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Energy Efficiency Financing Foundations

Training for Public Sector Facilities Managers and Finance Officers

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Module 1

Understanding Your Building Assets and Investment Needs

Learning Objectives

1. Terminology	• Energy conservation measures (ECMs) • Energy efficiency (EE) end uses
2. When and Why	• How do EE projects differ from other capital projects? • When is the best time to implement an EE project? • What factors might impact EE project implementation?
3. What to Include	• What are the typical elements of an EE project? • How can you identify energy-saving opportunities in your building and portfolio?

Terminology

Energy Conservation Measures

- ECMs or measures

Definition:
Building upgrades impacting total energy usage.

Building Components

Building Equipment

Common Items in an Energy Efficiency Project Scope

Heating, Ventilation, and Air Conditioning (HVAC)

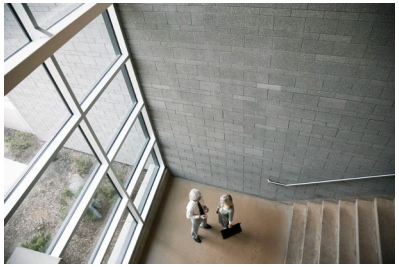
Water Heating

Refrigeration

Lighting

Controls

Plug Loads

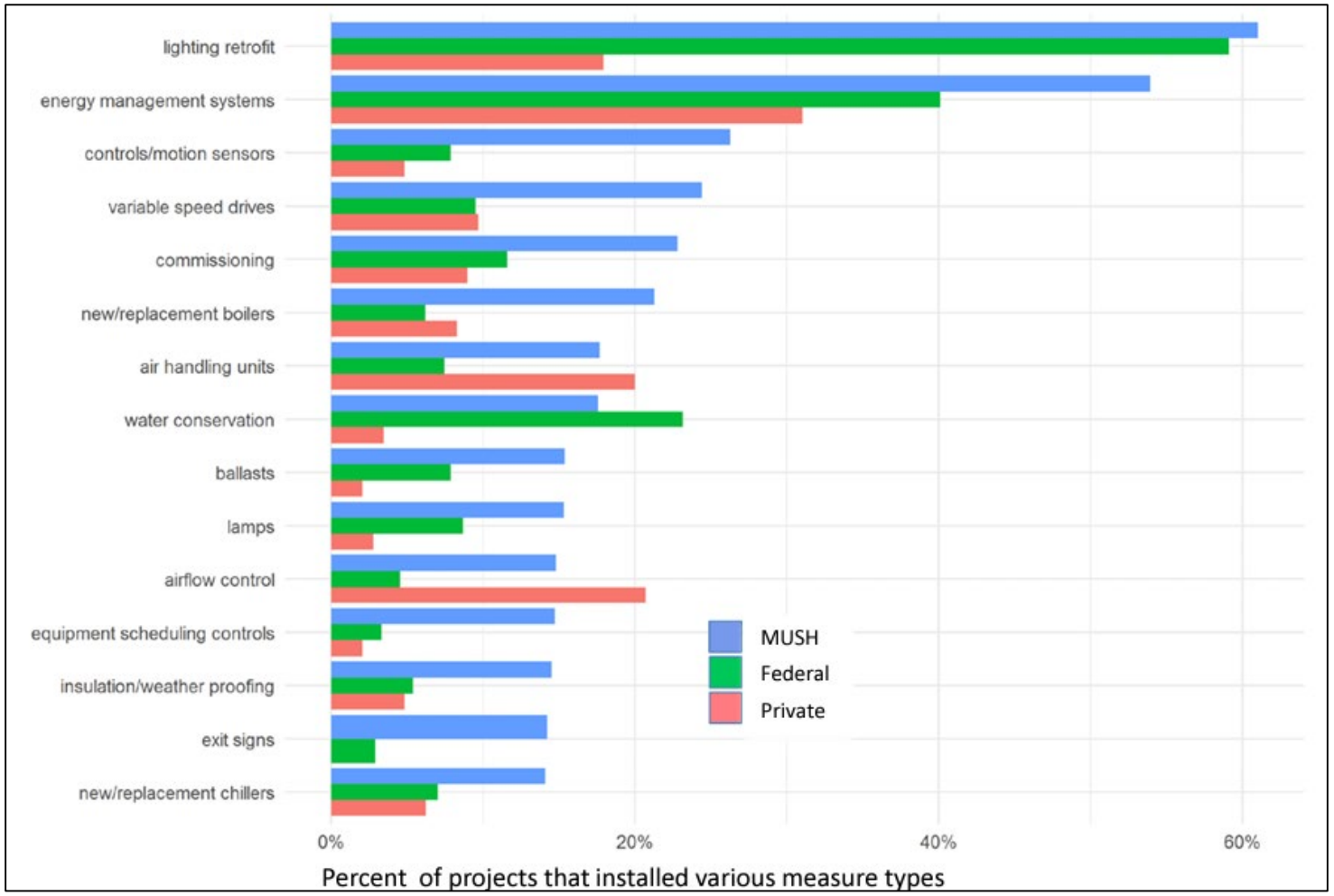


Building Shell*

* e.g., windows, insulation, air sealing

Stock images from Microsoft PowerPoint

ECMs in the MUSH*, Federal, and Private Sectors



*Municipalities, universities, schools, and hospitals

Source: Lawrence Berkeley National Laboratory/National Association of Energy Service Companies project database

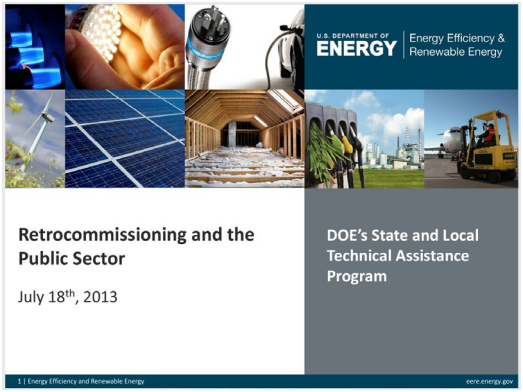
Retrocommissioning
(A Different Type of Energy-Saving Project)

A holistic analysis of building performance.

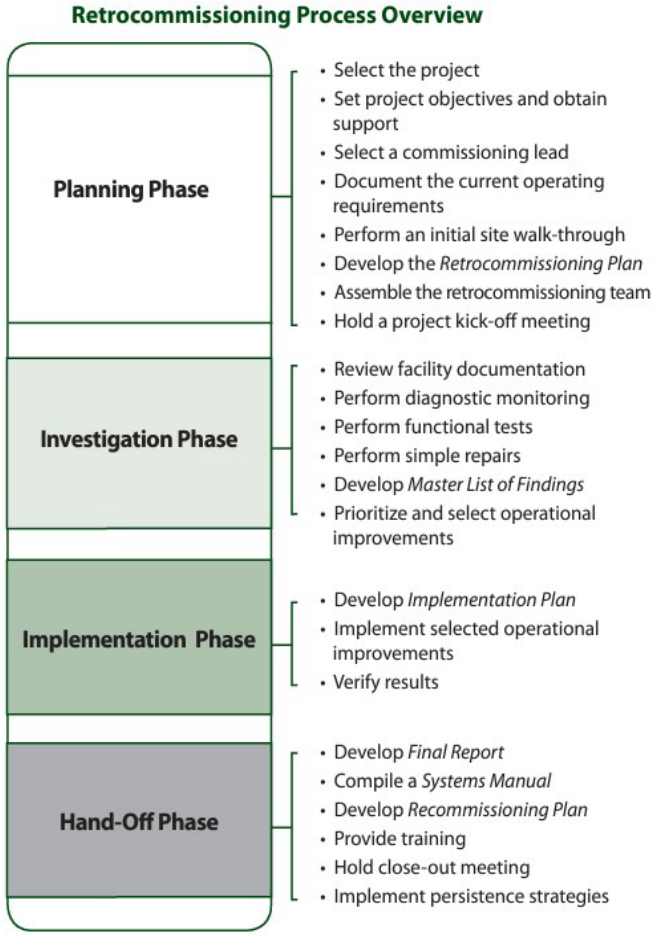
Retrocommissioning may include adjusting:
- Building operations and schedules
- Equipment condition and performance
- System operating schedules
- System interactions that may impact functional performance

Typical adjustments:
- Adding and adjusting controls
- HVAC and other equipment maintenance and tune-ups

End goal: Optimize overall building energy usage and performance.



Source: U.S. Department of Energy, "Retrocommissioning and the Public Sector"



Source: Lawrence Berkely National Lab, "Building Commissioning"

Non-Energy Upgrades

EE projects may also require non-energy upgrades (e.g., asbestos remediation).

- **Challenge:** can add complexity and cost; may be ineligible for discounted energy-related financing.
- **Opportunity:** may provide motivation for energy-related upgrades; some energy financing products allow a portion of the capital to be used for non-energy upgrades, especially to address health and safety issues.

2021 International Energy Conservation Code (IECC)

CHAPTER 5 [CE] EXISTING BUILDINGS

C501.3 Maintenance.

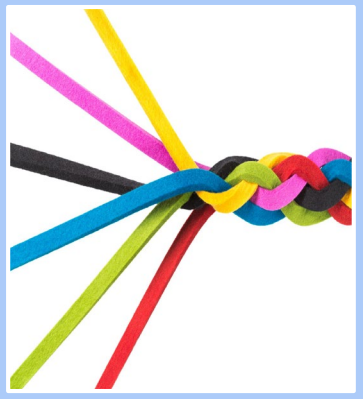
Buildings and structures, and parts thereof, shall be maintained in a safe and sanitary condition. Devices and systems required by this code shall be maintained in conformance to the code edition under which they were installed. The owner or the owner's authorized agent shall be responsible for the maintenance of buildings and structures. The requirements of this chapter shall not provide the basis for removal or abrogation of energy conservation, fire protection and safety systems and devices in existing structures.

Source: International Code Council, 2021 International Energy Conservation Code (IECC)

EE Projects: When and Why

Reactive Project Motivations:

- End of useful life
- Equipment failure
- Savings come from installing a more efficient measure than the standard baseline replacement measure
- Alternatively, savings from standard baseline measure compared with repairing old equipment to extend beyond expected useful life



Proactive Project Motivations:

- High efficiency gains/high returns compared to existing equipment
- Low replacement/installation costs for new equipment
- High repair costs for existing equipment
- Improved non-energy benefits (comfort, air quality, health and safety, etc.)
- Reduced maintenance

Images from Microsoft PowerPoint

Identifying EE Investment Needs

Images from Microsoft PowerPoint

Professional Energy Audit

- Use qualified third-party professionals.
- Identify energy- and cost-saving potential.
- Follow standard industry protocols.

https://www.ashrae.org/technical-resources/bookstore/procedures-for-commercial-building-energy-audits

In-House Audit

- Self-identify EE upgrade opportunities.
- See the Energy Treasure Hunt.

https://www.energystar.gov/industrial_plants/treasure_hunt

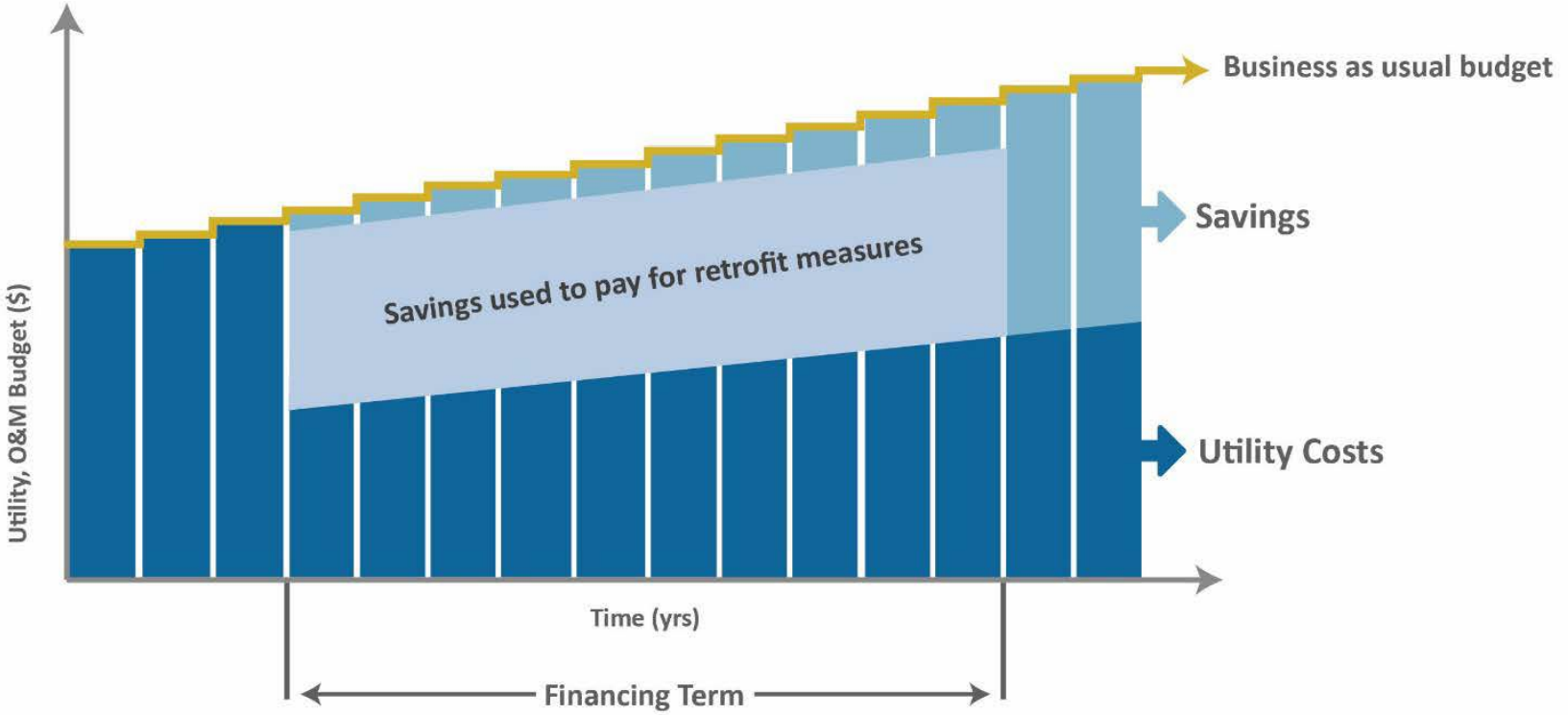
Energy Benchmarking

- Compare usage to other buildings.
- See ENERGY STAR® Portfolio Manager.

https://portfoliomanager.energystar.gov

What Is Different About EE vs. Other Capital Projects?

Financing EE can potentially have a positive budgetary impact if savings exceed financing costs.



Source: U.S. Department of Energy, "Energy Savings Performance Contracting: A Primer for K-12 Schools"

Hypothetical Retrofit Example

Two proposed measures: lighting and HVAC.

- Given a payback period threshold of 5 years, only the lighting would be included.
- But imagine the project is financed using a 20-year loan with a 5% interest rate. Including the HVAC results in:
  - Additional $2,081 of budget savings every year, from the very beginning.
  - Additional NPV of $26,271, a 28% increase overall.

Interest Rate	5.0%						
Term (Years)	20						
Measure	Incremental Cost*	EUL**	Incremental Annual Savings	Incremental Annual Payment	Annual Budget Impact	Payback Period (Years)	Net Present Value
Lighting	$60,000	10	$15,000	($4,752)	$10,248	4	$92,572
HVAC	$100,000	20	$10,000	($7,919)	$2,081	10	$26,271

*"Incremental" = as compared to the less efficient alternative replacement.
** "EUL" = estimated useful life. NPV assumes a lighting replacement at year 10.

Contextual Factors Can Influence Whether and When to Move Forward With EE Projects

Usage

- Primary usage of building
- Safety issues
- Construction impact on usage

Timing

- Proactive vs. reactive
- Timing of grants and other funding opportunities

Prioritization

- Building age
- Building condition and level of deferred maintenance

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Examples of EE Projects In Public Buildings

Example: Lighting and Retrocommissioning
Columbia, Missouri Health and Human Services Building

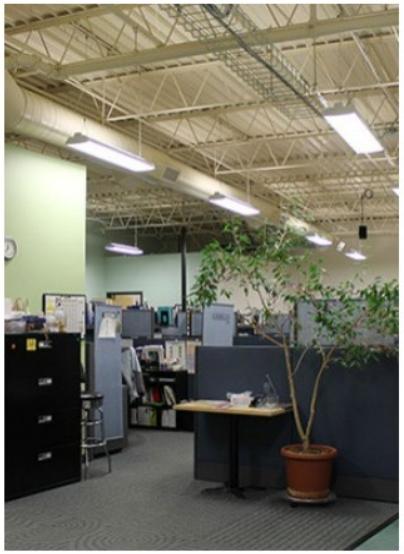
ECMs:

- Retro-commissioning of HVAC systems
- Lighting fixtures
- Daylighting

Benefits:

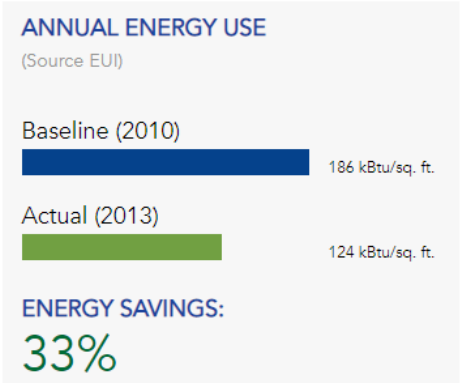
- Reduced energy usage and cost
- Improved comfort
- Reduced frequency of lighting maintenance

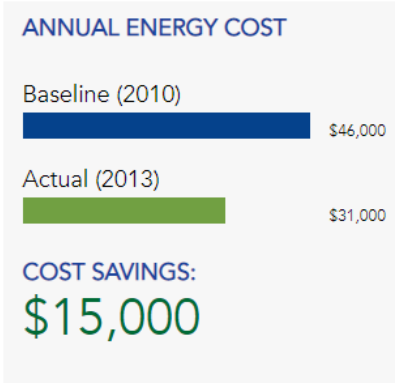
Photos from U.S. Department of Energy



Energy-efficient fixtures in office area.

Entryway lights off due to daylighting.





Source: U.S. Department of Energy, Better Buildings Solution Center

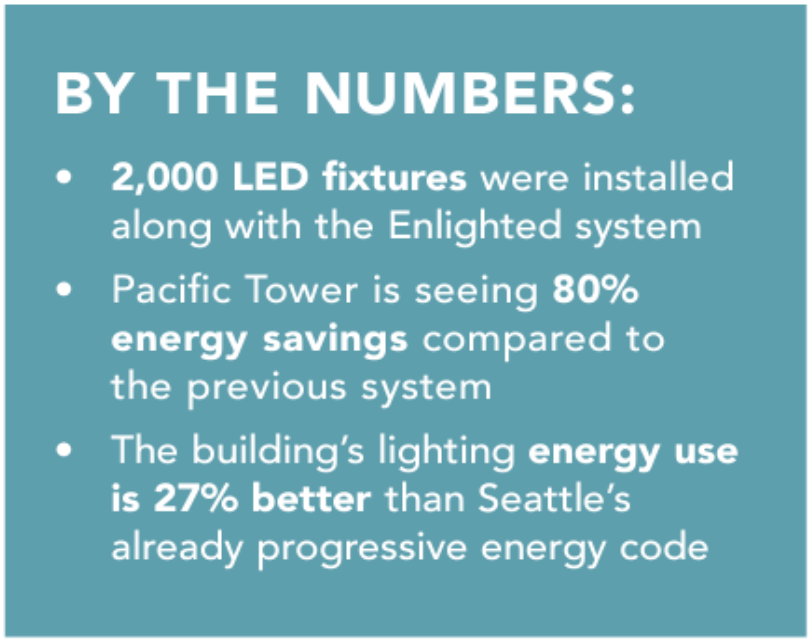
Example: Lighting and Integrated Controls
Washington State Department of Commerce

ECMs:

- Light-emitting diode (LED) fixtures
- Occupancy sensors
- Integrated lighting and HVAC controls.

Benefits:

- Reduced energy usage and cost
- Comfort (temperature controls; lighting quality controls)



Source: Northwest Energy Efficiency Alliance (NEEA), "Lighting Case Study"

Example: Efficiency's Impact on Energy System Costs
Hospital in Nashville, Tennessee

ECMs:

- Mix of measures reducing annual electricity usage by 20%

Benefits:

- Cost savings on electricity usage
- Cost savings on sizing of backup microgrid

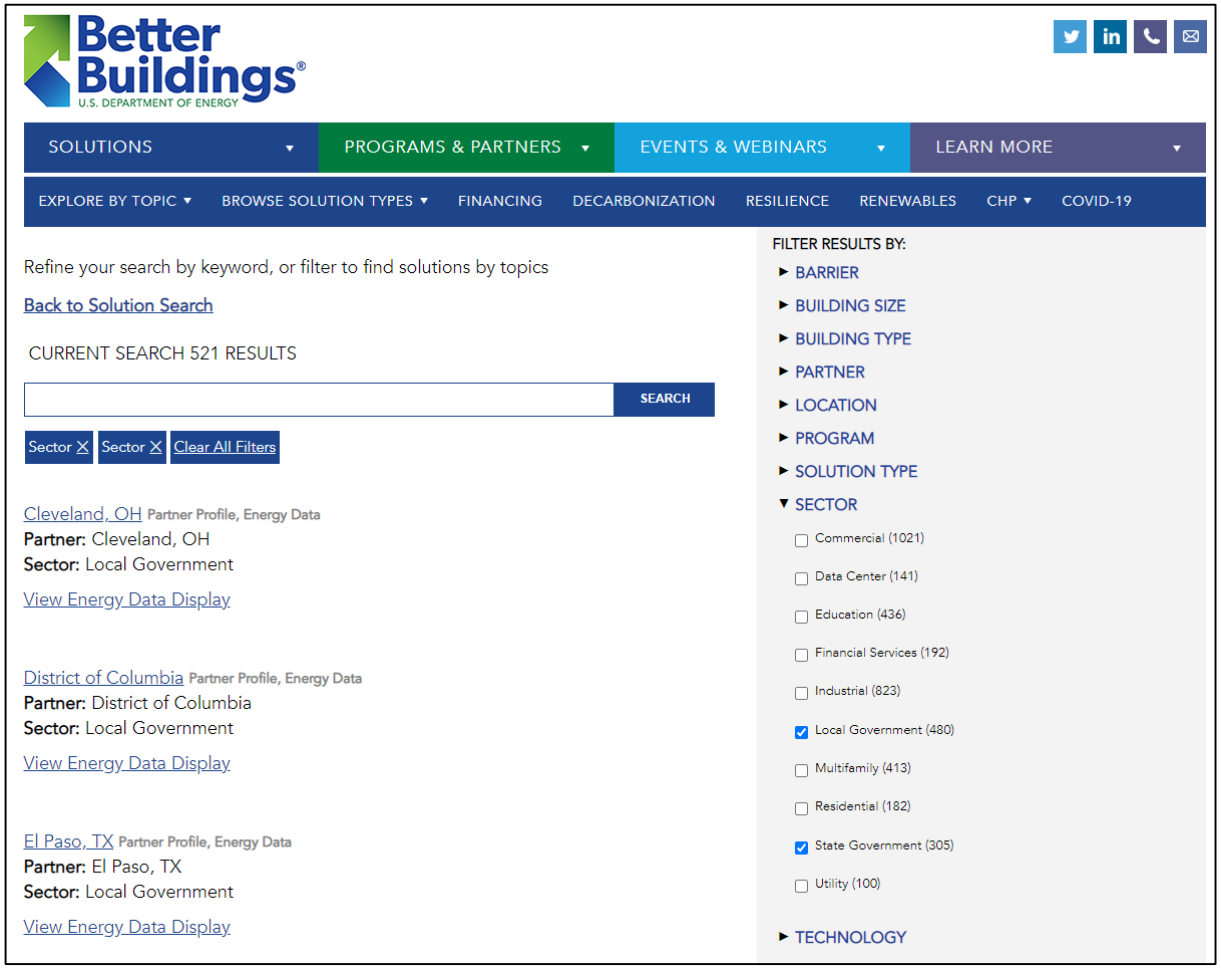
Hospitals are high-priority sites for ensuring a resilient power source is available during an outage. In this example, a hospital would reduce its investment cost by nearly $2 million by pursuing energy efficiency measures to achieve 20% energy savings before sizing its microgrid to run critical loads during a 48-hour grid outage.

Electricity Use Scenario	Solar Generation Capacity	Battery Storage Capacity	System Cost[16]
Baseline Annual Usage: 8.9 million kWh	*4,065 kW*	*6,944 kWh*	*$9,308,000*
20% Energy Savings: 7.1 million kWh	*3,252 kW*	*5,555 kWh*	*$7,446,000*

Graphic from U.S. Department of Energy (with additional examples)

Install EE measures → Reduce annual electricity usage and cost → Reduce sizing and system cost for backup microgrid

More Examples: Better Buildings Solution Center



Source: U.S. Department of Energy, Better Buildings Solution Center

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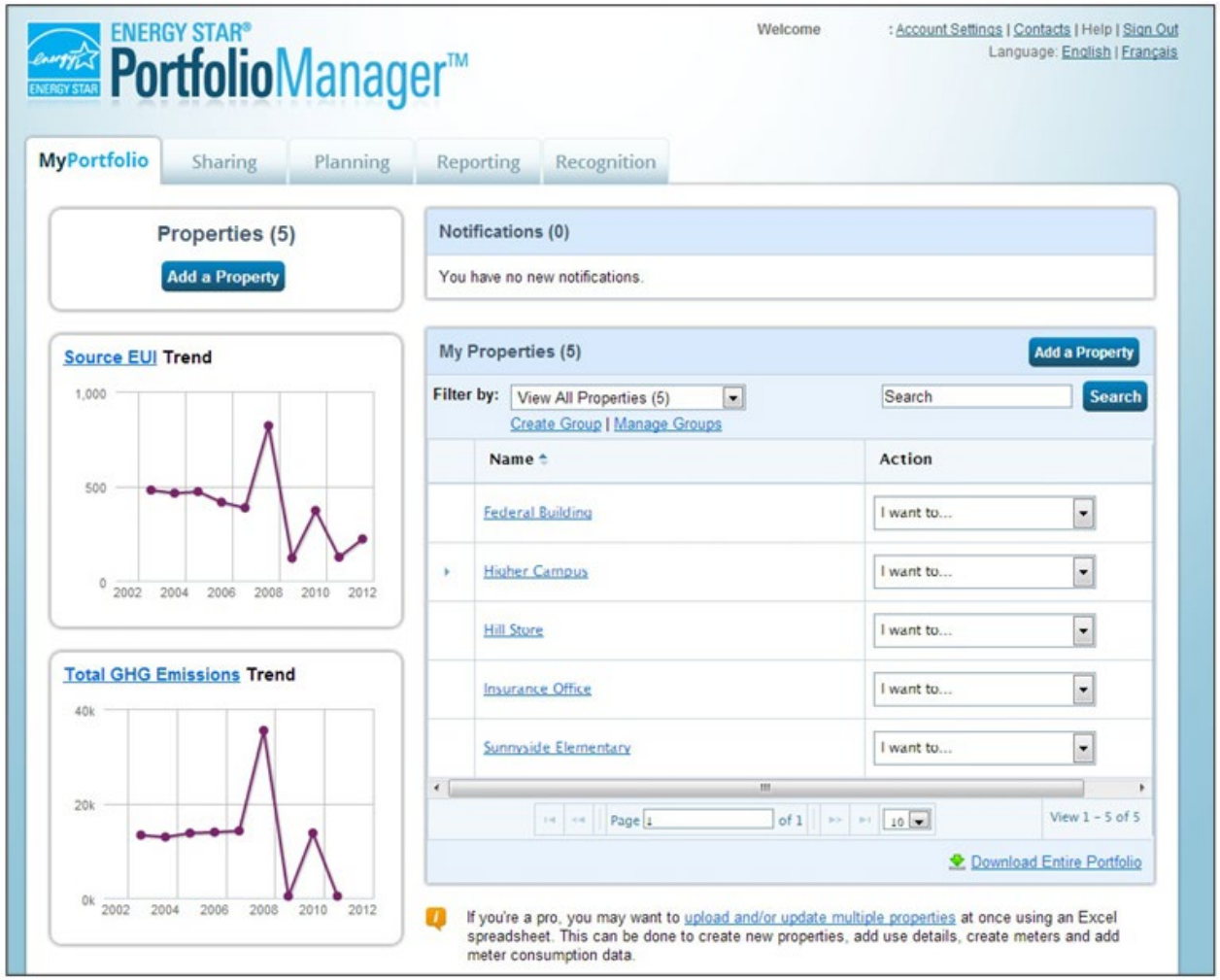
Building Energy Assessment Tools

Resources: ENERGY STAR Portfolio Manager

- Compare your building's energy to similar buildings, past consumption, or a reference performance level.
- Identify underperforming buildings to target for efficiency improvements.
- Share and report performance.



Source: ENERGY STAR Portfolio Manager

Public Service Property Types in Portfolio Manager

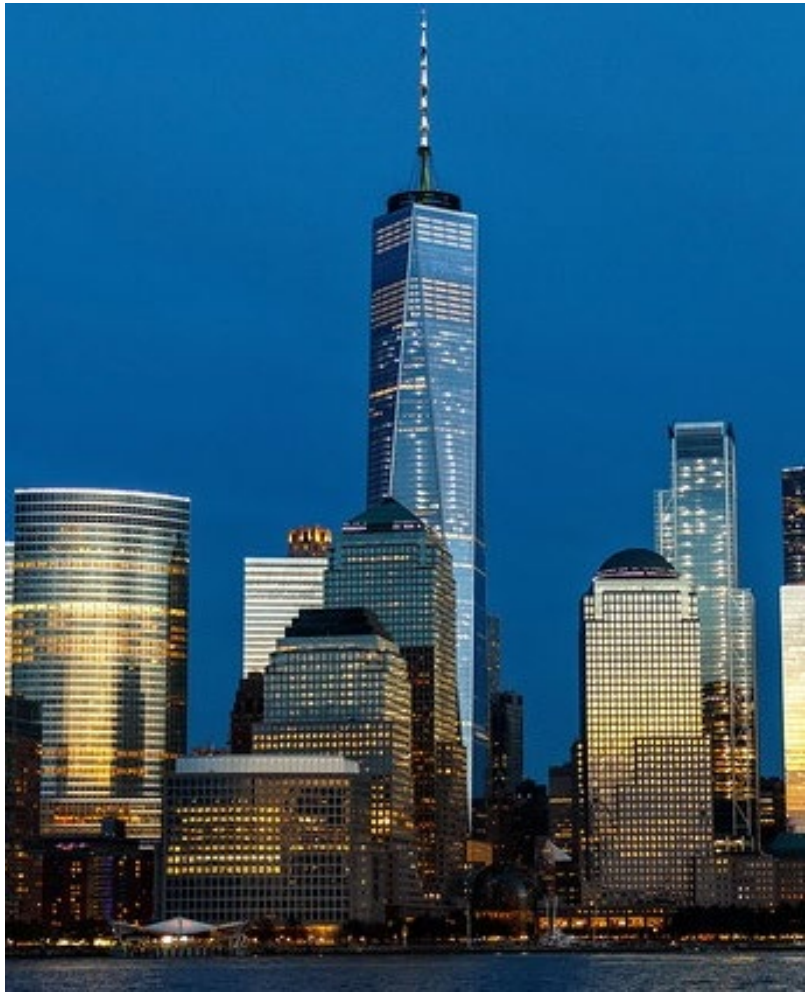
Courthouse	Drinking Water Treatment and Distribution	Fire Station	Library
Mailing Center/Post Office	Police Station	Prison/Incarceration	Social/Meeting Hall
Transportation Terminal/Station	Wastewater Treatment Plant	Other: Public Service	

Source: ENERGY STAR Portfolio Manager, "U.S. Property Types, Definitions, and Use Details"

Resources: The Building Efficiency Targeting Tool for Energy Retrofits (BETTER)

BETTER is a software toolkit that enables building operators to quickly and easily **identify the most cost-saving EE measures** in buildings and portfolios using **readily available building and energy data**.

- With utility billing data and basic building information, BETTER conducts an inverse modeling analysis effort to identify energy savings opportunities.
- Uncovers simple no- or low-cost measures to immediately cut energy costs 5–10% portfolio-wide.
- Identifies buildings ready to achieve net zero energy.

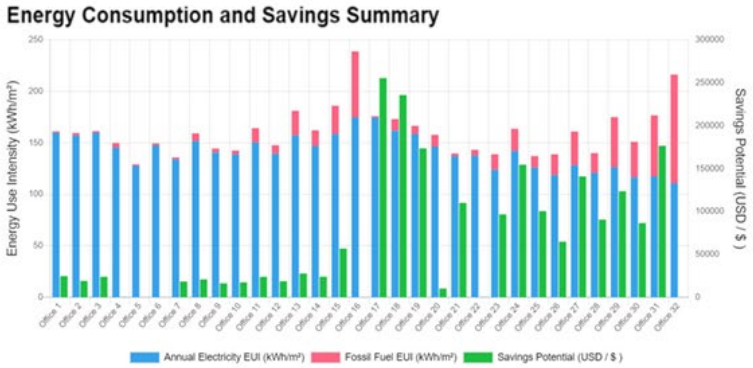


Source: https://better.lbl.gov/

BETTER: Additional Insights

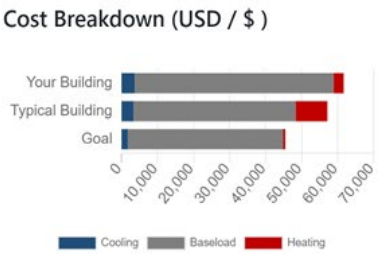
Portfolio Analysis

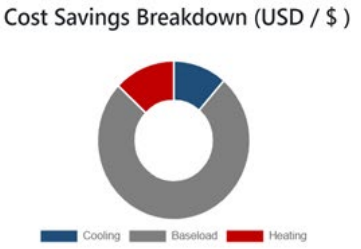
- Compare and rank buildings across a portfolio according to annual electricity and fossil EUI and annual cost savings potential.
- Buildings with high cost savings potential are good candidates for audits and further analysis.
- Buildings with high fossil EUI represent opportunities for electrification and decarbonization.



Utility Cost & Savings Breakdowns

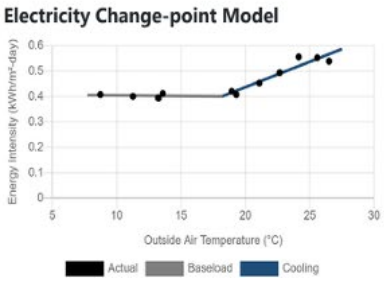
- Assess the breakdown of annual utility costs and potential savings by load type (e.g., cooling, baseload, and heating).
- Prioritize the highest cost-saving energy efficiency improvements in a building.

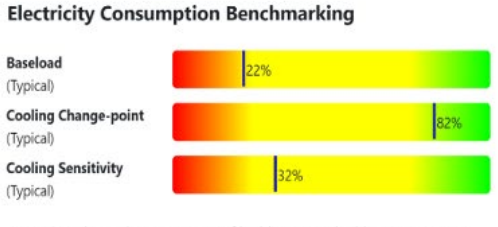




Change-Point Models & Benchmarking

- Investigate electricity and fossil fuel change-point models.
- See how model coefficients benchmark against peers to further evaluate energy savings.

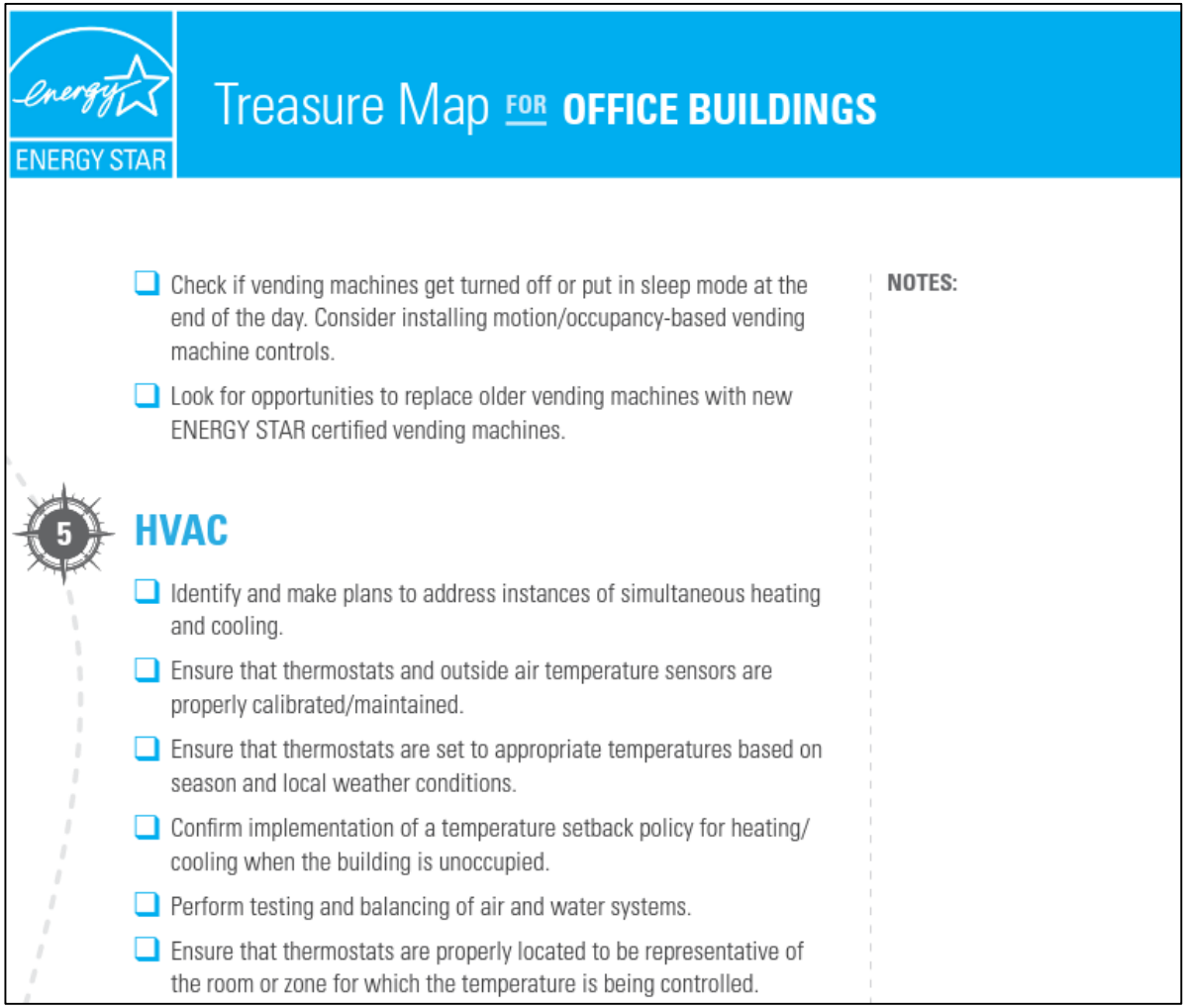




Source: U.S. Department of Energy, "Building Efficiency Targeting Tool for Energy Retrofits (BETTER)"

Resources: Energy Treasure Hunt

- In-house identification of energy savings opportunities.
- Includes general building occupants along with facilities staff and outside experts.
- Culminates in presentation to management and a plan and timeline for implementation.



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Treasure Map FOR OFFICE BUILDINGS

- ❑ Check if vending machines get turned off or put in sleep mode at the end of the day. Consider installing motion/occupancy-based vending machine controls.
- ❑ Look for opportunities to replace older vending machines with new ENERGY STAR certified vending machines.

NOTES:

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HVAC

- ❑ Identify and make plans to address instances of simultaneous heating and cooling.
- ❑ Ensure that thermostats and outside air temperature sensors are properly calibrated/maintained.
- ❑ Ensure that thermostats are set to appropriate temperatures based on season and local weather conditions.
- ❑ Confirm implementation of a temperature setback policy for heating/cooling when the building is unoccupied.
- ❑ Perform testing and balancing of air and water systems.
- ❑ Ensure that thermostats are properly located to be representative of the room or zone for which the temperature is being controlled.

Source: ENERGY STAR Treasure Hunt

Resources: "Achieving Energy Savings in Small- and Medium-Sized Public Facilities: A Strategic Approach to Prioritizing and Financing"

A strategic, step-by-step approach to financing building energy upgrades:*

Step 1: Energy Assessments	Step 2: Energy Audits	Step 3: Building Upgrades
Purpose: Obtain actionable information. Understand energy usage patterns across a portfolio of buildings and benchmark performance against similar buildings.	**Purpose:** Obtain information that can support a financial investment. Identify building components with most opportunity for energy savings.	**Purpose:** Execute building upgrades to capture energy savings, improve comfort, etc.
Scope: All buildings and facilities in your portfolio.	**Scope:** Only facilities with the highest potential for energy savings based on Step 1 results.	**Scope:** Targeted buildings and building components based on Step 2 results (i.e., audit).
Confidence in Energy Savings: Low confidence.	**Confidence in Energy Savings:** Medium confidence based on results of energy assessments (Step 1).	**Confidence in Energy Savings:** High confidence based on results of energy audits (Step 2).
Cost: No or low cost supported with staff and available energy usage data.	**Cost:** Low to high cost depending on the scope of the energy audit.	**Cost:** Higher costs that vary depending on project scope, technology, etc.
Financing Options: Not applicable.	**Financing Options:** ESPCs, Utility- and State-Supported Programs, Internal Funding.	**Financing Options:** Internal Funding, Leases, Loans, ESPCs, Bonds, ESAs.
Outcome: A reduced set of buildings meriting further exploration through an energy audit.	**Outcome:** A specific set of energy conservation measures and projected energy savings.	**Outcome:** Energy and cost savings, improved building performance and comfort.

*ESPC: Energy Savings Performance Contract; ESA: Energy Service Agreement

Source: U.S. Department of Energy, "Achieving Energy Savings in Small- and Medium-Sized Public Facilities"

Additional Resources

- Database of State Incentives for Renewables and Efficiency
  https://www.dsireusa.org
- Energy Data Management Guide
  https://www.eere.energy.gov/energydataguide
- Building Energy Asset Score
  https://www.energy.gov/eere/buildings/building-energy-asset-score
- A Guide to Energy Audits
  https://www.pnnl.gov/publications/guide-energy-audits
- Achieving Energy Savings in Small- and Medium-Sized Public Facilities
  https://www.energy.gov/sites/default/files/2021-05/Achieving-Energy-Savings-Small-and-Med-Public%20Facilities.pdf
- Energy Savings Performance Contracting for Small Projects
  https://www.energy.gov/sites/default/files/2021-10/ESPC-Small-Projects.pdf
- How-To Resource Summaries for Financing Efficiency Upgrades in Small and Medium Public Facilities: Internal Budget Process, Leasing, and Internal Revolving Loan Funds (Forthcoming)

Glossary

- Benchmarking: Measuring and comparing the energy consumption of a building to some alternative, such as energy usage in other similar buildings, the building's own past consumption, or a given standard of energy performance.
- Building Shell: Components of a building that separate the indoor space from the outdoors, including walls, roofs, foundations, windows, doors, and protruding ducts. Also referred to as building envelope. Related ECMs may include insulation, air sealing, duct sealing, and window replacement.
- ECMs: Energy conservation measures. These are building upgrades impacting total energy usage. Often referred to simply as measures
- MUSH: Municipalities, universities, schools, and hospitals. Also includes state-owned buildings. Sometimes used interchangeably with publicly owned buildings
- Retrocommissioning: Analyzing a building's operations and functional performance, often resulting in adjustments such as equipment maintenance and tune-ups, as well as installing or modifying building controls, to optimize the building's overall energy usage.

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