary schools often use packaged rooftop units for heating, cooling, and ventilation. Assess current conditions in your building against the simple, intermediate, and advanced options to begin planning your next steps to reduce carbon emissions. If you have a commercial kitchen, include [low carbon strategies for kitchens](#) (equipment, ventilation, refrigeration, and water heating).

Technology		Simple	Intermediate	Advanced
Lighting	Interior Lighting	<ul style="list-style-type: none"> Install Type B tubular TLEDs that meet DesignLights Consortium (DLC) technical requirements Reduce overlit spaces Install occupancy sensors or vacancy sensors 	<ul style="list-style-type: none"> Install dimmable LED retrofit kit or replace with LED fixture that meets DLC technical requirements Install daylighting controls and occupancy / vacancy sensors Integrate with building automation system (BAS) if possible 	<ul style="list-style-type: none"> Install retrofit kit or new luminaire with luminaire level lighting controls Include integrated daylight and occupancy sensor networked lighting controls that meet DLC requirements, load shed via Auto-DR interface, and integrate with BAS
	Exterior and Parking Lot Lighting	<ul style="list-style-type: none"> Install LED screw base replacement for HID lamps that meets DLC requirements Install photocell to control lighting 	<ul style="list-style-type: none"> Replace with area luminaires that meet DLC requirements Install time clock and reduce lighting at night 	<ul style="list-style-type: none"> Redesign using the Better Buildings Parking Lot specification and include video-based occupancy sensors
Space Conditioning and Water Heating	HVAC	<ul style="list-style-type: none"> Verify and repair dampers Test and seal ducts Install advanced RTU controls retrofit (variable speed supply fan, integrated air-side economizer, and RTU-level demand-controlled ventilation (DCV)) 	<ul style="list-style-type: none"> Replace equipment with right-sized, high-efficiency equipment (CEE Advanced Tier) Install air source heat pump RTUs, dual fuel RTUs, or variable refrigerant flow (VRF) systems Add energy recovery ventilators Implement air cleaning technology to reduce ventilation Install active thermal energy storage for load shifting and system optimization Add evaporative cooling in dry climate zones 	<ul style="list-style-type: none"> Install water source or ground source heat pumps Switch to radiant or chilled beam systems with a dedicated outdoor air system (DOAS) for ventilation Implement natural ventilation, controlled in coordination with mechanical ventilation
	Water Heating	<ul style="list-style-type: none"> Reduce water heating demand through various technologies like low-flow faucets and showerheads 	<ul style="list-style-type: none"> Install point-of-use electric water heaters for small, distributed loads Install high-efficiency, connected heat pump water heaters 	<ul style="list-style-type: none"> Install CO₂ air-to-water heat pumps
Controls and Analytics	Install or Upgrade Controls	<ul style="list-style-type: none"> Widen zone temperature dead band on existing thermostats Install wireless networked thermostats to centrally manage heating/cooling set points, setbacks, and schedules Implement building Re-tuning™ process Automatically shut off equipment (exhaust fans, room air cleaners, other loads) during unoccupied times 	<ul style="list-style-type: none"> Add controls to support holiday scheduling, optimal start, and additional monitoring points Reduce airflow to zones during unoccupied times with zone-level DCV Implement demand limiting RTU controls and continuous demand management 	<ul style="list-style-type: none"> Reduce airflow to zones during unoccupied times by integrating occupancy sensors from the lighting control system into the HVAC control system Implement controls that integrate building loads, thermal/battery storage, on-site co-generation plants, PV, and EV charging to provide demand flexibility (Market Brief)

- [K-12 Lighting Toolkit](#)
 - Webinars/Videos
 - Fact Sheets
 - Guidance
 - Reports
 - Case Studies
 - Specifications



SEARCH SOLUTIONS



K-12 LIGHTING TOOLKIT

K-12 schools can save up to 50% on energy use if they optimize their lighting equipment and operations.[1] School equipment replacement and operating costs drive the decision-making for infrastructure investments. Lighting is one of those investments where the ROI is attractive and visible, often the first step in major school energy efficiency upgrades. Nationally, schools have reduced lighting energy consumption by an average of 5% from 2003-2012 according to the Commercial Buildings Energy Consumption Surveys.[2] Many of these upgrades include lighting retrofits to highly-efficient light-emitting diode (LED) technology. There are additional energy and cost savings opportunities with new lighting technologies, controls, and design considerations.




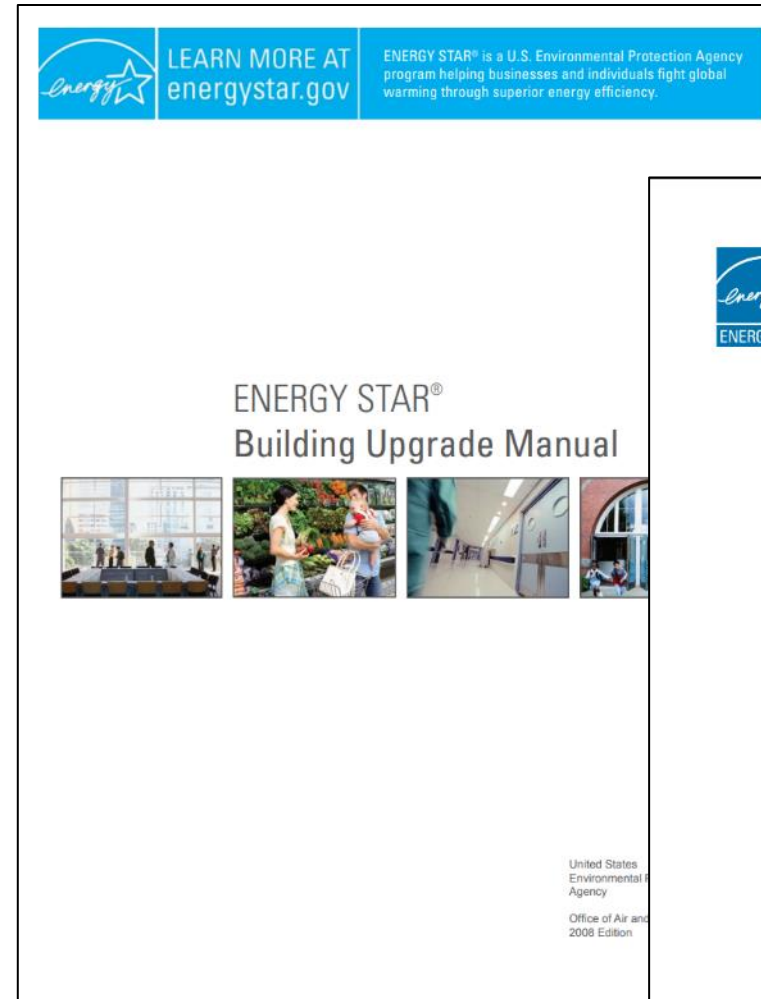
This toolkit covers a wide range of technical implementation details, case studies, specifications, and more on lighting technologies in K-12 schools. There are resources on new technologies for the classroom like tunable lighting and adaptive controls for parking lot lighting. Other resources cover various interior and exterior spaces like auditoriums, cafeterias, gymnasiums, and pedestrian walkways. Leveraging these outstanding results and strategies, the K-12 Lighting Toolkit provides some best practices for implementing energy-efficient lighting in schools.

Jump to: [Webinars/Videos](#) | [Fact Sheets](#) | [Guidance](#) | [Reports](#) | [Case Studies](#) | [Specifications](#)

DOE School Efficiency Enhancement Guides

- [School Building Management System Replacement Package](#)
- [School Boiler Replacement Package](#)
- [School Chiller Replacement Package](#)
- [School RTU Replacement Package](#)

- Built around the staged approach to energy management.
- Dedicated chapters for each defined stage (RCx, lighting, supplemental loads, air distribution, and heating/cooling), plus:
 - Chapters on investment analysis and financing
 - Dedicated chapter focused solely just K-12 schools



10. Facility Type: K-12 Schools

Revised November 2006

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ENERGY STAR Building Upgrade Manual

Other ENERGY STAR Resources

- ENERGY STAR Checklist of Energy-Saving Measures
- Broken out into lower-cost measures and rapid payback measures (where applicable)
 - Operations & Maintenance
 - Lighting
 - Plug Load: Office Equipment
 - Plug Load: Food Service Equipment
 - Heating and Cooling
 - Occupant Behavior and Education

CHECKLIST OF COMMON ENERGY-SAVING MEASURES

The simple choice for energy efficiency.



April 2021

Operations and Maintenance

Low-Cost Measures

- Conduct a nighttime audit to find out what's on afterhours that shouldn't be.
- Improve operations and maintenance practices by regularly checking and maintaining equipment to ensure that it's functioning efficiently.
- Optimize start-up time, power-down time, and equipment sequencing.
- Revise janitorial practices to reduce the hours that lights are turned on each day. Consider switching to day-cleaning, which takes place while occupants are in the building and has shown to also reduce complaints.
- Review and emphasize the financial and environmental results of a preventative maintenance program for major systems and components.
- Set goals and a methodology to track and reward improvements.
- Visually inspect insulation on all piping, ducting and equipment for damage (tears, compression, stains, etc.).
- Ask your utility if they offer free or inexpensive energy audits.
- Retro or re-commission the building to make sure it's running the way it was intended.
- Consider energy audits to identify areas where building systems have become inefficient over time and bring them back to peak performance.
- Repair leaking faucets and equipment. A dripping hot water faucet can leak hundreds of gallons per year.

Lighting

Low-Cost Measures

- Maximize daylighting. After all, sunlight is free! Open or close blinds to make the best use of natural daylight and take advantage of skylights or other natural daylight sources to reduce lighting during daytime hours.
- Turn off lights when not in use or when natural daylight is sufficient. This can reduce lighting expenses by 10 to 40 percent.
- Use task lighting where feasible.
- Implement a regular lighting maintenance program.
- Remove unnecessary lamps (de-lamp) in overlit areas. Check your light levels against standards from the Illuminating Engineering Society (IES) to see if you have areas that are over- or under-lit.

Rapid Payback Measures

- Replace old fluorescent and incandescent lighting with ENERGY STAR certified LEDs, T-8 (or even T-5) fixtures, ENERGY STAR certified LEDs, and other energy-efficient lighting systems that improve light quality and reduce heat gain. LEDs use up to 90% less energy than incandescent lighting and last 35 to 50 times longer.
- Install LED exit signs. These signs can dramatically reduce maintenance by eliminating the need to replace lamps and can save \$10 per sign annually in electricity costs.

ENERGY STAR® is the simple choice for energy efficiency. For more than 20 years, EPA's ENERGY STAR program has been America's resource for saving energy and protecting the environment. Join the millions making a difference at energystar.gov.

Polling Break

- What sources of guidance have been most useful to your District in identifying specific energy performance improvements for implementation at your school (select all that apply)?
 - 1) DOE
 - 2) ENERGY STAR
 - 3) Local utility
 - 4) Local government entities (town/city, county, regional)
 - 5) State energy office
 - 6) Third party contractors/consultants
 - 7) Other (please identify)

Finding Expert Help

- ENERGY STAR Partner organizations that assist owners and operators of commercial buildings to benchmark, improve performance, and earn recognition
- Partnership based on demonstrated experience benchmarking customer buildings in Portfolio Manager and/or helping buildings to earn the ENERGY STAR certification.
- Search for [all ENERGY STAR SPP Partners](#)
- Identify the [Most Active SPP Partners](#) (based on benchmarking/certification counts)
- Identify those [partners using the Portfolio Manager web services API](#) to exchange data with customers' buildings

Energy Service Companies (ESCOs)

- Turnkey solution (planning, financing, installation, measurement).
- Energy savings performance contracts (ESPC) may provide a solution when capital funds are not available, and/or when other financing options (debt, bond issuance) are not options.
- Typically suited for larger, more complex (multi-measure, multi-system) projects.
- See DOE/ORNL's [Energy Savings Performance Contracting: A Primer for K-12 Schools](#)

Reach Out to Your Utility

- Utility energy efficiency / demand side management programs often include incentives and/or cost-sharing opportunities for:
 - Technical assistance (e.g., engineering studies)
 - Energy assessments (audits, retro-commissioning)
 - Audits may include requirements for measure implementation (e.g., utility cost share dependent on customer implementing all measures with payback under X years)
 - Energy retrofit projects
 - Prescriptive
 - Custom
- Utility programs frequently depend on networks of pre-approved trade allies who will be able to carry out the work.
- When in doubt, don't hesitate to reach out to your utility account manager!

Polling Break

- Do you have experience with any of these expert resources (select all that apply)?
 - 1) ENERGY STAR Service and Product Providers
 - 2) Energy service companies (ESCOs)
 - 3) Utility-provided technical assistance
 - 4) Other (please identify)

Questions?

We look forward to working with you!

