NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Appropriate EERE applications for Historic Buildings

GovEnergy Conference - 2011

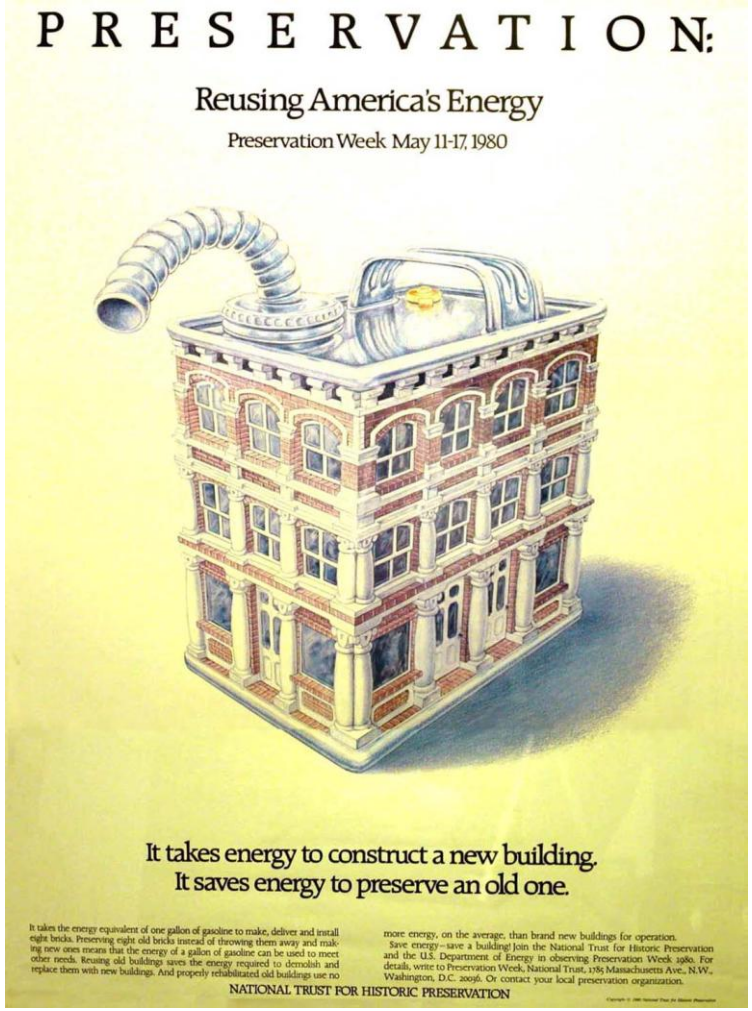
Alicen Kandt

August 8, 2011

NREL is a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, operated by the Alliance for Sustainable Energy, LLC.

Presentation Overview

- Historic Building Considerations
- Energy Efficiency (EE) Technologies
  - Example
- Renewable Energy (RE) Technologies
  - Implementation Process
  - Examples



Historic Building Considerations

- Some, though not all, could have environmental contamination
  - Lead paint
  - Asbestos
- National Historic Preservation Act (NHPA) of 1966:
  - ". . . the preservation of historic properties is in the public interest not only because of cultural, educational, aesthetic, inspirational, economic, and energy benefits."
- Balancing energy projects with NHPA can be delicate
- Also potential state and local historic requirements

Jim Leyshon, NREL

Historic Buildings in the Federal Sector

Statistics:

- 25% of the General Services Administration's (GSA's) 1,600 buildings are on the National Register of Historic Places, and fully 50% are more than 50 years old.[1]
- 30% of the Department of Defense's (DOD's) 350,000 buildings are historic, with a full 69% eligible for this designation within 20 years.[2]

If **a federal agency carries out, approves, or funds** a project affecting a national register listed or eligible property, it must go through Section 106 review.

1. http://misspreservation.com/2010/12/10/general-services-administration-historic-building-program/ Accessed December 27, 2010.
2. http://www1.eere.energy.gov/femp/news/news_detail.html?news_id=10482 Accessed December 27, 2010

Alignment of Energy Efficiency & Renewable Energy with Historic Preservation

- **Utility cost savings** provide more funds for preservation efforts

- **Historic preservation** *vs.* new construction reduces waste
  - Energy embodied in materials is 30% of energy used for entire life of building

- **Historic feature restoration** enhances efficiency: daylight, natural ventilation, shutters, awnings, etc.

- **New technology and infrastructure** can enhance quality of lighting, temperature & humidity, & enhance preservation of the shell and artifacts.

> "The greenest building is one that is already built!"
> -Carl Elefante

Energy Efficiency First

Energy savings = $$$ savings

Applicable to many operations

Often short payback

Non-energy benefits

- Water savings
- Reduced O & M costs

$1 invested in energy efficiency saves at least $2 in renewable energy

Reduce energy loads through:

- Efficient building envelope
- Building orientation
- Renewable energy (architectural)
  - Daylighting
  - Passive solar heating
  - Cooling load avoidance

Meet remaining loads with:

- Efficient HVAC & lighting equipment
- Renewable energy (building equipment)
  - Solar thermal: water heating, transpired collectors
  - Solar electric: photovoltaics, wind
  - Geothermal heat pumps

Restoring Historic Energy Features

Credit: U.S. Department of the Interior.
http://www2.cr.nps.gov/tps/standards/rehabilitation/sustainability-guidelines.pdf

Appropriate EE Technologies for Historic Applications

- Many efficiency measures are invisible, or can be installed in such a way as to minimize visibility
  - Electronic HVAC and lighting controls
  - Efficient HVAC and lighting equipment
  - Insulation
  - Low-flow water fixtures

NREL PIX 07737

Appropriate EE Technologies for Historic Applications

- Measures not visible from street-level
  - Green roofs
  - Efficient roofs
  - Renewable energy

NREL PIX 13397

Applications of EE in Historic Building

National Building Museum, Washington, D.C.

Site Energy Use Intensity (EUI) 143.2 kBtu/ft2 in 2008

- 5% reduction from FY 2006 -2008
- Total GHG CO_2 equivalent savings of 2,709 metric tons

Projects identified

- New chillers, more efficient humidifying system, low ballast factor ballasts, replace halogens with LEDs (almost 400 bulbs), occupancy sensors, T12s-T8s, VFDs, premium efficiency motors, 23% reduction
- EUI 110.8 kBtu/ft^2
  - 23% Reduction

Projects that triggered Historic Preservation Review

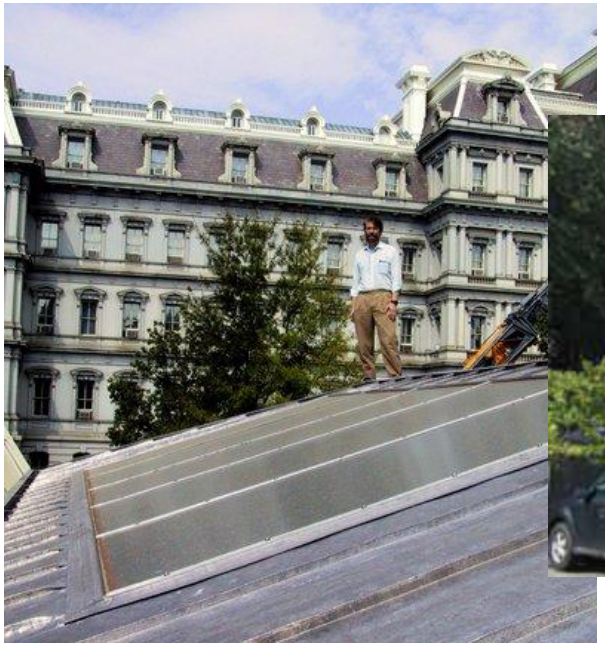
- Double-paned windows
- Revolving door
- Third-floor daylighting
- Exterior façade infiltration
- Solar hot water and PV

Implementing RE on Historic Buildings

Important to consider all applicable requirements

- Federal, state, and local

Project does not necessarily have to be invisible, but it cannot impact the character-defining features of the building



NREL PIX 15663

Credit: U.S. Department of the Interior

Credit: James Lindberg, National Trust for Historic Preservation

Project Background

- Project funded by Department of Energy's Solar Market Transformation Program
- Many Solar America Cities have a large number of historic buildings and districts
- Pursuing solar project implementation sometimes conflicted with historic preservation

Credit: Alicen Kandt, NREL

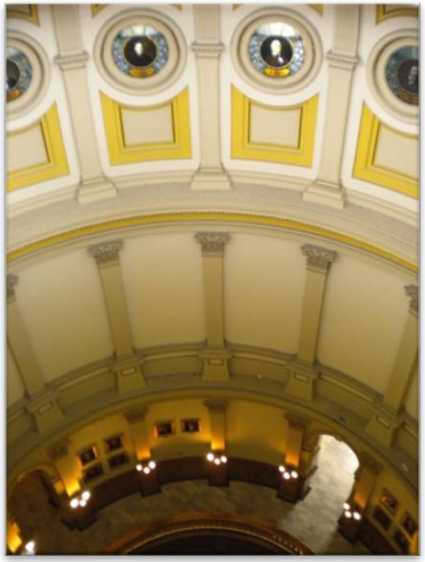
Project Description

Jim Leyshon, NREL

- Identify challenges and recommend solutions for developing solar projects on historic buildings and in historic districts in such a way as to not affect the characteristics that make a building or district eligible for historic status and protection.

Activities to Date

- Workshop
  - Two-day workshop at Denver capitol
  - More than 30 attendees
  - Included tour of capitol
  - Speakers from solar and historic industries
  - Many breakout sessions
- Website
  - www.solaramericacities.energy.gov/solarprojects.html
- Disseminate findings through conference presentations and website
- Development of 'Implementing Solar PV Projects on Historic Properties' paper



Credit: Eliza Hotchkiss, NREL

Process for Implementing Projects

- Identify potential projects and stakeholders
- Engage stakeholders
- Follow appropriate review requirements
- Implement projects
- Evaluate impact of completed project

1. Identify Potential Projects and Stakeholders

- Initial goal-setting exercise:
  - energy reduction or renewable energy use goals
  - LEED certification requirements
  - building owner or tenant motivations
- Identifying project location
  - solutions other than the roof of a historic structure (a carport or a ground-mounted array elsewhere on the property)
  - consider “community solar” and/or more distant solar locations than the site allows
- Determine whether the property has been designated at the local, state, or national levels
  - this will determine which set of stakeholders to engage

Lamar Buffalo Ranch in Yellowstone National Park
Credit: Altair Energy/NREL PIX 07678

Projects will have a greater chance of success with abundant stakeholder contributions and advance logistical and technical considerations.

2. Engage Stakeholders

- Project goals, type, and financing mechanism dictate the type of people who should be involved as stakeholders.

- Section 106 of the NHPA will define the level of federal involvement on a project; however, state and local governments may have separate processes.

- Stakeholders may include the following:
  - adjacent property owners
  - technical assistance providers such as National Trust for Historic Preservation
  - local preservation commissions U.S. Green Building Council
  - state historic preservation officers (SHPOs)
  - tribal government and stakeholders
  - public recipients of grants or funding
  - planners
  - contractors
  - engineers
  - property owners
  - federal agencies
  - non-profit preservation and environmental groups, and/or
  - local government

2. Engage Stakeholders

- Project goals, type, and financing mechanism dictate the type of people who should be involved as stakeholders.
- Section 106 of the NHPA will define the level of federal involvement on a project; however, state and local governments may have separate processes.
- Stakeholders may include the following:
  - adjacent property owners
  - technical assistance providers such as National Trust for Historic Preservation
  - local preservation commissions U.S. Green Building Council
  - state historic preservation officers (SHPOs)
  - tribal government and stakeholders
  - public recipients of grants or funding
  - planners
  - contractors
  - engineers
  - property owners
  - federal agencies
  - non-profit preservation and environmental groups, and/or
  - local government

2. Engage Stakeholders (cont.)

Table: Public agencies responsible for administering historic preservation regulations, designations, and incentives pertinent to solar PV installations on historic properties and in historic districts.

		National Park Service	Advisory Council on Historic Preservation	Tribal Historic Preservation Office	State Historic Preservation Office	Certified Local Government/ Historic Preservation Commission
Regulations	Section 106 of the NHPA		X	X	X	
	State Preservation Law				X	X
	Local Preservation Ordinance					X
Designations	National Register of Historic Places	X		X	X	
	State Register of Historic Places				X	
	Local Landmark					X
Incentives	Federal Rehabilitation Tax Credit	X		X	X	X*
	State Rehabilitation Incentives				X	X*
	Local Rehabilitation Incentives					X

* Some responsibilities may be delegated to the local commission or planning office.
Credit: National Trust for Historic Preservation

3. Follow Appropriate Review Requirements

- Historic preservation review process for solar installations varies according to the type of designation for the property and whether the installation involves a government agency or government property.

- Relevant requirements
  - Section 106 (federal and state equivalent)
  - National Environmental Policy Act (NEPA)
  - local zoning and ordinances
  - local and national code requirements
  - electrical codes
  - structural integrity of properties
  - federal, state and local environmental goals
  - Secretary's standards
  - setback codes
  - Leadership in Energy and Environmental Design (LEED) requirements in certain cities (such as Boston)

- There may also be requirements to meet for funding mechanisms such as grants or incentives or third-party financing agreements, such as Energy Savings Performance Contract (ESPC), Utility Energy Services Contract (UESC), and Power Purchase Agreement (PPA).

4. Implement Projects

- Now that project location, PV technology, and system have been identified, stakeholders identified and engaged, and requirements met, it's time for implementation.
- Consideration should be given to the impact of project implementation and construction on function of building and occupants.
- Ensure that projects are being implemented to maintain structural and historical integrity while ensuring PV projects are installed to maximize generation of energy.

5. Evaluate Impact of Completed Project

- Review criteria to consider three key measures:
  - Energy savings and system performance:

    Did the installation produce the energy savings expected?

  - Impact on historic integrity:

    Did the installation affect the historic integrity of the property? Impacts may include physical impacts on historic fabric as well as visual impacts.

  - Financial impact:

    Was the installation cost effective? Over what period of time?

5. Evaluate Impact of Completed Project (cont)

- Disseminate lessons learned from project:
  - Results of evaluation should be shared with all stakeholders in order to inform future projects.
  - Installed project can be used for outreach and education to the historic and solar communities and the general public.
  - Educational opportunities include print and online outreach documents, in-building real-time displays of PV electricity produced and greenhouse gas (GHG) emissions avoided, Web-based PV system performance tracking, and interpretive displays or verbal tours.

Case Study: CO State Capitol Building

- First LEED-certified capitol building in the U.S.
- 10-kW PV system (approximately 40 panels) on the roof of the capitol
  - Intended as a demonstration project with educational benefits. The attic was converted into an educational area.
  - From the attic, visitors can ascend 99 steps to an interior observation area that provides a 360-degree panoramic view of downtown Denver as well as a view of the PV system.

Credit: Eliza Hotchkiss, NREL

Process Applied

- Identify potential projects and stakeholders

- Capitol building selected as demonstration project due to:
  - Financial mechanisms (performance contract and tax credits)
  - Project timing coinciding with an existing attic educational area renovation
  - Approval by SHPO and Capitol Building Advisory Committee as long as PV panels not visible from grounds of the Capitol

Process Applied (continued)

- Engage stakeholders

- Stakeholders included:
  - Governor's Energy Office
  - SHPO, Capitol Building Advisory Committee
  - Department of Personnel and Administration
  - Energy savings performance contractors
  - PV installers

Process Applied (continued)

- Follow appropriate review requirements

- Requirements met by
  - Ensuring PV panels not visible from Capital grounds
    - Preserving the character and integrity of the historic features
  - Installation can be easily removed/reversed without impacting property

- During construction
  - Weekly meetings were held to discuss progress and ensure observation of all requirements
  - State electrical permit required
  - PV installation validated by Xcel Energy for compliance with their rebate program
  - A LEED consultant reviewed installation as part of certification process

Process Applied (continued)

- Implement projects

- PV system as demonstration
  - Half of PV panels face south, half face west
  - Impacts on panel orientation will be compared by Capitol staff and PV installer
- Funding
  - PV system funded through tax credits and performance contracting
- Length of project dictated by contractual challenges and stakeholder concerns relating to insurance and liability
- Working with community
  - Community was informed of project through approval processes associated with the Capitol Building Advisory Committee and the State Historical Society

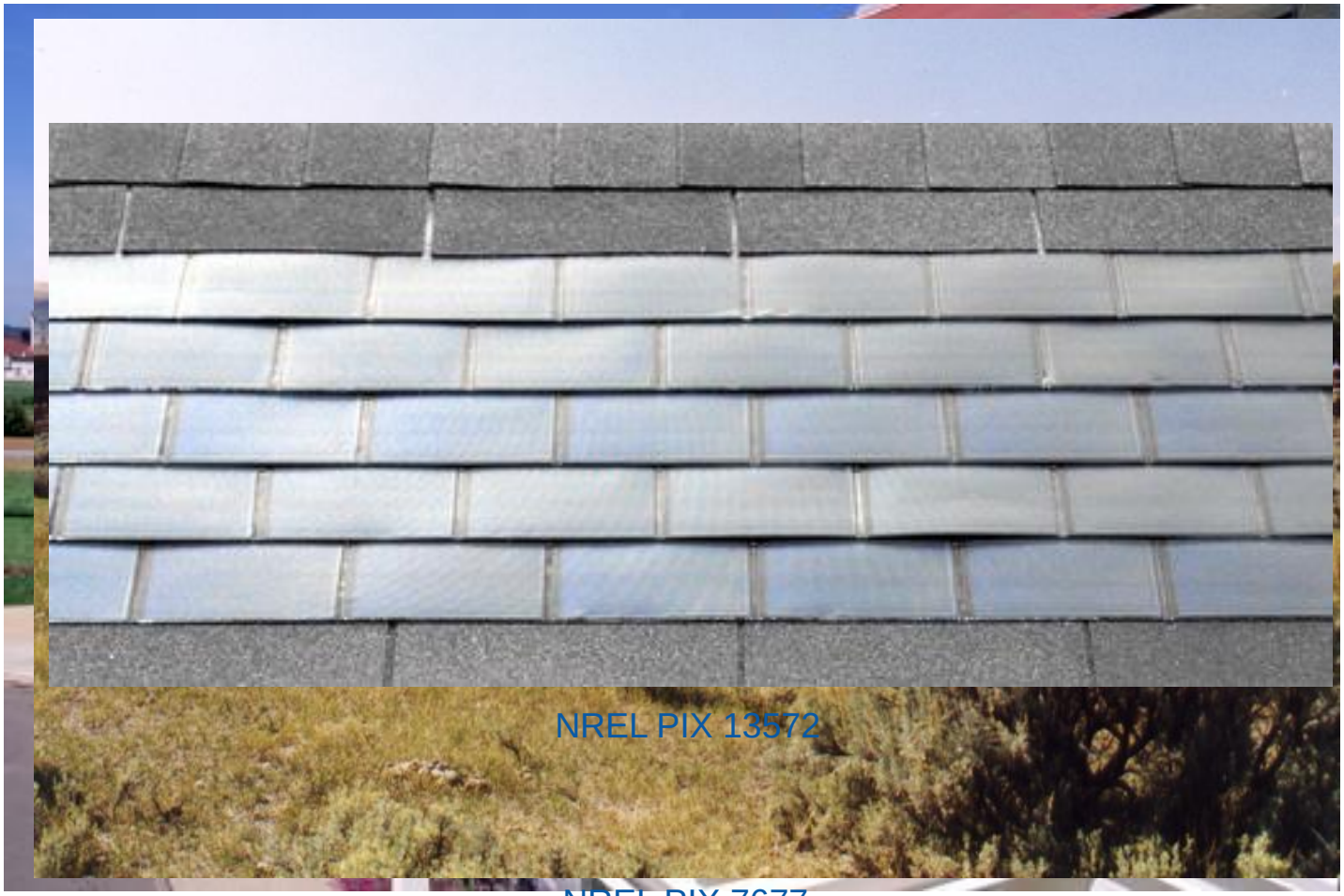
Process Applied (continued)

- Evaluate impact of completed project

- PV system installed as educational feature in attic educational space
  - PV system included in presentation on history of energy usage in Capitol
  - Power generation is monitored through a motion-sensing display in the attic, as well as an online PV monitoring system with secure log-in

- Public, historic community, solar installer, and Governor's Energy Office all had positive responses to project

Appropriate RE Technologies for Historic Applications (PV)



Appropriate RE Technologies for Historic Applications (PV, continued)

Credit all photos: U.S. Department of the Interior

Getting Started

- Define your goals and objectives for energy efficiency and renewable energy use
  - Reduce peak demand, save money, make money, provide a good example
- Get an energy audit
  - Contact your management
  - Contact utility
  - Contact your SHPO
  - Hire audit firm
- Enlist help
  - Within your organization, NREL, private firms, utility, SHPO
- Start to assess potential for renewable technologies
  - Resource maps
  - DSIRE (www.dsire-usa.org)
  - Software programs

Resources

- Advisory Council on Historic Preservation (ACHP): http://www.achp.gov
- National Register of Historic Places: www.nps.gov/nr
- National Trust for Historic Preservation: www.PreservationNation.org
- State Historic Preservation Offices (SHPOs): www.ncshpo.org
- National Alliance of Preservation Commissions: www.uga.edu/napc/
- National Association of Tribal Historic Preservation Officers: www.nathpo.org/
- National Center for Preservation Technology and Training: www.ncptt.nps.gov

Questions?

- Alicen Kandt

  Senior Mechanical Engineer

  National Renewable Energy Laboratory (NREL)

  alicen.kandt@nrel.gov

  (303) 384-7518