NATIONAL FUND FOR SACRED PLACES

QUICK REFERENCE GUIDE | ENERGY EFFICIENCY





Left: Historic chandelier in the sanctuary of Old First Reformed Church, Brooklyn, NY following a full restoration of the light fixture, including retrofitting it for LED light bulbs. Photo by Jane Hively Barber.
Center: Installation of a storm window on the "Christ Blessing the Children" stained-glass window at Central Presbyterian Church, Summit, NJ. Photo by Betsy Philips.
Right: New heat pump units installed along the Baltimore Avenue alley behind Calvary United Methodist Church, Philadelphia, PA that allow for spaces within the building to have individualized climate control. Photo by Tim Emmett-Rardin.

ENERGY EFFICIENCY

Historic buildings were often constructed using methods and materials that responded to local climate conditions. In colder climates, they were designed to reduce heat loss by using materials with thermal mass, clustering low-ceilinged rooms around a central chimney, and limiting window openings to what was needed for light and ventilation. In warmer climates, they were designed to reduce heat gain by using tall ceilings, porches, large roof overhangs, and windows positioned to promote cross ventilation. As mechanical heating, ventilation, and air conditioning systems were integrated into buildings, it became less common for buildings to be designed with the local climate in mind. Today, buildings are the United States' largest source of carbon emissions, and according to the U.S. Green Building Council, building operations (heating, cooling, and powering) account for 27% of carbon emissions in the United States. Carbon emissions act as an atmospheric blanket that traps heat and causes global climate change.

Historic buildings not only have embodied energy that can be saved by preserving the building, but they can also be updated or retrofitted to improve their energy efficiency and reduce their carbon emissions. There are numerous energy retrofit options for historic properties, ranging from traditional techniques to new technological innovations. When deciding which energy retrofits to use, it is important to consider their impact on the historic property's materials and features. Achieving a successful retrofit project requires balancing energy-efficiency goals with the protection of the historic building's character-defining features.

Embodied energy in buildings is the total amount of energy used through the entire lifecycle of a building – including raw materials extraction, manufacturing, transportation, on-site construction, maintenance, and final demolition.

GENERAL RECOMMENDATIONS

All projects funded by the National Fund for Sacred Places must respect the property's historic character and materials, and must adhere to the Secretary of the Interior's Standards for Rehabilitation. Below are general recommendations for updating historic buildings to be more energy efficient, but they do not cover all the specific recommendations. Reference the resources in the section below for more detailed recommendations.

- **CONSULT:** Consult with an integrated team of preservation professionals and sustainability experts to develop a holistic plan to improve a historic building's energy efficiency.
- **ASSESS:** Assess the historic building's existing sustainable features (such as shutters, storm windows, awnings, porches, vents, roof monitors, skylights, light wells, transoms, naturally lit corridors, thermal mass, etc.).
- **MAINTAIN:** Regularly maintain historic buildings to preserve historic materials and maximize the building's existing sustainable features.
- **ENERGY AUDIT:** Perform a professional energy audit or energy modeling to understand the historic building's existing performance and establish a baseline of building performance data to serve as a reference point for evaluating future energy improvements.
- **PLAN:** Develop a holistic energy efficiency plan based on the energy analysis that considers the entire building envelope, its systems and components, its site, and environment, and carefully evaluates the effects of the proposed treatment measures and their impact on the historic building. Prioritize minimally invasive improvements to reduce energy use (such as installing fixtures and appliances that conserve resources, including new energy-efficient light fixtures, energy-efficient lamps in existing light fixtures, low-flow plumbing fixtures, or sensors and timers that control water flow, lighting, and temperature) before installing more invasive treatments that may negatively impact the historic building.
- **DAYLIGHTING:** Retain features that provide natural daylight into historic buildings (such as windows, skylights, roof monitors, light wells, transoms, partial glass partitions, and glazed doors). If the historic features have been blocked, reopen them. Repair or reopen historically operable interior transoms, when possible, to improve daylighting in corridors, airflow, and cross ventilation. Install automated daylighting controls on the interior lighting system to balance indoor lighting with daylight while maintaining adequate light levels.
- **WINDOWS:** Regularly maintain historic windows to ensure they function properly and operate. Replace or install weatherstripping, as appropriate, to make the existing windows weathertight. Install exterior or interior storm windows or panels that are compatible with existing historic windows to improve their energy efficiency. If existing windows are too deteriorated to repair, install compatible and energy-efficient replacement windows. Refer to the Quick Reference Guide on Historic Windows for more information.
- **DOORS:** Regularly maintain historic doors to ensure they function properly. Replace or install weatherstripping, as appropriate, to make the existing doors weathertight.

- **AIR LEAKS:** Close or seal gaps and penetrations in the building envelope to limit uncontrolled airflow, including penetrations for utilities and building systems (piping, wiring, lighting, and ductwork), attic or roof access points, and chimneys. Pair any air-sealing efforts with strategies to increase ventilation, because it is important not to over seal historic buildings. Most historic buildings were not originally designed to be airtight, and they rely on natural ventilation to manage interior moisture and prevent it from becoming trapped within walls.
- **INSULATION:** Analyze the inherent thermal properties of the historic building materials and determine the building's insulation needs based on the specific climate and building type. If new insulation is needed, identify the appropriate insulation type and the correct installation methodology. The chosen insulation type should not trap moisture within the building assembly, conceal potential leaks, hide deteriorated structural systems, damage historic building materials during installation, or be difficult to remove in the future. For instance, mineral wool batt insulation meets these qualities, while spray foam insulation has different qualities that may not be appropriate for historic buildings. Install insulation in unfinished spaces first (such as attics, basements, and crawl spaces) and see whether it meets the overall goal of improved thermal efficiency. If additional thermal improvements are needed, work with qualified preservation professionals (such as a preservation architect or engineer) and building science professionals with experience working on historic buildings to determine whether insulation can be installed in the exterior walls. It is important that all moisture-related problems be addressed before installing wall insulation. When installing insulation in finished spaces, limit the removal of historic materials and reinstall finishes in their original locations after the insulation has been installed. It is not recommended to fully remove historic materials on the exterior or interior face of historic walls to install insulation, because it can permanently destroy character-defining features and historic materials and change the overall character of the historic building.
- **SITE FEATURES:** Add natural, sustainable features to a historic site (such as shade trees), if appropriate, to reduce cooling loads on the historic building. When adding new sustainable features, respect important cultural landscape and/or significant character-defining site features.
- **ELECTRIFICATION:** Replace gas- and oil-fired systems and equipment (such as heating, water heating, and cooking) with high-efficiency electric alternative powered systems to reduce the historic building's total carbon emissions. This can include replacing a combustion-based heating system with an electric heat pump, installing an electric heat pump water heater, and installing electric appliances (such as an induction cooktop). Work with an electrical engineer or licensed electrician to determine whether the historic building has sufficient capacity for the additional electrical load or whether the electrical service needs to be updated.
- **MECHANICAL/HVAC SYSTEMS:** When replacing existing HVAC systems, install a new energy-efficient system that considers the entire building's performance and retains the historic character of the building and site. Seal all connections in a ducted system and adequately insulate the ducts and pipes, especially in unconditioned spaces. Commission and regularly assess the performance of the HVAC system to ensure it operates efficiently. Refer to the Quick Reference Guide on Mechanical/HVAC Systems for more information.

- **SOLAR TECHNOLOGY:** Analyze whether solar technology can be used successfully to benefit the historic building without compromising its character-defining features, site, or surrounding historic district. Install solar technology in compatible locations on the site or building (such as on the rear portion of the roof or on a non-historic building or addition) that will not negatively impact the historic property. Install low-profile solar devices on historic buildings so they are not visible, or only minimally visible, from the public right-of-way. Install solar technology in a manner that does not damage historic roofing material and is reversible.
- **WIND-POWER TECHNOLOGY:** Analyze whether wind-power technology (such as wind turbines and windmills) can be used successfully and benefit a historic building without compromising its character-defining features, site, or surrounding historic district. Install wind technology in appropriate locations on the site so that it will not negatively affect the historic property.
- **COOL AND GREEN ROOFS:** Analyze whether a cool or green roof is appropriate for the historic building. Cool roofs are generally not practical in northern climates where buildings benefit from the added heat gain of dark-colored roofs during colder months. Install cool or green roofs only on flat-roofed buildings so they are not visible from the public right-of-way and do not negatively impact the historic property. Before installing a green roof, ensure that the historic building can structurally accommodate the added weight and is watertight.

RESOURCES

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

Preservation Brief #3: Improving Energy Efficiency in Historic Buildings

Energy Efficiency, Sustainability, and Green Building Practices in Historic Buildings, National Park Service

Weatherization of Historic Buildings, National Park Service

Cutting Carbon: Resources for Preservationists by Jim Lindberg, National Trust for Historic Preservation

National Trust for Historic Preservation Green Stories