The CRM's Guide to the Engineer's Energy Toolkit

Department of Defense
Legacy Program

Executive Summary

Cultural Resource Managers (CRMs) have the difficult task of blending historic preservation with installation development and sustainability. A component of installation development is upholding federal initiatives and service policies regarding energy efficiency. The CRM Guide to the Engineer's Energy Toolkit has been prepared to provide CRMs with the tools to answer preservation challenges he/she may encounter in meeting preservation needs and installation goals when dealing with upgrading a building's energy efficiency. By understanding the terminology used by engineers and the available options for evaluating a building's energy efficiency, a CRM can request certain types of studies or audits to be performed on a historic building. Understanding these studies and audits allows for better communication between the CRM and installation engineers, as well as the State Historic Preservation Office (SHPO) and consulting parties. While the focus of this guide is to assist CRMs, it should be utilized by any personnel involved in the maintenance and treatment of historic buildings on an installation.

Table of Contents

Introduction - goals, project processes, and methodologies.

Historic resources and sustainability initially seem to be opposing ideas. As such, historic buildings are often considered to be old, moldy structures with little insulation, drafty windows, inefficient heating and cooling, and possibly hazardous wiring. Initiatives by the Department of Defense (DoD) have forced the discussion of these two issues because of requirements associated with the increased sustainability goals within the military. Making a historic building energy efficient, though, requires modifications and improvements to either the interior, exterior or in some cases both, which in turn can cause adverse impacts to the historically or architecturally significant elements of the structure. These elements are identified as a result of following 36 CFR part 800, Section 106 of the National Historic Preservation Act (NHPA), as amended which states that "all Federal agencies must take into account the effects of their undertakings on historic properties. The Section 106 process seeks to accommodate historic preservation concerns with the needs of Federal undertakings through consultation among the agency official and other parties with an interest in the effects of the undertaking on historic properties, commencing at the early stages of project planning. The goal of consultation is to identify historic properties potentially affected by the undertaking, assess its effects and seek ways to avoid, minimize or mitigate any adverse effects on historic properties." Addressing these modifications/improvements follows a specific process, triggered by "DD Form 1391" to submit requirements and justification to Congress to support funding requests for military construction.

Green Building Certification.

Initially, the DoD sought to attain silver, gold, or platinum Leadership in Energy and Environmental Design (LEED) certification. LEED certification was a voluntary program that verified a building's sustainability through a third party. Participation in the program was voluntary, and a project needed to earn a minimum of 40 points on a 110-point LEED rating system. Under the LEED certification program, points were earned based on sustainability, water efficiency, energy performance, use of sustainable materials, and indoor environmental quality. Bonus points could be earned by neighborhoods and homes, and all buildings were eligible for bonus points under innovative design and regional environmental priorities. However, a balance must be struck between LEED certification and historic preservation.

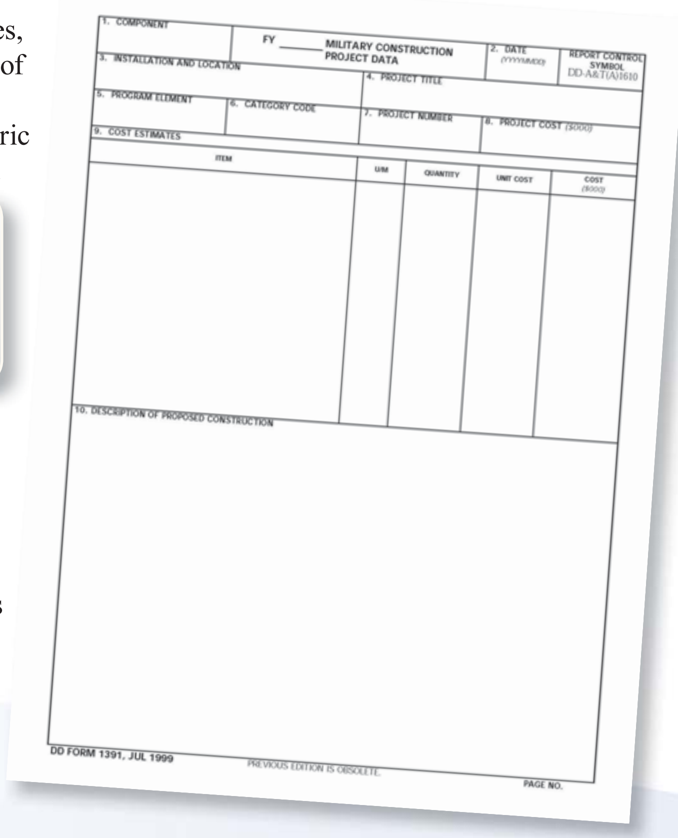
Coordinating historic preservation and sustainability can be a difficult process that initially seems to be complex and guaranteed to stall a proposed project. This is not necessarily true. So long as there is consultation between CRMs, facilities managers and SHPO, most issues can be resolved in such a way as to be mutually beneficial to all parties. Combining the processes associated with Section 106 and DD Form 1391, including the appropriate consultation with regulatory agencies and public parties, does not need to impact a project if planned accordingly. The goal of this guidebook is to provide the CRM with an understanding of an engineer's tools and vocabulary to better communicate about historic buildings on a military installation and during SHPO consultation.

> Early coordination efforts between the CRMs, facilities managers, and the SHPO means that a broad range of alternatives can be considered which will lead to efficient project planning, budgeting, and scheduling.

This guidebook has been prepared as a primary tool to assist with communication between CRMs and the appropriate building management personnel in understanding the terminology associated with energy audits (EA). Individuals who could benefit from this toolkit could include but are not restricted to facilities managers, base/installation engineers, Directorate of Public Works (DPW), and Naval Facilities Engineering Command (NAVFAC). In addition, this toolkit provides a brief discussion on previous energy studies. This guidebook will answer the following questions:

- What is an energy audit?
- How often are energy audits conducted and by whom?
- What systems and building elements are examined and how?
- How are the results reported? How do personnel interpret the results?

> The DD Form 1391 should provide detailed, informative statements as to why the project is needed and must identify each primary and supporting facility required to complete the construction project and the unit of measure, unit quantity, and unit cost for each facility. This form requires that the military installation requesting funds (stated in Block 9 on the DD Form 1391) to consider LEED and EPA 2005 compliance costs. The proposed budget should include the necessary budget needed to make the proposed modifications (if affecting an National Register of Historic Places [NRHP] building) as energy efficient as possible within a 15-year payback for the added cost. The military base CRM should request to review the bases upcoming Fiscal Year (FY) construction plans to prepare well in advance what projects would involve modifications to historic structures.



1. COMPONENT | FY ______ MILITARY CONSTRUCTION PROJECT DATA | 2. DATE (YYYYMMDD) | REPORT CONTROL SYMBOL DD-A&T(A)1610

3. INSTALLATION AND LOCATION | 4. PROJECT TITLE

5. PROGRAM ELEMENT | 6. CATEGORY CODE | 7. PROJECT NUMBER | 8. PROJECT COST ($000)

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)

10. DESCRIPTION OF PROPOSED CONSTRUCTION

DD FORM 1391, JUL 1999 PREVIOUS EDITION IS OBSOLETE. PAGE NO.

- What are the variables that can affect results (how subjective are the variables)?
- What are likely points of contention with the SHPO on audit recommendations?
- What alternatives can be discussed to find common ground for energy and preservation?

Understanding this information will allow CRMs to more effectively communicate preservation requirements and needs within the process of altering and improving a building for energy efficiency or LEED certification, in the hopes of cutting down on miscommunication, project delays, and funding problems.

Acronyms

ACHP	Advisory Council on Historic Preservation
AHU	Air Handling Units
ASHP	Air-source heat pump
ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers
BAS	Building Automation System
Btu	British Thermal Unit
CFL	Compact Fluorescent Lamp
CO2	Carbon Dioxide
CBECS	Commercial Buildings Energy Consumption Survey
CRM	Cultural Resource Manager
DPW	Directorate of Public Works
DoD	Department of Defense
DoE	Department of Energy
EA	Energy Audit
EEM	Energy Efficiency Measure
EM	Energy Modeling
EMS	Energy Management System
EPA	Environmental Protection Agency
FC	foot-candles
FY	Fiscal Year
gpf	Gallons per flush
gpm	Gallons per minute
GHG	Green House Gas
GSHP	Ground-source heat pump
HET	High-efficiency toilets
HVAC	Heating, Ventilation, and Air-Conditioning
kgal	Thousand gallons
KBtu/sq ft	Thousand British thermal units per square foot
Kgal/sq ft	Thousand gallons per square foot
kWh	kilowatts/hour
K	Temperature Measurement 0 Celsius = 273.15 Kelvin
LCC	Life Cycle Costing
LED	Light Emitting Diode
LEED	Leadership in Energy and Environmental Design
Low-E	Low-emittance
MERV	Minimum efficiency reporting value
NAVAC	Naval Facilities Engineering Command
NEMA	National Electrical Manufacturers Association
NFRC	National Fenestration Rating Council
NHPA	National Historic Preservation Act
NPS	National Park Service
NRHP	National Register of Historic Places
RS Means	Construction estimation database
R-factor	Thickness of insulation
R-value	An insulation's resistance to heat flow
SHPO	State Historic Preservation Office
SR	Solar reflectance
SRI	Solar reflectance index
Solar PV	Solar photovoltaic
SHGC	Solar heat gain coefficient
TE	Thermal emittance
U-factor	Measurement of conduction heat loss
VFD	Variable frequency drives

Making the Toolkit Work or When to Get Involved.

To properly maintain a balance between historic preservation, sustainability, and effective project management, understanding when the various parties should be involved in the EA process is crucial. Knowing when such a process is being undertaken may require some initiative on the part of the CRM to inquire with building managers, facility managers, or the engineering office as to what proposed actions are being planned for buildings over 50 years of age. It is recommended that the CRM ask the following questions:

1. What buildings are over 50 years of age on-site?
2. Is there a proposed action for any building or buildings that could possibly impact that resource? Has an EA been performed on the building? Is the proposed action directly related to sustainability?
3. Has the building been assessed for NRHP eligibility?
4. If yes, what was the NRHP recommendation and has the SHPO concurred with that recommendation? If a building has been recommended and accepted as not eligible for NRHP listing, it is recommended that a memo be written detailing that the resource was reviewed for NRHP eligibility. An example memo to file is shown below.
5. If a building has not been evaluated for NRHP eligibility, is recommended as eligible for NRHP listing, or is already listed, the building should be assessed for potential adverse impacts from the proposed action.
6. Are there any specific features to the building that make the building historically or architecturally significant?
7. Are there any mitigation documents pertaining to buildings individually or as a historic district?
8. Have appropriate parties and agencies been consulted in regards to the proposed action? Parties and agencies could include offices on base, the SHPO, and other parties deemed necessary to the process.

MEMO TO FILE

Date:

Subject:______________________________

____

Building:

Proposed Action:

Date of Section 110/106 Survey:

NRHP Recommendation:

SHPO Concurrence:

Date Proposed Action Completed:

Energy Audits Explained

What is an EA? An EA is a systematic inspection of a facility's interior and exterior to determine its total energy use and the potential for savings and efficiency. Energy usage is difficult to see; therefore it is necessary to use specialized equipment, training, and experience to identify key areas of energy improvement.

> ***Benefit:*** Routine energy audits ensure that the systems consuming energy in the building adapt to fit the need of the building according to the space utilization.

How often are EAs conducted and who conducts them? Section 432 of Energy Independence Security Act (EISA) of 2007 (Public Law 110-140) (December 2007) requires each Federal installation to complete comprehensive energy and water audits in 25% of its DoD facilities each year. This roughly translates to conducting an audit of a DoD facility every four years (Energy Assessment Training Manual 2007:9).

What systems and building elements are examined and how?

There are five primary systems focused on during energy audits:

- ✓ Heating, Ventilation and Air Conditioning (HVAC);
- ✓ Water;
- ✓ Lighting;
- ✓ Building Envelope (walls, doors, roofs, windows, insulation and foundation);
- ✓ Processes Associated with the Building Purpose.

> ***Examples of building functions with specific processes are:*** data centers, manufacturing facilities, cooking facilities, refrigeration facilities, and water treatment plants.

When evaluating a building, all five systems are audited. In addition, a review of the as-built drawings provides details about the building envelope elements. The energy use of a building increases with the presence of processes that support the function of a building. With the increased use of energy in a building there is typically increased opportunity for savings.

Building systems are interrelated in that when one system is changed it can affect another. For instance, changing to more efficient lighting will increase the heating load but decrease the cooling load on the HVAC system. However, increasing the building envelope insulation will decrease the cooling and the heating load. These relationships should be considered when implementing Energy Efficiency Measures (EEMs).

> Some recommended changes to building elements or systems that would likely negatively affect NRHP eligibility of a building could include:
> - Removal of building;
> - Modification of roof;
> - Siding, window, or door replacement;
> - Modification of foundation.

So how are these audits conducted? Visual inspection during the site-visit is typically sufficient, but a more detailed inspection with infrared imaging equipment will reveal greater detail. Infrared imaging can detect areas of poor insulation and water penetration.

What are the variables that can effect results (how subjective are these variables)? An energy audit can recommend a variety of changes to increase the energy efficiency of a building. These changes may or may not affect the historic character of a building. Each recommendation should be evaluated individually to determine how it would affect the building as a whole.

> Some recommended changes that would likely not negatively affect NRHP eligibility of a building could include:
> - Water efficiency measures;
> - Pipe and duct insulation;
> - Boiler efficiency;
> - Lighting efficiency.

The CRM and facility managers must consider these recommendations and their effect on the NRHP resource and consider offering alternatives or, if alternatives are not possible, how to minimize the effects. Look for areas to compromise.

How to interpret an EA. The goal of the EA is to balance three variables: the environmental benefit of an EEM, the economic gain (savings) from the EEM, and the impact of the EEM to the NRHP eligibility of the building. The EA is focused on decreasing the use of fuels, electricity, and water through energy efficiency measures. These values are translated into dollar savings and often reported with a simple payback of years compared to the estimated cost of implementing the recommended EEM. Once an EA evaluation has been completed on a building, a report is prepared that includes an assessment of the energy usage of the building, its systems, and potential EEM improvements. The report will include an analysis of utility data, benchmarking against similar buildings types, and options of potential EEMs with a simple payback analysis for each project along with supporting photographic documentation. The report may also include potential operation and maintenance measures, as well as clean technology opportunities available.

How is energy measured?
- Fuel and electricity → British thermal unit (Btu)
- Electricity savings → kilowatts/hour (kWh)
- Liquid → gallons (gal) and/or therms
- Water savings → thousand gallons (kgal) or cubic feet

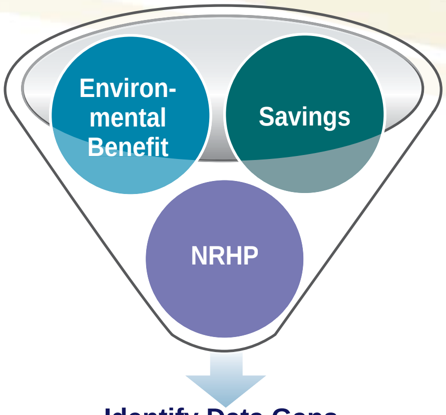
What follows is a discussion on reading and interpreting the EA and how each EEM could affect a building. Other discussion includes what concerns or considerations should be taken into account in the decision making process.

The EA (step-by-step). The American Society of Heating, Refrigerating and Air-conditioning Engineers (ASHRAE) have a standard for energy audits that is defined in the ASHRAE publication, *Procedures for Commercial Building Energy Audits, Second Edition.*

ASHRAE guidelines define three levels of an EA.

- Level I: Walk-through audit seeks to identify EEMs and capital projects pertinent to the facility type and use. The EEMs are reported with rough costs and savings.
- Level II: Building on the Level I with greater detail and the addition of a detailed energy analysis with refined cost / savings for EEMs.
- Level III: Builds on Level II with focus on capital-intensive projects, a refined energy analysis, additional measurements, and a building energy model.

Three ASHRAE levels of energy audits:
- Level I: walk-through
- Level II: walk-through and energy analysis
- Level III: refined energy analysis



On-site Energy Audit

- An interview with the facility engineer/occupant that is knowledgeable about the building's mechanical systems, occupancy patterns, and space utilization.
- A walk-through of the building and grounds to investigate all building systems related to energy use including: HVAC, building envelope, pumps and motors, plug loads, lighting, and any process loads.
- Written documentation of all energy efficiency opportunities, such as related model numbers and efficiencies of existing equipment.
- Photographic documentation as appropriate to support EEM.

The EPA Portfolio Manager can be found at www.energystar.gov.

The CBECS can be found at www.eia.gov/consumption/commercial/.

The process requires creating an account and entering general information about the subject building.

Twelve months of the most recent utility bills must be entered in the database.

The portfolio manager database normalizes for weather and location.

Level I: **Energy Use Analysis** consists of a walk-through, which includes a preliminary energy use analysis of existing thousand British thermal units per square foot (kBtu/sq ft) with comparison to similar types of buildings, and a walk-through identifying EEMs and capital projects. The EEMs are reported with rough costs and savings.

Level II: **Energy Survey and Analysis** builds on Level One with a breakdown of energy end-uses, detailed energy analysis, refined cost and savings for EEMs, and recommendations to operation and maintenance practices.

Level III: **Detailed Survey and Analysis** builds on Levels One and Two with a refined energy analysis, additional measurements, and hourly simulation through a building energy model

Energy Analysis

The energy analysis is comprised of benchmarking and utility analysis. Benchmarking is a process of comparing the subject building against other buildings of similar use and geographical location to assess the energy performance. Utility analysis is the process of reviewing the most recent 12 to 36 months of utility data for yearly cost, yearly consumption, and cost per measured unit. The analysis should also present the incremental cost per fuel in order to assess a true savings projection for any EEMs.

There are two sources of benchmarking:

1. **Portfolio Manager**: created by the US Environmental Protection Agency (EPA) to track and assess energy and water consumption in order to rate the building's or collection of buildings' energy performance between 1 and 100.
2. **Commercial Buildings Energy** Consumption Survey (CBECS): created by the US Energy Information Administration to provide comparisons for commercial buildings by use and square footage.

Building Energy Model

In a Level III audit, information from a detailed survey is used to create a computer generated energy consumption model. This model is developed based on the following building details:

- Construction details;
- Mechanical equipment;
- Lighting;
- Building occupancy patterns;
- Facility type/function (the use or purpose of the building – i.e. lab, school, hospital)
- Location;
- Fuel types; and,
- Rates.

Examples of energy model software include DOE-2, eQUEST, Trane Trace 700, and Carrier HAP.

Energy model software can be found at:

DOE-2: ***http://doe2.com***
eQUEST: ***www.doe2.com/equest***
Trane Trace 700: ***www.trane.com/commercial/Dna/view.aspx?i+1136***
Carrier HAP: ***www.commercial.carrier.com/commercial/hvac/general/1,,CLI1_DIV12_ETI496,00.html***

Reading and Interpreting Energy Efficiency Measures

EEMs are the actions taken to reduce energy consumption. EEMs to be considered include:

Water • Irrigation • Pipe and Duct Insulation • Boiler • Lighting • Windows • Doors • Air Sealing • Water Heaters • Air Stratification • HVAC • Thermostat • High Efficiency Cooling Equipment • Motors and Drives • Refrigerator • Vending Machines • Waste Heat Recovery • Solar Photovoltaic • Ground Source Heat Pumps • Insulation • and Roofs. Each of these EEMs are discussed below along with considerations and concerns for each that can be found in an easy to follow matrix included in this toolkit.

Energy drains on a building could include:

- Poor Insulation
- HVAC System
- Office Equipment
- Lighting
- Water
- Solar Equipment

Historic Preservation Concerns to Be Considered	Energy Efficiency Measure (EEM)																				
	Water Efficiency	Irrigation	Water Heater	Solar Water Heater	Insulation	Distribution Pipe and Duct Insulation	Windows and Doors	Roof	HVAC Cleaning	Thermostat	High Efficiency Cooling Equipment	Boiler Efficiency	Lighting	Air Sealing	Air Stratification	Motors and Drives	Refrigeration	Vending Machine	Waste Heat Recovery	Ground Source Heat Pumps	Solar Photovoltaic
Impact to material integrity, or association, or design integrity of the building if the significant feature is replaced	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Impact to material, association, and design integrity of a historic resource (if property boundaries are included in the historic boundaries) for cultural and historic landscapes		✓																			
Ramifications to the building as a whole if the building is not made energy efficient - will the building be adversely impacted through abandonment or safe if the modification is not made	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓						✓
Impacts to building to remove asbestos containing materials						✓															
Ability to meet the Secretary of Interior Standards and Guidelines for the Treatment of Historic Properties with Guidelines for Preserving, Rehabilitating, Restoring, and Reconstructing a Historic Building							✓	✓	✓	✓	✓	✓	✓		✓	✓		✓	✓	✓	
Is the element of the building actually significant to the building's NRHP eligibility									✓	✓	✓	✓	✓			✓	✓	✓	✓		
Impact to cultural features (artifacts) in climate controlled building where equipment is installed										✓	✓	✓	✓								

Water Efficiency EEM

Water efficiency EEMs are designed to reduce the amount of water consumed by the end user for a specific task while maintaining performance. The EPA has developed the WaterSense Program to bring water efficient products to consumers. WaterSense labeled fixtures must meet performance standards while meeting the water conservation standard.

General Water Efficiency EEM Concerns/Issues

The typical water efficiency EEM will call for changing out the existing fixtures for more efficient fixtures or accessories. The aesthetics can be maintained through careful selection from the wide variety of styles available from various manufacturers. In the case of existing faucets equipped with aerators, water efficiency can be achieved by changing out the aerator with minimal to no impact on the aesthetics.

1992 Federal Regulations Standards for Water Usage:

- Toilets → 1.6 gallons per flush (gpf)
- Faucets → 2.5 gallons per minute (gpm)
- Showerheads → 2.5 gpm

To earn a WaterSense label, each fixture should not exceed:

- High-Efficiency Toilet → 1.28 gpf
- Flushing Urinals → 0.5 gpf
- Showerheads → 2.0 gpm
- Faucets → 1.75 gpm
- Aerators → 1.75 gpm

See EEM Matrix for historic preservation concerns to be considered.

Irrigation EEM

WaterSense labeled irrigation systems automatically control the watering based on weather and landscape condition. This is an improvement over traditional timer systems that will water at the same time every day even if it is raining and irrigation is not needed.

Irrigation EEM Concerns/Considerations

Automated irrigation systems have significant upfront costs to install the piping, sensors, and computer. However, if it can be incorporated into a landscape project then there is little additional cost and disruption to the landscape itself.

See EEM Matrix for historic preservation concerns to be considered.

Water Heater EEM

Water for a building is commonly heated with an electric or gas-fired tank-style water heater. Water heaters older than 10 years typically have poor insulation and are approaching the end of their expected life. Similar tank-style water heaters that are natural gas-fired can be found with the Energy Star Label. More efficient though are the tankless, on-demand water heaters that can be fired on gas, or with electric resistance. The advantage is that it only produces hot water when the hot water is called for, thus eliminating the need to constantly maintain a tank full of hot water at 120°F.

Water Heater EEM Concerns/Considerations

Tankless water heaters are smaller than tank-style water heaters and can often be hidden away under a sink or hung on a closet wall. Consideration must be given to the number of hot water fixtures that might be calling for hot water at the same time because the tankless units have limits on the rate at which they can produce hot water. The natural gas tankless units are high efficiency and typically have a direct exhaust constructed of PVC and vented out the sidewall of the building. Adding a vent in the sidewall can affect the aesthetics and the envelope if done poorly. Tankless units have a higher upfront cost than traditional tank-style water heaters. Hard water can cause issues for the tankless water heaters as minerals build up inside the lines.

See EEM Matrix for historic preservation concerns to be considered.

Solar Water Heater EEM

Solar water heating uses solar plate collectors with a southern exposure to capture heat energy from the sun to heat water for domestic use. These systems are typically mounted on the roof of a facility or mounted on racks and placed on available open real estate. The external system is paired with insulated thermal storage sized according to the solar plate collectors and the domestic hot water demand of the facility.

Solar Water Heater EEM Concerns/ Considerations

Solar photovoltaic (PV) systems rely on sunlight and are typically visible, though placement on flat roofs or behind short walls can eliminate viewing from some vantage points. Consideration must be given to the routing of water lines feeding from the solar plate collectors to the storage tanks and then integrated into the building's hot water system. Hybrid systems combining solar PV with standard water heaters add efficiency to the Solar PV element because the water helps keep the Solar PV panels cooler. Solar PV systems are more often justified in situations where hot water is in high demand such as apartments, dorms, barracks, and hotels.

See EEM Matrix for historic preservation concerns to be considered.

Insulation EEM

Historic structures are typically lacking the level of insulation recommended by Department of Energy (DoE) standards. The amount of insulation is measured by the R-factor, resistance to heat flow. The thickness of insulation is the typical determination of the total R-factor. Typical insulation that is added to existing structures includes loose-fill cellulose or fiberglass, fiberglass batts and rolls, rigid foam, and spray-in foam. Each type of insulation has a specific R-value, an insulation's resistance to heat flow, per inch.

> The recommended amount of insulation depends on the climate region.
>
> The higher the R-factor, the thicker the insulation and the greater the insulating value.

Insulation EEM Concerns/Considerations

The greatest energy efficiency gain comes from insulating the bottom and top of a structure. Building science recommends an air-gap between the roof sheathing and the insulation. Consideration should be given to the presence of a vapor barrier depending on climate region and type of insulation.

> Insulation is made of a variety of substances but the most typical are fiberglass and foam. Insulations are rated with an R-value with the higher the R-value equating to better insulation value. Typical R-values range between 0.5 and 3.0 per inch of material.

Insulating the sidewalls of an existing building may present as many issues as it does benefits. Some of the issues deal with the type of insulation material used and the application method to get it inside the wall cavity without disturbing the building. The greater issue is the absence of a vapor barrier and the insulation's tendency to trap moisture. Since sidewall insulation does not increase efficiency to the same degree as floor and roof insulation, the threat of moisture issues on the structure tends to eliminate it from most historical building insulation projects.

See EEM Matrix for historic preservation concerns to be considered.

Distribution Pipe and Duct Insulation EEM

Uninsulated pipe and air ducts in non-conditioned spaces are inefficient because they lose Btus to the surrounding environment. Heated or chilled water, air, steam, and chilled refrigerant should be protected from Btu loss as it travels to its desired location. The opportunity for savings by adding insulation increases with the pipe diameter and flow rate of the fluid or gas. Savings associated with insulating air ducts also increases with duct size and air flow rate. Greater savings is relational to the greater the temperature difference between the material inside the pipe or duct and the air outside the pipe or duct.

Pipe and Duct Insulation EEM Concerns/Issues

Typically insulation in this EEM is applied to pipe and duct work that is in a basement, crawlspace, attic, or outside the building. A pipe and/or duct insulation EEM that requires opening up walls or ceiling is normally not cost justified based on savings alone. There is not significant energy savings associated with insulating pipe or duct within the conditioned area that it supplies. However, there may be justification for a pipe or duct being insulated within a conditioned space if it is supplying a process like refrigeration.

Asbestos piping insulation can be a concern in older buildings. In the event that asbestos insulation cannot be left undisturbed or encapsulated then asbestos mitigation would be required by an asbestos remediation professional.

See EEM Matrix for historic preservation concerns to be considered.

Windows and Doors EEM

Windows and doors are often a leading source of heat gain/loss through conduction, radiation, and air intrusion. The U-factor is a measurement of conduction heat loss (Btu/hr-ft2-°F) that the National Fenestration Rating Council (NFRC) applies to the whole window, door, or skylight unit. Low-E coating on the glass reduces heat loss thereby lowering the U-factor. Solar Heat Gain Coefficient (SHGC) is a measurement of the windows ability to block solar radiation from entering through the fenestration.

In a northern, heating intense climate, a low U-factor (≤ 0.32) with a higher SHGC (0.30 to 0.60) is most efficient for windows. In a southern, cooling intense climate, more efficient for windows should have a higher U-factor (0.35) with a lower SHGC (≤0.30).

Windows and Doors EEM Concerns/ Considerations

Restoring the existing window first maintains the historic element. It is also the most economical approach to achieving energy efficiency. Windows made prior to the 1950s were built primarily with old growth lumber that is stronger and more rot resistant than wood used today in modern historic reproductions. Original wood windows have lasted for the life of the building and once restored they will continue to serve their purpose for another 60 to 100 years with routine maintenance. However, typical replacement windows are not repairable and after their 20 to 30 year life will have to be replaced again. Restoration of a window involves replacement of any broken panes, replacing the glazing putty, new paint, and repairing sash cords. Restored single-pane windows, properly installed with a good storm window will have nearly the same energy savings as a replacement window. Interior storm windows are hardly noticeable but they do not provide the protection for the restored window that an exterior storm window does. For buildings with high heating demand, low-emittance (Low-E) glass is recommended in the storm windows. One issue created by storm windows is the entrapment of moisture between the windows, thus it is recommended to have weep holes to the exterior.

Replacement windows are available through custom shops that maintain the historic look but are built to energy efficient standards. The high cost of energy efficient historical replica windows typically eliminates the option on most projects. The higher cost of even basic replacement windows typically makes this project difficult to justify financially.

See EEM Matrix for historic preservation concerns to be considered.

Roof EEM

Sunlight is converted to heat energy when it hits a black or dark roof surface, heating the building and the environment around it. Cool roofs that reflect sunlight and heat can be used to replace dark roof surfaces. The ability of cool roofs to reflect light is measured by its solar reflectance (SR) and its ability to radiate heat is its thermal emittance (TE). A cooler roof reduces the cooling load on a building's HVAC system. A single story building with a large roof footprint in a southern climate is the most ideal candidate for a cool roof.

Vegetated roofs are roof systems that incorporate vegetation. These roofs help mitigate stormwater runoff and the urban heat island effect but do not offer significant energy savings.

Roof EEM Concerns/Consideration

A building's roof surface can have historic significance, particularly if it is visible from the ground. There are roofing materials available today with a respectable solar reflectance index (SRI) that are not white and may be an acceptable replacement for the existing roof. In the case of flat roofs with little to no visibility a cool roof should be considered based on climate region. Cool roofs are economically competitive with standard roofing materials. Vegetated roofs have a construction estimation database (RS Means) average cost of $20 more per square foot over a white roof. Vegetated roofs also add significant weight to the roof structure so consideration should be given to the structure's ability to carry an increased load.

See EEM Matrix for historic preservation concerns to be considered.

The SR and TE of a roof make up the solar reflectance index (SRI) which ranges from 0 to 100. A typical black roof has an SR of 0.05, TE of 0.9 for a 0 SRI while a typical white roof has a SR of 0.8, TE of 0.9 for a 100 SRI. An average white roof is typically 35°F to 50°F cooler than a dark roof.

HVAC Cleaning EEM

HVAC cooling coils, heating coils, and duct work have regular airflow over and through resulting in build-up of dirt over time impeding the flow of air. When the flow of air is restricted the fan motors work harder and use more energy. The first defense against dirty coils and ductwork is properly installed air filters. Air filters are rated with a minimum efficiency reporting value (MERV) rating from 1 to 20. The best scenario is a balance between ease of airflow and filtering ability. Cleaning the coils aids in heat transfer which reduces airflow demand and saves blower motor energy, as well as extending the life of the motor. Spray-on coil treatments are available on the market, which increase efficiency by helping the coils resist dirt build-up.

MERV 1 filters allow the air to pass with the least resistance and filtering out the least amount of contaminants, while a MERV 16 is the highest rated home air filter and is considered to filter the air well enough for general surgery in a hospital.

HVAC Cleaning EEM Concerns/Considerations

Cleaning the coils and regularly replacing air filters should have little to no impact on the building from a preservation perspective. Occasionally the filter housing is replaced on an air handler unit to accommodate a different style of filter but this is typically located in a mechanical room.

See EEM Matrix for historic preservation concerns to be considered.

Thermostat EEM

The thermostat is a measurement and control device located in the conditioned space that controls the on/off of a boiler, furnace, air conditioner, or other conditioning equipment. Significant savings are associated with using programmable thermostats by adjusting set points a few degrees, programming deeper setbacks when the area is unoccupied, and using occupancy sensors to control when a thermostat comes out of setback mode. Larger buildings with more sophisticated HVAC controls utilize a computer based system referred to as a building automation system (BAS) or an energy management system (EMS). These computer based controls have even greater control options with sensors that monitor CO_2 levels, humidity, pressure differentials, among others.

Recommended energy efficient settings of 78°F for cooling with 82°F for the setback and 68°F for heating with 55°F setback. These are the common methods used to save energy with thermostats.

Thermostat EEM Concerns/Considerations

Traditional thermostats were typically activated by a mercury switch. Today's programmable thermostats are safe and if programmed correctly can save money and energy. Typical programmable thermostats are rectangular in shape but round ones that mimic the traditional shape are available. In historic buildings and those housing historic artifacts care must be taken to not be too aggressive with setbacks causing dramatic temperature swings and architecturally unsafe humidity levels.

See EEM Matrix for historic preservation concerns to be considered.

High Efficiency Cooling Equipment EEM

Buildings are typically cooled by air blowing over a coil that has chilled water or refrigerant circulating. Chilled water is cooled by a chiller where as chilled refrigerant is cooled by a condenser. Today chillers are more efficient because of variable speed drives and low friction bearings. High efficiency condensers are available for both air conditioning and heat pumps.

High Efficiency Cooling Equipment Concerns/ Considerations

In a building where chillers are already at work as the primary cooling equipment the process to switch out to a high efficiency chiller is not something that will affect much beyond the mechanical room. New chillers can be broken down to manageable pieces that will fit through most existing doorways. A water cooled chiller works in conjunction with a cooling tower. These cooling towers are sizeable exterior units that commonly set on rooftops or concrete pads behind concealing fence. If a chiller or cooling tower is being added to a building, consideration should be given to the path for the mechanical pipes that connect the two units and the location of the cooling tower to have the least impact on the facility's exterior appearance.

The process for switching out air conditioner and heat pump condensing units is normally a one-for-one replacement, with little change to the existing building. These units are located outside and can be placed on rooftops, attached to the side of a building, or placed on a pad located on the ground. When adding air conditioning to a building these condensers are part of a packaged system that integrates the condensing unit and air handling unit (AHU) together as an exterior appliance, or these are separate with the condensing unit outside and the AHU inside the building. Planning the location of the equipment and routing of pipes and duct work is certain to impact the look of a building. It is possible to hide much of duct work and AHUs in basements and attics. The new air supply and return air duct diffusers and grates should be chosen so that they integrate best into the décor. See EEM Matrix for historic preservation concerns to be considered.

Boiler Efficiency EEM

Boiler efficiency gain can be achieved with new high efficiency boilers and or boiler controls. Typically an existing standard efficiency boiler has design efficiency of 75% to 82% but with age and poor combustion control it is not uncommon to observe an additional 10% decrease in efficiency. Efficiency of the boiler system can be increased through automated controls that factor in outside air temperature, circulating water temperature, and multiple boiler firing sequences.

> Standard boiler designs today can achieve 88% efficiency, and natural gas condensing boilers range from 90%-96% design efficiency.

Boiler Efficiency EEM Concerns/ Considerations

Replacing an existing boiler with a high efficiency boiler requires careful planning around fuel choice, fuel storage, exhaust requirements, combustion air requirements, along with removal and installation. Natural gas is the preferred fuel today because it is comparatively inexpensive, efficient, and clean burning. If the EEM requires switching from a bottled fuel to natural gas you need to consider where the natural gas line will enter the facility and how it will be routed to the boiler. Also in a fuel switch situation the existing boiler flue may not be built to the specifications required for a natural gas boiler. A flue lining may be necessary or a new flue exhaust out the sidewall of the building. Fuel oil and propane are more costly fuels that require on-site storage but are common in locations with no access to natural gas distribution lines

See EEM Matrix for historic preservation concerns to be considered.

Lighting EEM

Traditional incandescent lamps, metal halides and the larger, 1.5 inch diameter T12 Fluorescent lamps are commonly found in existing buildings. These lights today are being replaced with more efficient lighting consisting of compact fluorescent lamps (CFLs), light emitting diodes (LEDs), Fluorescent T8s and T5s (1 inch and 5/8 inch diameter). De-lamping is an energy saving solution for over-illuminated areas.

Lighting EEM Concerns/Considerations

The color of the lighting effects the way a room appears, often described as warm feeling or cold and harsh. The Kelvin (K) scale is used to measure light color. Color ranges include:

- Candle light: between 1,700 – 1,900 K
- Typical incandescent light: between 2,700 – 3,300 K
- LEDs: between 2,700 – 5,500 K
- CFLs: between 2,700 – 5,000 K
- Natural daylight: between 5,000 – 6,500 K

"Warm" describes color around 2,700 K and "full spectrum or white" describes color around 5,000 K.

The brightness, or light level of a room, is measured in foot-candles (FC) at the standard work surface height. Recommend light levels are: 75 FC for a lab, 50 FC for a classroom, 30 FC for a gym and computer room, and 20 FC for hallways.

In changing out lights the three concerns to deal with are the physical lamp, light color, and the brightness. CFLs and LEDs come in a range of lamp shapes and sizes that are similar to their incandescent counterparts. Incandescent lamps that rely on the visible filament to create the historic feel of the environment are not possible to duplicate with a CFL or LED. Replacing T12 fluorescent tube lighting with T8 only reduces the diameter of the lamp by 0.5 inch.

See EEM Matrix for historic preservation concerns to be considered.

Air Sealing EEM

Standard building construction has often neglected to create a tight envelope to prevent energy loss caused by drafts. Houses and smaller buildings (≤10,000 sq. ft.) are candidates for a blower door test to determine natural air changes per hour through the building envelope. The test is done by closing all windows and doors and then creating negative pressure with a powerful fan that is part of the blower door device. Pressure gauges and airflow meters monitors how quickly the outside air penetrates the envelope to balance the pressure. The goal is to achieve a healthy balance between air changes and an energy saving envelope.

Air sealing techniques utilize various weather stripping, sealants, caulks, and foams to close air leaks. Common air leaks are found around windows, doors, electrical outlets, at envelope penetrations, and along sill plates where the foundation walls and the building frame meet.

Air Sealing EEM Concerns/Considerations

Air sealing is typically not a visually noticeable practice. Air sealing should not render a door or window inoperable.

See EEM Matrix for historic preservation concerns to be considered.

Air Stratification EEM

Air stratification becomes an issue in buildings with tall ceilings (≥14 feet) because the air temperature at working height (5 feet) will be cooler than the air at the ceiling height. Energy savings occurs in the heating season when fans are used to destratify the air by circulating the warm air downward to mix with the cooler air. Destratification will bring up the temperature by several degrees at normal working height (5 feet) depending on the ceiling height resulting in less heating because the desired temperature is met.

Air Stratification EEM Concerns/Considerations

Destratification is typically done with large volume, low velocity ceiling fans or an encased directional fan. These are great solutions to lowering heating costs in buildings like hangers, gymnasiums, auditoriums, and warehouses. Fans also require additional wiring and controls along with secure anchoring to the ceiling.

See EEM Matrix for historic preservation concerns to be considered.

Motors and Drives EEM

Motors are found in nearly every building to circulate air and water. AHU's rely on fan motors to push air out to the conditioned space. Pump motors are used in buildings to circulate heated and chilled water for heating and cooling. In large residential buildings such as hotels or barracks, domestic hot water is also circulated to keep it readily available. National Electrical Manufacturers Association (NEMA) rated premium efficiency motors offer significant savings over standard efficiency motors. Nearly all motors have a NEMA rating stamped onto the nameplate as a percentage.

> Turning motors off or at least slowing them down if they do not have to run at full power. Variable frequency drives (VFD) are controllers that control the speed of a motor by slowing them down or speeding them up according to the required load.

Motors and Drives EEM Concerns/ Considerations

Replacing a standard efficiency motor for premium efficiency motor is a simple one-to-one change out. Adding a VFD to a motor is an electrical wiring job with the VFD typically mounted on a wall near the motor it controls. With most motors located in mechanical rooms, motor replacement does not have a significant impact on the historic feel of a building. However, if the motor itself is of historic significance it is most likely not compatible with a VFD.

See EEM Matrix for historic preservation concerns to be considered.

Refrigerator EEM

Refrigerators manufactured prior to 2000 typically use twice the energy of a similar sized efficient model today. The US EPA's Energy Star program labels products with their logo if they meet the specific energy guidelines for that type of appliance. Many of the refrigerators sold today are Energy Star certified.

Refrigeration EEM Concerns/Considerations

Energy Star rated refrigerators are competitively priced for most typical sizes and colors but the post World War II look will cost more. Replacing a refrigerator for an Energy Star refrigerator is a simple one-to-one change out. However, if the refrigerator itself is of historic significance this may be seen as an adverse effect.

See EEM Matrix for historic preservation concerns to be considered.

Vending Machine EEM

Vending machines typically cool beverages and are lit 24/7. This unnecessary waste of energy can be reduced with technology that senses activity at the machine and utilizes a timer. Together, the timer and sensor, keep beverages cool and the lights on when the building occupants are likely to purchase items, but during the unoccupied times the machines save energy by entering a sleep mode.

Vending Machine EEM Concerns/ Considerations

This control device is available as an add-on to existing vending machines. The simple wiring and attachment of the sensor can be performed by the facility maintenance personnel. The unit has little impact on the vending machines beyond the presence of a small sensor mounted to the top.

See EEM Matrix for historic preservation concerns to be considered.

Waste Heat Recovery EEM

Traditional boilers along with process heating gives off significant amounts of heat. These valuable Btus can be captured by heat exchangers and used to preheat hot water.

Waste Heat Recovery EEM Concerns/ Considerations

No major concerns or considerations were identified for waste heat recovery.

See EEM Matrix for historic preservation concerns to be considered.

Ground Source Heat Pumps EEM

Ground source heat pumps (GSHPs) operate very similarly to the air-source heat pumps (ASHPs) that consist of a typical exterior pad mounted condenser and an interior air handling unit. The difference is that GSHPs circulate water inside a closed loop through the earth, using the earth as a heat source and sink instead of the outside air. GSHPs are more energy efficient than ASHPs because ground temperature is much steadier than air temperature and it is closer to desirable indoor temperatures. This technology is often referred to as geothermal, but true geothermal is able to use the heat from the earth without having to use a condenser process to increase the Btus.

Ground Source Heat Pump EEM Concerns/ Considerations

GSHPs rely on the water circulated underground. This can be done in an open loop configuration that utilizes an underground aquifer or well to withdraw and return water. The more common closed-loop systems can be configured with multiple vertical wells tied together keeping the water inside the buried pipe or it can be configured horizontally. The horizontal system requires trenching over a large open area. The vertical system is often more practical in areas with limited open space and it is less disturbing to the terrain. The associated pumps and heat pump air handling units can often be located in the same area as the equipment they are replacing.

See EEM Matrix for historic preservation concerns to be considered.

Solar Photovoltaic EEM

The sun is a great source of energy that can be converted into electricity using solar photovoltaic (solar PV) systems. These systems are typically mounted with a southern exposure to the roof of a facility, integrated into the actual building envelope, mounted to parking canopies, or mounted on racks and placed on available open real estate. Solar PV allows a facility to maintain some independence from the utility company while decreasing demand and energy charges. Energy consumption and charges are reduced by the energy produced by the PV system.

Solar Photovoltaic EEM Concerns/Considerations

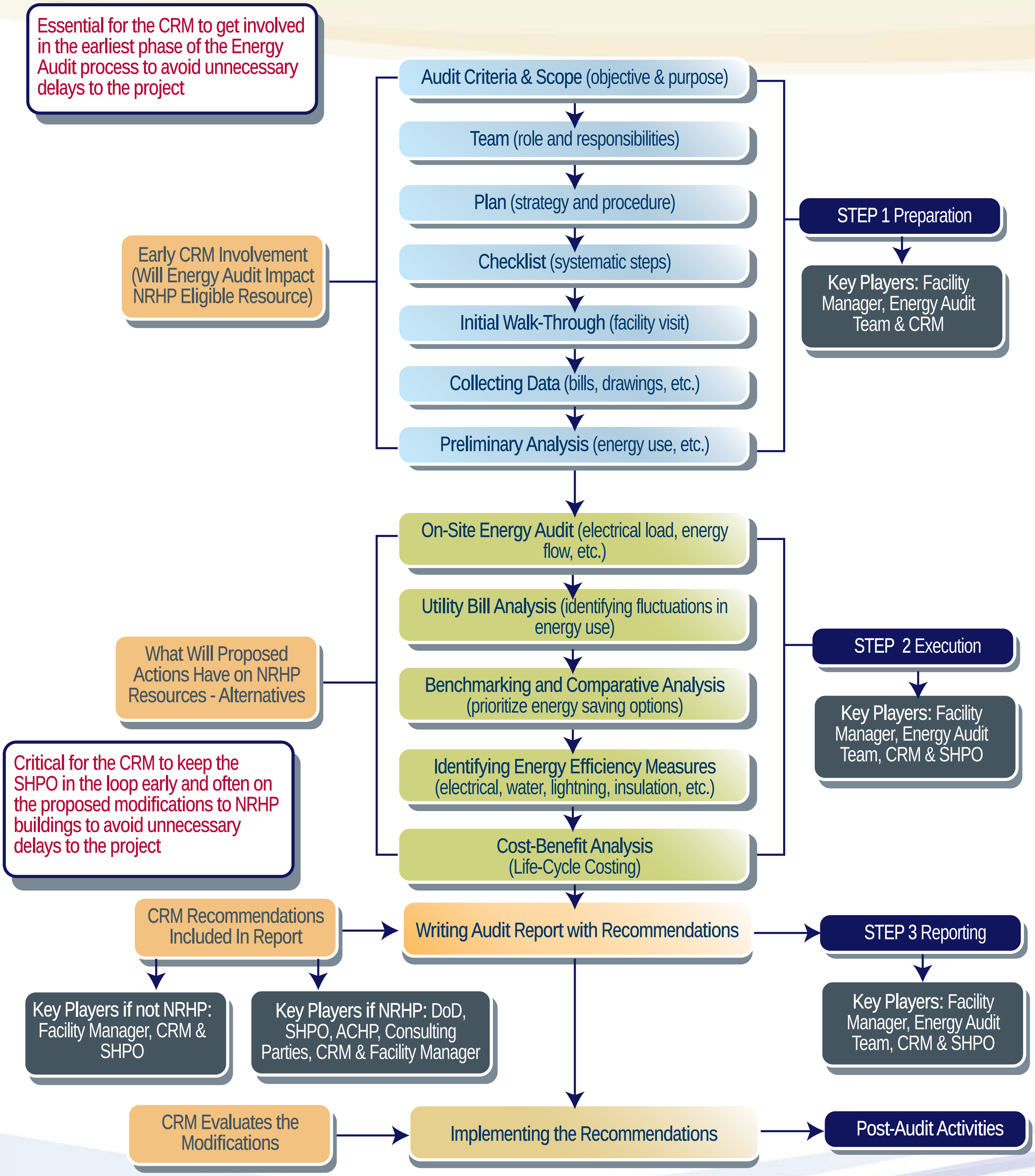
Solar PV panels are a noticeable addition to most buildings, however, when placed on flat roofs or behind short walls they may not be visible from typical vantage points. The inverters that are paired with the PV are typically small units mounted on a wall in the mechanical room near the electric panel. Consideration should be given to the routing of the transmission lines from the PV panel to the inverter.

See EEM Matrix for historic preservation concerns to be considered.

A properly designed solar PV system, consisting of solar collectors and inverter(s), allows a facility to operate in parallel with the providing utility.

The flow chart on the next page provides an outline of the process of integrating historic preservation with the energy audit process. It provides a breakdown of the specific steps in the process, appropriate parties to be involved in each step, and critical issues to be aware of during the process.

Process for Energy Audits and Section 106



Checklist for Energy Audits (adapted from the *Nebraska Energy Office – Energy Efficiency and Historic Preservation, A Planning Guide for Buildings*).

BUILDING AND ENERGY AUDIT CHECKLIST

1. BUILDING OWNER TYPE	2. BUILDING CONDITION
= Private ☐ Public ☐ Nonprofit ☐ Other ______________	☐ Currently in Use ☐ Vacant ☐ Other ____________

3. BUILDING COMPONENTS

Exterior Walls

Structure	Exterior Finish	Insulation Type	Insulation Material	Interior Finish
☐ Frame	☐ Masonry	☐ Batt	☐ Fiberglass	☐ Plaster
☐ Wood	☐ Wood Siding	☐ Blown-in	☐ Rock wool	☐ Gypsum Board
☐ Solid Masonry	☐ Stucco	☐ Loose-fill	☐ Cellulose	☐ Masonry
☐ Hollow Masonry	☐ Metal Panel	☐ Rigid	☐ Polystyrene	☐ Wood Paneling
☐ Other ____________	☐ Vinyl Siding	☐ Other ____________	☐ Urethane	☐ Metal/Plastic Panel
	☐ Other ____________		☐ Wood	☐ Other ____________
			☐ Fiberboard	
			☐ Other ____________	

Existing Energy Upgrades:

Roof

Structure	Exterior Finish	Insulation Type	Insulation Material	Interior Finish
☐ Frame	**Built-Up Roof**	☐ Batt	☐ Fiberglass	☐ Plaster
☐ Wood	☐ Single Ply Membrane	☐ Blown-in	☐ Rock wool	☐ Gypsum Board
☐ Steel	☐ Asphalt and Gravel	☐ Loose-fill	☐ Cellulose	☐ Masonry
☐ Other____________	☐ Other ____________	☐ Rigid	☐ Polystyrene	☐ Wood Paneling
	Sloped Rood	☐ Other ____________	☐ Urethane	☐ Metal/Plastic Panel
	☐ Composition or Wood Shingles		☐ Wood	☐ Other ____________
	☐ Tiles		☐ Fiberboard	
	☐ Slate		☐ Other ____________	
	☐ Metal			
	☐ Other ____________			

Existing Energy Upgrades:

Foundation – Crawl Space or Basement

Structure	Exterior Finish	Insulation Type	Insulation Material	Interior Finish
☐ Frame	☐ Masonry	☐ Batt	☐ Fiberglass	☐ Plaster
☐ Wood	☐ Wood Siding	☐ Blown-in	☐ Rock wool	☐ Gypsum Board
☐ Solid Masonry	☐ Stucco	☐ Loose-fill	☐ Cellulose	☐ Masonry
☐ Hollow Masonry	☐ Metal Panel	☐ Rigid	☐ Polystyrene	☐ Wood Paneling
	☐ Vinyl Siding	☐ Other ____________	☐ Urethane	☐ Metal/Plastic Panel
	☐ Other ____________		☐ Wood	☐ Other ____________
			☐ Fiberboard	
			☐ Other ____________	

Existing Energy Upgrades:

Windows

Glazing Material			Frame Material		
☐ Clear	☐ Glass Block	☐ Insulated Panels	☐ Wood	☐ Steel	☐ Other ________
☐ Low-E Coated	☐ Tinted	☐ Other ________	☐ Aluminum (solid or thermally broken)	☐ Vinyl	______________
☐ Storm Windows	☐ Single or Thermopane	______________		☐ Clad	______________
				☐ Bronze	

Existing Energy Upgrades:

Doors

Type	Material	Frame Material	Insulation Material	Glazing Material
☐ Swinging Door	☐ Wood (solid slab or paneled)	☐ Wood	☐ Urethane	☐ Clear
☐ Storm Doors	☐ Aluminum	☐ Clad	☐ Polystyrene	☐ Tinted
☐ Revolving Doors	☐ Steel	☐ Steel	☐ Other ____________	☐ Low-E Coated
☐ Garage		☐ Bronze	____________________	☐ Single or Thermopane

☐ Overhead	☐ Bronze	☐ Metal (hollow or insulated)
☐ Sliding Door	☐ Other ___________	☐ Other ___________
☐ Other ___________		

Existing Energy Upgrades:

4. FIXTURES AND EQUIPMENT

Heating System		Cooling System	Combination Heating And Cooling System	Ventilation and Circulation
☐ Boiler	☐ Furnace	☐ Central Air Cond.	☐ Central Systems with remote condensing units	☐ Exhaust Fans
☐ Wood Stove	☐ Fireplace	☐ Window Air Cond.	☐ Heat Pumps	☐ Heat Exchangers
☐ Electric Residence heaters	☐ Space Heaters	☐ Swamp Cooler	☐ Other ___________	☐ Circulation Fans
	☐ Solar System	☐ Other ___________		☐ Other ________
	☐ Other ___________			

Existing Energy Upgrades:

4. FIXTURES AND EQUIPMENT (continued)

Lighting Systems	Lighting Function	Cooking Equipment	Office Equipment	Shop Equipment
☐ Incandescent	☐ Task	☐ Stoves	☐ Copiers	☐ Welders
☐ Fluorescent	☐ Ambient	☐ Ranges	☐ Fax Machines	☐ Grinders
☐ Halogen	☐ Display	☐ Refrigerators	☐ Computers	☐ Saws
☐ High –Pressure Sodium	☐ Security	☐ Microwaves	☐ Shredders	☐ Drills
☐ Other ___________	☐ Emergency	☐ Walk-in Coolers	☐ Telephones	☐ Pumps
	☐ Warning	☐ Other ___________	☐ Other ___________	☐ Other ___________
	☐ Other ___________			

NOTES:

5. LOOK AHEAD – Will The Building Use Change?

Existing Use of Building

Use of Building to Stay the Same?	☐ YES	☐ NO
Building Currently Occupied?	☐ YES	☐ NO

Future Use of Building

6. BUILDING CERTIFICATION – Is This Building LEED Certified?

Is an energy audit needed? Are possible energy upgrades needed? What would those upgrades be, if needed? Would there be a possible impact to the resources?

7. DEFINE GOAL OR PROJECT STATEMENT – What Do You Want to Do?

Develop the project goal or grogram statement. What is to be accomplished with the building? What energy efficiency and historic preservation goals are to be achieved?

8. ORGANIZE THE PROJECT TEAM – Who Can Help?

What professionals may be helpful during the project?

Engineer

Architect

State Energy

Banker

State Historic Preservation Office

Contractor

Other

9. ANALYZE THE TRADE OFFS

1. Does the proposed change have a positive energy efficiency impact? ☐ YES (Check Historic impact) ☐ NO

2. Does the proposed change have a negative historic preservation impact?

☐ YES (Consult Preservation Architect, State Historic Society and you Contractor, Architect or Engineer to discuss potential solutions that will not negatively impact the historic character of the structure.)

☐ NO (Proceed with improvement)

CRMs will have to consult with the SHPO if there is a proposed action to a resource over 50 years of age. Consultation with the SHPO follows specific guidelines, and can impact a project in terms of schedule, cost, and proposed action. To facilitate consultation with the SHPO, a CRM can anticipate questions and comments from the SHPO, specifically in regards to EAs and points of contention between historic preservation and sustainability.

Questions SHPO May Have Regarding Energy Audits and Historic Buildings. In addition to the questions identified in Section V, the following questions should be considered prior to consultation with the SHPO:

1. Was the CRM at the installation contacted about the proposed action prior to and during detailed project planning? Did the CRM communicate with the individual/firm performing the EA?
2. Is the CRM familiar with buildings and the Section 106 process? If not, has the CRM initiated consultation with the SHPO to help facilitate this process and provide guidance to help facilitate project planning?
3. How can the project avoid or minimize impacts to historically or architecturally significant features of a building? Have replacement materials been sympathetic to the building? If replacement materials are not sympathetic, will the proposed action require work where more appropriate design or materials could be incorporated? Can it be documented that the materials to be replaced are beyond repair? Have all alternatives to replacement been considered and opportunities for compromise explored?
4. Have publications such as the Secretary of Interior's Standards and Guidelines, NPS Preservation Briefs, or other accepted resources been consulted and incorporated or referenced in plans and specifications, as appropriate?
5. Do the contractors chosen have experience working with historic buildings?
6. Have a full range of effects that the project could have – direct and indirect – been considered? Are there any long-term effects that need to be considered?
7. Will interior alterations be visible from the exterior through windows or other openings?
8. If an adverse impact from the proposed action is unavoidable, is the installation prepared and able to mitigate this adverse impact?

Points of Contention. The SHPO believes that Section 106 studies and EAs are very important, but there are points of contention between historic preservation and sustainability that create conflict between the SHPO and installations. The primary issue that the SHPO sees with energy audits is the recommendation of replacement of historic and architecturally significant features rather than repair. A second issue is the recommendation of treatments that are successful in modern, non-historic buildings, but ultimately can be harmful to historic buildings. A final issue for the SHPO is the priority or lack of priority placed on certain recommendations. The combination of these three issues can be anticipated early in the planning process, and as a result, ensure the best compromise between historic preservation, energy upgrades, and cost while maintaining the project schedule.

Examples of "Points of Contention":

- **Replacement over repair**: *windows*
  - Replacement is often chosen over repair due to misinformation about efficiency
  - Single-pane historic windows with a storm window has comparable efficiencies to modern replacements, making it a more cost-effective treatment
  - Replacement of historic windows with in-kind of materials, such as wood windows, can have potential for future problems due to the inferiority of modern materials
- **Common treatments in historic buildings**: *insulation*
  - Blown-in wall insulation and spray foam insulation have been successful materials in modern buildings
  - In historic buildings, these materials could impact the way a building moves air or moisture throughout the building

Examples of “Points of Contention”:

- **Priority on recommendations:** *efficient window updates*
  - The individual/firm performing the EA may not be aware of what types of treatments compliment historic buildings and are monetarily efficient
  - Window replacement will be considered before a review of basic air filtration, roof and attic insulation, or the HVAC system
  - Low-impact options are often overlooked, such as caulking or weather-stripping

Common Ground Between Historic Preservation and Energy. The SHPO is there to help the CRM make responsible choices that benefit all parties involved. The SHPO recommends that a CRM consider the following when dealing with a conflict between preservation and energy:

- The DoD is not in the business of historic preservation, however under Section 110 of the National Historic Preservation Act, it does have a responsibility to preserve historic buildings.
- It is worth considering training and education opportunities for CRM and engineering staff to educate them on historic preservation issues, such as conferences/workshops, speakers, or preservation tradeshows training programs, many of which are sponsored by state and local preservation organizations and the SHPO.
- The SHPO can be consulted for issues other than Section 106, such as trends in preservation, products used on historic buildings, or treatments for historic buildings.
- Look at what other installations are doing in regards to the treatment of historic buildings as they provide the best examples of integrating issues specific to military installations with historic buildings, such as security requirements and military training or equipment needs.

Glossary

The following chapter provides a glossary of terms commonly used in preparation for an energy evaluation of a building. These terms have been compiled from a variety of sources and have been divided into section that include nomenclature related to engineering, historic preservation, and architecture.. For additional definitions, acronyms, and abbreviations please consult the DoD Dictionary of Military and Associated Terms available at http://www.dtic.mil/doctrine/dod_dictionary.

Engineer's Energy Toolkit Terms

Below is a brief analysis of common energy tools used by engineers when completing an energy evaluation of a building.

Energy Modeling (EM): Energy modeling is the process to determine the energy use of a building based on software analysis.

Energy Audit (EA): An Energy Audit is a systematic inspection of a facility's interior and exterior to determine its total energy use and the potential for savings and efficiency. Energy usage is difficult to see; therefore it is necessary to use specialized equipment, training, and experience to identify key areas of energy improvement.

Fluorescent Light Ballast Discriminator: The light ballast discriminator is used to determine if a fluorescent fixture has magnetic or electronic ballast.

Infrared Imaging: Infrared imaging equipment captures the temperature gradients in a photograph using colors ranging from cool blues to hot reds. Interpretation of these images can determine insulation quality, air duct leaks, moisture intrusion, and more.

Life-Cycle Costing (LCC): Life-cycle costing is an important economic analysis used in the selection of alternatives that impact both pending and future costs. It compares initial investment options and identifies the least cost alternatives for a twenty year period. As applied to building design energy conservation measures, the process is mandated by law and is defined in the Code of Federal Regulations (CFR), Title 10, Part 436, Subpart A: Program Rules of the Federal Energy Management Program.

Light Meter: A light meter is an instrument that reads the light intensity in a specific location. This value is reported in foot candles.

Thermometers: Thermometers of different types are used to capture air temperature, water temperature, pipe temperature, and more.

Historic Preservation Terms

Advisory Council on Historic Preservation (ACHP): An independent agency of the United States government that promotes the preservation, enhancement, and productive use of the nation's historic resources, and advises the President and Congress on national historic preservation policy.

Contributing Element: An architectural detail or object that adds to the historic character, historic association, historic architectural quality, or architectural values for which a property is significant because it was present during the period of significance, of a building or structure is considered to be a "Contributing" or "Historic" element. A Contributing element relates directly to the documented significance, and possesses historic integrity.

Cultural Resource: An aspect of a particular society that is valued by or significantly representative of a culture or that contains significant information about a culture. A cultural resource may be a tangible entity, such as a building, or a cultural practice as in acts of spiritual worship.

Cultural Resource Manager (CRM): Term used for archaeologists, architectural historians, historic architects and others individuals within cultural related fields that are charged by the DoD to help manage historic places of archaeological, architectural, and historic significance. These professionals are often employed to consider such places in compliance with environmental and historic preservation laws.

Integrity: The authenticity of a property's historic identity, evidenced by the survival of physical characteristics that existed during its historic or prehistoric period; the extent to which a property retains its historic appearance.

National Historic Preservation Act (NHPA): Federally mandated Act of l966 that requires federal agencies or those organizations utilizing federal funds to take into account the effects of their proposed activities on properties included, or eligible for inclusion, on the NRHP.

National Register of Historic Places (NRHP): A comprehensive list of historic resources including districts, sites, buildings, structures, and objects that have been determined significant in American history, architecture, archaeology, engineering, and culture on a national, regional, state, and/or local level. The NRHP is administered by the National Park Service under authority of the National Historic Preservation Act of 1966.

Non-Contributing Element: An architectural detail or attributes does not add to the historic architectural qualities or historic association of a district because it was not present during the period of significance, does not relate to the documented significance, or due to alteration, additions, and other changes it no longer possesses historic integrity is considered "Non-Contributing" or "Non-Historic". Non-contributing elements are often introduced either by the addition of new materials or by damage/removal of original elements.

Preservation: The act or process of applying measures necessary to sustain the existing form, integrity, and materials of an historic property. Work, including preliminary measures to protect and stabilize the property, generally focuses upon the ongoing maintenance and repair of historic materials and features rather than extensive replacement and new construction. The limited and sensitive upgrading of mechanical, electrical, and plumbing systems and other code-required work to make properties functional is appropriate within a preservation project.

Rehabilitation: The act or process of making possible a compatible use for a property through repair, alterations, and additions while preserving those portions or features, which convey its historical, cultural, or architectural values.

Significance: The importance for which a property has been evaluated and found to meet the NRHP criteria and retain historic integrity. It may include associations with historic events or people, as well as visual aspects and design features that comprise the architecture of a cultural resource.

State Historic Preservation Office (SHPO): The government agency within each state appointed by the governor to administer the state historic preservation program and carry out certain responsibilities relating to federal undertakings within the state.

Architectural Terms

Bituminous Roofing: A waterproof roofing material composed of bitumen, limestone or sand, polymers, polyester, fiber glass, rag fiber, paper, and minerals.

Building: An enclosed structure with walls and a roof, created to serve some residential, industrial, commercial, military, agricultural, or other human purpose.

Eave: The projecting overhang at the lower edge of a roof

Elastometric Membrane: A rubber-like protective membrane that can be used on various roof types for water-proofing and solar reflectance, important aspects of energy conservation.

Gable: The triangular end of an exterior wall on a building with a ridged roof.

Lintel: A supporting wood or stone beam, used to transfer loads, which is located across the top of an opening such as a window, door, or fireplace.

Masonry: Any brick, stone, and/or concrete units, including those used as decorative elements, used in construction. Historic masonry includes stone, brick, architectural terra cotta, cast stone, concrete and concrete block.

Muntin: A strip of wood or metal separating and holding panes of glass in a window.

Sill: A horizontal piece along the outside lower member of a window that helps keeps water clear of the wall below. The base of a window frame.

Structure: A constructed work, usually immovable by nature or design, consciously created to serve some human activity. This can include, but is not limited to, houses, monuments, dams, roads, canals, bridges, tunnels, boats, stockades, forts, earthworks, Indian mounds, ruins, fences, and outdoor sculpture.

Stucco: An exterior wall covering consisting of a mixture of Portland cement, sand, lime, and water. Modern synthetic construction materials, such as Exterior Insulation and Finishing System (EIFS), commonly known as Dryvit®, are often confused with historic stucco.

Report Summaries

The DoD must achieve greater goals of energy efficiency improvements in both existing and new facilities. Building renovations must be conducted in accordance with sustainability strategies, including resource conservation, reduction, and use; siting; and indoor environmental quality. The reuse of an existing building maximizes resource conservation. Historic buildings, therefore, are inherently sustainable because their preservation maximizes the use of existing materials and infrastructure, reduces waste, and preserves the historic character of older installations. As an example of recent work performed on military installations, below is a summary of recent projects that were funded by the DoD Legacy Program that can be used as guides or examples for further research into understanding the delicate balance that must be made between sustainability and historic buildings.

Department of Defense Legacy Resource Management Program – Project Number 09-452 – Strategies for Greening Historic Properties. Van Citters: Historic Preservation, LLC 08/2010.

Focus: Using DoD and private sector historic buildings to highlight design and construction processes, building systems upgrades, building modifications and alterations, and other practices that could enhance a building's sustainable design, while maintaining the building's historic character.

Purpose

- Identify DoD projects that have incorporated sustainability with the rehabilitation of historic buildings;
- Analyze data of these DoD green projects and similar non-DoD rehabilitation projects;
- Provide information to assist DoD personnel in applying sustainability principals to historic properties.

Findings

- Identify design and construction processes, buildings systems upgrades, alterations, and practices that can enhance sustainable design elements while maintaining historic character.
- Building examples demonstrate that the historic architecture can be maintained even with the introduction of certain sustainability measures.
- Sustainability measures performed on each case study and any impacts or potential impacts of these sustainability measures were noted on the historic character of the buildings.

Key Points

1. Historic buildings have character-defining features, which should be protected and maintained.
2. With proper attention, energy and other sustainability measures can be added to historic buildings while simultaneously protecting historic features.
3. When original character-defining features cannot be preserved, replacements that are sympathetic to the original features can lessen the negative impact of projects on the overall historic character of the property.

Appendix contains other sustainability measures for further study and research:

- Heat Island Effects;
- Acoustics and;
- Construction Waste Management.

Department of Defense Legacy Resource Management Program – Project Number 09-456 – Maintaining Elements that are Efficient by Design (or What's Already Green About Our Historic Buildings). Van Citters: Historic Preservation, LLC 07/2010.

Focus: Sustainable elements of military buildings constructed between 1870 (the beginning of the "modern" US Army) and 1989 (the end of the Cold War era).

Purpose

- Outlines federal statutes and regulations requirements and gives guidance for sustainability and increased energy efficiency for DoD buildings along with policies for the continued use or adaptive use of historic buildings.
- Demonstrate that the requirements can meet federal laws for energy efficiency, sustainability, and the preservation of historic resources.

Findings

- Historic buildings need to be evaluated differently, as being "shades" of green rather than as being green or not green.
- Individual historic building features may be characterized today as "green" or sustainable, but overall, historic buildings were designed to behave differently than modern buildings.

- This study determined that historic DoD buildings should be analyzed as "systems" to determine the original functionality prior to developing retrofits in the name of sustainability.
- Understanding that proposed energy efficiency improvements may reduce the effectiveness of the inherent characteristics of a historic building.
- Understanding how the pieces work together can prevent the energy efficiency team from making changes that negatively affect the overall sustainability of the building, and at the same time can help prevent the energy efficiency team from negatively affecting the historic character of the building.
- The best way to ensure that federal laws for energy efficiency, sustainability, and the preservation of historic resources are met is to understand the existing sustainable elements of historic buildings by conducting a thorough historic preservation and sustainability analysis prior to making alterations.

Key Points

1. Historic and contemporary notions of sustainability should not be directly compared.
2. Historic buildings were designed as "systems."
3. The systemic functions of historic buildings should be carefully studied and understood before energy efficiency and other sustainability improvement measures are taken.
4. When the historic functions and systems of buildings are understood and recognized, modern improvements can be made to improve the energy efficiency and sustainability of historic buildings, and resource managers can meet both the requirements set out in energy policies and historic preservation policies.

Appendix contains supplemental case study information for further study and research:

- Energy Modeling Assumptions;
- Output Matrices;
- Supporting Documentation;
- Reference Standards; and
- Energy Modeling Output Reports.

Department of Defense Legacy Resource Management Program – Project Number 09-451 – A Case Study for Preserving a Department of Defense Historic Building and Achieving LEED Certification for a Major Renovation Project Indiana Army National Guard Stout Field, Building 5. Jayne Aaron, LEED AP, Architectural Historian 03/2011.

Focus: Is it feasible to renovate a DoD historic building to achieve LEED Silver certification and preserve the historic integrity of the building?

Purpose

- To develop strategies to explore whether preservation, sustainability, and energy conservation goals could be achieved, and then to determine the costs, benefits, and tradeoffs of doing so.
- To meet the building program and LEED certification standards and, have "no adverse effect" under Section 106 of the NHPA.

Findings

- Achieving LEED Silver certification and having no adverse effect under Section 106 of the National Historic Preservation Act of 1966, as amended (NHPA) (preserving the historic integrity) to Building 5 was achievable (not considering Antiterrorism Force Protection constraints), both from sustainability and economic perspectives.
- The reuse of an existing building maximizes resource conservation because preservation maximizes the use of existing materials and infrastructure, reduces waste, and preserves the historic character of older installations.

Key Points

1. This information can be used by the INARNG and the architectural team during design of the renovation as a decision-supporting document and a road map if LEED certification is to be pursued in actual renovation of the building.
2. For DoD, this document presents the feasibility and cost analysis for combining LEED certification and historic preservation goals and policies; and lessons learned and recommendations to be carried forward in other DoD construction, planning, and cultural resources management projects.

Appendices contain supplemental information for further study and research:

- Regulations, Policy, Guidance;
- History of Stout Field, Building 5;
- LEED Points, Strategies, and Charrette Groups LEED Score Cards;,
- Green Products Research;
- Project Presentations and Contributors.

Department of Defense Legacy Resource Management Program – Project Number 04-220 – DoD Sustainability Application Guide for Historic Properties. Julie L. Webster and Kathleen S. McQuiggan, ERDC-CERL; Charissa Wang Durst and James G. MacMillan, Hardlines Design Company 05/2007.

Focus: To act as a guide on how to incorporate sustainable design principles and feasible ways that the DoD can utilize LEED-EB criteria on historic buildings they own.

Purpose

- To provide specific discussion and strategies relevant both to historic preservation and sustainable design and development by exploring reuse and rehabilitation of historic DoD buildings instead of demolishing them.

Findings

- Investigating inherent features of historic buildings and sites that support sustainability objectives.
- Conducting a survey of existing LEED-EB qualifying historic building projects and assessing them to determine the best ways of obtaining LEED-EB credits without significantly impacting historic character-defining features.
- Compiling a comprehensive list of sustainable design and development strategies for achieving LEED-EB credits, and developing guidelines for implementing heritage and sustainability design.
- Providing resource lists for obtaining [a] cost issues associated with sustainable design, [b] green products and materials for LEED point accumulation, and [c] information on the LEED certification process.

Key Points

- Sustainable Sites – (Required) Erosion and Sedimentation Control, Age of Building, plus additional credit recommendations.
- Water Efficiency – (Required) Minimum Water Efficiency, Discharge Water Compliance, plus additional credit recommendations.
- Energy and Atmosphere – (Required) Existing Building Commissioning, Minimum Energy Performance, Ozone Protection, plus additional credit recommendations.
- Materials and Resources – (Required) Source Reduction and Waste Management: Waste Management Policy and Waste Stream Audit, Source Reduction and Waste Management: Storage and Collection of Recyclables, Toxic Material Source Reduction: Reduced Mercury in Light Bulbs, plus additional credit recommendations.
- Indoor Environmental Quality – (Required) Outside Air Introduction and Exhaust Systems, Environmental Tobacco Smoke (ETS) Control, Asbestos Removal or Encapsulation, Polychlorinated Biphenyl (PCB) Removal, plus additional credit recommendations.
- Innovations in Upgrades, Operations and Maintenance (i.e., creative solutions)

Appendices contain supplemental information for further study and research:

- LEED-NC Credits Not Covered by LEED-EB,
- Survey of DoD Sustainability Projects;
- Additional Sustainability Resources and;
- The Secretary of the Interior’s Standards for Rehabilitation.

Office and Contacts

Know your Offices and Contacts - List the proper office and position title within each military service at installation and Command/Region levels to contact concerning energy audits, planning, and processes.

Service Branch	Energy Audits	Energy Planning	Energy Processes
Air Force			
Installation Level	CEP: Base Civil Engineering Flight, Asset Management and Operations; REM (CTR); ESCO; UESCO	A7CI/P: Base Civil Engineering Flight, Planning/ Programming	Facility Managers
MAJCOM Level	A7COE: Directorate of Installations and Mission Support, Energy Program Manager	A7COE: Directorate of Installations and Mission Support, Energy Program Manager	A7CA: Directorate of Installations and Mission Support, Energy Program Manager
Army			
Installation Level	G2: Directorate of Public Works Energy Manager; REM (CTR); ESCO; UESCO	G2: Directorate of Public Works Planning/ Programming	Facility Managers
Regional Level	Installation Management Command (IMCOM) G4, Public Works (PW) Energy/Utilities Manager	IMCOM G4, Public Works Planning/Programming	Corps of Engineers Districts and Huntsville National Energy Center
Navy/Marines			
Installation Level	Navy Shore Energy Manager (Public Works Officer (PWO) Asset Management), REM (CTR); ESCO; UESCO	Navy Planning, Programming, and Budgeting System (NPBBS)	Facility Managers
Regional Level	Naval Facilities Engineering Command (NAVFAC) PWO, Asset Management	Navy Planning, Programming, and Budgeting System (NPBBS)	Naval Facilities Engineering Command (NAVFAC) Energy Manager

Additional Resources

Historic Preservation

National Conference of State Historic Preservations Officers - State Information and SHPO List

http://www.ncshpo.org/find/index.htm#VA

National Park Service – Technical Preservation Services - Weatherization

http://www.nps.gov/tps/sustainability/energy-efficiency/weatherization.htm

National Trust for Historic Preservation – Weatherization Guide for Older Historic Buildings

http://www.preservationnation.org/information-center/sustainable-communities/weatherization/

The Secretary of the Interior's Standards for Rehabilitation & Illustrated Guidelines on Sustainability for Rehabilitating Historic Buildings

http://www.nps.gov/tps/standards/rehabilitation/sustainability-guidelines.pdf

National Park Service – Technical Preservation Services - Sustainability

http://www.nps.gov/tps/sustainability.htm

National Park Service – Technical Preservation Services: Improving Energy Efficiency in Historic Buildings

http://www.nps.gov/history/hps/tps/briefs/brief03.htm

36 CFR 800 – Protection of Historic Properties – Section 106

http://www.achp.gov/regs-rev04.pdf

The Secretary of the Interior's Standards and Guidelines for Federal Agency Historic Preservation Programs Pursuant to the National Historic Preservation Act - Section 110 of the National Historic Preservation Act (16 U.S.C. 470)

http://www.nps.gov/hps/fapa_110.htm

Energy

Energy Saving Assessment Training Manual

http://www1.eere.energy.gov/femp/pdfs/esa_manual.pdf

US Department of Energy - Energy Efficiency and Renewable Energy

http://www1.eere.energy.gov/

Vending machine EEM - Vending Miser Store

http://www.vendingmiserstore.com/

Pipe and duct insulation calculator - 3Eplus

http://www.pipeinsulation.org/

Environmental Protection Agency - Watersense

http://www.epa.gov/watersense/

Environmental Protection Agency - Energy Star

http://www.energystar.gov/index.cfm?c=home.index

Energy Star Refrigerator calculator

http://www.energystar.gov/index.cfm?fuseaction=refrig.calculator

Energy Star Windows, Doors and Skylights

http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=WI

CBECS

http://www.eia.gov/consumption/commercial/

CBECS Briefing

http://www1.eere.energy.gov/femp/pdfs/michaels_pres0408.pdf

National Fenestration Ratings Council

http://www.nfrc.org/

US Energy Information Administration

http://www.eia.gov/consumption/

Bibliography

2007

Energy Assessment Training Manual. A practical and hands-on guide to conducting an energy saving assessment audit. US Department of Energy, Washington, D.C.

Energy Independence and Security Act of 2007. Public Law 110–140, 121 STAT. 1492, Dec. 19, 2007.

Code of Federal Regulations (CFR), Title 10, Part 436, Subpart A: Program Rules of the Federal Energy Management Program.

Code of Federal Regulations (CFR), Part 800, Protection of Historic Properties (incorporating amendments effective August 5, 2004)

2002

United States Department of the Interior National Register Bulletin #15: Guidelines for Local Surveys: A Basis for Preservation Planning. United States Department of the Interior, Washington D.C.

2001

Energy Efficiency and Historic Preservation, A Planning Guide for Buildings, Nebraska Energy Office, US Department of Energy, Washington, D.C.

1995

Weeks, Kay D. and Anne E. Grimmer. Secretary of the Interior's Standards for the Treatment of Historic Properties *Guidelines for Preserving, Rehabilitating, Restoring and Reconstructing Historic Buildings. United States Department of the Interior, Washington, D.C.*

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